Retirement Income Analysis
with scenario matrices

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1. Demographics

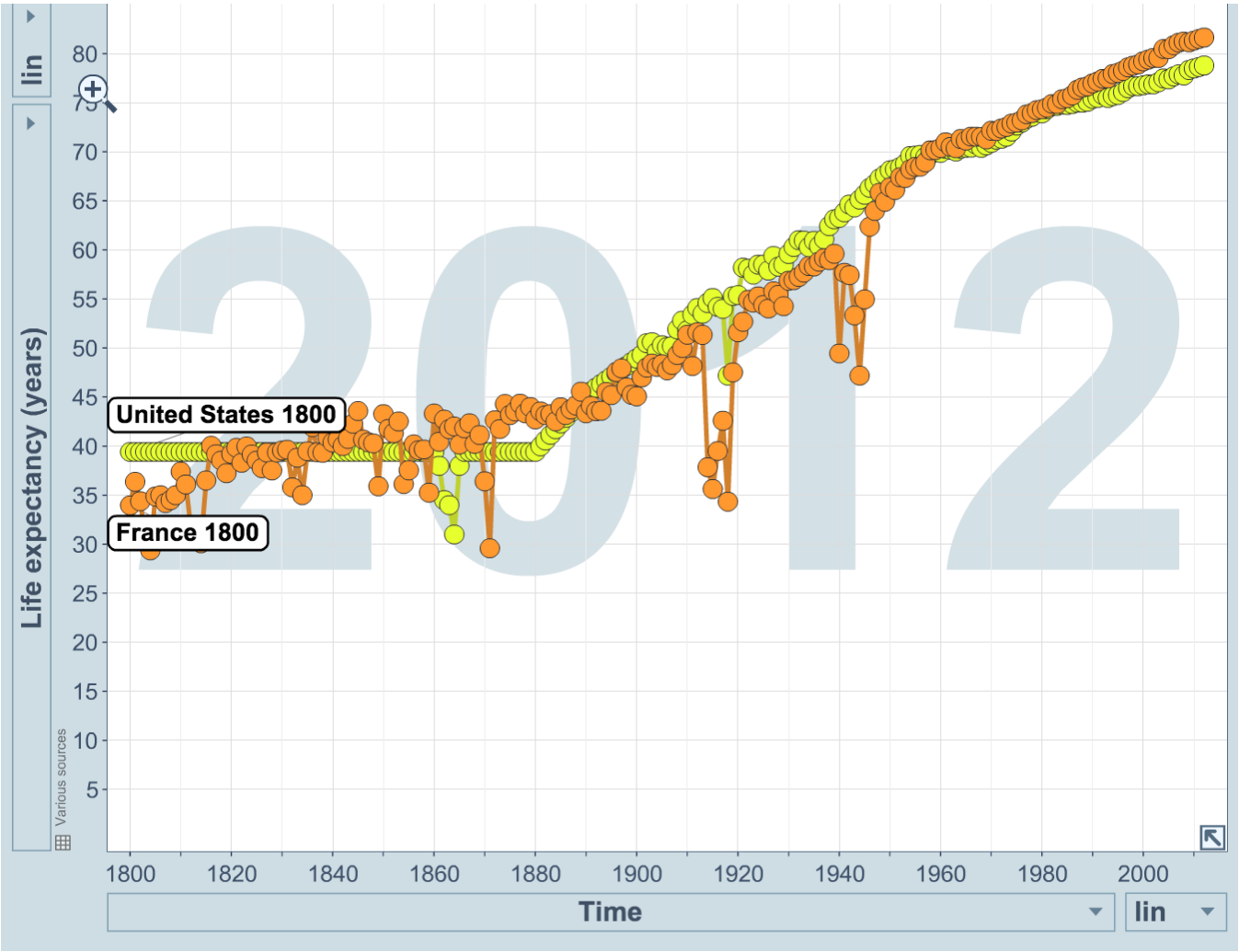
This is a book about strategies for producing *retirement income* – personal income during one's "retirement years". The latter expression is far from ambiguous, but suffice it to say here that such years typically begin well past middle age, when income for one's services ceases or is drastically reduced. In some countries, the median retirement age might be 65, in others 62, in others 67 or older. In any event, our focus is on "older people" who rely for income mostly or entirely on payments from social programs and their own savings.

Before approaching such issues in detail, it is useful to get a sense of the need for retirement income, historically and currently. Accordingly, this chapter deals with *demographics,* the statistical data of a population (as defined by Dictionary.com).

Life Expectancy

A key aspect of any retirement income strategy is *longevity*. How long might a recipient live? The answer is in any particular case likely unknowable. As will be seen, the best one can do in advance is to estimate a probability distribution of years to be lived in retirement. Chapter 3 will deal at length with such estimates. But it is important to appreciate the extent to which longevity has increased world-wide over the last two centuries.

The figure below provides information for France, for which detailed demographic data have been gathered for over 200 years, and the United States, for which such information has been collected carefully only since 1880. The figure shows *Life Expectancy at birth* for each country for each year. As can be seen, in both countries this statistic has increased from 40 years to roughly 80 years over the period, with most of the growth in the 20th and 21st centuries. In these countries, and most others, people are living much longer. Hence the current and future need to provide retirement income for a many people for long periods of time.



