Estimating the Size of Households and Number of School-Aged Children in New Development:

Applications for Forecasting and Impact Analysis

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Urban and regional planners forecast population size and number of school-aged children to estimate the demand for public facilities and services over near-term and long-term planning horizons. They also estimate the economic, environmental and fiscal impacts of new development projects on local jurisdictions. State planners forecast public-school enrollments generated by county-level residential development and demographic change. Accurate estimates of the size and composition of households are needed for these important planning purposes.

The best information available to planners comes from the decennial *Census of Population and Housing* and related census reports. Information from other U.S. Department of Commerce sources is also widely used. For example, the Bureau of Economic Analysis provides long-term forecasts of population, employment and earnings for counties, metropolitan areas, economic regions and states. Unless planners have the resources to conduct local field surveys, they rely on these federal sources and on state data centers that compile statistics from various state and federal agencies. For example, the State Data Center in the North Carolina Office of State Planning performs this function.

This article reports the results of a recent telephone survey of households in five large urban areas of North Carolina. The survey results are compared to estimates from the 1990 Public Use Microdata Sample (PUMS) for these urban areas of the state. These 1% and 5% samples provide detailed demographic, economic, and housing information for counties, states, and other areas in the United States. The purpose of the comparison is to see whether the 1990 reported values for single-family detached dwelling units and apartment units in the 5% PUMS remain accurate in the late 1990s. In addition, the values for single-family houses and apartments are compared.

The results indicate that the characteristics of North Carolina households have changed since the 1990 census. Planners should be able to use these new household size and composition estimates for recent development to adjust the parameters they currently use. Results for all units are applicable in forecasting, while differences by housing type are applicable in impact analysis.

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Sample Survey

In October 1996, researchers at the University of North Carolina at Chapel Hill's Center for Urban and Regional Studies conducted a telephone survey of randomly selected housing units. The sample focused on recently built housing in five metropolitan areas: Asheville, Charlotte, the Piedmont Triad, the Research Triangle, and Wilmington. This focus was taken because planners are most interested in recently built housing when making near-term forecasts, conducting impact assessments, or assessing impact fees. The Apartment Association of North Carolina sponsored the survey.

The survey was specifically intended to determine the number of persons per dwelling unit and the number of children per unit being sent to public schools for households living in apartments and single-family dwellings. The questions pertained to household size; number, age and grade level of children; public, private or home schooling; tenure of the household in the dwelling, county, urban area and state; and housing size, value or rent and age. Results were tallied for 216 apartment units and 239 single-family housing units—455 units in all.

Results

Exhibits 1 and 2 show the survey results for household size and composition for all units and for apartments and single-family housing. Exhibit 1 gives average generation rates. "Generation rate" is the term used to indicate the number of persons "generated" by the average household in one age or schooling-status cohort. Exhibit 2 presents the standard errors. (Estimated standard errors are the standard deviations of the sampling distribution of sample means that are used to determine whether the mean values are statistically significant.) Each row in Exhibit 1 is additive. That is, the number of children 18 or younger per dwelling unit is the sum of preschool children per unit, children receiving private or home schooling per unit, and children in public school per unit for three different grade levels. The number of children

Exhibit 1. Population, Age Cohorts and Schooling Status by Housing Type: Average Generation Rates per Unit

Type of Unit	Pre-School (0-4 yrs.)	Grades K-5	Grades 6-8	Grades 9-12	Priv./Home School	Children <19 yrs	Adults	Persons per Dwelling Unit
All Units	0.2102	0.2374	0.0879	0.0879	0.0953	0.7187	1.9383	2.6586
Single Family	0.3002	0.3264	0.0921	0.1130	0.1432	0.9749	2.0840	3.0630
<3 BR	0.2000	0.0667	0	0	*	0.2667	1.4667	1.7333
Three BR	0.3333	0.2857	0.0556	0.0714	*	0.7460	2.0320	2.7840
>3 BR	0.6224	0.4184	0.1531	0.1837	*	1.3776	2.2449	3.6224
Apartments	0.1106	0.1389	0.0833	0.0602	0.0422	0.4352	1.7778	2.2130
One BR	0	0.0200	0	0	*	0.0200	1.3400	1.3600
Two BR	0.1282	0.1026	0.0598	0.0342	*	0.3248	1.7350	2.0598
Three BR	0.3673	0.3469	0.2245	0.1837	*	1.1224	2.3265	3.4490

