Demographic Analysis 2010: Sensitivity Analysis of the Foreign-Born Migration Component

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The U.S. Census Bureau produced estimates of net international migration for the 2010 Demographic Analysis (DA). This paper focuses on the 2000 to 2010 estimates of net foreign-born migration, which was a large component of the total net international migration estimates. Specifically, it describes how data from the American Community Survey were used along with the residence one year ago and year of entry methods to develop a range of estimates of foreign-born immigration during the decade. It also discusses the residual methodology used to produce estimates of foreign-born emigration. It then describes how these estimates of immigration and emigration were combined to produce four estimates of net foreign-born migration during the decade and presents results. Finally, it discusses alternative estimates of net foreign-born migration developed by calculating the change in stock of the foreign-born population over time and compares these alternative estimates to the estimates of net foreign-born migration included in the DA estimates.

Introduction

Demographic analysis (DA) is a term that refers to a set of methods that have been used to develop national-level estimates of the population for comparison with the decennial census counts. The U.S. Census Bureau has been developing DA estimates as a tool for evaluating results from decennial censuses since the 1950 Census (Robinson 2011). DA estimates are developed from historical vital statistics, estimates of international migration, and other data sources. These estimates are then compared to census counts and differences by demographic characteristics are examined. For DA to provide an accurate estimate of the population, reliable estimates of births, deaths, and net international migration (NIM) are essential. In an effort to communicate the impact of uncertainty of these components on the total DA estimates for DA in 2010, the Census Bureau produced five estimates of the total U.S. population as of April 1, 2010. The Low, Low Middle, Middle, High Middle, and High estimates were released in December of 2010 and included alternate assumptions for each of the components of DA (Devine, Bhaskar, DeSalvo, Robinson, Scopilliti, and West 2012). The estimates discussed in this paper are from the December 2010 release. Revised estimates were later developed and released in May 2012, but these estimates are not included in this paper.

This paper will focus on the largest flows of NIM - the immigration and emigration of the foreign-born population (i.e., the population who were not U.S. citizens at birth). While net foreign-born migration makes up a small portion of the total resident population, this component represents a large portion of the uncertainty in the DA estimates. Because of issues with data quality and availability, reliable estimates of net foreign-born migration are difficult to produce. The Census Bureau has used a variety of data and methods in the past to measure the immigration and emigration of the foreign-born population. In the 1990s, administrative records from the Immigration and Naturalization Service served as the primary data source to measure

the flow of legal immigrants to the United States. Other data and methods were used to measure the remaining migration flows. With the implementation of the American Community Survey (ACS), a new data source became available to produce estimates of immigration and emigration. The ACS provides data on citizenship, place of birth, year of entry, and place of residence in the prior year, which can be used to estimate migration of the foreign born into and out of the United States. Using the ACS and other data sources, four estimates of net foreign-born migration from 2000 to 2010 were developed and used as inputs in the five final DA series. The Low and Low Middle DA series included the same estimate of net foreign-born migration for this decade.

In summary, this paper presents the data and methods used to produce estimates of net foreign-born migration for the 2000 to 2010 period for the DA 2010 total population estimates by demographic characteristics. Specifically, it describes how data from the ACS were used along with the residence one year ago and year of entry methods to develop a range of estimates of foreign-born immigration during the decade. It also discusses the residual methodology used to produce estimates of foreign-born emigration. Estimates of immigration and emigration are presented by demographic characteristics (age, sex, race, and Hispanic origin). The paper also describes how estimates of immigration and emigration were combined to produce four estimates of net foreign-born migration during the decade and presents the results. Lastly, it discusses alternative estimates of net foreign-born migration developed by calculating the change in stock of the foreign-born population over time and compares these alternative estimates to the estimates of net foreign-born migration included in the official DA estimates.

Foreign-Born Immigration

Foreign-born immigration includes the immigration of both non-U.S. citizens and naturalized U.S. citizens to the United States. In previous DA estimates, immigration was measured as several different components, the largest of which, legal immigration, was estimated primarily using administrative records from the Immigration and Naturalization Service. Additional data and indirect methods were used to estimate additional flows of international migration. Detailed descriptions of the methods used to estimate components of net international migration for 2000 DA are available on the Census Bureau website (Cassidy and Pearson 2002; Christenson 2002; Costanzo, Davis, and Malone 2002; Deardorff and Blumerman 2001; Gibbs, Harper, Rubin and Shin 2001; Mulder, Hollmann, Lollock, Cassidy, Costanzo, and Baker 2001). This historical work served as a base for estimating migration prior to 2000 for the 2010 DA estimates.

For this decade, the ACS is the primary data set used to produce estimates of immigration. After conceptual development and design proposals in the 1990s, the ACS was first demonstrated in 2000. Full implementation of the survey began in 2005, with an annual household sample size of approximately three million addresses throughout the United States each year (U.S. Census Bureau 2009). The ACS includes data on citizenship, place of birth, year of entry, and place of residence

in the prior year, which can be used to estimate migration of the foreign born to and from the United States.

The estimates of foreign-born immigration from 2000 to 2010 included in DA 2010 are based on single-year ACS data collected from 2000 through 2009. The foreign-born population is defined as those who responded to the ACS citizenship question as either "Yes, U.S. citizen by naturalization" or "No, not a U.S. citizen." To estimate immigrants who entered the country in the last year, two questions from the ACS were used - the Residence One Year Ago (ROYA) and the Year of Entry (YOE) questions. The ROYA question asks respondents, "Where did you live one year ago?" ROYA estimates of foreign-born immigration were defined as the foreign-born household population in each year of the ACS whose residence one year ago was abroad.[1] Because this question was asked only to those aged one and older, we assumed that the number of immigrants under the age of one was equal to half of the number of immigrants aged one. The YOE question asks respondents "When did you come to live in the United States?" YOE estimates of foreign-born immigration were defined as the foreign-born household population in each year of the ACS whose year of entry was the year before the survey year.

Both the ROYA and YOE estimates were assumed to represent migration from July 1 of the year prior to the survey year to June 30 of the survey year. For example, the foreign-born population in the 2007 ACS whose residence one year ago was abroad was assumed to represent foreign-born immigrants from July 1, 2006 to June 30, 2007. We divided these annual estimates by twelve to produce monthly estimates in order to ultimately produce estimates for April 1 through March 31. For both the ROYA and YOE estimates, the estimates based on data prior to 2005, when the ACS was fully implemented, were smoothed using a moving average to account for variability. At the time of this analysis, ACS data were available through 2009. To estimate migration from 2009 to 2010, we assumed constant levels of migration from the previous year.