Source: Free material from www.gapminder.org, recorded October 23, 2014

The site at which this figure was produced (*gapminder.org*) has a wealth of demographic data for many countries. Exploration of the information will show that while levels of life expectancy have differed across countries, in the vast majority of cases, life expectancy has increased over time. Almost everywhere in the world, societies are aging.

While the basic message of this figure is clear, some of the year-to-year variations in life expectancy may seem mysterious. To better understand them, one needs to know a bit more about the mechanics of the computation of this measure. Consider, for example, the statistic for life expectancy in France in 1918. To compute it, population records were used to measure the proportion of those in each age group that died in 1918. It was assumed that a population of 100,000 people would experience the same mortality rates at each age, then the number of people likely to survive to each age was determined. Finally, the average age at death for the 100,000 people was computed. The resulting figure is that reported as the "life expectancy at birth" for the year 1918.

This explains why the life expectancies at birth declined for both the U.S. and France in 1918. The world was ravaged in 1918 and 1919 by the H1N1 influenza virus epidemic, which killed between 50 and 100 million people worldwide. One can also see the effects of wars on France: the Franco-Prussian War in 1871, World War I from 1914 through 1918 and World War II from 1939 to 1945. The statistics for the U.S. were apparently unchanging estimates before 1880 except for the period from 1861 to 1865, which presumably reflected the effects of the American Civil War. In the twentieth century, the only break in a relatively smooth path upward was that in the 1918 period, likely reflecting the impact of World War I.

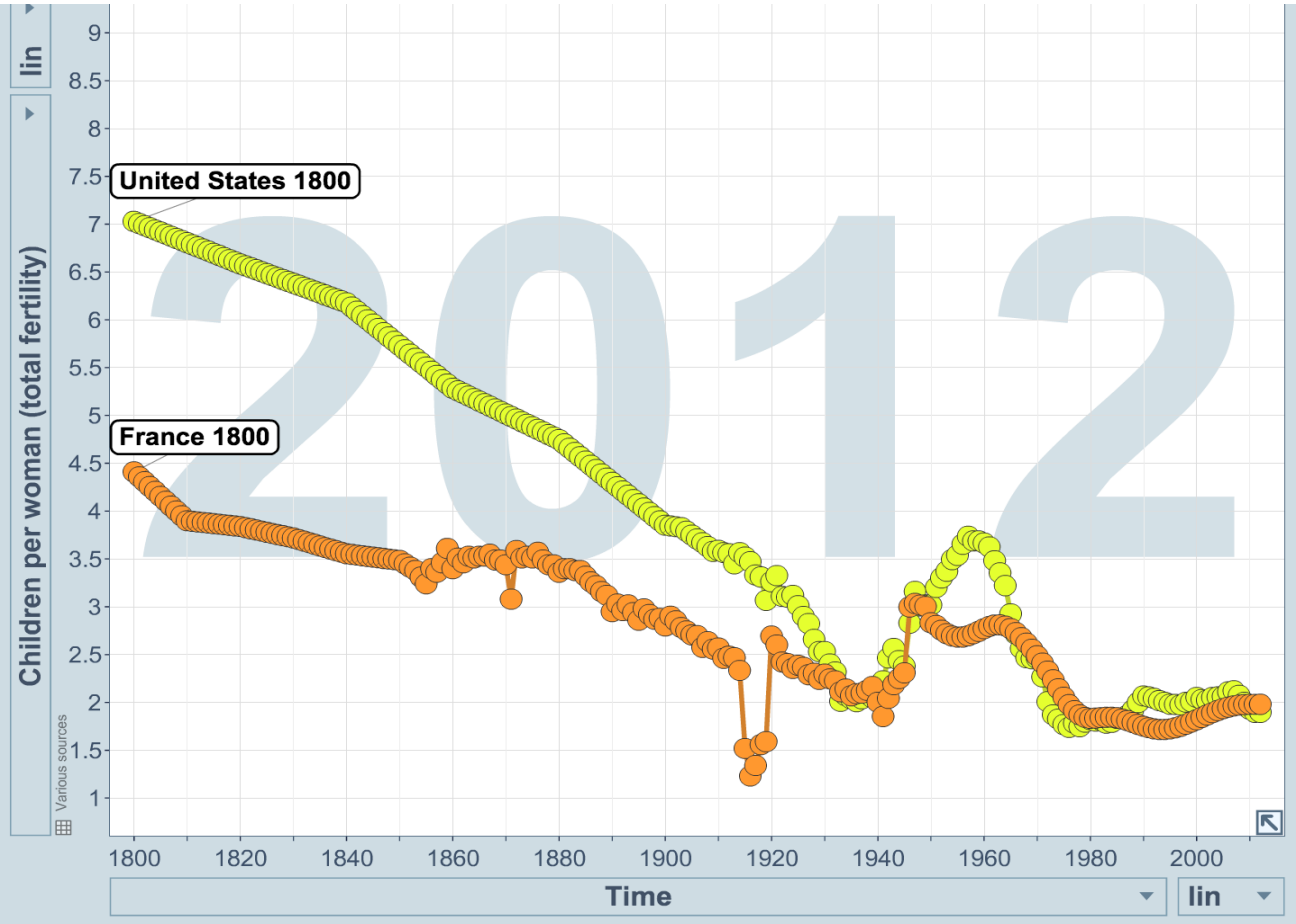
These variations suggest that these estimates of life expectancy do not necessarily represent the best possible estimates that could have been made at the time. If in 1918 you were estimating the likely longevity of a male newborn baby it is unlikely that you would have predicted a world war when he reached the age of military service (in 1936). Yet the computation assumes a mortality rate at age 18 equal to that experienced by those who of age 18 in 1918. It is thus best to interpret the traditional Life Expectancy at Birth for a given year as a summary statistic of mortalities experienced by people of different ages in that year. Chapter 3 will describe other and better methods used to compute probabilities of death in future years.

