Volume Title: The Detroit Prototype of the NBER Urban Simulation Model

Volume Author/Editor: Gregory K. Ingram, John F. Kain, and J. Royce Ginn

Volume Publisher: NBER

Volume ISBN: 0-870-14258-5

Volume URL: http://www.nber.org/books/ingr72-1

Publication Date: 1972

Chapter Title: Detroit and the Modeled City

Chapter Author: Gregory K. Ingram, John F. Kain, J. Royce Ginn

Chapter URL: http://www.nber.org/chapters/c3502

Chapter pages in book: (p. 73 - 82)

5

DETROIT AND THE MODELED CITY

ALTHOUGH THE MODEL described here is called the Detroit Prototype, the current version of the NBER Urban Simulation Model is not intended to represent a particular city. At the same time, it is convenient to work with a specific metropolitan area in calibrating the model. A description of an urban area is required to begin the simulations, and it is easier to use an actual city for this purpose than to fabricate one. Information on employment by location and industry; households by workplace location, residence location, and type; housing units by location and type; housing prices by location; and travel patterns by origin, destination, and mode in the initial year are needed to begin model simulations. The use of an actual city insures a general consistency among these variables that would be difficult to achieve in any other way. Therefore, the first version of the NBER Urban Simulation Model employs a description of Detroit, Michigan, during the period of 1960–65 as the base year for model simulations. Even so, it is important that the reader not be misled into believing that the NBER Urban Simulation Model represents Detroit in any strict sense.

The one case in which data from the Detroit area were not used extensively involves the estimation of moving rates for each household class. Since the Detroit home interview survey did not include detailed information on household-relocating patterns, data from San Francisco were used instead. Obviously it is possible that the moving behavior of Detroit households differs from that found in San Francisco. The extent to which such differences exist is one reason why the present model must be considered an imperfect representation of Detroit. Again, the Detroit Prototype, with its various simplifications, is not intended to be a planning or forecasting

tool for the Detroit metropolitan area. Instead, this market model is an experimental representation of a metropolitan area that is substantially similar to, but not identical with, the Detroit area.

A total of 1,395,228 persons are employed in the Detroit-like place used to start the model simulations. Of these, the model represents only the 1,092,232 jobs held by heads of households and only their primary employment at that. Moonlighting and the jobs held by wives and children are excluded from this version of the NBER model. These primary jobs are located at the nineteen workplaces shown in Figure 5.1. The number of jobs at each workplace varies from a high of 155,000 in workplace 5 to a low of 3,000 in workplace 19.

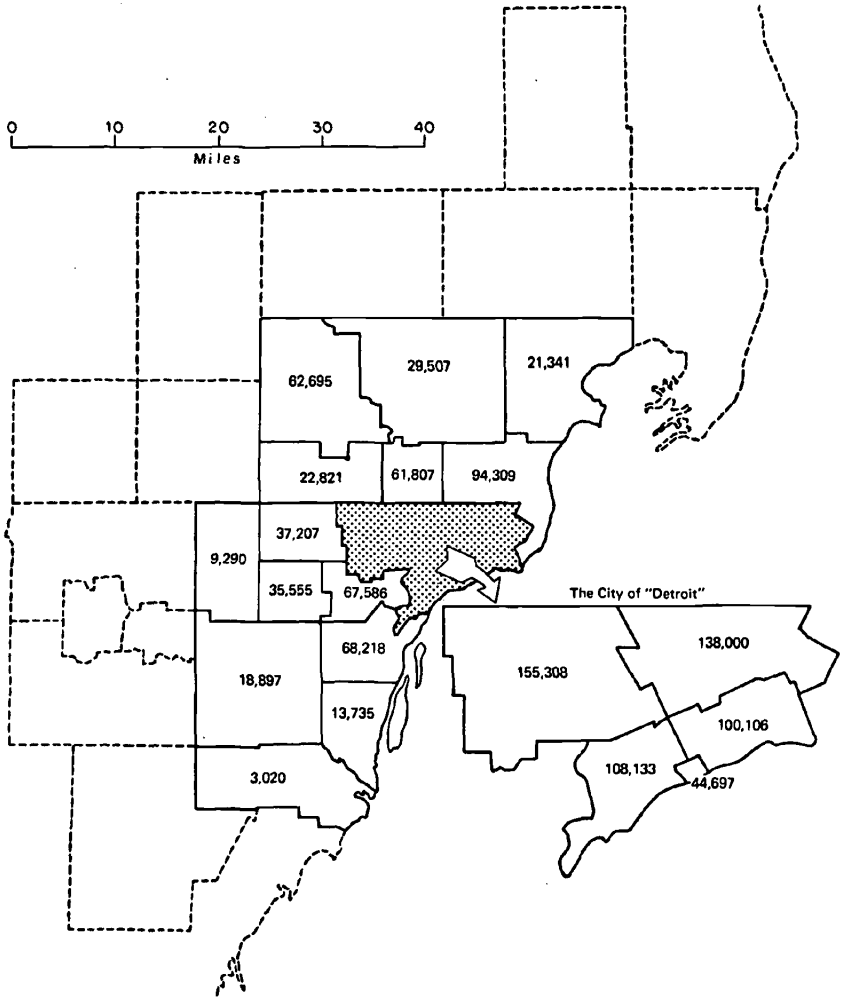
The area containing jobs is smaller than the area containing residences, and some residence areas contain no jobs. In reality 130,000 workers are employed in the fourteen outlying residence zones not represented as employment locations in the Detroit Prototype, a number which is 9 per cent of all primary jobs in the Greater Detroit region. The only workplace of any size located in this excluded area is Ann Arbor, residence zones 36 and 37, a city over thirty-five miles from downtown Detroit.[1] Although it interacts with the remainder of the Detroit metropolitan area in a number of interesting ways, its quantitative effects on the region's housing market are relatively small.

