PROJECTING MULTI-RACE POPULATIONS USING COHORT CHANGE RATIOS.

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Introduction

Although data on race have been collected since the first census in 1790, it was only in 2000 that Americans that Americans were first given the opportunity to self-identify with more than one race.

This practice continued in the 2010 census and with the release of the 2010 census data, we have learned some interesting facts about multi-racial populations in the United States.

Introduction

For example, in an article published by the New York Times (March 24th, 20110) Susan Saulny wrote that The US Census Bureau had reported that among American children, the multiracial population increased almost 50 percent, to 4.2 million between census 2000 and census 2010, making it the fastest growing youth group in the country.

She also noted that the number of people of all ages who identified themselves as both white and black increased by 124 percent between census 2000 and census 2010.

Introduction

In a detailed analysis of the multi-race population, Jones and Bullock (2012) reported that between census 2000 and census 2010 the number of Americans who consider themselves multiracial grew faster than those who self-identify as a single race.

Specifically, they found that those who self-identified as multi-racial increased by 32 percent while those who self-identified as a single race increased by 9.2 percent.

Introduction

Given the growth in this population segment, a natural question is what will it look like in the future?

The usual approach to answering a question about the future number and composition of a given population is the cohort-component method.

However, its data requirements, already substantial, increase considerably when one attempts to use this approach for a multi-race population since one must have birth, death, and migration data.

Introduction

The birth data are particularly problematic since birth rates are needed by race of father and race of mother. Fortunately, there is a way to project multi-race populations that does not require birth, death, and migration data, only census data from two points in time to implement – The Hamilton-Perry Method (Hamilton and Perry, 1962), which uses "cohort change ratios."

In this short note, I describe the Hamilton-Perry method and then show examples of its use in projecting multi-race populations, including an example in which the method is run in reverse in order to estimate a multi-race population in 1990.

Introduction

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Hamilton-Perry Method

The major advantage of this method is that it has much smaller data requirements than the traditional cohort-component method.

Instead of mortality, fertility, migration, and total population data, the Hamilton-Perry method simply requires data from the two most recent censuses.

Hamilton-Perry Method

The Hamilton-Perry method projects population by age and sex using cohort-change ratios (CCR) computed from data in the two most recent censuses. The formula for a CCR is:

$$ {}_nCCR_x = {}_nP_{x+y,l} \; / \; {}_nP_{x,b} $$

where

${}_nP_{x+y,l}$ is the population aged x+y to x+y+n in the most recent census (l),

${}_nP_{x,b}$ is the population aged x to x+n in the second most recent census (b),

and y is the number of years between the two most recent censuses (l-b).

Hamilton-Perry Method

Using the 1990 and 2000 censuses as an example, the CCR for the population aged 20-24 in 1990 would be:

$$ {}_5CCR_{20} = {}_5P_{30,2000} \; / \; {}_5P_{20,1990} $$

Hamilton-Perry Method

The basic formula for a Hamilton-Perry projection is:

$$ {}_nP_{x+z,t} = {}_nCCR_x * {}_nP_{x,l} $$

where

$$ {}_nCCR_x = ({}_nP_{x+y,l} \; / \; {}_nP_{x,b}) $$

and, as before,

${}_nP_{x+y,l}$ is the population aged x+y to x+y+n in the most recent census (l),
${}_nP_{x,b}$ is the population aged x to x+n in the second most recent census (b),
and y is the number of years between the two most recent censuses (l-b).

Hamilton-Perry Method

Using data from the 1990 and 2000 censuses, for example, the formula for projecting the population 30-34 in the year 2010 is:

$$ {}_5P_{30,2010} = ({}_5P_{30,2000} \; / \; {}_5P_{20,1990}) * {}_5P_{20,2000} $$

The quantity in parentheses is the CCR for the population aged 20-24 in 1990 and 30-34 in 2000.

Hamilton-Perry Method

Given the nature of the CCRs, 10-14 is the youngest age group for which projections can be made (if there are 10 years between censuses).

To Project the population aged 0-4 and 5-9 one can use the Child Woman Ratio. It does not require any data beyond what is available in the decennial census.

For projecting the population aged 0-4, the CWR is defined as the population aged 0-4 divided by the population aged 15-44. For projecting the population aged 5-9, the CWR is defined as the population aged 5-9 divided by the population aged 20-49.

Hamilton-Perry Method

Here are the CWR equations for males and females aged 0-4 and 5-9, respectively.

Females 0-4: $${}_5FP_{0,t} = ({}_5FP_{0,l} / {}_{30}FP_{15,l}) * {}_{30}FP_{15,t}$$

Males 0-4: $${}_5MP_{0,t} = ({}_5MP_{0,l} / {}_{30}FP_{15,l}) * {}_{30}FP_{15,t}$$

Females 5-9: $${}_5FP_{5,t} = ({}_5FP_{5,l} / {}_{30}FP_{20,l}) * {}_{30}FP_{20,t}$$

Males 5-9: $${}_5MP_{5,t} = ({}_5MP_{5,l} / {}_{30}FP_{20,l}) * {}_{30}FP_{20,t}$$

Where

FP is the female population,
MP is the male population,
l is the launch year,
and t is the target year.

