

**THE LONG-RANGE DEMOGRAPHIC ASSUMPTIONS
FOR THE 2018 TRUSTEES REPORT**

OFFICE OF THE CHIEF ACTUARY
SOCIAL SECURITY ADMINISTRATION

June 5, 2018

PRINCIPAL DEMOGRAPHIC ASSUMPTIONS

OVERVIEW

SECTIONS

- 1 FERTILITY**
- 2 MORTALITY**
- 3 IMMIGRATION**

Overview

Each year the Board of Trustees of the Federal Old-Age and Survivors Insurance (OASI) and Disability Insurance (DI) Trust Funds provides an annual report to the Congress on the financial and actuarial status of the OASDI program. The Office of the Chief Actuary (OCACT) produces projections of future cost and income based on three separate sets of long-range (75-year) assumptions for key demographic variables. The intermediate (alternative II) set of assumptions represents the Trustees' best estimate for future experience, while the low cost (alternative I) and high cost (alternative III) sets of assumptions are more and less favorable, respectively, from the perspective of program cost as a percent of taxable payroll. In addition, the intermediate assumptions serve as the central tendency for the stochastic projections presented in the OASDI Trustees Report. This memorandum presents the demographic assumptions used in the 2018 annual report of the Board of Trustees (the "Trustees Report").

The basic demographic assumptions are:

- The total fertility rate, along with the single year of age birth rates,
- The annual rates of reduction in central death rates by broad age group (0 – 14, 15 – 49, 50 – 64, 65 – 84, and 85+) and cause of death (cardiovascular, cancer, violence, respiratory, and all other), and
- Immigration levels, by age and sex, of lawful permanent resident (LPR) new arrivals, LPR exits, adjustments of status, and other-than-LPR entrants; and other-than-LPR rates of exit.

For the 2018 Trustees Report, there are no changes to these basic assumptions from those used in the 2017 Trustees Report, except for decreasing new arrival LPRs by 10,000 for each alternative. This reflects the fact that the 2014 executive action on immigration for entrepreneurs, which was intended to increase the number of entrepreneurs by 10,000 per year, has not been implemented and is assumed will not be implemented in the future. The following table shows the basic ultimate assumptions or summary measures for the basic assumptions.

Key Demographic Assumptions and Summary Measures for the Long-Range (75-year) Projection Period									
2017 Trustees Report and 2018 Trustees Report									
	2017 Trustees Report Alternative			2018 Trustees Report Alternative			2018 Trustees Report Less 2017 Trustees Report		
	I	II	III	I	II	III	I	II	III
Ultimate total fertility rate (children per woman)	2.2	2.0	1.8	2.2	2.0	1.8	0.0	0.0	0.0
Average annual percentage reduction in total age-sex-adjusted death rates for the 75-year projection period	0.42	0.77	1.16	0.41	0.77	1.15	-0.01	0.00	-0.01
Average annual net LPR immigration (in thousands) for the 75-year projection period	1,008	795	602	1,000	788	595	-8	-7	-7
Average annual net other-than-LPR immigration (in thousands) for the 75-year projection period	615	491	359	607	484	356	-8	-7	-3

In total, the demographic changes are estimated to have a negligible effect on the OASDI actuarial balance. New data and modified transitioning to ultimate values for fertility, mortality, and immigration result in a net decrease in the OASDI actuarial balance of about 0.04 percent of taxable payroll. Other data updates result in an increase in the OASDI actuarial balance of about 0.04 percent of taxable payroll. In addition, changes to the method for projecting death rates by marital status result in an increase in the OASDI actuarial balance of about 0.01 percent of taxable payroll. Law or policy changes related to the demographic assumptions (including the scheduled phase-out of the DACA program and the non-implementation of the 2014 executive action on immigration of entrepreneurs) are estimated to have a negligible effect on the actuarial balance.

The remainder of this memorandum provides details regarding the historical values and future values for each of the demographic assumptions, and the basis for the assumptions.

1. FERTILITY

ASSUMPTIONS FOR THE 2018 TRUSTEES REPORT
OFFICE OF THE CHIEF ACTUARY, SSA

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1.1 Summary

The ultimate total fertility rates (TFRs) assumed for the 2018 Trustees Report are 2.2, 2.0, and 1.8 children per woman for the low-cost, intermediate, and high-cost alternatives, respectively. These ultimate TFRs are the same as those used for the 2017 Trustees Report. Final birth data for 2016 from the National Center for Health Statistics (NCHS) produce a TFR of 1.82 for the year. Based on provisional data from NCHS for the first quarter of 2017, the intermediate alternative TFR is assumed to be 1.80 for the full year 2017.

The sharp drop in the historical TFR from a level of 2.12 in 2007 to a level of 2.00 in 2009 and 1.85 in 2013 is most likely largely due to the effects of the economic recession. The TFR increased slightly to 1.86 in 2014, then decreased in 2015 to 1.85 and in 2016 to 1.82, and is expected to decrease further in 2017. The Trustees assume that the TFR will ultimately return to an average level of 2.0. This assumption is based primarily on the continued and persistent expectation among women of childbearing age that they will have more than 2 children on average. Due to the extraordinary depth of the recent recession and extremely slow recovery, the assumption that lower birth rates experienced in recent years will be largely offset by additional delayed births is being eliminated for the 2018 Trustees Report. Specifically, for the intermediate alternative, the Trustees now assume that the TFR will transition from the 2017 TFR of 1.80 to the ultimate level of 2.0 for 2027, without a rise above 2.0 during that period. Compared to the intermediate path of the TFR assumed for the 2017 Trustees Report, this path assumed for the 2018 Trustees Report is considerably lower through 2027. This change in the transition path, along with the incorporation of recent data, results in a decrease (worsening) in the long-range actuarial balance, under the intermediate alternative, of about 0.08 percent of taxable payroll.

In addition to the overall level of the TFR, the distribution of birth rates by age of mother has implications for the size of the population. As in the prior Trustees Report, the Trustees assume a continuation of the historical trend toward lower birth rates for women below age 20 and higher birth rates for women above age 30 through the transition to the ultimate period. This continued trend tends to result in a somewhat smaller population in the future than if the future relative distribution of birth rates by age of mother were unchanged.

1.2 Historical Experience

Past TFRs in the United States are shown in table 1.1 and chart 1.1. The TFR for a given year is defined as the average number of children that would be born to a woman throughout her lifetime if she were to survive the entire childbearing period and were to experience, at each age of her life, the birth rate¹ observed in that year. During the period 1917 through 1924, the TFR was more than 3.0 children per woman. From 1924 through 1933, the TFR declined from 3.1 to 2.2 children per woman, and then remained level at 2.1 to 2.2 children per woman through 1940. After 1940, the TFR once again began to rise, reaching a peak of 3.7 in 1957 and stayed above 2.8 for the “baby boom” years of 1946 through 1965. This period of high fertility was followed by a period of declining fertility. The TFR reached a historical low of 1.7 in 1976. Beginning in

¹ The ratio of: (1) the number of live births to mothers of a specified age, to (2) the midyear female population of that age.

1977, the TFR remained fairly stable at 1.8 children per woman until 1987, when it started to increase, reaching 2.1 in 1990. Between 1990 and the start of the Great Recession, the TFR remained fairly stable, fluctuating between 2.0 and 2.1. The TFR decreased from 2.12 in 2007 to 1.85 in 2013. The 1.86 TFR for 2014 represents the first time the TFR had increased from the prior year since 2007. However, the TFR decreased again in 2015 to 1.85 and further in 2016 to 1.82. The 2017 TFR is estimated to decrease even more. It is important to note that, despite the recession, birth expectations of women have not dropped below 2.2, as noted in the next section.

The increase in the TFR after 1976 was primarily due to increases in birth rates among women in their 30s. After dropping dramatically between 1960 and 1976, birth rates for women in their 20s remained quite stable between 1976 and 2007 (see chart 1.2). Because much of the decline in birth rates for women in their 20s was understood to represent a desire to defer births until women were in their 30s, the gradual increases in birth rates for women in their 30s for 10 to 15 years after 1976 were expected. However, birth rates for women in their 30s continued to rise through 2007, partially due to advancements in infertility treatments.

1.3 Assumed Future Birth Rates

The Trustees do not expect the TFR to return to the high levels experienced during the baby boom. Several changes in our society have occurred during the past 50 years that have contributed to reducing birth rates. Some of these changes are:

- increased availability and use of birth control methods,
- increased female participation in the labor force,
- increased postponement of marriage and childbearing among young women,
- increased prevalence of divorce,
- decreased death rates among children (requiring fewer births for a desired family size), and
- increased percentage of women choosing to remain childless.

The Trustees do not expect a significant reversal of these changes. In addition, a sharp decline in the TFR to the low levels experienced by certain other industrialized countries is unlikely due to economic, demographic, and cultural differences between the U.S. and those countries.

The Trustees assume an ultimate TFR of 2.0 for alternative II. The 2007 and 2011 Technical Panels both recommended retaining the ultimate alternative II TFR assumption of 2.0. However, the 2015 Technical Panel recommended an ultimate alternative II TFR assumption of 1.9. The Congressional Budget Office adopted the 2015 Technical Panel's recommended TFR assumption of 1.9 for their 2016 projections and continue this assumption for their 2017 projections.² The 2014 National Population Projections released by the Census Bureau also have a slightly lower TFR path. In those projections, Census assumptions resulted in a projected TFR of 1.87 for 2014. The Census TFR stays almost constant at this level through the end of their projection period in 2060.³

² See <https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/52298-socialsecuritychartbook.pdf> and <https://www.cbo.gov/system/files/115th-congress-2017-2018/reports/52480-ltbo.pdf>.

³ See <https://www2.census.gov/programs-surveys/popproj/technical-documentation/methodology/methodstatement14.pdf>.

As shown in chart 1.2, the general historical trend for increasing birth rates for women over age 30 and decreasing rates for women below age 20 is projected to continue through the transition to the ultimate period, with age-specific rates remaining constant in the ultimate period. This changing distribution of birth rates by age of woman has significant effects on population size, but these effects essentially stabilize after the age distribution of birth rates stabilizes.

Examining data from other countries is useful in selecting a range of ultimate assumptions for the low-cost and high-cost alternatives. Historical TFRs during the period 1980-2013 that were reported to the United Nations are shown for 24 countries in table 1.2. The TFRs for the most recent year shown in the table range from 1.3 for Greece, Portugal, and Spain to 2.3 for India. If India is excluded from the comparison, the highest TFR is 2.1 for Mexico followed by 2.0 for France, Ireland, and New Zealand. Although the TFR in the industrialized countries has been observed at levels as low as the 1.2 to 1.5 range, the cultural and economic climate in the U.S. makes it highly unlikely that our TFR will return to the level of 1.7 achieved in 1976 for any sustained period. Thus, the Trustees assume an ultimate TFR for the high-cost scenario of 1.8 children per woman. Using the range of past experience for the United States and other countries as a guide, the Trustees assume an ultimate TFR for the low-cost scenario of 2.2 children per woman.

The Trustees assume the ultimate TFR is reached in 2027 for both the low-cost and intermediate alternatives, and in 2023 for the high-cost alternative. The ultimate years used for the 2017 Trustees Report were 2024, 2027, and 2032 for the low-cost, intermediate, and high-cost alternatives, respectively.

For the intermediate assumptions, the Trustees assume that the TFR gradually increases from 2017 through 2027, with larger increases in the TFR in the middle of the 2017-2027 period and smaller increases in the TFR around 2017 and 2027. For the low-cost and high-cost alternatives, the Trustees assume that the paths of the TFRs gradually grade away from the intermediate alternative path. Chart 1.3 shows the historical path of the TFR starting in 1917 and the projected paths of the TFRs for all three alternatives.

Examining the TFR by birth cohort is also a useful tool in evaluating an ultimate assumption. As shown in chart 1.4, the cohort TFRs vary much less over time than the annual TFRs shown in chart 1.3. Chart 1.4 also shows that the cohort TFR has been near or greater than 2.0 for all cohorts who have finished their childbearing years. The most recent cohorts that have just completed their childbearing years show an upward trend in their TFRs. The transition path for the intermediate alternative continues that trend before coming back down to the ultimate assumption of 2.0.

As mentioned above, reported birth expectations for women of childbearing age provide another measure to help assess trends in birth rates. NCHS conducts the National Survey of Family Growth (NSFG) to gather information about men and women aged 15-44.⁴ Prior to the 2002-2005 survey, NCHS only asked married women about birth expectations. However, for the 2002-2005, 2006-2010, and 2011-2015 surveys, NCHS asked all women about past and future

⁴ Persons are aged 15-44 at the time of the sampling but may have had their 45th birthday by the interview date.

expected births.⁵ As shown in chart 1.5, past and future expected births in all three survey waves is well above 2.0. The consistency of birth expectations well above 2.0 strongly suggests that the current reduction in the TFR will not be permanent.

⁵ NCHS refers to the data collected from 2002 through 2005 as “Cycle 6” as shown at http://www.cdc.gov/nchs/nsfg/nsfg_questionnaires.htm.

Table 1.1: Past and Projected Total Fertility Rates for the United States

Calendar Year	2018 Trustees Report	2017 Trustees Report
1920	3.263	3.263
1930	2.533	2.533
1940	2.229	2.229
1950	3.028	3.028
1960	3.606	3.606
1965	2.882	2.882
1970	2.432	2.432
1975	1.770	1.770
1980	1.820	1.820
1985	1.835	1.835
1990	2.069	2.069
1991	2.057	2.057
1992	2.043	2.043
1993	2.018	2.018
1994	2.002	2.002
1995	1.981	1.981
1996	1.980	1.980
1997	1.974	1.974
1998	2.002	2.002
1999	2.008	2.008
2000	2.054	2.054
2001	2.032	2.032
2002	2.025	2.025
2003	2.055	2.055
2004	2.059	2.059
2005	2.062	2.062
2006	2.112	2.112
2007	2.123	2.123
2008	2.074	2.074
2009	2.002	2.002
2010	1.925	1.925
2011	1.889	1.889
2012	1.874	1.874
2013	1.851	1.850
2014	1.864	1.860
2015	1.846	1.841
2016	1.818	1.870
Alternative I:		
2017	1.818	1.931
2020	1.909	2.066
2025	2.149	2.200
2027+	2.200	2.200
Alternative II:		
2017	1.800	1.898
2020	1.836	1.982
2025	1.986	2.025
2027+	2.000	2.000
Alternative III:		
2017	1.781	1.864
2020	1.764	1.899
2025	1.800	1.891
2030	1.800	1.826
2032+	1.800	1.800

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**Table 1.2: Historical Total Fertility Rates, by Country
1980 - 2013**

