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ABSTRACT

This paper focuses on partial models for solving urban problems to contrast our achievements as social scientists with our aspirations as prescribers of public policy. The objectives of this paper are (1) to review some of the reasons that an ideal set of solutions for urban problems has not been produced by social scientists and (2) to describe two efforts currently underway at the Urban Institute to arrive at useful, if not ideal, answers. An ideal methodology for seeking answers to urban problems would incorporate the principle that nearly everything is related to everything else. Thus the model would be interactive in the sense that a given variable could be both an independent variable and a dependent variable to allow for "feedback effects". The urban metropolitan area and its population would be regarded as a complex organism in which a diverse set of outcomes would follow from the decisions of various subsets of decision makers, each subset complying with known behavioral relationships within specified constraints. Another paradigm for this kind of modelling effort is a micro-analytic simulation model. The methodological base for this type of modelling is the assignment of behavioral characteristics to individual micro-units according to known probabilities of occurrence of those behavioral characteristics within identifiable subgroups of the population. (Author/JM)

Some Partial Models for Urban Problems

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This paper focuses on partial models for solving urban problems to contrast our achievements as social scientists with our aspirations as prescribers of public policy. The lack of congruence between aspirations and achievements should not surprise anyone; if urban problems had easy solutions we would have known the answers long ago. The objectives of this paper are (1) to review some of the reasons that an ideal set of solutions for urban problem has not been produced by social scientists and (2) to describe two efforts currently under way at the Urban Institute to arrive at useful, if not ideal, answers.

An ideal methodology for seeking answers to urban problems would incorporate the well established principle of economics, and perhaps all social sciences, that nearly everything is related to everything else. Thus the model would be interactive in the sense that a given variable could be both an independent variable and a dependent variable to allow for "feedback effects." The urban metropolitan area and its population would be regarded as a complex organism in which a diverse set of outcomes would follow from the decisions of various subsets of decision makers, each subset complying with known behavioral relationships within specified constraints. This kind of model would be similar to the aggregative econometric models developed over the last 30 years which have led to modest successes in understanding our national economic system.

Another paradigm for this kind of modelling effort, perhaps less well known, is a microanalytic simulation model such as the one developed by Guy Orcutt and his colleagues at the Urban Institute. The methodological base for this type of modelling is the assignment of behavioral characteristics to individual micro-units (persons, families, households) according to known probabilities of occurrence of those behavioral characteristics within identifiable subgroups of the population. For example, the national annual mortality rate for white males, age 80, is .20. In running a simulation model 20% of the subgroup, white males, age 80, would be expunged from the population.

The building blocks for the construction of a microanalytic simulation model are the "operating characteristics," a term used to describe the set of probabilities or regression equations by which the probabilities of occurrence of behavioral events can be determined for specified subgroups. One operating characteristic, for example, may determine for married females the probability that they are employed. Another operating characteristic would determine, for those married women imputed to be employed, a range of earning rates.

The microsimulation model currently under construction is based, not on the urban population, but a national population. The purpose of the model is to provide a tool for national policy analysis. The model operates by using as original input a national cross-section data base, such as the public use samples of the 1970 census. The elements of the population are then up-dated annually, by Monte Carlo type imputation, according to the operating characteristics for each behavioral event. The operating characteristics in our model include: births, deaths, marriage, separation and divorce, spatial mobility, education, labor force participation, employment, earnings, transfer payments, yield on assets held by the family, Federal personal income tax liability, savings, changes in portfolio composition, and bequests.

Thus there are at least two paradigms of fairly complete models: the macroeconomic simultaneous equation system and the microanalytic simulation model. Some major methodological characteristics of these paradigms should be noted:

1) The simulation model just described is very comprehensive with respect to the household sector, but, unlike aggregative econometric models it does not, in its present form, try to include the interaction of the household sector with other major sectors such as financial, production, or government sectors. Theoretically it could be expanded to a complete model.

2) The level of analytical unit is also important. The history of aggregative econometric models reveals steady disaggregation from fairly simple models of relatively few equations to models with many equations. The microanalytic simulation technique starts at the other end of the spectrum with the individual element and then aggregates analytically by forming significant subgroups by way of operating characteristics. This characteristic is very important for policy analysis because many of our more important policy questions concern specific subgroups of the population, e.g., youth, the poor, the aged, employed females, etc.

3) Econometric models of the simultaneous equation type require closure of the model, partly through the simple counting of endogenous variables and structural equations and partly through statements of equilibrium

conditions, e.g., that supply equals demand, or saving equals investment. Some level of closure can also be built into microanalytic simulation models. Indeed, the model described here has such components.

4, Both aggregative econometric models and microanalytic simulation models require a very large investment of research effort to establish the equations or the operating characteristic that provide the framework of the models. These models rely heavily on an infra-structure of theory and empirical research extending over many past years.

5) Finally, both model types are voracious in their data needs. Aggregative econometric models require extensive time series data taken from national accounts and related sources. Microanalytic simulation requires intensive analyses of census and cross-section sample data. The longer the time period for which such data are available, the more comfortable we might feel about projections made from the model.

