Housing and Population Density in Columbus:

A Summary of Data and Findings

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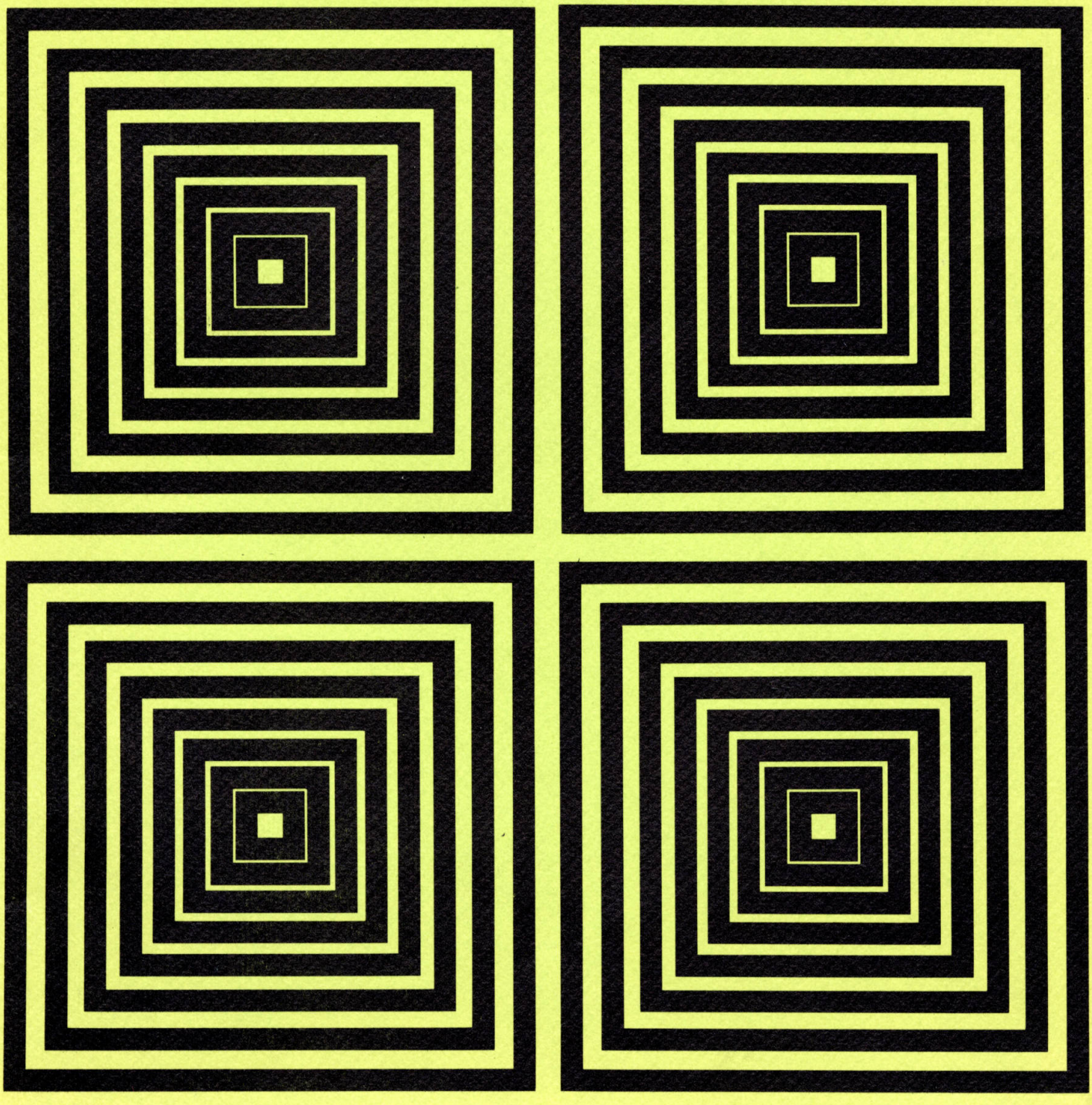
September 1974



HOUSING AND POPULATION DENSITY IN COLUMBUS: A SUMMARY OF DATA AND FINDINGS

August, 1974

A 49 Page Report by the City of Columbus, Department of Development

REPORT SUMMARY

The purpose of this study is to present data for use by urban planners. It provides a structural urban model which can be used for areawide analysis, and examines the patterns and trends of housing and population density in Columbus. While this study is primarily intended to be used as a planning tool, students, civic organizations, and other public officials should find this information useful and valuable. This study is divided into three parts:

Part I presents acreage, housing, and population density figures by census tracts for Franklin County. This information can be used extensively by planners, urban researchers, students, and civic organizations as a resource for micro-studies of the Columbus Urban Area. The density figures presented are based on acreage estimates of each census tract in conjunction with 1970 census tract data. Acreage, population, and housing figures can be combined and recombined to give the density for any tract, or any combination of census tracts.

In Part II a concentric zone system is devised by assigning census tracts to concentric zones based on distance from the Central Business District (C.B.D.). This method of examining the structure of a city is particularly appropriate where the Central Business District is the employment center of the region. Also, every census (tract) variable can be given a spatial dimension based on its distance from the C.B.D. Thus, a vast amount of census information can be utilized more effectively to chart the various elements of urban structure, growth, and change.

Finally, in Part III, the zone system and census tract density data are combined to construct housing and population density gradients for the Columbus/Franklin County urban area. The purpose of this section is to show how census tract data can be given a spatial dimension. Median housing value and median gross rent are plotted to show their corresponding trends. Population density gradients have also been plotted depending on their direction (north, east, south, and west) from the Central Business District (C.B.D.). The results give a graphic picture of housing and population density patterns in Columbus and Franklin County. In addition, two standard housing density models are reviewed, and a comparison of the empirical results with these two models is made.

NOTE: Table 2 has been prepared for wide distribution since the information it contains can be used for a variety of studies, and is generally unavailable from other sources. Table 2 gives acreage, population, and density data for all census tracts in Franklin County.

HOUSING AND POPULATION DENSITY IN COLUMBUS:
A SUMMARY OF DATA AND FINDINGS

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HOUSING AND POPULATION DENSITY BY CENSUS TRACT

A. Verification of Census Tract Acreage Figures.

In order to compute densities we need a measure of the area of each census tract. Such figures are not provided by the Bureau of the Census. They must, therefore, be computed in some other manner. Acreage figures used in this study were found by using a planimeter. To compute acreage figures using this method, a scale map is used showing census tract boundaries. The boundary of each tract is then traced with a compass-like device (the planimeter) which gives the area of the tract in square inches. This process is repeated 3 times for each tract. The square inch figures are then converted to acreage figures. Using this method members of the planning staff of the Department of Development have computed the acreage of all tracts in Franklin County.

The accuracy of these figures has been checked in two ways. First, the computed (and corrected) acreage figures (given in Table 2) were totaled and then compared with the standard acreage total for Franklin County. The total of computed acreage was 339,713 which compares favorable with the standard figure 344,177.26 acres (1970 City of Columbus Land Use Survey). The percentage error is 1.30% and implies that the error resulting from computing the acreage is extremely low. However, this low error figure may be deceptive since errors above and below the true acreage figures would counteract each other.

A second check of the accuracy of these figures was made by comparing the computed tract acreage figures with independently computed acreage figures from another source. The only source of such figures is a 1964 Land Use Study conducted by the Mid Ohio Regional Planning Commission using 1960 census tracts. Unfortunately, census tract boundaries were changed for the 1970 census. Thus not all of the tracts were comparable. The results of this comparison are shown in Table 1. The results show that, with few exceptions, the computed acreage figures are quite accurate. Of the 55 comparable tracts, only 6 had errors in excess of 10%. Corrections of the acreage figures of tracts with errors in excess of 10% were made to reduce the probable error. The results of these checks suggest that the acreage figures are generally accurate and may be used with a substantial degree of confidence.

I. B.

TABLE 1. A COMPARISON OF CENSUS TRACT ACREAGE FIGURES

(Comparable Tracts Only)

TRACT NO.	(1970) A_c CITY OF COLUMBUS	A_m MORPC	% DIFFERENCE $\frac{\lvert A_m - A_c \rvert}{A_m}$	TRACT NO.	(1970) A_c CITY OF COLUMBUS	A_m MORPC	% DIFFERENCE $\frac{\lvert A_m - A_c \rvert}{A_m}$
1.10	504	485.45	3.92	36.00	155	164.29	5.49
2.10	452	452.79	0.22	37.00	510	509.12	0.20
3.30	207	214.42	3.27	38.00	176	180.16	2.22
4.10	211	209.61	0.48	41.00	161	195.94	17.95
4.20	349	348.56	0.13	42.00	349	351.75	0.85
5.00	271	291.40	7.51	46.10	355	545.28	1.83
6.00	207	232.33	10.78	46.20	180		
7.10	318	317.14	0.32	47.00	320	319.88	0.04
7.20	535	529.39	1.13	48.10	198	399.57	1.50
8.10	242	593.29	2.02	48.20	196		
8.20	339			55	368	347.57	5.75
10.00	202	215.42	6.05	58.10	233	481.92	0.21
12.00	151	159.16	5.03	58.20	260		
13.00	143	162.74	12.27	59	157	190.15	17.37
14.00	436	435.51	0.11	60	236	234.77	0.42
15.00	306	317.90	3.77	61	254	267.17	4.87
16.00	124	127.04	2.36	87.10	357		
17.00	122	122.55	0.36	87.20	645	2253.81	6.92
21.00	118	130.03	9.23	87.30	509		
22.00	155	163.60	5.49	87.40	587		
23.00	308	276.33	11.59	89	370	367.46	0.82
27.10	190	201.02	5.47	90	618	650.39	4.92
27.20	116	115.76	0.21	91	486	493.57	1.62
27.40	205	214.97	4.65	92.20	481	498.93	3.61
27.50	231	222.14	4.05	92.30	511	471.23	8.49
27.60	310	313.92	1.27	92.40	246	230.07	6.96
27.70	205	221.15	7.11	92.50	295	289.08	2.07

TABLE 1. (continued)

TRACT NO.	(1970) A_c CITY OF COLUMBUS	A_m MORPC	% DIFFERENCE $\frac{\lvert A_m - A_c \rvert}{A_m}$	TRACT NO.	(1970) A_c CITY OF COLUMBUS	A_m MORPC	% DIFFERENCE $\frac{\lvert A_m - A_c \rvert}{A_m}$
29.00	180	206.34	12.62	93.22	353	2353.16	1.31
30.00	298	322.25	7.45	93.23	713		
33.00	23	24.01	4.17	93.24	996		
34.00	233	244.78	4.90	93.31	149		
35.00	207	222.24	6.76	93.32	432		
93.33	198	2418.83	5.37				
93.34	374						
93.34	1136						

OF THE 55 ONLY 6 HAVE ERRORS GREATER THAN 10%

12 HAVE ERRORS GREATER THAN 7%

A_c = Acreage figures computed by using a planimeter on 1970 Census tract boundaries

A_m = Acreage figures computed by the Mid-Ohio Regional Planning Commission in conjunction with a 1964 Land Use Study using 1960 Census Tract boundaries.

ADDENDUM:

Recently the Department of Development has received census tract acreage figures from National Planning Data Corporation of Rochester, New York. Their estimates were made using an electronic planimeter, and closely correspond to the acreage figures presented in this report. An estimate of the accuracy of their figures reveals that the acreage figures from National Planning Data Corporation tend to be slightly high, while the figures presented in this report (Table 2) tend to be a little low. The differences may be shown by a comparison of Franklin County Total Acreage figures.

City of Columbus Land Use Survey (1970)	344,177 acres
MORPC Land Use Survey (1964)	344,260 acres
Sum of Census Tract Acreage Figures, Department of Development	339,713 acres
Sum of Census Tract Acreage Figures, National Planning Data Corporation	353,141 acres

The acreage estimates presented in this report are quite accurate for general types of studies and density calculations. The acreage estimates computed by National Planning Data are available from the City of Columbus, Department of Development, for those who seek to make revised or more accurate estimates.

C. Computation of Housing and Population Density by Census Tract.

Assured of reasonably accurate acreage figures, housing and population densities for each tract were calculated. The results are shown in Table 2. The information presented in Table 2 can be used in conjunction with other census data for a wide variety of general studies (e.g. transportaion and housing) of the Columbus urban area. The data can also be used selectively or recombined to provide information for small area studies as well. The level of density is a key indicator of the growth potential of an area, of its need for public services, its need for open space, and the incidence of crime, poverty, and other social problems in an area. Therefore, Table 2 is presented as a ready reference for those concerned with the problems and potential of the Columbus urban area.

The 1973 densities were computed using census tract population and household estimates from the National Planning Data Corporation.[1] Telephone and auto data were combined with density information in arriving at these 1973 estimates. Density in Table 2 is computed as simply households or persons per acre, based on these estimates.

The densities computed here represent gross density. No considerations of variation in land use within each tract have been made. Gross density is distinguished from net residential density which gives the persons per acre of residential land. A more specific analysis of smaller areas can be obtained by using gross density in conjunction with land use data available at the traffic zone level.

In order to include as much information as possible, as well as take advantage of the data available, two variations of housing density have been presented. In Table 2 the number of households is used to compute housing density for the years 1970 and 1973. The housing component used in Table 4 and the one used to compute housing density used in Figure 1 is the number of dwelling units per census tract. The alert planner should be aware of this distinction.

[1] 1973 Census Tract Update File, National Planning Data Corporation, 65 Broad Street, Rochester, N.Y., copyright 1974. Note, information about the equations used is available from the Research Section of the Department of Development.

I.D.

