Age and sex composition

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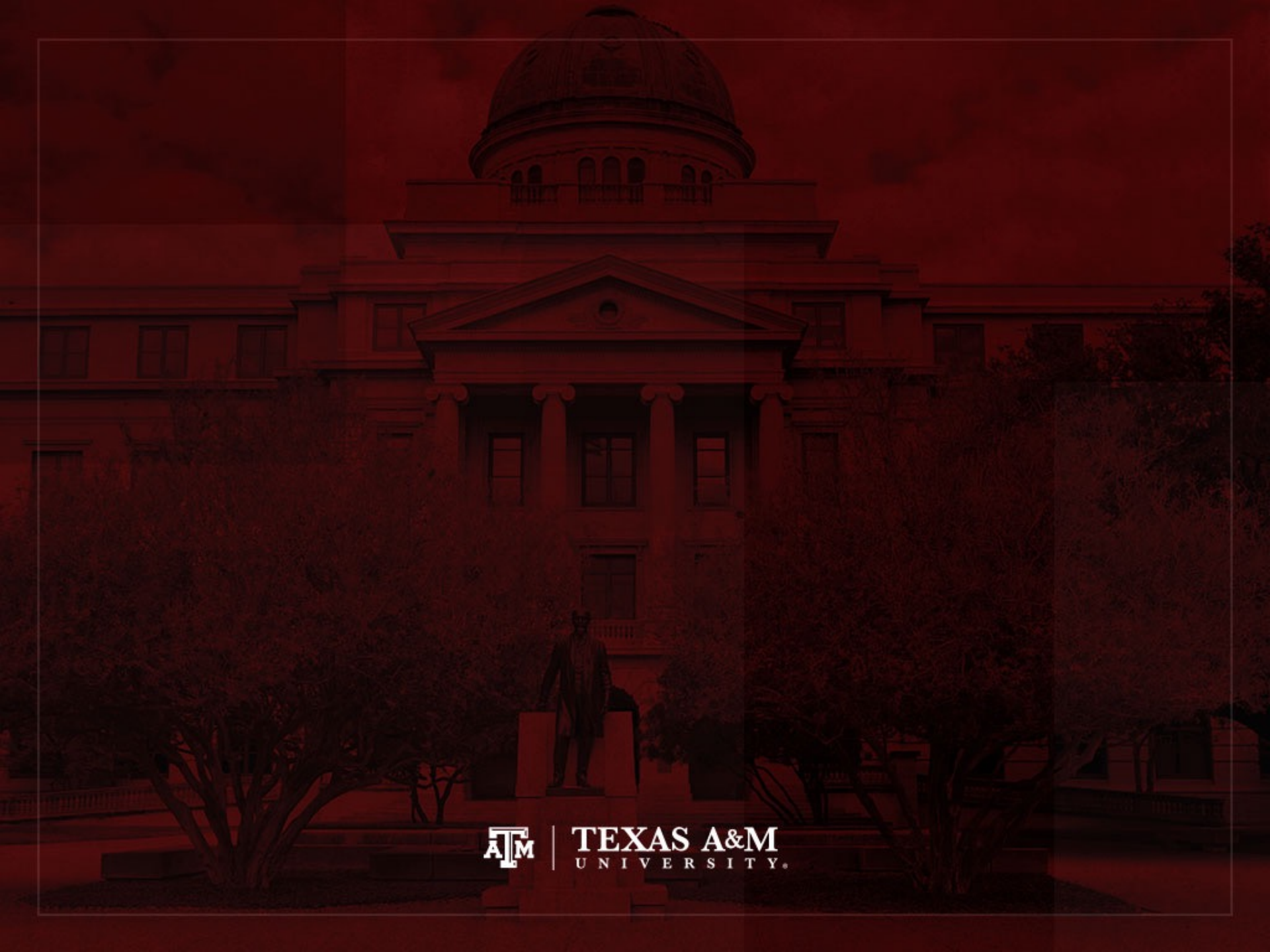
Outline

- Introduction
- Concepts of age and sex
- Theoretical issues
- Population pyramid
- Age dependency
- Age heaping
- Sex structure
- Sex ratio at birth
- Population aging

Introduction

- Age and sex are the most important and relevant characteristics of populations for demographers
  - They tell us about population structure
  - They are known as the demographic characteristics

- Age and sex are tied in with the three demographic processes
  - Fertility, mortality, migration
  - These components produce the population's age and sex structure, which in turn influences the demographic processes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Concepts of age and sex

- Age is an ascribed and changeable characteristic
  - In population censuses, it is usually defined in terms of the age of a person at his/her last birthday
  - UN definition: estimated or calculated interval of time between the date of birth and the date of the census, expressed in complete solar years

- Sex is an ascribed characteristic and, for most people, unchangeable
  - For most people, sex is fixed at birth, but there are some who do change their sex

Sex versus gender

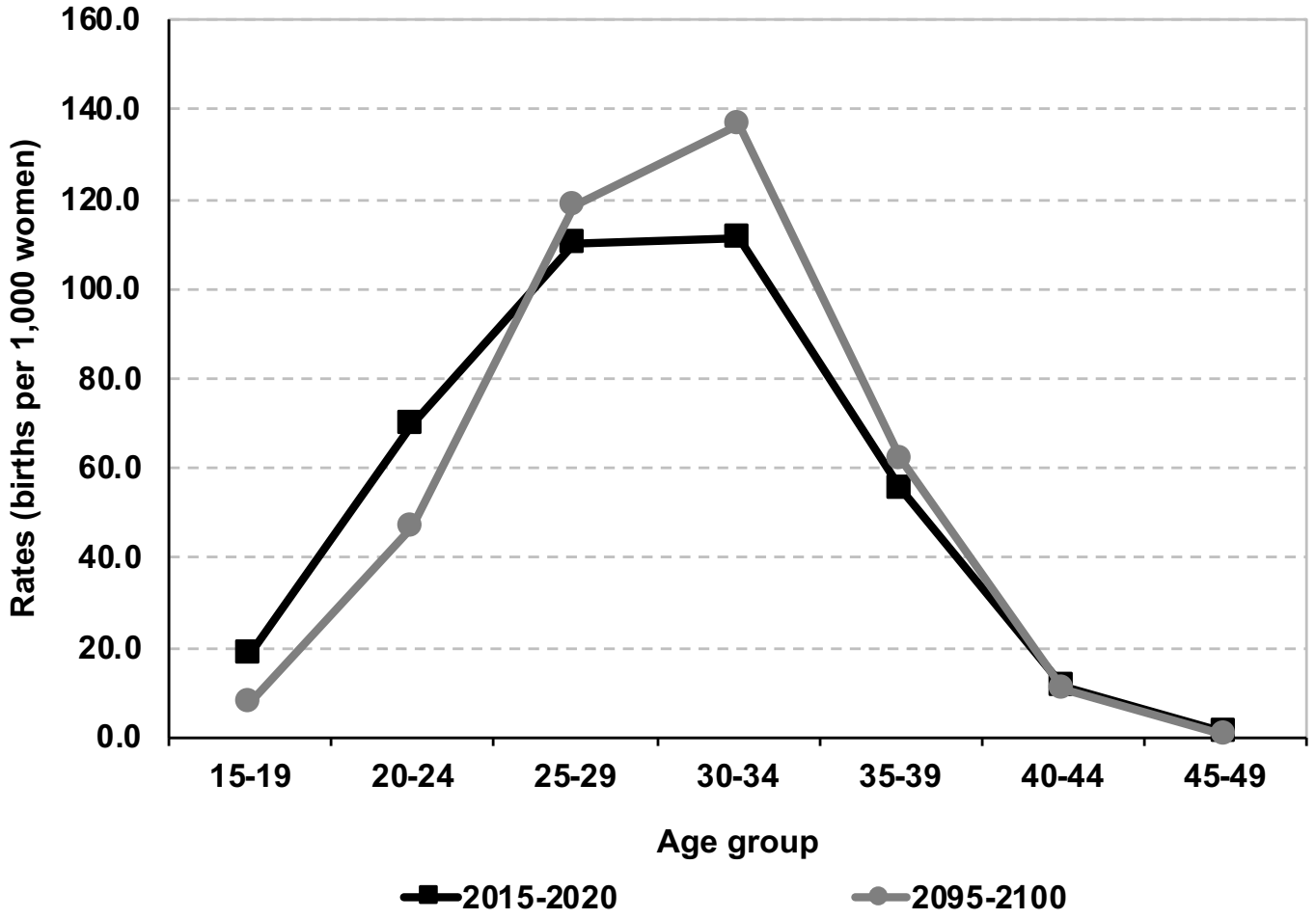
- Sex
  - For the most part though not always, is an ascribed variable whose designation is based on biology
- Gender
  - It is more often used when discussing nonbiological differences between males and females
  - For example, differences between males and females in migration, marriage, divorce, and labor force participation
- Demographers
  - Tend to use the term sex when discussing both biological and nonbiological differences

Fertility varies by sex and age

- Fertility (actual production of children)
  - More males are born than females
  - Normal sex ratio at birth (SRB): around 105 boys per 100 girls
- Fecundity (ability to produce children)
  - Females: between ages of around 15 and 49
  - Males: between ages of around 15 and 79

Source: Poston, Bouvier, 2017.

Age-specific fertility rates, United States



Source: United Nations, World Population Prospects 2017
https://esa.un.org/unpd/wpp/Download/Standard/Population/ (medium variant).

Mortality varies by sex

- Females have lower death rates than males at every age of life
  - This differential has been observed through the centuries and may be attributed to both behavioral and genetic causes
  - Males are more prone than females to engage in health or life risk-taking behaviors, such as cigarette smoking
  - Estrogen (female's primary hormone) protects the heart and blood vessels
  - Testosterone, in contrast, tends to promote higher blood pressure, suppress the effectiveness of the immune system, and increase thrombosis

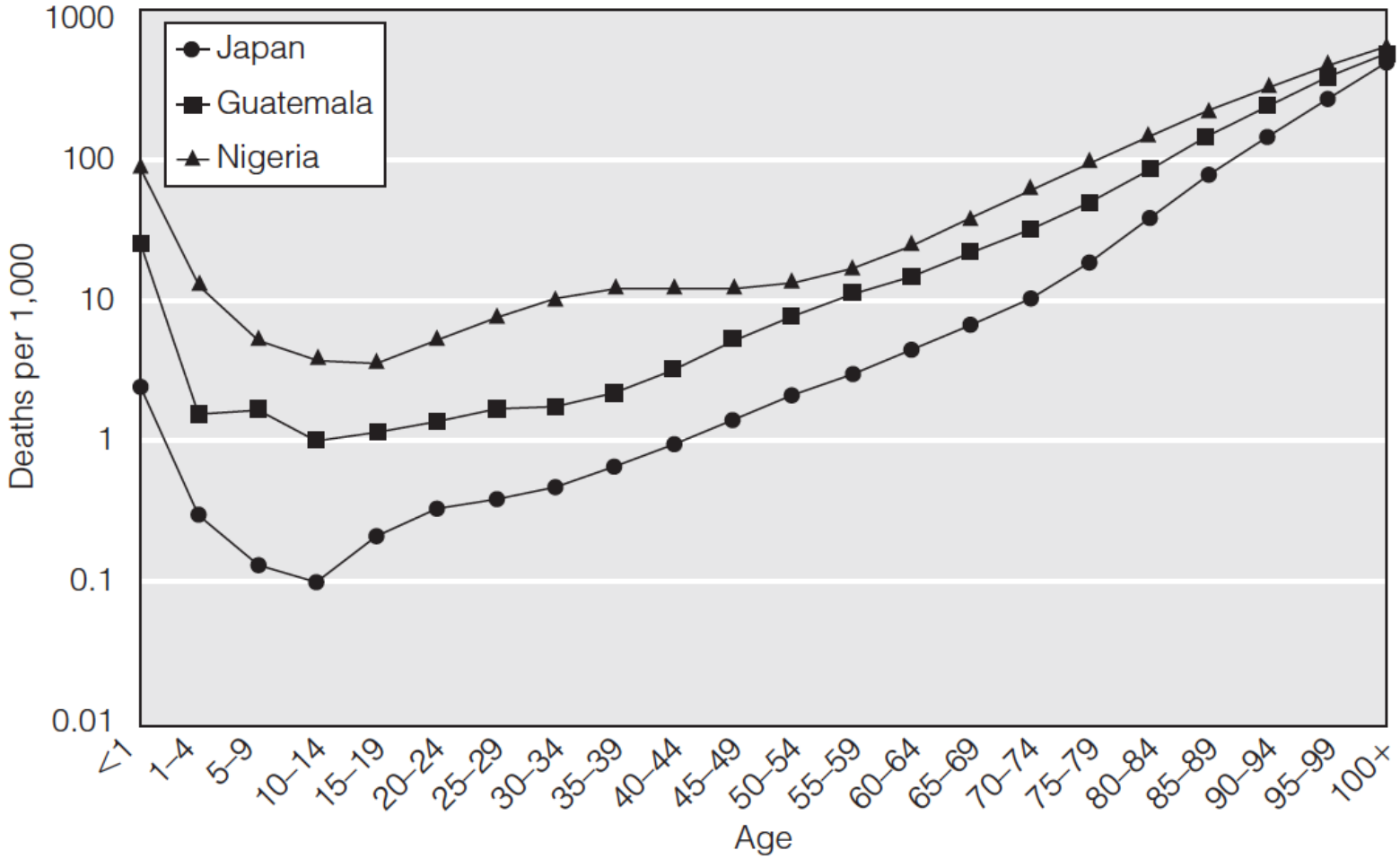
Source: Poston, Bouvier, 2017.

Mortality varies by age

- Death rates are high in the first year of life and then drop to very low levels
- In modern populations, death rates do not reach the level of the first year of life for another 50–60 years
- Cause-specific mortality is often age related

Source: Poston, Bouvier, 2017.

