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Detroit Regional Transportation and Land-Use Study

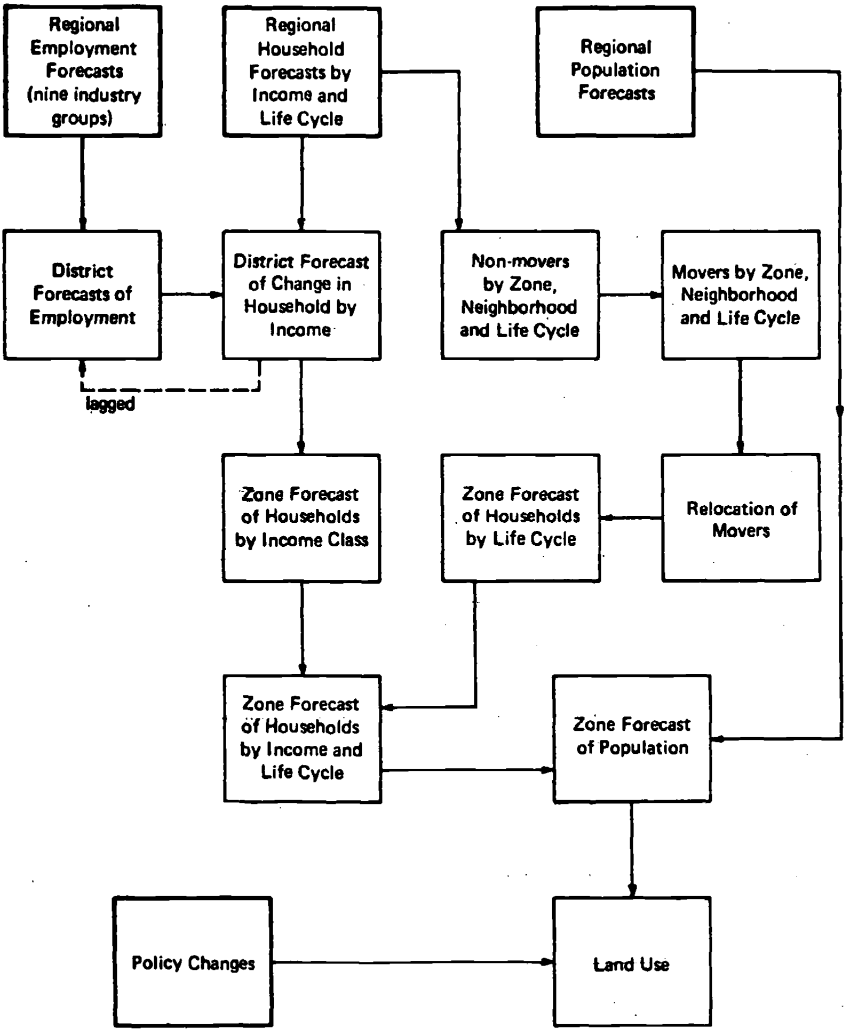
INTRODUCTION

THE DETROIT REGIONAL Transportation and Land-Use Study (TALUS) is a four-year project intended to provide estimates of growth and development in the Detroit area through the year 1990. The purposes of the models and analytical procedures are to estimate the change in land use and in socioeconomic and demographic characteristics of the zones in the region. These models were developed cooperatively by CONSAD Research Corporation and the TALUS staff.

As part of these efforts, a Southeastern Michigan growth model (SEMOD) was developed; a schema of it is presented in Figure 7. For this model, the Detroit area is broken into 297 districts, each of which is further divided into zones (1,446 total). The model requires exogenous forecasts of the area's employment by industrial groups, total households by income class and life cycle, and total population by age and sex cohort. The model then forecasts employment in nine employment groups for each of the districts. These forecasts are made on the basis of characteristics (e.g., lagged employment, households, access) of the districts. The household-income models first forecast changes in total households by district, then changes in the number of households in each of seven income classes. The final step is the forecast of total households and households by income class for each zone. At each stage in the household-income model the new forecasts are adjusted to the control totals for the previous stage.

A separate model forecasts the number of households by life cycle

Figure 7
Synthesized Flow Diagram for the
Southeastern Michigan Growth Model



for each zone, first forecasting nonmoving households. By subtracting this estimate from total households by life cycle in each zone, the model generates a group of moving households originating from each zone broken down by life cycle. These movers are allocated to destination zones on the basis of their origin zone, life cycle, and the characteristics of available zones. The total number of households by life cycle in each zone after movers are allocated is the sum of non-movers and new locators, and this total is reconciled with the previous forecast of households by zone.

