MISER Population Projections for Vermont, 2000–2020

By

Stefan Rayer,[1] Ph.D.

August 2003

[1] Massachusetts Institute for Social and Economic Research, 128 Thompson Hall, University of Massachusetts, Amherst, MA 01003. (413) 545-3460. srayer@miser.umass.edu.

Summary of Population Projections Methodology

The MISER Population Projections for Vermont, 2000–2020, employ a cohort-component model in which fertility, mortality, and migration are projected independently. The projections were produced in 5-year steps covering the periods 2000–2005, 2005–2010, 2010–2015, and 2015–2020. The launch year population for 2000–2005 was the Census 2000 population. In each of the following projection periods the launch year population was the target population of the previous 5-year projection interval. The projections were executed for each Vermont minor civil division (MCD; i.e. the 255 cities and towns) following a bottom-up model that was not controlled to a higher level of geography. In addition to total population, the projections also include sex and 5-year age group demographic detail.

Overview of the Cohort-Component Method

1. Preparation of the Launch Year Population

The launch year population for the MISER population projections for Vermont is the Census 2000 population by sex and 5-year age group for each Vermont MCD. The only adjustment made to the launch year population was the modification of the college age population.

In contrast to other segments of the population, the population attending college does not age in place. College towns, such as Middlebury town and Johnson town, have peculiar age profiles due to the presence of students attending college, which is evident by bulges in their population pyramids in the late teens and early twenties. This skewed age profile will remain largely unchanged over time and, if unchecked, has the potential to adversely impact the population projections, especially with respect to the application of migration rates. Therefore, following common projection practice, the MISER population projections for Vermont are executed excluding the college age population for 15 cities and towns that had significant college populations.[2] The standard procedure for excluding the college age population is to use group quarters data. The group quarters data from Census 2000 provide information on college enrollment by 5-year age group (calculated as a residual when subtracting the household from the total population). For 11 of the 15 cities and towns with sizeable college populations the group quarters procedure yielded satisfactory results, i.e. excluding the group quarters population from the total population for the age groups 15–19 and 20–24 produced a smooth age profile. For Burlington, Castleton, Johnson, and Lyndon, the group quarters population is significantly different from the college population, mainly because large numbers of students live off-campus. For these MCDs, the age profile was smoothed using the previous and the following age groups.

[2] The cut-off criterion was a group quarters population in college or college equivalent exceeding 3% of the total population in 2000. The 15 cities and towns are: Bennington, Burlington, Castleton, Colchester, Craftsbury, Johnson, Lyndon, Marlborough, Middlebury, Northfield, Plainfield, Poultney, Putney, Randolph, Vergennes.

All the projection components, with the exception of fertility (see below), were calculated and applied to the adjusted launch year population in each projection interval, which equals the total population in 240 MCDs, and which equals the total population minus the college population in the 15 cities and towns with colleges.

2. Mortality Component

The first step of the cohort-component model involves calculating the number of survivors to the end of the projection interval. This is done by applying age-specific survival rates to each age-sex cohort of the launch year population. Because survival rates are the least variable of the three projection components, and because of the unavailability and unreliability of mortality data at small levels of geography, the MISER population projections for Vermont apply state-level survival rates. The five-year survival rates were calculated using an abridged life table with five year age groups except for ages 0–1, 1–4, and 85+. The input data were the Census 2000 population and the three-year average of 1999–2001 recorded Vermont resident deaths. The survival rates were calculated using a three-year average in order to smooth out annual fluctuations in the number of deaths by age group.

The survival rates were projected in each five-year period as the average of the following three age-specific survival rates: (a) linear extrapolation of recorded Vermont survival rates using life table methods and covering the period 1990–2000; (b) Census Bureau 2000–2020 mortality projections for the total population for the United States; and (c) Social Security Area 2000–2020 mortality projections for the total population of the United States.

