MICROANALYTIC SIMULATION AND THE DEVELOPMENT OF SOCIAL ACCOUNTS*

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I. INTRODUCTION

The social accounting "movement" has spawned considerable strategy debate, much of it ranged across two competing positions characterized as "theorist" vs "inductivist":

> To sum up, if not caricature, the two positions: The "theorist" says, "Let us think long and hard about what we want to measure and why. Then we will feel confident about what ought to be done by way of making observations." The "inductivist" responds, "Let us see if we can measure something, for whatever reason, and standardize our measurements so that we achieve an acceptable level of reliability. Then let us study how the quantity being measured behaves." (Duncan, 1969, p. 9)

In the same article, Duncan recommended an "inductivist" priority for social reporting efforts to be directed at the measurement of social change by means of replicating important "baseline" studies, such as the 1962 O.C.G. survey, Project Talent, the 1965 E.E.O.S., et al. An "inductivist" bias can be a necessary corrective to the measurement paralysis which often stems from preoccupation with theoretical frameworks. For example, insofar as certain "theory"-oriented definitions of social indicators as components of models (Land, 1971; Wilcox and Brooks, 1971; Anderson, 1973) are understood to mean that only those variables included in precisely specified models deserve attention and measurement, the price may be a loss in that richness of the data base which often leads to improved modeling efforts.

Nevertheless, these allowances having been made, it remains true that a role in a system of relationships enormously enhances the usefulness of a social indicator. Although initially simply measuring a criterion variable may be of interest, such measurement usually stimulates interest in influencing the indicator for the better, i.e., in policy guidance. And to raise the question of the effect of various policies on a criterion almost always leads beyond the simple policy-to-criterion relationship. Intervening contingencies more proximate in time or in the causal chain (usually both) to the policy instruments must be included in the model. Some of these contingencies, because of their effects on the initial indicator, may themselves gain meaning as social indicators. Policy analyses must also take account of unintended consequences to other criterion variables, whether flowing directly from the policies or indirectly from one or more intervening contingencies. As models specifying the relationships among indicators of states of social systems are improved to take account of these complexities, the indicators themselves assume more meaning and offer more useful policy guidance. It is towards such social accounting and policy guidance purposes that our modeling efforts have been directed.

However, the purpose of this paper is not to simply urge more inductive modeling efforts but rather to suggest the advantage of a particular modeling paradigm. This approach - a dynamic, microanalytic model of family and person behavior coupled with an auxiliary model of the national economy - has been developed in a series of papers by Orcutt (1957, 1960, 1968). A partial realization of the approach constructed in the late 1950s was described in Orcutt, et al. (1961). The suggestion to apply this modeling paradigm to social accounting was first broached by Sprehe and Michielutte (1969). Our purpose is to further emphasize the advantages of the microsimulation paradigm for social accounting purposes.

II. THE URBAN INSTITUTE MICROANALYTIC MODEL

A full description of the model and of certain experiments performed with it is given in a forthcoming volume (Orcutt, et. al., forthcoming). Only a brief description, drawn from the volume, is given below.

The Urban Institute microanalytic model of the U.S. population takes a sample representation of the U.S. population at some point in time and modifies the sample in ways which simulate the behavior of individuals and families in the population over a year's time. The result is a new sample representation of the population one year later. Both the number and characteristics of persons and families in the sample are changed. This new sample can then be modified by the model a second time, and so on.

The sample population, moved forward in time by applying the microanalytic household model, is comprised of three types of entities: persons embedded within nuclear families which in turn are embedded within interview units. For purposes of the paper, a nuclear family consists of either an unmarried person or a couple with own children, if any, still living at home. An interview unit consists of one or more nuclear families, related by blood, marriage or adoption and residing together.

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The microanalytic model is composed of an interrelated set of processes, or operating characteristics, each of which embodies a set of behavioral or accounting relationships that specify, for each entity, the outputs generated by that entity given inputs into the entity and its previous state. The current microanalytic model consists of four broad groups of operating characteristics: (1) demographic, including leaving home, divorce, birth, death, aging, marriage, education and geographic mobility; (2) labor, including labor force participating, occupation, hours in the labor force, unemployment, hours worked and wage rate; (3) taxes and transfers, including private intergenerational transfers; and (4) income and wealth of nuclear families including nuclear family consumption, wealth accumulation and income from wealth. Work on, and implementation of, the above last two groups of operating characteristics is still at an early stage of development.

