ACCURACY OF THE HOUSING UNIT METHOD IN PREPARING POPULATION ESTIMATES FOR CITIES

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RESUMEN

Este artículo informa sobre los resultados de un test sobre la exactitud relativa del método de unidad de vivienda en la estimación de la población de ciudades. Fueron preparadas estimaciones para 47 ciudades de más de 50.000 habitantes en las cuales se han conducido censos especiales durante los años 1964–66. Esta sciudades fueron elegidas porque en general las ciudades que han afrontado los gastos de un censo especial son comunmente lugares que estan desarrollandose rápidamente o que han realizado incorporaciones de territorios vecinos a su ejido (anexiones); estimaciones sobre este tipo de areas estan sujetas a un margen de error mayor que las estimaciones sobre areas donde los cambios de población son más normales.

El test señala cinco caracteristicas del método de unidad de vivienda para la estimación de la población de las ciudades: (1) En general, el método da estimaciones que tienden a sobrestimar la población. Cuando datos sobre permisos de construcción fueron usados como base para las estimaciones, las desviaciones fueron positivas en 36 de lost 47 casos. En las ciudades donde las desviaciones fueron negativas aproximadamente la mitad había realizado importantes anexiones luego de 1960. (2) El uso de datos sobre los servicios públices en lugar de los permisos de construcción permite generalmente reducir el tamaño de los errores, a pesar de que las desviaciones continuan siendo más positivas que negativas. (3) Las desviaciones son menores cuando los valores de 1960 no son usados y el tamaño medio de la familia (hogar censal) es extrapolado. (4) Tanto con el uso de permisos de construccion como con el numero de usuarios de servicios públicos, el error promedio en la estimacion del numero de viviendas familiares (hogares censales) es alto. (5) La estimacion del número de hogares censales es un mayor contribuyente a los errores de estimacion de población que la estimación del tamaño medio de los hogares censales (para este test extrapelaciones de los valores 1950–60 o asumiendo no cambios desde 1960). A pesar de que el alcance de este test fué limitado, el metodo revelo una eficacia relativa aceptable, con errores promedio de 3.6 a 5.8 por ciente, con exclusión de las areas que estan experimentando grandes anexiones.

SUMMARY

This paper reports the results of a test of the relative accuracy of the housing unit method in the estimation of the population of cities. Estimates were prepared for 47 cities in excess of 50,000 population in which special censuses were conducted during the years 1964–66. Because cities that undertake the expense of a special census are commonly areas that are experiencing rapid growth or large annexations, extimates for such areas are subject to wider margins of error than estimates for areas of more normal population-change patterns.

The test points up five features of the housing unit method for the estimation of the population of cities. (1) In general, the method yields estimates on the high side. When building-permit data were used as a basis for estimates, the deviations were positive in about 30 of the 47 cases. Of the cities in which the deviations were negative, about one-half had had substantial annexation after 1960. (2) The use of utility data instead of building-permit data generally reduces the size of errors, although here too there are substantially more positive than negative deviations. (3) Deviations are smaller when the average size of household is extrapolated than when the 1960 values are used. (4) When either building-permit or utility data were used, the average error in the estimate of the number of households was high. (5) The estimate of the number of households is a greater contributor to errors in estimates of population than is the estimate of the average size of household (for this test, extrapolated from 1950–60 values or assuming no change since 1960).

Although the scope of the test was limited, the method made a relatively creditable showing, with average errors of 3.6 to 5.8 percent, excluding areas that are experiencing large annexations.

This paper reports on the results of a limited-scale research project on the relative accuracy of the "housing unit" method of estimating the population of cities. In this method, data that relate to building permits, demolitions, utility con-

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nections, and the like are used to measure changes in the number of housing units, and these in turn are used to measure population change. This basic approach to population estimates seems to have wide appeal to local estimators for developing current population estimates for such small areas as cities and census tracts.[1] This general use of the method at the local level may be attributed both to its simplicity in concept and, in recent years, to the common availability of residential building permit data, the basic element used for measuring change in the housing supply. The method has not been extensively tested, however, as have other techniques for estimating small area population, perhaps because of the known inadequacies or unavailability of the housing unit basic data in earlier years.[2]

The test that we report here involved deriving estimates of population by the general housing unit technique,[3] with several alternative approaches, for the 47 cities in excess of 50,000 population in which special censuses were conducted during 1964–66. It should be emphasized that cities that undertake the expense of a special census are not typical of all cities in the United States. They are commonly areas of rapid growth, or they may have had extensive annexation since the last census.[4] Thus, special problems are involved in trying to derive meaningful estimates. Estimates for such areas may be expected to be subject to wider margins of error than those that we would expect for areas of "more normal" population change patterns. The limited scope of this particular test should be kept in mind in interpreting the results.