Fertility Rates

Mortality rates affect the number of older people that may be alive at any given time. But the extent to which they may be supported by younger people depends on the ratio of the former to the latter. And this depends in large part on the *fertility* of the population.

The simplest way to measure fertility is to compute the average number of children born per woman. In the long-run, absent substantial immigration or out-migration, if this ratio is greater than 2.0, the population is likely to grow, if it is less than 2.0, the population is likely to decrease, and if it is close to 2.0, the population should be relatively stable.

The next figure provides estimates of this fertility ratio for the United States and France from 1800 through 2012. Initially, the United States was more fecund, no doubt due to its more agrarian status. But for both countries the ratios were considerably above the replacement rate of 2.0. However, over time, fertility rates fell dramatically in both the U.S. and France, reaching levels close to 2.0 by 2012.



Source: Free material from www.gapminder.org, recorded October 30, 2014

Notable in both countries was the surge in births following the depression and World War II, the latter giving rise to the generation of children we call the Baby Boomers. A plausible story is that the depression of the 1930s led to a Baby Bust and the end of WWII a Baby Boom, after which fertility rates continued their long secular decline. Whatever the reasons, at present both countries are producing children at rates barely sufficient to maintain their populations at current levels

As always, it is important to understand the ways in which the estimates for population fertility are computed. Procedures differ somewhat, but the general approach is start by computing the ratio of children born to mothers of each of a number of groups based on the age of the mother, with the latter ranging rom 15 to 45 or 49. The results are known as age-specific fertility rates. Then it is assumed that an hypothetical woman lives from age 15 to 45 or 49, having children at the corresponding rates as she ages. The result is the estimated children per woman, or total fertility rate. Importantly, the estimate for a given year does not reflect the relative number of women of different child-bearing ages. Thus in any given year the effects of fertility and the number of women of child-bearing ages are not reflected directly in the number of children born in that year.

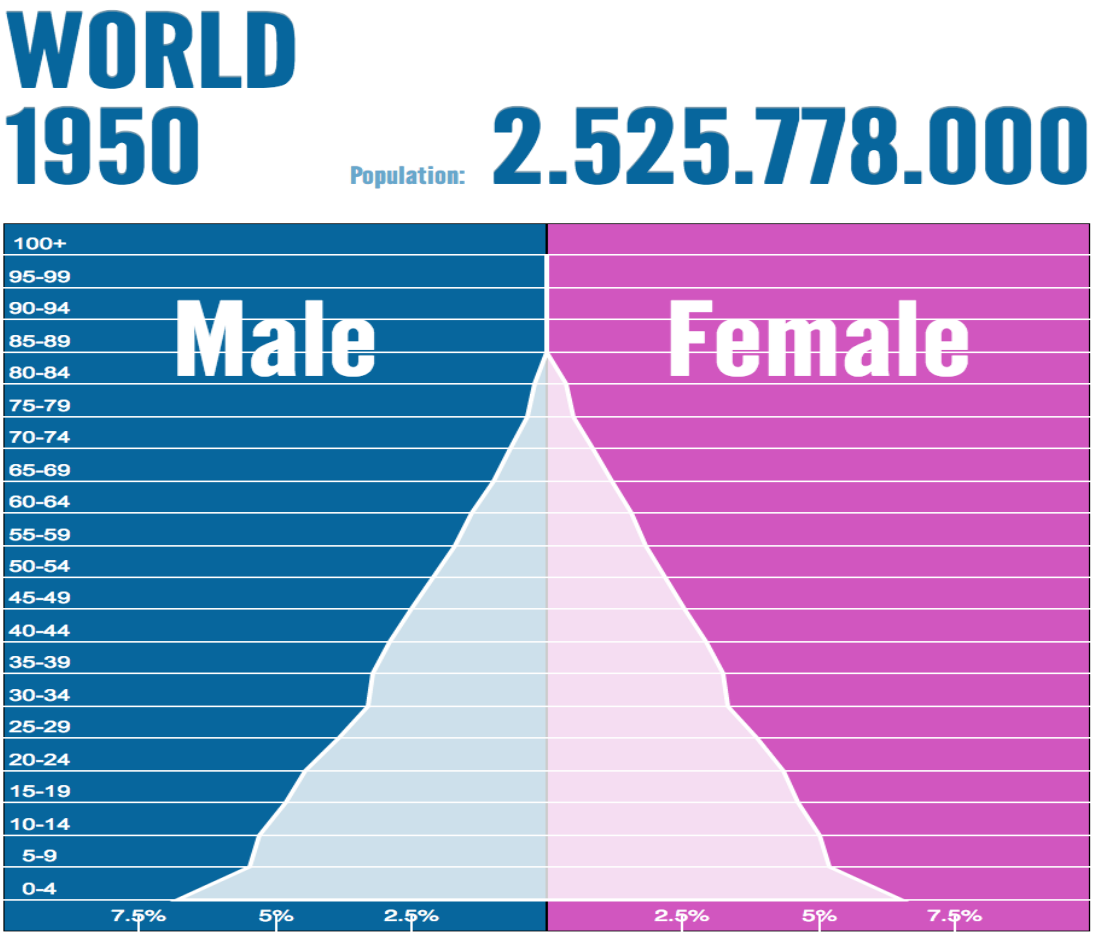
Despite the caveats, people are having fewer children in France and Germany. And this is broadly true for most countries, although some less-developed countries started initially with higher fertility rates and still produce more children per woman than do more-developed countries.