TABLE 2. HOUSING AND POPULATION DENSITY IN COLUMBUS AND FRANKLIN COUNTY BY CENSUS TRACT

Census Tract	Zone[a]	Computed Acreage[b]	Population[c] 1970	Population[c] 1973	Population Density[f] 1970	Population Density[f] 1973	Households[d] 1970	Households[d] 1973	Household Density[g] 1970	Household Density[g] 1973
1.10	7	504	4631	5184	9.18	10.49	1807	2022	3.58	4.01
1.20	7	700	4219	4168	6.02	5.95	1575	1556	2.25	2.22
2.10	6	452	4055	4325	8.97	9.57	1436	1531	3.18	3.39
2.20	6	440	5153	5376	11.71	12.22	1693	1765	3.84	4.01
3.10*	6	413	4325	4873	10.47	11.80	1336	1505	3.23	3.64
3.20	6	281	3700	4053	13.16	14.42	1078	1181	3.84	4.20
3.30	5	207	3272	3561	15.80	17.20	1142	1243	5.52	6.00
4.10	5	211	3750	3751	17.77	17.78	1403	1403	6.65	6.65
4.20	5	349	4168	4358	11.94	12.49	1497	1565	4.29	4.48
5.00	5	271	4476	4612	16.51	17.02	1763	1815	6.50	6.70
6.00	4	220	5426	5161	24.66	23.46	1956	1860	8.89	8.45
7.10	5	318	5208	5398	16.37	16.97	1745	1808	5.49	5.69
7.20	4	535	4203	4419	7.85	8.26	1288	1354	2.41	2.53
7.30	4	236	6113	6134	25.90	25.99	1688	1693	7.15	7.17
8.10	5	242	3618	3876	14.95	16.02	1159	1241	4.79	5.13
8.20	5	339	4155	4386	12.25	12.94	1479	1561	4.36	4.60
9.10	5	302	5087	5212	16.84	17.26	1611	1650	5.33	5.46
9.20	5	213	3187	3363	14.96	15.79	1073	1132	5.04	5.31
10.00	4	202	6430	6284	31.83	31.11	2339	2285	11.57	11.31
11.10	4	136	2978	3052	21.89	22.44	1082	1108	7.95	8.15
11.20*	4	1510[h]	12479	12995	8.26	8.61	377	392	0.25	0.26
12.00	3	151	4482	4267	29.68	28.26	1360	1295	9.01	8.58
13.00	3	153	6297	7835	41.15	51.21	1886	2346	12.33	15.33
14.00	3	436	3736	4353	8.56	9.98	1072	1248	2.46	2.86
15.00	3	306	4287	4036	14.00	13.19	1185	1115	3.87	3.64
16.00	3	124	3127	3086	25.21	24.89	1029	1014	8.30	8.18
17.00	3	122	3620	3716	29.67	30.46	1430	1467	11.72	12.02
18.10	3	89	4059	4642	45.60	52.16	1706	1951	19.17	21.92
18.20	2	194	4148	3967	21.38	20.45	1691	1617	8.72	8.34
19.00*	3	688	6557	5679	9.53	8.25	3397	2941	4.94	4.27

I.D.
TABLE 2. (Continued)

Census Tract [e]	Zone [a]	Computed Acreage [b]	Population [c]		Population Density [f]		Households [d]		Household Density [g]	
			1970	1973	1970	1973	1970	1973	1970	1973
20.00	2	161	5979	6029	37.14	37.45	1906	1921	11.84	11.93
21.00	2	118	2343	2373	19.86	20.11	1049	1062	8.89	9.00
22.00	2	155	3129	3175	20.19	20.48	1197	1214	7.72	7.83
23.00	2	292	2869	2484	9.82	8.51	876	758	3.00	2.60
24.00	3	324	859	863	2.65	2.66	289	290	0.89	0.90
25.10	4	428	2977	3188	6.95	7.45	904	968	2.11	2.26
25.20	3	372	4693	4905	12.61	13.19	1672	1747	4.49	4.70
26.00	5	562	4989	4417	8.87	7.86	1712	1515	3.05	2.70
27.10	5	190	2954	2826	15.54	14.87	1316	1258	6.93	6.62
27.20	5	116	2205	1985	19.00	17.11	885	796	7.63	6.86
27.30	6	188	2490	2522	13.24	13.41	1084	1097	5.76	5.84
27.40	5	205	1913	2063	9.33	10.06	608	655	2.96	3.20
27.50	6	231	2815	2929	12.18	12.68	1001	1041	4.33	4.51
27.60	5	310	4173	4243	13.46	13.69	1774	1803	5.72	5.82
27.70	6	205	2510	2413	12.24	11.77	943	905	4.60	4.41
27.80	5	432	2935	3144	6.79	7.28	954	1022	2.21	2.37
28.00	3	236	5147	4489	21.80	19.02	2042	1781	8.65	7.55
29.00	2	193	2725	2722	14.11	14.10	754	743	3.86	3.85
30.00	2	298	1008	964	3.38	3.23	318	303	1.07	1.02
31.00	1	174	1346	1308	7.73	7.52	603	585	3.46	3.36
32.00	1	341	2155	2529	6.31	7.42	1009	1184	2.96	3.47
33.00	1	23 [h]	1980	-	-	-	-	-	-	-
34.00	1	233	562	594	2.41	2.55	120	126	0.52	0.54
35.00	1	207	1975	1999	9.54	9.66	929	939	4.49	4.54
36.00	2	155	3755	3257	24.22	21.01	1583	1372	10.21	8.85
37.00	3	510	7467	6902	14.64	13.53	2461	2274	4.82	4.46
38.00	2	176	5225	5246	29.68	29.81	1907	1914	10.83	10.88
39.00	1	225	2636	2411	11.71	10.72	1376	1258	6.12	5.59
40.00	1	322	1333	1486	4.13	4.61	753	839	2.34	2.61
41.00	1	178	3603	3620	20.34	20.34	1358	1364	7.63	7.66

I.D.
TABLE 2. (Continued)

Census Tract [e]	Zone [a]	Computed Acreage [b]	Population [c] 1970	Population [c] 1973	Population Density [f] 1970	Population Density [f] 1973	Households [d] 1970	Households [d] 1973	Household Density [g] 1970	Household Density [g] 1973
42.00	1	349	1862	1824	5.33	5.23	589	576	1.69	1.65
43.00	2	1225	4783	5221	3.90	4.26	1587	1746	1.30	1.43
44.00	3	506[h]	5213	5590	10.30	11.05	409	438	0.81	0.87
45.00	4	376	6243	6220	16.60	16.54	2150	2142	5.72	5.70
46.10	5	355	4563	4973	12.85	14.01	1549	1688	4.36	4.75
46.20	4	180	3365	3400	18.69	18.89	1115	1126	6.19	6.26
47.00	4	320	7263	6534	22.69	20.42	2278	2049	7.12	6.40
48.10	4	198	3506	3563	17.70	17.99	1236	1256	6.24	6.34
48.20	4	196	3361	3462	17.14	17.66	1101	1134	5.62	5.79
49.00*	3	382	6130	6537	16.04	17.11	2192	2337	5.74	6.12
50.00	2	308	5059	4854	16.42	15.76	1701	1631	5.52	5.30
51.00	2	1074	5222	6359	4.86	5.92	1830	2228	1.70	2.07
52.00	2	242	3949	4031	16.31	16.66	1582	1614	6.54	6.67
53.00	2	329	7509	6540	22.82	19.88	2207	1921	6.71	5.84
54.10	3	238	3795	3693	15.94	15.52	1097	1066	4.61	4.48
54.20	3	217	4286	4068	19.75	18.75	1231	1167	5.67	5.38
55.00	3	368	7909	7182	21.49	19.52	2409	2186	6.55	5.94
56.10	2	136	3666	3605	26.95	26.51	1097	1078	8.07	7.93
56.20	3	169	3715	3698	21.98	21.88	1257	1251	7.43	7.40
57.00	2	514	5255	4739	10.22	9.22	2160	1947	4.20	3.79
58.10	2	233	4570	4433	19.61	19.03	1574	1526	6.75	6.55
58.20	3	260	3704	3997	14.24	15.37	1210	1305	4.65	5.02
59.00	3	173	3629	3587	20.98	20.73	1234	1219	7.13	7.05
60.00	3	236	3646	3548	15.44	15.03	1154	1122	4.88	4.75
61.00	3	254	5400	5120	21.25	20.16	1703	1615	6.70	6.36
62.00	9	14925	3017	3102	0.20	0.21	900	925	0.06	0.06
63.10	7	1053	5955	6630	5.65	6.30	1637	1822	1.55	1.73
63.20*	6	1552	8499	8197	5.47	5.28	2521	2431	1.62	1.57
63.30*	6	748	6113	6578	8.17	8.79	1970	2119	2.63	2.83
63.40*	8	824	1119	1128	1.35	1.37	332	334	0.40	0.41

I.D.
TABLE 2. (Continued)

Census Tract[e]	Zone[a]	Computed Acreage[b]	Population[c] 1970	Population[c] 1973	Population Density[f] 1970	Population Density[f] 1973	Households[d] 1970	Households[d] 1973	Household Density[g] 1970	Household Density[g] 1973
63.50*	8	5266	4344	5976	0.82	1.13	1410	1939	0.27	0.37
63.90*	9	8202	5888	8399	0.71	1.02	1551	2212	0.18	0.27
64.10*	6	537	2911	3527	5.42	6.57	1036	1255	1.93	2.34
64.20	5	200	1463	1478	7.31	7.39	678	684	3.39	3.42
64.30	5	446	4065	4365	9.11	9.79	1222	1312	2.74	2.94
65.00	5	616	3907	3978	6.34	6.46	1262	1285	2.05	2.09
66.00	4	508	5184	5510	10.20	10.85	1816	1930	3.57	3.80
67.10*	9	446	4254	3281	9.53	7.36	1324	1388	2.96	3.11
67.20	9	1717	6885	6949	4.00	4.05	1683	1698	0.98	0.99
68.10	8	376	3287	3485	8.74	9.27	957	1013	2.54	2.69
68.20*	8	754	7137	6921	9.46	9.18	2752	2668	3.65	3.54
68.30	8	209	-	-	-	(School for the Deaf and Blind)		-	-	-
69.10*	9	486	1952	1928	4.47	3.97	599	591	1.23	1.22
69.21	8	609	3783	4358	6.21	7.16	1310	1161	2.15	1.91
69.22	8	810	9589	10157	11.83	12.54	2673	2830	3.30	3.49
69.30*	8	1500	7759	8684	5.17	5.79	2366	2647	1.58	1.76
69.40*	9	2014	7779	8629	3.86	4.28	2036	2258	1.01	1.12
69.50*	8	990	2600	2970	2.62	3.00	713	814	0.72	0.82
69.90*	9	5539	2032	2223	0.36	0.40	460	503	0.08	0.09
70.10	9	678	4688	4915	6.91	7.25	1241	1301	1.83	1.92
70.20	9	969	4510	4283	4.65	4.42	1227	1164	1.27	1.20
71.10*	9	2876	3138	3293	1.09	1.14	938	984	0.33	0.34
71.20	9	826	4399	3970	5.32	4.81	1100	992	1.33	1.20
71.30*	9	3267	895	1144	0.27	0.35	277	311	0.08	0.10
71.90	9	6275	3837	4589	0.61	0.73	988	1219	0.16	0.19
72.00	9	16564	3480	3432	0.21	0.21	979	965	0.06	0.06
73.90*	9	12946	3471	3508	0.26	0.27	981	991	0.08	0.08
74.10*	7	2746	722	769	0.26	0.28	205	218	0.07	0.08
74.21*	8	1707	9584	9191	5.61	5.38	2475	2373	1.45	1.39
74.22*	8	2463	3704	4086	1.50	1.66	1065	1174	0.43	0.48

I.D.
TABLE 2. (Continued)

Census Tract [e]	Zone [a]	Computed Acreage [b]	Population [c] 1970	Population [c] 1973	Population Density [f] 1970	Population Density [f] 1973	Households [d] 1970	Households [d] 1973	Household Density [g] 1970	Household Density [g] 1973
74.90*	8	2440	566	550	0.23	0.23	170	165	0.07	0.07
75.10*	5	864	7999	6932	9.25	8.02	2147	1860	2.48	2.15
75.20*	6	622	3993	4372	6.41	7.03	1016	1112	1.63	1.79
75.30*	7	1762	3214	3636	1.82	2.06	1031	1165	0.58	0.66
75.90*	7	3591	3210	4185	0.89	1.17	877	1143	0.24	0.32
76.00*	4	717	2409	2652	3.35	3.70	672	739	0.94	1.03
77.10*	6	486	5821	6398	11.97	13.16	1696	1863	3.49	3.83
77.20*	7	930	8576	9531	9.22	10.25	2841	3156	3.05	3.39
77.30	7	314	4506	4948	14.35	15.76	1369	1503	4.36	4.79
77.40*	7	409	1823	1707	4.45	4.17	540	505	1.32	1.23
78.11*	6	638	6018	7344	9.43	11.51	1787	2180	2.80	3.42
78.12*	6	919	2310	2603	2.51	2.83	644	725	0.70	0.79
78.20	5	517	5472	4925	10.58	9.53	2430	2186	4.70	4.23
78.30*	3	279	2566	2635	9.19	9.44	1257	1290	4.50	4.62
79.20	9	4415	3274	3385	0.74	0.77	887	917	0.20	0.21
79.30*	9	4014	5844	6291	1.45	1.57	1439	1548	0.36	0.39
79.40*	7	4820	884	875	0.18	0.18	278	275	0.06	0.06
79.50*	8	3496	3834	4797	1.09	1.37	1041	1302	0.30	0.37
80.00	9	13803	1056	993	0.07	0.07	284	266	0.02	0.02
81.10	7	512	5583	5621	10.90	10.98	1806	1817	3.53	3.55
81.20	7	479	5632	5660	11.75	11.82	1721	1729	3.59	3.61
81.90*	8	17644	5005	5220	0.28	0.30	1463	1525	0.08	0.09
82.10*	6	1789	2797	2465	1.56	1.38	1028	905	0.58	0.51
82.30	6	262	1332	1324	5.08	5.05	601	597	2.29	2.28
82.90*	4	2919	3300	3914	1.13	1.34	1038	1231	0.35	0.42
83.11*	6	583	4717	4702	8.09	8.07	1382	1377	2.37	2.36
83.12*	6	368	5800	6302	15.76	17.13	1740	1890	4.73	5.14
83.21	5	260	3226	3588	12.40	13.80	974	1083	3.75	4.17
83.22*	4	401	5223	5731	13.02	14.29	1705	1870	4.25	4.66
83.30*	3	388	2796	3193	7.20	8.23	926	1056	2.39	2.72

I.D.