Age-specific mortality rates, 2011

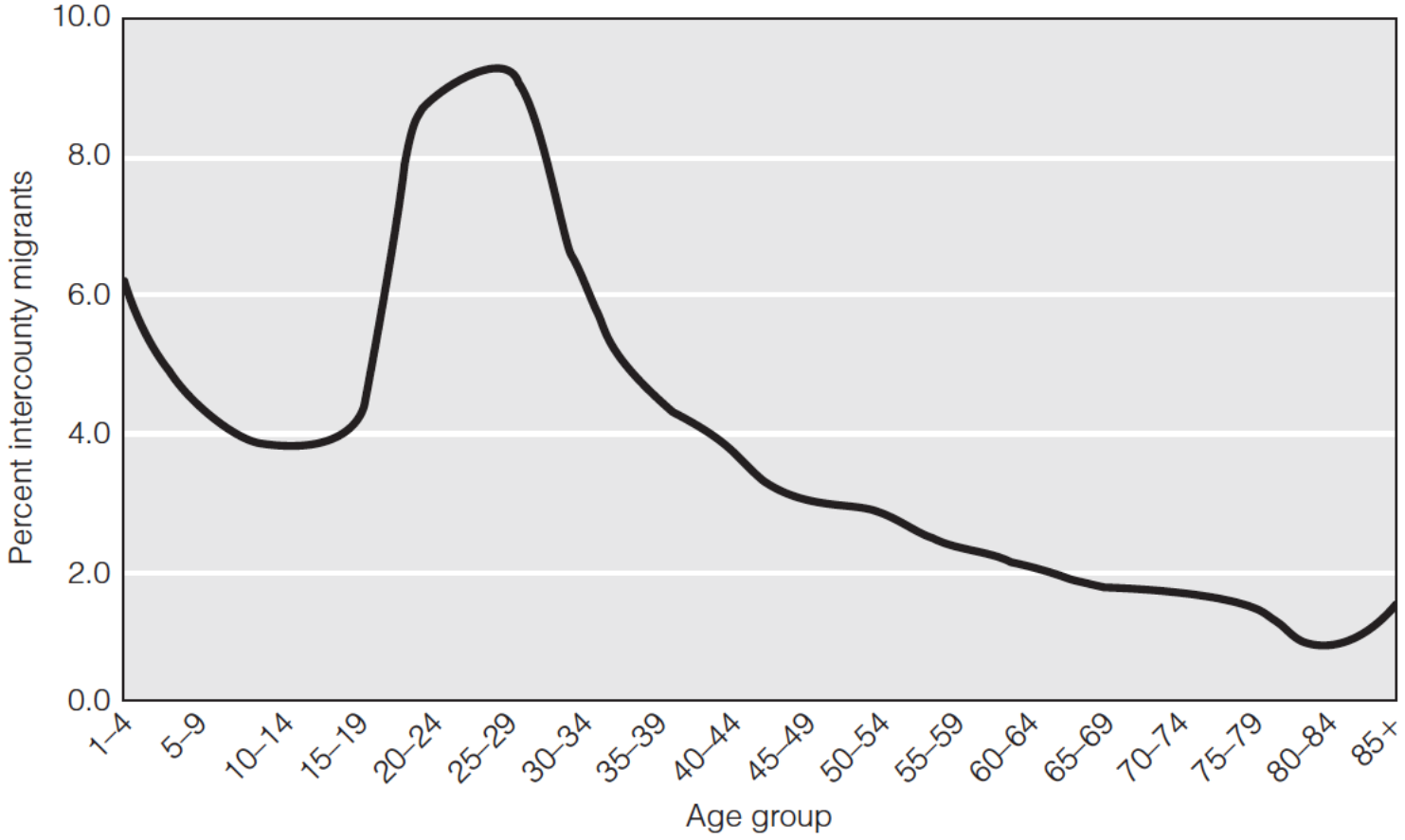


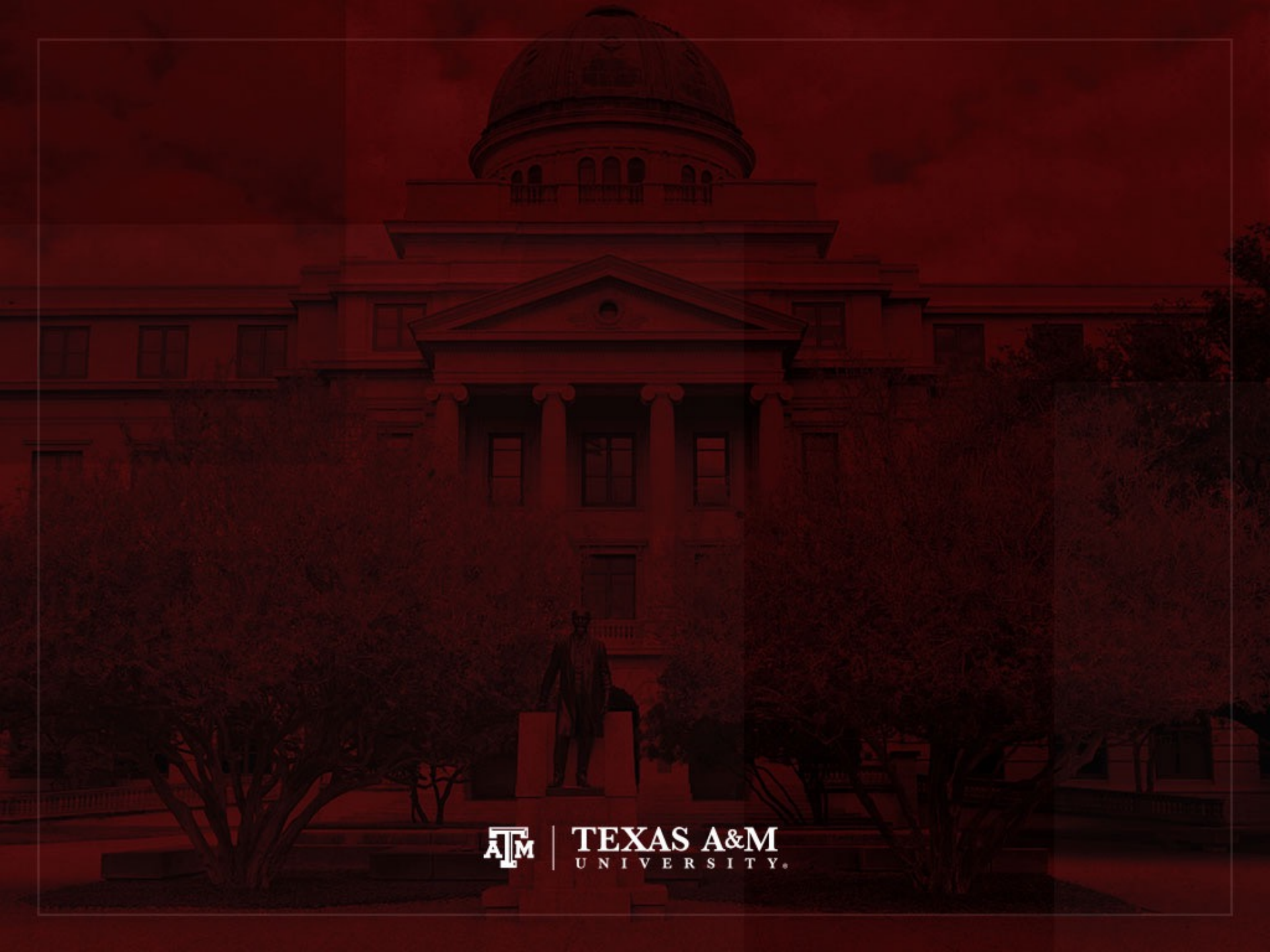
Migration varies by sex and age

- Especially in developing countries, sex is related to distance of migration
  - Long-distance migration tended to favor males
  - Short-distance migration tended to favor females
  - With increases in gender equity, migration of females and males tend to be similar
- Migration is age-selective
  - The largest numbers of migrants found among young adults

Source: Poston, Bouvier, 2017.

Age-specific migration rates, United States, 2011–2012

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Theoretical issues

- Age and sex structure helps to understand demographic history of a population
  - Persons of the same age constitute a group or cohort who were born during the same period
  - Therefore, they have been exposed to similar historical facts and conditions
  - These experiences also differ according to sex
- Income, home ownership, occupation, or group membership are likely to vary by age and sex

Age, sex, and organization

- Age and sex structure of human populations sets important limits with respect to sustenance organization
  - The demographic structure of age and sex contains the possibilities and sets the limits of organized group life (Amos Hawley)

- The degree to which a population's age and sex structure limits the kinds of sustenance activities is an important analytical issue
  - It is not well explored or understood

Examples of theories

- Ansley J. Coale
  - Development of marriage patterns by age
- Louis Henry
  - Description of fertility patterns by age in the absence of voluntary fertility control
- Andrei Rogers
  - Mathematical model for migration patterns by age
- Stable population theory
  - The most powerful and elegant formal mathematical theory in demography
  - It incorporates a population's age and sex structure, particularly age

Stable population theory

- It considers a closed population
  - A population in which migration does not occur
- If a population experiences constant age-specific fertility and mortality rates for a long time
  - It develops a constant age distribution and grows at a constant rate, irrespective of its initial age distribution
  - Demographers sometimes indicate that stable populations forget their past
- Age distribution of a stable population depends on
  - The underlying age-specific mortality rates
  - The rate of growth

Stationary population

- Stationary population is a stable population in which the birth rate equals the death rate
- This results in no change in the size of the population
- It is also considered in the absence of migration

Births * Life expectancy at birth

Elon Musk @elonmusk · Jan 18

UN projections are utter nonsense. Just multiply last year's births by life expectancy. Given downward trend in birth rate, that is best case unless reversed.

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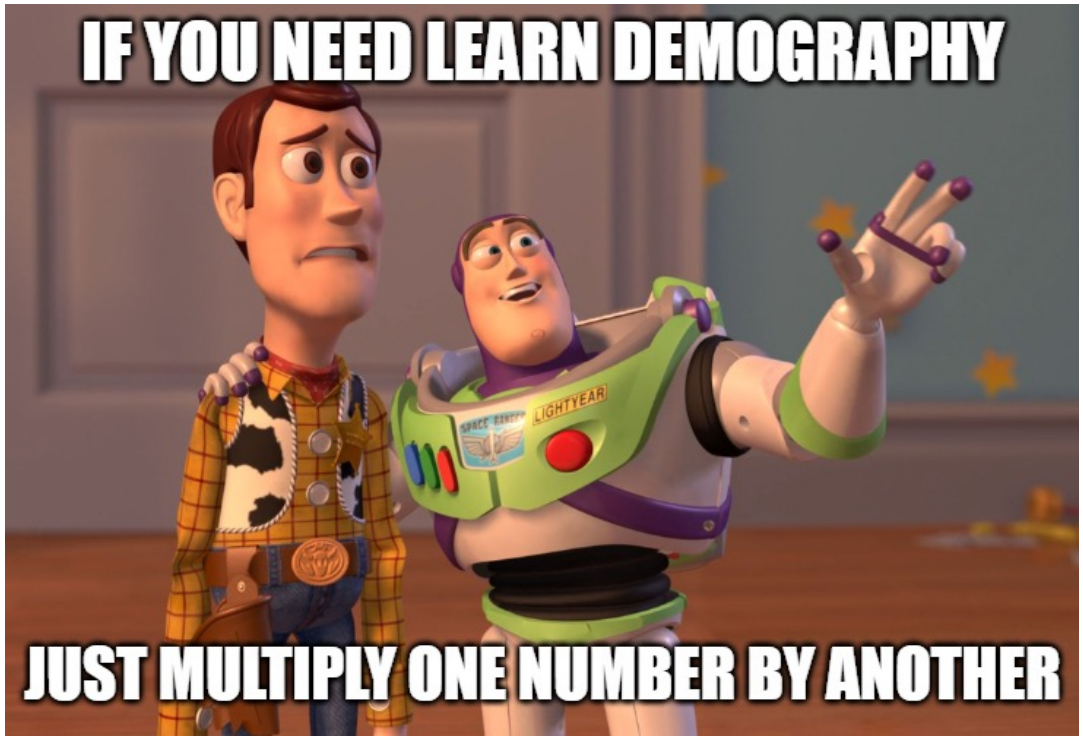

Source: Ilya Kashnitsky, Assistant Professor at the University of Southern Denmark (@ikashnitsky), 2022.