What might explain this change? In part it may reflect a move from agrarian to urban societies. In the classical nostalgic image of the family farm, children can be considered both consumer goods and producer goods. To at least some extent, on a family farm, having a child can be considered an investment in future production. But in many modern societies, children cost their parents money for a number of years and may or may not reciprocate late in their parents' lives. The latter possibility will be discussed in later chapters. At this point it suffices to point to the fact that for whatever reasons, at present many countries are experiencing reproduction rates that are not quite sufficient to maintain their populations at current levels (due to infant mortality).

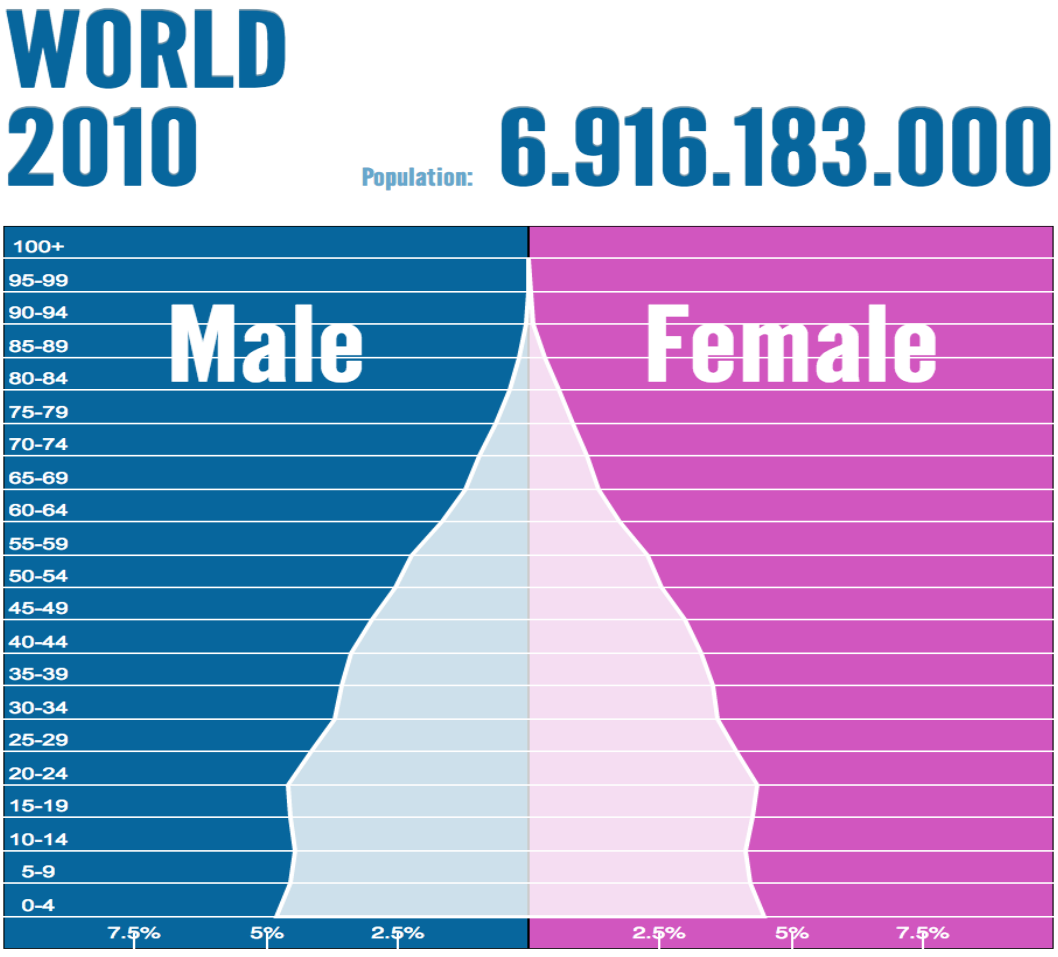
Population Pyramids

While mortality and fertility rates are key determinants of the distribution of populations by age, they are not the only elements. Immigration and outmigration can play important roles. And prior population distributions, along with mortality and fertility will be major influences on the current distribution.