TABLE 2. (Continued)

Census Tract[e]	Zone[a]	Computed Acreage[b]	Population[c]		Population Density[f]		Households[d]		Household Density[g]	
			1970	1973	1970	1973	1970	1973	1970	1973
83.40*	3	2099	3727	3227	1.77	1.54	1047	905	0.50	0.43
83.90*	5	6494	6103	7570	0.93	1.17	1645	2040	0.25	0.31
84.00	3	438	3802	4049	8.68	9.24	1272	1341	2.90	3.06
85.00	3	537	5334	5243	9.93	9.76	1872	1840	3.49	3.43
87.10	4	357	3519	3047	9.85	8.54	1222	1057	2.27	2.96
87.20	4	645	4672	4817	7.24	2.57	1699	1751	2.63	2.71
87.30	5	589	2964	3140	5.03	5.33	835	884	1.42	1.50
87.40	4	587	317	338	0.54	0.58	13	13	0.02	0.02
88.11	4	725	1884	1791	2.59	2.47	478	454	0.66	0.63
88.12	5	618	3968	4076	6.42	6.60	979	1005	1.58	1.63
88.13	6	585	3943	3987	6.74	6.82	929	938	1.59	1.60
88.14	6	1407	740	839	0.52	0.60	213	241	0.15	0.17
88.21	4	1126	4860	5081	4.31	4.51	1346	1407	1.20	1.25
88.22*	6	1333	2177	2130	1.63	1.60	690	674	0.52	0.51
88.23*	6	1548	6441	8757	4.16	5.66	1638	2226	1.06	1.44
89.00	4	370	5815	5970	15.71	16.14	1725	1771	4.66	4.79
90.00	4	618	3521	3495	5.69	5.66	1160	1151	1.88	1.86
91.00	5	486	5552	5650	11.42	11.63	1758	1788	3.62	3.68
92.10*	7	1512	3431	4085	2.26	2.70	1301	1548	0.86	1.02
92.20	6	481	3608	3768	7.50	7.83	1258	1313	2.62	2.73
92.30	7	519	6824	7393	13.14	14.24	2067	2238	3.98	4.31
92.40	7	295	3216	3401	10.90	11.53	943	996	3.20	3.38
92.50	7	246	2798	2956	11.37	12.02	893	943	3.63	3.83
93.11	8	403	3994	4212	9.91	10.45	1107	1166	2.75	2.89
93.12	8	366	3521	3587	9.62	9.80	935	951	2.55	2.60
93.21	7	260	2840	2918	10.92	11.22	796	817	3.06	3.14
93.22	8	353	5195	5533	14.71	15.67	1434	1526	4.06	4.32
93.23	7	713	4258	4822	5.97	6.76	1308	1480	1.83	2.08
93.24	7	996	503	717	0.50	0.72	211	300	0.21	0.30
93.31	6	149	1777	1813	11.92	12.17	776	791	5.21	5.31

I.D.
TABLE 2. (Continued)

Census Tract [e]	Zone [a]	Computed Acreage [b]	Population [c]		Population Density [f]		Households [d]		Household Density [g]	
			1970	1973	1970	1973	1970	1973	1970	1973
93.32	5	432	4209	4231	9.74	9.79	1161	1166	2.69	2.70
93.33	6	198	2700	2877	13.63	14.53	834	888	4.21	4.48
93.34	6	374	4229	4479	11.30	11.98	1121	1187	3.00	3.17
93.35	6	1136	3551	4200	3.12	3.70	1054	1246	0.93	1.10
93.40	8	362	3334	3241	9.20	8.95	1038	1108	2.87	3.06
93.50	8	424	2161	2406	5.09	5.67	829	923	1.96	2.18
93.61*	8	1537	2911	4144	1.89	2.70	818	1164	0.53	0.76
93.62*	9	986	3808	4075	3.86	4.13	964	1031	0.98	1.05
93.70*	8	3455	7799	10938	2.25	3.17	2033	2851	0.59	0.83
93.81*	9	760	1615	1809	2.12	2.38	435	487	0.57	0.64
93.82	9	500	3356	3485	6.71	6.97	876	908	1.75	1.82
93.83	9	338	2903	2791	8.58	8.26	773	742	2.29	2.20
93.84	9	308	3231	3058	10.49	9.93	902	852	2.93	2.77
93.85	9	752	1447	1544	1.92	2.05	428	456	0.57	0.61
93.86*	9	624	322	413	0.51	0.66	86	110	0.14	0.18
93.90	9	1614	1139	1474	0.70	0.91	375	485	0.23	0.30
94.10	9	603	1794	1972	2.97	3.27	450	494	0.75	0.82
94.20	8	938	6470	7696	6.89	8.20	1573	1870	1.68	1.99
94.30*	7	2979	1489	1514	0.49	0.51	414	420	0.14	0.14
94.40	9	2048	2807	2984	1.37	1.46	856	910	0.42	0.44
94.50	9	3014	2285	1978	0.75	0.66	755	653	0.25	0.22
94.90	9	23384	2899	3110	0.12	0.13	793	850	0.03	0.04
95.10	9	2882	5623	5520	1.95	1.92	958	939	0.33	0.33
95.20*	7	1467	2271	2273	1.54	1.55	672	672	0.46	0.46
95.90	8	11915	4567	4708	0.38	0.40	1191	1227	0.10	0.10
96.00	8	742	4112	3838	5.54	5.17	1402	1308	1.89	1.76
97.10	7	727	8624	8564	11.86	11.78	2327	2310	3.20	3.18
97.20	6	1756	1807	2577	1.02	1.47	515	733	0.29	0.42
97.30	7	754	840	727	1.11	0.96	256	221	0.34	0.29

I.D.
TABLE 2. (Continued)

Census Tract [e]	Zone [a]	Computed Acreage [b]	Population [c] 1970	Population [c] 1973	Population Density [f] 1970	Population Density [f] 1973	Households [d] 1970	Households [d] 1973	Household Density [g] 1970	Household Density [g] 1973
97.90	8	18159	3436	3350	0.18	0.18	910	886	0.05	0.05
98.00	9	28663	4171	4308	0.14	0.15	1189	1227	0.04	0.04
Totals		339713	833249	856794	2.45	2.52	259321	279136	0.83	0.82

a. The Zone to which the census tract has been assigned. This represents distance from the center of the city. Thus, Zone 5 is a concentric ring one (1) mile wide of the area within four (4) to five (5) miles of the Central Business District.

b. City of Columbus Acreage estimates with correction of those census tracts where an error of greater than 10% has occurred (see Table 1). These include census tracts 6.00, 13.00, 23.00, 29.00, 41.00 and 59.00. Since the origin of measurement error is unknown an average of the two figures was used.

c. 1970 Census of Population and Housing, Census Tracts, Columbus, Ohio, PHC (1)-50, U. S. Department of Commerce, Bureau of the Census, May, 1972, Table P-1 (All Persons).
1974 Census Tract Update File, National Planning Data Corporation (estimated), copyright, 1974.

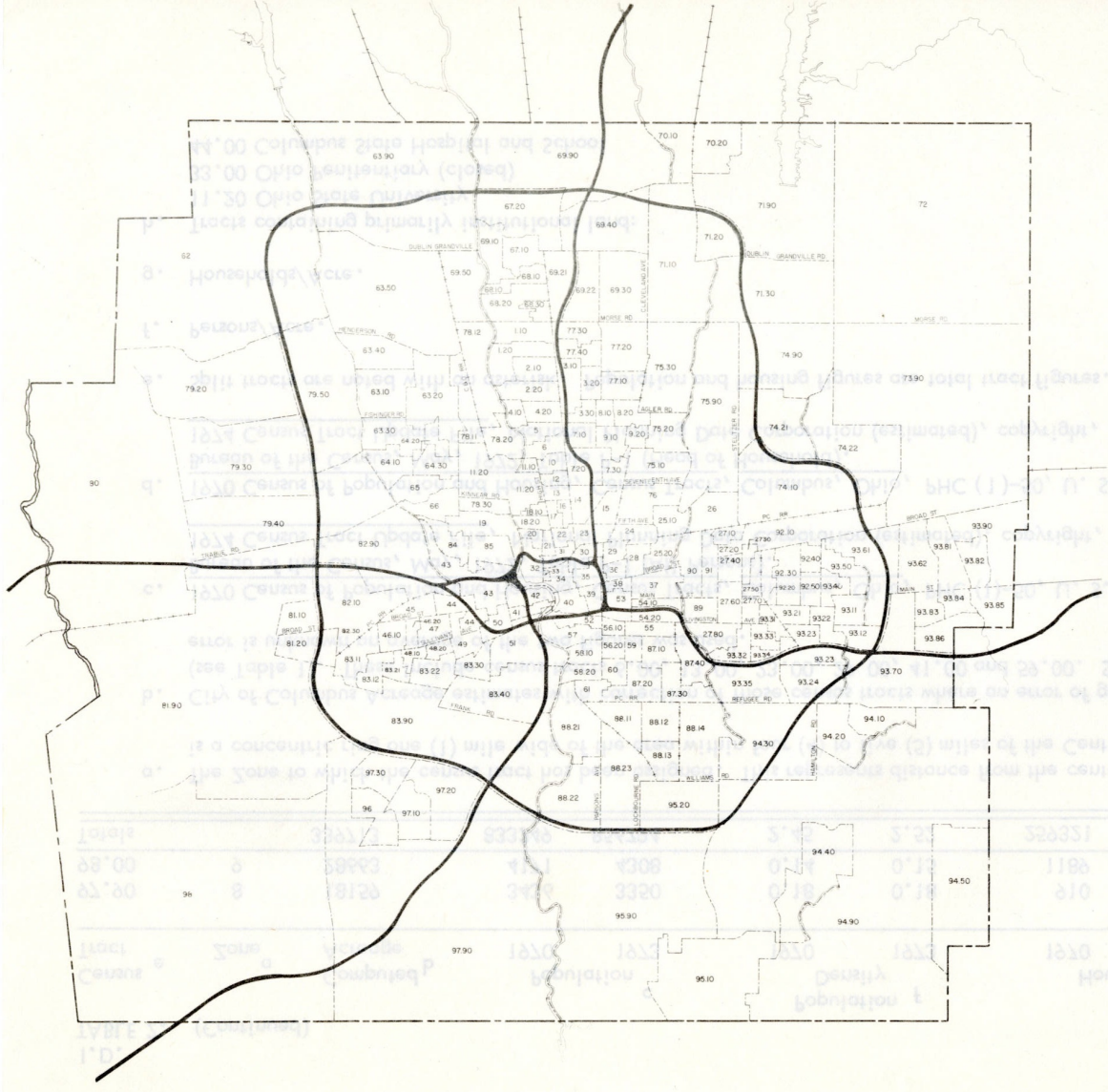
d. 1970 Census of Population and Housing, Census Tracts, Columbus, Ohio, PHC (1)-50, U. S. Department of Commerce, Bureau of the Census, May, 1972, Table P-1 (Head of Household).
1974 Census Tract Update File, National Planning Data Corporation (estimated), copyright, 1974.

e. Split tracts are noted with an asterisk. Population and housing figures are total tract figures.

f. Persons/Acre.

g. Households/Acre.

h. Tracts containing primarily institutional land:
11.20 Ohio State University
33.00 Ohio Penitentiary (closed)
44.00 Columbus State Hospital and School



Columbus, Ohio
Mayor Tom Moody
Department of Development
N. Jack Huddle Director

Division of Planning

Census tract boundary

Major freeways

0 2 mi

Franklin County Census Tracts, 1970

May 1974

II

A CONCENTRIC ZONE SYSTEM FOR URBAN ANALYSIS

A. An Overview of Urban Structure Theory

In this section a concentric zone system is devised which can be used to reveal the patterns and trends of urban structure. The use of this model implies a theoretical framework about how urban areas are structured, and how they grow and evolve. The use of a concentric zone system was chosen over other possible approaches because (a) it is consistent with major theories of urban structure, (b) the nature of the Columbus Metropolitan area indicates that this is a worthwhile method of analysis, and (c) it permits greater utilization of census tract variables by giving them a spatial dimension.

Many urban models are not mutually exclusive but complementary. None are completely explanatory. A multitude of factors affect the shape and size of a city, complicating analysis. Nor, are all cities alike. Therefore, a brief review of various theories of urban structure will provide many insights into the processes of urban growth and development.

Several theoretical models have been put forward to explain the processes of urban change. The first major attempt at such an explanation was made by Robert Park and Ernest Burgess.[2] The basic assumptions were that Cities expand in ringlike fashion over time, that the process of upward social mobility involved geographic migration, and this migration consists of movement of households from areas close to the C. B. D. to areas on the periphery as their incomes rise. This theory also embodies the "filtering" process i.e. as families move outward from the center to new homes, new arrivals move into the vacated older houses. Thus, the housing stock is said to "filter down" to those in lower income groups. The result of this process was a city with a specific spatial pattern of activity and residential zones.

The concentric zone model was "tested" by combining Chicago census tracts in zones from the C. B. D. When allowances for variations in the model were made (based on race, ethnicity, or type of residence) the model reflected the basic residential patterns of the City of Chicago with low income families near the C. B. D., and wealthier families on the periphery of the City.

[2]Robert E. Park and Ernest W. Burgess, The City, University of Chicago Press, 1925.

It was not long before the validity of the concentric zone theory of Burgess was questioned by Homer Hoyt who presented a sectoral model of urban structural change.[3] Hoyt, on the basis of an extensive study, said that high and low rent areas occupy distinct subareas of the city. These subareas are not arranged concentrically around the C. B. D. but rather sectorally. Hoyt suggested that in any city certain pieces of land will be preferred to others. This land will be used by those who can afford to pay the highest rents. Hoyt pointed out other factors such as (1) accessibility to best transportation, (2) high ground, and (3) land along waterfronts which also influenced the household location decision.

The concentric zone and sectoral zone theories are not necessarily mutually exclusive. For example, Homer Hoyt noted a tendency for the innermost parts of high-rent sectors to become low grade residential areas. Thus, one can hypothesize a cyclical zone system operating within sectors at differential rates of growth. For example, as housing near the C. B. D. becomes completely run down, and the costs of commuting (particularly the time costs) rise, an area may be redeveloped creating an area which attracts high income residents. German Village is an example of an area resulting from this process.