Country	1980	1985	1990	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Most Recent TFR
Australia	1.9	1.9	1.9	1.7	1.8	1.7	1.8	1.8	1.8	1.9	2.0	2.0	2.0	1.9	1.9	1.9	1.9
Austria	1.7	1.5	1.5	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	—	1.4
Belgium	1.7	1.6	1.6	—	—	—	—	—	—	1.8	—	—	1.8	1.8	—	—	1.8
Canada ¹	1.7	1.6	1.8	1.5	1.5	1.5	1.5	1.5	1.6	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6
China	2.2	2.2	2.3	—	—	—	—	—	—	—	—	—	—	—	—	—	1.8
Denmark	1.5	1.4	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.8	1.9	1.8	1.9	1.8	1.7	—	1.7
Finland	1.6	1.6	1.8	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.9	1.9	1.8	1.8	—	1.8
France	2.0	1.8	1.8	1.9	1.9	1.9	1.9	1.9	2.0	2.0	2.0	—	2.0	2.0	2.0	—	2.0
Germany	1.5	1.4	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.4	—	1.4	1.4	—	—	1.4
Greece	2.2	1.5	1.4	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.5	1.5	1.5	1.4	1.3	—	1.3
India	4.4	4.3	3.8	3.1	3.0	3.0	2.9	2.9	2.8	2.7	2.6	2.6	2.5	2.4	2.4	2.3	2.3
Ireland	3.2	2.5	2.2	2.0	2.0	2.0	2.0	1.9	1.9	2.0	2.1	2.1	2.1	2.0	2.0	—	2.0
Italy	1.6	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	—	1.4
Japan	1.7	1.7	1.5	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Mexico	3.1	3.3	3.7	2.5	2.3	2.3	2.2	2.2	2.2	2.1	2.1	—	—	—	—	—	2.1
Netherlands	1.6	1.5	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.7	—	1.7
New Zealand	2.0	1.9	2.2	2.0	1.9	1.9	2.0	2.0	2.0	2.2	2.2	2.1	2.2	2.1	2.1	2.0	2.0
Norway	1.7	1.7	1.9	1.8	1.8	1.8	1.8	1.8	1.9	1.9	2.0	2.0	2.0	1.9	1.9	—	1.9
Portugal	2.1	1.7	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.3	1.4	1.3	1.4	1.4	1.3	—	1.3
Spain	1.9	1.6	1.3	1.2	1.3	1.3	1.3	1.3	1.4	1.4	1.5	1.4	1.4	1.3	1.3	—	1.3
Sweden	1.7	1.7	2.1	1.6	1.7	1.7	1.8	1.8	1.9	1.9	1.9	1.9	2.0	1.9	1.9	—	1.9
Switzerland	1.5	1.5	1.6	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	—	1.5	—	1.5
United Kingdom	1.8	1.8	1.8	1.6	1.6	1.7	1.8	1.8	1.8	1.9	2.0	—	—	1.9	1.9	—	1.9
United States ²	1.8	1.8	2.1	2.0	2.0	2.0	2.1	2.1	2.1	2.1	2.1	2.0	1.9	1.9	1.9	1.9	1.9

¹ Estimates for Canada from Statistics Canada website for 2010-2013

² Estimates for the U.S. from NCHS NVSR 64-12

Source: United Nations Demographic Yearbook Historical Supplement 1948-1997
 United Nations Demographic Yearbook Fertility Supplement 1980-1999
 United Nations Demographic Yearbooks 2000 - 2014

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Chart 1.1: Historical Total Fertility Rates for the United States

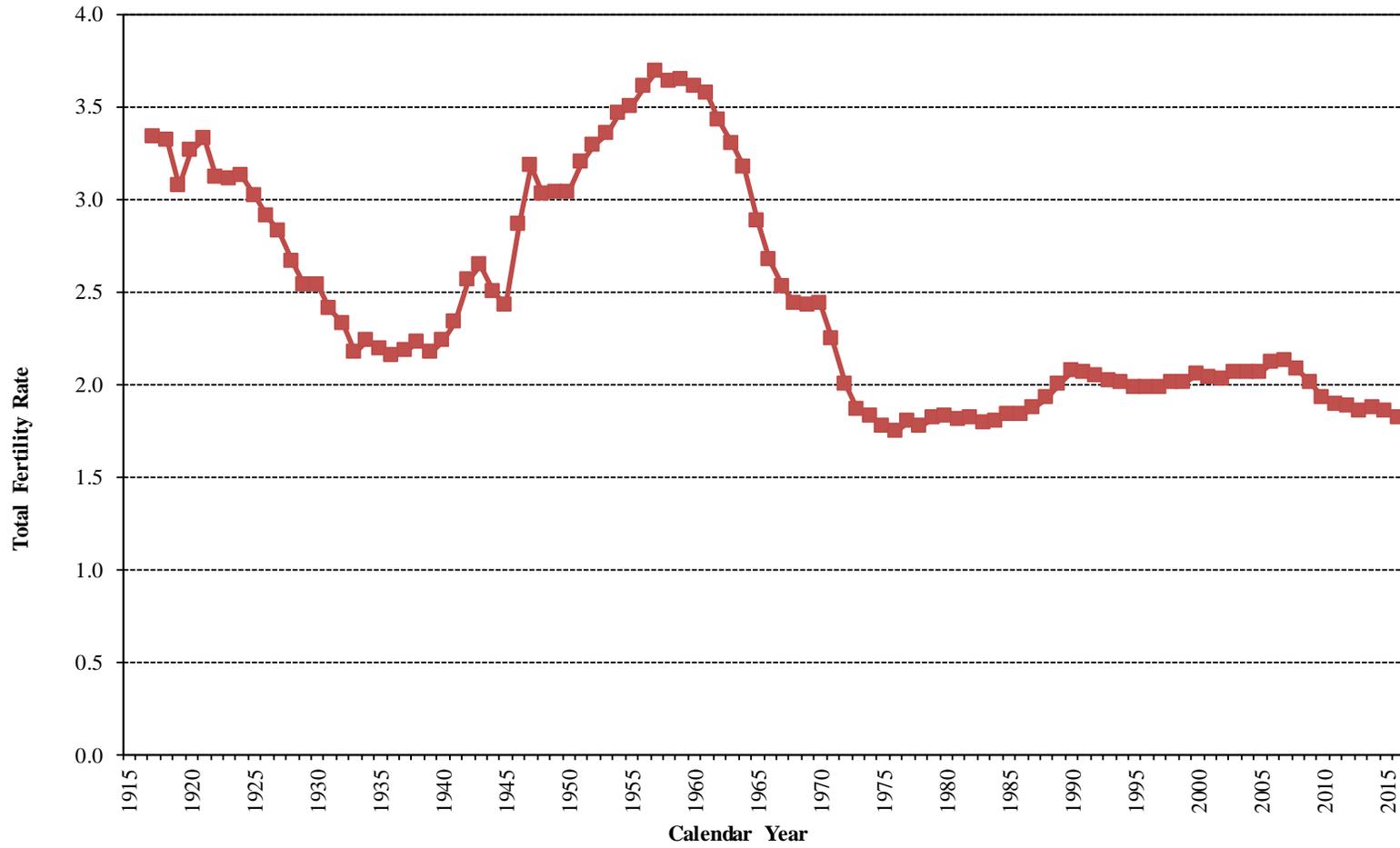


Chart 1.2: Central Birth Rates for Five Year Age Groups: Historical and Alternative II Projection

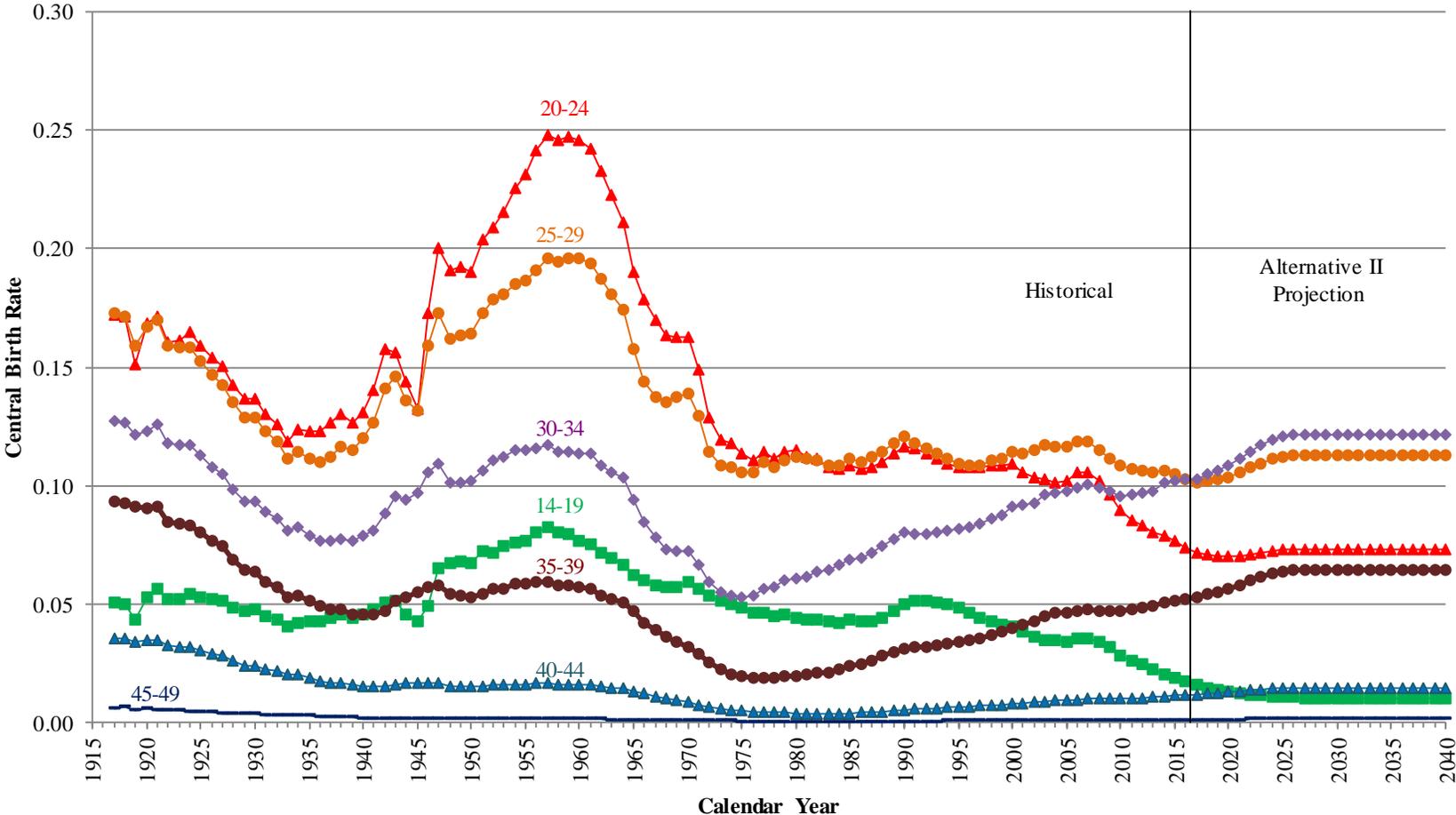
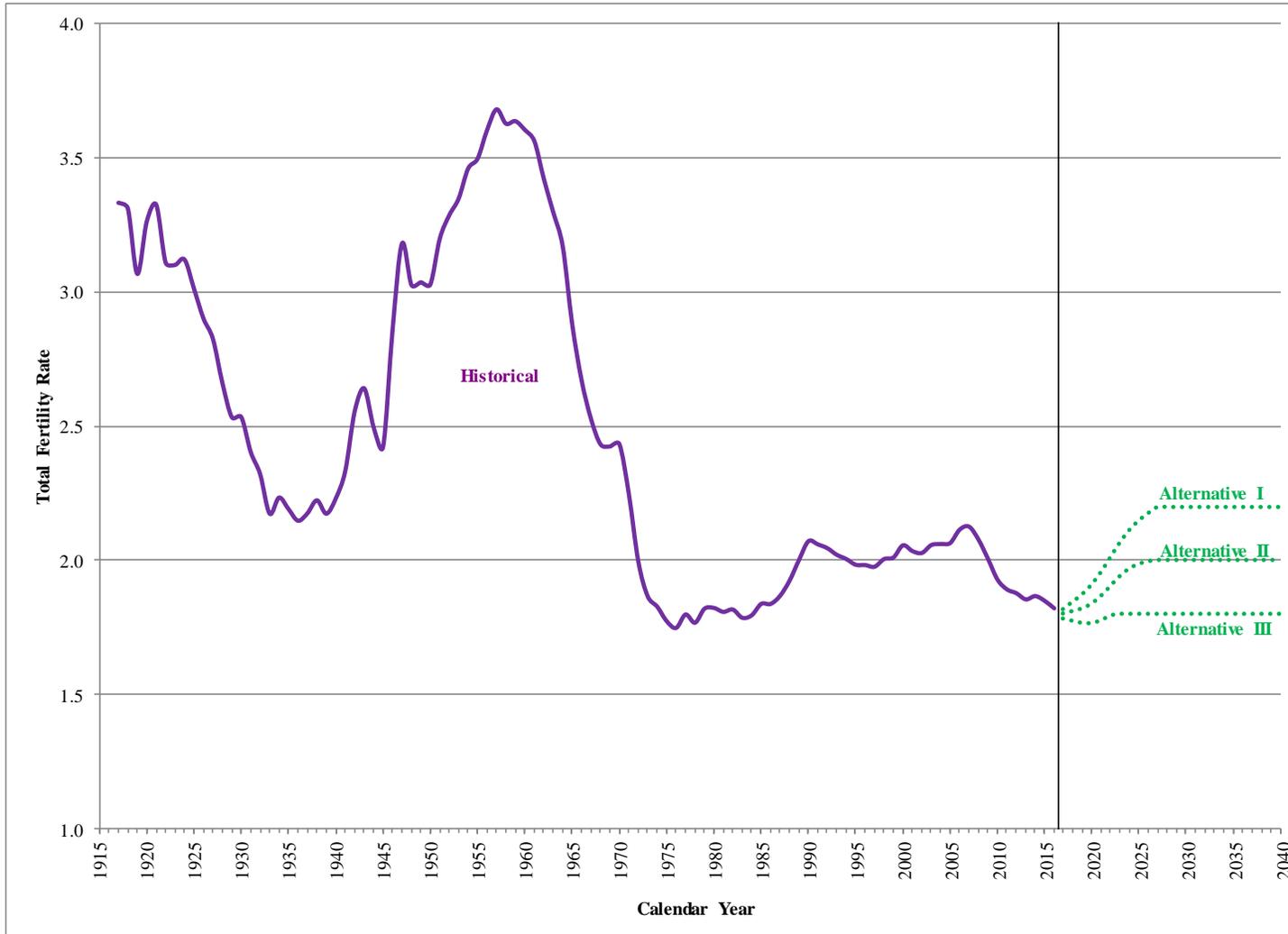
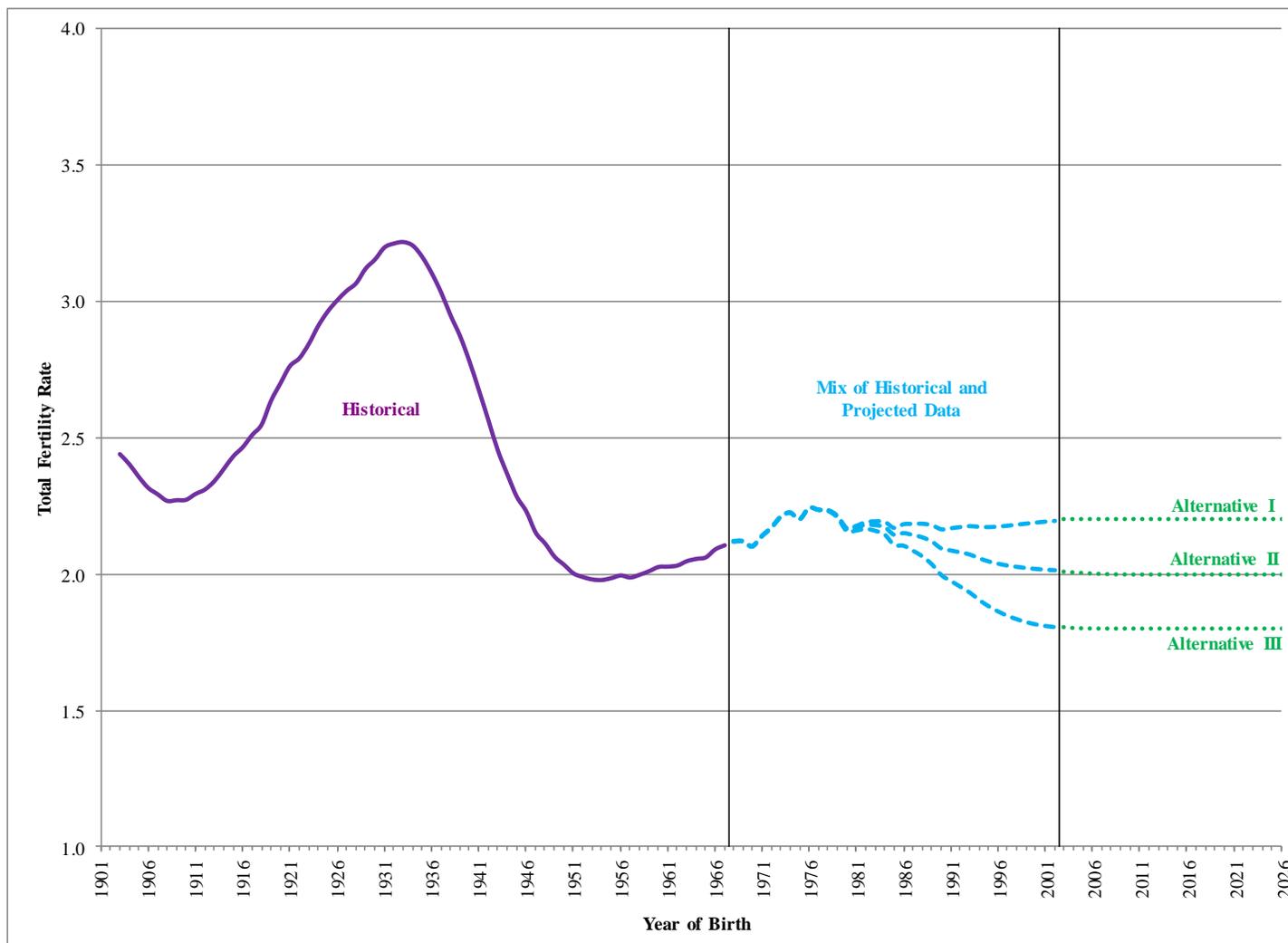