The housing unit method is beset with a number of hazards, and much of the information that is required for accurate results is often not available. Even the elements that are obtainable, such as building permit data, demolition, or utility data are often inaccurate, inadequate, or require substantial manipulation before use. Vacancy rates and number of persons per household are two other important variables for which current information is usually not available. In addition, each step in this estimation process required decision-making that commonly must be based on sketchy information or on intuition.

Many of the problems that are involved in the housing unit approach are well known. The filing of building permits indicates the *intent* to build, and a certain percentage (probably small) of all permits issued may not result in a building. There is also the time lag between issuance of a building permit and ultimate completion of the unit. Time lag patterns vary considerably from area to area and with type of unit constructed (single family, walk-up apartment, or elevator apartment, for example) and with changes in local housing demands and financing. Pending changes in housing codes may result in the abnormal issuance of permits that will badly distort a building permit series in

[1] United States Bureau of the Census, "Inventory of State and Local Agencies Preparing Population Estimates: Survey of 1965," *Current Population Reports*, Series P-25, No. 328, March, 1965.

[2] For California cities, Carl Frisén presented summaries of tests based on special censuses in the 1950 decade in the Proceedings of the Social Statistics Section, Annual Meeting of the American Statistical Association, (Chicago, Illinois, December 27–30, 1958), pp. 231–32. More recent tests have been conducted by Mr. Frisén's successors at the California Department of Finance, but these findings have not been published. (See also footnote 9.)

[3] A variation of this basic method used by the Bureau of the Census is discussed in some detail in United States Bureau of the Census, *Current Population Reports*, Series P-25, No. 371.

[4] Some 31 of the 47 cities that are included here requested special censuses. Of the remaining 16 cities, Cleveland and Louisville were counted as a consequence of 1970 decennial census test programs instituted by the Bureau of the Census. The seven New York cities listed were counted as part of county-wide censuses requested by the county governments. The four Rhode Island cities were enumerated as part of a state-wide census. Counts for the three North Carolina cities were initiated by the Bureau of the Census as a consequence of voting-rights legislation.

the short run. A few cities require the issuance of certificates of completion of construction or certificates of occupancy for new construction. Where statistical series of this type are maintained, they should provide a much better count of additions to the housing inventory than do building permits.

Conversions and mergers also affect the housing supply but not to a great extent. Data on these types of modifications are generally poor or nonexistent.

In conjunction with the use of building permit data, statistics on demolitions are needed, and this information in the past has not been uniformly reported or has been very poorly reported. Even the modest number of cities where accurate demolition data are maintained frequently have record only of the number of *structures* demolished, not housing units. They often do not distinguish between demolition of residential structures and of commercial or industrial properties.[5]

A major alternative to the use of permit and demolition data in developing housing unit estimates is the compilation of changes in the number of residential housing units that are served by public utilities. One of the greatest difficulties in using utility data for population estimates, however, is the handling of master meters (single meters that serve a large number of apartments). Occasionally a utility company maintains records on the number of residential units that are served by master meters, but more commonly no such compilation is available. Since the use of master meters is becoming more common with time, utility data may tend to understate the true change in number of occupied units, thus offsetting to some extent a "high bias" of the method.

Of course, a determination of the change in the residential housing inventory needs to be supplemented by an adequate current estimate of the average number of persons per household. The second key variable in developing the housing unit method may be both difficult and expensive to obtain on a current basis.

[5] Beginning in 1967 the Construction Statistics Division of the Bureau of the Census has collected demolition statistics for reporting areas. To date no data have been published for this series.

NATURE OF THE TEST

Estimates of the number of occupied housing units were prepared for cities in the test by two different approaches. In the first method (Method X) residential building permits and demolition data were compiled from appropriate sources (using building permit data from January 1, 1960 to 3 months prior to the special census date, assuming a three-month lag between issuance of permit and completion of unit). These figures, combined with 1960 Census figures on total housing units and gross vacancy rates, yielded estimates of occupied housing units on the estimate date.[6] In the second method (Method Z) residential utility data were used to measure changes in the number of occupied housing units since the last census. These data, coupled with 1960 Census figures on number of occupied units, provide current estimates of number of occupied units. Absolute rather than relative change in number of residential meters was used.