A third set of models combines an analysis of housing market, land use, and behavioral assumptions about "household equilibrium" to explain the structure of a city.[4] These models reflect a general approach used by urban economists. These models are consistent with a concentric zone approach, but tend to be more sophisticated and mathematically precise. However, these models rely primarily on two factors of household location: (1) the cost and location of housing, and (2) the costs of transportation (the journey to work). While these are important factors, several others must also be considered. Also, these models assume a central business district which is the center of employment and business activity, an unrealistic assumption in many instances.

[3]Homer Hoyt, The Structure and Growth of Residential Neighborhoods in American Cities, Federal Housing Administration, Washington, D.C., 1939.

[4]These include (among others) William Alonzo, Location and Land Use: Toward a General Theory of Land Rent, Harvard University Press, Cambridge, Mass., 1964, and "Equilibrium of the Household" reprinted in Page A, and Seyried (eds.), Urban Analysis, Scott Foresman, 1970; Richard Muth, Cities and Housing, University of Chicago Press 1969; Lowdon Wingo, Transportation and Urban Land, Resources for the Future Inc., Washington 1961; Edwin S. Mills, Urban Economics, Scott Foresman, Glenview, Illinois, 1972, and "An Aggregative Model of Resource Allocation in a Metropolitan Area" American Economic Review, LVII No. 2, May, 1967; and Emilio Casetti, "Equilibrium Land Values and Population Density in an Urban Setting," "Economic Geography, January, 1971

Still a fourth set of models seeks to determine intra-urban movement patterns by analyzing various factors affecting the residential location decision.[5] These models are listed under the headings of Social Area Analysis, Factorial Analysis, or Factorial Ecology. As a result of such factor analysis, three basic variables have been identified as being significant indicators of location within a city. These are: (1) urbanization or family status (2) socio-economic status and (3) population growth and mobility. Other factors have also been found to be important spatial indicators. These are: (1) the stage in the life cycle of the family, (2) ethnic factors, and (3) the resources of the households. Results of early studies tended to show that family status and urbanization factors tend to reflect a concentric zone pattern, while considerations of socio-economic factors tend to exhibit a sectoral distribution. One major study has used factorial analysis to show the spatial distribution for a wide variety of factors in the City of Chicago.[6] Philip Rees has conducted a similar study in Chicago using census tracts with similar results.[7]

Social area analysis involves the correlation of variables with factors affecting intra-urban migration. Then selecting those variables which seem to be the best indicators of the factors being considered. These indicators are then mapped to reveal urban patterns in social space. The results of such studies above reinforce the concentric zone and sector theories presented earlier. As noted by Berry and Horton, "Both Burgess and Hoyt were correct when they described the socio-economic population pattern of cities as respectively zonal and sectoral: they had both based their original work on Chicago where their hypotheses held simutaneouly."[8]

[5]The classic publications are Eshref Shevky and Marianne Williams, The Social Areas of Los Angeles: Analysis and Typology, University of California Press, Berkely and Los Angeles, 1949; Wendell Bell, "The Social Areas of the San Francisco Bay Region," American Sociological Review XVII, February, 1953; Eshref Shevky and Wendell Bell, Social Area Analysis: Theory, Illustrative Application and Computational Procedures, Stanford University Press, Stanford, California, 1955.

[6]Brian J. L. Berry and Robert Tennant Commercial Structure, Northeastern Illinois Planning Commission, Chicago, 1965.

[7]Philip Rees, "The Factorial Ecology of Metropolitan Chicago, "University of Chicago, Masters Thesis, 1968.

[8]Brian J. L. Berry, and Frank E. Horton, Geographic Perspectives on Urban Systems, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1970, p. 371.

The City of Columbus has several characteristics which make a concentric zone framework of analysis particularly appropriate. First of all, the City of Columbus has a Central Business District (C. B. D.) which is clearly the center of employment and business activity. The nature of the economic base of the city as a business services and government center does not require large amounts of land and equipment which might necessitate a suburban location. Also, there are no major geographical boundaries which would complicate the analytical task. Interstate highways, the innerbelt, and the outerbelt provide access to all areas with little difficulty.

The use of census tracts as the areal unit of analysis gives the planner access to the wealth of data collected by the Census Bureau for his study. In addition this data can be more efficiently utilized by giving it a spatial dimension.

Finally, as shown by the previous discussion, a concentric zone approach is generally consistent with, if not in complete agreement with the major theories of urban structure. Indeed, data limitations prevent an adequate test of the more sophisticated and elaborate models. Thus, a concentric zone analysis is a useful link between empirical reality and urban structure theory.

B. A Zone System for the Columbus Metropolitan Area

In this section a concentric zone system is constructed to give census tract variables a spatial dimension. Such a system is particularly useful for charting areawide patterns of housing and population density. In constructing this system, census tracts were assigned to zones based on their distance from the C.B.D. (Central Business District). As nearly as possible, census tracts were assigned to conform to the boundaries of concentric zones one mile wide starting from the C.B.D.

The Central point of reference for this system is the 3 way intersection of census tracts 34, 40, and 42 with the Scioto River. Zone one, therefore, includes census tracts falling within a one mile radius of this central reference point. While much overlapping occurs, as long as it is kept under control and accounted for, it need not affect our attempt to construct a system which shows the underlying spatial patterns and trends of metropolitan Columbus.

A close check on the acreage totals for each zone is accomplished by mathematically computing the expected acreage in each zone. Using the formula for the area of a circle, we compute the expected acreage in zone one as follows:

$A_1 = \Pi r_1^2 \quad (640)$

$A_1 = (3.14)\,(1)\,(640)$

$A_1 = 2009.6$

Where,

A_1 = expected acreage in zone 1

r_1 = radius (1 mile)

II = 3.14

640 = acres/square mile.

Likewise, the formula for acreage in Zone 2 will be:

$A_2 = \text{II}\,(r_2)^2 \quad (640) \quad - A_1$

$A_2 = \text{II}\,(r_2)^2 \quad (640) \quad - \text{II}\,(r_1)^2 \quad (604)$

$A_2 = \text{II}\,(640)\,(r_2^2 - r_1^2)$

$A_2 = 3.14\,(640)\,(4-1) = 6,028.8$ acres

This process is completed for each zone giving the expected acreage for each zone. These "acreage constraints" are shown in Table 3. Using these checks census tracts were then assigned to each zone. As long as the total acreage of tracts assigned to each zone conforms to the expected zone acreage, the results from aggregation are likely to be valid and useful.

II. C

TABLE 3. EXPECTED ACREAGE BY ZONE

(Where A_1, A_2, ...A_9 are the expected acreage, zones 1 through 9)

$A_1 = \pi r_1^2 \ (640) = 3.14 \ (1) \ (640) = 3.14 \ (640) = 2{,}009.6$ acres

$A_2 = \pi r_2^2 \ (640) - \pi r_1^2 \ (640) = 3.14 \ (r_2^2 - r_1^2) \ (640) = 3.14 \ (3) \ (640) = 6{,}028.8$ acres

$A_3 = \pi r_3^2 \ (640) - \pi r_2^2 \ (640) = 3.14 \ (r_3^2 - r_2^2) \ (640) = 3.14 \ (5) \ (640) = 10{,}048.0$ acres

$A_4 = \pi r_4^2 \ (640) - \pi r_3^2 \ (640) = 3.14 \ (r_4^2 - r_3^2) \ (640) = 3.14 \ (7) \ (640) = 14{,}067.2$ acres

$A_5 = \pi r_5^2 \ (640) - \pi r_4^2 \ (640) = 3.14 \ (r_5^2 - r_4^2) \ (640) = 3.14 \ (9) \ (640) = 18{,}086.4$ acres

$A_6 = \pi r_6^2 \ (640) - \pi r_5^2 \ (640) = 3.14 \ (r_6^2 - r_5^2) \ (640) = 3.14 \ (11) \ (640) = 22{,}105.6$ acres

$A_7 = \pi r_7^2 \ (640) - \pi r_6^2 \ (640) = 3.14 \ (r_7^2 - r_6^2) \ (640) = 3.14 \ (13) \ (640) = 26{,}124.8$ acres

$A_8 = \pi r_9^2 \ (640) - \pi r_7^2 \ (640) = 3.14 \ (r_9^2 - r_7^2) \ (640) = 3.14 \ (32) \ (640) = 64{,}307.2$ acres

$A_9 = \pi r_{13}^2 \ (640) - \pi r_9^2 \ (640) = 3.14 \ (r_{13}^2 - r_9^2) \ (640) = 3.14 \ (88) \ (640) = 176{,}844.8$ acres

II

D. Assignment of census tracts to Concentric Zones

The assignment of tracts to zones was strictly an arbitrary process. Only two criteria were used. The basic criterion was "in which zones does the bulk of the census tract fall." A second criterion was the use of our expected acreage constraint for each zone described above. Using these criteria, census tracts were assigned to zones as presented in Table 4 and as shown on Map 2. We should note also that Zone 8 is a two-mile wide concentric ring, and Zone 9 is a four mile wide ring which includes the balance of Franklin County.

As shown in Table 4 the actual (census tract) acreage totals closely approximate the expected acreage in each zone. The range of variation goes from a very small .06% in Zone 3 to a maximum of 11.37% in Zone 6. While much variation occurs within each zone a general pattern begins to emerge with density first rising then falling steadily with distance from the C. B. D.

II. E.

TABLE 4. A ZONE DESCRIPTION OF ACREAGE, POPULATION DENSITY, AND HOUSING VARIABLES

ZONE 1

(includes tracts falling within a one mile radius of the Central Business District)

TRACT NUMBER	ACREAGE	POPULATION	DWELLING UNITS	PERSONS ACRE	DWELLING UNIT ACRE	MEDIAN GROSS RENT	MEDIAN HOUSING VALUE
31.00	174	1,346	714	7.73	4.10	63	7,100
32.00	341	2,155	1,088	6.31	3.19	163	14,400
33.00	23	1,980	-0-	86.08	-----	(OHIO PENITENTIARY)	
34.00	233	562	127	2.41	0.54	84	-----
35.00	207	1,975	1,098	9.54	5.30	74	9,800
39.00	225	2,636	1,599	11.71	7.10	91	10,800
40.00	322	1,333	809	4.13	2.51	66	14,400
41.00	178	3,603	1,427	20.24	8.02	73	9,000
42.00	349	1,862	635	5.33	1.81	86	8,500
TOTALS	2,052[a]	17,452	7,497	8.50[b]	3.65[c]	87.50[d]	10,571[e]

EXPECTED ACREAGE: 2,009.6 acres COMPUTED ACREAGE: 2,052 acres PERCENT DEVIATION: $D_1 = \frac{42.4}{2,009.6} = 2.11\%$

TABLE 4. (Cont'd.)

ZONE 2

(includes tracts falling within a one mile wide concentric ring one to two miles from the C. B. D_o)

TRACT NUMBER	ACREAGE	POPULATION	DWELLING UNITS	PERSONS / ACRE	DWELLING UNIT / ACRE	MEDIAN GROSS RENT	MEDIAN HOUSING VALUE
18.20	194	4,148	1,840	21.38	9.48	91	12,100
20.00	161	5,979	2,125	37.13	13.19	90	9,400
21.00	118	2,343	1,202	19.85	10.18	82	15,800
22.00	155	3,129	1,269	20.18	8.18	70	8,600
23.00	292	2,869	970	9.82	3.32	96	9,400
29.00	193	2,725	829	14.11	4.29	88	9,300
30.00	298	1,008	362	3.38	1.21	80	12,900
36.00	155	3,755	1,752	24.22	11.33	78	9,700
38.00	176	5,225	2,286	29.68	12.98	87	12,100
43.00	1,225	4,783	1,682	3.90	1.37	91	8,700
50.00	308	5,079	1,780	16.42	5.77	98	10,600
51.00	1,074	5,222	1,881	4.86	1.75	80	10,800
52.00	242	3,949	1,693	16.31	6.99	90	9,900
53.00	329	7,509	2,560	22.82	7.78	94	10,900
56.10	136	3,666	1,162	26.95	8.54	94	10,700
57.00	514	5,255	2,277	10.22	4.42	91	11,400
58.10	233	4,570	1,641	19.61	7.04	97	12,100
TOTALS	5,803 [a]	71,214	27,311	12.27 [b]	4.71 [c]	88.06 [d]	10,847 [e]

EXPECTED ACREAGE: 6,028.8 acres COMPUTED ACREAGE: 5,803 acres PERCENT DEVIATION: $D_2 = \frac{225.8}{6028.8} = 3.74\ \%$

TABLE 4. (Cont'd.)

ZONE 3

(includes tracts falling within a one mile wide concentric ring two to three miles from the C. B. D.)

TRACT NUMBER	ACREAGE	POPULATION	DWELLING UNITS	PERSONS / ACRE	DWELLING UNIT / ACRE	MEDIAN GROSS RENT	MEDIAN HOUSING VALUE
12.00	151	4,822	1,411	29.68	9.34	115	18,500
13.00	153	6,297	1,982	41.15	12.95	120	17,100
14.00	436	3,736	1,173	8.56	2.69	104	12,000
15.00	306	4,287	1,247	14.00	4.07	78	10,900
16.00	124	3,127	1,132	25.21	9.12	93	10,300
17.00	122	3,620	1,608	29.67	13.18	95	10,400
18.10	89	4,059	1,796	45.60	20.17	108	17,100
19.00	688	6,557	3,467	9.53	5.03	110	15,100
24.00	324	859	339	2.65	1.04	94	9,400
25.20	372	4,693	1,843	12.61	4.95	106	17,200
28.00	236	5,147	2,156	21.80	9.13	72	11,400
37.00	510	7,467	2,846	14.64	5.58	96	15,100
44.00	506	5,213	424	10.30	0.83	103	12,300
49.00	382	6,130	2,262	16.04	5.92	104	14,200
54.10	238	3,795	1,194	15.94	5.01	101	12,400
54.20	217	4,286	1,297	19.75	5.97	111	13,300
55.00	368	7,709	2,456	21.49	6.91	103	13,900
56.20	169	3,715	1,299	21.98	7.68	98	11,600
58.20	260	3,704	1,272	14.24	4.89	97	12,000
59.00	173	3,629	1,255	20.97	7.25	105	14,600
60.00	236	3,646	1,127	15.44	5.02	68	11,800
61.00	254	5,400	1,824	21.25	7.18	92	10,000
78.30	279	2,566	1,351	9.19	4.84	129	16,200
83.30	388	2,796	939	7.20	2.42	128	15,300
83.40	2,099	3,727	1,074	1.77	0.51	107	13,800
84.00	438	3,802	1,301	8.68	2.97	192	21,500
85.00	537	5,334	1,908	9.93	3.55	117	18,300
TOTALS	10,055[a]	119,983	41,983	11.93[b]	4.18[c]	105.41[d]	13,929[e]

EXPECTED ACREAGE: 10,048 acres COMPUTED ACREAGE: 10,055 acres PERCENT DEVIATION: $D = \frac{7}{10,048.0} = 0.06\%$

TABLE 4. (Cont'd.)