Including the outermost zones in the model would require the use of either many more workplace zones or else very large ones. A zonal system covering the entire area, used in earlier versions of the model, is shown in Figure 5.2. We abandoned it when we discovered that almost none of the sampled work trips was made outside of the workplace zones. Observing this behavior, which was particularly pronounced in the seven outermost workplace zones, we decided that the demand by peripherally located workers for housing outside their workplace zones could be ignored during the model development phase. Therefore, we removed them from the model and reduced the size of the interior workplace zones.

The 1,092,232 primary wage earners employed in the modeled city in the base year are employed in the nine industries listed in Table 5.1. These industries are basically one-digit SIC categories, except that manufacturing of transportation equipment is separated from

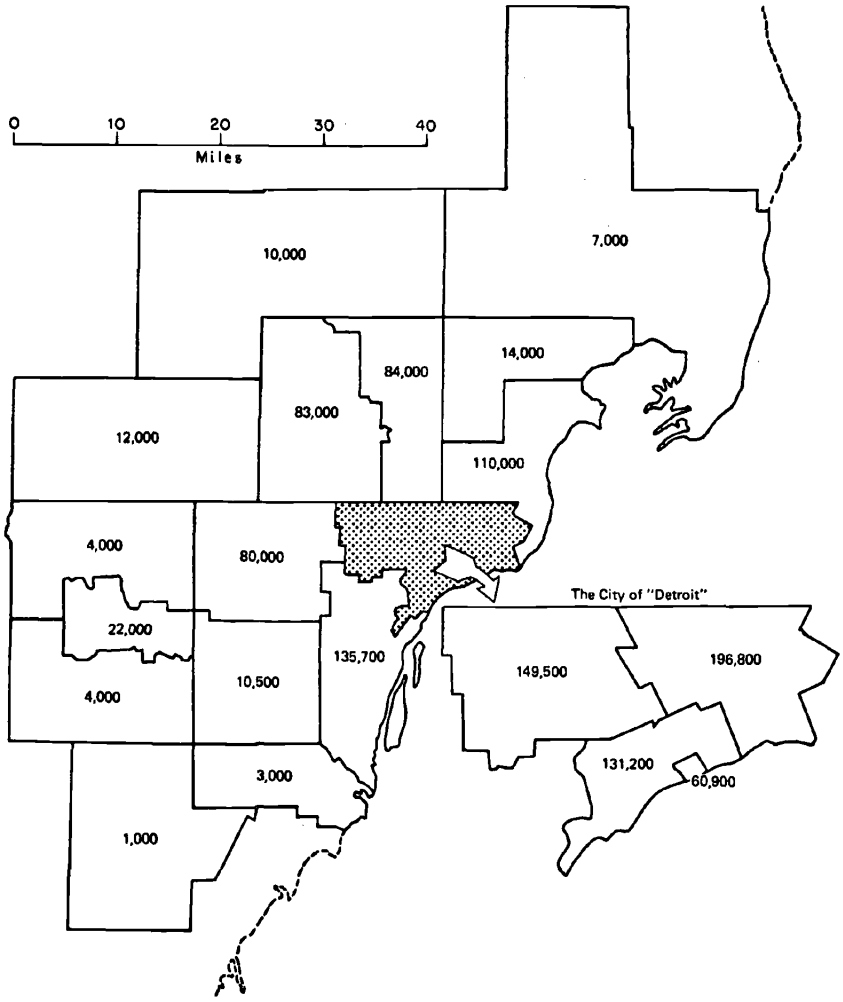
1. The residence zone numbers are shown in Figure 1.1, above.