Chart 1.3: Historical and Projected Total Fertility Rates



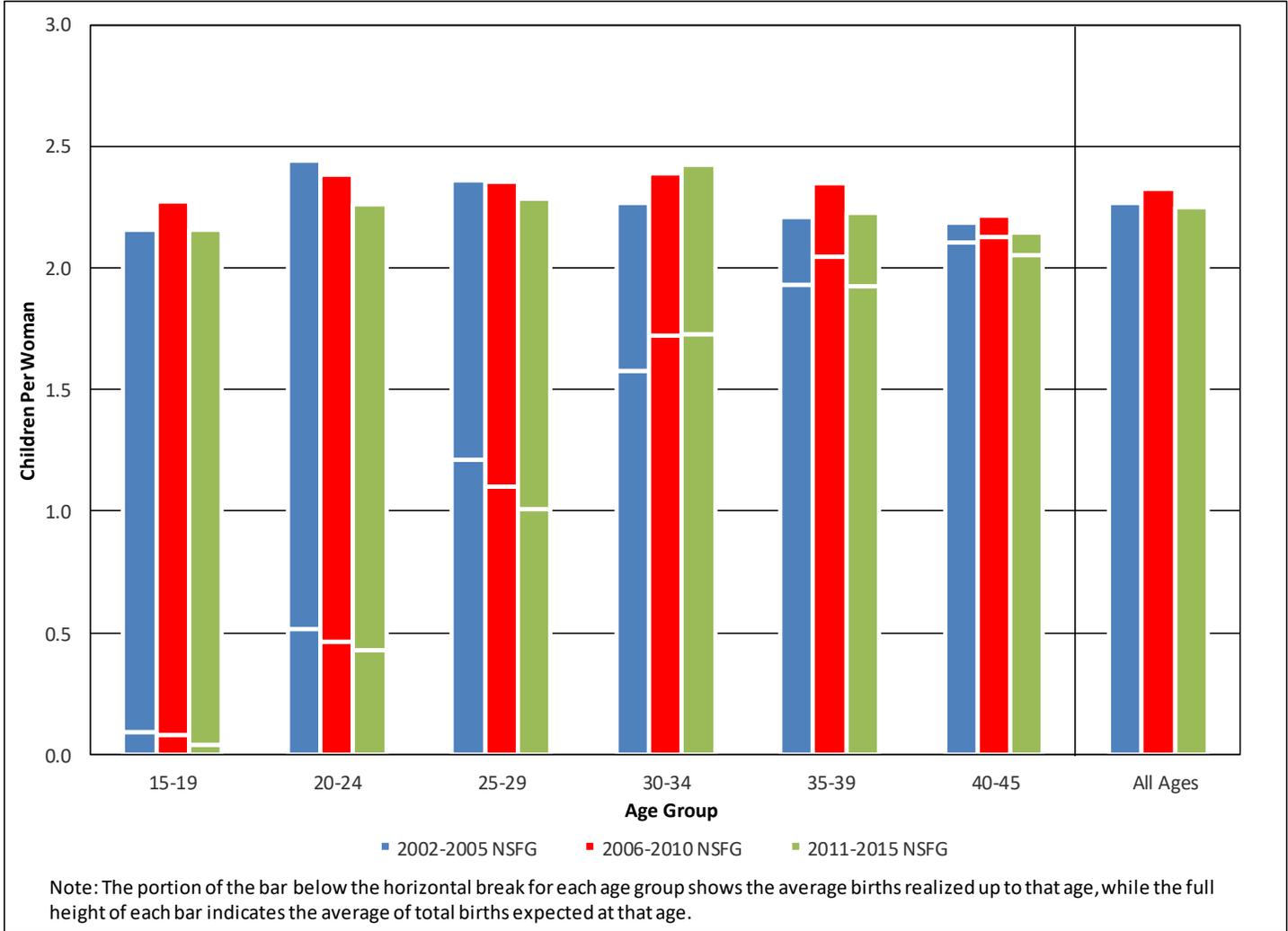
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Chart 1.4: Historical and Projected Total Fertility Rates by Birth Cohort



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Chart 1.5: Past and Future Expected Births per Woman Based on the National Survey of Family Growth (NSFG)



2. MORTALITY

ASSUMPTIONS FOR THE 2018 TRUSTEES REPORT
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2.1 Summary

For the 2018 Trustees Report, the ultimate annual rates of mortality reduction by age and cause of death are the same as those used for the 2017 Trustees Report. The assumed ultimate rates of reduction apply fully for years 2042 and later in the projection. For years between the most recent observed data and the full implementation of the ultimate rates of reduction in 2042, there is a transition from recently observed trends by age, sex, and cause to the ultimate assumed rates of reduction.

Projections for this report reflect final National Center for Health Statistics (NCHS) data for 2015, final Medicare data for 2014, and preliminary Medicare data for 2015. These new data show an increase in just about every sex/age-group, with death rates higher than those projected in last year's report. These additional data result in higher death rates at the start of the long-range projection period than projected for last year's report, as well as higher death rates throughout the projection period. Incorporating these new data results in an increase (improvement) in the long-range actuarial balance, under the intermediate set of assumptions, of about 0.05 percent of taxable payroll.

Deaths by marital status were modeled based on data from 1995 and 1996. The methodology used to project the marital status deaths was updated this year and now uses data through 2015. This update results in an additional increase in the actuarial balance of 0.01 percent of taxable payroll.

The low-cost and high-cost alternative ultimate rates of improvement by age and cause are set as percentages of the intermediate alternative assumed rates and, as such, are not displayed separately in the tables. Male and female ultimate rates of improvement by age and cause are set equal to each other, but are displayed separately because historical rates of change, projected rates of change through the transition years, and rates of change for all causes combined throughout the projection period vary by sex.

2.2 Considerations in Selecting a Mortality Projection Method

Projections of mortality improvement are subject to uncertainty that is possibly greater than any other variable used in the Trustees' assumptions. Some demographers argue that life expectancy is potentially limitless and that rates of mortality reduction will match or exceed historical trends indefinitely into the future. Others believe that biological limitations make mortality improvement more difficult to achieve in the future and, combined with behavioral factors and economic considerations, future rates of reduction will be more modest than in the past.

Because the method for projecting future mortality is critical in determining the results, this section compares four approaches that are currently in use by demographers. These approaches can provide very different results, and make very different use of the available data. Some relatively simple approaches have been popular for illustrating trends in longevity but do not address the full complexities of changing conditions over time. Any projection of mortality used to model the size and age structure of the population, which is the foundation for analyzing the actuarial status of programs like Social Security and Medicare, should explicitly consider the

past and expected future conditions that affect rates of improvement.

Perhaps the simplest approach to projecting future mortality is to extrapolate past trends in life expectancy. Some have presumed that the rate of increase in life expectancy at birth will be linear for the indefinite future. Oeppen and Vaupel in 2002 contended that a trend for the “best nation” would continue to rise linearly and that the U.S. would catch up to that trend. Further analysis by Ron Lee, and more recently by Jacques Villan and France Meslé, has shown that this historical trend has not been linear but has been decelerating in recent years. In addition, experience for the U.S. and for other countries has demonstrated that there are clear differences in the populations among developed nations that have made differences in mortality persist. Finally, life expectancy at birth is most highly affected by changes in death rates at young ages, particularly at infancy. Even if mortality reduction trends by age were to continue unchanged into the future, increase in life expectancy at any age would slow. For assessing the actuarial status of Social Security and Medicare, extrapolation of life expectancy is not useful, because it does not address the age structure of mortality rates or of the population.

A second approach extrapolates death rates on a cohort basis. Shifts in death rates from one cohort to the next have been observed particularly in the U.K., and to a lesser extent in the U.S. However, extrapolating such shifts across ages within a cohort requires careful analysis. If a cohort shows lower death rates up to a given age due to better health, then the improvement may be expected to persist to older ages. However, if the shift is primarily due to interventions that have lowered death rates for individuals with compromised physiology, then death rates for the cohort at older ages might actually be worse than the prior cohort. In addition, advances that are for one cohort may reflect a level shift in mortality and not a trend of improvement that will continue for succeeding cohorts.

A third, more commonly used approach extrapolates past rates of reduction in mortality, by age and sex, indefinitely into the future. Lee and Carter are the most notable proponents of this approach. They developed a model for fitting a trend to a selected historical period that is then applied for projected future improvement, effectively assuming that future conditions for overall reduction by age and sex will match the conditions over the past. Key to this approach is the selection of the “appropriate” historical period. For many years, Lee and Carter suggested using the period starting with 1900. More recently, they suggested a period starting with 1950, which results in somewhat faster projected rates of mortality improvement. If a longer period were used (starting with 1800, for example), then the rates of reduction would be substantially less. Relative to all of human history, the twentieth century, and particularly the latter half of the twentieth century, was a time of exceptionally rapid mortality decline. The Lee and Carter extrapolation method presumes no deceleration in the future rate of reduction in mortality, and also presumes no change in the relative rate of decline across ages in the historical period. In 2016, Ron Lee produced projections of death rates through 2090 using national data by age and sex for the period 1950 through 2011. These death rates result in the same overall 75-year actuarial balance for the Social Security program as the death rates used in the 2015 Trustees Report. See Actuarial Note 158 at https://www.ssa.gov/OACT/NOTES/pdf_notes/note158.pdf.

The fourth approach for projecting mortality involves more comprehensive use of available data and flexibility for considering how future conditions are expected to differ from the past. This

approach takes advantage of historical mortality data by cause of death, age, and sex, which is available on a relatively complete basis for the U.S. starting in 1979. Biologists and many demographers have long recognized the value of modeling mortality by cause. Ken Manton was a pioneer in evaluating effects of eliminating death by a given cause. Others, like Jay Olshansky, have emphasized the strides made in mortality for some causes and the failure to improve for other causes. The Trustees' model has, for decades, reflected past trends in mortality by cause, taking into account future expected changes based on input from researchers at the National Institutes of Health, the Centers for Disease Control and Prevention, and others. More recently, medical researchers and clinicians at Johns Hopkins University (JHU) independently assessed prospects for mortality improvement by cause and age. The JHU study has been extremely useful in evaluating and benchmarking the Trustees' assumptions. Of course, developing assumptions for future rates of mortality reduction by cause and age requires judgment about the expectation of future conditions relative to the past. Consideration of past changes in the rates of mortality reduction for individual causes, along with expert opinion, provides a rich basis for such judgment. Perhaps most importantly, this approach provides a clear disclosure of specific assumptions used for improvement by age and cause of death. This can then be explicitly compared to the historical experience in considerable detail.

It is important to note that the 2015 Technical Panel on Assumptions and Methods, appointed by the independent Social Security Advisory Board, endorsed the use of mortality assumptions by cause group. See page 19 of their report at http://www.ssab.gov/Portals/0/Technical%20Panel/2015_TPAM_Final_Report.pdf?ver=2015-09-24-113145-693.

2.3 Considerations in Selecting Mortality Assumptions by Age and Cause of Death

Simple extrapolation of the average trends experienced for any past period to project long-term future trends should only be considered when there is a basis for assuming that future conditions will, on average, replicate past conditions. This approach may have merit for processes where there is no reason to believe there are natural limits, such as for labor productivity of workers, where technology has no apparent limit. Human mortality, on the other hand, is limited by biology. The maximum verified age of survival for a human is age 122, and shows no signs of extending significantly. Biological researchers suggest that extension of the maximum lifespan would require fundamental alteration of the aging process. This may be possible, but there is no clear evidence that it will be achieved in the future.

In addition, reductions in mortality have occurred in a very irregular pattern over time, closely reflecting changes in the economy, access to medical care, and behavior of the population. Therefore, in developing assumptions for future mortality improvement by age and cause, it is crucial to study the differing historical rates of decline for various periods and the conditions that contributed to these variations. Only after considering how future conditions will differ from the past can one speculate about future mortality improvement.

The remainder of this section describes many of the overarching factors that have influenced mortality improvement during the past century and that will affect it in the future. Section 2.5

provides greater detail regarding the Trustees' assumptions for rates of improvement for each cause of death.

A number of extremely important developments have contributed to the generally rapid overall rate of mortality improvement during the past century. These developments include:

- Access to primary medical care for the general population (in particular, the access due to Medicare and Medicaid health coverage for the elderly, disabled, and poor),
- Discovery of and general availability of antibiotics and immunizations,
- Clean water supply and waste removal, and
- The rapid rate of growth in the general standard of living.

Each of these developments is expected to make a substantially smaller contribution to annual rates of mortality improvement in the future.

Future reductions in mortality will depend upon such factors as:

- The development and application of new diagnostic, surgical, and life-sustaining techniques,
- The rate of future increase in health spending and the efficiency of that spending relative to mortality improvement,
- The presence of environmental pollutants,
- Changes in amount and type of physical activity,
- Improvements in nutrition,
- The incidence of violence and suicide,
- The isolation and treatment of causes of disease,
- The emergence of new forms of disease,
- The evolution of existing forms of disease,
- Improvements in prenatal care,
- The prevalence of obesity,
- The prevalence of cigarette smoking,
- The misuse of drugs (including alcohol),
- The extent to which people assume responsibility for their own health,
- Education regarding health, and
- Changes in perception of the value of life.