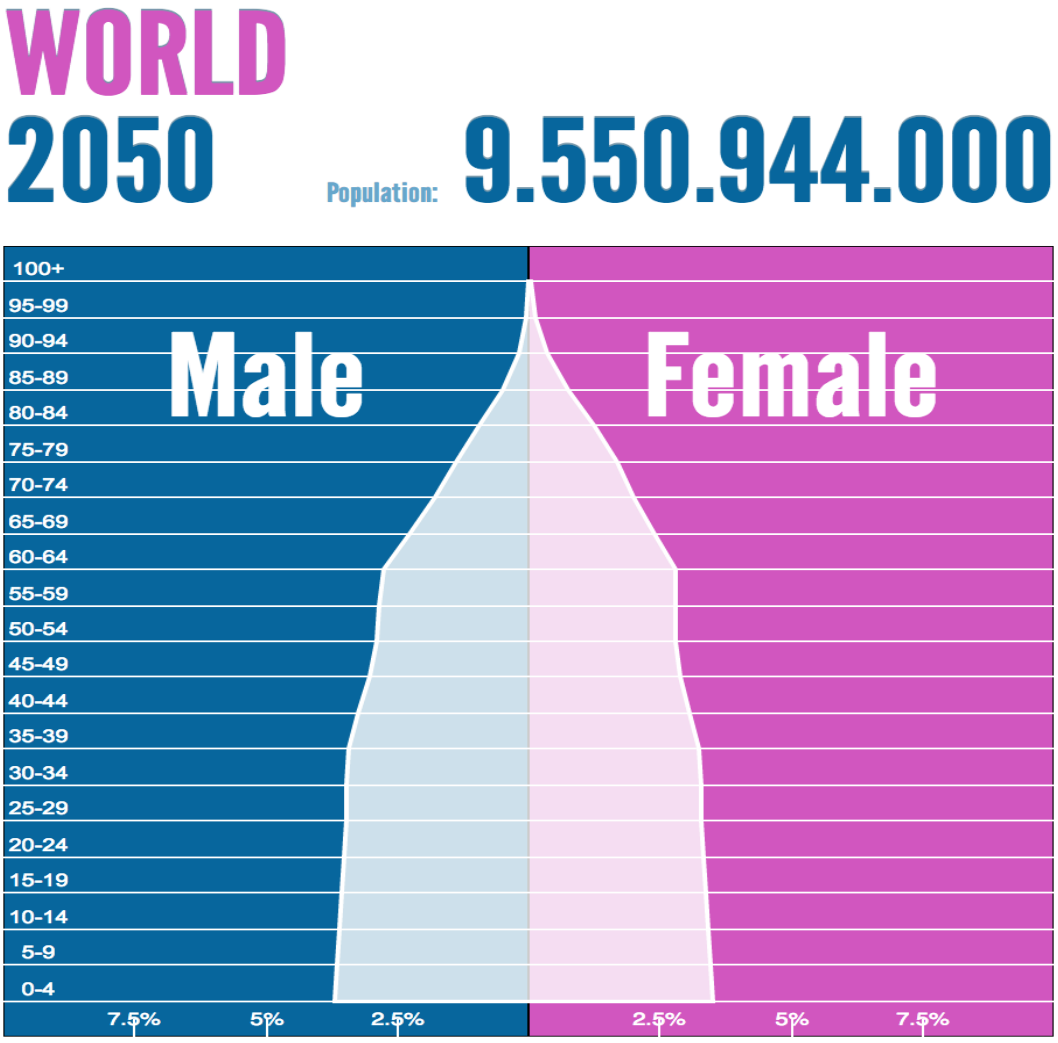
To summarize the distribution of population by age, generations of demographers have utilized diagrams known generically as *population pyramids*. These are constructed of layers, each representing a range of ages (usually, 5 years), with the percent of the population in each range shown, males on the left and females on the right. The figure below is typical. It shows the world population distribution in 1950 using data compiled in 2012 by the United Nations Department of Economic and Social Affairs Population Division (details and data are at *http://esa.un.org/wpp/unpp/panel_population.htm*). As can be seen, the picture is rather like a pyramid – the width decreases as one moves up to older ages. There are some indentations, due primarily to the two World Wars and the Spanish Flu epidemic. But in 1950 there were fewer and fewer people as one went up the ladder to older ages. In particular, there were plenty of younger folk who could, if needed, support those surviving to older ages.