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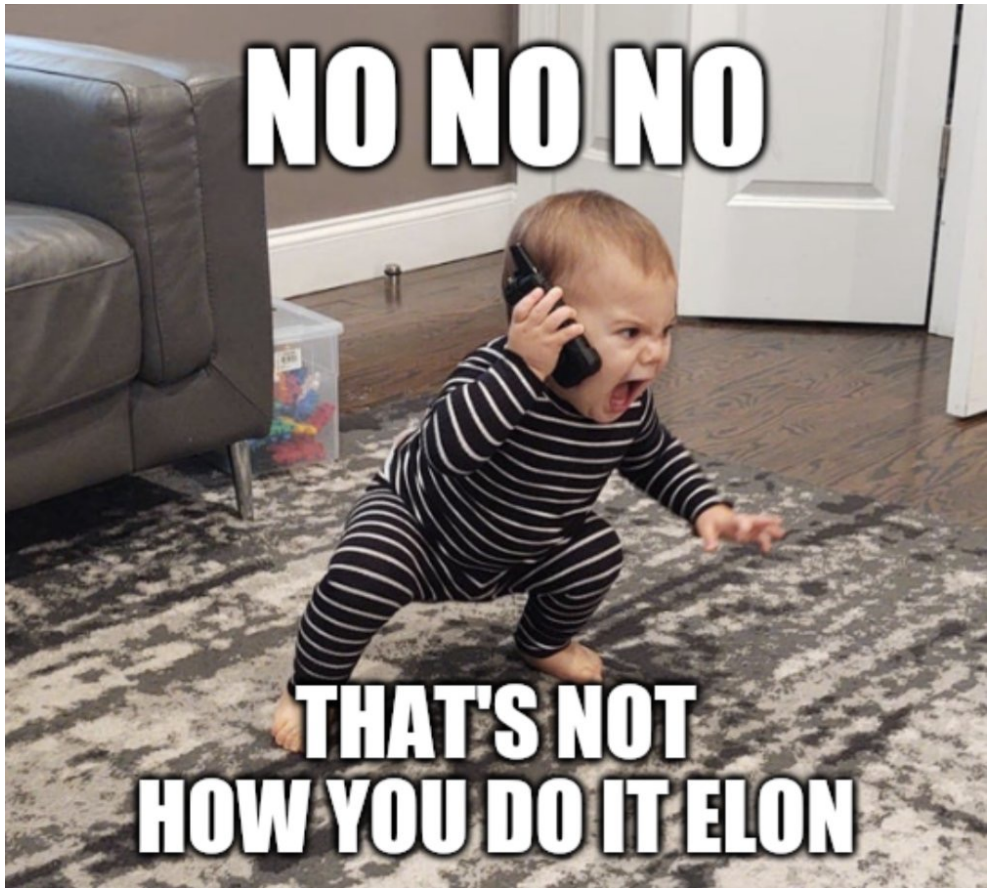

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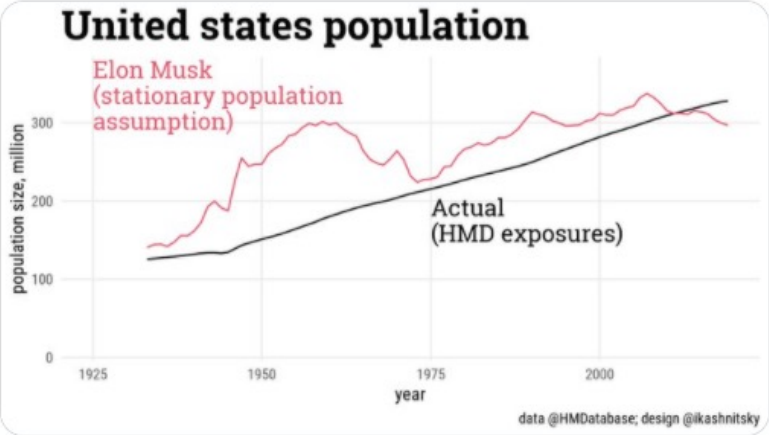
Ilya Kashnitsky @ikashnitsky · Jan 19

Okay. Maybe this is a bit overkill but let's illustrate how this projection method of @elonmusk (in fact, a stationary population assumption) worked with past data using @HMDatabase

Here is just the US 🇺🇸



Ilya Kashnitsky
@ikashnitsky

If there is just one take-home message from this thread let it be

✅ Life expectancy is a snapshot of the *current* mortality

❌ It's not a projection/forecast of the actual experience of the newborn cohorts

11/

9:14 AM · Mar 5, 2021 · Typefully

Jonas Schöley
@jschoeley

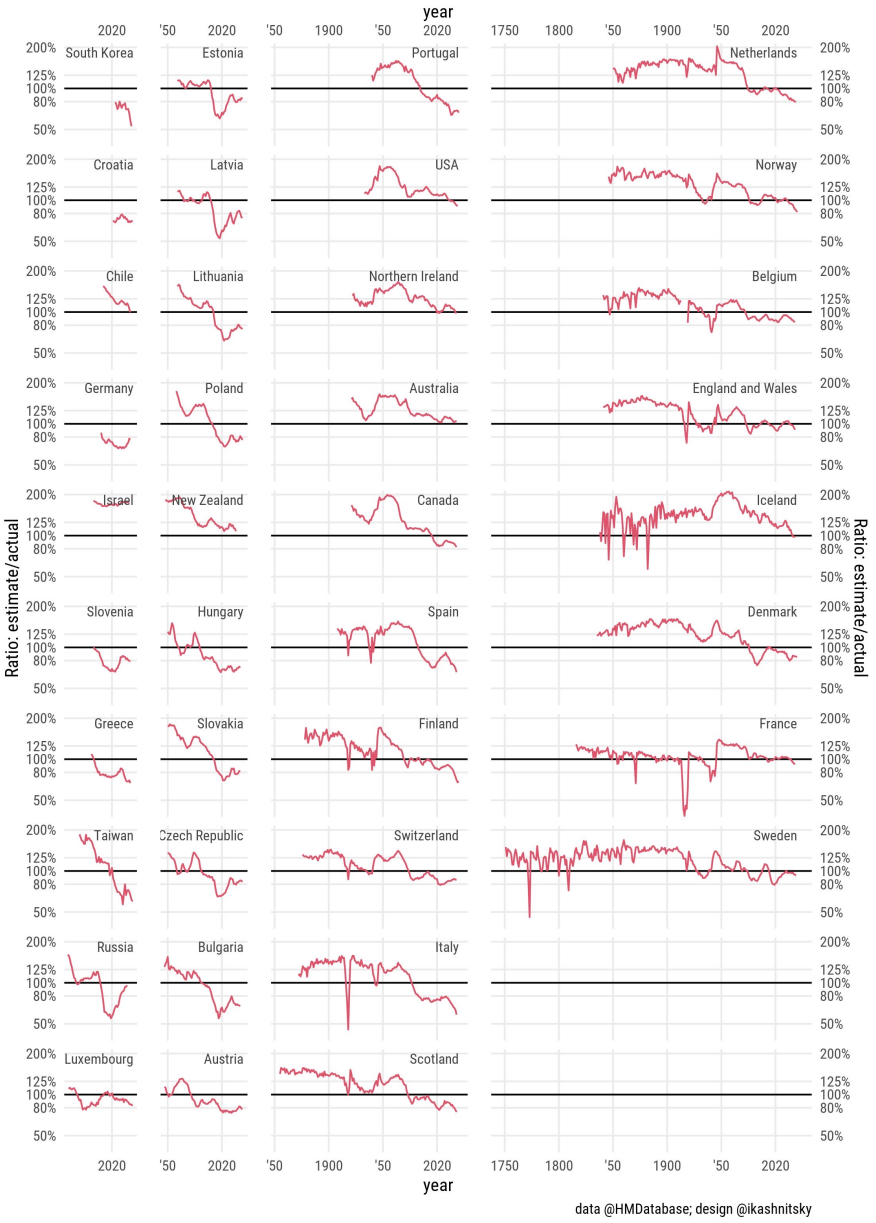
Replying to @ikashnitsky @elonmusk and @HMDatabase

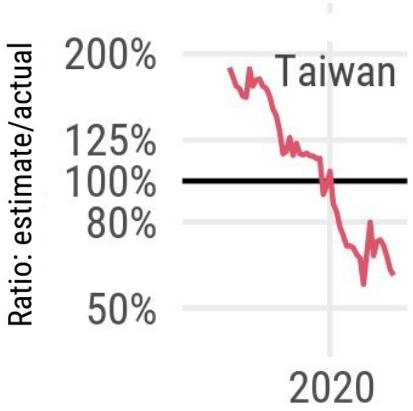
It's true IF we look at world population (0 migration) AND it's stationary (birth rates = death rates since generations) AND mortality remains constant whereas fertility is allowed to decline. Then we reached peak population which can be estimated by B*e0. Bullshit assumptions.

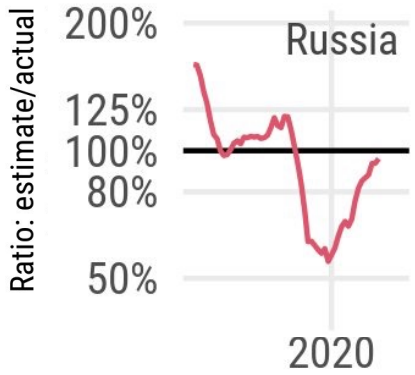
5:41 AM · Jan 19, 2022 · Twitter Web App

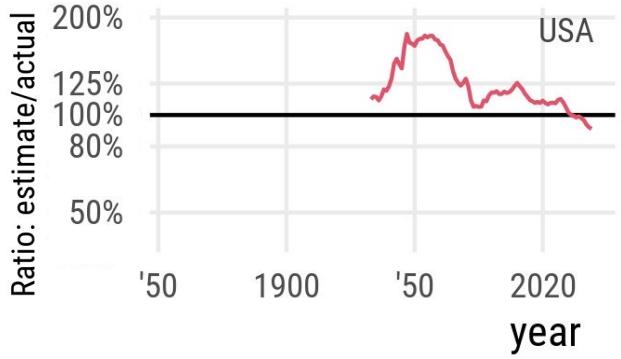
Source: Ilya Kashnitsky, Assistant Professor at the University of Southern Denmark (@ikashnitsky), 2022.

Population size under the stationary assumption relative to the actual dynamics









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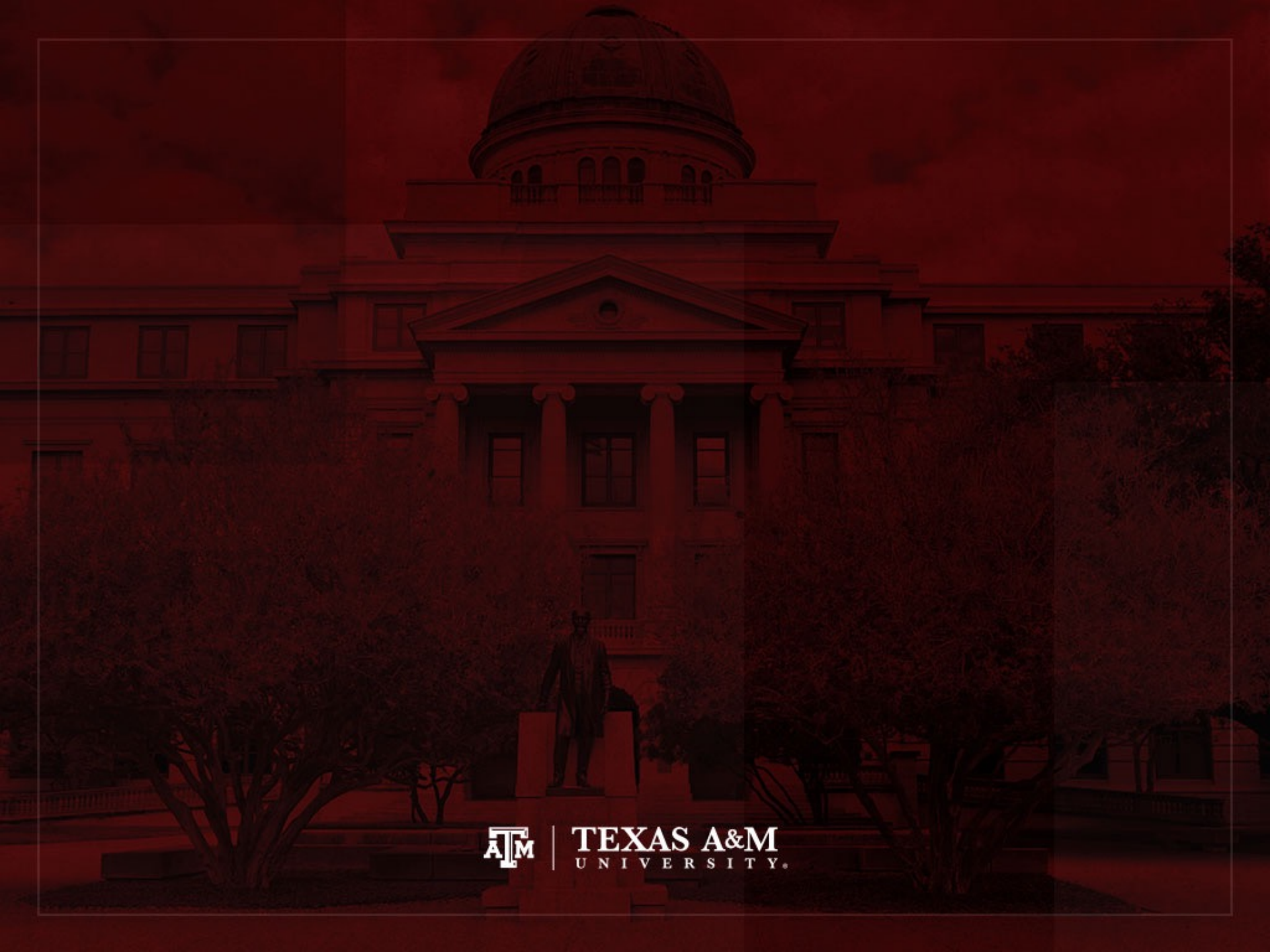
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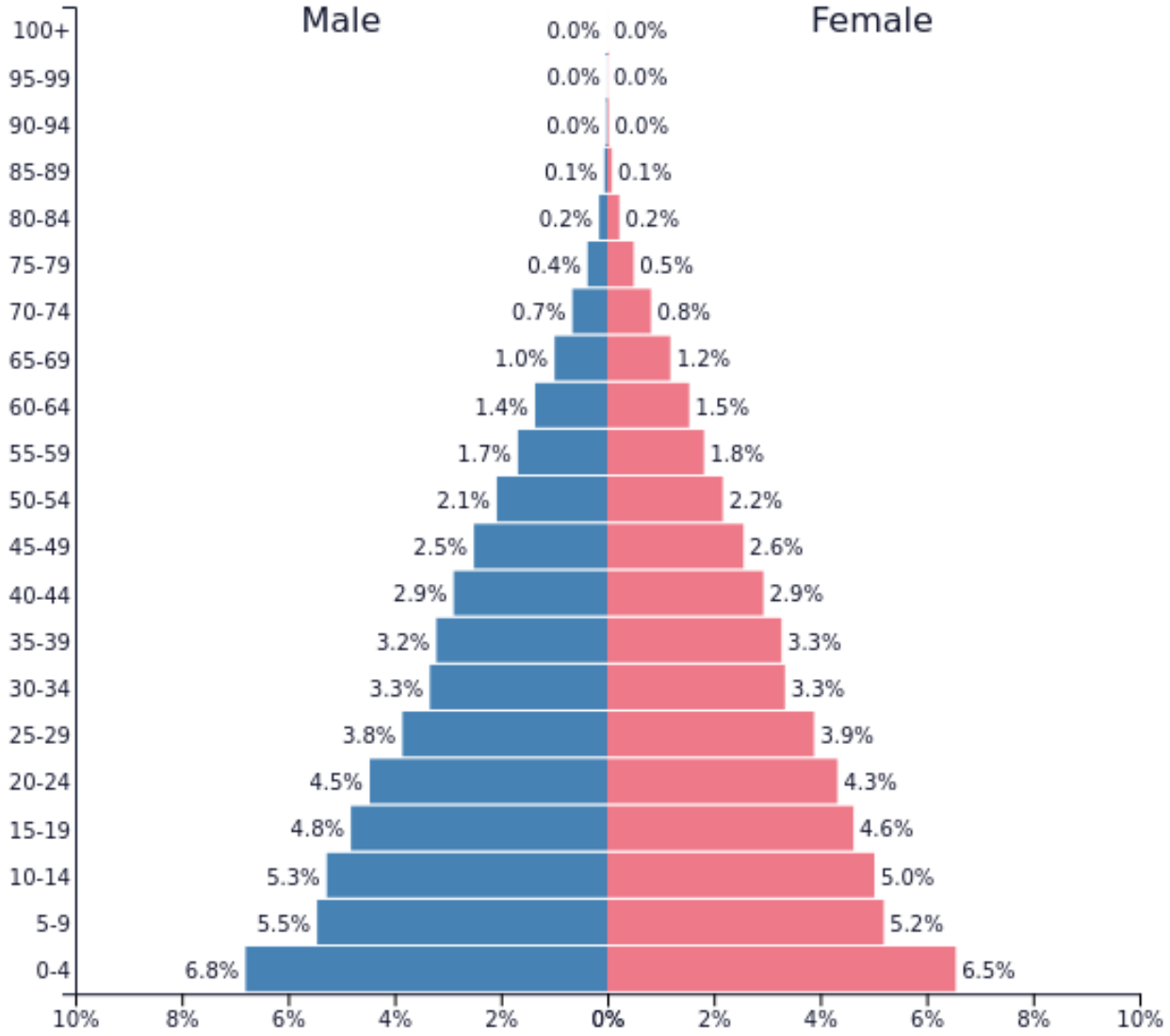
Population pyramid