A second step in the computations involves converting the number of occupied housing units to population in households by multiplying the number of units by the estimated size of household. Since current information for this component is lacking, two different assumptions were tested: (1) use of 1960 values, and (2) extrapolation of the 1950–60 trend. Thus four separate estimates of household population were derived. Each of these estimates was combined with a single estimate of the population in "group quar-

[6] A variation of this assumption using separate vacancy rates for new construction for estimating the housing supply was also applied, and the results are discussed below, but computations are not shown separately in the tables.

Table 1.—ACCURACY OF VARIATIONS OF THE HOUSING UNIT METHOD IN ESTIMATING THE POPULATION OF SELECTED CITIES
(Includes all cities of 50,000 and over population for which special censuses were taken 1964–66.
Asterisk indicates central city of an SMSA.)

City, State, and problem code (a)	Census April 1, 1960 (thousands)	Special census			Percentage change	Percent difference from special census						Ratio, 1960 residential utility data to census count of households
						Method X			Method Z			
		Date	Total population (thousands)	Population in areas annexed since 1960 (thousands)		Number of households	Population		Number of households	Population		
							X_1	X_2		Z_1	Z_2	
*Binghamton, N.Y.	75.9	3/15/66	69.4	....	-8.57	7.11	11.66	7.22	1.64	6.28	2.08	.88
Bloomington, Minn.	50.5	4/1/65	66.5	....	31.77	3.44	3.97	(b)	1.22	1.75	(b)	1.00
*Boise City, Idaho (A)	34.5	5/12/66	72.1	40.0	109.07	-46.88	-48.03	-49.47	-10.61	-13.11	-15.54	.98
*Buffalo, N.Y. (C)	532.8	4/18/66	481.5	....	-9.63	8.66	11.73	5.13	4.51	7.59	1.24	.84
*Cedar Rapids, Iowa	92.0	9/21/65	103.5	5.5	12.51	5.02	1.18	0.86	0.80	- 2.82	- 3.14	.96
*Cleveland, Ohio (U)	876.1	4/1/65	810.9	....	-7.44	5.69	10.09	8.06	(b)	(b)	(b)	(b)
Costa Mesa, Calif. (A)	37.6	4/27/66	66.4	5.3	76.82	- 4.24	-5.19	- 4.13	- 4.93	- 5.86	- 4.81	1.07
Council Bluffs, Iowa	55.6	5/23/66	53.0	1.3	-4.82	11.94	12.49	12.29	5.94	6.54	6.35	.92
Cranston, R.I.	66.8	10/1/65	71.9	....	7.71	2.74	4.09	2.61	0.23	1.70	0.25	1.01
*Davenport, Iowa	89.0	10/7/66	95.8	.2	7.66	3.23	3.59	3.21	3.00	3.37	2.99	.93
*Des Moines, Iowa	209.0	5/28/66	206.7	1.0	- 1.07	7.93	8.61	7.55	3.23	3.99	2.97	.86
Des Plaines, Ill.	34.9	2/9/65	50.8	2.3	45.59	- 5.26	- 4.73	- 4.20	- 0.75	- 0.21	0.55	1.00
*Dubuque, Iowa	56.6	10/7/66	62.9	3.5	11.04	6.47	1.51	0.67	3.37	- 1.24	- 2.06	.96
*Evansville, Ind.	141.5	10/20/66	144.5	1.6	2.06	- 2.79	0.00	- 1.12	7.28	10.13	8.89	.76
*Fayetteville, N.C. (A)	47.1	9/15/64	51.0	5.8	8.31	(b)	1.22	1.33	(b)	5.43	5.55	.96
*Fort Smith, Ark.	53.0	6/1/64	64.2	.2	21.15	(b)	- 9.18	- 9.76	(b)	- 1.59	- 2.22	.98
*Greensboro, N.C. (C)	119.6	1/25/66	131.7	2.6	10.15	6.72	7.61	4.10	9.43	10.22	6.63	1.39
*High Point, N.C. (C)	62.1	1/25/66	61.4	....	- 1.07	7.79	9.92	8.21	20.95	23.08	21.16	1.34
Huntington Beach, Calif (A)	11.5	10/21/65	75.1	5.7	553.09	- 6.24	-22.40	(b)	2.07	-15.55	(b)	.93
*Huntsville, Ala. (C,D)	72.4	9/22/64	123.5	5.6	70.69	1.81	- 1.27	1.33	- 3.93	- 6.83	- 4.37	.84
*Little Rock, Ark. (D)	107.8	6/8/64	128.9	8.0	19.59	- 4.35	- 6.91	- 7.39	0.88	- 2.02	- 2.53	.89
*Louisville, Ky.	390.6	5/14/64	389.0	6.5	- 0.41	3.06	1.57	0.06	3.52	2.02	0.50	1.02
*Madison, Wis. (U)	126.7	10/5/64	157.8	8.4	24.58	- 0.68	- 7.63	- 9.53	(b)	(b)	(b)	(b)
Mesa, Ariz. (A,C)	33.8	10/18/65	50.5	4.0	49.62	- 6.82	- 3.52	- 3.65	4.63	8.32	8.16	.83
Mount Vernon, N.Y. (D)	76.0	4/6/65	72.9	....	- 4.07	5.60	8.58	3.31	2.82	5.77	0.65	.90
New Rochelle, N.Y. (D)	76.8	4/6/65	75.2	....	- 2.09	6.30	7.42	4.06	2.69	3.90	0.65	.90
*North Little Rock, Ark.	58.0	8/18/65	61.5	2.0	5.99	0.40	3.09	4.14	2.52	5.19	6.26	1.15
Orange, Calif. (A)	26.4	9/30/65	67.2	25.3	154.14	- 5.31	-15.30	-11.49	- 0.33	-10.90	- 6.89	.93
*Oxnard, Calif. (A,C)	40.3	11/11/64	58.3	12.4	44.71	4.56	3.00	3.76	1.54	0.18	0.91	.85
*Pawtucket, R.I. (U,D)	81.0	10/1/65	77.5	....	- 4.28	5.24	7.10	3.77	(b)	(b)	(b)	(b)
*Phoenix, Ariz. (A,C)	439.2	10/16/65	505.7	36.5	15.14	2.69	5.22	10.13	23.35	26.14	32.05	.66
*Providence, R.I. (D)	207.5	10/1/65	187.1	....	- 9.85	9.93	13.07	7.13	2.89	6.09	0.54	.96