ZONE 4

(includes tracts falling within a one mile wide concentric ring three to four miles from the C. B. D.)

TRACT NUMBER	ACREAGE	POPULATION	DWELLING UNITS	PERSONS ACRE	DWELLING UNIT ACRE	MEDIAN GROSS RENT	MEDIAN HOUSING VALUE
6.00	220	5,426	2,041	24.66	9.27	106	12,400
7.20	535	4,203	1,327	7.85	2.48	100	13,300
7.30	236	6,113	1,737	25.90	7.36	110	13,900
10.00	202	6,430	2,412	31.83	11.94	106	12,000
11.10	136	2,978	1,156	21.89	8.50	109	13,500
11.20	1,510	12,479	393	8.26	0.26	86	17,800
25.10	428	2,977	958	6.95	2.23	110	15,700
45.00	376	6,243	2,191	16.60	5.82	105	13,900
46.20	180	3,365	1,166	18.69	6.47	109	12,900
47.00	320	7,263	2,405	22.69	7.51	97	11,700
48.10	198	3,506	1,265	17.70	6.38	112	16,800
48.20	196	3,361	1,130	17.14	5.76	104	13,100
66.00	508	5,184	1,864	10.20	3.66	159	30,700
76.00	717	2,409	704	3.35	0.98	110	14,600
82.90	2,919	3,300	1,655	1.13	0.36	115	16,500
83.22	401	5,223	1,751	13.02	4.36	134	20,200
87.10	357	3,519	1,247	9.85	3.49	129	19,000
87.20	645	4,672	1,731	7.24	2.68	88	17,400
87.40	587	317	14	0.54	0.02	---	-------
88.11	725	1,884	499	2.59	0.68	101	10,300
88.21	1,126	4,860	1,395	4.31	1.22	90	14,600
89.00	370	5,815	1,797	15.71	4.72	122	20,100
90.00	618	3,521	1,179	5.69	1.91	127	39,700
TOTALS	13,706[a]	105,048	32,017	7.66[b]	2.34[c]	110.41[d]	16,822[e]

EXPECTED ACREAGE: 14,067.2 acres COMPUTED ACREAGE: 13,706 acres PERCENT DEVIATION: $D_4 = \frac{361.2}{14,067.2} = 2.57\%$

TABLE 4. (Cont'd.)

ZONE 5

(includes tracts falling within a one mile concentric ring four to five miles from the C. B. D.)

TRACT NUMBER	ACREAGE	POPULATION	DWELLING UNITS	PERSONS ACRE	DWELLING UNIT ACRE	MEDIAN GROSS RENT	MEDIAN HOUSING VALUE
3.30	207	3,272	1,159	15.80	5.59	114	14,000
4.10	211	3,750	1,434	17.77	6.79	110	16,200
4.20	349	4,168	1,526	11.94	4.37	114	18,400
5.00	271	4,476	1,781	16.51	6.57	112	15,400
7.10	318	5,208	1,782	16.37	5.60	111	13,800
8.10	242	3,618	1,182	14.95	4.88	119	15,600
8.20	339	4,155	1,523	12.25	4.49	112	15,300
9.10	302	5,087	1,668	16.84	5.52	111	13,600
9.20	213	3,187	1,113	14.96	5.52	101	12,800
26.00	562	4,989	1,769	8.87	3.14	104	12,400
27.10	190	2,954	1,513	15.54	7.96	114	------
27.20	116	2,205	999	19.00	8.61	109	18,500
27.40	205	1,913	621	9.33	3.02	125	17,100
27.60	310	4,173	1,818	13.46	5.86	116	20,000
27.80	432	2,935	969	6.79	2.24	118	34,200
46.10	355	4,563	1,577	12.85	4.44	116	19,300
64.20	200	1,463	684	7.31	3.42	165	28,000
64.30	446	4,065	1,234	9.11	2.76	153	30,300
65.00	616	3,909	1,275	6.34	2.06	140	34,300
75.10	864	7,999	2,209	9.25	2.55	68	15,100
78.20	517	5,472	2,495	10.58	4.82	128	19,200
83.21	260	3,226	983	12.40	3.78	131	20,600
83.90	6,494	6,103	1,699	0.93	0.26	123	21,700
87.30	589	2,964	1,044	5.03	1.77	93	16,600
88.12	618	3,968	1,002	6.42	1.62	129	15,800
91.00	486	5,552	1,783	11.42	3.66	121	30,100
93.32	432	4,209	1,171	9.74	2.71	162	28,200
TOTALS	16,144[a]	109,583	38,013	6.79[b]	2.35[c]	118.86[d]	19,129[e]

EXPECTED ACREAGE: 18,086.4 acres COMPUTED ACREAGE: 16,144 acres PERCENT DEVIATION: $D_5 = \frac{1,942.4}{18,086.4} = 10.74\%$

TABLE 4. (Cont'd.)

ZONE 7

(includes tracts falling within a one mile concentric ring six to seven miles from the C. B. D.)

TRACT NUMBER	ACREAGE	POPULATION	DWELLING UNITS	PERSONS / ACRE	DWELLING UNIT / ACRE	MEDIAN GROSS RENT	MEDIAN HOUSING VALUE
1.10	504	4,631	1,826	9.18	3.62	123	19,400
1.20	700	4,210	1,588	6.02	2.26	128	27,000
63.10	1,053	5,955	1,668	5.65	1.58	211	44,600
74.10	2,746	722	209	.26	0.07	95	9,800
75.30	1,762	3,214	1,053	1.82	0.59	111	14,700
75.90	3,591	3,210	896	.89	.24	123	23,400
77.20	930	8,576	3,084	9.22	3.31	130	16,700
77.30	314	4,506	1,386	14.35	4.41	140	22,100
77.40	409	1,823	542	4.45	1.32	173	28,100
79.40	4,820	884	291	0.18	0.06	106	17,300
81.10	512	5,583	1,886	10.90	3.68	131	19,600
81.20	479	5,632	1,778	11.75	3.71	133	17,000
92.10	1,512	3,431	1,387	2.26	.91	115	21,900
92.30	519	6,824	2,097	13.14	4.04	130	17,800
92.40	295	3,216	956	10.90	3.24	140	14,700
92.50	246	2,798	903	11.37	3.67	128	18,100
93.21	260	2,840	804	10.92	3.09	142	18,600
93.23	713	4,258	1,420	5.97	1.99	141	16,900
93.24	996	503	301	.50	.30	155	11,000
94.30	2,979	1,489	433	.49	.14	96	18,800
95.20	1,467	2,271	678	1.54	.46	106	13,300
97.10	727	8,624	2,372	11.86	3.26	125	19,500
97.30	754	840	309	1.11	0.40	70	8,000
TOTALS	28,288[a]	86,040	27,767	3.04[b]	0.98[c]	128.35[d]	19,056[e]

EXPECTED ACREAGE: 26,124.8 acres COMPUTED ACREAGE: 28,288 acres PERCENT DEVIATION: $D_7 = \frac{2,163.2}{26,124.8} = 8.28\%$

TABLE 4. (Cont'd.)

ZONE 8

(includes tracts falling within a two mile wide concentric ring seven to nine miles from the C. B. D., mean distance = eight miles)

TRACT NUMBER	ACREAGE	POPULATION	DWELLING UNITS	PERSONS / ACRE	DWELLING UNIT / ACRE	MEDIAN GROSS RENT	MEDIAN HOUSING VALUE
63.40*	824	1,119	376	1.37	0.45	221	46,900
63.50	5,266	4,344	1,575	0.82	0.29	178	32,600
68.10	376	3,287	986	8.74	2.62	139	19,300
68.20	754	7,137	2,921	9.46	3.87	139	18,800
68.30	209	-----	-----	----	----	---	------
69.21	609	3,783	1,362	6.21	2.23	141	20,500
69.22	810	9,589	2,810	11.83	3.46	168	27,100
69.30	1,500	7,759	2,513	5.17	1.67	161	26,300
69.50	990	2,600	722	2.62	0.72	187	39,500
74.21	1,707	9,584	2,502	5.61	1.46	145	19,300
74.22	2,463	3,704	1,095	1.50	0.44	136	25,100
74.90	2,440	566	176	0.23	0.07	---	26,600
79.50	3,496	3,834	1,052	1.09	0.30	183	32,900
81.90	17,644	5,005	1,501	0.28	0.08	106	19,800
93.11	403	3,994	1,139	9.91	2.82	194	19,400
93.12	366	3,521	943	9.62	2.57	140	19,100
93.22	353	5,195	1,448	14.71	4.10	119	19,900
93.40	362	3,334	1,069	9.20	2.95	120	13,900
93.50	424	2,161	871	5.09	2.05	168	34,200
93.61	1,537	2,911	890	1.89	0.57	207	40,600
93.70	3,455	7,799	2,109	2.25	0.61	179	20,900
94.20	938	6,470	1,607	6.89	1.71	176	17,400
96.00	742	4,112	1,444	5.54	1.94	114	15,700
97.90	18,159	3,436	924	0.18	.05	108	24,700
TOTALS	65,003	104,125	31,659	1.60	0.49	152.76	24,254

EXPECTED ACREAGE: 64,307.2 acres COMPUTED ACREAGE: 65,003 acres PERCENT DEVIATION: $D_8 = \frac{695.8}{64,307.2} = 1.08\%$

* Data from this tract was omitted from totals.

TABLE 4. (Cont'd.)

ZONE 9

(includes tracts falling within a four mile wide concentric ring nine to thirteen miles from the C. B. D., including the remaining tracts in Franklin County, mean distance = eleven miles)

TRACT NUMBER	ACREAGE	POPULATION	DWELLING UNITS	PERSONS ACRE	DWELLING UNIT ACRE	MEDIAN GROSS RENT	MEDIAN HOUSING VALUE
62.00	14,925	3,017	917	0.20	0.06	105	31,600
63.90	8,202	5,888	1,573	0.71	0.19	154	38,100
67.10	446	4,254	1,359	9.53	3.04	127	22,200
67.20	1,717	6,885	1,753	4.00	1.02	146	33,300
69.10	486	1,952	1,609	4.47	1.39	140	36,900
69.40	2,014	7,779	2,072	3.86	1.02	154	23,000
69.90	5,539	2,032	534	0.36	0.09	134	32,600
70.10	678	4,688	1,276	6.91	1.88	104	17,500
70.20	969	4,510	1,244	4.65	1.28	142	21,400
71.10	2,876	3,138	947	1.09	0.32	179	26,100
71.20	826	4,399	1,140	5.32	1.38	213	20,900
71.30	3,267	895	281	0.27	0.08	112	24,300
71.90	6,275	3,837	1,042	0.61	0.16	161	27,300
72.00	16,564	3,480	1,029	0.21	0.06	83	23,300
73.90	12,946	3,471	1,019	0.26	0.07	137	24,700
79.20	4,415	3,274	912	.74	0.20	129	15,200
79.30	4,014	5,844	1,474	1.45	0.36	160	17,300
80.00	13,803	1,056	299	.07	0.02	114	29,600
93.62	986	3,808	1,096	3.86	1.11	193	24,800
93.81	760	1,615	463	2.12	0.60	136	22,800
93.82	500	3,356	883	6.71	1.76	136	15,100
93.83	338	2,903	783	8.58	2.31	176	18,400
93.84	308	3,231	936	10.49	3.03	174	18,500
93.85	752	1,447	443	1.92	0.58	90	21,900
93.86	624	322	92	0.51	0.14	169	39,000
93.90	1,614	1,139	376	0.70	0.23	113	25,900
94.10	603	1,794	459	2.97	0.76	---	17,900
94.40	2,048	2,807	868	1.37	0.42	120	16,600
TOTALS							

(Continued Next Page)

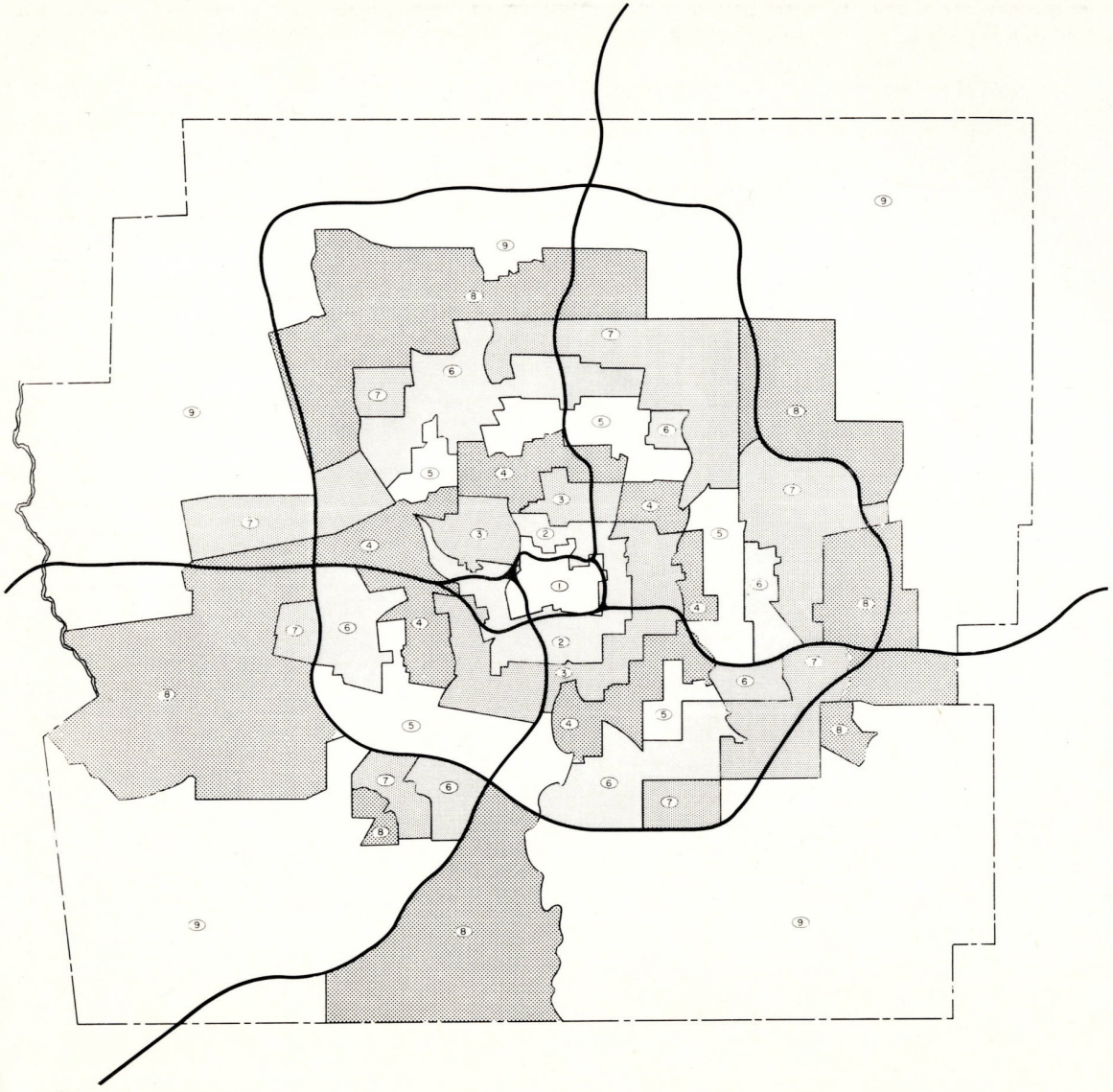
TABLE 4. (Cont'd.)