Total population is forecast using a relationship between households by life cycle and population, estimated with 1965 data. Forecasting land use by zone is essentially a bookkeeping task, given previously specified commercial, industrial, public, and semipublic land use and new residential requirements.

The model also forecasts car ownership and recreation participation, but these are not shown in Figure 7, nor will they be discussed, since they are not directly a part of the subject matter of this review.

METHODOLOGY

Population and Employment Control Totals

The aggregate population and employment forecasts are essentially expansions of a Michigan manpower study. Greater detail is developed, however, for the Detroit area. Shift and share analysis techniques are employed, as well as an input-output analysis for the region. The final estimate is described as a forecast "demand for labor," and a conversion is made to obtain the labor supply in categories such as age, sex, and education level. Population totals are derived from these labor supply estimates.

Employment Model

Separate equations for each of nine employment sectors[1] are used to estimate employment for each district. Calibration of these equations is based on 1953 data for districts.[2] The equations are estimated using linear regression techniques. While each of the nine equations is slightly different, they can be broadly described as forecasting district employment as a function of that industry's lagged employment, some other industries' lagged employment, dummy variables relating to transpor-

[1] Transportation equipment manufacturing, other manufacturing, transportation communication and utility, wholesale, retail, F.I.R.E., business and personnel services, professional and related services, and public administration.

[2] Adjustments in the estimated coefficients were necessary because (1) the calibration area was smaller than the prediction area and (2) the model was run over a shorter period than that for which the equations were estimated. These adjustments are explained in the major report.

tation access, and lagged households and income in the district. The model also includes unique adjustments for retail trade in eight districts and for the automotive manufacturing industry in seven districts.

Household-Income Model

In this model regional households are distributed by income class among zones. This is done in two steps: allocation to districts within the region and allocation to zones within each district. The first stage estimates the change in total households and the number of households in each of the nine classes for each district. The predictions of change are made with regression analysis where the dependent variable is the observed changes between 1953 and 1965. The explanatory variables are, broadly speaking, the lagged total number of households, access to employment (employment is sometimes broken into various groups —not necessarily mutually exclusive), change in employment in the district, base-period residential holding capacity, and proportion of land devoted to commercial use. The estimates of these equations are adjusted in light of the total regional forecast of households.

For the highest income class, the explained variance using the above method was found to be unsatisfactory. As a result, the district net change in households with incomes over $15,000 is obtained by estimating the number of these households in each zone and summing for the district totals.

The explanatory variables used to predict the number of households (total and by income class) in a zone are, broadly, the lagged number of households (often by income class), the characteristics of the zone (e.g., proportion of zone in forest, total shoreline, density of residential development), and density constraints set by policy for new development. These forecasts are adjusted to eliminate any negative forecasts and make the zonal total consistent with the district forecasts.

Life-Cycle Model

The life-cycle model allocates households to zones by a family's life style. The distribution of households to zones accomplished by this model is independent of the household forecasts of the household-income model and so the two forecasts must be reconciled. The life cycle model gives some suggestion of being an intrametropolitan moving model, but in fact the model generates movers only as a residual.

Eight neighborhood types are identified, using discriminant and factor analysis on zone characteristics in 1953 and 1965. The zone characteristics used are the proportion of households in each life cycle, the proportion of households in each income class, a few measures of density, and two physical characteristics (proportion of zone in forest and total shoreline). Zones are classified as one of the eight neighborhood types by applying to each the coefficients of the eight sets of factor loadings and by defining the zone to be in the neighborhood class giving the highest score. Zones can be reclassified after each step to reflect policy changes and new state variables forecast.

There are seven life cycle categories. They were defined on an a priori basis in the following categories:

Life Cycle 1: The head of household is unmarried, less than forty-five years of age, and no children are present.

Life Cycle 2: The head of household is married, less than forty-five years of age, and no children are present.

Life Cycle 3: The head of household is married, and the youngest child present is less than five years old.

Life Cycle 4: The head of household is married, and the youngest child is between five and seventeen years of age.