In reviewing the above list, future progress for some factors seems questionable when recent statistics are considered. Recent NCHS releases have reported a substantial increase in the prevalence of obesity and diabetes, decreased environmental air quality, and an increase in negative side effects from invasive surgical procedures. On the other hand, there is good basis for speculation that there will continue to be substantial breakthroughs in advancing medical technology and treatment in the future. The extent to which such new technologies will have purely positive effects (like improved sanitation) versus mixed effects (as in the case of chemotherapy) will determine their potential for improving mortality. A fundamental consideration, however, is the ability and willingness of society to pay for the development of new treatments and technologies, and to provide these to the population as a whole.

The expansion of national expenditures for health services, research, and development over the last 60 years has been remarkable. Total national health expenditures have risen from 4 percent of GDP in 1952 to nearly 18 percent of GDP by 2009. This expansion has both enhanced health care for those who already had access and extended access to tens of millions through Medicare, Medicaid, and more recently, the Affordable Care Act. However, national health expenditures cannot continue to expand at this pace in the future. In fact, the Medicare Trustees Report projects a dramatic slowdown in the rate of increase in per-enrollee Medicare spending in the future, even as the average number of enrollees will be increasing. Even with improved efficiency and targeting of medical care in the future, a deceleration in spending per enrollee of this magnitude will tend to slow the rate of reduction in mortality.

Much has been made of the reduction in smoking in the U.S. over the past 30 years, particularly for males. However, there is a looming concern over other behavioral factors. Reduced physical activity and consumption of excess calories has led to the rising epidemic of obesity. In the future, assuming the prevalence of obesity stabilizes, an increasing portion of the adult and aged population will have been obese for long durations. The effects of prolonged obesity will clearly have negative cumulative effects for diabetes, cardiovascular disease, and cancer in the future.

Education and income are factors that are correlated with mortality differences in the population. More education and higher income are associated with lower mortality. It is not entirely clear whether this correlation is largely due to the benefits of higher income and education, or to the “selection” of more advantaged (and thus healthier) individuals in gaining access to the best education and job opportunities. To the extent that the former factor is important, then increasing education and income for the population as a whole may provide some further benefits, but substantially less than in the past, given that further increases in education are likely to slow.

Future progress in treatment of currently predominant diseases is contingent on the availability of funding, research outcomes, society’s views on moral issues, and education about lifestyle choices that affect one’s health. Quality of life and average years of healthy living have improved on a continual basis. Much progress has been made in the predominant causes of death (cardiovascular and respiratory disease) over the past several decades. These medical advances have caused the predominant causes of death to become less dominant, so that other causes, which have had slower rates of improvement or have only recently emerged, are becoming more predominant. For the still-predominant causes of death where significant progress has been made, further progress may be more difficult. In contrast, causes that have been less addressed may receive more research attention in the future. Therefore, many causes of death that have recently had rapid rates of reduction may have slower rates in the future. Causes that have had slower rates of improvement in the past may have more rapid rates of improvement in the future.

Finally, note that improvements in mortality and extension of longevity through the last century were relatively unconstrained by limitations of senescence and gradual deterioration of body systems, as we had not yet reached the apparent practical limit to life span. While there is likely no fixed limit for human longevity, it is true that the average human lifespan has improved much more than the maximum observed lifespan. This suggests that even with continued technological

advances, the inherent limitations of the physical body and the mind to endure successfully past about 110 years will gradually result in a decelerating force of mortality improvement.

2.4 Past Experience by Cause of Death

In the past, the reduction of mortality rates has varied greatly by cause of death. In assessing experience and future possible improvement in mortality, it is important to understand the varying trends in mortality by cause of death. For the relatively recent period 1979-2015, average annual reductions in central death rates¹ by age group and sex were analyzed for five basic categories of cause of death: four major groups of cause of death, and a residual group (Other) that contains all other causes (see table 2.3). (Note that in the past, death rates by more than five categories were analyzed and the Trustees developed assumptions for the same. For example, in the 1990's there were 10 different categories. See Actuarial Study 112 at https://www.ssa.gov/OACT/NOTES/pdf_studies/study112.pdf.) The analysis has focused on the period 1979-2015 because NCHS has provided death rates by cause on a consistent basis since 1979, allowing for consistent groupings of death rates by selected cause groups.

For all ages combined, the largest average annual rate of reduction over the period 1979-2015 was in the category of **Cardiovascular Disease**, which has been about 2.6 percent for males and about 2.4 percent for females. The rate of reduction for **Cancer** has been about 1.0 percent for males and about 0.5 percent for females. For the category of **Violence**, which includes accidents, there has been a rate of reduction of about 0.5 percent for males, but a rate of *increase* of about 0.2 percent for females. For the **Respiratory Disease** category, there has been a rate of reduction of about 0.4 percent for males and a rate of *increase* of about 1.4 percent for females. For the **Other** category, the rate of *increase* has been about 0.8 and 1.5 percent for males and females, respectively.

2.5 Assumed Future Rates of Reduction in Mortality by Cause of Death

The ultimate average annual percentage reductions by age group and cause of death that are assumed for the intermediate alternative of the 2018 Trustees Report are presented in table 2.3, along with the intermediate assumptions from the 2017 Trustees Report, and the average rates experienced during the periods 1979-2015 and 2005-2015. The ultimate rates of improvement by age, sex, and cause for the low-cost and high-cost alternatives are developed as a ratio to the intermediate alternative, with low-cost being 1/2 of the intermediate rates of improvement and the high-cost being 5/3 of the intermediate rates.

As seen in table 2.3, the rate of reduction in mortality due to cardiovascular disease and respiratory disease has generally slowed in the last 10 data years (2005-2015) for ages under 65. The Trustees believe that ultimate rates of decline for these causes under age 65 will generally be higher than for the last 10 years, but somewhat lower than the rapid pace since 1979. For ages 65 and over, reductions in death rates from cardiovascular disease and respiratory disease have

¹ Average annual reductions are calculated as the complement of the exponential of the slope of the least-square line through the logarithms of the central death rates. The rates for the period 1900-2015, as shown in table 2.2, are a weighted average of the rates shown for the seven distinct periods of change.

generally increased in the last 10 years, consistent with a partial continuation of the gains at younger ages in the previous 10 years. For the ultimate rates of reduction, the Trustees expect more modest improvement at ages 65 and over for these causes as the gains from reduced smoking and interventions for heart disease will slow, while effects from obesity will increase.

Reductions in death rates due to cancer for those over age 65 have improved significantly in the last 10 data years (2005-2015). As indicated by researchers at NCHS, cancer is actually many different diseases and each will be addressed gradually. Progress has been made for lung cancer in large part due to reduced smoking. Progress has been made in other areas such as breast cancer and prostate cancer due to increased awareness and medical treatments. However, progress for other cancers has been slower. In addition, there are indications that treatment for a first cancer may result in greater susceptibility to a second cancer at a later time. On balance, however, the Trustees expect that the ultimate average rate of reduction in death due to cancer will match or exceed the rate of reduction experienced from 1979 to 2015.

Death rates from violence have actually increased substantially in the last 10 years for ages over 50. The Trustees believe that this trend will not continue. However, because this category includes suicide, it is not clear that the rate of decline will be substantial at older ages.

Analyzing death rates from all other causes is always a challenge, because this category incorporates new causes that are identified over time. In addition, this broad group includes neurological diseases like Alzheimer's disease. Death rates for this category have risen substantially since 1979. Progress in reducing death rates in this category will be extremely challenging in the future, even as the proportion of all deaths from this group increases. Even with decelerating spending on health research and services relative to GDP for the future, it is reasonable to assume that spending will be redirected from the largest causes of death in the past (cardiovascular disease and respiratory disease) to other causes (neurological and emerging diseases). Thus, the Trustees expect that some progress, even if modest, will be achieved for this category.

Advice from the medical research community (including CDC, NCHS, and others) has been received on a largely informal basis and has been an essential component in guiding the Trustees' assumptions for reductions in mortality by cause. Recently, insights were gained from a Johns Hopkins University (JHU) study, which enlisted medical researchers and clinicians to develop expectations for reductions in death rates over about the period 2009-2040. This specific input has been highly instructive in corroborating the Trustees' assumptions for the medium-term and long-term reductions in death rates by cause. The JHU work was published in the North American Actuarial Journal, Volume 20, Issue 3 (see <https://www.soa.org/naaj/>). Note that the JHU expectations included an assumption that declines for causes not specifically considered by their experts would occur at about one-half of the rate for all other causes combined, somewhat similar to the Trustees' assumptions for the "Other" category.

There are three directly comparable categories of cause of death between the JHU experts and the Trustees. As an example, consider these three categories at ages 85+. For cardiovascular disease, the JHU experts project an average annual rate of decline from 2009-2040 of 0.5 percent for females and 0.6 percent for males. The Trustees' ultimate assumption for cardiovascular

disease is 1.2 percent. For cancer, the JHU experts project an average annual rate of decline from 2009-2040 of 0.4 percent for females and 0.6 percent for males. The Trustees' ultimate assumption for cancer is 0.5 percent. For respiratory disease, the JHU experts project an average annual rate of decline from 2009-2040 of 0.1 percent for females and 0.4 percent for males. The Trustees' ultimate assumption for respiratory disease is 0.2 percent. Note in particular the similarity of expectations for the respiratory disease and cancer categories between the JHU experts and those assumed for the 2018 Trustees Report.

2.6 Projected Future Rates of Reduction based on Assumptions by Age, Sex, and Cause of Death

The averaging period for determining starting levels of annual mortality reduction is 10 years. Average annual reductions observed for the period 2005-2015 are calculated by age group, sex, and cause. These average annual reductions are set to be the starting levels. The rates of improvement begin grading to the ultimate rates immediately after the last year of data. The reductions in mortality are assumed to change rapidly from the starting levels² of average annual reductions to the assumed ultimate rates of reduction for years 2042 and later. Under the low-cost and high-cost scenarios, the starting levels of average annual reduction are assumed to be 50 percent and 150 percent,³ respectively, of the starting levels for the intermediate assumptions.

Instead of using the measured mortality rates for the last single year of data (calendar year 2015) as the starting point of the mortality projections, mortality rates calculated to be consistent with the trend inherent in the last 12 years of available data are used. The last 12 years of data are 2004-2015. This approach reduces the impact of wide fluctuations that tend to occur in annual data on the starting levels used for the mortality projection.

It is also useful to compare the resulting reductions in death rates for all causes combined to past trends. These are the "Resulting Total" entries displayed in table 2.3. This analysis allows for a further look at the reasonableness of the projections that result from the cause-specific assumptions. In addition, results using the Trustees' assumptions are compared with those of demographers who prefer to extrapolate past trends without specific consideration of the underlying causes of death.

Table 2.4 provides age-sex-adjusted death rates⁴ for historical years and projected years, based on the assumed future rates of reduction by cause group. For the 2018 Trustees Report, the base year for the mortality projections is 2015. The age-sex-adjusted death rates presented in table 2.4 use the April 1, 2010, Census resident population as the standard population for the age-sex adjustment.

² If the starting level of annual reductions for a particular cause age-sex group is negative, then 75 percent of that starting level is assumed for the intermediate alternative.

³ If the starting level of annual reductions for a particular cause age-sex group is negative, then 100 percent of that starting level is assumed for the low-cost alternative and 50 percent is assumed for the high-cost alternative.

⁴ The age-sex-adjusted death rate is the crude rate that would occur in the enumerated total population as of a specific date, if that population were to experience the death rates by age and sex observed in, or projected for, the selected year.

Because reductions in mortality have differed widely by age in the past, the ultimate reductions in death rates vary by age group. Historically, reductions have been very rapid at the youngest ages. However, reductions at the highest ages, ages 85 and over, have been very slow. For many years, the Trustees' assumptions have reflected the belief that neither of these extremes will persist indefinitely into the future. The Trustees' assumptions have reflected slower improvement at the youngest ages than evidenced since 1900, and faster improvement at the highest ages (85 and over) than experienced historically. While this "compression" of rates of mortality improvement is in conflict with a literal interpretation of the Lee and Carter method, it was nevertheless endorsed explicitly by the 1999 Technical Panel, where Ron Lee was the principal demographer on the panel.

Table 2.2 shows historical rates of improvement and the projected rates of improvement based on assumed rates of reduction by cause, by alternative for the 2018 Trustees Report, summarized by age group and sex. For the intermediate alternative, projected rates of improvement for ages under 50 are generally lower than those experienced over the period 1900-2015, consistent with the Trustees' expectation of continued generally slower improvement in the future for these age groups. For males age 50 and older, the average projected rates of improvement for years after 2015 are slightly higher than those experienced since 1900. The projected rates of improvement for women age 50 and older are slightly lower than those assumed for men and generally lower than the rates experienced by this group of women over the period 1900-2015. This is consistent with the Trustees' long-held belief that average rates of mortality improvement for women, which had been faster than for men until around 1980, would ultimately converge with male improvement rates. Evidence that improvement for females will not always be faster than for males is apparent in data for years since 1980. The rate of improvement in mortality for women age 65 and older averaged only 0.51 percent per year during the period 1979-2015. This amount was a little less than one-half of the average rate of improvement for aged men during this period (1.12 percent).

Table 2.2 also shows that, for all ages combined, the projected rate of improvement under the intermediate alternative for the period 2042-2092 is 0.74 percent per year for men and 0.69 percent per year for women. The ultimate rates of improvement for the 2017 Trustees Report were also 0.74 and 0.69 percent per year for males and females, respectively.

A comparison of the basis for past improvement in mortality with the expected basis for future improvement suggests that future improvement is likely to continue, but at a generally slower rate than experienced during the extraordinary 1900-2015 period for ages under 65. Based on analysis of experience by cause of death, and expected future conditions affecting mortality improvement, it seems reasonable to expect the rate of mortality improvement for the age group 65 and older for the next 75 years to be slightly slower compared to that experienced during 1900-2015 (0.81 percent as shown in table 2.2). The Trustees believe that the average annual rate of decline of 0.69 percent (as shown in table 2.2) over the period 2015-2092 for the intermediate assumption is reasonable in this context.

2.7 Trustees' Assumptions versus Historical Trends and Other Assumptions

Table 2.1 shows average rates of reduction in mortality for three broad age groups over two historical periods. In addition, the table includes the following ultimate rates of reductions (the rate of reduction in mortality averaged over the last 50 years of the 75-year long-range period):

- Those assumed for the intermediate ultimate assumptions for various Trustees reports (choosing those reports that included changes in the ultimate assumptions or in the methodology),
- Those recommended by various Technical Panels, and
- Those resulting from a survey taken at a Society of Actuaries (SOA) seminar.

Rates of improvement shown on the first page of table 2.1 reflect age-sex adjustment to the distribution of the 1990 U.S. population; those on the second page use the distribution of the 2000 U.S. population; and those on the third page use the distribution of the 2010 U.S. population. As seen by comparing the rates on the first and second pages in table 2.1 under the intermediate assumptions of the 2002 and the 2004 Trustees Reports (for which ultimate rates of improvement were the same), the difference in using the different populations for age-sex adjusting makes little difference in the *ultimate average rates* by the broad age groups. This conclusion is further supported by comparing the rates from the 2013 Trustees Report using two different populations for age-sex adjusting, as shown on the second and third pages in table 2.1. For presentations other than table 2.1 of this memorandum, rates of improvement are presented with age-sex adjustment to the distribution of the 2010 U.S. population.