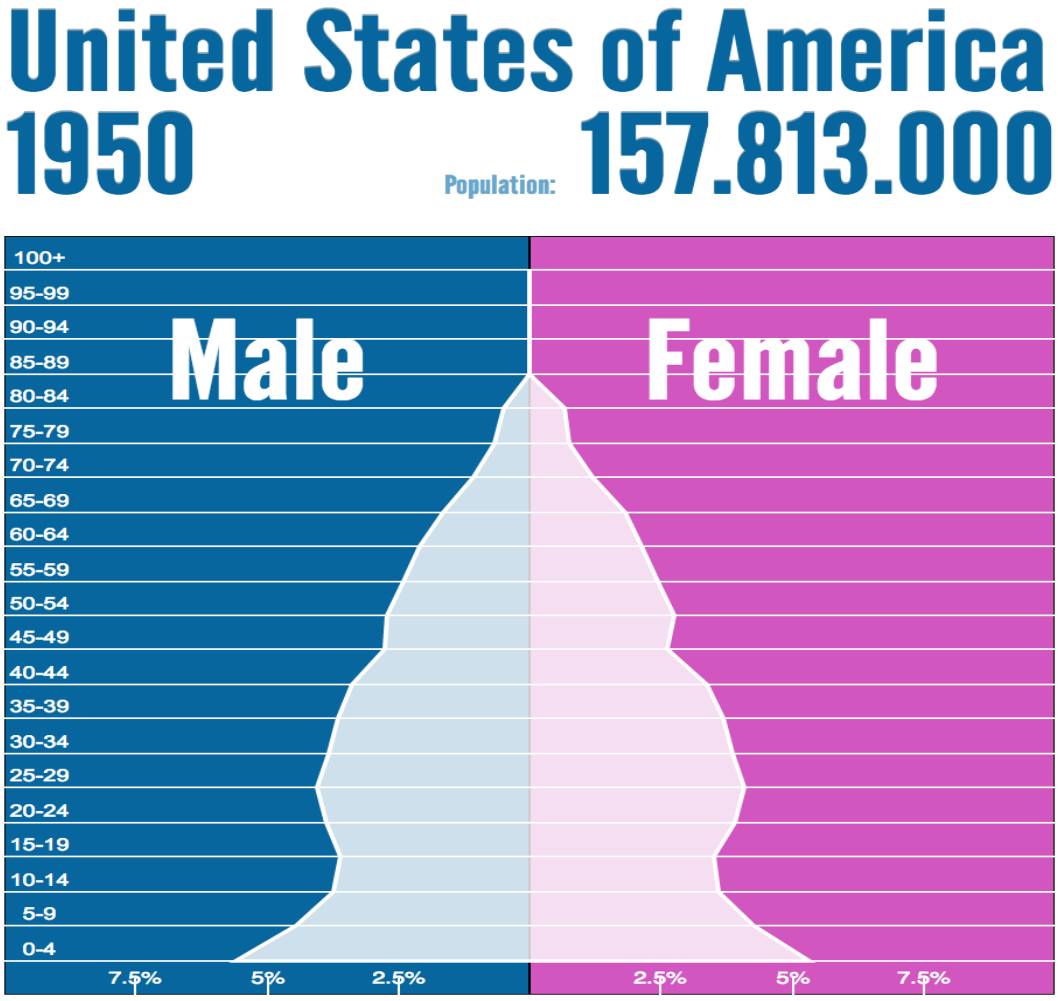
The world was in some ways a simpler place in 1950. For example, the estimated population was approximately 2.5 billion people. As the next figure shows, by 2010 the world population had almost tripled, to 6.9 billion. And the pyramid had become somewhat more like a spire. There were relatively more old folks and they were supported by a smaller base of younger ones. Increasing life expectancy and lower fertility had begun to increase the height of the pyramid and reduce the relative size of its base.



No one knows with any precision how the diagram might appear in the future. But the U.N. agency has made a number of projections based on alternative assumptions about future rates of fertility and mortality. The figure below is based on their "medium variant" (neither the highest nor the lowest assumptions). With some poetic license one could characterize it as a pyramid (or triangle) on top of a rectangle – even more old people, supported by fewer young people.



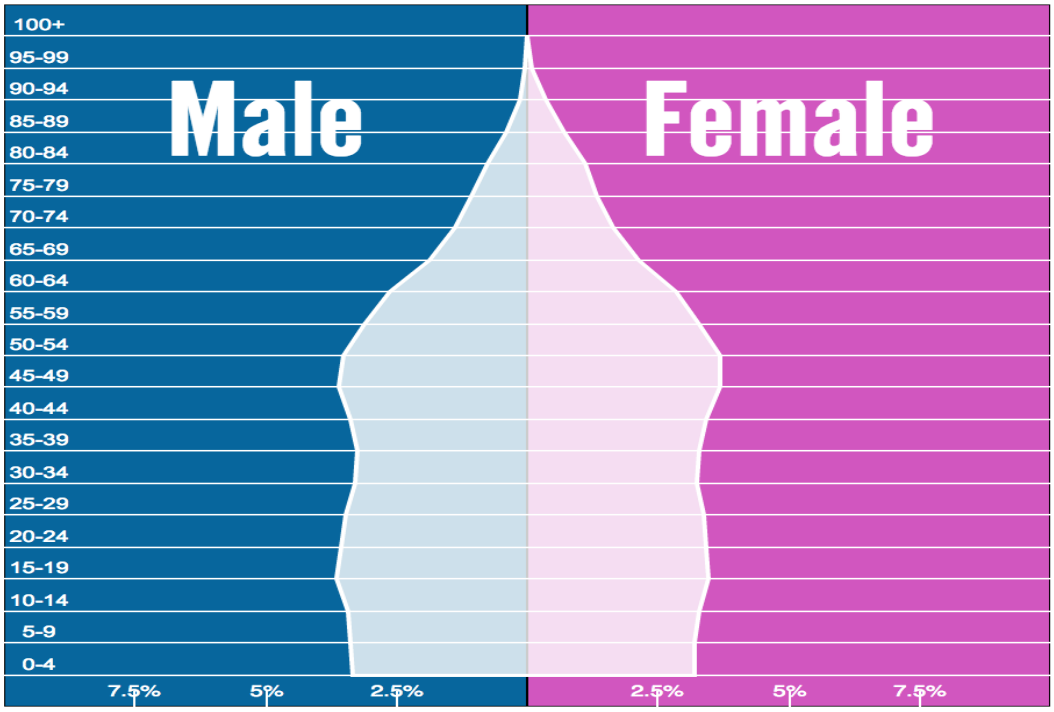
The three figures below show the population distributions for the United States for the same years – two historic, and one projected. In the broadest sense, the same changes are apparent. The classic population pyramid appears to be increasingly a relic of the past.