* Pre-school children and children in private or home schooling were combined as one category in the data set. Note that average generation rates for Grades K-12 pertain to public schools only

Exhibit 2. Population, Age Cohorts and Schooling Status by Housing Type: Standard Errors for Average Generation Rates per Unit

Type of Unit	Pre-School* (0-4 yrs.)	Grades K-5	Grades 6-8	Grades 9-12	Children (<19 yrs)	Adults	Persons per Unit
All Units	0.029	0.026	0.014	0.015	0.046	0.034	0.061
Single Family	0.047	0.040	0.020	0.024	0.067	0.049	0.085
<3 BR	0.145	0.067	0	0	0.182	0.165	0.316
Three BR	0.055	0.052	0.021	0.023	0.083	0.060	0.106
>3 BR	0.083	0.071	0.039	0.049	0.106	0.083	0.123
Apartments	0.032	0.029	0.021	0.016	0.056	0.049	0.079
One BR	0	0.020	0	0	0.020	0.068	0.074
Two BR	0.039	0.035	0.025	0.017	0.063	0.054	0.083
Three BR	0.095	0.085	0.067	0.056	0.156	0.089	0.168

* Children in private or home schools are included with pre-school children.

per unit plus the number of adults per unit equals the number of persons per unit.

These average rates can be compared to PUMS results and to other sources frequently cited in the impact analysis handbooks. For example, the following values pertain to housing in the South according to information in the 1985 *American Housing Survey*, compiled by the U.S. Census Bureau, and widely cited and applied in impact studies:

Average Household Size (persons per household)
- 2.34 2BR Single Family
- 2.96 3BR Single Family
- 1.30 1BR Garden Apartment
- 2.14 2BR Garden Apartment
- 2.76 3BR Garden Apartment

School-Aged Children per household
- 0.679 Single Family
- 0.199 Garden Apartment

Exhibit 3 provides information compiled from the North Carolina PUMS. The PUMS statistics pertain to the five metropolitan areas in the telephone survey; PUMS data are also available for the other four metropolitan areas in North Carolina—Burlington, Fayetteville, Hickory, and Jacksonville.

Analysis

The averages from the 1990 PUMS in Exhibit 3 are treated as if they were the true population parameters for purposes of this analysis because they are based on a large (5%) random sample and are therefore highly accurate. The survey results in Exhibit 1 are clearly different and generally higher than the 1990 PUMS data in Exhibit 3, indicating that household size may have changed since 1990 and may be different for recently built housing. Are these differences statistically significant, or could they have occurred by chance?

Testing the hypothesis that average values from the sample survey equal the PUMS averages at the one-percent level of significance answers the question. If the test statistics are sufficiently larger than zero, the hypothesis is rejected since the differences between the survey results and the PUMS data have less than a one percent probability of occurring by chance.

The tests indicate that significant differences exist between PUMS data and the survey results. Five out of seven average rates for all dwelling units are significantly different than the rates in the PUMS. The average per-unit rates for number of persons, number of children, number in K-5 and number of pre-school, private school or home school children are higher in the survey. The per-unit number in high school is lower in the

Exhibit 3. Public Use Microdata Sample (PUMS) 1990: Population, Age-Cohorts and Schooling Status by Housing Type (Average Generation Rates per Unit)

Type of Unit	Pre-School* (0-4 yrs.)	Grades K-5	Grades 6-8	Grades 9-12	Children (<19 yrs)	Adults	Persons per Unit
All Units	0.200	0.172	0.089	0.122	0.582	1.897	2.479
Single Family	0.211	0.185	0.100	0.138	0.634	2.013	2.647
<3 BR	0.132	0.069	0.030	0.056	0.296	1.524	1.820
Three BR	0.131	0.107	0.048	0.055	0.341	1.735	2.076
>3 BR	0.239	0.213	0.119	0.166	0.838	2.013	2.851
Apartments	0.165	0.129	0.051	0.069	0.415	1.528	1.935
One BR	0.043	0.021	0.002	0.009	0.075	1.135	1.210
Two BR	0.052	0.028	0.012	0.016	0.108	1.244	1.352
Three BR	0.205	0.137	0.051	0.063	0.455	1.618	2.073

* Children in private or home schools are included with pre-school children.

survey. Average rates for children in Grades 6-8 and for adults are not significantly different than the PUMS results.