Figure 1 shows the annual ROYA and YOE estimates of immigration for the April 2000 to March 2010 period along with the upper and lower bounds of the estimates using the 90 percent confidence interval. For all years, YOE estimates are higher than ROYA estimates, though the two methods show a similar trend in immigration across the decade. The ROYA estimate of foreign-born immigration for the April 1, 2000 to March 31, 2010 period is: 11.9 million. The YOE estimate is 1.6 million higher at 13.5 million foreign-born immigrants.

Both these estimates provide plausible values of foreign-born immigration during the decade, but they included several assumptions that should be noted. The reliability of the estimates depends on accuracy of reporting on citizenship, previous place of residence, and year of entry to the United States. Additionally, both of the estimates were based on sample data from the ACS and are

[1] The estimates described here were produced for the population living in households. Net international migration to and from group quarters for the 2000 to 2010 period was assumed to sum to zero. A revised middle series of estimates released in May 2012 varied the group quarters assumption.

therefore subject to sampling variability.[2] Finally, potential undercoverage of foreign-born immigrants in the ACS impacts the results. Further work was done to evaluate how these assumptions may impact the estimates, and additional estimates of foreign-born immigration were produced.

As both of the ROYA and YOE estimates were based on sample data, further work was done to evaluate how sampling variability might impact the estimates of immigration. The degree of the uncertainty arising from sampling variability can be represented through the use of margins of error (U.S. Census Bureau 2009). The margins of error around the ROYA and YOE estimates of foreign-born immigration were used to produce additional estimates of foreign-born immigration. As shown in Figure 1, using the 90 percent confidence intervals around the ROYA and YOE estimates from the 2000 through 2009 ACS, we developed cumulative foreign-born immigration estimates ranging from 11.4 million (lower bound of the ROYA estimate) to 13.9 million (upper bound of the YOE estimate) for the April 1, 2000 to March 31, 2010 period.

An additional factor considered is the potential for undercoverage of foreign-born immigrants in the survey data used to estimate immigration. To account for representation in the ACS, the ACS is controlled to population and housing unit estimates produced by the Population Estimates Program (U.S. Census Bureau 2009). The ACS data are controlled so that the number of housing units and number of people by age, sex, race, and Hispanic origin are consistent with the Census Bureau's official population and housing unit estimates. Differential coverage of those who have immigrated in the last year within these control categories or imprecision in the population controls may result in variation in the survey-based estimates of foreign-born immigration. An important assumption of the survey-based estimates is that the controlling of the ACS to Census 2000-based estimates fully accounted for the potential underrepresentation of foreign-born immigrants in the ACS.

To evaluate the potential impact of error resulting from possible differential coverage, the Census Bureau produced alternative coverage factors using data from Census 2000, the Census 2000 Supplementary Survey, and the Dual System Estimate of the U.S. population in 2000 that were developed as part of the Accuracy and Coverage Evaluation (A.C.E.) Revision II project.[3,4] Foreign-born specific coverage factors were developed by broad demographic groups and applied to ROYA and YOE estimates to produce additional estimates of foreign-born immigration for the 2000 to 2010 period (Jensen, Scopilliti, and Bhaskar 2011). Figure 2 shows the ROYA and YOE estimates both with and without the application of foreign-born specific coverage factors. The YOE estimate with the coverage factor is the highest estimate of foreign-born immigration included in the analysis. Figures 1 and 2 represent estimates of immigration that were considered

[2] See U.S. Census Bureau (2009) for further information on sampling variability in the ACS.
[3] The Census 2000 Supplementary Survey was a large-scale demonstration of the American Community Survey (ACS) (U.S. Census Bureau 2009).
[4] The A.C.E. Revision II project was used to estimate population over- and under-counts in the 2000 Census (Hogan 2003).

for inclusion in the final DA 2010 estimates. Four of these estimates of foreign-born immigration were incorporated into the final five DA series. The Low and Low Middle DA series used the lower bound of the ROYA estimate, our lowest estimate of immigration. The Middle DA series used the ROYA estimate, and the High Middle used the YOE estimate. Finally, the High DA series used the highest estimate of foreign-born immigration, the YOE estimate with coverage factors.

Each of these four estimates of foreign-born immigration was produced by single year of age, sex, and two broad race groups (Black and non-Black) for the population under the age of 65.[5,6] Additionally, estimates were produced by Hispanic origin for the population under the age of 20.[7] The characteristics of age, sex, race, and Hispanic origin of foreign-born immigrants were based on data on recent foreign-born immigrants from Census 2000 and the 2005-2007 ACS. Foreign-born immigrants were assigned the demographic characteristic distribution of the foreign-born population who entered the United States within five years of the Census/survey year. Age was adjusted to represent age at arrival into the United States instead of age at the time of the survey using a probability distribution and information on age, year of entry, and the Census/survey year. Estimates for the year 2000 used information from Census 2000, while 2005 and later years used information from the 2005-2007 ACS. The incorporation of ACS data was phased in through linear interpolation between estimate years 2000 and 2005.

Because the data and methodology used to determine the demographic characteristics were the same for each estimate of foreign-born immigration, the distributions by demographic characteristics are generally the same for each estimate with one exception. The YOE with coverage factors estimate had a different distribution than the other estimates because of the use of coverage factors in the proxy universe distribution (Jensen, Scopilliti, and Bhaskar 2011).

Table 1 shows the four estimates of foreign-born immigration by age, sex, and race for the population under the age of 65. The total foreign-born immigration estimates from April 1, 2000 to March 31, 2010 range from 11.0 million (ROYA lower bound) to 13.8 million (YOE with coverage factors), a range of 2.8 million.[8] The majority of foreign-born immigrants are non-Black; estimates of non-Black foreign-born immigrants range between 10.0 and 12.6 million (91.0 to 91.5 percent of foreign-born immigrants).[9] Men comprise more than half of the number of immigrants

[5] Because of the limited race detail available from historical vital statistics data, the DA estimates have traditionally been developed for only two race categories, Black and non-Black (Devine et al. 2012).
[6] Estimates of foreign-born immigration and foreign-born emigration were produced for the population under the age of 65, while the population aged 65 and older was estimated using administrative data on Medicare enrollment adjusted for under-enrollment (West et al. 2011).
[7] Estimates by Hispanic origin were only produced for the population under age 20 primarily due to the limited availability of information on Hispanic origin in historical vital statistics records (Scopilliti et al. 2010).
[8] The estimates in Table 1 are restricted to immigrants under the age of 65 as of April 1, 2010 and thus differ from those presented in Figures 1 and 2.
[9] For this paper, the Black race category is defined as those who report Black as their only race. Those who report more than one race are included in the non-Black category. The original race data from Census 2000 and the ACS were modified to recode the "Some Other Race" category to one of the Office of Management and Budget (OMB)

among both the Black and the non-Black populations. In addition, between 47.8 and 48.9 percent of immigrants are aged 18 to 34 as of April 1, 2010.