ZONE 9 (Cont'd.)

TRACT NUMBER	ACREAGE	POPULATION	DWELLING UNITS	PERSONS / ACRE	DWELLING UNIT / ACRE	MEDIAN GROSS RENT	MEDIAN HOUSING VALUE
94.50	3,014	2,285	777	0.75	0.25	108	20,100
94.90	23,384	2,899	820	0.12	0.03	115	22,900
95.10	2,882	5,623	965	1.95	0.33	---	27,400
98.00	28,663	4,171	1,243	0.14	0.04	112	18,100
TOTALS	178,353[a]	107,799	30,684	0.60[b]	0.17[c]	137.87[d]	24,209[e]

EXPECTED ACREAGE: 176,844.8 acres COMPUTED ACREAGE: 178,353 acres PERCENT DEVIATION: $D_9 = \frac{491.8}{176,844.8} = 0.28\%$

a. Total Acreage for the Zone; b. Population Density for the Zone(Persons/Acre); c. Housing Density(Dwelling Units Acre); d. The mean of the medians for each zone; e. The mean of the medians for each zone.



Columbus Ohio
Mayor Tom Moody
Department of Development
N. Jack Huddle Director

Division of Planning

COLUMBUS OHIO

Zones
1, 5, 9 as indicated
2, 6 as indicated
3, 7 as indicated
4, 8 as indicated
Zone boundary
Major freeways

0 2 mi.

Franklin County Concentric Zones

May 1974

III

HOUSING AND POPULATION DENSITY PATTERNS

A. Areawide Patterns of Housing and Population Density.

The purpose of this section is to show how census and density data can be combined with a zone system to reveal social and residential patterns in the Columbus Metropolitan Area. Using the data computed in Table 4, a summary of population density, housing density, median gross rent, and median housing value by zone is presented in Table 5. This information is also presented graphically in Figures 1 and 2.

The density figures in Table 5 were found by adding census tract population and housing (dwelling unit) figures for each zone and dividing through by total census tract acreage in the zone. Gross rent and housing value were found by using the median value of each tract (to eliminate the effect of extreme values). Then, an average of these median tract values was taken to give a zone figure. The patterns revealed are clearly shown. Housing and population density first rise then fall with distance from the C. B. D. Gross rent and Housing Value rise correspondingly with distance from the C. B. D.

Further insight into the Columbus Metropolitan Area can be obtained by noting the variations in density with direction from the C. B. D. To compute such figures, census tract data from each zone in each direction (North, East, South and West) is computed to show density in each zone in every direction. The results of this computation are shown graphically in Figure 3. These show that there are wide variations in density at various distances when we move in different directions from the C. B. D. implying a sectorally structured city.

Finally after reviewing the two basic density models a comparison between the empirically computed density and these theoretical models was made. The results of this comparison are shown in Figure 4. The results imply that at the aggregated County level, population density closely follows the pattern predicted by the density models.

III. B.

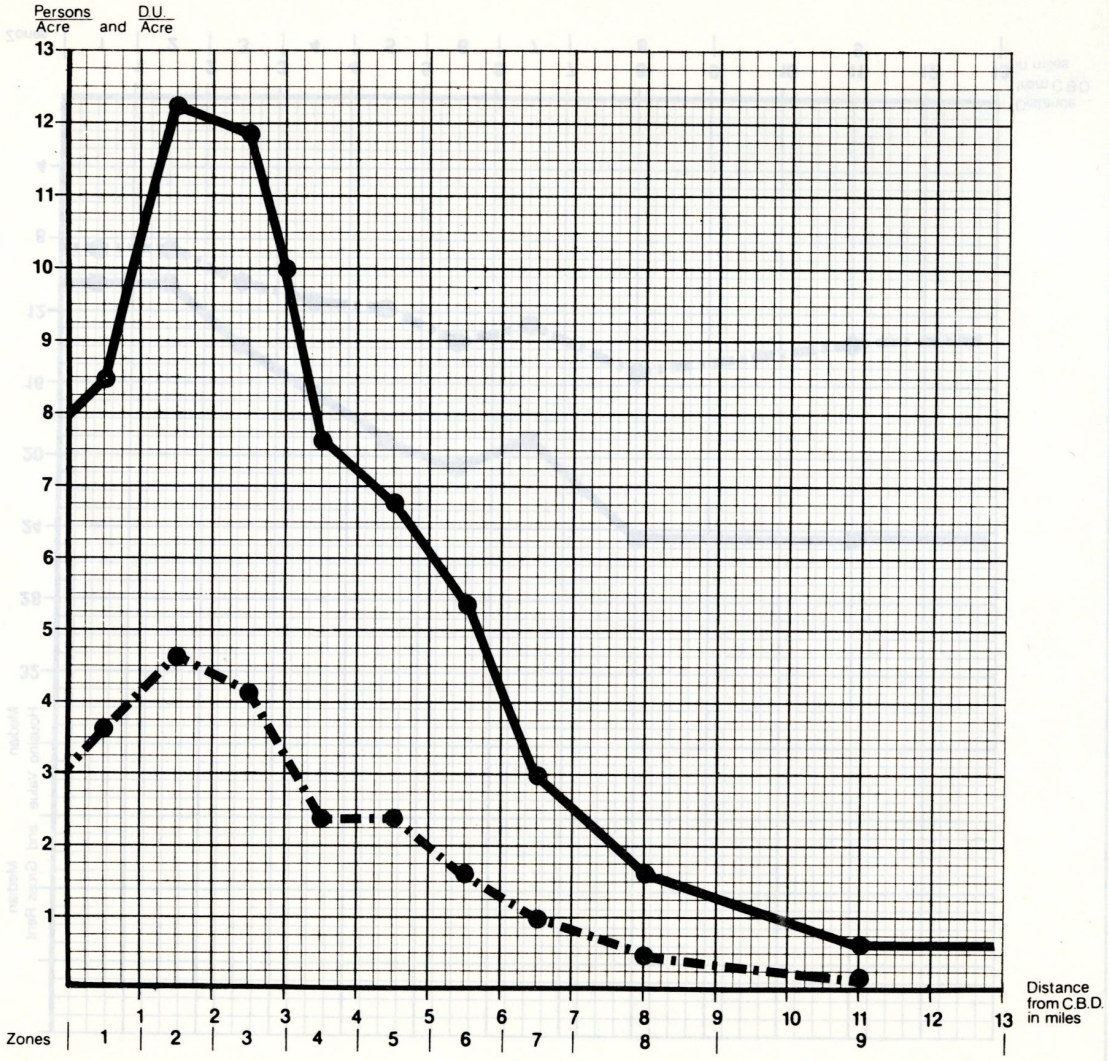
TABLE 5 A SUMMARY OF DENSITY AND HOUSING VARIABLES BY ZONE.

Zone	Population Density	Housing[a] Density	Gross[b] Rent (median)	Housing[c] Value (median)
1	8.50	3.65	87.50	10,571
2	12.27	4.71	88.06	10,847
3	11.93	4.18	105.41	13,929
4	7.66	2.34	110.41	16,822
5	6.79	2.35	118.86	19,129
6	5.33	1.68	138.85	20,876
7	3.04	0.98	128.35	19,056
8	1.60	0.49	152.76	24,254
9	0.60	0.17	137.87	24,209

a Dwelling Units/Acre.

b The mean of medians for each zone.

c The mean of median housing value of tracts in each zone.



Columbus, Ohio
Mayor Tom Moody
Department of Development
N. Jack Huddle Director
Division of Planning

COLUMBUS THE CITY OF OHIO

Population density (persons per acre)
Housing density (dwelling units per acre)

Figure 1.

A Profile of Housing and Population Density in Franklin County 1970

May, 1974

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Mayor Tom Moody
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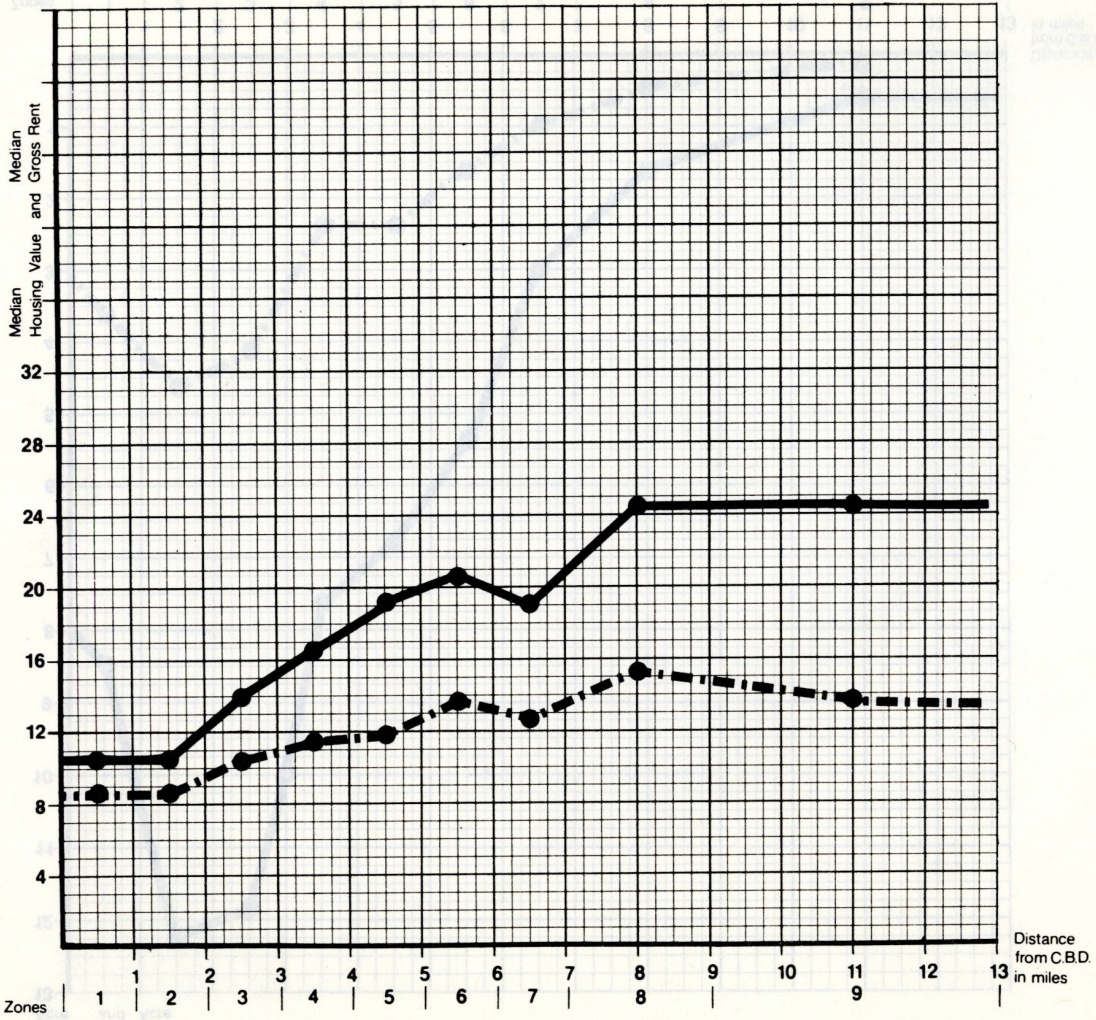
N. Jack Huddle Director
Division of Planning



Median housing value (in thousands)

Median gross rent (in tens)

Figure 2.