Table 2.1 provides the assumed ultimate average annual percent reductions in mortality for the intermediate assumptions of the 1999, 2000, 2002, 2004, 2008, 2009, 2011, 2013, and 2018 Trustees Reports. The 1999 and 2000 Trustees Reports are included because ultimate annual percent reductions were increased substantially in the 2000 Trustees Report. The 2002 Trustees Report is included because changes in methodology were made that resulted in increased ultimate annual percent reductions. The 2004 Trustees Report is included to provide comparability in the results using a different population for the purpose of age-sex adjustment. The 2008 and 2009 Trustees Reports are included because ultimate annual percent reductions were revised. The 2011 Trustees Report is included because changes in methodology were made that put more emphasis on the recent historical data. The 2013 Trustees Report values are shown on both the second and third pages of the table to compare results using different populations for age-sex adjustment.

Also included in table 2.1 are the assumed ultimate annual percent reductions in mortality recommended by the 1994-96, 1999, 2003, 2007, 2011, and 2015 Technical Panels and the median response from actuaries, demographers, biologists, and economists who participated in the 1997 Society of Actuaries Seminar. Focusing on mortality for ages 65 and over, it should be noted that since 2000, the Trustees' intermediate assumptions have provided for an ultimate rate of reduction that is somewhat less than the average experienced since 1900. A description of the recommendations of recent technical panels is presented later in this report.

Comparisons of historical and assumed rates of improvement are included in table 2.2. All rates of improvement shown in this table reflect age-sex adjustment to the distribution of the 2010

U.S. population. For the age group 65 and over (where mortality is concentrated), the average annual rate of improvement experienced during 1900-2015 was 0.81 percent. In the most recent two sub-periods, there has been both a period of fast improvement (1.78 percent per year for 1999 through 2009) and a period of slow improvement (0.46 percent per year for 2009 through 2015). In fact, mortality at ages 65 and over generally improved at about 0.51 percent per year, or less, during 1900-2015 with the exception of three notable periods. The first was for the World War II period and subsequent years, 1936-1954. During this time frame, dramatic advances in the standard of living were achieved due to expanded medical practice including the introduction of antibiotics. The second period was from 1968-1982, during which additional dramatic advancements in medicine were made and access to medical services was greatly expanded through Medicare and Medicaid for the old, frail, and disadvantaged, those who account for the vast majority of deaths in the population. During the third period, 1999-2009, advances in medicines and surgical treatments led to rapid improvements. Cancer and cardiovascular patients especially benefitted from these advancements.

Chart 2.1 displays the annual age-sex-adjusted central death rates experienced since 1900. An examination of these rates reveals a sequence of distinct periods of mortality reduction. Table 2.2 provides average annual rates of reduction for these periods. During the period 1900-1936, annual mortality reduction averaged about 0.7 percent for males and 0.8 percent for females. During the following period, 1936-1954, there was more rapid reduction (with the help of antibiotics and other medical advances), averaging 1.5 percent per year for males and 2.3 percent per year for females. The period 1954-1968 saw a much slower reduction of 0.7 percent per year for females and an increase of 0.3 percent per year for males. From 1968 through 1982, the rate of reduction in mortality surged (with the help of Medicare and Medicaid), averaging 1.8 percent for males and 2.1 percent for females, annually. From 1982 to 1999, moderately slow reduction in mortality returned, averaging 0.9 percent per year for males and 0.4 percent per year for females. From 1999 to 2009, another more rapid period occurred, averaging 1.8 percent per year for males and 1.4 percent per year for females, annually. The latest period, 2009-2015, has mortality reduction slowing with average mortality improvement of 0.4 percent per year for males and 0.2 percent per year for females.

For the first four periods mentioned above, spanning 1900 through 1982, the average annual rate of improvement for males was less than that for females. For the last three periods, spanning 1982 through 2015, the opposite was true, i.e., the average annual rate of improvement for females was less than that for males. Chart 2.2 shows differences between male and female annual rates of mortality improvement for the age group 65 and older for each year of the period 1969 through 2015. Differences are shown for rates based on Medicare data. Even with normal year-to-year variation, improvement was generally greater for females until about 1980, as had been the case since the beginning of the past century. However, female improvement was generally less than or equal to that for males beginning about 1980.

2.8 Recommendations of the Previous Technical Panels and Other Projections

The 2007 Technical Panel appointed by the Social Security Advisory Board recommended generally larger rates of decline than those assumed under the 2007 Trustees Report. Their recommendation was for an assumption of 1.0 percent annual reduction in death rates for all ages

and both sexes. Their recommendation was based on the average rate of reduction in the total population (all ages combined) observed for the period 1953-2003.

The 2011 Technical Panel recommended an increase in life expectancy at birth that was consistent with generally larger rates of mortality reduction than those assumed under the 2011 Trustees Report. Their recommendation was for reductions in mortality at the same rate for all ages that would result in a life expectancy at birth of 88.7 years in 2085. This is consistent with having an annual 1.26 percent reduction in death rates for all ages and both sexes. This is a large increase over the recommendation of the 2007 Technical Panel.

The approach of the 2007 and 2011 Technical Panels fails to take into account significant deviations in the rates of reduction by age groups as evidenced by the data shown in tables 2.2 and 2.3. The rates of reduction at younger ages have been much larger than the rates experienced at older ages. While differences by age will likely diminish in the future, it is unlikely that they will vanish completely.

The 2015 Technical Panel recommended substantially larger rates of decline than those assumed under the 2015 Trustees Report. Their recommendation was for an assumption of an overall average 1.00 percent annual reduction in the age-sex-adjusted death rate for the ultimate period (2040 to 2089), compared to the 0.71 percent overall average rate of decline for the 2015 Trustees Report. However, they supported having an age gradient (i.e., having the rates of improvement at younger ages be greater than rates of improvement at the older ages) and using cause-specific assumptions. Their 1.00 percent annual reduction recommendation was based on the average rate of reduction in the total population (all ages and causes combined) observed for the period since 1950. However, the mortality data through 2015 have continued to improve much less than was assumed for the 2015, 2016, and 2017 Trustees Reports. Based on recent slow rates of mortality improvement, the chairperson of the panel stated that she was glad that the Trustees did not follow the panel's recommendation for faster overall mortality reduction (see <http://crr.bc.edu/briefs/social-securitys-financial-outlook-the-2016-update-in-perspective/>).

The Congressional Budget Office assumes mortality rates will decrease by 0.98⁵ percent per year in their 2016 Long-Term Budget Outlook. However, unlike in their prior reports, they now assume an age gradient in the decline of mortality. Specifically, they assume each five-year age group will continue to decline at the average rate that it declined from 1950 through 2012. This results in a life expectancy at birth of 87.3 years in 2090.⁶ Comparing with Census, the assumed mortality rates in the 2014 National Population Projections result in a life expectancy at birth of 85.6 years in 2060.⁷

⁵ From unpublished correspondence.

⁶ See <https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/52298-socialsecuritychartbook.pdf>.

⁷ See Table 17 at <https://www.census.gov/data/tables/2014/demo/popproj/2014-summary-tables.html>.

Table 2.1: Historical and Assumed Rates of Reduction in Mortality¹

(Using the 1990 Census Resident population as the standard population for age-sex adjusting)

	Historical average annual percent reductions in age-sex-adjusted death rates		Assumed ultimate annual percent reductions in age-sex-adjusted death rates						
			1999	1994-96	October-97	1999	2000	2002	2003
	1900-2000	1982-2000	Trustees	Technical	SOA	Technical	Trustees	Trustees	Technical
			Alternative 2 ²	Panel ³	Seminar ⁴	Panel ⁵	Alternative 2 ⁶	Alternative 2 ⁷	Panel ⁸
0 - 14	3.30	2.74	1.20	3.30	0.95	2.20	1.35	1.55	2.33
15 - 64	1.44	1.15	0.57	1.40	0.75	1.12	0.75	0.78	1.11
65 & Over	0.73	0.49	0.50	0.75	0.60	0.98	0.65	0.70	0.92

¹Rates of reduction are the average of male and female annual rates of decline in age-adjusted central death rates. The rates for the period 1900-2000 are a weighted average of rates for five separate distinct periods of change.

²The 1999 Trustees ultimate intermediate assumptions are for the period 2023-2073.

³The 1994-96 Technical Panel (appointed by the Advisory Council) recommended assuming reduction at the average rate experienced during the century.

⁴The Society of Actuaries Seminar included 60 actuaries, demographers, economists, and other experts on Social Security financing. Values shown are the median responses of the participants.

⁵The 1999 Technical Panel (appointed by the Advisory Board) recommended that ultimate rate of reduction in mortality be increased at all ages (over the 1999 TR assumptions) by enough to increase the projected life expectancy at birth for 2070 by 3.7 years (to the level assumed for the high-cost alternative).

⁶The 2000 Trustees ultimate intermediate assumptions are for the period 2024-2074. Ultimate rates of mortality reduction increased.

⁷The 2002 Trustees ultimate intermediate assumptions are for the period 2026-2076. Changes to projection methodology increased rates of mortality reduction.

⁸The 2003 Technical Panel ultimate assumptions are for the period 2027-2077.

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Office of the Chief Actuary
June 5, 2018

Table 2.1 (Continued): Historical and Assumed Rates of Reduction in Mortality¹

(Using the 2000 Census Resident population as the standard population for age-sex adjusting)

	Historical average annual percent reductions in age-sex-adjusted death rates		Ultimate annual percent reductions in age-sex-adjusted death rates						
			2004	2007	2008	2009	2011	2011	2013
			Trustees	Technical	Trustees	Trustees	Trustees	Technical	Trustees
1900-2009	1982-2009	Alternative 2 ²	Panel ³	Alternative 2 ⁴	Alternative 2 ⁵	Alternative 2 ⁶	Panel ⁷	Alternative 2 ⁸	
0 - 14	3.15	2.34	1.55	1.00	1.57	1.55	1.56	1.26	1.57
15 - 64	1.38	1.25	0.78	1.00	1.00	0.99	0.96	1.26	0.98
65 & Over	0.79	0.77	0.69	1.00	0.65	0.71	0.66	1.26	0.64

¹Rates of reduction are the average of male and female annual rates of decline in age-adjusted central death rates. The rates for the period 1900-2009 are a weighted average of rates for five separate distinct periods of change.

²The 2004 Trustees ultimate intermediate assumptions are for the period 2028-2078.

³The 2007 Technical Panel ultimate assumptions are for the period 2031-2081.

⁴The 2008 Trustees ultimate intermediate assumptions are for the period 2032-2082.

⁵The 2009 Trustees ultimate intermediate assumptions are for the period 2033-2083.

⁶The 2011 Trustees ultimate intermediate assumptions are for the period 2035-2085.

⁷The 2011 Technical Panel ultimate assumptions are for the period 2035-2085.

⁸The 2013 Trustees ultimate intermediate assumptions are for the period 2037-2087.

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Table 2.1 (Continued): Historical and Assumed Rates of Reduction in Mortality¹

(Using the 2010 Census Resident population as the standard population for age-sex adjusting)

	Historical average annual percent reductions in age-sex-adjusted death rates		Ultimate annual percent reductions in age-sex-adjusted death rates		
			2013	2015	2018
	1900-2015	1982-2015	Trustees	Technical	Trustees
			Alternative 2 ²	Panel ³	Alternative 2 ⁴
0 - 14	3.04	2.23	1.57	2.44	1.55
15 - 64	1.23	1.17	1.00	1.47	1.01
65 & Over	0.81	0.86	0.63	0.86	0.63

¹Rates of reduction are the average of male and female annual rates of decline in age-adjusted central death rates. The rates for the period 1900-2015 are a weighted average of rates for five separate distinct periods of change.

²The 2013 Trustees ultimate intermediate assumptions are for the period 2037-2087.

³The 2015 Technical Panel ultimate assumptions are for the period 2039-2089.

⁴The 2018 Trustees ultimate intermediate assumptions are for the period 2042-2092.

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Table 2.2: Average Annual Percent Reductions in Age-Adjusted Central Death Rates: for the 2018 Trustees Report ¹

Sex	Age	Historical Period (last year of final data is 2015)								Intermediate Alternative		
		1900-1936	1936-1954	1954-1968	1968-1982	1982-1999	1999-2009	2009-2015	1900-2015	2015-2042	2015-2092	2042-2092
Male	0-14	2.91	4.79	1.65	4.33	2.91	1.29	1.53	3.02	1.67	1.59	1.54
	15-49	1.46	3.01	-0.25	2.21	0.65	0.80	0.13	1.34	0.98	0.91	0.87
	50-64	0.42	0.96	-0.13	2.28	1.92	1.15	-0.25	0.92	1.15	1.10	1.07
	65-84	0.20	1.16	-0.11	1.46	1.25	2.45	0.84	0.85	1.03	0.86	0.77
	85+	0.22	1.21	-0.89	1.56	-0.29	1.53	0.22	0.45	0.61	0.55	0.51
	65+	0.21	1.17	-0.37	1.50	0.70	2.08	0.58	0.70	0.84	0.72	0.65
	Total	0.67	1.49	-0.25	1.78	0.94	1.80	0.41	0.95	0.92	0.80	0.74
Female	0-14	3.14	5.06	1.72	4.15	2.63	1.12	1.49	3.06	1.68	1.61	1.57
	15-49	1.53	4.68	0.28	2.91	0.59	0.26	0.02	1.72	0.97	0.95	0.94
	50-64	0.71	2.57	0.76	1.72	1.09	1.46	-0.36	1.20	1.13	1.08	1.06
	65-84	0.35	2.05	1.06	2.03	0.47	1.72	0.69	1.07	0.93	0.79	0.72
	85+	0.23	1.21	0.13	2.06	-0.14	1.13	-0.04	0.61	0.57	0.52	0.49
	65+	0.31	1.74	0.69	2.04	0.22	1.46	0.36	0.88	0.76	0.66	0.60
	Total	0.79	2.31	0.70	2.11	0.43	1.38	0.24	1.15	0.84	0.75	0.69
Total	0-14	3.01	4.90	1.68	4.26	2.79	1.22	1.51	3.04	1.68	1.60	1.55
	15-49	1.49	3.69	-0.06	2.44	0.63	0.61	0.09	1.49	0.98	0.93	0.90
	50-64	0.55	1.62	0.19	2.08	1.61	1.27	-0.29	1.04	1.14	1.09	1.06
	65-84	0.28	1.60	0.42	1.72	0.92	2.11	0.76	0.96	0.98	0.83	0.75
	85+	0.23	1.21	-0.22	1.86	-0.18	1.30	0.06	0.55	0.58	0.53	0.49
	65+	0.26	1.46	0.19	1.77	0.51	1.78	0.46	0.81	0.80	0.69	0.63
	Total	0.73	1.88	0.22	1.95	0.75	1.59	0.32	1.05	0.89	0.78	0.72

¹Using the 2010 Census Resident population as the standard population for age adjusting

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Table 2.2 (Continued): Average Annual Percent Reductions in Age-Adjusted Central Death Rates: for the 2018 Trustees Report ¹