Hamilton-Perry Method

The formula for projecting the youngest age groups using the CWR approach, is according to that shown below using, as an example, females 0-4 in 2010:

$$ {}_5FP_{0,2010} = ({}_5FP_{0,2000} \; / \; {}_{30}FP_{15,2000}) * {}_{30}FP_{15,2010} $$

Hamilton-Perry Method

Projections of the oldest age group differ slightly from projections for the age groups from 10-14 to the last closed age group (e. g., age group 80-84). For example, if the final closed age group is 80-84, with 85+ as the terminal open-ended age group, then calculations for the CCR require the summation of the three oldest age groups to get the population age 75+:

$$CCR_{75+} = P_{85+,l} / P_{75+,b}$$

Hamilton-Perry Method

Using data from the 1990 and 2000 censuses, for example, the formula for projecting the population 85+ in the year 2010 is:

$$P_{85+,2010} = (P_{85+,2000} / P_{75+,1990}) * P_{75+,2000}$$

The quantity in parentheses is the CCR for the population aged 75+ in 1990 and 85+ in 2000.

Hamilton-Perry Method

The Hamilton-Perry Method can be used to develop projections not only by age, but also by age and sex, age and race, age, sex and race, and so on.

Hamilton-Perry Method

Limitations of the Hamilton-Perry Method

The Hamilton-Perry method can lead to unreasonably high projections in rapidly growing places and unreasonably low projections in places experiencing population losses.

Geographic boundary changes are an issue, even with census tracts. Since the Hamilton-Perry and other extrapolation methods are based on population changes within a given area, it is essential to develop geographic boundaries that remain constant over time. For some sub-county areas, this presents a major challenge.

Hamilton-Perry Method

Overcoming Limitations of the Hamilton-Perry Method

1. Control Hamilton-Perry projections to independent projections produced by some other method
2. Calibrate Hamilton-Perry projections to post-censal population estimates
3. Otherwise set limits on population change (e.g., “caps”)
4. Account for all boundary changes

Illustrative Projections

Here, two projections and one "backcast" are provided.

All three use the Hamilton-Perry methodology just described, with the two youngest age groups found by using the "Adult Child Ratio" method.

All three are done in excel and the three tables are copied directly from their respective spreadsheets.

Illustrative Projections

Table 1. A Hamilton Perry Projection for Native Hawaiians and Part-Hawaiians, Hawai'i, 2010 to 2030

	2000 POPULATION	2010 POPULATION	2000-2010 CCR	PROJECTED 2020
Total Population: 0 to 4 years	24,677	30,727	0.48796	35,067
Total Population: 5 to 9 years	26,675	28,829	0.49916	35,370
Total Population: 10 to 14 years	25,660	26,801	1.08607	33,372
Total Population: 15 to 19 years	23,694	27,233	1.02092	29,432
Total Population: 20 to 24 years	18,011	22,450	0.87490	23,448
Total Population: 25 to 29 years	16,539	21,538	0.90901	24,755
Total Population: 30 to 34 years	16,427	18,982	1.05391	23,660
Total Population: 35 to 39 years	17,488	17,235	1.04208	22,444
Total Population: 40 to 44 years	15,866	17,175	1.04553	19,846
Total Population: 45 to 49 years	13,795	17,971	1.02762	17,711
Total Population: 50 to 54 years	11,015	16,058	1.01210	17,383
Total Population: 55 to 59 years	8,814	13,484	0.97746	17,566
Total Population: 60 to 64 years	6,363	10,368	0.94126	15,115
Total Population: 65 to 69 years	5,149	7,958	0.90288	12,174
Total Population: 70 to 74 years	4,078	5,158	0.81062	8,405
Total Population: 75 to 79 years	2,720	3,750	0.72830	5,796
Total Population: 80 years and over	2,684	4,253	0.44853	5,903
Total Population	239,655	289,970	1.20995	347,448
GROWTH RATE		0.01906		0.01808

1. Data from 2000 and 2010 census counts from American Factfinder, US Census Bureau
2010 data are from Table QT-P1, STF 2, Census 2010
2000 data are from Table QT-P1, STF 2, Census 2000
www.factfinder2.census.gov/faces/nav/jsf/index.xhtml

Illustrative Projections

Table 2. A Reverse Hamilton Perry Projection to Estimate Native Hawaiians and Part-Hawaiians in 1990: Hawai'i