United States of America

2010

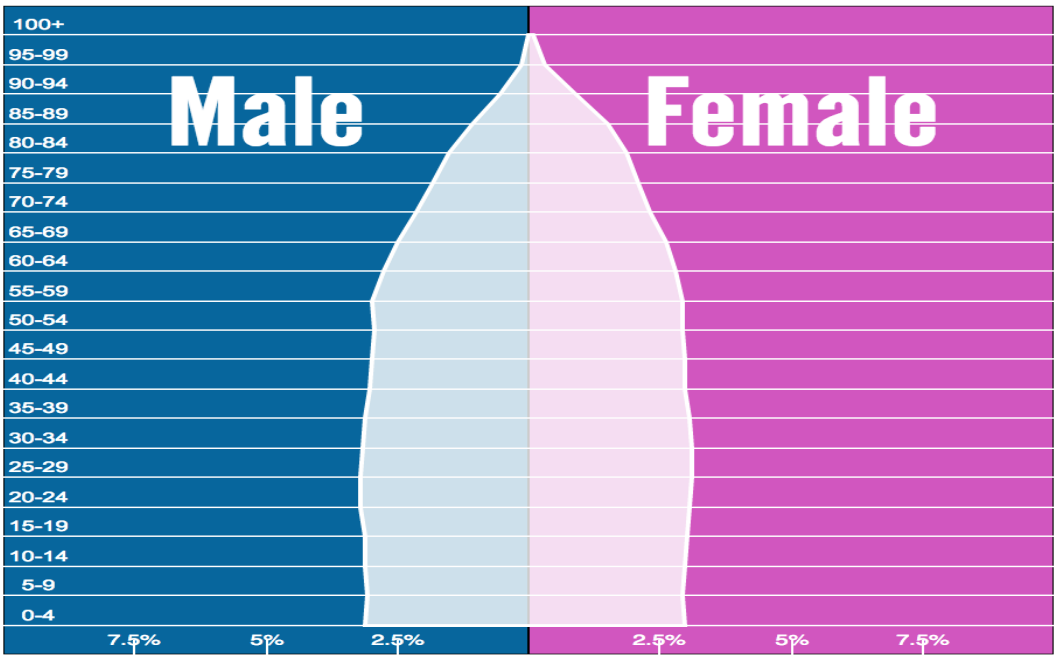
Population: 312.247.000



United States of America

2050

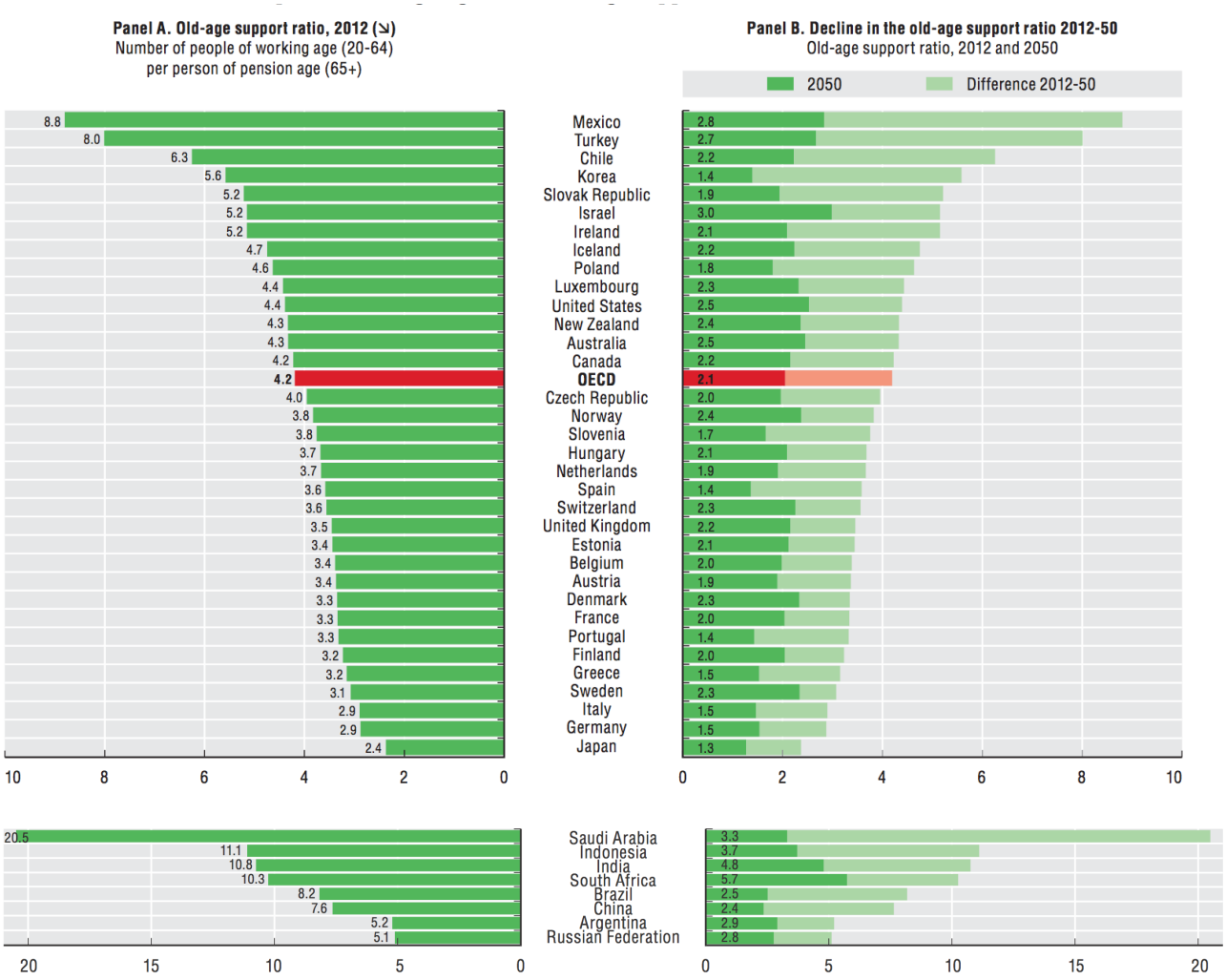
Population: 400.853.000



Old Age Support Ratios

This book is concerned with the provision of income to people in their "retirement years". Of course the age at which such income should begin will depend on the circumstances of each individual or family. Many people move from earning money to spending their savings gradually, working part-time after leaving their full-time jobs. And the transitions from employment to retirement vary widely within and across countries. But it is useful to get at least a broad sense of the effects of the demographic changes taking place.

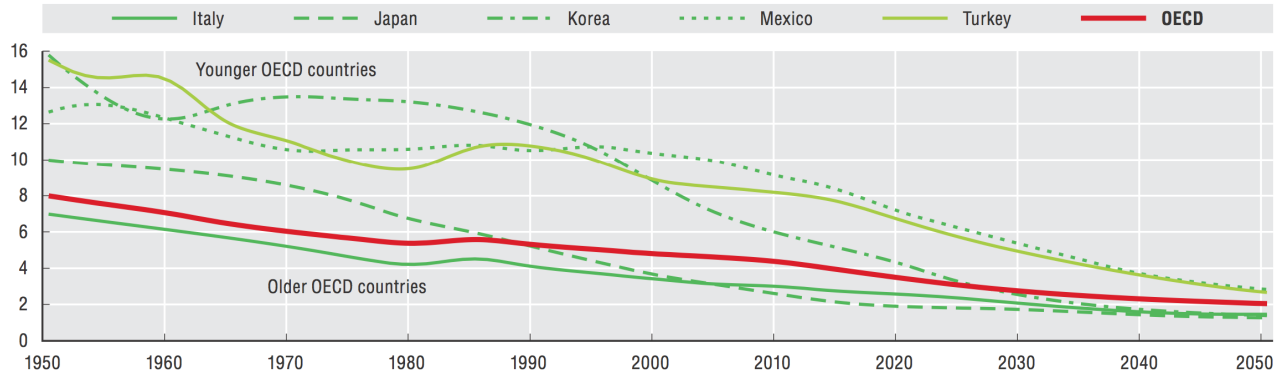
For such analyses, demographers have traditionally focused on a measure termed the "*Old-age support ratio*", which measures the number of people "of working age" per person of "pension age". The former are typically assumed to be those between the ages of 20 and 64 (inclusive) and the latter, those 65 and older. The following diagrams (with different scales), developed by the Organization for Economic Cooperation and Development ("*Society at a Glance, 2014*") , show such ratios for a number of countries in 2012 (the solid bars on the left and the total length of the bars on the right) and those projected for 2050 (the solid bars on the right).



The differences between 2012 and 2050 are striking. For the OECD countries as a whole, there are now 4.2 people of working age for every person of pension age. In 2050 there are projected to be only 2.1 people of working age for every person of pension age.

The figure below shows that these changes are continuations of trends that have been occurring for decades. As recently as 1950 the old age support ratio was 8. It is now close to 4. And by 2050 it could well be closer to 2. The rate of change has been profound and is likely to continue to be so.

Number of people of working age (20-64) per person of pension age (65+) in selected countries, 1950-2050



If these trends continue, a number of things will have to change. Some people will have to work longer, spending more years in the "supporting" category and fewer in the "supported" (or "retired") category. Others will have to save more in each of their working years and/or spend less in each of the years of retirement. And it will be more important than ever for both individuals and societies to adopt efficient procedures for saving funds for retirement and providing income from those funds during retirement.

This book focuses on the latter part of this picture. How can an individual or family beginning retirement use its resources to provide the most desirable range of possible incomes during its retirement years? This is only part of the problem, but it is an important part, and many of the approaches covered here may be applied to the more general analysis of possible financial plans for entire lifetimes.