Sex	Age	Low-Cost Alternative			High-Cost Alternative		
		2015-2042	2015-2092	2042-2092	2015-2042	2015-2092	2042-2092
Male	0-14	0.85	0.81	0.78	2.72	2.58	2.50
	15-49	0.50	0.47	0.45	1.58	1.47	1.40
	50-64	0.56	0.58	0.59	1.89	1.69	1.58
	65-84	0.53	0.48	0.45	1.61	1.26	1.07
	85+	0.28	0.28	0.28	1.00	0.84	0.75
	65+	0.42	0.39	0.37	1.34	1.07	0.92
	Total		0.46	0.43	0.42	1.47	1.21
Female	0-14	0.85	0.82	0.80	2.74	2.63	2.57
	15-49	0.48	0.48	0.49	1.59	1.53	1.50
	50-64	0.55	0.57	0.58	1.86	1.69	1.59
	65-84	0.48	0.44	0.42	1.45	1.16	1.00
	85+	0.25	0.26	0.27	0.94	0.79	0.71
	65+	0.37	0.36	0.35	1.21	0.98	0.85
	Total		0.41	0.40	0.39	1.35	1.12
Total	0-14	0.85	0.81	0.79	2.73	2.60	2.53
	15-49	0.50	0.47	0.46	1.59	1.49	1.44
	50-64	0.55	0.57	0.58	1.88	1.69	1.58
	65-84	0.51	0.46	0.44	1.53	1.21	1.04
	85+	0.26	0.27	0.27	0.96	0.81	0.73
	65+	0.40	0.37	0.36	1.27	1.02	0.89
	Total		0.44	0.42	0.41	1.42	1.17

¹Using the 2010 Census Resident population as the standard population for age adjusting

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Table 2.3: Average Annual Rates of Reduction in Central Death Rates by Age Group, Sex, and Cause

	Historical		Alternative II*		Historical		Alternative II*	
	1979 to 2015	2005 to 2015	2017 TR	2018 TR	1979 to 2015	2005 to 2015	2017 TR	2018 TR
Under Age 15	Male				Female			
Cardiovascular Disease	2.73	2.53	2.3	2.3	2.63	2.32	2.3	2.3
Cancer	2.28	1.20	1.5	1.5	1.91	1.43	1.5	1.5
Violence	2.78	2.01	1.0	1.0	2.34	2.39	1.0	1.0
Respiratory Disease	2.48	1.37	2.0	2.0	2.50	0.86	2.0	2.0
Other	2.29	2.42	1.7	1.7	2.17	2.17	1.7	1.7
Resulting Total **	2.41	2.27	1.54	1.54	2.21	2.14	1.58	1.57
Ages 15 - 49	Male				Female			
Cardiovascular Disease	1.94	1.62	1.5	1.5	1.18	1.17	1.5	1.5
Cancer	1.90	2.31	1.5	1.5	1.67	1.89	1.5	1.5
Violence	0.74	0.57	0.7	0.7	-0.05	-0.46	0.7	0.7
Respiratory Disease	0.79	0.37	0.5	0.5	-0.21	-0.21	0.5	0.5
Other	0.69	2.20	0.8	0.8	-0.33	0.66	0.8	0.8
Resulting Total **	1.14	1.28	0.88	0.87	0.56	0.65	0.94	0.94
Ages 50 - 64	Male				Female			
Cardiovascular Disease	2.95	1.33	2.2	2.2	2.56	1.37	2.2	2.2
Cancer	1.64	1.40	1.5	1.5	1.41	1.47	1.5	1.5
Violence	-0.10	-2.12	0.5	0.5	-0.79	-3.10	0.5	0.5
Respiratory Disease	0.99	-0.49	0.7	0.7	-0.48	-1.04	0.7	0.7
Other	-0.47	-0.69	0.6	0.6	-0.49	-0.65	0.6	0.6
Resulting Total **	1.55	0.41	1.07	1.07	1.10	0.42	1.06	1.06
Ages 65 - 84	Male				Female			
Cardiovascular Disease	3.22	2.75	2.2	2.2	2.90	3.07	2.2	2.2
Cancer	0.97	2.00	0.9	0.9	0.09	1.42	0.9	0.9
Violence	0.52	-0.41	0.5	0.5	-0.14	-0.52	0.5	0.5
Respiratory Disease	0.71	1.31	0.3	0.3	-1.76	0.37	0.3	0.3
Other	-0.77	-0.58	0.3	0.3	-1.45	-0.54	0.3	0.3
Resulting Total **	1.59	1.51	0.77	0.77	0.79	1.24	0.72	0.72
Ages 85 and older	Male				Female			
Cardiovascular Disease	1.75	2.35	1.2	1.2	1.93	2.72	1.2	1.2
Cancer	-0.13	1.11	0.5	0.5	-0.44	0.42	0.5	0.5
Violence	-0.67	-1.04	0.3	0.3	-1.29	-2.07	0.3	0.3
Respiratory Disease	-0.38	1.45	0.2	0.2	-1.57	0.72	0.2	0.2
Other	-2.25	-1.53	0.2	0.2	-3.09	-1.60	0.2	0.2
Resulting Total **	0.34	0.86	0.51	0.51	0.13	0.68	0.48	0.49
Total	Male				Female			
Cardiovascular Disease	2.63	2.32			2.40	2.67		
Cancer	1.00	1.70			0.54	1.31		
Violence	0.49	-0.26			-0.23	-1.10		
Respiratory Disease	0.39	1.15			-1.43	0.30		
Other	-0.82	-0.59			-1.54	-0.79		
Resulting Total **	1.22	1.11	0.74	0.74	0.64	0.90	0.69	0.69

* Alternative 1 is 1/2 times Alternative 2; Alternative 3 is 5/3 times Alternative 2.

**Resulting total represents average annual percent reduction in age-adjusted death rates for the last 50 years of the 75-year projection period.

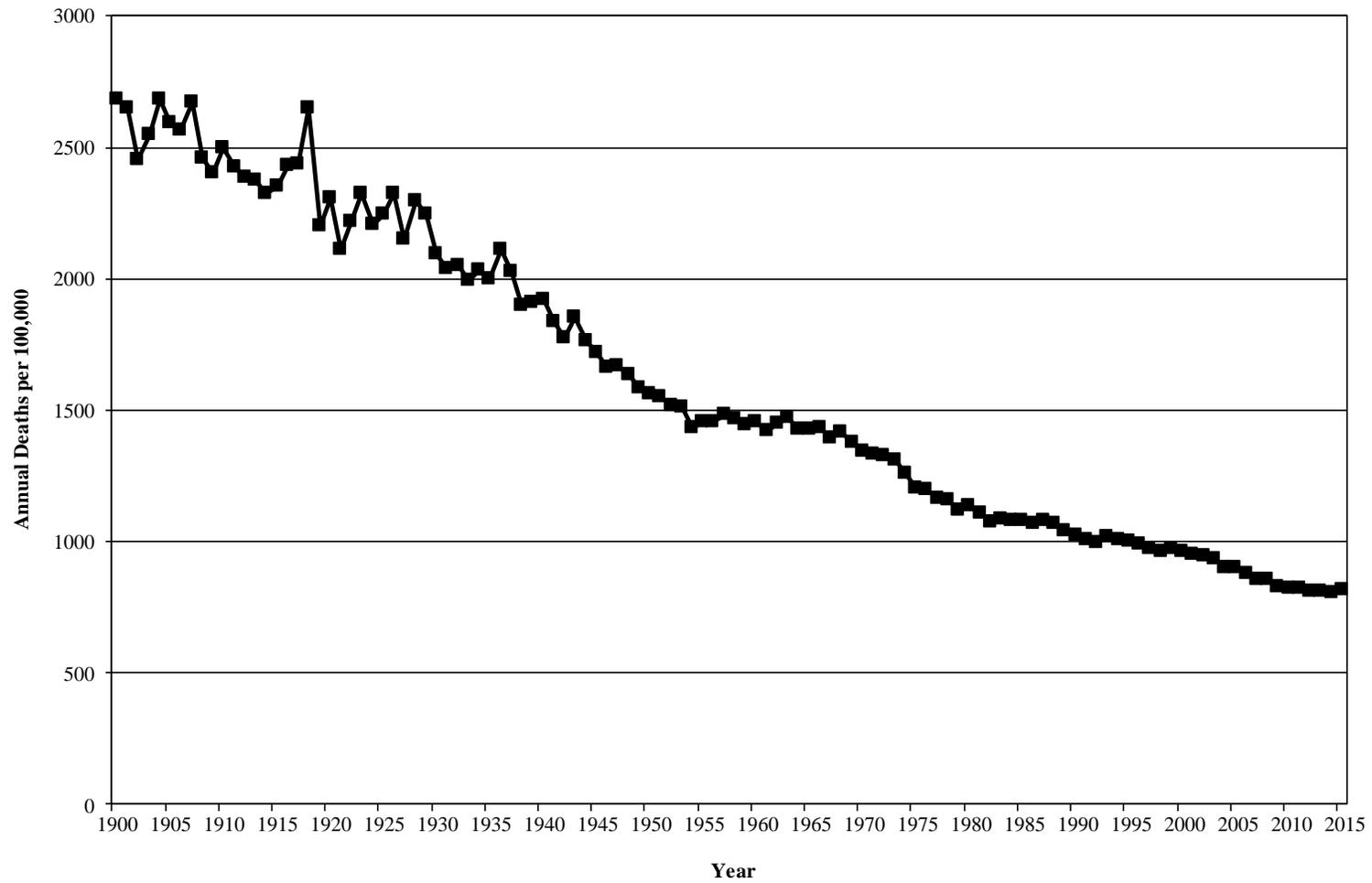
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Table 2.4: Age-Sex-Adjusted Central Death Rates
(per 100,000 population)

Year	2017TR		2018TR			
1900		2,684.3		2,684.3		
1910		2,495.9		2,495.9		
1920		2,304.5		2,304.5		
1930		2,094.9		2,094.9		
1940		1,919.8		1,919.8		
1945		1,716.6		1,716.6		
1950		1,561.9		1,561.9		
1955		1,453.8		1,453.8		
1960		1,454.3		1,454.3		
1965		1,428.8		1,428.8		
1970		1,340.0		1,340.0		
1975		1,204.8		1,204.8		
1980		1,136.9		1,136.9		
1985		1,081.0		1,081.0		
1990		1,021.3		1,021.3		
1991		1,007.7		1,007.7		
1992		992.7		992.7		
1993		1,016.4		1,016.4		
1994		1,004.1		1,004.1		
1995		1,001.5		1,001.5		
1996		987.8		987.8		
1997		971.9		971.9		
1998		963.8		963.8		
1999		970.6		970.6		
2000		960.7		960.7		
2001		951.1		951.1		
2002		947.0		947.0		
2003		933.4		933.4		
2004		898.9		898.9		
2005		901.3		901.3		
2006		876.1		876.1		
2007		856.8		856.8		
2008		857.0		857.0		
2009		827.1		827.1		
2010		821.3		821.3		
2011		819.3		819.4		
2012		811.9		812.0		
2013		811.9		812.1		
2014		805.4		805.3		
2015		787.9 ¹		815.8		
2016		779.8 ¹		791.0 ¹		
2017		772.1 ¹		783.6 ¹		
	Alternative I		Alternative II		Alternative III	
	2017TR	2018TR	2017TR	2018TR	2017TR	2018TR
2020	779.0	785.3	750.2	762.4	719.4	737.6
2025	762.6	769.3	716.9	728.9	667.6	684.8
2030	745.9	752.7	686.1	697.7	622.2	638.0
2040	713.8	720.2	630.8	641.1	545.7	558.7
2050	683.6	689.7	582.3	591.5	483.7	494.5
2060	655.4	661.1	539.7	547.9	432.7	441.8
2070	629.1	634.5	502.0	509.4	390.2	398.0
2080	604.4	609.5	468.6	475.2	354.3	361.1
2090	581.2	586.1	438.7	444.7	323.7	329.7
2100	559.5	564.1	411.9	417.4	297.4	302.6

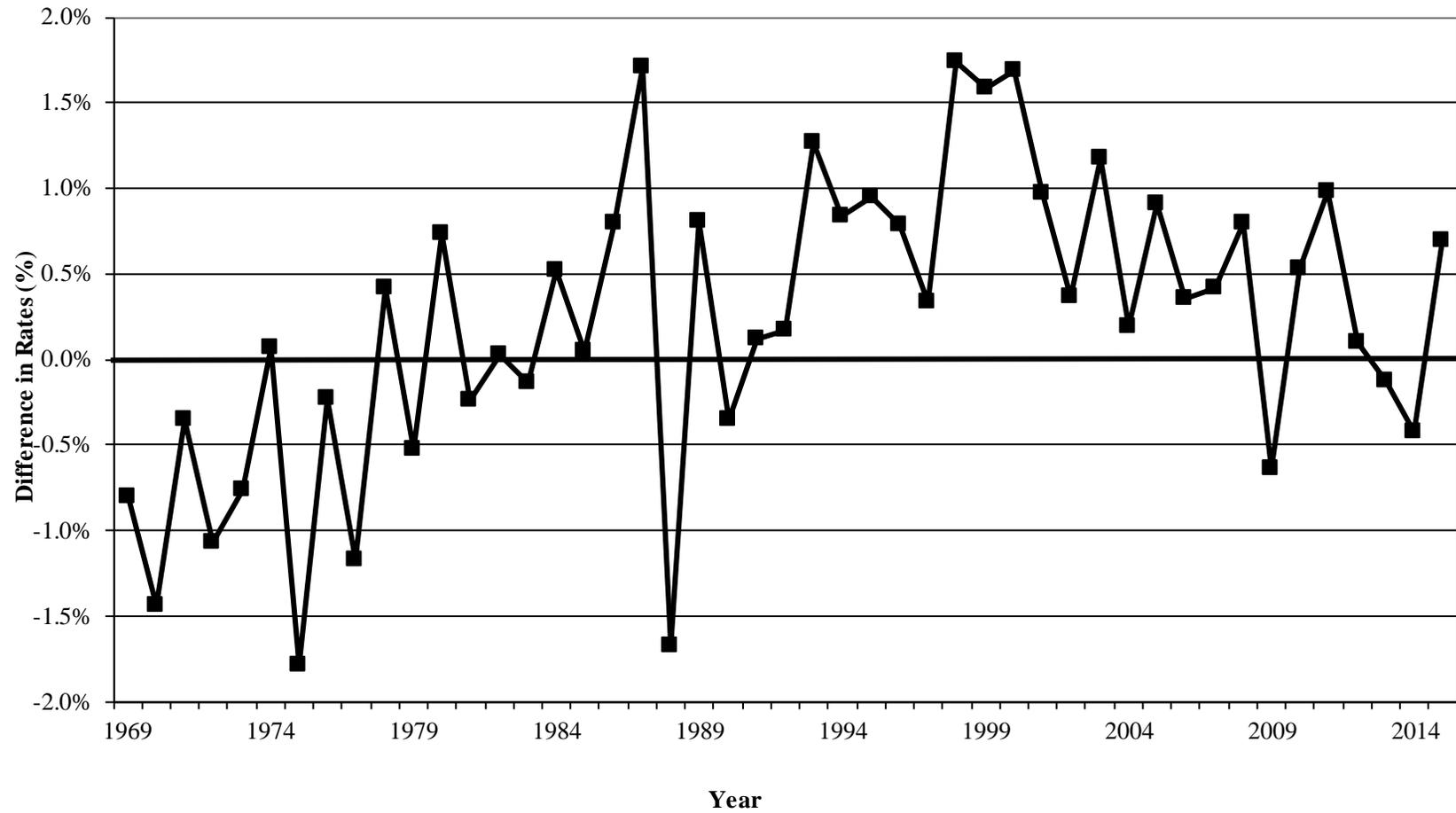
¹ Estimated, Intermediate Alternative

Chart 2.1: Historical United States Age-Sex-Adjusted Central Death Rates from 1900-2015



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Chart 2.2: Difference Between Male and Female Annual Percent Reduction in Age-Adjusted Death Rates for Population 65+
(based on Medicare data)



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3. IMMIGRATION

ASSUMPTIONS FOR THE 2018 TRUSTEES REPORT
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3.1 Summary

For the 2018 Trustees Report, the ultimate immigration assumptions are changed slightly from those used in the 2017 Trustees Report, as a result of clarification from the Department of Homeland Security (DHS) regarding the implementation of the 2014 executive actions on immigration. Table 3.1 displays the annual immigration levels assumed for the 2018 Trustees Report as well as those assumed for the 2017 Trustees Report. Updated historical data result in a decrease (worsening) in the long-range OASDI actuarial balance of about 0.01 percent of taxable payroll. The scheduled phase-out of the DACA program and the non-implementation of the 2014 executive action on immigration of entrepreneurs are estimated to have a negligible effect on the actuarial balance.