Life Cycle 5: The head of household is married, and the youngest child present is eighteen years old or older.

Life Cycle 6: The head of household is married, forty-five years of age or older, and no children are present.

Life Cycle 7: The head of household is unmarried, forty-five years of age or older, and no children are present.

The model begins by generating nonmovers for each zone. Nonmovers are estimated by life cycle and neighborhood of residence. The explanatory variables in each case are the number of households in the base period in a zone in each life cycle class. Movers for each life cycle and neighborhood are determined by subtracting estimates of nonmoving households from the base-year totals. Total movers by life cycle and previous neighborhood type are obtained by summing over all zones.

These fifty-six values (eight neighborhoods and seven life cycles) are multiplied by a transition matrix giving the probability by life cycle of moving from neighborhood type *i* to neighborhood *j*. These movers are then summarized by life cycle and neighborhood of destination. Allocation to particular zones is accomplished by using an attractiveness index calculated for all zones. The attractiveness index gives the proportion of all movers in each life cycle class and from each neighborhood type who will locate in a zone. The attractiveness is measured by the number of households by life cycle and neighborhood who have been in present residence less than five years. The explanatory variables are the number of households by life cycle located in the zone, the zone's relative share of the district's total households in that life cycle, and the zone's residual holding capacity. As explained, the new totals of households, nonmovers plus relocators, must be reconciled with the household-income forecasts.

Population Model

Population is forecast using equations estimated from 1965 data. Separate estimates are made for white and nonwhite populations. The independent variables are, in both cases, the total households in some of the life cycle classes.[8] The forecast equations are:

$$P_{wi} = 267.0 - 5.0\,LC1_i + 4.6\,LC3_i + 4.2\,LC4_i + 3.3\,LC6_i$$

$$P_{ni} = 0.8 + 2.4\,LC1_i + 4.4\,LC3_i + 4.1\,LC4_i + 3.1\,LC5_i + 1.3\,LC6_i + 1.7\,LC7_i$$

where P_{wi} is white population in zone i, P_{ni} is nonwhite population in zone i, and LCk_i is number of households in life cycle k in zone i.

Land-Use Model

The land-use estimates are largely a bookkeeping situation in which the major force of change consists in exogenously introduced policy decisions. Additions to residential land use, however, are endogenous to the model. Since the model does not allow structures to be torn down or converted to other uses, negative changes can be introduced only exogenously. Vacant and agricultural land use is changed by policy updating.

OVERVIEW

In many ways, the TALUS effort is an important step forward in urban land-use modeling. For example, the attempt to understand changing household locations through an analysis of life cycle and intrametropolitan migration is highly innovative. Furthermore, the overall plan of the model is quite reasonable and builds well on the best in previous modeling efforts.

[8] It is not clear why some average household size by income, life cycle, and neighborhood was not used to estimate population in light of the statistical problem of the multicollinearity among the number of households by life cycle in a zone.

Nevertheless, certain problems remain. For example, the two separate methods for determining allocation of households seem rather artificial. It is also true that, while parts of the model reflect the stated purpose of focusing on changes taking place within the region, there are many areas where the model does not really address change. Totals instead of changes are forecast in the employment allocation model, the household-income model at the zonal level, and the life cycle moving model. The reliance on totals is sometimes required by data limitations, but this is not always the case. For example, employment data were available for both 1953 and 1965.

The model's equations seem to have been determined mainly with regard to maximizing the explained variance. For example, instead of attempting estimates of movers, the model estimates nonmovers. It is quite clear that single equation regression analysis will explain a great deal more of the variance of nonmovers by zone than movers, but this does not imply any better forecast of movers. In essence, the approach taken does not provide more information about what determines moving—which is of greatest interest. It is also difficult to rationalize some of the variables included or the signs of the coefficients. For example, it is difficult to explain why access to a trunk line highway is part of the equation estimating "professional and related services," but not included in the equations for "other manufacturing." Nor is it easy to understand why the change in a district's households in the $3,000 to $6,000 income class is (1) positively related to access to group two employment (transportation, manufacturing, other manufacturing, retail, service, professional, and related); and (2) negatively related to the change in group two employment; or (3) negatively related to access to Group Three employment (which contains transportation manufacturing, other manufacturing, and retail from Group Two, as well as transportation, utilities, and commercial and public administration); and (4) positively related to change in Group Three employment.