- A population pyramid
  - It is a graphic representation of the age/sex structure of the population
  - It is also called “age/sex pyramid”
  - Due to changes in the shape of population distributions, it has been simply called “age/sex structure”

- A population pyramid is nothing more than two ordinary histograms (bar graphs)
  - They represent male and female populations
  - Usually, demographers use 1- or 5-year age categories

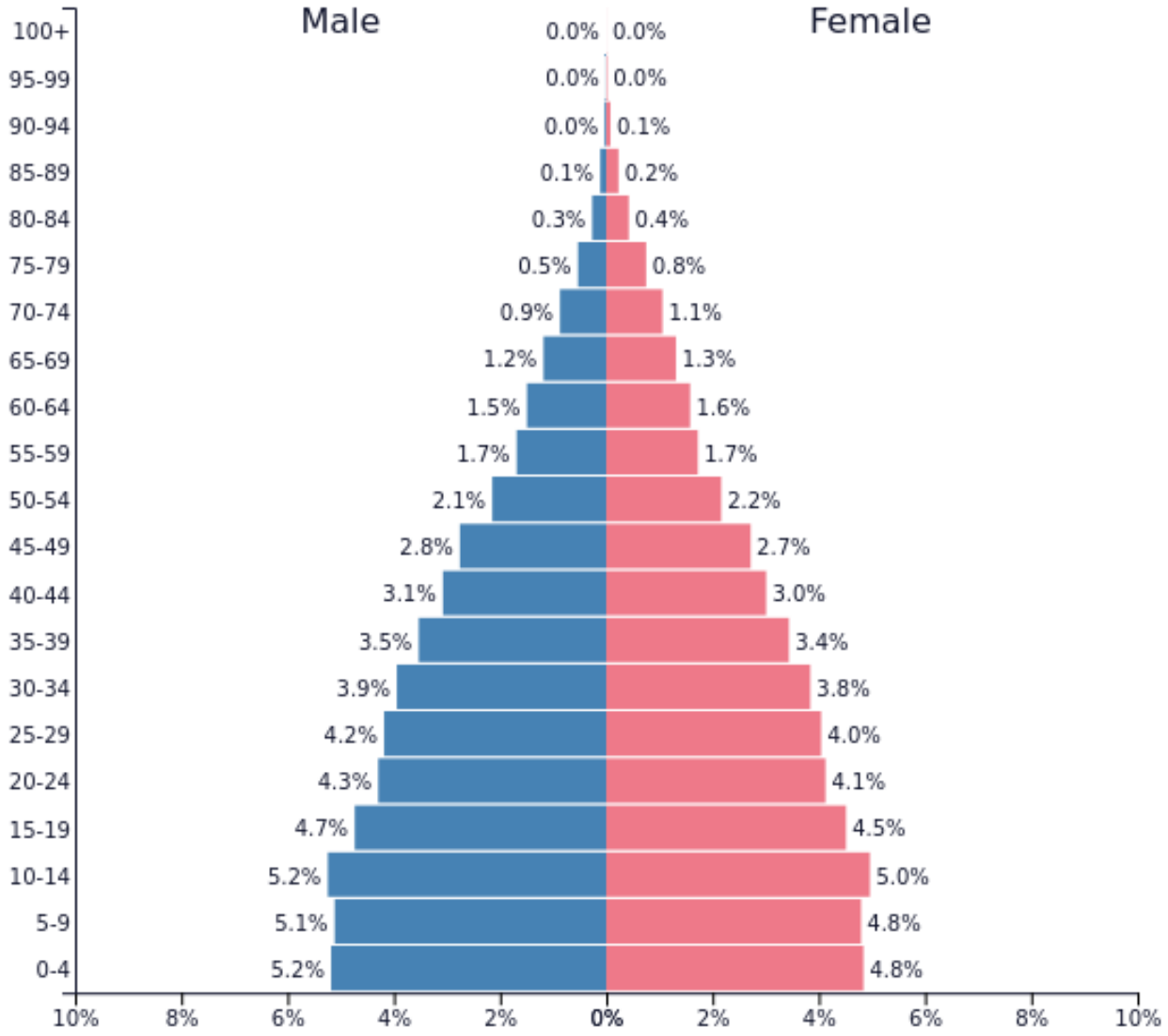
- A main characteristic of age transitions is a change from very young to older populations



PopulationPyramid.net

WORLD - 1950

Population: **2,536,431,017**

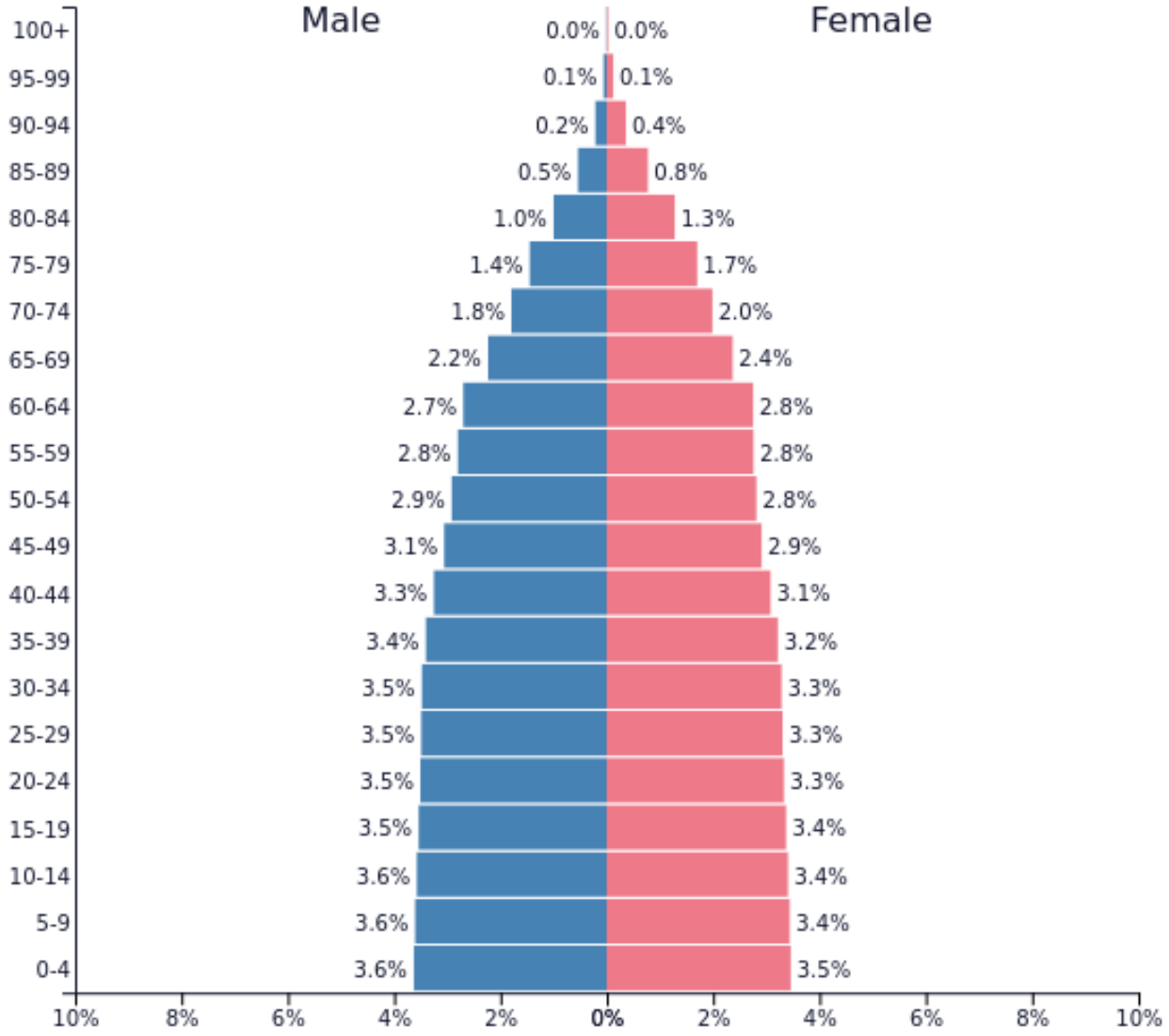


PopulationPyramid.net

WORLD - 2000
Population: **6,143,493,805**

PopulationPyramid.net

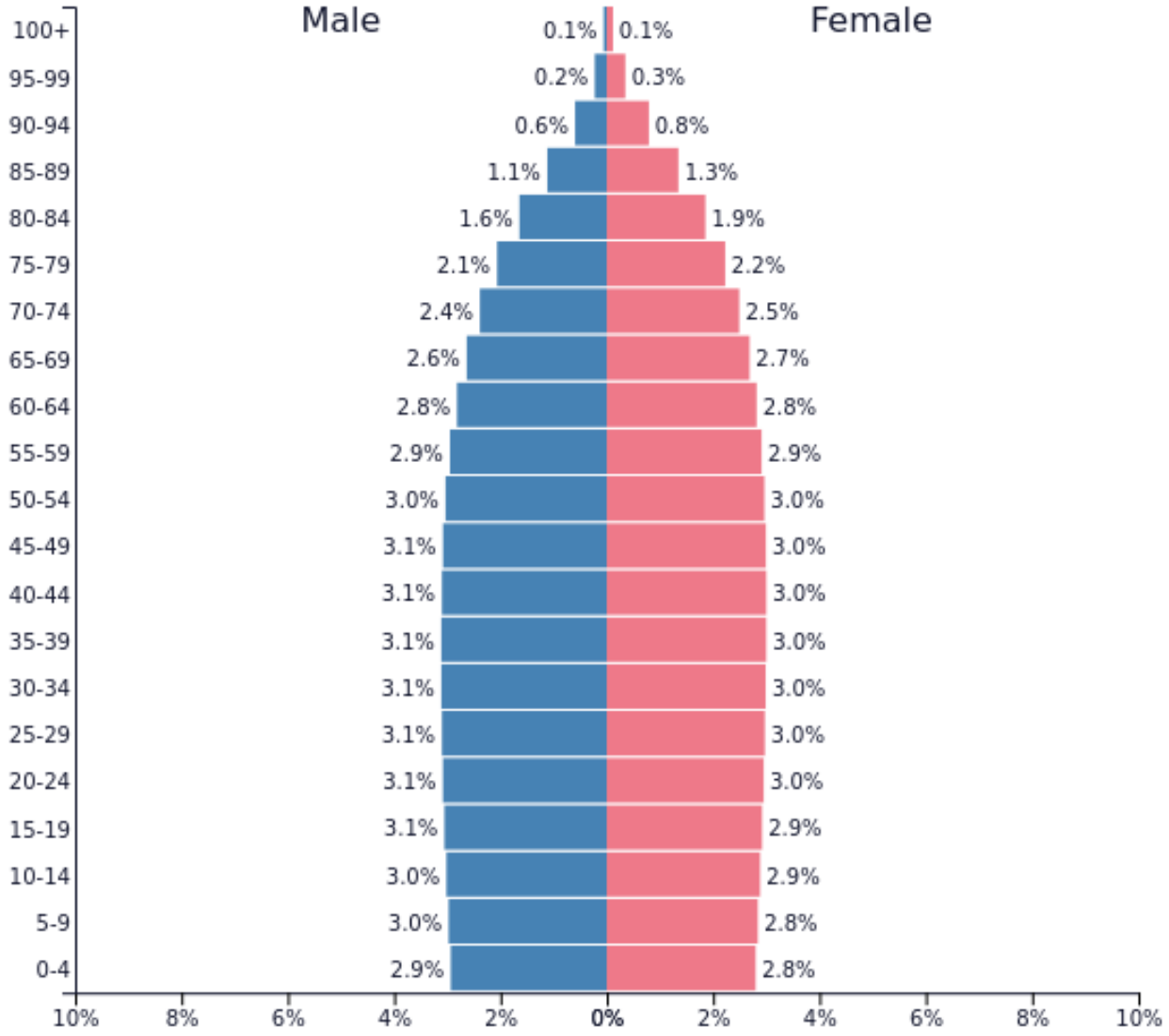
WORLD - 2020
Population: **7,794,798,729**