Table 2 shows the four estimates of foreign-born immigration by age, sex, and Hispanic origin for the population under age 20. The foreign-born immigration estimates from April 1, 2000 to March 31, 2010 for the population under 20 range between 2.5 million (ROYA lower bound) to 3.3 million (YOE with coverage factors). For the Hispanic population, immigration estimates range between 1.3 million and 1.9 million, representing between 53.3 and 56.1 percent of all immigrants under the age of 20. Males represent 54.2 to 55.1 percent of Hispanic immigrants and between 49.4 and 49.7 percent of non-Hispanic immigrants.

Foreign-Born Emigration

Foreign-born emigration is a difficult component to measure as there is no direct data source to measure the foreign-born population who have emigrated from the United States. Historically, researchers have utilized residual methods using data from decennial censuses in which the foreign-born population in one census is compared to the foreign-born population in the subsequent census. Assumptions for deaths are made using data from life tables and an indirect estimate of emigration is developed (Warren and Peck 1980; Ahmed and Robinson 1994).

More recently, the Census Bureau has used a residual method that incorporates data from the ACS (Dick, Scopilliti, and Bhaskar 2011). For DA 2010, three estimates of foreign-born emigration – a low, middle, and high estimate – were developed using this residual method. The middle estimate reflects the data and methodology used in the Census Bureau's Population Estimates Program to produce estimates for 2000 to 2010.

To calculate the middle estimate of emigration, the foreign-born household population in Census 2000 was survived forward using life tables from the National Center for Health Statistics (NCHS) to obtain the expected population in 2005, 2006, 2007, 2008, and 2009. The estimate of the expected foreign-born population was then compared to the foreign-born population estimated by the 2005, 2006, 2007, 2008, and 2009 ACS. Subtracting the estimated from the expected population produced a residual, which was annualized and used to develop annual rates of emigration. This calculation was performed for two period-of-entry groups: the foreign born who entered the United States between 1990 and 1999, and the foreign born who entered before 1990.

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race categories. The OMB standards are detailed in Office of Management and Budget, "Revisions to the Standards for the Classification of Federal Data on Race and Ethnicity" Notice, Vol. 62, No. 210, Thursday, October 30, 1997 <http://www.whitehouse.gov/omb/fedreg/1997standards.html>. Information on the modification of the "Some Other Race" category can be found at <http://www.census.gov/popest/data/historical/files/MRSF-01-US1.pdf>.

Using different ACS years as the time two population results in different annual rates of emigration. This could be a result of changes in actual emigration patterns over time as well as variation in the ACS. Thus, we calculated three-year averaged rates for each period of entry group and applied the rates to the population at risk of emigrating each year to obtain estimates of emigration of the foreign-born population who entered the United States within the last ten years and of those who entered more than ten years ago. To estimate emigration from 2000 to 2007, we used an average of the rates developed from the 2000 to 2005, 2000 to 2006, and 2000 to 2007 residuals. To estimate emigration in 2008, we used an average of the rates developed from the 2000 to 2006, 2000 to 2007, and 2000 to 2008 residuals. Finally, to estimate emigration in 2009, we used an average of the rates developed from the 2000 to 2007, 2000 to 2008, and 2000 to 2009 residuals.

The resulting rates of emigration by period of entry are shown in Table 3. The different averages produced multiple emigration rates; therefore, the rates are presented as a range. For recent immigrants (those who entered ten or fewer years before the survey), the annual emigration rates range from 13.8 to 14.3 per 1,000 people. For those who entered the United States more than ten years ago the rates range from 2.4 to 3.0 per 1,000 people.

These rates were then applied to the population at risk of emigrating each year (i.e., the foreign-born population in the ACS who indicated that they lived in the United States one year ago) to obtain annual estimates of emigration from 2000 to 2010. To estimate emigration for the 2000 to 2007 period, an average of the rates developed from the 2000 to 2005, 2000 to 2006, and 2000 to 2007 residuals was applied to estimates of the foreign-born population at risk of emigrating from the 2000 to 2007 ACS. To estimate emigration from 2008 to 2009, an average of the rates developed from the 2000 to 2006, 2000 to 2007, and 2000 to 2008 residuals was applied to the population at risk of emigrating estimated by the 2008 ACS. Finally, emigration from 2009 to 2010 was calculated by applying the rates developed from the 2000 to 2007, 2000 to 2008, and 2000 to 2009 residuals to the foreign-born population at risk of emigrating estimated by the 2009 ACS. This resulted in an estimate of 2.1 million foreign-born emigrants for the April 1, 2000 to March 31, 2010 period, which is the middle estimate of emigration.

There are several important assumptions included in this methodology. As with the immigration estimates described above, sampling variability impacts estimates derived from the ACS. Furthermore, this method assumes limited coverage differentials between Census 2000 and each of the years of the ACS used, as well as reliability and consistency of year of entry reporting. In addition, the method assumes emigration rates of those who entered the United States between 1990 and 1999 are applicable to more recent entrants in the 2000 decade. Additionally, while the emigration rates produced account for differences in the likelihood of emigrating for different

period of entry groups, it does not include differential emigration rates by other characteristics that might be important such as sex and Hispanic origin (Dick, Scopilliti, and Bhaskar 2011).[10]

Our ability to assess the impact of these assumptions is limited by data availability and the stability and robustness of the ACS. However, in an effort to evaluate the uncertainty around this estimate due to sampling error, the 90-percent confidence intervals around the ACS estimates were used to develop low and high estimates of emigration.

To develop a low estimate of foreign-born emigration, the upper bound of the ACS estimate in the residual calculation was used to develop an estimated low rate of emigration. These rates range from 12.8 to 13.5 per 1,000 people for the foreign-born population who entered the United States within the last ten years and 1.7 to 2.5 per 1,000 people for those who entered more than ten years ago. These rates were then applied to the lower-bound estimates of the foreign-born population in each year of the ACS to develop a low annual estimate of 1.8 million foreign-born emigrants across the decade.