Median Gross Rent and Median Housing Value, Franklin County 1970

May, 1974

Columbus, Ohio
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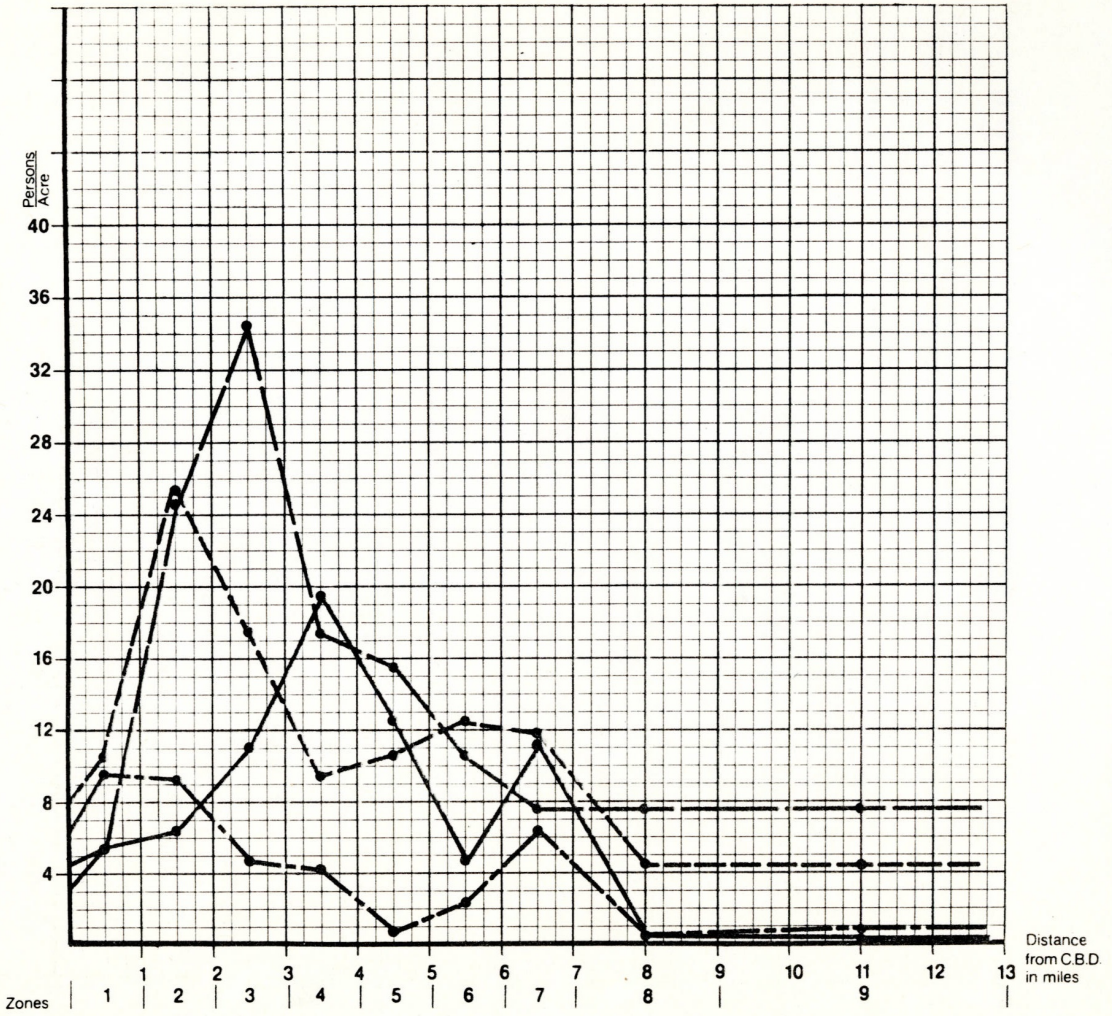

Figure 3.

Density by Direction from the Central Business District

May, 1974

III

F. A Review of Standard Density Models

The relationship between distance from the C. B. D. and changes in population density has been examined in many different cities for long periods of time. The results have revealed a frequently repeated pattern which forms the empirical base for the accepted descriptive models presently being used. There are two such models which, because of their simplicity and predictability, are widely accepted.

It should be noted, however, that the density/distance models, unlike the urban structure theories discussed earlier, only seek to describe the relationship between density and distance from the C. B. D. They do not pretend to explain the processes which lead to the results (data) obtained from density/distance studies. However, urban structure theories, if they are to be credible, must at least be consistent with such descriptive models. At best they explain the processes leading to the structure implied by density/distance graphs.

The most widely used model states that population density is greatest at the core of the City and declines exponentially with distance from the C. B. D.[9]

$$d_x = d_o \; e^{-bx}$$

where,

d_x = population density at distance x

d_o = population density at the C. B. D.

e = the natural log. base

x = distance from the C. B. D.

and b = density gradient.

The density gradient b gives the rate of decline of density with distance from the C. B. D. For mathematical convenience the equation can be transformed into its natural log. form:

$$\ln d_x = \ln d_o - bx.$$

[9]Brian J. L. Berry and Frank E. Horton, Geographic Perspectives on Urban Systems, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1970, p. 276.

In this form density declines linearly, and b, the density gradient, gives the slope of the line. The equation above and others like it are often found as a part of larger more complex urban models.

Another model proposed by Bruce Newling, Assistant Professor of Geography at the City College of New York, seeks to account for the density "crater" found at the core of many large cities with a slightly modified form of the above model.[10] Algebraically this model is,

$$d_x = d_o = e^{bx - cx^2}$$

where,

d_x = population density at distance x

d_o = density at the C. B. D.

b = the instantaneous rate of change of density at the C. B. D. (may be + or -)

c = density gradient for negatively sloped portion of density/distance curve.

If the b parameter is positive, a density crater exists. There is also a density crest located at a distance, $X = \frac{b}{2c}$. The existance of a density crater implies land at the core of a city is being used for non-residential uses. Thus, the existance of a crater and the distance of its crest from the C. B. D. are indicators of the age and stage of development of the city.

Hypothetical parameters, using the first model described above, have already been made for the City of Columbus.[11] Central Core density for Columbus (d_o) is estimated to be 10,000 persons/square mile (or 15.63 persons/acre). The density gradient (b) is estimated to be 0.19. We can thus compare the theoretical model with the empirical results obtained in this study.[12] This comparison is shown in Figure 4.

[10] Bruce Newling, "The Spatial Variation of Urban Population Densities," The Geographical Review, Vol. 59., 1969, pp 242-252.

[11] Found in Bruce Newling's "Urban Growth and Spatial Structure: Mathematical Models and Empirical Evidence," Ekistics, Vol. 36, Number 215, October, 1973.

[12] It should be noted that while the empirical results are shown as a continuous curve in Figure 3, the data are measured in discrete units joined by a curved line.

It is also possible to compare the second model ($d_x = d_o e^{bx - cx^2}$) with our computed density/distance data. The following parameters were chosen:

d_o = 8.0 persons/acre

b = .40

c = (.10).

The density crest in this model is thus $X = \frac{b}{2c} = \frac{.40}{.20}$ = 2 miles from the C. B. D.

This comparison is also shown in Figure 4 which follows.

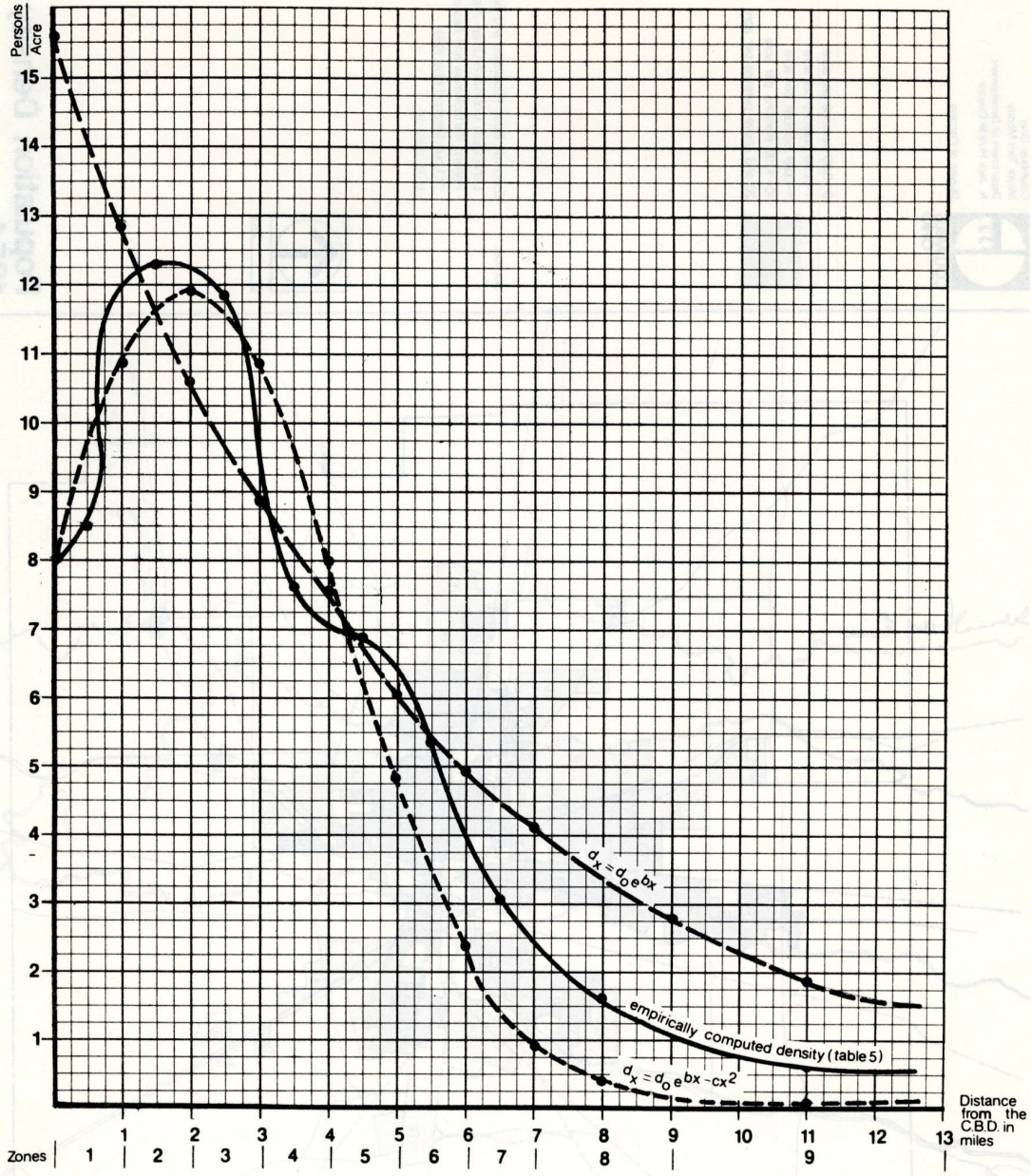

Figure 4.

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Division of Planning

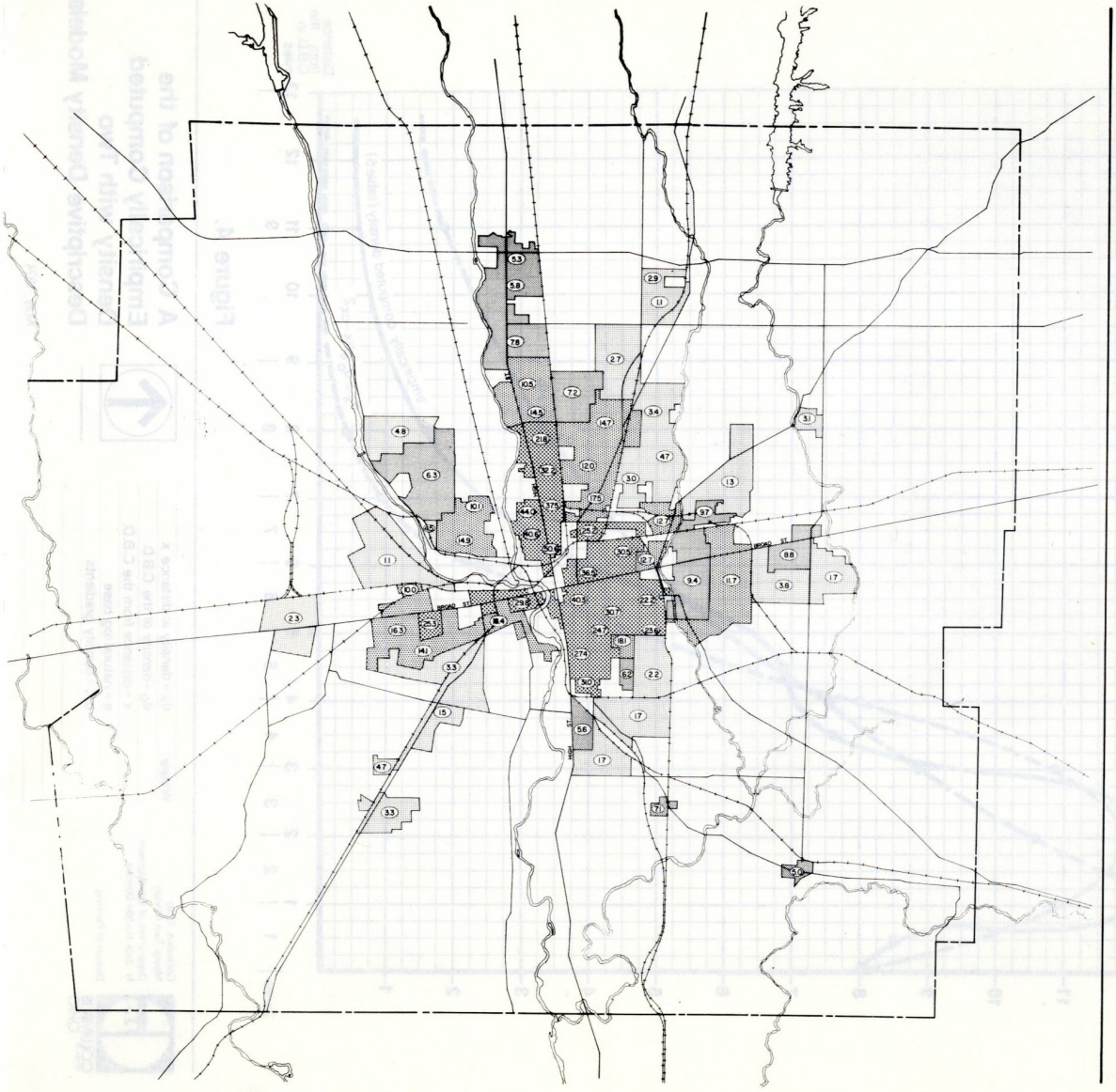
COLUMBUS THE CITY OF OHIO

Where:

d_x = density at distance x
d_o = density at the C.B.D.
x = distance from the C.B.D.
e = natural log base
b,c = density gradients

A Comparison of the Empirically Computed Density with Two Descriptive Density Models

