Shining the Soles of Your Shoes:
Highly Detailed Small Area Projections

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The following is the user documentation of the Tennessee population projections that are the topic of this paper. It offers a cursory overview of the methods and issues. The paper, however, concentrates on the pragmatic development and application of methodologies needed to produce projections for small populations on a tight schedule and limited budget.

Name of the Study/Data Set: 2000 to 2020 Population Projections By Single Years of Age, Race, Ethnicity and Sex.

Sponsor: Tennessee Department of Health and the Community Health Research Group of The University of Tennessee, Knoxville.

Source: Decision Demographics, Arlington, VA

Description: This data set includes annual population projections by single years of age, race, ethnicity, and sex.

Sample Population: All Tennessee residents. Race and ethnicity groups covered include white, black, and "other" race groups, and Hispanic ethnicity. Hispanics may be of any race, and the white, black, and other race groups include both non-Hispanics and Hispanics. The "other" race group includes American Indian or Alaska Natives, and Asian or Pacific Islanders.

Methods

The cohort-component method was employed for forecasting. The future size of a county's population is affected by three demographic factors: births, death, and migration. People enter the county population by birth, leave the population when they die, or they may move into or out of the county—migration. The cohort-component method projects a population by accounting separately for the effects of births, deaths, and migration within each of the four race and ethnic groups. The general formula is as follows:

Projected Population = Base Population + Births - Deaths + Net Migration

Base Population

The Applied Population Laboratory at the University of Wisconsin-Madison supplied the 1990 and 2000 base populations for counties by age, sex, race, and Hispanic origin. These populations were adjusted for net undercount, which particularly affects young minorities. It is important to note, however, that the projected population data are adjusted back to the level that they would be measured by a census.

Birth Assumptions

Projected birth rate assumptions were created separately for the state and counties by race and ethnic group. Age-specific birth rates for the three-year period centered on 2000 were calculated for the state. These rates were projected into the future by following the trends forecasted by the US Census Bureau in its most recent national projections. Births for the state as a whole form the control totals for the county births.

At the county level there are often too few births to calculate age-specific birth rates for each race/ethnic group, so child/woman ratios were calculated for 2000 and projected into the future with a gradual convergence to the state-level ratio. Child-woman ratios compare the number of 0-4 year olds to the number of women in their childbearing years.

Death Assumptions

Age-specific survival rates for Tennessee as a whole were constructed in a manner quite similar to that followed for birth rates. A model of survival known as a life table was made from death data for the three-year period centered on 2000 for the four race and ethnic groups. Life tables are commonly used to estimate life span and to "survive" a population forward into the future by age in cohort-component population projections. Tennessee survival rates also were projected into the future by following the trends forecasted by the Census Bureau in its most recent national projections

Migration

For most counties, the greatest change in population results not from births and deaths, but from migration. Migration patterns exhibit many differences at the county level and result from a broad spectrum of local and regional factors. The role of migration was measured in terms of *net* migration, or the net difference between the numbers of people moving into and out of each county from 1990 to 2000. Each age, sex, race/ethnicity group was examined separately. The Applied Population Laboratory provided these migration estimates.

Tennessee recently has witnessed a change in its migration levels. During the 1970s, Tennessee had a net population gain from migration of about 393,000. In the 1980s that dropped to 128,000, while in the 1990s Tennessee added nearly 482,000 residents from migration, much of it international in origin. The Census Bureau's state population estimates for 2002 suggest a

dramatic decline in net migration. Between 2000 and 2002 there was a net gain of about 51,000 people from migration, a decline of nearly 50 percent from the annual levels of the preceding decade. In addition, there has been a decline in Tennessee employment in the last two years after nearly a decade of strong increases.

There probably was considerable momentum behind the migration streams to the state, and migration could be reduced further as the recession continues. However, the state-level assumption in the projections is that the state will carry its 2000-2002 migration pattern forward for the remainder of the decade. For 2010-2020 the domestic portion of the migration stream was trended downward while holding the international portion of migration to the state constant. These state-level patterns provide a total to which net migration for the counties was limited.