PopulationPyramid.net

WORLD - 2050

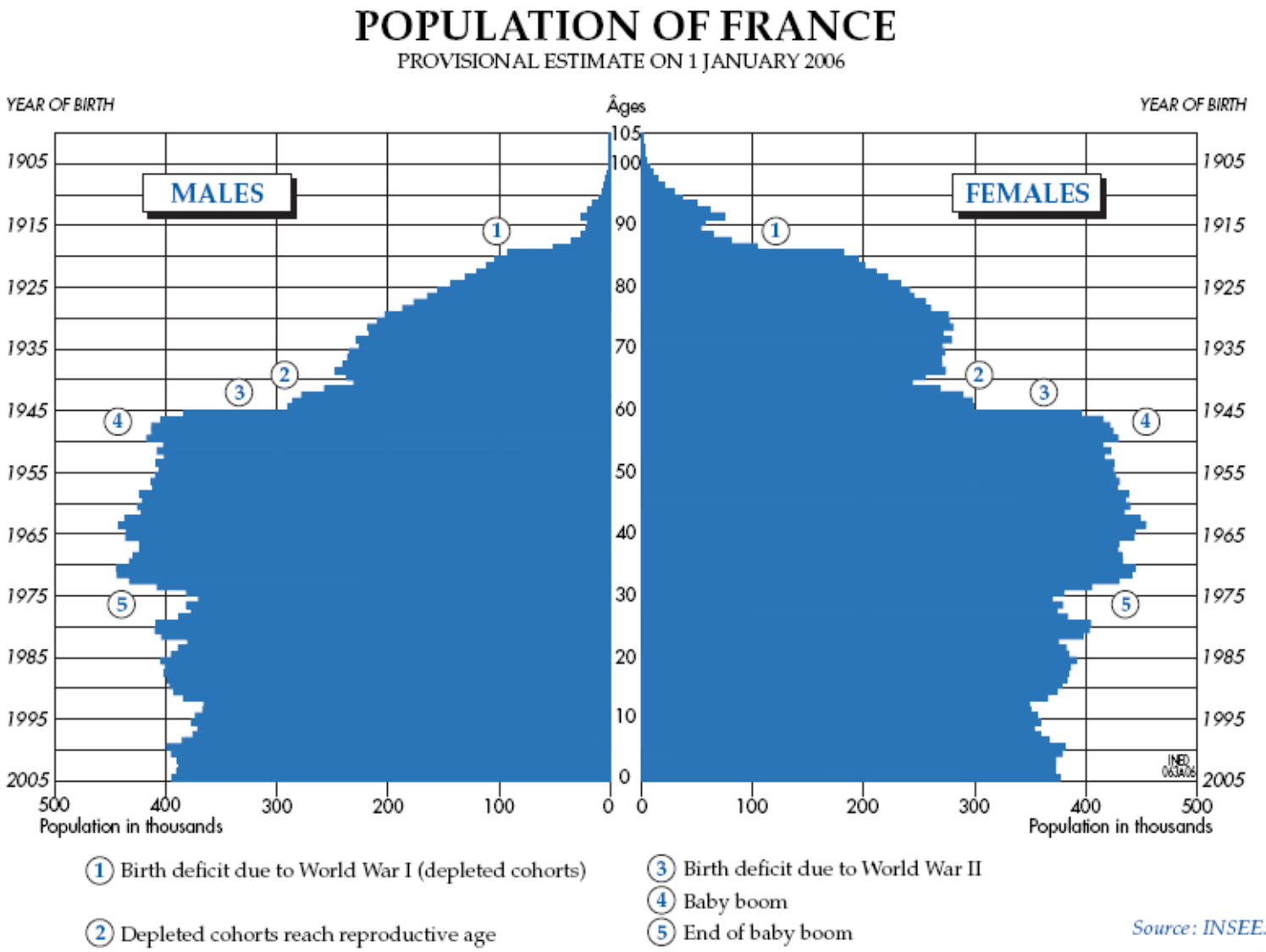
Population: **9,735,033,899**



PopulationPyramid.net

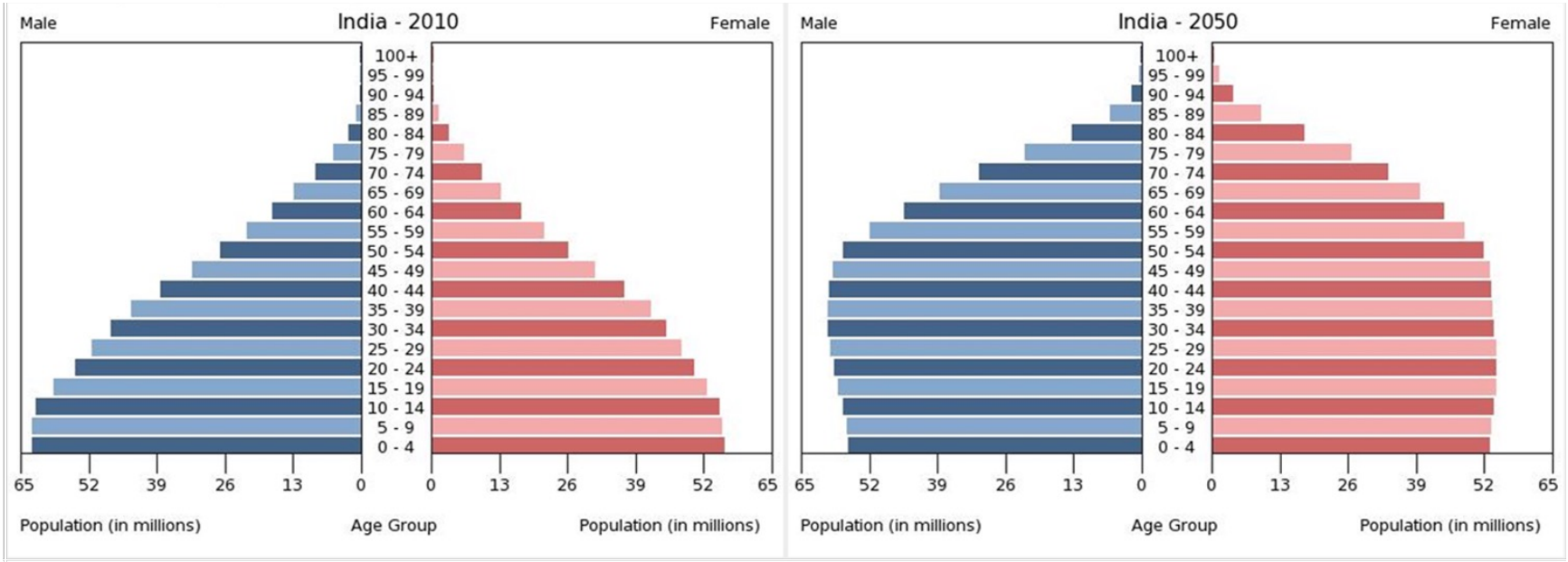
WORLD - 2100

Population: **10,875,393,719**



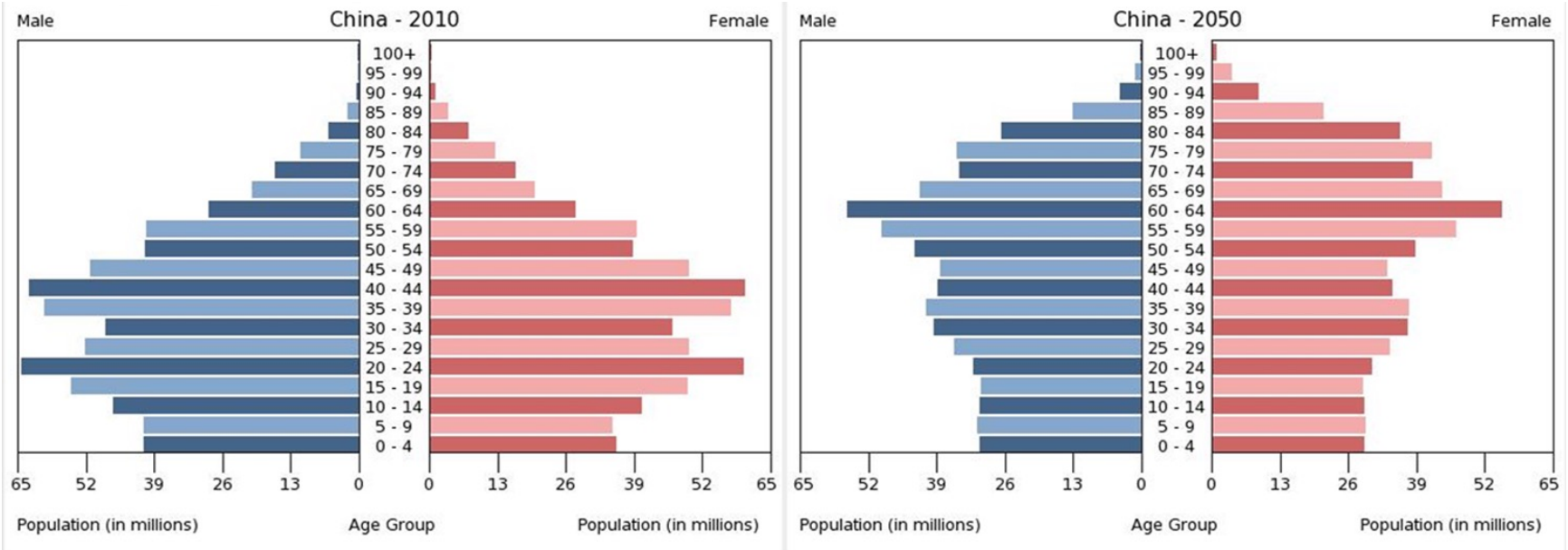
Source: Pison, 2006: 3, reprinted with permission of Institut National d'études Démographiques (INED).

Population structure by age and sex, India, 2010–2050



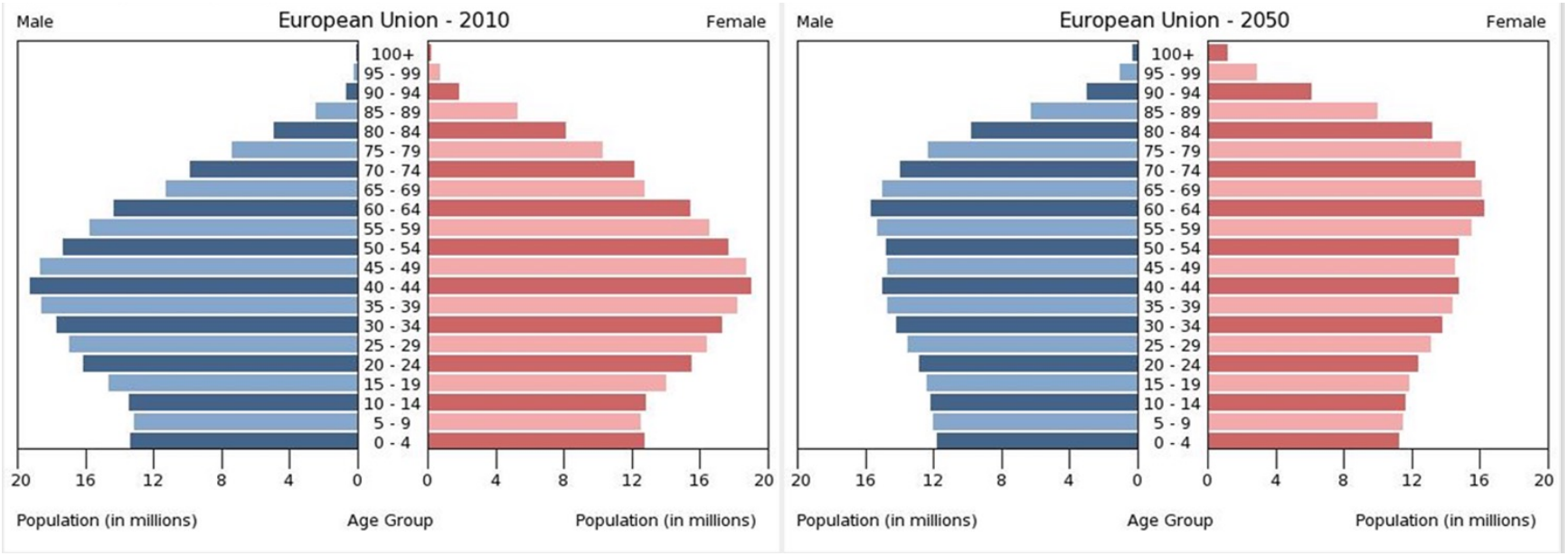
Source: http://www.fdbetancor.com/wp-content/uploads/2012/10/demochallenge2.png