Historically, the annual number of lawful permanent resident (LPR) immigrants has risen substantially, averaging around 1.1 million persons per year since 2005. Based on this experience and the belief that the number of future LPR immigrants in the category of *immediate relatives of U.S. citizens* will remain close to current levels, the Trustees' intermediate ultimate assumption is 1.05 million new LPRs per year for the 2018 Trustees Report. This is slightly lower than the ultimate assumption of 1.06 million for the 2017 Trustees Report. The decrease is due to clarification from DHS regarding the implementation of the 2014 executive actions on immigration. One of those executive actions was intended to increase the number of entrepreneur green cards issued. The Trustees assumed an increase of about 10,000 persons per year. DHS recently clarified that this executive action was never implemented, and the Trustees assume it will not be implemented. Therefore, for the 2018 Trustees Report, the Trustees are reversing this earlier assumption. The Trustees made no change to the assumption that legal emigration out of the Social Security area will be 25 percent of the number of LPR immigrants, or 262,500 per year, ultimately.

For other-than-LPR immigration, there were no changes to the immigration model introduced for the 2014 Trustees Report, and no changes to the updated exit rates used for the 2017 Trustees Report. The model projects the annual other-than-LPR immigration flows in three main components: (1) the other-than-LPR immigrants entering the Social Security area each year, (2) those who leave the stock of other-than-LPR immigrants and move outside the Social Security area, and (3) the other-than-LPR immigrants who adjust status to become LPRs, thereby leaving other-than-LPR status. The net other-than-LPR immigration is equal to the gross level of other-than-LPR immigration, less other-than-LPR emigration out of the Social Security area, and less those who adjust status to become LPRs.

The model continues to project these annual other-than-LPR immigrant flows and further projects the other-than-LPR immigrants in three specific categories: (1) those who have temporary legal status ("nonimmigrant"), (2) those who never had legal status ("never-authorized"), and (3) those who originally entered legally as nonimmigrants but overstayed their visa ("visa-overstayers").

Using this model of other-than-LPR immigration, the level of net other-than-LPR immigration, under the intermediate alternative, is projected to be about 853,000 persons for 2018, 710,000 persons for 2020, 459,000 persons for 2050, and 431,000 persons for 2090. The average level of

net other-than-LPR immigration during the 75-year projection period is approximately 484,000 persons per year. The following table presents the projected net numbers of immigrants for the intermediate alternative.

Annual Net Immigration: Alternative II Levels for the 2018 Trustees Report			
Year	LPR	Other-than-LPR	Total
2018	825,000	853,000	1,678,000
2020	788,000	710,000	1,498,000
2030	788,000	533,000	1,321,000
2040	788,000	485,000	1,272,000
2050	788,000	459,000	1,247,000
2060	788,000	446,000	1,233,000
2070	788,000	438,000	1,225,000
2080	788,000	433,000	1,221,000
2090	788,000	431,000	1,218,000

Notes: Totals do not necessarily equal the sums of rounded components.
Levels rounded to the nearest 1,000.

3.2 Lawful Permanent Resident (LPR) Immigration

The term LPR immigration refers to the number of persons granted authorization to live and work in the United States on a permanent basis. These individuals are referred to as *lawful permanent residents* (LPRs). Many individuals are admitted to the country legally but on a temporary basis. These individuals are included as other-than-LPR immigrants and are discussed in the following sections of this memorandum.

LPR immigration has been a very important element in the growth of the United States population. For the period 1870 through 1930, the population averaged about 13 percent foreign born. The Census Bureau estimates that the percentage of the civilian non-institutionalized population that is foreign born declined to a low of about 5 percent in the 1970 Census, rose to about 8 percent in the 1990 Census, and was estimated to be approximately 13.5 percent in the 2016 American Community Survey.

Data on the number of LPR immigrants admitted to the U.S., which include U.S. possessions and territories and Armed Service posts abroad, are obtained from the Office of Immigration Statistics (OIS), a component of DHS. LPR immigration averaged nearly one million per year for the period 1904 through 1914. LPR immigration decreased greatly during World War I and following the adoption of quotas based on national origin in 1921. The economic depression in the 1930's caused an additional, but temporary, decrease that resulted in more emigration than immigration. Annual LPR immigration increased after World War II to around 200,000 to 300,000 persons and stayed at that level through the 1950's and into the 1960's. With the Immigration Act of 1965 and other related changes, annual LPR immigration increased to about 400,000 and remained fairly stable until 1977. Between 1977 and 1990, LPR immigration

(excluding aliens admitted under the Immigration Reform and Control Act of 1986 [IRCA]) averaged approximately 580,000 per year. This increase was due to the increase in the numbers of relatives admitted and to the large numbers of refugees and political asylees admitted during this period. Table 3.2 lists LPR immigration for fiscal years 1966 through 1991, reflecting the immigration categories established in the 1965 Act.

The Immigration Act of 1990, which took effect in fiscal year 1992, restructured the immigration categories and substantially increased the number of immigrants that may legally enter the United States each year. For fiscal years 1995 and later, the 1990 law specified an annual limit that could range between 421,000 and 675,000 for certain categories of immigrants. These categories and their limits include those admitted based on: family-sponsored preference (226,000 to 480,000), employment-based preference (140,000) and diversity (55,000). Other categories of immigrants, such as refugees, are subject to separate limits. The Real ID Act of 2005 eliminated the numerical limit on asylees and no numerical limitation exists for immediate relatives of U.S. citizens. For each of the numerically limited categories, the limits may be adjusted annually based on unused amounts from prior years or other categories. Table 3.3 displays these unadjusted limits and the adjusted limits for each fiscal year from 1995 through 2015.

The annual level of total LPR immigration and the levels by category can vary considerably from year to year as shown in table 3.4. For fiscal years 1998 and 1999, annual LPR immigration was about 650,000, the lowest level since the 1990 Act went into effect. This drop is attributed to a backlog in the process caused mainly by the longer time required to process the affidavit of support and the shifting of responsibilities from the Department of State to DHS. LPR immigration was 841,000 in 2000 and over 1,000,000 in 2001 and 2002. These levels in 2000 through 2002 were significantly above the low levels in 1998 and 1999, mainly due to the efforts to reduce the backlog of pending immigration applications. In 2003, LPR immigration declined to a level of 704,000 due to a slowdown in processing because of increased security checks. Since then, the level has increased dramatically and peaked at a level of 1,266,000 persons in 2006 before declining about 17 percent to 1,052,000 in 2007. However, the decline in 2007 is attributed to an unanticipated spike in naturalization applications that temporarily shifted resources away from processing immigration applications. In 2008, the level increased slightly from the 2007 level, to 1,107,000. In 2009, there was another slight increase, to 1,131,000. From 2010 through 2013, total LPR immigration declined from 1,043,000 in 2010 to 991,000 in 2013. Total LPR immigration then increased over the next two years to 1,051,000 in 2015. For the intermediate assumptions, the Trustees assume that the future LPR immigration levels will average approximately 1,050,000 persons per year.

It is possible that future global economic conditions assumed under the high-cost alternative and/or less favorable attitudes toward immigration could result in generally lower immigration. Therefore, the Trustees assume an ultimate level of 850,000 LPR immigrants per year for the high-cost (low-immigration) alternative. On the other hand, the possibility of a significant increase in the number of immediate relatives admitted and the uncertainty of the number of asylees permits the possibility of annual LPR immigration substantially higher than 1,050,000 persons per year. Therefore, the ultimate level for the low-cost (high-immigration) alternative is 1,250,000 persons per year.

3.3 Legal Emigration

Statistics on emigration are sparse and most analysis is based largely on estimates. Research done by the Census Bureau, the OIS, and other experts suggests that annual emigration may generally be in the range of 20 to 40 percent of annual LPR immigration. Expected emigration from the Social Security area should be less than emigration from the United States, especially at the older ages. This is primarily because most individuals who leave the United States having achieved fully insured status are still eligible to receive OASDI benefits and thus are still considered to be in the Social Security area population. For the 2017 Trustees Report, the assumed ratio of emigration to immigration was 20, 25, and 30 percent for the low-cost, intermediate, and high-cost alternatives, respectively. The same ratios of emigration to immigration are assumed for the 2018 Trustees Report.

3.4 Net LPR Immigration

Combining the levels of LPR immigration with the ratios for legal emigration yields ultimate levels of net LPR immigration of 1,000,000, 787,500, and 595,000 per year for the low-cost, intermediate, and high-cost alternatives, respectively.

3.5 Other-than-LPR Immigration

The term “other-than-LPR immigration” refers to persons entering the United States in a manner other than lawfully admitted for permanent residence. This population consists of three components:

- 1) Nonimmigrants who are defined as foreign nationals that enter the U.S. with authorization to stay for a temporary period of time and for a specific purpose such as students and exchange visitors, temporary workers, and diplomats and other representatives.
- 2) Those who are unauthorized on entry and were never previously legally authorized to be residing in the United States (“never-authorized”).
- 3) Those who at one point had temporary legal authorization to be residing in the United States but have overstayed their visas (“visa-overstayers”).

The stock of the other-than-LPR immigrant population is included in the starting year population level for the Trustees’ projections, in accordance with the official policy of the Census Bureau to enumerate all persons residing in the U.S., as well as to provide a basis for estimating the total labor force in the United States and total births in the Social Security area.

During the 1990s there was rapid growth in the size of the other-than-LPR immigrant population. In a joint project, the OIS and the Census Bureau examined the size of the unauthorized immigrant population between October 1988 and October 1992. In 1988 there were over 4 million unauthorized immigrants residing in the United States. Not counting those who would

be subsequently legalized under the Immigration Reform and Control Act of 1986 (IRCA), it is estimated that there were 2.2 million unauthorized immigrants in the population as of October 1988. At the time of the 1990 Census, 2.6 million persons were estimated to be unauthorized, again excluding those who would subsequently be legalized under the IRCA. (The total unauthorized population in 1990 was roughly 5.3 million.) Subsequent estimates suggest an increase to 3.4 million for October 1992 and approximately 5.0 million for October 1996. The rapid rise in the other-than-LPR immigrant population between 1990 and 1996 reflected the continued inflow of other-than-LPR immigrants combined with a decreased number leaving this status, due to the reduced stock of other-than-LPR immigrants that resulted from the IRCA.

The 2000 Census gave evidence that other-than-LPR immigration since 1990 had been consistently underestimated. In producing intercensal estimates of the U.S. population between the 1990 and 2000 Census, the Census Bureau estimated the average level of annual net other-than-LPR immigration to be approximately 550,000. For 2000, DHS estimated a total other-than-LPR stock of 9.9 million. Based on DHS estimates, the total other-than-LPR stock was 12.2 million in 2005, then increased to a peak of 14.1 million in 2008, and then decreased to 13.3 million by 2012. Using DHS methods, the 2016 total other-than-LPR stock is estimated to be 13.3 million.

The other-than-LPR immigration model makes explicit estimates of the following categories:

- The annual numbers of new-arrival other-than-LPR immigrants who enter as never-authorized and who enter legally as nonimmigrants;
- The annual number of non-immigrants who become visa-overstayers;
- The annual numbers of other-than-LPR emigrants (those leaving the Social Security area) who were never-authorized, nonimmigrants, or visa-overstayers; and
- The annual numbers of adjustments of status who were never-authorized, nonimmigrants, or visa-overstayers.

For the 2018 Trustees Report, the Trustees assume no change to the ultimate number of new other-than-LPR immigrants per year. The Trustees assume an ultimate level of 1,350,000 per year under the intermediate projections. Due to the projected economic recovery, the Trustees assume a slow increase in the number of new other-than-LPR immigrants from current levels to 1,550,000 in 2018 and 2019 before gradually decreasing to the ultimate level of 1,350,000 in 2022. It is possible that the ultimate level will be higher than 1,350,000 in the future, as other-than-LPR immigrants already in the U.S. may help family members or additional other-than-LPR immigrants enter the country and the demand for other-than-LPR immigrant labor in the economy may increase. Thus, the Trustees assume an ultimate level of 1,650,000 per year under the low-cost (high-immigration) scenario. Due to the possibility of an increased willingness of the government to pursue deportation of unauthorized immigrants or withhold services from them and to crack down on those who employ them, the Trustees assume an ultimate level of 1,050,000 under the high-cost (low-immigration) scenario.

The average annual other-than-LPR emigration level (departures from the Social Security area) during 2008 through 2010 is estimated to be around 470,000. Although the expected annual other-than-LPR emigration level in 2017 is around 231,000, this number is projected to rise throughout the projection period. As the stock of the other-than-LPR immigrant population

risers, more emigration is likely to occur. Thus, other-than-LPR emigration is estimated as a function of the population at risk. Rates of emigration by age and sex have been developed for the never-authorized, the nonimmigrants, and the overstayers based on the number of exits from each of these categories estimated to have occurred during the period 2008 through 2011. Ideally, these rates would be developed by age, sex, and duration of stay in the country. Unfortunately, at this time, data are too sparse to develop accurate estimates of the current stock by duration of stay. However, as in the 2017 Trustees Report, the Trustees assume continuing higher rates of emigration for recent entrants.

Applying the method described above results in increasing levels of other-than-LPR emigration¹ throughout the projection period. Under the intermediate alternative, the gross emigration rate (number of other-than-LPR emigrants divided by the midyear other-than-LPR population) is about 1.6 percent at the start of the projection period, increasing to a maximum of about 1.7 percent in 2022, but declining to about 1.3 percent at the end of the 75-year projection period.

Another component of the immigration model takes into account the following two ways immigrants attain LPR status:

- 1) New-arrival LPRs are persons who file an application to become an LPR with the Department of State while living outside of the United States and become an LPR upon entry.
- 2) Adjustments of Status² are persons who are already living in the United States as temporary workers, students, or unauthorized immigrants and apply and receive an adjustment of status to an LPR.

Historically, the adjustment of status category has been a substantial portion of all new LPRs. For years 2000 through 2005, approximately 50 percent of all new LPRs were people that had already been in the country as a temporary worker, foreign student, or unauthorized immigrant and who filed an application for adjustment to LPR status. Since then, however, the trend decreased to slightly under 40 percent. Thus, the Trustees assume slightly over 40 percent of future individuals becoming LPRs will be adjustments of status from the other-than-LPR immigrant population.