If we should accept these methodological criteria as one way of expressing our aspirations as social scientists how well prepared are we to seek satisfactiory answers to questions about urban problems? Policy-makers want to know what they can and should do about urban growth or decline, about how their revenues can be changed, about how their expenditures should be allocated and used efficiently, about land use patterns, about transportation systems, about desirable industrial mixtures, about housing patterns and policies, etc. I would argue that ideal policy prescription can be achieved only when we can cope analytically with the facts that (1) policy-makers do not have single objectives but multiple, sometimes conflicting, objectives and multiple constraints, and (2) that the policy questions used above as examples are inter-related by complex interactions. Starting analysis on one policy question, say transportation planning, simply leads to other questions and constraints such as land use patterns, industrial mix and location, housing policy, and certainly, competing uses of public expenditures.

Apart from the problem of inter-relatedness which is a serious impediment to designing an ideally structured analytical model of cities there are other formidable obstacles to the feasibility of comprehensive urban modelling. First, urban areas are highly heterogeneous and to generalize from specific places to others may be a dangerous public policy game. Second, even for specific urban areas the data bank available for empirical testing of hypotheses and models is exceedingly thin. It is difficult to conceive, on the one hand, of building a comprehensive model for each urban area (because they are unique) and, on the other hand, gathering the data that such models would require for testing and estimation.

Given these obstacles to realizing fulfillment of ideal model-building conditions it is still possible to build useful partial models - those that close out major parts of an interactive system. Two such partial models currently being developed at the Urban Institute serve as examples. The first is a simutaneous equation model of population growth and employment in urban areas. This model has been developed by a team under the direction of Joel Bergsman. The second is a simulation model of the demand for and supply of housing in urban areas. This effort has been directed by Frank deLeeuw. The following description of the models draws heavily on the writing of Bergsman and deLeeuw.

The population-employment model has as its ultimate goal the production of planning models to help design and evaluate alternative urban growth strategies. Thus alternative laws and regulations could be introduced as parameters and the relative efficiency of the laws and regulations toward attaining desired social goals could be evaluated. Two assumptions about population policy are basic to the research effort. The first assumption is that the economic structure of urban growth is just as important as the fact of accretion of people as a source of problems related to congestion, environment deterioration, and social discontent. The second assumption is that we must understand the economic and social forces that have produced the current distribution of the nation's urban population before we can effectively develop programs designed to change the distribution of population or programs that attempt to deal with the impacts of growth.

The evolution of modern research on urban growth began with two hypotheses considered to be alternative independent propositions: (1) that jobs move to people and (2) that people move to jobs. In the one case the location of industry and employment was explained by measuring known variation in population. In the other case migration of people and size of population in urban areas was explained by known variation in the employment possibilities available. While each of these propositions may be true in some sense the knowledge gives little guidance for planning because it leaves open the question of what determines the known variation in either population or employment possibilities. More recent research has demonstrated that either single equation approach yields results that are not only of little policy value but are biased as well. Thus the kind of simultaneous equation model described here is the logical next step in research related to urban growth policy.

The scope of the model includes over 300 Standard Metropolitan Statistical Areas and other smaller places for which the required data could be obtained. One important feature of the population sector of the model is the disaggregation of the population into demographic groups defined by age, sex, race, and education. Separate equations are specified for each demographic group. This allows the structure of the population to interact with the employment sector of the model. The employment sector is disaggregated into 490 industries defined by four-digit categories of the Standard Industrial Classification code.

The population sector is specified by four sources of population change: births, deaths, in-migration, and out-migration. The determinants of births and deaths were judged to be already well established and consisted primarily of the demographic composition of the area. New equations describing the determinants of in and out-migration required specification.

Changes in population due to in-migration are hypothesized to result from four major kinds of effects: economic opportunity; closeness to sources of in-migrants; presence of friends, relatives or similar people; and other attractions.

Economic opportunity is represented by change in total employment, relative wage rate, and relative level of welfare and other benefits in the form of transfer payments. Closeness to sources of in-migrants requires experimentation with functions measuring distance to other places and the demographic composition of the other places to identify those with the highest propensity to move. The presence of friends, relatives, or similar people is measured in proxy form for any given demographic group by the number of in-migrants of the same demographic groups in a preceding period.

Other attractions included are a measure of how temperate the climate is, and identification by dummy variables of a few cities that offer unusually favorable retirement facilities.

Out-migration from a given city for each demographic group is hypothesized to depend on the size of the city, change in total employment, relative wage rate, relative unemployment rate, relative level of welfare and other benefits in the form of transfer payments, and the other attractions of amenity of climate. The complete change in population for any city is then the sum of births and deaths (given exogenously) and in-migration and out-migration.

The employment sector of the model is based on previous research by Joel Bergsman and others. They began with employment data for 490 industries in each of 311 SMSA's and smaller places and developed methods for aggregating industrial classes into clusters that were locationally homogeneous. This is quite different from merely collapsing sectors of the Standard Industrial Classification codes and, for example, prevents the combination of employment in motor vehicles, aircraft, and boat building, into the "transportation equipment" sector of the SIC. The locationally homogeneous clusters can be aggregated, with some necessary loss of similarity, into 30-40 employment groups for each of which an employment model is to be specified.