AGE IN 2010 & 2000	2010 POPULATION	2000 POPULATION	REVERSE 2010-2000 CCR	AGE IN 1990	BACKCASTED 1990
Total Population: 0 to 4 years	30,727	24,677	0.92075	Total Population: 0 to 4 years	23,626
Total Population: 5 to 9 years	28,829	26,675	0.97951	Total Population: 5 to 9 years	23,209
Total Population: 10 to 14 years	26,801	25,660	1.14298	Total Population: 10 to 14 years	20,586
Total Population: 15 to 19 years	27,233	23,694	1.10010	Total Population: 15 to 19 years	18,195
Total Population: 20 to 24 years	22,450	18,011	0.94885	Total Population: 20 to 24 years	15,587
Total Population: 25 to 29 years	21,538	16,539	0.95962	Total Population: 25 to 29 years	16,782
Total Population: 30 to 34 years	18,982	16,427	0.95645	Total Population: 30 to 34 years	15,175
Total Population: 35 to 39 years	17,235	17,488	0.97312	Total Population: 35 to 39 years	13,424
Total Population: 40 to 44 years	17,175	15,866	0.98804	Total Population: 40 to 44 years	10,883
Total Population: 45 to 49 years	17,971	13,795	1.02306	Total Population: 45 to 49 years	9,017
Total Population: 50 to 54 years	16,058	11,015	1.06240	Total Population: 50 to 54 years	6,760
Total Population: 55 to 59 years	13,484	8,814	1.10756	Total Population: 55 to 59 years	5,703
Total Population: 60 to 64 years	10,368	6,363	1.23362	Total Population: 60 to 64 years	5,031
Total Population: 65 to 69 years	7,958	5,149	1.37307	Total Population: 65 to 69 years	3,735
Total Population: 70 to 74 years	5,158	4,078	2.22949	Total Population: 70 Years and over	5,984
Total Population: 75 to 79 years	3,750	2,720	n/a	n/a	
Total Population: 80 years and over	4,253	2,684	n/a	n/a	
Total Population	289,970	239,655		Total Population	193,696
REVERSE GROWTH RATE		-0.01906			-0.02129

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Illustrative Projections

Table 3. A Hamilton Perry Projection for The Multi-Race Population of Riverside & San Bernardino Counties, 2010 to 2020

AGE GROUP	2000 POPULATION	2010 POPULATION	2000-2010 CCR	PROJECTED 2020
Total Population: 0 to 4 years	21,266	30,261	0.71079	51,141
Total Population: 5 to 9 years	20,271	26,798	0.73593	44,732
Total Population: 10 to 14 years	16,418	26,522	1.24715	37,740
Total Population: 15 to 19 years	13,514	24,268	1.19720	32,083
Total Population: 20 to 24 years	10,159	17,040	1.03786	27,526
Total Population: 25 to 29 years	8,952	13,461	0.99607	24,173
Total Population: 30 to 34 years	7,871	12,073	1.18844	20,251
Total Population: 35 to 39 years	7,969	10,880	1.21535	16,360
Total Population: 40 to 44 years	7,053	10,319	1.31104	15,828
Total Population: 45 to 49 years	5,377	9,525	1.19520	13,004
Total Population: 50 to 54 years	4,116	7,914	1.12205	11,578
Total Population: 55 to 59 years	2,806	5,955	1.10751	10,549
Total Population: 60 to 64 years	2,128	7,914	1.92279	15,217
Total Population: 65 to 69 years	1,735	4,115	1.46636	8,732
Total Population: 70 to 74 years	1,301	1,982	0.93148	7,372
Total Population: 75 to 79 years	894	1,424	0.82082	3,378
Total Population: 80 to 84 years	570	974	0.74864	1,484
Total Population: 85 to 89 years	430	707	0.40753	1,677
Total Population	132,830	212,132	1.59702	342,824
GROWTH RATE		0.04681		0.04800
10-year change		79,302		130,692
10-year percent change		59.70%		61.61%

1. Data from 2000 and 2010 census counts from American Factfinder, US Census Bureau
2010 data are from Table QT-P1, STF 2, Census 2010
2000 data are from Table QT-P1, STF 2, Census 2000
www.factfinder2.census.gov/faces/nav/jsf/index.xhtml

Discussion

As can be seen from the three tables, generating a projection for a given multi-race population is very straightforward. One only needs to collect the 2000 and 2010 data by age group, generate the cohort change ratios for 2000 to 2010, and then apply them to the 2010 data to generate a 2020 forecast. Similarly, a backcast to 1990 is straightforward One simply reverses the cohort change ratios from 2010 to 2000, and then applies them to the 2000 data to generate a backcast for 1990.

Discussion

Some cautions are in order, of course. As Smith, Tayman, and Swanson (2001) advise, the Hamilton-Perry works best for short term forecasts, advice also given by Hamilton and Perry (1962). There are some accuracy issues with the 2000 multi-race data, such that the population reporting two or more races was overstated nationally by about 15 percent (Jones and Bullock, 2012). However, these same cautions would apply to any forecasting method.

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Questions?