Similarly, to develop a high estimate of foreign-born emigration, the lower bound of the ACS estimate in the residual calculation was used to develop high rates of emigration. These rates range from 14.7 to 15.2 for the foreign-born population who entered the United States within the last ten years and 3.0 to 3.5 for those who entered more than ten years ago. These high rates were then applied to the upper-bound estimates from the ACS to develop a high estimate of foreign-born emigration. These calculations resulted in a high emigration estimate of 2.3 million across the decade.

As with the estimates of immigration, foreign-born emigration estimates were produced by single year of age, sex, and two broad race groups (Black and non-Black) for the population under the age of 65. Estimates were also produced by Hispanic origin for the population under the age of 20. The age, sex, race, and Hispanic origin distributions of each of the estimates of foreign-born emigration were based on data from Census 2000 and the 2005-2007 ACS. Again, estimates for the year 2000 used information from Census 2000, while estimates for 2005 through 2010 used information from the 2005-2007 ACS. The incorporation of ACS data was phased in through linear interpolation between estimate years 2000 and 2005. Characteristics were applied to the estimates of foreign-born emigration by period of entry. The age, sex, race, and Hispanic origin distributions of the foreign born who entered the United States within ten years of the Census/survey year were applied to the estimate of emigrants who entered within ten years of the estimate year. The age, sex, race, and Hispanic origin distributions of the foreign-born who entered the United States more than ten years before the Census/survey year were applied to the estimate of emigrants who entered the United States more than ten years before the estimate year.

[10] Research on producing emigration rates by sex and Hispanic origin and the associated data and methodological limitations are described by Dick et al. (2011).

Table 4 shows the three estimates of foreign-born emigration from 2000 to 2010 of the population under age 65 by age, sex, and race. The foreign-born emigration estimate from April 1, 2000 to March 31, 2010 ranges from 1.8 million (low series) to 2.3 million (high series). Emigration for the non-Black population ranges between 1.7 and 2.1 million, representing approximately 91 percent of the total foreign-born emigration estimates. The population aged 35-64 comprises the highest proportion of Black and non-Black emigrants. Males comprise more than half of the number of emigrants among both the Black and the non-Black populations.

Table 5 shows the three series of foreign-born emigration estimates from 2000 to 2010 by age, sex, and Hispanic origin for the population under age 20. The total foreign-born emigration estimates for the population under age 20 ranges from 239 thousand (low series) to 287 thousand (high series). Hispanics represent about 53 percent of the foreign-born emigrants under age 20. For both Hispanics and non-Hispanics, most of the emigration under age 20 is of those between the ages of 10 and 19.

Net Foreign-Born Migration

The four estimates of foreign-born immigration and three estimates of foreign-born emigration were then combined to produce a series of net foreign-born migration estimates, as shown in Table 6. Four estimates were produced, as the Low and Low-Middle DA total population estimates had the same estimate of net foreign-born migration for the 2000 to 2010 period.[11] For both of these series, the ROYA lower-bound estimate of immigration was combined with the high estimate of emigration, producing the lowest estimate of net foreign-born migration for the 2000 to 2010 period used in DA 2010. For the Middle DA series, the ROYA estimate of immigration was combined with the middle estimate of emigration. This series incorporated the same methods of estimating net foreign-born migration as was used in the Population Estimates Program. For the High-Middle Series, the YOE estimate of foreign-born immigration was combined with the Middle estimate of foreign-born emigration. Finally, for the High DA series, the YOE with coverage factors estimate of foreign-born immigration was combined with the Low estimate of foreign-born emigration to produce the highest estimate of net foreign-born migration used for DA.

Table 7 shows the four net foreign-born migration estimates by age, sex, and race for the population under the age of 65. The total net foreign-born migration estimates from 2000 to 2010 range from 8.7 million to 12.0 million. The non-Black population represents about 91 percent of each of the net foreign-born migration estimates. Males represent the largest proportions among

[11] The Low and Low-Middle series used the same input of net foreign-born migration for the 2000 to 2010 period. The difference in the estimate of net international migration between these two series results from differences in the assumption of the coverage of the residual foreign-born population in Census 2000. For more information, see Demographic Analysis Research Team (2010a).

both non-Black and Black migration. Table 8 shows the four estimates of net foreign-born migration from 2000 to 2010 by age, sex, and Hispanic origin for the population under age 20. The estimates of net foreign-born migration under the age of 20 range from 2.2 to 3.1 million. Hispanics comprise between 53.4 and 56.4 percent of these estimates. Between 54.3 and 55.3 of Hispanic net foreign-born migrants are male, and between 49.4 and 49.7 non-Hispanic net foreign-born migrants are male.

Alternative Estimates

In addition to these four estimates of net foreign-born migration, two additional estimates were produced for comparison to those used in DA 2010. Rather than estimating immigration and emigration separately, the methods used to produce the estimates involved comparing the stock of the foreign-born population at two periods and using the difference to develop an estimate of net foreign-born migration. The results were then compared to the net foreign-born migration estimates developed by combining ROYA and YOE estimates of immigration with residual-based estimates of emigration as described above (Demographic Analysis Research Team 2010b).

The first estimate of net foreign-born migration started with the Census 2000 foreign-born population by single year of age and sex. Death rates from NCHS life tables for the resident population were applied to this population to calculate the expected population on June 30, 2009. This expected population was then compared to the 2009 ACS estimate of the foreign-born population.[12] The difference was assumed to be net foreign-born migration from April 1, 2000 to June 30, 2009. This estimate was then annualized and then inflated to estimate net foreign-born migration for the entire decade (i.e., April 1, 2000 to March 31, 2010). This calculation resulted in an estimate of net foreign-born migration of 10.5 million across the decade.