Table 1.—*Continued*

City, State, and problem code (a)	Census April 1, 1960 (thousands)	Special census			Percentage change	Percent difference from special census						Ratio, 1960 residential utility data to census count of households
						Method X			Method Z			
		Date	Total population (thousands)	Population in areas annexed since 1960 (thousands)		Number of households	Population		Number of households	Population		
							X_1	X_2		Z_1	Z_2	
*Raleigh, N.C. (U)	93.9	1/24/66	105.7	7.8	12.55	6.10	5.18	2.35	(b)	(b)	(b)	(b)
*Rochester, N.Y. (C)	318.6	4/1/64	305.8	....	-4.01	5.24	4.40	1.57	4.60	3.70	0.89	.81
*Rockford, Ill	126.7	1/9/64	132.1	5.3	4.26	4.61	1.19	1.70	5.52	2.05	2.56	.95
*Sacramento, Calif. (A,U)	191.7	11/9/64	237.7	42.8	24.02	-10.76	-13.88	-15.44	(b)	(b)	(b)	(b)
*Salinas, Calif. (A)	29.0	2/7/66	52.2	20.2	80.29	-27.68	-25.50	-24.74	1.41	3.21	8.66	.91
Scottsdale, Ariz. (A,U)	10.0	10/18/65	54.5	38.2	443.63	-49.03	-51.00	(b)	(b)	(b)	(b)	(b)
*Shreveport, La	164.4	6/15/66	160.5	3.3	-2.33	7.13	10.63	9.62	4.53	7.99	7.00	.95
Skokie, Ill(C)	59.4	6/16/64	67.9	(Z)	14.32	- 2.40	- 1.81	0.16	1.66	2.27	4.18	1.18
*Tallahassee, Fla. (U)	48.2	11/4/64	58.0	3.3	20.44	- 7.59	- 8.00	- 7.80	(b)	(b)	(b)	(b)
*Tucson, Ariz. (A)	212.9	10/11/65	236.9	16.2	11.27	- 0.06	2.83	5.90	1.64	4.53	7.65	.91
*Warwick, R.I	68.5	10/1/65	77.6	....	13.33	- 0.01	- 0.31	0.40	1.09	0.77	1.49	1.05
*Waterloo, Iowa	71.8	7/8/66	74.0	1.3	3.16	4.21	5.04	4.65	1.61	2.44	2.07	.95
West Covina, Calif	50.6	5/6/64	60.3	.8	19.12	- 0.86	0.74	(b)	- 1.96	- 0.38	(b)	1.00
White Plains, N.Y.	50.5	4/6/65	50.0	....	- 0.88	3.48	5.58	- 0.86	2.03	4.17	- 2.18	.89
Yonkers, N.Y. (D)	190.6	4/6/65	201.6	....	5.74	2.88	4.18	0.90	- 3.43	- 2.12	- 5.20	.93