Figure 5.1
Number of Employed Heads of Household, Classified by Workplace in the Base Year
(base year is 1965)



other manufacturing because of its importance in the Detroit area, and agricultural and other extractive industries are omitted because of their unimportance. For simulations in subsequent years the model requires exogenous forecasts of employment levels in each industry by each of the workplace zones.

Figure 5.2
Employment of Heads of Household by Zone
for Initial System of Workplaces



When we removed the 130,000 primary workers from the outermost ring it was, of course, also necessary to remove them from the housing market. Using information on actual work trips of workers employed in these outlying workplaces, we subtracted a number of dwelling units from each residence zone equal to the number of work

Table 5.1
Primary Workers by Industry in the Base Year

Industry Type	Industry Description	Total Primary Workers
1	Manufacturing of transport equipment	203,005
2	Other manufacturing	259,518
3	Transportation, communication, and utilities	69,217
4	Wholesaling	42,560
5	Retailing	172,997
6	Finance, insurance, and real estate	43,874
7	Services	97,472
8	Professionals	157,863
9	Public administration	45,726
	Total	1,092,232

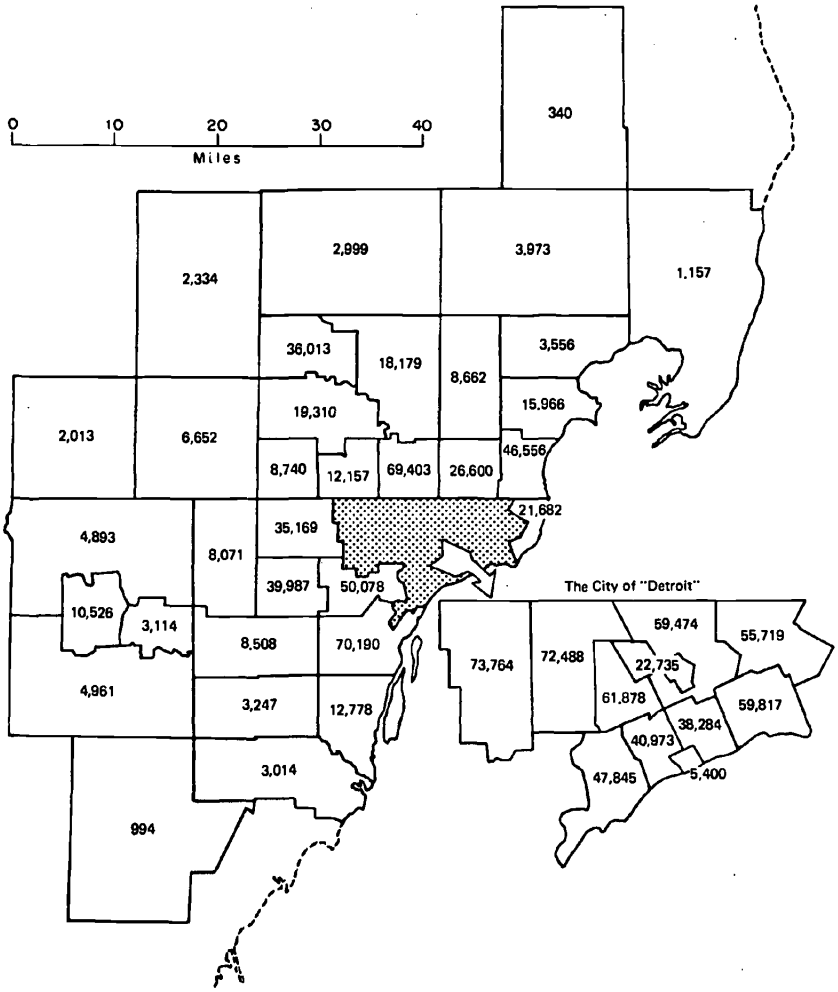
Source: 1965 Detroit TALUS survey.