A second estimate of net foreign-born migration was developed using a similar method in which the foreign-born population from Census 2000 was survived forward to March 31, 2010. However, in this case the estimate of the time two population with which this number was compared was not taken directly from the ACS. Instead, a combination of data from Census 2000, NCHS, and ACS, as well as estimates of net native migration and ACS-based ratios of the foreign to native born population were used to develop an estimate of the foreign-born population on March 31, 2010.[13] First, Census 2000 estimates of the native population were tabulated by single year of age and sex. Estimates of births, deaths, and net migration of natives were then used to estimate the native population on April 1, 2010. The estimate of births was based on NCHS annual data by sex and was projected for 2008 to 2010, as data were not yet

[12] The 2009 ACS data file was used as it was the most recent file available at the time of this research.
[13] Natives are defined as the population born in the United States, Puerto Rico, U.S. Island Areas, or born abroad of U.S. citizen parents.

available for those periods. Death rates from NCHS life tables for the resident population were applied to the native population as measured by Census 2000 by single year of age and sex to estimate deaths from 2000 to 2010. Finally, estimates of net native migration from 2000 to 2010 were based on census data from other countries. The estimates of births and net native migration were added to the Census 2000 estimate of natives in 2000 and the estimate of deaths was subtracted to develop an estimate of the stock of natives in 2010.

Separately, ratios of the foreign born to native populations were calculated by single year of age and sex using data from the 3-year 2006-2008 ACS file. These ratios were applied to the estimated stock of natives on April 1, 2010 to develop a stock estimate of the foreign-born population. Finally, as in the previous method, this estimate was compared to the expected population calculated by applying NCHS survival rates to the Census 2000 estimate of the foreign-born population. The difference provided a second alternative estimate of net foreign-born migration of 9.7 million for the April 1, 2000 to March 31, 2010 period.

These alternative estimates represent net foreign-born migrants of all ages rather than the population under the age of 65. Figure 3 shows these alternative estimates along with the four estimates of net foreign-born migration used in DA 2010 for the total population of all ages. Both of the alternative estimates of net foreign-born migration fall within the range of the estimates used in DA 2010 and in particular between the estimates used in the Middle and High Middle Series. While these estimates were impacted by similar assumptions and data limitations as the methods used in DA, they provide further support of the range of estimates of net foreign-born migration from 2000 to 2010 used in DA 2010.

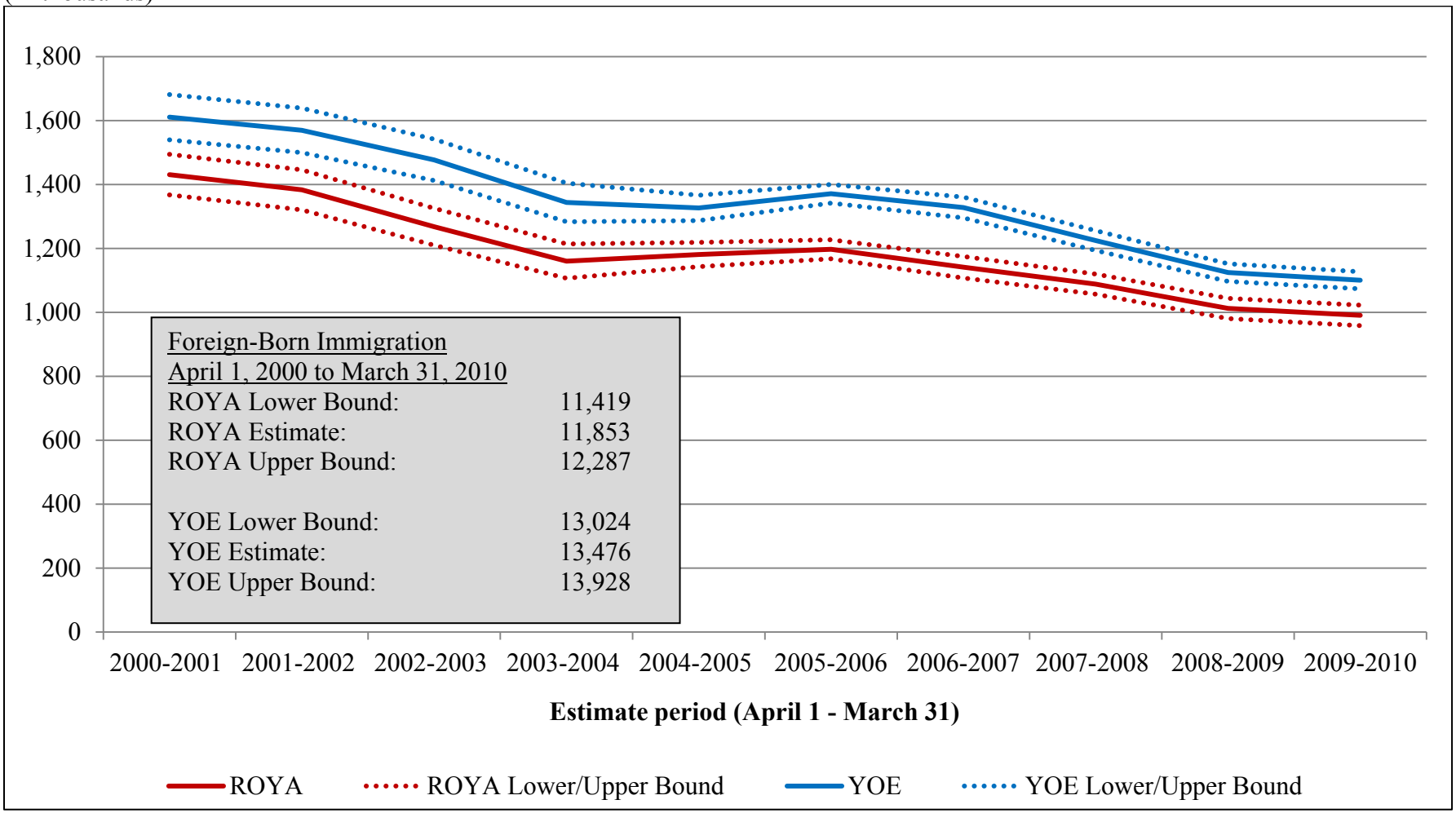
Conclusion

For DA 2010, the Census Bureau produced a series of estimates of net foreign-born migration from 2000 to 2010 based on varying data and assumptions in an effort to account for the uncertainty in estimating migration flows of the foreign born. Unlike previous decades, the estimates of net foreign-born migration were based on survey data from the ACS. By using data on both prior place of residence and year of entry to the United States and considering variation arising from sampling variability and coverage of the foreign born, four estimates of foreign-born immigration were produced. These estimates ranged from 11.0 to 13.8 million for the population under the age of 65. Three estimates of foreign-born emigration were developed; each of these methods used a residual approach but the use of the confidence intervals around ACS estimates allowed for consideration of sampling error. These estimates ranged from 1.8 to 2.3 million foreign-born emigrants for the 2000 to 2010 period. By combining the four estimates of foreign-born immigration with the three estimates of emigration, four estimates of net foreign-born migration were included in DA ranging from 8.7 to 12.0 million. This range in the estimates

of net foreign-born migration of 3.3 million represents approximately 47 percent of the total variation in the overall DA estimates of the resident population.