Mortality or survival rates have changed significantly throughout the last century with the trend being toward lower mortality, higher survival, and higher life expectancy for both sexes, most age groups, nearly everywhere. This trend is likely to continue into the future, but the speed and magnitude are difficult to ascertain. For this reason, the MISER population projections for Vermont, 2000–2020, apply an average of Vermont-specific and nationwide projected trends in survival rates. The Vermont trend was calculated as a linear extrapolation from 1990 to 2000, where survival rates in both years were calculated using a three year average in reported resident deaths (1989–1991 for 1990, 1999–2001 for 2000). The other two components used were the projected changes in age-specific survival rates from the Census Bureau's National Population Projections, Middle Series, Total Population, 1999–2100 life tables, and the projected changes in age-specific survival rates from the 1997 Social Security Area Population Projections, Intermediate Alternative, 2000–2080.

3. Migration Component

The next step in the cohort-component projection model involves the calculation of net migration during the projection period. For that purpose, demographers commonly apply net migration or gross migration rates, or a combination of both. Gross migration covers both the in- and out-migration of people into or out of an area, while net migration is simply the difference between in- and out-migration. From a theoretical standpoint, it is advantageous to use gross migration rates, because actual in- and out-migration streams more closely resemble the true migration process, whereas net migration is largely an accounting exercise. A further advantage of the use of gross migration data is that the at-risk population used in the denominator for calculating the migration rates is clearly defined – the population in the area of interest for out-migration, and the population in the rest of the world (United States) for in-migration – whereas there exists no real at-risk population for net migration. Unfortunately, especially at the subcounty level, reliable gross migration data are hard to come by. The only source for gross migration data are the migration stream data from the decennial census, which are based on the question "where did you live 5 years ago?"

For the MISER population projections for Vermont, it was decided that the advantages provided by the gross migration data from the decennial census were outweighed by the problems associated with their use, and therefore the migration rates are based on residual migration estimates. This decision was guided by the fact that the only migration data available at the time of production of the population projections were the 1985–1990 data from the 1990 census. These data are considerably out of date, and they cover a time period of relatively strong gains through in-migration which are unlikely to continue. Indeed, annual residual migration estimates provided by the Census Bureau for the 1980s and 1990s have shown that the late 1980s were a rather unique period with respect to migration gains in Vermont. Furthermore, and more significantly, a careful analysis of the migration stream data revealed severe problems in many areas with small populations. It was deemed that the needed geographic and demographic detail for the population projections was beyond the level at which the sample-based migration stream data can be considered reliable.

The net migration rates used in the population projections were calculated using the survival rate method, which is computed as follows:

$$M_{x+t} = P^{t}_{x+t} - sP^{0}_{x},$$

Where x is an age or age group

t is the interval in years between censuses

P^{0}_{x} is the population aged x at the first census

P^{t}_{x+t} is the population at the next census at age $x+t$

s is the ten year survival rate

The survival rate method applies survival rates to the launch year population in order to estimate the expected population at the end of a time period. Net migration is then calculated as the difference between the expected population and the actual population. For example, to estimate net migration between 1990 and 2000 by the survival rate method, one applies ten year survival rates to the 1990 census population and compares the expected population in 2000 with the census population for 2000. If the expected population is lower than the census population, net in-migration has occurred and vice versa.

The above formula refers to the ordinary survival rate method, which is also called the forward survival rate method. Another way to estimate net migration for an intercensal period is by using the reverse survival rate method, in which survival rates are divided into the population in the age group at the end of the period. Net migration is then estimated by subtracting the launch year population:

$$M_{x+t}' = (P^{t}_{x+t} / s) - P^{0}_{x}$$

The two methods give comparable results, with the difference being a factor of the amount of net migration and the level of the survival rates. Averaging the two methods provides the most meaningful results, and this is the method applied for the MISER population projections for Vermont.