trips to these outer workplaces originating in each residence zone. In making these adjustments to the housing stock, we first deleted all multifamily units on the assumption that only locally employed workers would reside in apartments that far from the core. Then we reduced the single-family housing stock proportionally to cover the remaining job loss. The resulting distributions of dwelling units by residence zone are shown in Figure 5.3.

The 1,173,356 dwelling units included in the Detroit housing stock are divided into twenty-seven housing types representing twenty-seven distinct housing submarkets. These twenty-seven submarkets are defined by nine basic structural types in combination with three quality classifications. The nine basic structural types are composed of six categories of single-family unit, differentiated by dwelling unit size (5 rooms or less, 6 or 7 rooms, and 8 or more rooms) and lot size (quarter-acre and half-acre lots); plus common wall units (row and town houses), small apartment buildings (walk-ups), and large apartment buildings. The three quality classifications of the dwelling units are made up of a three-class description of the unit's physical quality. The number and proportion of dwelling units in each housing type at the start of the simulation are shown in Table 5.2.

The basic structural types and their characteristics derive from the major dwelling unit types reported in the TALUS (Transportation and

Figure 5.3
Total Housing Units Classified by Residence Zone in the Base Year
(base year is 1965)



Land-Use Study) data source. Several types of housing unit, such as trailers, rooming houses, residential hotels, and institutions have been eliminated from consideration since altogether they represent only a small percentage of the housing stock. Although lot size, number of rooms, and quality are all attributes of individual units, the TALUS home interview survey, which provided most of the data used to

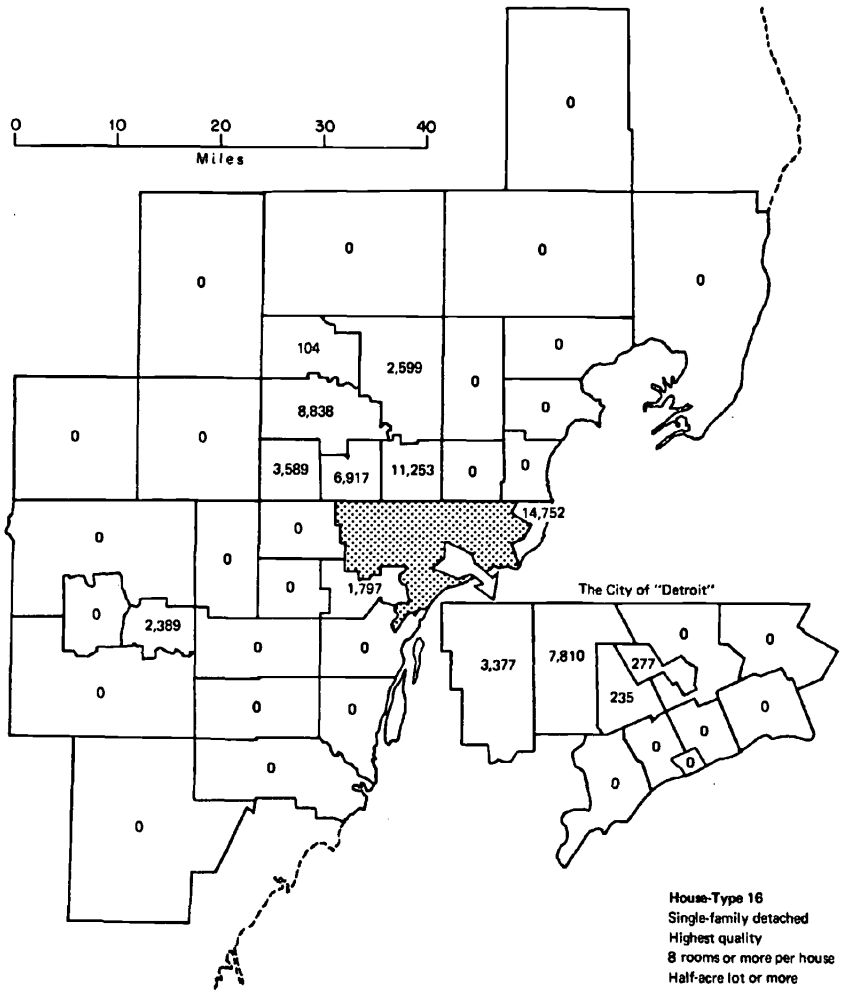
Table 5.2
Number and Proportion of Housing Units by Type in the Base Year (base year is 1965)