Population structure by age and sex, China, 2010–2050



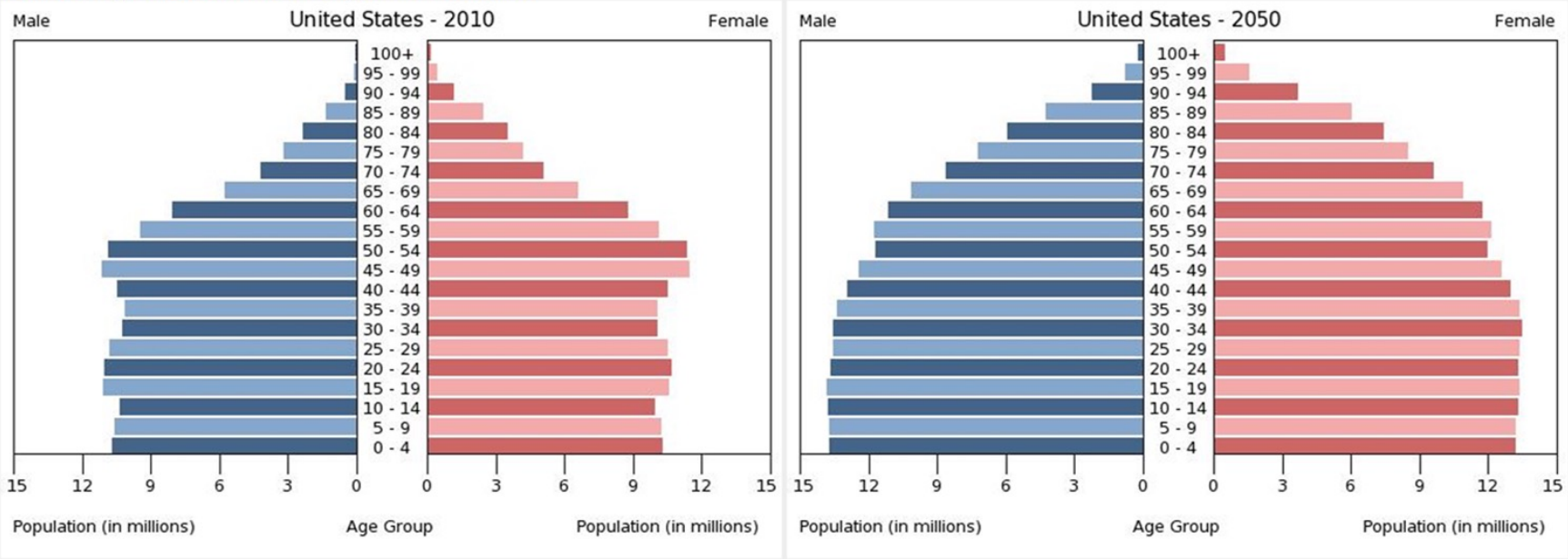
Source: http://www.fdbetancor.com/wp-content/uploads/2012/10/demochallenge2.png

Population structure by age and sex, European Union, 2010–2050



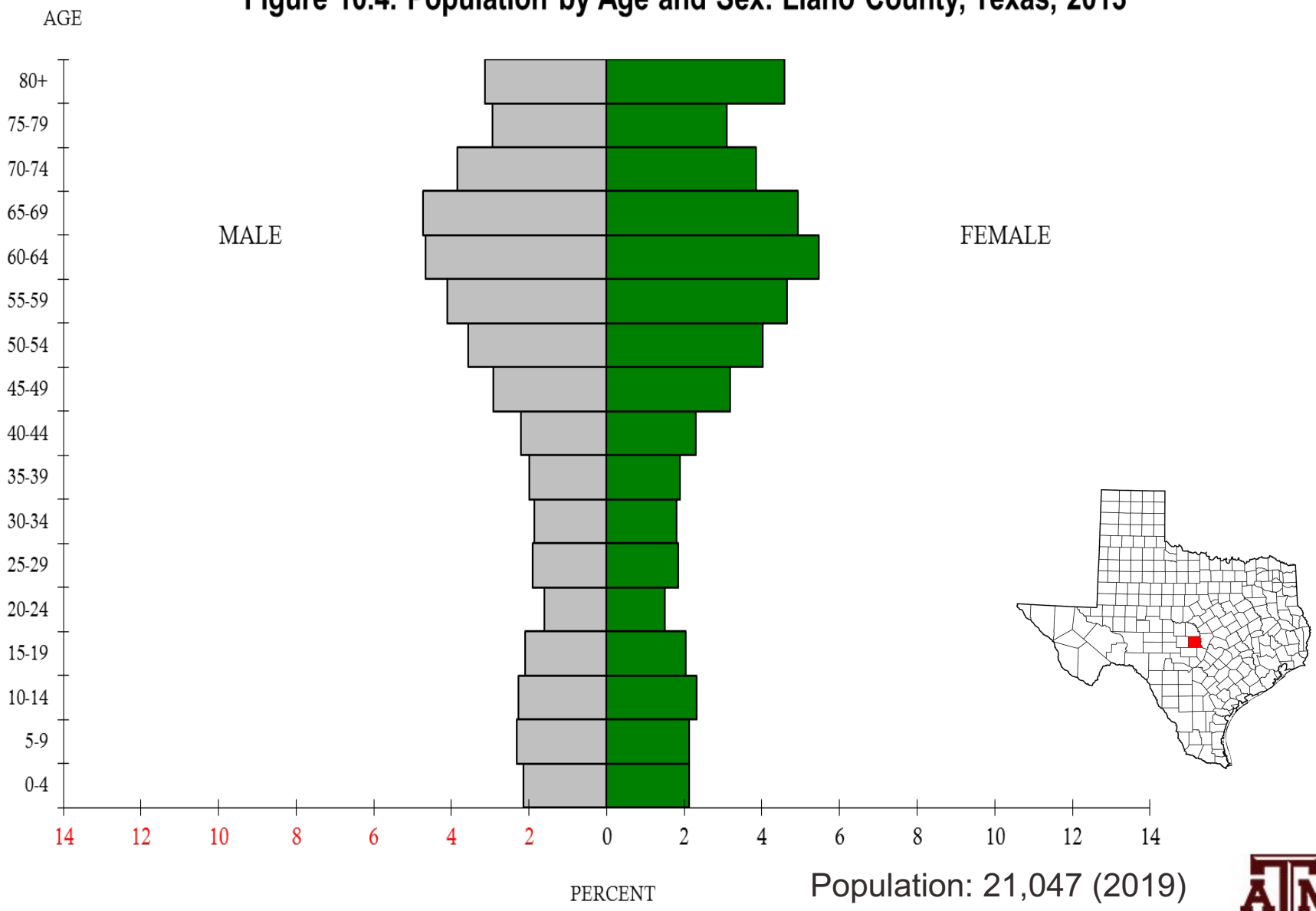
Source: http://www.fdbetancor.com/wp-content/uploads/2012/10/demochallenge2.png

Population structure by age and sex, United States, 2010–2050



Source: http://www.fdbetancor.com/wp-content/uploads/2012/10/demochallenge2.png

Figure 10.4. Population by Age and Sex: Llano County, Texas, 2013



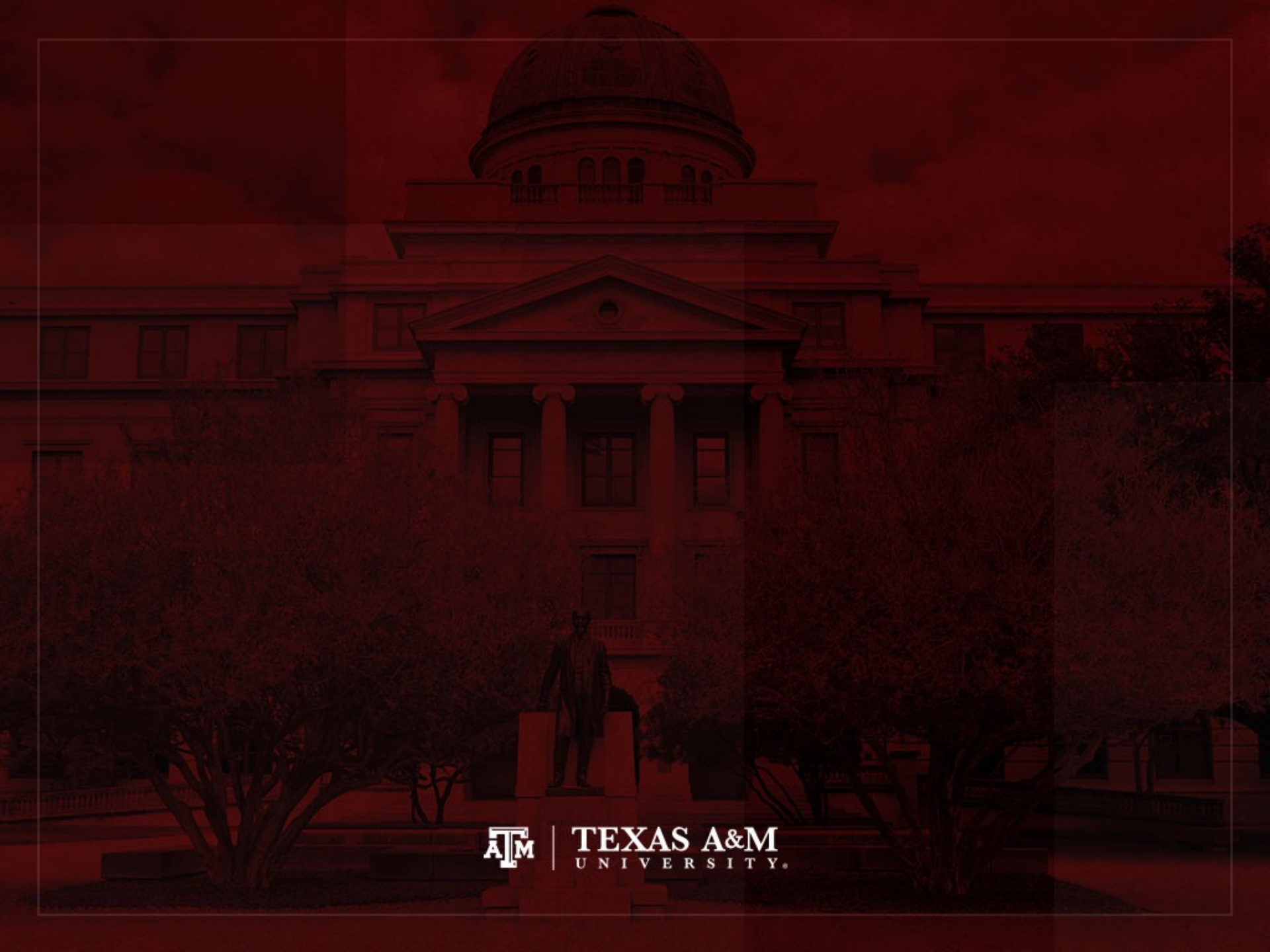
Population: 21,047 (2019)

Source: U.S. Bureau of the Census. Figure prepared by Dudley L. Poston.

Figure 10.5. Population by Age and Sex: Brazos County, Texas, 2013

Population: 229,211 (2019)

Source: U.S. Bureau of the Census. Figure prepared by Dudley L. Poston.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Age dependency

- A popular measure of age structure is the total dependency ratio (TDR)
  - It is the ratio of the dependent-age population
    - Both young (persons 0–14 years old)
    - And old (persons 65+ years old)
  - To the working-age population
    - Persons 15–64 years old
  - It is usually multiplied by a constant of 100
- The higher the ratio
  - The more people each worker has to support
- The lower the ratio
  - The fewer the number of dependents

YDR and ADR

- Demographers usually split dependency ratio into
  - Youth-dependency ratio (YDR or Youth-DR)
  - Old-age dependency ratio (Old Age-DR), also known as the aged-dependency ratio (ADR or Aged-DR)
- Numerator
  - The numerator of the YDR is the population 0–14
  - The numerator of the ADR is the population 65+
- Denominator is the same: population 15–64
- YDR plus ADR equals the TDR