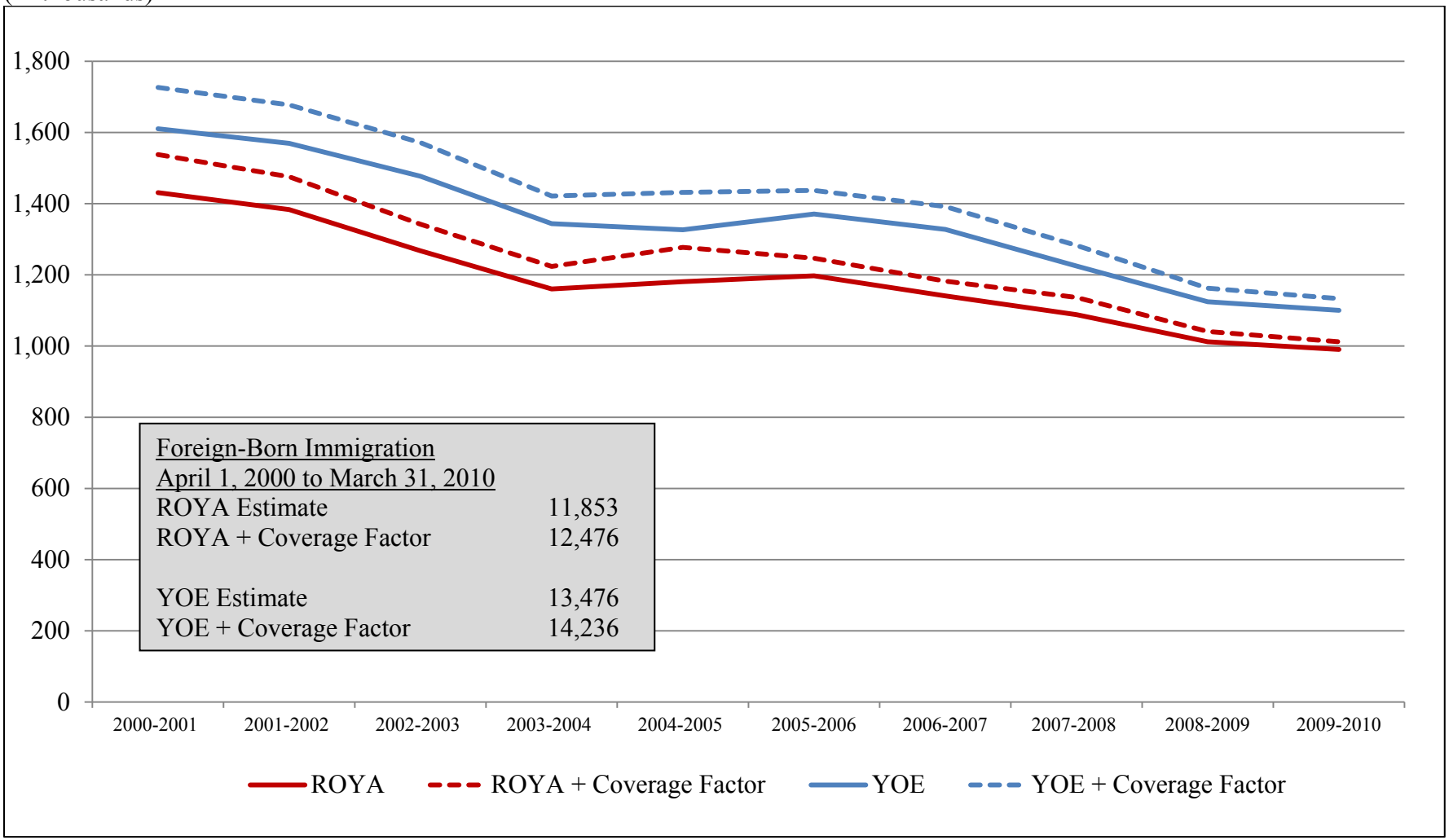
In addition to the estimates included in the final DA series, two alternative estimates of net foreign-born migration were developed by comparing stock estimates of the foreign-born population in two periods over the decade. The results of this research produced estimates of net foreign-born migration that fell within the range of the estimates used for DA 2010.

Figure 1. Residence-One-Year-Ago (ROYA) and Year-of-Entry (YOE) Estimates of Foreign-born Immigration: 2000 to 2010 Estimates and Lower and Upper Bounds
(In thousands)