Projections Process

Projections for Tennessee and its 95 counties were carried in three stages. In stage one the state projections for five-year age groups 0-4 through 80-84 and 85 and over for 2005, 2010, 2015, and 2020 were created and calibrated. These projections served as the basis for controlling the total of the county projections to follow. County projections were done in the second stage for the same age groups and years. In stage three the projections were adapted to single calendar years from 2001 through 2020 and single years of age.

Separate projections were prepared for each race/ethnic group in counties with sufficient populations. Counties with very small populations of Blacks, others, or Hispanics were projected in county groups and then distributed back to the individual counties on the basis of their 2000 Census populations. In addition, white Hispanics and white non-Hispanics were projected separately and then combined to form total whites since their migration patterns are distinct.

Adapting the projections to single calendar years and single years of age was a two-step process. In step one, a compounding growth interpolation formula was applied to make the transition from each five-year age group in the initial year to the corresponding group five years later.

In step two, the five-year age group data was converted to single years of age by applying a modified Karup-King Third Difference Formula for osculatory interpolation.[1] For any given five year age group, this formula derives single-year age data by taking into account the size of that age group and the two age groups adjacent to it. For example, to derive the 10, 11, 12, 13, and 14 year-olds, the formula starts with the 10-14 age group as well as the 5-9 and 15-19 age groups. If the 15-19 age group is significantly larger than the 5-9 group, then the formula will allocate a larger amount to the 13-14 year-olds than to the 10-11 year olds.

Decision Demographics modified the basic formula in three ways. First, the 15-19 and 20-24 age groups in a county are subject to unique and unbalanced distributions due to the presence or absence of universities, prisons, or military bases. A county with a university, for example, will have many more 18-19 year-olds than 15-17 year-olds. Therefore, the distribution within those age groups was based on the 2000 Census distribution rather than the Karup-King formula.

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[1] Henry S. Shryock, Jacob S. Siegel, et. al., *The Methods and Materials of Demography,* Washington, DC: USGPO, 1973, p. 701 ff.

Second, the Karup-King approach works best with age groups that are in the middle of other, equivalent groups. To take advantage of this fact, a temporary estimate of the 85-89 age group was created in order to break down the 80-84 age group as if it were in the middle of the distribution. Third, there are some county age-race-sex distributions where there are extreme differences in the size of adjacent age groups that would cause the Karup-King formula to yield unbalanced, or even negative estimates of the single-year population. Most of these occur in smaller, rural counties with small non-white populations where there may be four people in one age group and only zero or one persons in an adjacent group—a very large percent difference. In such extreme cases, the adjustments applied to the central age groups that are derived from the adjacent groups have been limited in their extent. In addition to these methods, Decision Demographics employed several other distribution techniques to deal with very small age groups and to control to the exact original total when rounding the single year of age data.

Scope/Geographic Scale: The state as a whole and all counties.

Duration (Number of Years Covered): 2000-2020

Variables Included: Basic demographic characteristics of age, sex, white, Black, and other races, and Hispanic ethnicity.

Uses of the Study/Data Set: This data set can be used for analysis and planning in many fields. It can provide denominators for the calculation of vital rates in the near future, it can provide information valuable for economic development activities, and it can provide a yardstick against which future change can be measured to identify newly emerging trends.

Strengths: This is a well-grounded set of projections that takes into account recent trends and reasonable assumptions about the future course of population change. Since these projections provide highly detailed annual single year of age information, virtually any age group can be constructed from the underlying data. Data through 2002 on births, deaths, and migration for Tennessee and its counties have been analyzed and incorporated with assumptions about the future course of these basic components of population change.

Limitations or Biases: There are many counties in Tennessee that have either no Blacks, others, or Hispanics, or they have very small total numbers of those groups. The single year of age data based on small groups can be highly volatile. Such small populations should be used only in combination with other age groups or other counties in a region in order to compute totals for custom geographic areas. When used alone, these data will yield unpredictable results. In addition, Blacks, others and Hispanics in the 2000 Census as well as these projections are subject to undercounting to a greater extent than whites.