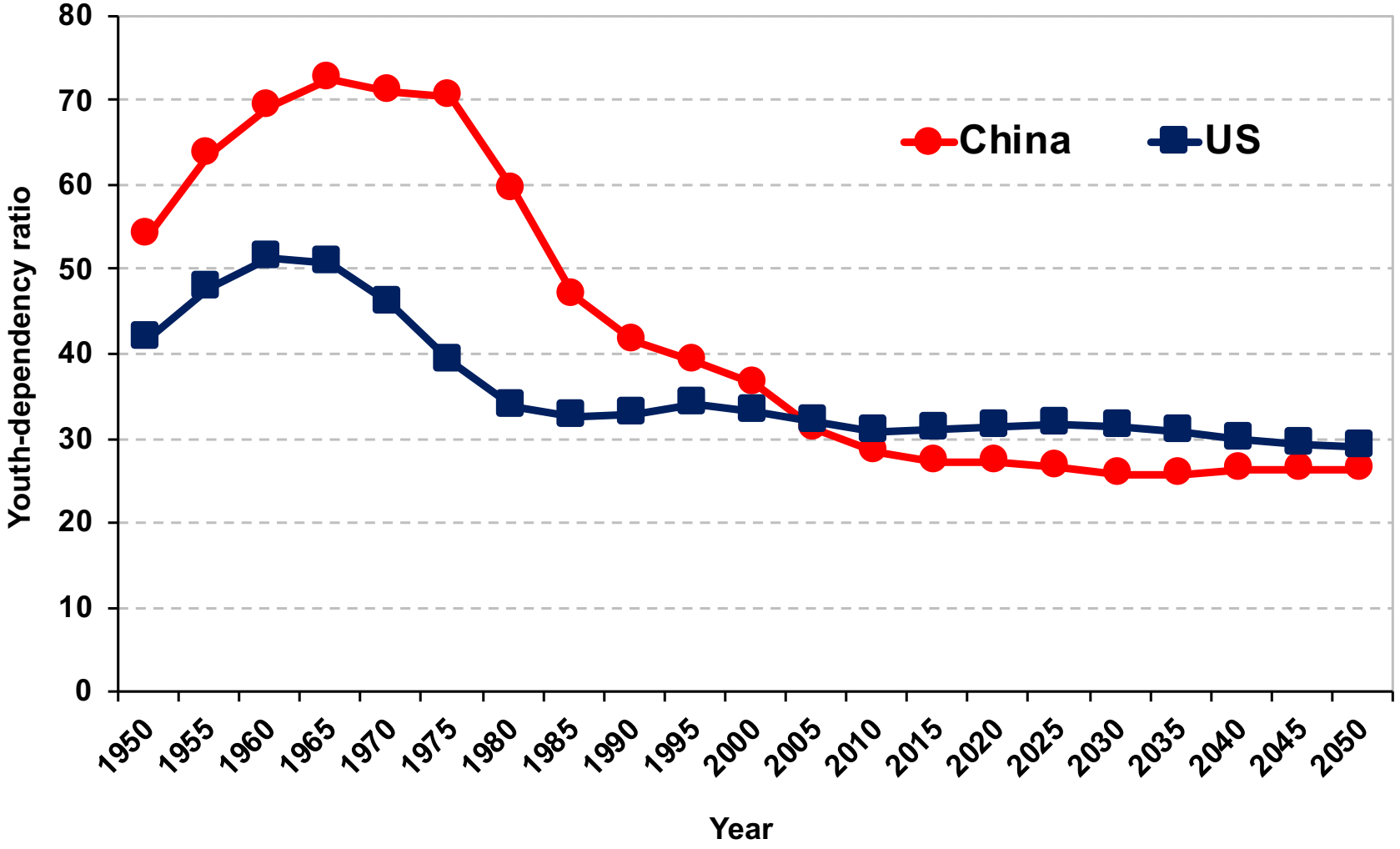
Age dependency

Values of Youth-Dependency Ratio, Old-Age-Dependency Ratio, and Total Dependency Ratio, Selected Countries of the World, 2014

Country	Youth-DR	Old-Age-DR	Total DR
Macao	13.6	9.9	23.5
South Korea	21.6	13.5	35.1
China	20.5	16.4	36.9
Russia	22.5	18.3	40.8
Spain	22.4	26.9	49.3
United States	28.4	20.9	49.3
Mexico	42.4	9.1	51.5
Italy	21.5	32.3	53.8
Japan	21.3	42.6	63.9
Nigeria	83.0	5.7	88.7
Gambia	88.5	3.8	92.3
Uganda	96.0	4.0	100.0
Chad	100.0	4.1	104.1
Niger	106.4	6.4	112.8

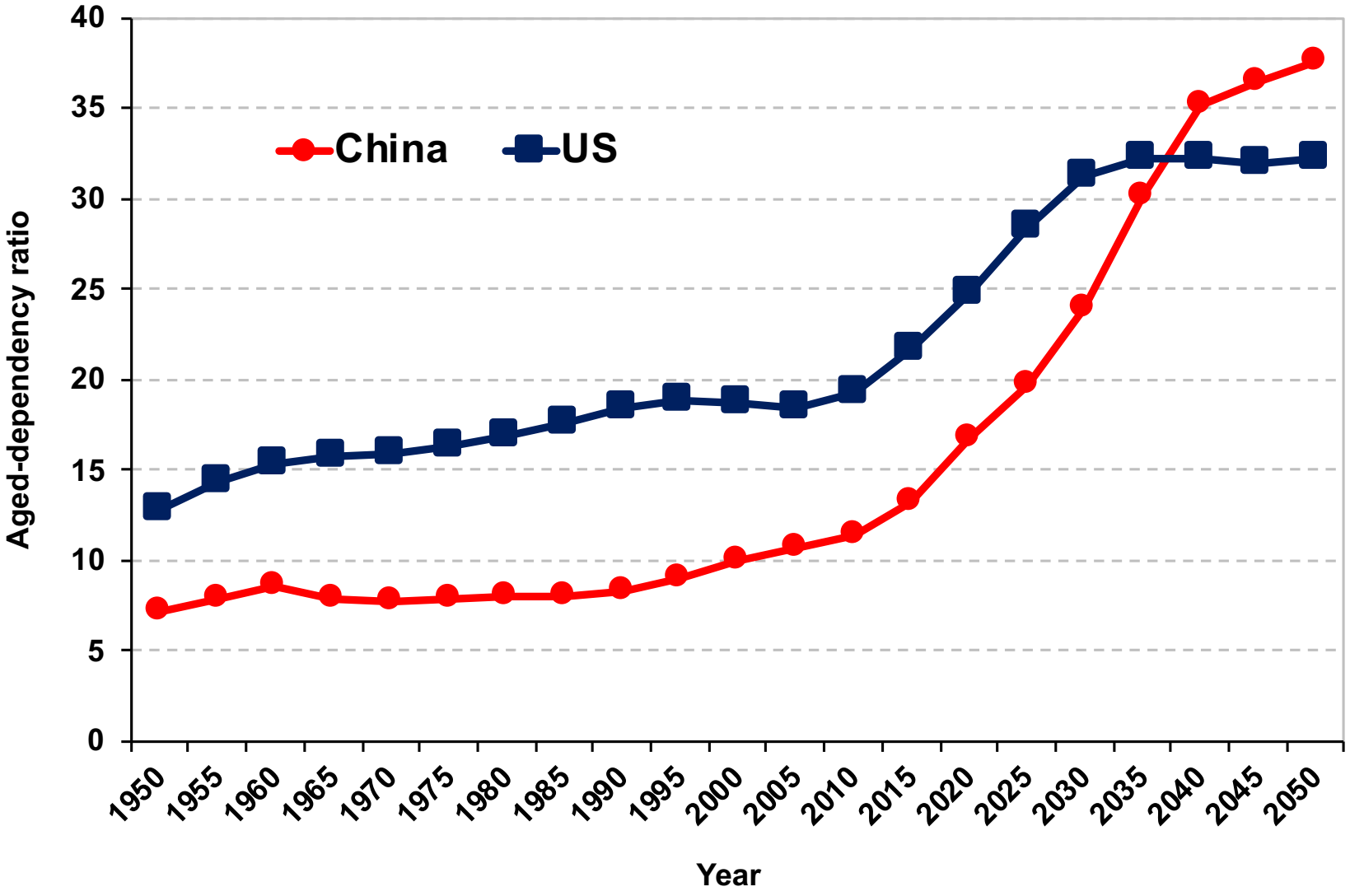
Source of Data: Population Reference Bureau, 2014

Youth-dependency ratios, China and the United States, 1950–2050



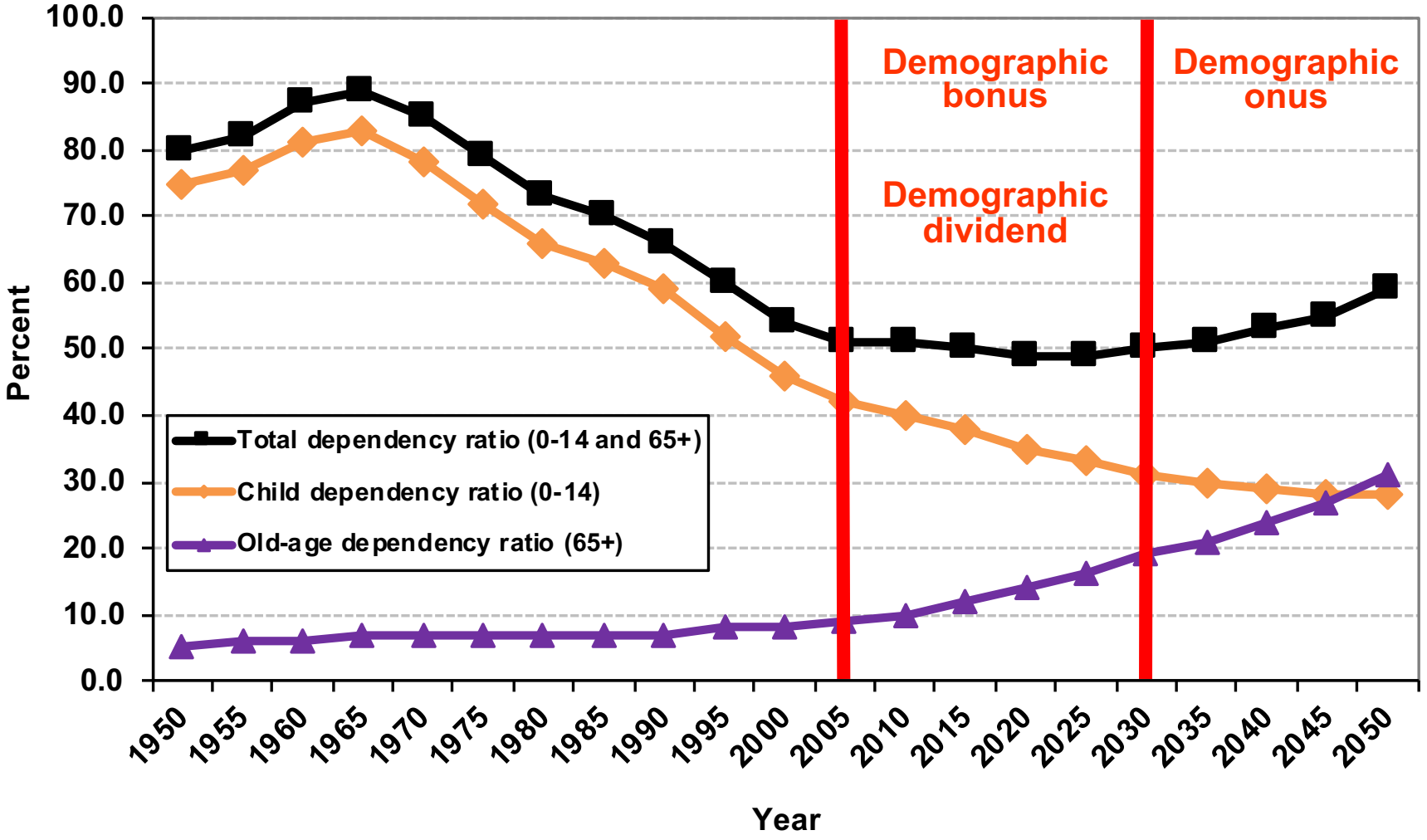
Source: Poston, Bouvier (2017).

Aged-dependency ratios, China and the United States, 1950–2050

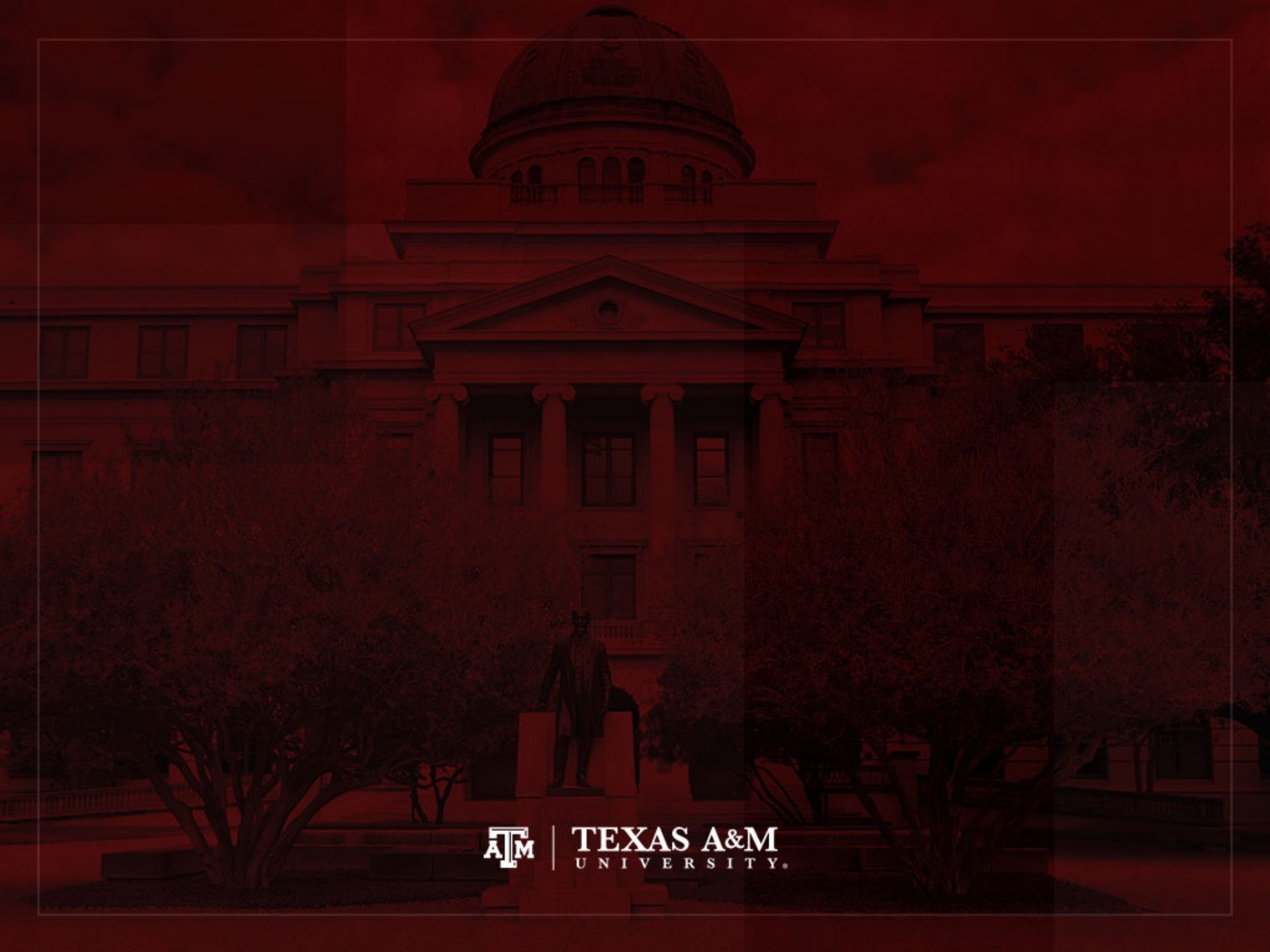


Source: Poston, Bouvier (2017).