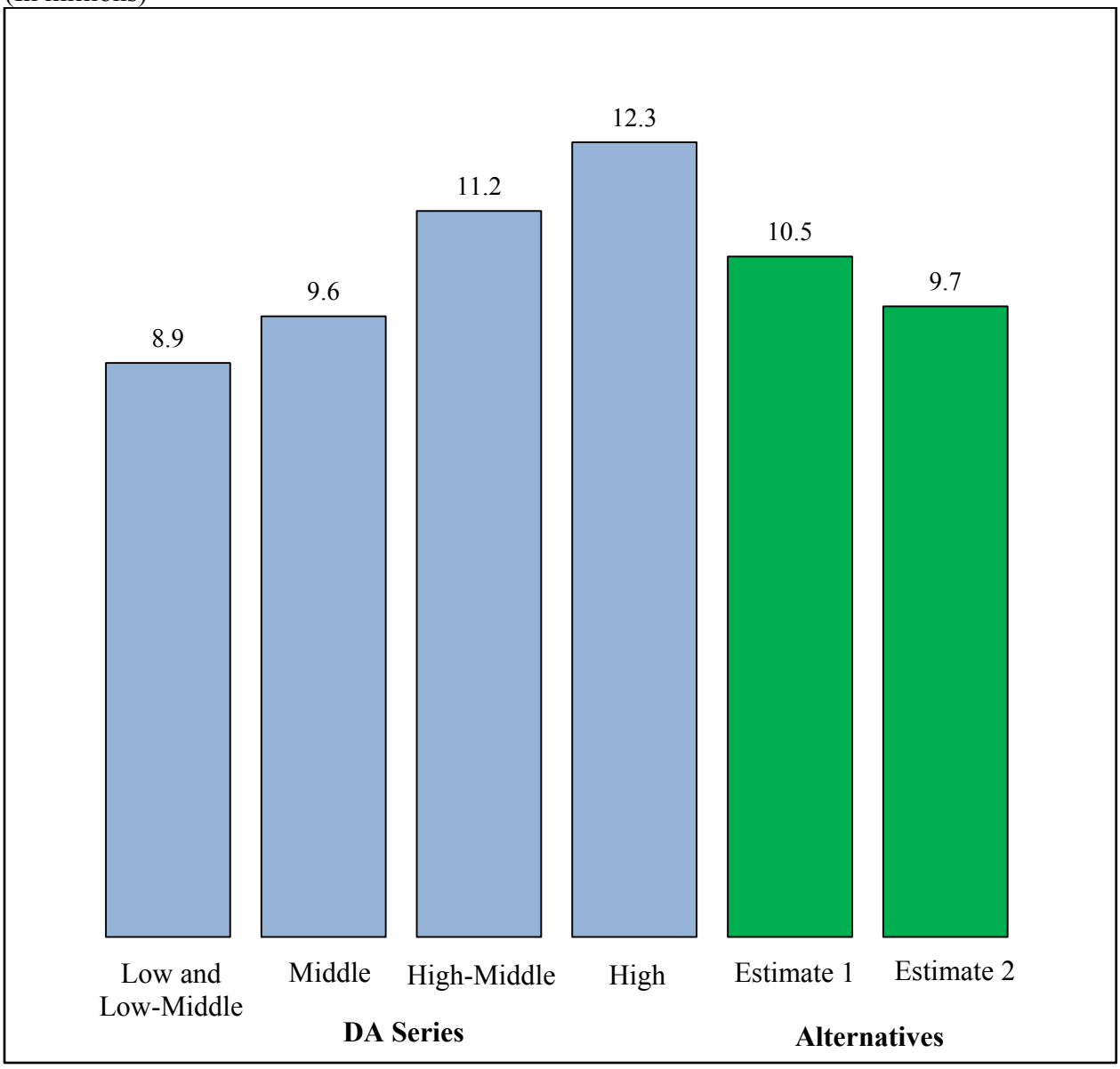
Note: Estimates are for the population of all ages.
Source: U.S. Census Bureau, Population Division, 2010 Demographic Analysis, December 2010 release, special tabulation.

Figure 2. Foreign-Born Immigration Using the Residence-One-Year-Ago (ROYA) and the Year-of-Entry (YOE) Methods With and Without Coverage Factors: 2000 to 2010
(In thousands)



Note: Estimates are for the population of all ages.
Source: U.S. Census Bureau, Population Division, 2010 Demographic Analysis, December 2010 release, special tabulation.

Figure 3. Net Foreign-Born Migration: April 2000 to April 2010
(In millions)



Note: Estimates are for the population of all ages.
Source: U.S. Census Bureau, Population Division, 2010 Demographic Analysis, December 2010 release, special tabulation.

Table 1. Foreign-Born Immigration Estimates by Age, Sex, and Race: 2000 to 2010
(In thousands)

Race, sex, and age	Lower-bound Residence One Year Ago	Residence One Year Ago	Year of Entry	Year of Entry with Coverage Factors
TOTAL	11,000	11,417	12,980	13,780
Males	5,826	6,048	6,875	7,233
0-17 years	1,084	1,124	1,276	1,446
18-34 years	2,884	2,993	3,402	3,637
35-64 years	1,858	1,931	2,198	2,150
Females	5,173	5,370	6,104	6,547
0-17 years	1,022	1,060	1,204	1,336
18-34 years	2,375	2,464	2,801	3,104
35-64 years	1,776	1,845	2,100	2,107
BLACK	988	1,025	1,165	1,166
Males[1]	505	524	595	584
0-17 years	103	106	121	127
18-34 years[1]	234	242	275	266
35-64 years[1]	169	175	199	191
Females	483	501	570	582
0-17 years	102	106	120	126
18-34 years	214	222	253	262
35-64 years	166	173	197	193
NON-BLACK	10,012	10,392	11,814	12,614
Males	5,322	5,524	6,280	6,649
0-17 years	982	1,018	1,155	1,319
18-34 years	2,651	2,750	3,126	3,371
35-64 years	1,689	1,756	1,998	1,959
Females	4,690	4,868	5,535	5,965
0-17 years	920	954	1,084	1,210
18-34 years	2,160	2,242	2,548	2,842
35-64 years	1,610	1,673	1,903	1,913

[1]The Year of Entry with Coverage Factors estimate is lower than the Year of Entry estimate because of differences in the coverage adjustments. The coverage factors were produced by age, sex, and Hispanic origin, but not race. The Year of Entry estimate includes population controls to account for coverage, which were produced by age, sex, Hispanic origin, and race.
Note: Estimates are for the population under age 65.
Source: U.S. Census Bureau, Population Division, 2010 Demographic Analysis, December 2010 release, special tabulation.

Table 2. Foreign-Born Immigration Estimates by Age, Sex, and Hispanic Origin: 2000 to 2010
(In thousands)

Hispanic origin, sex, and age	Lower-bound Residence One Year Ago	Residence One Year Ago	Year of Entry	Year of Entry with Coverage Factor
TOTAL	2,484	2,575	2,923	3,296
Males	1,294	1,342	1,522	1,733
0-9 years	434	449	509	568
10-19 years	860	893	1,014	1,165
Females	1,190	1,234	1,401	1,563
0-9 years	430	445	505	550
10-19 years	759	788	896	1,013
HISPANIC	1,325	1,374	1,559	1,850
Males	718	745	845	1,019
0-9 years	231	239	271	322
10-19 years	487	506	573	697
Females	607	629	714	831
0-9 years	205	213	241	273
10-19 years	401	416	473	558
NON-HISPANIC	1,159	1,202	1,365	1,446
Males	576	597	678	714
0-9 years	202	209	238	246
10-19 years	373	387	440	468
Females	583	605	687	732
0-9 years	225	233	264	277
10-19 years	358	372	423	455

Note: Estimates are for the population under age 20.
Source: U.S. Census Bureau, Population Division, 2010 Demographic Analysis, December 2010 release, special tabulation.