Unit Type	Lot Size (acres)	No. Rooms per Unit	Quality[a]	No. of Units	Proportion
		In Single-Family Structures			
1	.25	5	SN	165,442	.1410
2	.25	5	DT	14,609	.0125
3	.25	5	DL	11,858	.0101
4	.50	5	SN	130,730	.1114
5	.50	5	DT	13,013	.0111
6	.50	5	DL	10,567	.0090
7	.25	6–7	SN	159,357	.1358
8	.25	6–7	DT	12,668	.0108
9	.25	6–7	DL	11,102	.0095
10	.50	6–7	SN	161,512	.1376
11	.50	6–7	DT	12,229	.0104
12	.50	6–7	DL	12,699	.0108
13	.25	8	SN	75,010	.0639
14	.25	8	DT	4,893	.0042
15	.25	8	DL	5,017	.0043
16	.50	8	SN	85,146	.0726
17	.50	8	DT	3,735	.0032
18	.50	8	DL	4,311	.0037
		In Common-Wall Structures (Row and Town Houses)			
19	.0625	5	SN	132,066	.1126
20	.0625	5	DT	11,991	.0102
21	.0625	5	DL	20,879	.0178
		In Small Multifamily Structures			
22	.25	4	SN	20,599	.0176
23	.25	4	DT	1,285	.0011
24	.25	4	DL	4,022	.0034
		In Large Multifamily Structures			
25	.25	3	SN	70,156	.0598
26	.25	3	DT	5,543	.0047
27	.25	3	DL	12,924	.0110

a. SN = sound; DT = deteriorating; DL = dilapidated.

calibrate the Detroit Prototype, did not obtain these characteristics for sampled units. Therefore, they had to be imputed from aggregate Census tract data using techniques described in Chapter 8. The quality classification used in the model follows the 1960 Census

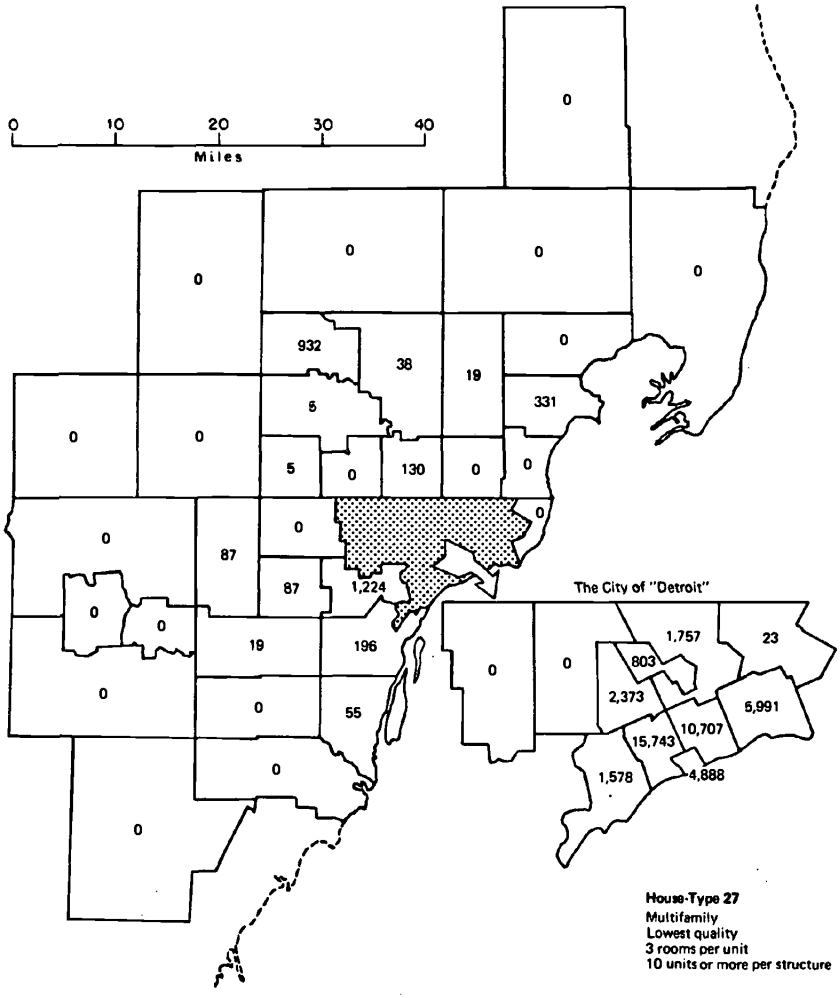
Figure 5.4
Locational Distribution of Dwelling Units in House-Type 16