The ten year migration estimates calculated by the average survival rate method were converted to five year migration rates following a method by which both expected survivors and estimated net migration are averaged over adjacent five year age cohorts. An alternative is to produce the population projections in ten year intervals, applying the ten year migration rates, and then deriving the projections for intermediate years (2005 and 2015) by interpolation. Although the migration period conversion procedure is not without problems, it was determined that this method is preferable over producing projections in ten year intervals.

After net migration has been estimated, the migration rates were computed by applying the net migration numbers to the population of each MCD, sex, and age group at the beginning of the period. The migration rates were then held constant throughout the projection period and they were based on the average of the migration rates for 1980–1990 and 1990–2000. Averaging migration rates over two ten year periods serves to limit short-term fluctuations and limits the impact of extreme values. It also reduces the potential impact of a differential over- or undercount in the 1980, 1990, and 2000 censuses.

4. Fertility Component

After mortality and migration rates have been applied to the adjusted launch year population, the third step in the cohort-component projection model is to calculate the number of births during each projection interval. This is done by applying age-specific birth rates to the female population in each age cohort from ages 15 to 49. The birth rates were calculated at the MCD level using a multi-year average of the recorded number of resident births during the period 1997–2001. Demographers often calculate birth rates using multi-year averages in order to smooth out annual fluctuations in the number of births. Because the annual number of resident births is very low for many cities and towns in Vermont, even a three-year average for 1999–2001 proved unsatisfactory. Instead, the birth rates for the MISER population projections for Vermont were calculated using the average of three three-year averages: 1997–1999, 1998–2000, and 1999–2001. The rates were computed with the unadjusted (i.e., including college population) 2000 female census population by five-year age group as the denominator. Although ideally the denominator for the three rates should have been the population in 1998, 1999, and 2000, the differences are trivial compared to the annual variability in the number of births.

Unfortunately, a close inspection of the birth data revealed that even using three three-year averages did not produce satisfactory age-specific birth rates for about 1/3 of the cities and towns. Because of small populations, for these MCDs either the total fertility rate for 2000 was unreasonably low or high, the total fertility rate for 2000 was significantly different from the 1990 TFR, or the TFR was reasonable but the age-specific birth rates (ASBRs) were not. If there was a problem with the TFR, but not the ASBRs, the ASBRs were scaled to produce a more moderate TFR. If the TFR was within reasonable limits, but the ASBRs were not, the state level age-specific birth rates were scaled to the MCD's TFR. If there were problems with both the TFR and the ASBRs, a combination of the two procedures was applied.

Deciding what constitutes a problematic ASBR or TFR is a judgment call. For example, if the TFR decreased significantly between 1990 and 2000, one needs to determine if this reflects true change or if it merely is an artifact created by annual fluctuations in MCDs with small populations. The objective followed in making adjustments was to avoid extreme values either in the form of unreasonably high or low total fertility rates for a city or town, or in the form of age-specific birth rates that differed significantly from the state's ASBRs.

Over the last twenty years, in many cities and towns in Vermont the trend has been toward lower fertility rates and toward a shift to having births at later ages. It was decided to use the most recent age-specific birth rates and hold these constant throughout the projection period, because it seems unlikely that fertility rates are going to fall much lower, especially given the fact that the fertility rates for Vermont are among the lowest in the nation. It is also hard to envision that the trend toward having births at older ages is going to continue much further. Moreover, there is reason to believe that continued in-migration of minority groups, both from other states and from abroad – which have accounted for some of the highest growth rates throughout the 1990s – may serve to counterbalance this trend. Thus, given the uncertainty in predicting the direction of future fertility trends, it is reasonable to hold the fertility component of the population projections constant throughout the 20 year projection horizon.

5. Final Adjustments

The final step in the cohort-component projection model is to add in the college population that was taken out in step 1. This yields a target population for each MCD by sex and five-year age group that was survived five years from the launch population, that was subject to migration, and to which births were added that were projected to occur during the five-year projection interval. The target year population for the first projection interval then becomes the launch year population for the second projection interval, and all the above described steps of the cohort-component projection model are again applied to the new launch year population.