¹ As the population begins to mature, higher numbers of other-than-LPR immigrants in the population and thus higher levels of emigration are expected, particularly at the ages 35 and over. The current other-than-LPR immigrant population is centered very heavily at the younger ages. This concentration at the younger ages is likely due to (1) the relatively high levels of other-than-LPR immigration that began in the late 1990's (individuals entering at relatively young ages) and (2) the effects of the IRCA legislation in the late 1980's (which legalized largely older individuals due to required substantial durations of residence in the country). These reasons result in a population of other-than-LPR immigrants that is relatively young, with short durations of stay in the country.

² DHS also considers refugees and asylees to be adjustments of status, but for the purposes of the immigration model, these categories are treated as new arrivals.

3.6 Recommendations of Previous Technical Panels and Other Projections

The total net levels of immigration recommended by the 2003, 2007, and 2011 Technical Panels appointed by the Social Security Advisory Board are higher than the levels assumed for the 2018 Trustees Report. However, the levels recommended by the 2015 Technical Panel are generally similar to the levels assumed for the 2018 Trustees Report. For the intermediate assumptions, the 2003 Technical Panel recommended a continuing annual growth rate in the total net immigration equal to approximately one-half of the annual growth rate in the total population through the next 75 years. Under this specification, total net immigration would have been projected to reach 1.5 million by 2065, with continuing increases thereafter.³

The 2007 Technical Panel recommended setting total net immigration equal to 1.35 million for 2007, with increases of 1.0 percent per year for the first 25 years of the projection period and increases of 0.5 percent per year thereafter. This would have resulted in a total net immigration flow of nearly 2.2 million by the end of the projection period.

The 2011 Technical Panel recommended setting total net immigration equal to 0.32 percent of the total population for all years after 2025. This would have resulted in a total net immigration flow of nearly 1.63 million by the end of the projection period.

The 2015 Technical Panel recommended setting total net immigration to equal the average between that assumed in the 2015 Trustees Report and that projected by the Census Bureau, while maintaining the proportion of net LPR and net other-than-LPR the same as assumed in the 2015 Trustees Report. This would have resulted in a total net immigration flow of nearly 1.32 million by the end of the projection period.

These increases in the levels of total net immigration recommended by the panels prior to the 2015 panel reflect a number of factors. One factor is that each panel includes the assumption of continuing changes in immigration law to allow more immigrants as the population increases. Historically, the Trustees, as well as other Federal Government entities, have assumed that future immigration will be consistent with current law and that changes based on potential future legislation should not be reflected until enactment. Reflecting the possibility of future changes in immigration law is not unreasonable if there is a conviction that such changes are truly expected to occur and this change in the basis for projecting is fully disclosed. On the other hand, presuming such changes could result in the peculiar situation where the Trustees would need to change assumptions in the future because immigration law had *not* been modified. On balance, the Trustees have retained the practice of reflecting changes in the immigration law only upon enactment. Another factor is the potential number of immigrants entering the U.S. The Trustees recognize that birth rates have dropped in several countries that supply significant numbers of immigrants to the U.S. Most of those countries, particularly Mexico, have seen drops in birth rates since 1990 and will likely average less emigration in the future.

³ All results displayed in this section are based on that current year's Trustees Report model. For example, the result using the 2003 Technical Panel recommendation is based on the 2003 Trustees Report model.

In their 2017 projections, the Congressional Budget Office (CBO) projects total net immigration of 1.3 million people in 2047.⁴ Comparing with the Census Bureau, the middle series of the 2014 National Population Projections results in total net immigration of 1.4 million people in 2040.⁵ The Trustees' assumptions for the intermediate alternative of the 2018 Trustees Report result in total net immigration of 1.3 million people in 2040.

⁴ See <https://www.cbo.gov/system/files/115th-congress-2017-2018/reports/52480-ltbo.pdf>.

⁵ See <https://www2.census.gov/programs-surveys/popproj/technical-documentation/methodology/methodstatement14.pdf>.

Table 3.1: Annual Immigration Assumptions¹ for the Social Security Area Population
 (All values rounded to the nearest 1,000)

Values Used for 2017 Trustees Report					
Alternative	Year	Gross LPR	Net LPR	Gross Other-than-LPR	Net Other-than-LPR
Low Cost:	2018	1,260,000	1,008,000	1,850,000	1,036,000
	2020	1,260,000	1,008,000	1,750,000	896,000
	2030	1,260,000	1,008,000	1,650,000	688,000
	2040	1,260,000	1,008,000	1,650,000	617,000
	2050	1,260,000	1,008,000	1,650,000	578,000
	2060	1,260,000	1,008,000	1,650,000	556,000
	2070	1,260,000	1,008,000	1,650,000	543,000
	2080	1,260,000	1,008,000	1,650,000	536,000
	2090	1,260,000	1,008,000	1,650,000	534,000
	Intermediate:	2018	1,060,000	795,000	1,550,000
2020		1,060,000	795,000	1,450,000	717,000
2030		1,060,000	795,000	1,350,000	537,000
2040		1,060,000	795,000	1,350,000	487,000
2050		1,060,000	795,000	1,350,000	462,000
2060		1,060,000	795,000	1,350,000	448,000
2070		1,060,000	795,000	1,350,000	439,000
2080		1,060,000	795,000	1,350,000	434,000
2090		1,060,000	795,000	1,350,000	432,000
High Cost:		2018	860,000	602,000	750,000
	2020	860,000	602,000	850,000	274,000
	2030	860,000	602,000	1,050,000	419,000
	2040	860,000	602,000	1,050,000	381,000
	2050	860,000	602,000	1,050,000	360,000
	2060	860,000	602,000	1,050,000	348,000
	2070	860,000	602,000	1,050,000	340,000
	2080	860,000	602,000	1,050,000	336,000
	2090	860,000	602,000	1,050,000	333,000

Values Used for 2018 Trustees Report					
Alternative	Year	Gross LPR	Net LPR	Gross Other-than-LPR	Net Other-than-LPR
Low Cost:	2018	1,250,000	1,000,000	1,850,000	1,044,000
	2020	1,250,000	1,000,000	1,750,000	892,000
	2030	1,250,000	1,000,000	1,650,000	685,000
	2040	1,250,000	1,000,000	1,650,000	615,000
	2050	1,250,000	1,000,000	1,650,000	576,000
	2060	1,250,000	1,000,000	1,650,000	554,000
	2070	1,250,000	1,000,000	1,650,000	541,000
	2080	1,250,000	1,000,000	1,650,000	535,000
	2090	1,250,000	1,000,000	1,650,000	532,000
	Intermediate:	2018	1,100,000	825,000	1,550,000
2020		1,050,000	788,000	1,450,000	710,000
2030		1,050,000	788,000	1,350,000	533,000
2040		1,050,000	788,000	1,350,000	485,000
2050		1,050,000	788,000	1,350,000	459,000
2060		1,050,000	788,000	1,350,000	446,000
2070		1,050,000	788,000	1,350,000	438,000
2080		1,050,000	788,000	1,350,000	433,000
2090		1,050,000	788,000	1,350,000	431,000
High Cost:		2018	900,000	630,000	750,000
	2020	850,000	595,000	850,000	264,000
	2030	850,000	595,000	1,050,000	413,000
	2040	850,000	595,000	1,050,000	378,000
	2050	850,000	595,000	1,050,000	357,000
	2060	850,000	595,000	1,050,000	346,000
	2070	850,000	595,000	1,050,000	339,000
	2080	850,000	595,000	1,050,000	335,000
	2090	850,000	595,000	1,050,000	332,000

¹ This table contains basic assumptions along with key summary values that are derived from basic assumptions.

Table 3.2: LPR Immigrants Admitted to the United States: Fiscal Years 1966-1991
(in thousands)
Reflecting Categories Established in the 1965 Immigration Act

Fiscal Year	IRCA ¹	Total non IRCA	Numerically Limited ²	Western Hemisphere ³	Immediate Relatives of Citizens	Refugees & Asylees	Other Specially Legislated Immigrants ⁴
1966	—	323	126	148	39	4	6
1967	—	362	153	125	47	30	7
1968	—	454	156	154	44	95	6
1969	—	359	291	—	60	1	7
1970	—	373	287	—	79	—	7
1971	—	370	281	—	81	—	8
1972	—	385	284	—	86	—	15
1973	—	400	283	—	101	—	16
1974	—	395	274	—	105	—	16
1975	—	386	282	—	92	—	13
1976	—	399	285	—	102	—	12
TQ 1976 ⁵	—	104	73	—	28	—	3
1977	—	462	277	—	106	68	12
1978	—	601	341	—	126	122	12
1979	—	460	279	—	138	32	11
1980	—	531	289	—	158	76	8
1981	—	597	330	—	152	107	7
1982	—	594	260	—	168	157	9
1983	—	560	269	—	178	103	10
1984	—	544	262	—	183	92	7
1985	—	570	264	—	204	95	6
1986	—	602	267	—	223	104	7
1987	—	602	271	—	219	92	20
1988	—	643	264	—	219	82	78
1989	479	612	280	—	218	84	30
1990	884	656	298	—	232	97	29
1991	1,133	704	294	—	237	139	34

¹ This category includes those aliens admitted under the Immigration Reform and Control Act of 1986.

² Legal limits on immigration visas were 170,000 per fiscal year before 1969, 290,000 per fiscal year for 1969 through 1979, 280,000 for fiscal year 1980, and 270,000 for fiscal years 1981 and later. Includes additional visas starting 1989.

³ Natives of Western Hemisphere countries, their children and spouses, Act of October 3, 1965. This category became numerically limited to 120,000 starting fiscal year 1969.

⁴ This category consists mainly of children born abroad to alien residents, ministers and their families, beginning 1971, spouses of U.S. citizens who entered as fiances and their children, and beginning 1988 Amerasians, special Cuban / Haitian entrants, and aliens in the U.S. since 1972.

⁵ The transition quarter (TQ) for 1976 covers the 3-month period, July-September 1976. Fiscal years 1966 through 1976 end on June 30. Beginning with fiscal year 1977, the data for fiscal years end on September 30.

Source: Annual Reports of the Immigration and Naturalization Service, Department of Justice

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Table 3.3: LPR Immigration Limits for Fiscal Years Beginning in 1995

	Family Sponsored Preference	Immediate Relatives of U.S. Citizens	Employment Based	Diversity	Refugees	Asylees	
Unadjusted Limit	226,000 to 480,000 ¹	Not Limited	140,000 ²	55,000 ³	Set Annually	Not Limited ⁴	
Limit For Fiscal Year	1995	253,721	Not Limited	146,503	55,000	111,000	10,000
	1996	311,819	Not Limited	140,000	55,000	90,000	10,000
	1997	226,000	Not Limited	140,000	55,000	78,000	10,000
	1998	226,000	Not Limited	140,000	55,000	83,000	10,000
	1999	226,000	Not Limited	160,906	55,000	91,000	10,000
	2000	294,601	Not Limited	142,299	55,000	90,000	10,000
	2001	226,000	Not Limited	192,074	55,000	80,000	10,000
	2002	226,000	Not Limited	142,632	55,000	70,000	10,000
	2003	226,000	Not Limited	171,532	55,000	70,000	10,000
	2004	226,000	Not Limited	204,422	55,000	70,000	10,000
	2005	226,000	Not Limited	148,449	55,000	70,000	Not Limited
	2006	226,000	Not Limited	143,949	55,000	70,000	Not Limited
	2007	226,000	Not Limited	147,148	55,000	70,000	Not Limited
	2008	226,000	Not Limited	162,704	55,000	80,000	Not Limited
	2009	226,000	Not Limited	140,000	55,000	80,000	Not Limited
	2010	226,000	Not Limited	150,657	55,000	80,000	Not Limited
	2011	226,000	Not Limited	140,000	55,000	80,000	Not Limited
2012	226,000	Not Limited	144,951	55,000	76,000	Not Limited	
2013	226,000	Not Limited	158,466	55,000	70,000	Not Limited	
2014	226,000	Not Limited	150,241	55,000	70,000	Not Limited	
2015	226,000	Not Limited	144,796	55,000	70,000	Not Limited	

¹ The family preference limit is given as a range because it is equal to the larger of: 226,000 or 480,000 minus the previous year's immediate relatives of U.S. citizens minus certain other small categories of children minus certain categories of aliens paroled into the U.S. in the second preceding fiscal year plus unused employment preferences from the previous year.

² The employment-based preference can be higher than 140,000 if certain other preferences go unused in the previous year.

³ The Diversity category includes those immigrating through the Nicaraguan Adjustment and Central American Relief Act (NACARA).

⁴ The REAL ID Act of 2005 eliminated the numerical limit for Asylees.

Sources:

1. Family sponsored, Employment based, and Diversity: Table A 1 of https://www.dhs.gov/sites/default/files/publications/Lawful_Permanent_Residents_2015.pdf
2. Immediate Relatives: all "not limited" unless legislation changes
3. Refugees: Table 1 of https://www.dhs.gov/sites/default/files/publications/Refugees_Asylees_2015.pdf
4. Asylees: Historical years: text on page 6 of <http://www.dhs.gov/xlibrary/assets/statistics/yearbook/2003/2003Yearbook.pdf>

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Table 3.4: LPR Immigrants Admitted to the United States: Fiscal Years Beginning in 1985
(in thousands)

Reflecting revised categories in the 1990 Immigration Act, Subject to limitation under the overall flexible cap

Fiscal Year	IRCA ¹	Total non IRCA ²	Family Sponsored	Employment Based	Immediate Relatives	Refugees & Asylees	Diversity	Other Specially Legislated Immigrants
1985	—	570	213	53	204	95	—	4
1986	—	602	213	57	223	104	—	4
1987	—	602	212	58	219	92	3	19
1988	—	643	201	59	219	82	6	76
1989	479	612	217	58	218	84	7	28
1990	884	656	215	58	232	97	29	25
1991	1,133	704	216	60	237	139	22	30
1992	163	811	213	116	235	117	89	40
1993	17	880	227	147	255	127	89	35
1994	4	798	212	123	250	121	75	17
1995	3	716	238	85	220	115	48	10
1996	3	916	294	117	300	128	58	17
1997	1	798	213	90	321	112	49	12
1998	1	653	191	77	283	52	45	4
1999	—	645	217	57	258	43	48	24
2000	—	841	235	107	346	63	51	39
2001	—	1,059	232	179	440	108	42	59
2002	—	1,059	187	174	484	126	43	46
2003	—	704	159	82	331	45	46	41
2004	—	958	214	155	418	71	50	49
2005	—	1,122	213	247	436	143	46	37
2006	—	1,266	222	159	580	216	44	44
2007	—	1,052	195	162	495	136	42	23
2008	—	1,107	228	165	488	166	42	18
2009	—	1,131	212	141	536	177	48	17
2010	—	1,043	215	148	476	136	50	17
2011	—	1,062	235	139	453	168	50	16
2012	—	1,032	202	144	479	151	40	16
2013	—	991	210	161	439	120	46	14
2014	—	1,017	229	152	416	134	53	32
2015	—	1,051	214	144	465	152	48	28

¹ This category includes those aliens admitted under the Immigration Reform and Control Act of 1986.

² Comprehensive immigration legislation increased total immigration under an overall flexible cap of 675,000 immigrants beginning in fiscal year 1995, preceded by a 700,000 level during fiscal years 1992 through 1994.

Source: Table 6 of Annual Reports of the Office of Immigration Statistics, Department of Homeland Security

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