Differences in public school impacts probably reflect the fact that the average household in the PUMS has older adults and older children present. These results are not strong enough to recommend changing the school generation rates used for planning purposes. On the other hand, the number of persons and the number of children per unit are significantly higher in the survey than in the PUMS. Planners may underestimate the increases in population and number of children generated by recent residential development if they rely on PUMS statistics alone.

The average generation rates for households living in apartments are significantly different in two of seven cases. Number of persons and number of adults per unit are higher in the surveyed apartments compared to PUMS. There are no differences between the per-unit average rates for number of children by schooling status.

Conversely, surveyed single-family housing units generate more population and children than the PUMS statistics would indicate. The average rates are significantly larger in four of seven cases. The per-unit averages from the sample survey are higher for number of persons, number of children, number of pre-school children or children in private or home schools, and number of children in grades K-5. These results suggest that using PUMS statistics for the number of persons and the number of children per unit may result in underestimates if applied to recently built single-family housing.

Planners may underestimate the increases in population and number of children generated by recent development if they rely on PUMS statistics alone.

As shown in Exhibit 1, the differences for persons per household and children per household by housing type generally confirm our expectations. The existence of differences by housing type is consistent with empirical results from the American Housing Survey and other national and local surveys of housing in the Southeast. On the basis of difference-of-means tests, single-family houses have more persons per unit and more children per unit than apartments, and these differences are highly statistically significant. The rates for single-family houses are higher than the apartment rates for every category. For example, all apartment units generate 0.435 children per unit, or less than half the single-family generation rate of 0.975 children per unit. Thus, new apartments generate less demand for public education and for other demographically-driven public services per unit than new single-family housing in these North Carolina urban areas.

The results for units by number of bedrooms are interesting. As expected, the rates for apartments with one bedroom, the smallest dwelling units, are the lowest while the rates for houses with four or more bedrooms are the highest. The overall difference amounts to about one additional adult and one additional child living in a single-family house with four or more bedrooms compared to a one-bedroom apartment. On the other hand, the rates for two- and three-bedroom apartments compared to two- and three-bedroom houses are quite similar. Two-bedroom apartments appear to generate more population and school-aged children than two-bedroom houses. However, these differences are not statistically significant, primarily because the small number of two-bedroom houses results in relatively high standard errors. The PUMS statistics support this conclusion; average rates for one- or two-bedroom single-family houses are slightly higher than rates for one- or two-bedroom apartments.

The average rates for three-bedroom apartments are higher than the rates for three-bedroom houses and usually lower than the rates for houses with four bedrooms or more. The statistical analysis indicates that differences in the former are significant while the differences in the latter are not. That is, the impacts of three-bedroom apartments are greater than the impacts of three-bedroom houses. Also, three-bedroom apartments have the same average impact on the public schools as houses with four or more bedrooms. However, each standard error for three-bedroom apartments in Exhibit 2 is higher than the comparable standard errors for both three-bedroom and four-bedroom or more single-family units. The PUMS results indicate virtually no difference between three-bedroom households living in apartments compared to single-family housing.

Interpretation

In most urban areas, the average cost of apartments (monthly rent) is less than the comparable cost of single-family housing (imputed monthly rent or monthly carrying costs). In general, the size of apartment units is smaller than the heated square footage (SF) of single-family housing while development density is greater. Apartment households live at higher densities per SF than single-family households.

Differences in dwelling-unit cost, size and density arise because apartment complexes serve different market segments than single-family housing. Thus, the characteristics of the occupants are different. Apartment dwellers tend to have less income and less certainty about continued residence in the area. Apartments are attractive to newcomers and to smaller households consisting of single persons, unrelated individuals, or families at the early or late stages of the family life-cycle. Owner-occupied housing has usually represented an attractive investment vehicle for building net worth and a preferred environment for raising children.