Z - Less than 50.

(a) Annexation of more than 10,000 or 10 percent; U: unavaility of utility data for city; C: utility data suspect (1960 coverage varies by 15 percent from count of households); D: no residential demolition data available.

(b) Data not available from which to compute values.

ters," using 1960 figures to arrive at estimates of total population.

The above combinations of data, when compared with the special censuses, permit us to examine a number of variations of the housing unit approach to population estimation for local areas. In addition to the overall relative accuracy of the method per se, the tests provide information on the effectiveness of utility data as compared with building permit statistics, a suggestion of the relative accuracy of the estimated number of households, and some indication of the relative contribution to the errors of the estimated number of households and the estimates of size of households.

SUMMARY OF FINDINGS

For each of the cities in the test, Table 1 presents the percent difference of housing unit estimates, derived as indicated above, from the special census counts. The table shows the population in 1960 and on the special census date, the percentage change in population between the two dates, and the percentage deviation of the estimates of households and population from the special census counts. Deviations in population are shown using both building permit (Method X) and utility data (Method Z). For each of these two basic variations, deviations are shown using the 1960 average size of households (X_1, Z_1) versus extrapolated 1950–60 values (X_2, Z_2).

Since special problems are associated with many of the areas, a guide is provided to shortcomings in the data series from which the estimates are derived. Code A shown beside the name of the city in Table 1 indicates those areas with substantial annexation—at least 10,000 population or 10 percent of the population in 1960. Code U indicates unavailability of utility data. Code C signifies that the number of utility connections as reported for April 1, 1960 varied by more than 15 percent from the census count of the number of households, raising doubt as to the adequacy of coverage of the data series in deriving estimates of change in the housing inventory. Areas for which demolition data were not available are indicated by code D.

Despite some of these problems, the data point up a number of interesting features concerning the adequacy of the housing unit method for estimating population. Some of the more important findings, summarized in Table 2, are as follows.

1. In general, the method tends to yield estimates on the high side. Of the 47 cities for which building permit data are available and used for making the estimates, the deviations were positive in about 30 cases. Of the cities in which the differences were negative, about one-half had annexed territory after 1960. In some cases where large annexations have occurred, use of building permit data results in decided undercounts of the population.
2. The use of utility data rather than building permit data generally reduces the errors; although here too there are substantially more positive than negative deviations. Thus, with utility data the positive bias of the method continues, although at somewhat a lower level.
3. Smaller deviations result when average size of household was extrapolated than when the 1960 values were used. This is to be expected inasmuch as there were general declines in size of households during the years 1950–60.[7]
4. The average error in the estimate of the number of households when either building permit or utility data was used was also quite high. This may reflect overreporting of new construction, underreporting of demolished units, or increase in the vacancy rates since 1960. In effect, the household estimate is a greater contributor to the errors in the estimates of population than the estimate of average size of households.[8] Thus, the advantage of using extrapolated

[7] Not all areas included in this test experienced a decline in size of household during 1950–60, however. Occasionally, the extrapolated value will reflect a small increase.

[8] It is assumed here that the portion of the "error" in the population estimate that is attributed to the use of 1960 figures for "group quarters" population is negligible for most of the areas in the study.

average size of households is due, to a great extent, to the high initial estimate of the number of households. (See Table 3.) This conclusion is made on the assumption of using either no change in size of household or an extrapolation of change. Substitution of some other value of size of household will affect the results, of course, but it is believed that the two basic assumptions encompass the range of reasonable assumptions for the procedure tested and are the ones most frequently used. Whatever variations occur within this range, they should not materially affect the conclusions.