May, 1974



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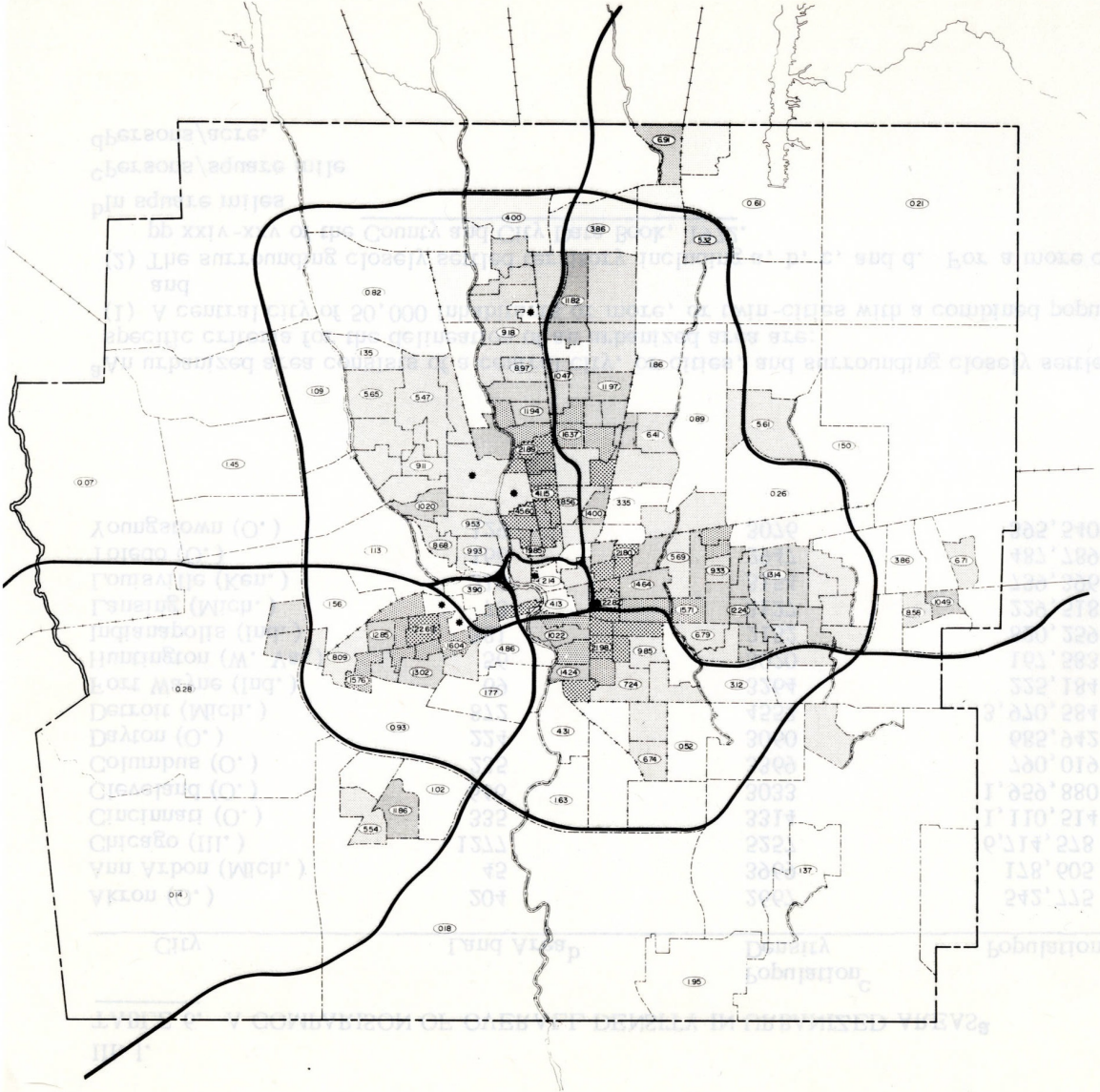
0–0.99 persons per acre
1–4.99 persons per acre
5–9.99 persons per acre
10–19.99 persons per acre
20 and above persons per acre

Source: Economic Base, Population and General Land Uses, Columbus Urban Area, Harland Bartholomew and Associates, St. Louis, Missouri, May, 1954 p. 36, plate 9

0 2mi.

Population Density 1954

May, 1974



Columbus, Ohio
Mayor Tom Moody
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Division of Planning

COLUMBUS
THE CITY OF
OHIO

0–0.99 persons per acre
1–4.99 persons per acre
5–9.99 persons per acre
10–14.99 persons per acre
15–19.99 persons per acre
20 and above persons per acre
Tracts containing primarily institutional lands

Note: density data for this map obtained from table two of this report

0 2mi.

Population Density 1970

May, 1974

III. J.

TABLE 6. A COMPARISON OF OVERALL DENSITY IN URBANIZED AREAS[a]

City	Land Area[b]	Population[c] Density	Population	Population[d] Density
Akron (O.)	204	2667	542,775	4.17
Ann Arbon (Mich.)	45	3969	178,605	6.20
Chicago (Ill.)	1277	5257	6,714,578	8.21
Cincinnati (O.)	335	3314	1,110,514	5.18
Cleveland (O.)	646	3033	1,959,880	4.74
Columbus (O.)	235	3369	790,019	5.26
Dayton (O.)	224	3060	685,942	4.78
Detroit (Mich.)	872	4553	3,970,584	7.11
Fort Wayne (Ind.)	69	3264	225,184	5.10
Huntington (W. Va.)	56	3020	167,583	4.72
Indianapolis (Ind.)	381	2152	820,259	3.36
Lansing (Mich.)	73	3127	229,518	4.89
Louisville (Ken.)	210	3154	739,396	4.93
Toledo (O.)	166	2947	487,789	4.60
Youngstown (O.)	129	3076	395,540	4.81

[a]An urbanized area consists of a central city, or cities, and surrounding closely settled territory. The specific criteria for the delineation of an urbanized area are:
(1) A central city of 50,000 inhabitants or more, or twin-cities with a combined population of at least 50,000, and
(2) The surrounding closely settled territory including a, b, c, and d. For a more complete explanation see pp xxiv-xxv of the County and City Data Book, 1972.

[b]In square miles

[c]Persons/square mile

[d]Persons/acre.

K. A Summary of Findings

The structure of the City as described by its density pattern is the result of a multitude of factors. First of all, the pattern reflects historical trends of residential location. Past density patterns are shown on Map 3. High density areas prevailed near the downtown, indicating the high costs of commuting, and the importance of being centrally located. The high density also reflects the limited transportation facilities available to the private sector at that time. The automobile was just coming into widespread use, and many roads were in poor condition. High densities also existed in the university area, indicating its importance to the City as an educational services center. Also, residential growth tends to move upstream while manufacturing industrial growth moves downstream. This variation is shown by comparing density north (upstream) with density south (downstream) in Figure 3. Many of these basic patterns of residential location continue into the present.

Since 1954, however, several important changes have occurred. Perhaps the most obvious is the decline in density at the center of the City itself. The decline in density, however, does not reflect a decline in the downtown as an economic and employment center. Indeed, it reflects just the opposite. Generally, land near the C.B.D. has become too valuable for residential use. The construction of the innerbelt and other freeways also replaced residential land. The fall in density, therefore, resulted from a change in land use rather than the decline of the C.B.D. as a regional center of economic activity.

With the construction of the innerbelt, and the completion of inter-state highways (I-71, I-70) general accessibility was increased. The expanded transportation network substantially reduced the costs of commuting. The level of incomes also rose during this period. Rising incomes and falling commuting costs (both time and money) combined to cause a continuing migration to the suburbs. The result was a flattening of the density-distance curve and a spreading of the population generally in spite of a population increase.

The most important result of this study is the recognition that areawide patterns of housing and population distribution do exist. These imply that underlying economic forces, though only vaguely perceived, crucially affect the structure, growth, and development of the City. Among such determinants of residential location are transportation costs, household income, housing market conditions, and place of work. An awareness of the existance and basic nature of such patterns is crucial to meaningful planning.

In addition, the results are quite compatible with prevailing urban structure theory. Figure 4 shows how closely the actual density corresponds to our expectations using the two most widely used density models. Several factors contribute to this close relationship. Most urban theories start with the assumption that the C. B. D. is the center of economic activity (an employment center). The actual situation in Columbus closely approximates this theoretical assumption. State government, City government offices, numerous banking and financial institutions, and the state headquarters for many organizations are located in downtown Columbus. Therefore, individuals employed in the central city will locate in reference to the C. B. D. The smoothness of the density curve may be attributed to a well developed transportation system which provides relatively uniform accessibility to all areas of the City and County. No major geographical boundaries restrict this flow. The close relationship shown in Figure 4 suggests that regardless of how diverse and disorganized the City might appear to be on the surface, these diverse elements are in fact responding to, or are part of, a larger urban pattern. It also provides a frame of reference from which divergent patterns can be charted and evaluated.

As shown in Figure 3, there are substantial variations in density both with distance and direction from the C. B. D. which exist within the larger density pattern. These wide variations reflect the influence of other factors than those mentioned above. Among such factors are: 1) ethnic or racial influences, 2) community status factors, 3) geographical terrain variations, or 4) traditional variations in land use. These factors operate to form a sectoral or neighborhood residential pattern which may operate in opposition to the basic pattern. Thus, an increase in income may provoke a move toward the center of the City for certain groups--to Bexley, German Village, or Upper Arlington for example.

In Table 6 we have compared population density in the Columbus urbanized area with density in other cities. As shown in Table 6 Columbus is neither significantly higher nor lower than cities of similar size. However, a relationship does seem to exist between city size and population density.

One may hypothesize the future structure of the City of Columbus. Because of a generally excellent transportation network, density extremes will be reduced while overall density will increase slowly as the City grows. A diversification and dispersion of firms in Columbus will likewise contribute to a reduction of density extremes. While service oriented firms (including government) will tend to locate in the downtown area, manufacturing and other capital (land) intensive firms will tend to locate near the outerbelt interchanges. Residential growth will occur primarily in areas adjacent to developing economic subcenters, and generally between developed areas on the fringe of the City, and the outerbelt.

The City of Columbus is constantly changing and evolving. The energy crisis, the availability of funds for homes, inflation, shortages of materials, and the demand for goods produced in Columbus are just some of the factors influencing urban change. Many urban processes fall outside the control of the City's governmental structure. Indeed, urban structure is a complex blend of economic reality, personal preferences, and political initiative. Creative City Government through its projects and policies, can ensure that Columbus continues to grow and mature. Monitoring, projecting, and providing direction for urban change is an important function of the Department of Development. This is not an easy task. Hopefully this study has contributed to the basic foundation of information upon which meaningful policies can be formulated and sound decisions made.

BIBLIOGRAPHY

Alonso, William, Location and Land Use: Toward a General Theory of Land Rent, Harvard University Press, Cambridge, Mass., 1964.

Alonso, William, "Equilibrium of the Household," in Page, A., and Seyfried (editors), Urban Analysis, Scott Foresman, Glenview, Illinois, 1970.

Bell, Wendell, "The Social Areas of the San Francisco Bay Region," American Sociological Review, February, 1953.

Berry, B. J. L., J. W. Simmons, and R. J. Tennant, "Urban Population Densities: Structure and Change," Geographical Review, 53 (1963), pp. 389-405).

Berry, Brian J., and Frank E. Horton, Geographic Perspectives on Urban Systems, (with integrated readings), Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1970.

1970 Census of Population and Housing, Census Tracts, Columbus, Ohio, PHC (1) - 50, U.S. Department of Commerce, Bureau of the Census, Washington, D.C., May, 1972.

1974 Census Tract Update File, National Planning Data Corporation, Rochester, N.Y., copyright, 1974.

Casetti, Emilio, "Urban Population Density Patterns: An Alternate Explanation," Canadian Geographer, 11, (1967), pp. 96-100.

Casetti, Emilio, "Equilibrium Land Values and Population Densities in an Urban Setting." Economic Geography, Vol. 47, pp. 16-20, (1971).

Casetti, Emilio, "Alternate Urban Population Density Models: An Analytical Comparison of their Validity Range," Studies in Regional Science, ed. by A. J. Scott, Pion Ltd., 1969. pp. 105-16.

Hoover, Edgar M., The Location of Economic Activity, McGraw Hill Inc., N.Y., 1963.

Hoyt, Homer, The Structure and Growth of Residential Neighborhoods in American Cities, Federal Housing Administration, Washington, D.C., 1939.

Johnston, Ronald, Urban Residential Patterns, Praeger Publishers Inc., New York, 1971.

Mills, Edwin S., "An Aggregative Model of Resource Allocation in a Metropolitan Area, "American Economic Review, May, 1967.

Mills, Edwin S., Urban Economics, Scott Foresman, Glenview, Illinois, 1972.

Muth, Richard F., Cities and Housing, The University of Chicago Press, Chicago, 1969.

Muth, Richard F., "The Spatial Structure of the Housing Market," Papers and Proceedings of the Regional Science Association (7th Annual Meeting), Vol. 7, 1961, pp. 207-220.

Newling, Bruce E., "Urban Growth and Spatial Structure: Mathematical Models and Empirical Evidence," Ekistics Vol. 36, Number 215, October, 1973. (abstracted from The Geographical Review, Vol. LVI, No. 2, 1966).

Newling, Bruce E., "The Spatial Variation of Urban Population Densities," The Geographical Review, Vol. 59, (1969), pp. 242-252.

Perloff, Harvey S., and Wingo, Lowdon Jr., Issues in Urban Economics, Johns Hopkins Press, Baltimore, Maryland, copyright, 1968.

Papageorgiou, G. J., "A Theoretical Evaluation of the Existing Population Density Gradient Functions," Economic Geography, Vol. 47, pp. 21-26, 1971.

Park, Robert E., and Burgess, Ernest W., The City, University of Chicago Press, 1925.

Schwirian, Kent P., "Analytical Convergence in Ecological Research: Factorial Analysis, Gradient, and Sector Models." Models of Urban Structure, ed. by David Sweet, Lexington Books, D. C. Heath and Company, Toronto, Canada, 1972.

Shevky, Eshref, and Mariane Williams, The Social Areas of Los Angeles: Analysis and Typology, University of California Press, Berkely and Los Angeles, 1949.

Shevky, and Wendell Bell, Social Area Analysis: Theory, Illustrative Application, and Computational Procedures, Stanford University Press, Stanford, California, 1955.

Wingo, Lowdon, Transportation and Urban Land, Resources for the Future Inc., Washington, 1961.

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