classification of housing as "sound," "deteriorating," or "dilapidated." Nearly 15 per cent of the housing stock falls into the two lower classifications.

The Detroit Prototype does not model tenure choice. However, most single-family and common wall units are owner-occupied, and units in both small and large multifamily buildings are generally

Figure 5.5
Locational Distribution of Dwelling Units in House-Type 27



renter-occupied. When it is necessary in the model, rents are transformed into house values by means of value-rent factors calculated from the Detroit data.

Across dwelling unit types the location of the various housing types varies widely in the metropolitan area. Figures 5.4 and 5.5, which show the distribution of housing types 16 and 27, illustrate these

Table 5.3
Proportion of Households in Each Household Class

Annual Income (000 dollars)	0–11 Years' Education by Family Size (number of persons)			12+ Years' Education by Family Size (number of persons)		
	1 to 2	3 to 4	5 or More	1 to 2	3 to 4	5 or More
	Age of Head 30 Years or Less					
0 to 5	(1) .0122	(13) .0147	(25) .0045	(37) .0068	(49) .0109	(61) .0048
5+ to 10	(2) .0153	(14) .0260	(26) .0088	(38) .0027	(50) .0081	(62) .0050
10+ to 15	(3) .0055	(15) .0111	(27) .0046	(39) .0002	(51) .0024	(63) .0012
15+	(4) .0022	(16) .0050	(28) .0020	(40) .0005	(52) .0013	(64) .0006
	Age of Head 31 to 60 Years					
0 to 5	(5) .0319	(17) .0476	(29) .0407	(41) .0433	(53) .0398	(65) .0393
5+ to 10	(6) .0405	(18) .0666	(30) .0644	(42) .0417	(54) .0582	(66) .0561
10+ to 15	(7) .0210	(19) .0385	(31) .0392	(43) .0089	(55) .0143	(67) .0129
15+	(8) .0125	(20) .0193	(32) .0194	(44) .0016	(56) .0041	(68) .0039
	Age of Head Greater Than 60 Years					
0 to 5	(9) .0068	(21) .0024	(33) .0004	(45) .0133	(57) .0039	(69) .0009
5+ to 10	(10) .0085	(22) .0024	(34) .0006	(46) .0123	(58) .0055	(70) .0012
10+ to 15	(11) .0020	(23) .0017	(35) .0002	(47) .0030	(59) .0018	(71) .0005
15+	(12) .0038	(24) .0011	(36) .0010	(48) .0009	(60) .0006	(72) .0002

Note: Figures in parentheses identify household classes.

differences. Housing type 16 is a large, high-quality, single-family unit on a large lot; housing type 27, by contrast, is a low-quality, small, high-density apartment.

The households which appear in the simulation model are defined by household class much in the way that dwelling units are defined by type. A household may fall within any of seventy-two household classes depending on the age and educational level of the household head, the household's income, and its family size. The proportions of households in each class are shown in Table 5.3. The development of these seventy-two household classes was basically arbitrary, although the classes generally reflect differences in housing consumption patterns that were sustained in empirical work.

While in some respects the dimensionality of the over-all model may seem to be insufficient, the existing detail produces an impressive number of potential household characteristics. A given household could fall into one of 1,625,184 cells depending on its household class, housing type, and locational characteristics.