5. As would be expected, there is a very high correlation ($r = 0.95$) between the errors in the population and household estimate. Thus, about 90 percent of the variation in the errors in estimating population, using building permit data and an assumed unchanged size of household, for example, is accounted for (or "explained") by the variation in household estimates errors. (See Fig. 1.)
6. For approximately 35 cities which did not have substantial annexations, the average error in the estimates using building permit data was 4.91 percent for number of households, 5.83 percent for population (using 1960 average size of household), and 4.42 percent for population (using extrapolated size of household). Within this group adequate utility data were available for only 30 cities, and here the average errors were 3.73 for number of households, 4.61 for population (using 1960 average size of household), and 3.63 for population (using extrapolated size of household). (See Ta-

Table 2.—SUMMARY OF THE AVERAGE PERCENTAGE DEVIATION OF THE ESTIMATED NUMBER OF HOUSEHOLDS AND POPULATION FROM THE SPECIAL CENSUS, WITH THE NUMBER OF POSITIVE AND NEGATIVE DEVIATIONS

Category and deviation	Based on building permit and demolition data			Based on utility data		
		Deviation in population			Deviation in population	
	Deviation in household	Using 1960 size of household	Extrapolating 1950-60 size of household	Deviation in household	Using 1960 size of household	Extrapolating 1950-60 size of household
All cities with available data	(n=45)	(n=47)	(n=43)	(n=38)	(n=40)	(n=37)
Total	7.36	8.54	6.41	4.17	5.79	5.18
Positive deviations	28	30	30	31	28	27
Negative deviations	17	17	13	7	12	10
Cities that have all data series in common	6.73	7.45	6.22	4.38	5.91	5.26
N = 35:						
Positive deviations	24	24	26	29	26	26
Negative deviations	11	11	9	6	9	9
Cities without substantial annexations (a)						
Total	4.91	5.83	4.42	3.73	4.61	3.63
Positive deviations	26	26	26	25	22	21
Negative deviations	8	9	7	4	8	7
Cities that have all data series in common	5.08	5.64	3.87	3.88	4.98	3.68
N = 27						
Positive deviations	22	21	23	24	21	21
Negative deviations	5	6	4	3	6	6

(a) Less than 10,000 population or 10 percent

Table 3.—Difference Between the Percentage Deviation in Population and the Percentage Deviation in the Number of Households in Estimating the Population of Selected Cities by the Housing Unit Method

(Includes all cities of 50,000 and over population for which special censuses were taken, 1964–66.)