Running along with the micro model is a small macro model which is linked to the micro model by means of a time series data bank. The primary function of the macro model is to link macro variables, such as GNP and the GNP price deflator, as well as micro variables, such as labor force participation and unemployment of persons, to macro-policy actions as embodied in the realized level of unemployment. Data from the time series data bank can be used to influence how the micro model updates information about the sample and can, in turn, be modified by summary information drawn from the micro population data arrays. For example, the total number of persons simulated to be in the micro population can be stored in the time series data bank each year. The macro model can also send information to and receive information from the time series data bank. This entire computerized structure is called the Microanalytic Simulation of Households system (MASH).

III. APPLYING THE MODEL

Experiments with the model can be performed to explore the effects over time of particular alterations in one or more initial conditions, specifications or parameters. These experiments may be intended to simulate the impact of either a deliberate public policy or an ongoing socioeconomic trend outside the control of public policy. Experiments are performed as follows. First the behavior of the population is simulated for the years of interest with the "standard" set of operating characteristics. The simulation is then repeated over the identical period beginning from the same initial population but with certain alterations in the model. Any differences in output between the two runs are, within certain confidence intervals dictated by sampling variability, attributed to the alterations. In this way predictions of the effects of a range of potential policies can be made as a partial basis for policy selection. Of course, the accuracy of the predictions depends entirely on the validity and scope of the understanding built into the model.

Since samples of microunits are used to represent corresponding populations (of families, sub-families and persons), the range of potential output from an experiment is limited only by the scope of the variables describing the microunits. At any stage in the simulation the sample of families and individuals can be read into a compatible package of analysis routines. Output from "control" and "experiment" simulations can thus be compared in great detail.

The ability to perform experiments using the model greatly increases its usefulness for social accounting. For most social and economic indicators, some, if not all, of their claim on our attention is due to their impact on other variables. This is most obviously the case with macroeconomic indicators, whose importance rests ultimately on their presumed connection, however indirect, with the welfare of individuals. But it is just as true for micro-level indicators. They also derive at least some of their importance from their presumed effects on other indicators. Thus, to specify the effects of being in a particular status is to clarify the importance of indicators of that status. An example is the social indicator 'marital status'. Whether, if considered somehow in isolation, differences in marital status imply differences in individual welfare is problematic. But to the extent systematic relationships between, say, age at first marriage, and longevity, income, fertility, occupational mobility and other variables are uncovered, then to that extent marital status also becomes worthy of attention as a social indicator. A social accounting framework must incorporate the linkages between indicators, so that the implications of changes in particular indicators will be apparent.

To illustrate the use of the microsimulation model to explore the effects of changes in a given social indicator, we present selected results from an experiment performed on the model. The experiment was conducted to explore the implications of a sharp change in the pattern of age at first marriage. Although it is certainly possible to conceive of public policies having effects (probably unintended) on first marriage patterns, it is more appropriate to view the experiment as simulating a social change (change in a social indicator) over which public policy may have little control but whose consequences such policy may have to take into account. Since such social changes are continually modifying the policy environment, alleviating some problems, worsening others and creating entirely new ones, it is just as important for the purposes of policy analysis to be able to predict the consequences of nondeliberate, as of induced, social changes (i.e., changes in social indicators).

Both the "control" and "treatment" used an initial population drawn from the 1960 census and both generated ten years of simulated behavior. In the treatment the equation generating first marriage probabilities was altered so that all never-married persons were assigned a first marriage probability equivalent to the

one assigned to a person four years younger in the control. The effect of this alteration is to shift the age pattern of first marriage four years to the right, while preserving differentials by age, race, sex, education and marital status. Table 1 presents selected differences between control and treatment. Significant differences were found for the number of marriage, divorces and children involved in divorce, births, and deaths, and also for the total persons in the labor force, total employment and gross national product. The results depend, of course, on the validity of the causal assumptions embedded in the model.

TABLE 1

FOUR YEAR DELAY IN AGE AT FIRST MARRIAGE EXPERIMENT

$$[\%\ \text{change in } X = \frac{\text{experiment-control}}{\text{control}} = a_o + a_1\ (\text{YEAR} - 1960)]$$

X	a_o	a_1	Total Impact over the entire period 1960-70
Marriages			
(t-statistic)	-43.73	2.27	-5,851,000
	(34.6)	(10.6)	
Divorces	-3.18	-2.65	-784,000
	(0.3)	(10.0)	
Births	-5.62	-3.02	-6,882,000
	(1.1)	(8.2)	
Deaths	-0.42	-0.62	-590,000
	(0.4)	(7.9)	
Total Population	0.20	-0.39	-6,292,000
	(8.1)	(33.2)	
Children in Divorce	0.31	-2.62	-832,000
	(2.8)	(15.7)	
Female Headed Families	-8.57	0.90	*
	(1.5)	(.9)	
Total Persons in Labor Force Any Time	-0.64	0.15	296,000
	(7.4)	(8.8)	
Total Employment	-0.64	0.14	250,000
	(7.6)	(8.6)	
Average Earnings of Full-Time Black Males	-2.80	1.44	*
	(1.3)	(2.8)	
GNP	-0.61	0.01	-$39.9 billion
	(5.6)	(0.4)	

*Impact considered not significant if t-statistics for both slope and intercept are <3.0.