These differences help explain why recently built three-bedroom apartments in the sample survey have greater demographic impacts than single-family houses with three bedrooms. First, as the number of children in a household increases, less affluent households are more likely to remain in apartments while more affluent households purchase single-family houses. Second, more affluent newcomers often prefer to rent an apartment and then search for a single-family home. Households with children would tend to occupy three-bedroom apartments before purchasing homes with three or four bedrooms or more.

Other Findings

The sample survey information on the number of bedrooms, number of bathrooms, square footage and value of single-family houses was also analyzed. Correlation analysis determined how closely related these variable were. High correlation coefficients would allow planners to use information on number of bedrooms or bathrooms, for example, to estimate unit size and value.

All correlation coefficients among these four variables are statistically significant. Not surprisingly, the highest correlation is between single-family housing square footage and value ($r = 0.883$). The next highest correlation coefficients for single-family units are between number of bathrooms and square footage ($r = 0.804$) and number of bathrooms and value ($r = 0.786$). Thus, number of bathrooms is a better predictor of housing size and housing value than number of bedrooms. Yet these correlation coefficients are not high enough to recommend using room count variables to estimate unit size or value.

Exhibit 4 gives the average length of residence for a household in a single dwelling unit, county, urban area or the state of North Carolina. For both housing types, the average duration of residence increases from a single dwelling unit to a county or urban area to the state, and these values are all statistically significant. The difference between years lived in the county and in the urban area is not significant.

The length-of-residence values for single-family houses and apartments clearly show the expected result that single-family households are relatively less mobile than apartment dwellers. All differences are highly significant. The average single-family household surveyed has lived in North Carolina and

Exhibit 4. Average Tenure of Households by Housing Type

	Years of Residence in:			
Type of Unit	Dwelling Unit	County	Urban Area	North Carolina
All Units	3.240	9.069	10.056	15.648
Single-Family	5.208	11.979	13.140	18.662
Apartments	1.079	5.888	6.684	12.367

Exhibit 5. Demographic Impacts of Two Hypothetical Residential Development Projects

Type of Unit	Number of: Persons	Children	Children in Public School
Single-Family (200 units)			
PUMS rates	529	127	85
Survey rates	613	195	106
Apartments (200 units)			
PUMS rates	387	83	50
Survey rates	443	87	56

in one of the five urban areas for some time. The representative household usually stays in the same county after moving to the urban area and finds new housing within that county. The statistics indicate that most households have moved into their current residences from another location within the state.

The average apartment household surveyed has lived in the unit for about one year. On average, apartment households have lived in the county or urban area six or seven years. These results indicate that the average household occupying recently built apartments consists of persons who are not newcomers but have lived in the urban area for some time and in North Carolina for over 12 years, as Exhibit 4 shows.

Planning Applications and Conclusions

In Exhibit 5, the results for two hypothetical 200-unit projects are compared. State and local planners using the PUMS data would forecast the demographic impacts from the 400 units of residential development shown in the two rows where PUMS rates are applied. The demographic impacts shown in the next two rows are calculated using the sample survey rates for all single-family housing and all apartment units. The demographic impacts are considerably higher when using the sample survey average rates for each type of housing.

This research is not sufficiently comprehensive to warrant substituting sample survey average generation rates for PUMS-based generation rates. However, planners with the task of forecasting the impacts of recent residential development should expect that using average rates derived from the 1990 PUMS will generate underestimates of the demographic impacts resulting from this development. *They may want to consider increasing the average rates using the sample survey-based rates shown in Exhibit 1 as the upper limits and the PUMS rates for their area as the lower limits.*

Planners must make judgments to forecast the impacts of growth. They usually do not have the resources needed to collect primary data. To the extent that they have to use secondary data from federal and state sources to make informed forecasts, they should view the sample survey results reported here as an additional information source available for their use. The results should be particularly helpful in estimating the near-term impacts of new residential development. CP

Related Internet Resources

http://www.ciesin.org/datasets/pums/pums-home.html

The Public Use Microdata Samples home page, maintained by the Socioeconomic Data and Applications Center, provides interactive query of the 1970-1990 PUMS data and documentation for each dataset from 1940-1990.