City and State	Based on building permit and demolition data		Based on utility data	
	Using 1960 size of household	Extrapolating 1950–60 size of household	Using 1960 size of household	Extrapolating 1950–60 size of household
Binghamton, N.Y.	4.55	0.11	4.64	0.44
Bloomington, Minn.	0.53	....	0.53	....
Boise City, Idaho	-1.15	-2.59	-2.50	-4.93
Buffalo, N.Y.	3.07	-3.53	3.08	-3.27
Cedar Rapids, Iowa	-3.84	-4.16	-3.62	-3.94
Cleveland, Ohio	4.40	2.37	....	....
Costa Mesa, Calif.	-0.95	-0.11	-0.93	0.12
Council Bluffs, Iowa	0.55	0.35	0.60	0.41
Cranston, R.I.	1.35	-0.13	1.47	0.02
Davenport, Iowa	0.36	-0.02	0.37	-0.01
Des Moines, Iowa	0.68	-0.38	0.76	-0.26
Des Plaines, Ill.	0.53	1.06	0.54	1.30
Dubuque, Iowa	-4.96	-5.80	-4.61	-5.43
Evansville, Ind.	2.79	1.67	2.85	1.61
Fayetteville, N.C.	....	....	....	....
Fort Smith, Ark.	....	....	....	....
Greensboro, N.C.	0.89	-2.62	0.79	-2.80
High Point, N.C.	2.13	0.42	2.13	0.21
Huntington Beach, Calif.	-16.16	....	-17.62	....
Huntsville, Ala.	- 3.08	-0.48	-2.90	-0.44
Little Rock, Ark.	-2.56	-3.04	-2.90	-3.41
Louisville, Ky.	-1.49	-3.00	-1.50	-3.02
Madison, Wisc.	-6.95	-8.85	....	....
Mesa, Ariz.	3.30	3.17	3.69	3.53
Mount Vernon, N.Y.	2.98	-2.29	2.95	-2.17
New Rochelle, N.Y.	1.12	-2.24	1.21	-2.04
North Little Rock, Ark.	2.69	3.74	2.67	3.74
Orange, Calif.	-9.99	-6.18	-10.57	-6.56
Oxnard, Calif.	-1.56	-0.80	-1.36	-0.63
Pawtucket, R.I.	1.86	-1.47	....	....
Phoenix, Ariz.	2.53	7.44	2.79	8.70
Providence, R.I.	3.14	-2.80	3.20	-2.35
Raleigh, N.C.	-0.92	-3.75	.....	....
Rochester, N.Y.	-0.94	-3.77	-0.90	-3.71
Rockford, Ill.	-3.42	-2.91	-3.47	-2.96
Sacramento, Calif.	-3.12	-4.68	....	....
Salinas, Calif.	2.18	2.94	1.80	7.25
Scottsdale, Ariz.	-1.97	....	....	....
Shreveport, La.	3.50	2.49	3.46	2.47
Skokie, Ill.	0.59	2.56	0.61	2.52
Tallahassee, Fla.	-0.41	-0.21	....	....
Tucson, Ariz.	2.89	5.96	2.89	6.01
Warwick, R.I.	-0.30	0.41	-0.32	0.40
Waterloo, Iowa	0.83	0.44	0.83	0.46
West Covina, Calif.	1.60	....	1.58	....
White Plains, N.Y.	2.10	-4.34	2.14	-4.21
Yonkers, N.Y.	1.30	-1.98	1.31	-1.77

ble 2 for average errors for cities common to both series of data.)

7. When the effect of error in number of households is allowed for (Table 3), the average error that was contributed by using 1960 average size of households was 2.13 percent in the group of 35 cities, whereas the extrapolated size of household average error was 2.29 percent. The corresponding figures for the group of cities using utility data are 2.00 and 2.05.
8. An additional variation of the housing unit method tested in this series makes use of building permit and demolition data and applies separate vacancy rates to the most recently constructed units. This procedure