The employment model hypothesizes that changes in employment for a given industry are associated with level of employment and recent growth in employment in the industry, population of the city in which the plant is located, change in personal income in the locality to measure local aggregate demand and change in personal income in other places (weighted by distance) to measure potential external aggregate demand. Another set of hypotheses accounts for employment generated by inter-industry trade, the appropriate linkages between firms being supplied by input-output coefficients. Here it is the distance between the given firm and its customers or suppliers that is hypothesized to affect location. Other variables introduced into the model to capture the effects of special conditions include: presence of special transport facilities, e.g., ports, and airline terminals, distance to large cities, climate, and volume of government spending.

The interplay of variables common to the population model and the employment model is assumed to lead to more reliable estimates of determining variables than would be the case if single equation estimators were used. Whether this partial modelling approach will lead to useful policy analysis of growth and the effects of alternative laws or regulations remains to be seen.

A second example of a partial model that attempts to capture some of the sophistication of general models is a housing market model developed by Frank deLeeuw and his associates. Comprehensive description of this model is contained in "The Market Effects of Housing Policies," recently published by the Urban Institute, and a forthcoming monograph, "The Web of Urban Housing." The Department of Housing and Urban Development has funded the research required to build the model.

The model is based on a conceptualization of the housing market that differentiates this market from markets for other commodities normally purchased by consumers. deLeeuw asserts that "durability" and "neighborhood effects" are the distinguishing characteristics of housing markets. "Durability" refers not just to the fact that dwellings last a long time, but to the facts that (a) each dwelling yields its stream of services gradually over a period of many years, and that (b) the nature of many of those services - those that reflect room size, structure type, or location, for example - is very expensive to alter after initial dwelling construction. "Neighborhood effects" refers not just to the fact that the value of a dwelling depends in part on the physical appearance of neighboring dwellings. It refers even more importantly to the facts that (a) there is an inescapable jointness about the choice of a dwelling and the choice of location-related services such as accessibility and local public goods, and (b) the value households attach to the services of a dwelling depends heavily on who lives nearby, particularly the social class and/or race of neighborhood residents.

The model represents a housing market for a particular metropolitan area by tracing out the behavior of four kinds of actors: households, dwellings, a building industry, and government.

Households are collections of people deciding on which dwelling to occupy. They make their decisions on the basis of the stream of housing services offered by each dwelling and the price per unit of the housing services. Households also have certain imputed characteristics such as income, ethnic origin, age, size, etc. They are not currently classified by owner-renter status, each owner of a dwelling is conceived as renting to himself or to another household. Households may have preferences among zones in which dwellings are located, the zones being identified by average travel time to and from work, average net rent per dwelling, and proportions of zone residents belonging to the same ethnic group as the household making a choice. All of these variables influencing households' choices of dwellings are combined into a utility function which the household is attempting to maximize.

Dwellings give off fixed streams of housing services and they have owners who maximize expected profits by seeking their maximum supply price. Each dwelling is located in a zone, as described above, which describes the neighborhood characteristic. The stream of housing services is characterized by an index of the components of service, e.g., space, shelter, privacy, pleasing design, etc. Each dwelling has a fixed initial quantity of service that depreciates through time. Each dwelling also has a minimum price per unit of service, defined as the price which is just sufficient to cover the cost of operating a dwelling. If no household is willing to pay the minimum price the dwelling is withdrawn from the stock available.

The building industry plays a passive role in responding to the outcome of the interaction between the demand of households and the supply of dwellings. It is prepared to offer new dwellings at prices determined empirically for each metropolitan area. Their principal role in the model is to set a general ceiling on the supply price of the existing stock of dwellings.

The role played by government is essential for policy analysis. Government sets the parameters for exogenous changes in an existing stable housing market and the impacts of these changes can be traced out though the model. Depending on the specifications set for the demand and supply components the policy effects of such policy changes as tax changes, money transfers, housing allowances, and zoning regulations, for example, can be solved out of the model.

The solution of the model begins with determining an empirical description of the housing stock and population for a particular metropolitan area. A very small number of dwellings and households are then specified to represent the universes by simulation. They interact with each other and the building industry through an iterative process, households seeking utility maximization and the owners of dwellings seeking maximum return. A solution is achieved when none of the actors has any incentive to change position. The housing market model has been tested in several empirical applications of government policy, and the results of these trial being used to further refine the model.

I suggested at the outset that in spite of the as[illegible] of social scientists to seek general equilibrium solutions for urban policy questions, this seems to be a hopeless quest for the present. It seems hopeless because generalizations from one or a few cities to many cities is extremely hazardous and the data bases for most cities are not sufficiently large or rich in content to allow estimation and testing of big models.

The kinds of partial models described here seem to me to be our best prospect for bringing the disciplines of the social sciences to bear on urban policy issues. They are "do-able." They are not as cheap as quick and dirty extrapolations and guesstimates but neither do they require vast sums of money and long term developmental commitment.