Experiments such as this in effect explore the importance of various social indicators. The age-at-first-marriage indicator gains importance, for example, insofar as age-at-first-marriage has an effect on such variables as employment, fertility, children involved in divorce and gross national product. Finally, insofar as we can link some public policy to a change in first marriage behavior, we can explore the secondary policy implications flowing from that linkage. In this way the model functions as a social accounting system relating public policies or social trends to changes in other related criterion variables.

IV. THE MICROSIMULATION PARADIGM FOR SOCIAL ACCOUNTING

In this section we summarize what we believe to be the major advantages of the approach described above for social accounting.

A. Microanalytic Focus. By directly representing individuals, nuclear families and families, the micro analytic model can directly treat distributional questions. Certainly questions of the distribution of benefits and costs of alternative policies are among the most important policy analysis ought to treat.[1] Moreover, micro representation enables indicators for very detailed subpopulations to be presented simultaneously with indicators for larger populations. Decisions between aggregate vs. disaggregate indices can be alleviated in certain cases by presenting indicators for several levels of aggregation at once. Micro representation also makes it possible to utilize research results concerning micro units. The far greater number of microunits than of macrounits means that problems of hypothesis testing and parameter estimation are somewhat less severe.

B. Realism of the Model. Solving the microanalytic model using simulation techniques imposes certain costs, but it also means that many fewer concessions need be made in the specification of relationships than is the usual case when models are solved analytically or using the numerical transition matrix approach. (This advantage of course follows from the solution mode, not the level of analysis.) Parsimony and elegance can be subordinated to the real needs of policy analysis - validity and predictive accuracy. The potential realism of the model is therefore greater. Analytic approaches, though preferable, are currently infeasible when nonlinearities, feedbacks, and other complexities are introduced. Transitional matrix approaches quickly become intractable as the number of dimensions describing the state of the population increases. By in effect having one function to predict change in each separate dimension, the problem of estimating an enormous number of transition probabilities as the number of categories and dimensions increases is avoided.

C. Output Capabilities. Each simulation in effect creates a simulated public use sample. This method of representing joint frequency distributions has considerable advantages as indicated by the increasing use of public use samples by the Census (Orcutt, 1973). Moreover, the model generates life history data for each micro unit, including, if applicable, characteristics of its unit of origin. Thus, suitable

[1]The particular focus of the Urban Institute model is the distribution of disposable income and of wealth among families and individuals in the U.S.

interrogation after a generation of simulation would produce data that would serve as a check on the validity of the intergenerational relationships embedded in the model. The possibilities of developing a dynamic model of inter- and intra-generational mobility are greatly increased.

D. Macro-Micro Linkages. The presence of the auxiliary macro model creates the capability of exploring distributional implications of major macroeconomic changes, including those induced by monetary and fiscal policies. Moreover, individual and family decisions affect macroeconomic variables. Currently these linkages are primitive, but the presence of both levels in the same model at least poses challenging questions of linkage between individual and national decisions.

E. Comprehensiveness. The Urban Institute model provides a framework in which to imbed a great deal of interdisciplinary research. The model functions, however, as a core model. Linkages to particular policies must be added using further evidence from evaluation studies, experiments, and analyses of non-experimental data. Given the additional links, the model can be used to explore the impacts of a particular policy on a wide range of criterion variables. The model's unusual breadth does not, of course, eliminate the need for ceteris paribus assumptions but it broadens the amount of information generated by each simulation experiment. One useful by product might be an increased sense of coherence and interrelatedness to existing knowledge.

F. Direct Focus on Change. The model is dynamic. It generates individual and family histories directly and consistently. Distributions of the population by various characteristics are the natural outcomes of the trajectories of its components. The paths by which change can be influenced are thus directly incorporated.

V. CONCLUSION

Certain advantages of the microanalytic paradigm are of course shared by other approaches. But the combination of features of the microanalytic paradigm makes it quite attractive for social accounting and related policy analyses. Work is continuing on improving the specification and estimation of the relationships in the present model. We hope the present model is a useful first step toward a major social accounting and policy analysis tool.

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