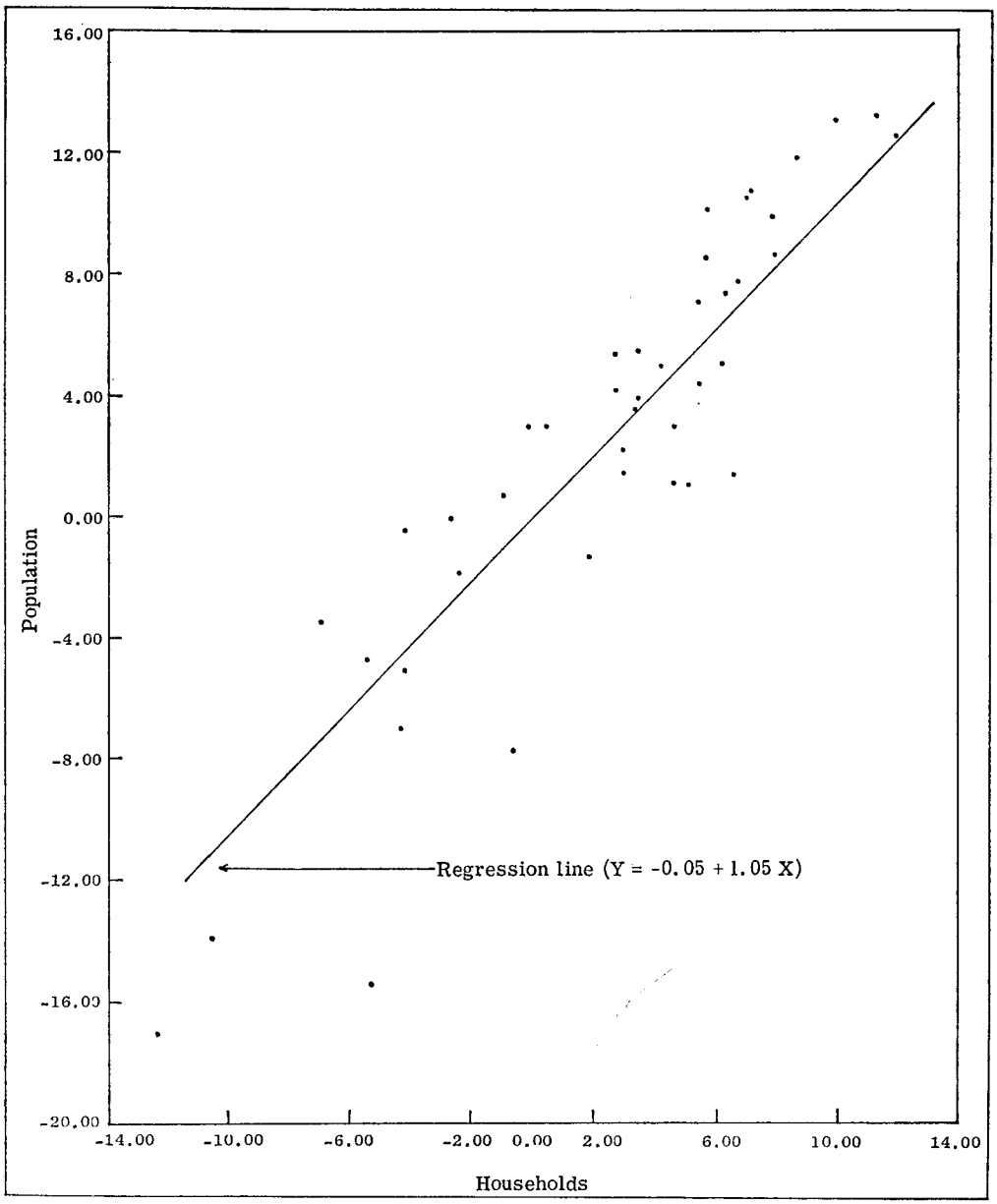

FIG. 1.—Percentage of error of households (X) and population (Y)

is employed by the Bureau of the Census in its current estimates program for SMSA counties. Results are not shown in the tables, but the test indicates that an improvement of about one-half of one percent (0.6) results from the use of this refinement. The statistical significance of the difference has not been tested, but we might tentatively judge this to be a worthwhile modification to consider when using building permit data in conjunction with the housing unit method.

The findings that have been presented here reflect the use of data that in some cases would have to be further refined in developing satisfactory population estimates. Boise City, for example, experienced an annexation of territory with a larger population than that contained within the 1960 city limits. Most of this territory was already built up at the time of annexation, so that a housing unit estimate based on building permit data must be further augmented by a count of the population in annexed areas in 1960 plus information on building activity since 1960 in the annexed area. In the case of High Point, North Carolina, utility coverage is for an area that is far too broad to be representative of the city (an overstatement of 40 percent in 1960). Any sizable amount of growth occurring to the utility service area would be likely to occur outside the city limits, which have not changed since 1960. Another area for further refinement is change in the population in group quarters since 1960. For most areas covered in this report, no dramatic change is anticipated. For an area like Madison, Wisconsin, however, extensive construction of university student dormitories has occurred since 1960. An assumption of no change in the group quarters population since 1960 will result in understatement of its population.

CONCLUSIONS

Allowing for the limited nature of the test, the results suggest that the housing unit method can be a useful approach to population estimation. In spite of the many problems cited, and of the uncertainties of the nature of the data, the method makes a surprisingly strong showing, with average errors falling within the level of error which we have to expect for areas smaller than states. On the one hand, the findings here in many respects are not different from those shown by Frisén for selected California cities.[9] The average errors that he reported for a group of cities in Los Angeles County for 1955 and 1956 were about 4 percent. For 32 cities outside of Los Angeles County, however, the average error was 7.7 percent. On the other hand, his evidence was not as clear as the evidence here that the error in the estimate of the number of households is at least as important, if not more important, than the error in the population estimate that is introduced by the assumption about average size of households.

The present study suggests that it may be worthwhile to devote considerably more effort to refining the input data for estimating number of households in addition to dealing with the problem of deriving current estimates on size of households.

[9] *Report to The League of California Cities on a Test of Population Estimating Techniques Applied to Selected California Cities*, California Department of Finance, Budget Division, Financial and Population Research Section, March, 1957.