Table 3. Rates of Emigration for the Foreign-Born Population: 2000 to 2010

Period of entry to the United States	Low	Middle	High
Entered 10 or fewer years before the survey year	12.8 to 13.5	13.8 to 14.3	14.7 to 15.2
Entered more than 10 years before the survey year	1.7 to 2.5	2.4 to 3.0	3.0 to 3.5

Note: Rates expressed per 1,000 people. Rates for each series are shown as a range to reflect the use of different years of the ACS in the calculation of averaged rates of annual emigration.
Source: U.S. Census Bureau, Population Division, 2010 Demographic Analysis, December 2010 release, special tabulation.

Table 4. Foreign-Born Emigration Estimates by Age, Sex, and Race: 2000 to 2010
(In thousands)

Race, sex, and age	Low	Middle	High
TOTAL	1,822	2,081	2,330
Males	950	1,084	1,213
0-17 years	98	107	117
18-34 years	381	425	469
35-64 years	471	551	626
Females	872	997	1,117
0-17 years	95	105	114
18-34 years	314	351	388
35-64 years	462	541	615
BLACK	164	187	209
Males	82	94	105
0-17 years	9	9	10
18-34 years	31	35	39
35-64 years	42	49	56
Females	82	93	104
0-17 years	9	9	10
18-34 years	30	34	37
35-64 years	43	50	57
NON-BLACK	1,658	1,894	2,121
Males	868	990	1,108
0-17 years	89	98	107
18-34 years	350	390	430
35-64 years	428	502	571
Females	790	904	1,013
0-17 years	87	95	104
18-34 years	284	318	351
35-64 years	420	491	558

Note: Estimates are for the population under age 65.
Source: U.S. Census Bureau, Population Division, 2010 Demographic Analysis, December 2010 release, special tabulation.

Table 5. Foreign-Born Emigration Estimates by Age, Sex, and Hispanic Origin: 2000 to 2010
(In thousands)

Hispanic origin, sex, and age	Low	Middle	High
TOTAL	239	263	287
Males	122	134	147
0-9 years	23	25	27
10-19 years	99	109	119
Females	117	129	141
0-9 years	23	25	28
10-19 years	94	104	113
HISPANIC	126	138	151
Males	66	73	80
0-9 years	12	13	14
10-19 years	54	60	65
Females	59	65	71
0-9 years	11	11	12
10-19 years	49	54	59
NON-HISPANIC	113	125	136
Males	56	61	67
0-9 years	11	12	13
10-19 years	45	49	54
Females	58	64	69
0-9 years	13	14	15
10-19 years	45	50	54

Note: Estimates are for the population under age 20.
Source: U.S. Census Bureau, Population Division, 2010 Demographic Analysis, December 2010 release, special tabulation.

Table 6. Estimates of Foreign-Born Immigration and Emigration: 2000 to 2010
(In thousands)

Net foreign-born migration estimate	Foreign-born immigration	Foreign-born emigration
Low	Lower-bound Residence One Year Ago (11,000)	High (2,330)
Low-Middle	Lower-bound Residence One Year Ago (11,000)	High (2,330)
Middle	Residence One Year Ago (11,417)	Middle (2,081)
High-Middle	Year of Entry (12,980)	Middle (2,081)
High	Year of Entry with Coverage Factor (13,780)	Low (1,822)

Note: Estimates are for the population under age 65.
Source: U.S. Census Bureau, Population Division, 2010 Demographic Analysis, December 2010 release, special tabulation.

Table 7. Net Foreign-Born Migration Estimates by Age, Sex, and Race: 2000 to 2010
(In thousands)

Race, sex, and age	Low and Low Middle Series	Middle Series	High Middle Series	High Series
TOTAL	8,670	9,337	10,899	11,959
Males	4,614	4,964	5,792	6,284
0-17 years	967	1,017	1,169	1,349
18-34 years	2,415	2,567	2,976	3,256
35-64 years	1,232	1,380	1,647	1,680
Females	4,056	4,373	5,107	5,675
0-17 years	908	956	1,099	1,241
18-34 years	1,987	2,113	2,449	2,790
35-64 years	1,161	1,304	1,559	1,644
BLACK	779	838	978	1,002
Males	400	430	502	502
0-17 years	92	97	111	119
18-34 years[1]	195	207	240	234
35-64 years[1]	113	126	150	149
Females	379	408	477	500
0-17 years	92	97	111	118
18-34 years	177	189	219	232
35-64 years	109	123	147	151
NON-BLACK	7,891	8,498	9,920	10,956
Males	4,213	4,534	5,290	5,782
0-17 years	875	920	1,057	1,230
18-34 years	2,220	2,360	2,736	3,021
35-64 years	1,119	1,254	1,497	1,530
Females	3,677	3,965	4,631	5,175
0-17 years	816	859	988	1,123
18-34 years	1,810	1,924	2,230	2,558
35-64 years	1,051	1,182	1,412	1,494

[1]The High Series estimate is lower than the High Middle Series estimate because of differences in the coverage adjustments. The coverage factors were produced by age, sex, and Hispanic origin, but not race. The High Middle Series estimate includes population controls to account for coverage, which were produced by age, sex, Hispanic origin, and race.
Note: Estimates are for the population under age 65.
Source: U.S. Census Bureau, Population Division, 2010 Demographic Analysis, December 2010 release, special tabulation.

Table 8. Net Foreign-Born Migration Estimates by Age, Sex, and Hispanic Origin: 2000 to 2010
(In thousands)

Hispanic origin, sex, and age	Low and Low Middle Series	Middle Series	High Middle Series	High Series
TOTAL	2,196	2,312	2,660	3,057
Males	1,147	1,207	1,388	1,611
0-9 years	406	423	484	545
10-19 years	741	784	905	1,066
Females	1,049	1,105	1,272	1,446
0-9 years	403	420	480	527
10-19 years	646	685	792	919
HISPANIC	1,174	1,235	1,420	1,725
Males	639	672	772	953
0-9 years	217	226	258	310
10-19 years	422	446	514	643
Females	535	564	649	772
0-9 years	193	201	230	263
10-19 years	342	362	419	509
NON-HISPANIC	1,022	1,077	1,240	1,333
Males	509	536	616	658
0-9 years	189	197	225	235
10-19 years	319	338	391	423
Females	514	541	623	675
0-9 years	210	219	250	264
10-19 years	304	322	373	410

Note: Estimates are for the population under age 20.
Source: U.S. Census Bureau, Population Division, 2010 Demographic Analysis, December 2010 release, special tabulation.

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