Dependency ratios, Brazil 1950–2050



Source: United Nations - http://esa.un.org/unpp (medium variant).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Age heaping

- Demographers use data from single years of age to determine whether there are irregularities or inconsistencies in the data

- **Age heaping** happens if a population tends to report certain ages (e.g., those ending in 0 or 5) at the expense of other ages

- Age heaping tends to be more pronounced among populations or population subgroups with low levels of education

Examples of age heaping

- In some cultures, certain numbers and digits are avoided
- For example, “13” is frequently avoided in the West because it is considered unlucky
  - Hotels in the US and in some Western countries sometimes do not have floors designated as 13
- The numeral “4” is avoided in Korea and China, since it has the same sound as the word/character for “death”
  - Many hotels in China, South Korea, and some other East Asian countries do not have floors designated as 4

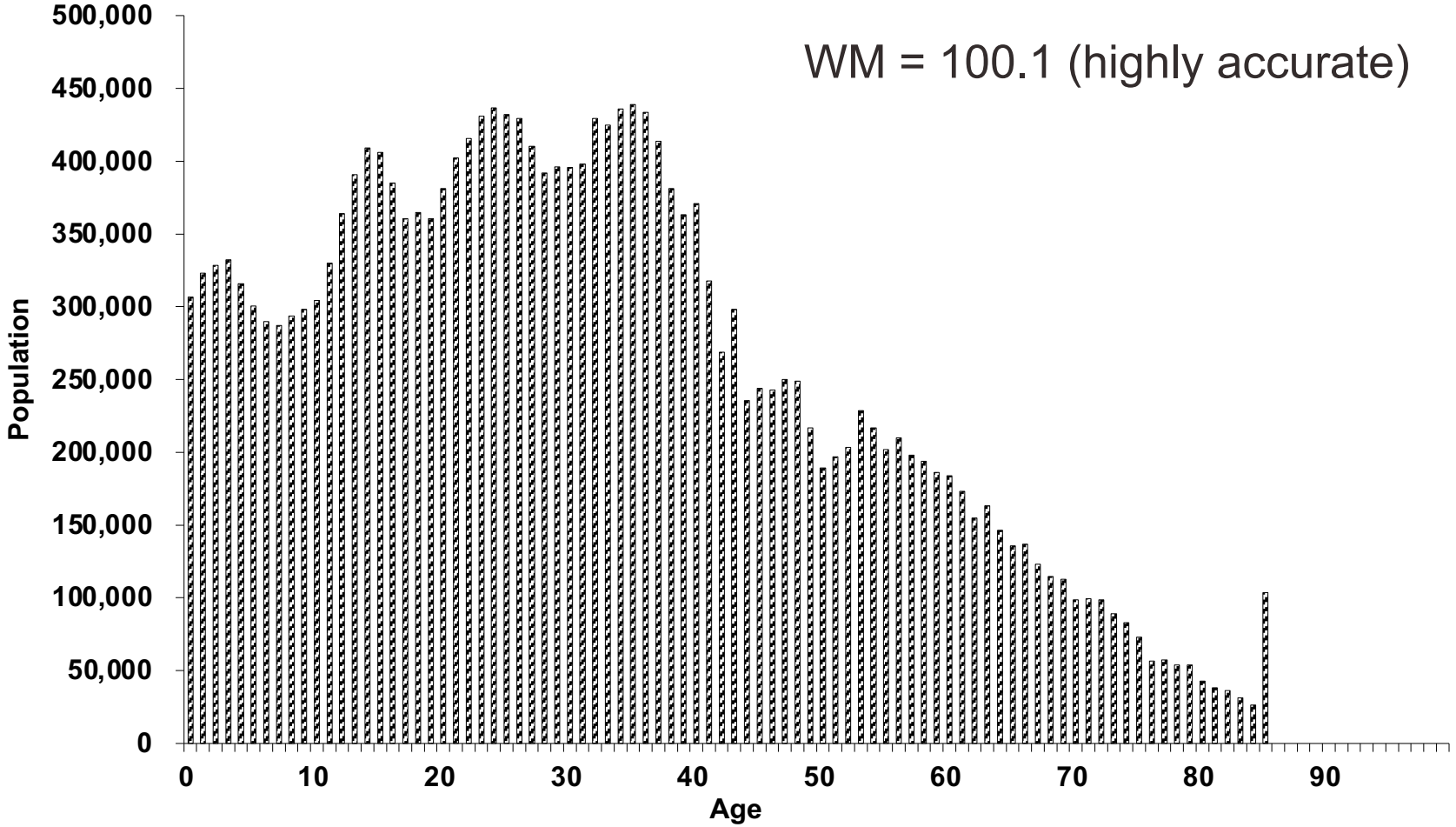
Whipple's Method (WM)

- WM measures preference for the terminal digits of "0" and "5", usually in the age range of 23 to 62

$$WM = \frac{\sum(P_{25} + P_{30} + \cdots + P_{55} + P_{60})}{\sum(P_{23} + P_{24} + P_{25} + \cdots + P_{60} + P_{61} + P_{62})} * 5 * 100$$

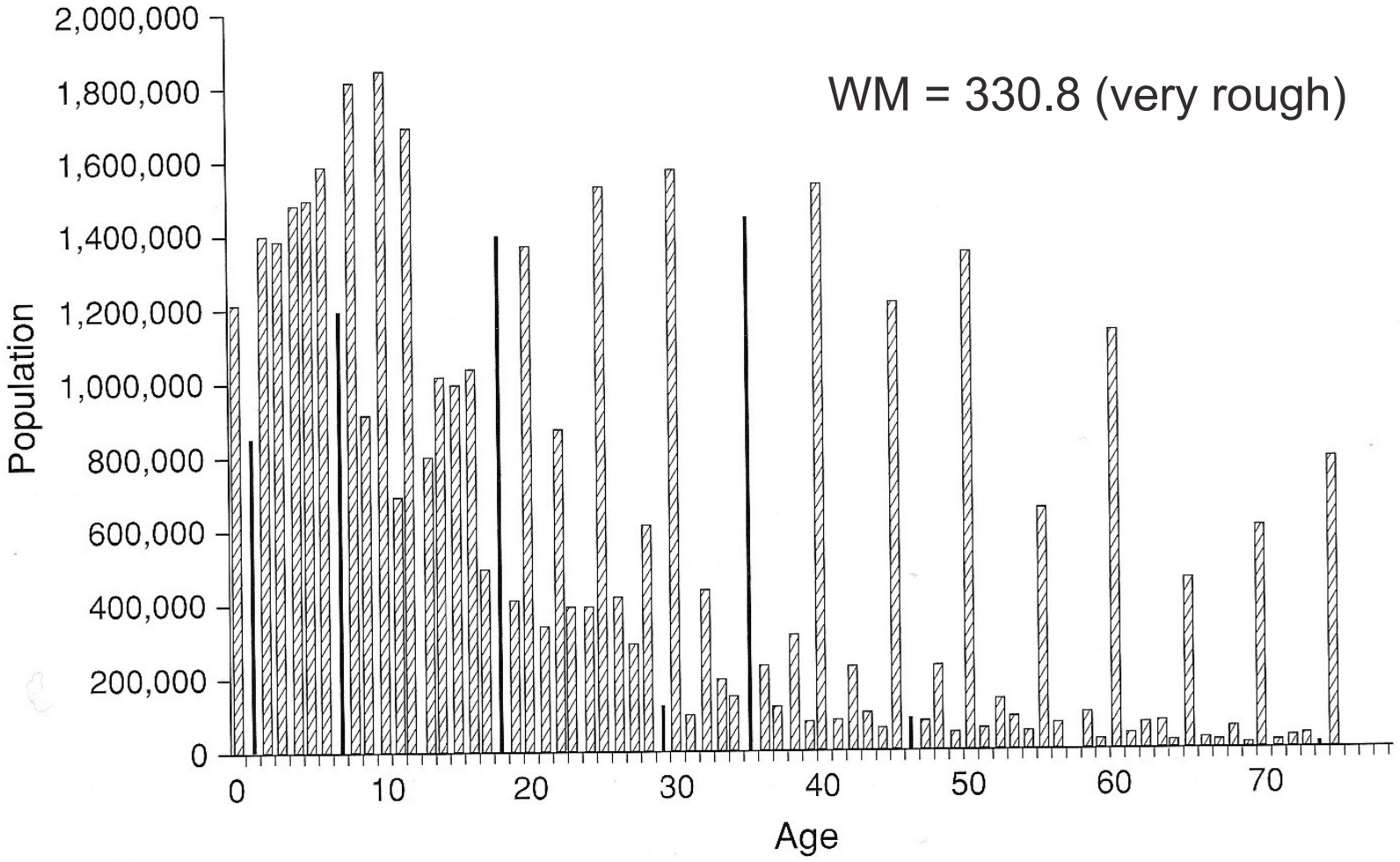
  - Technically, WM could have the following values
    - 0, when the digits 0 and 5 are not reported
    - 100, when there is no preference for 0 or 5
    - 500, when only digits 0 and 5 are reported
  - Based on real data about age distribution
    - <105, highly accurate
    - 105–109.9, fairly accurate
    - 110–124.9, approximate
    - 125–174.9, rough
    - 175+, very rough

Single years of age, female population, Republic of Korea, 1995

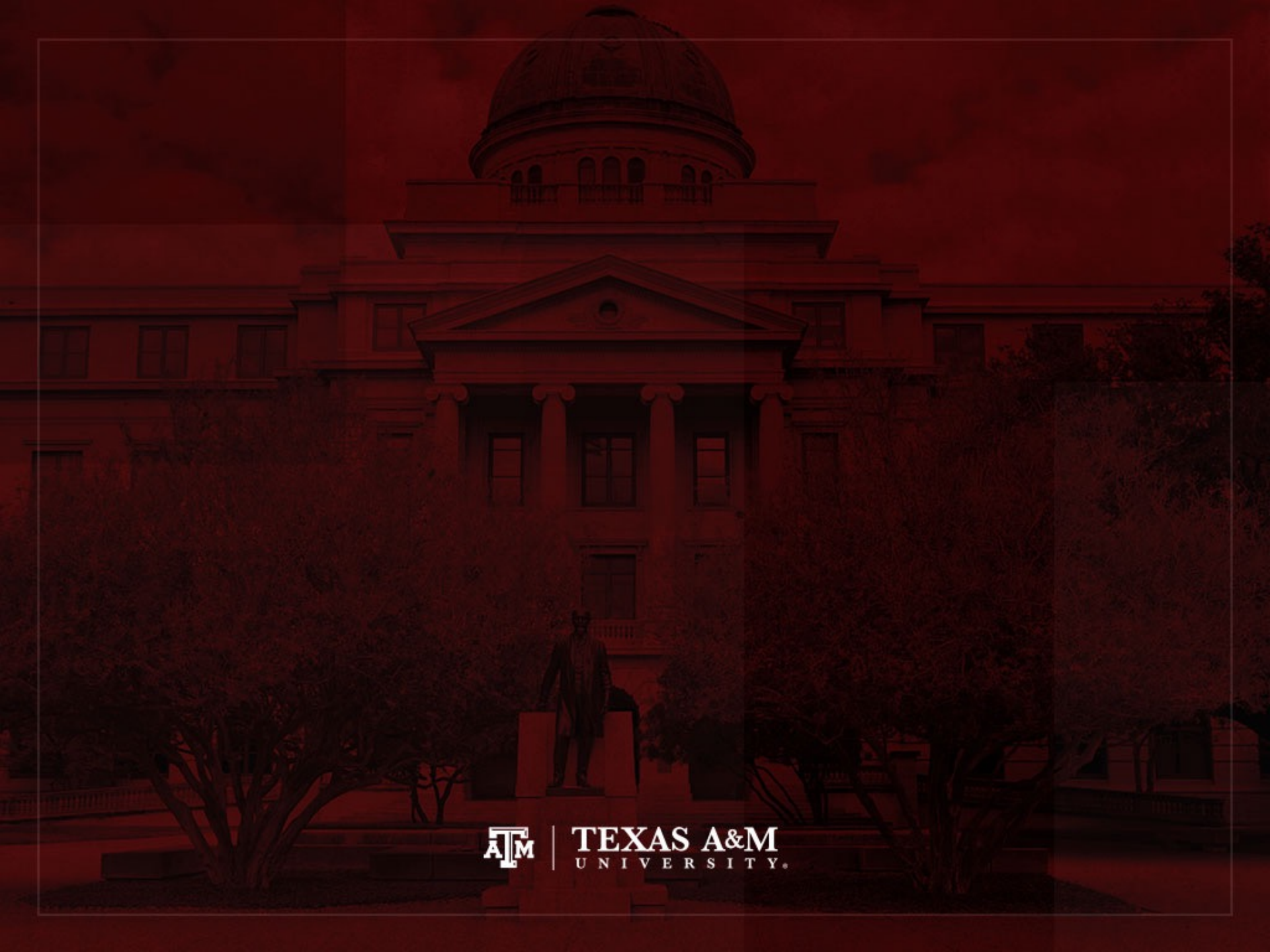


Source: Population Reference Bureau, 2014

Single years of age, male population, Pakistan, 1981



Source: U.S. Bureau of the Census, International Data Base. Figure prepared by Dudley L. Poston.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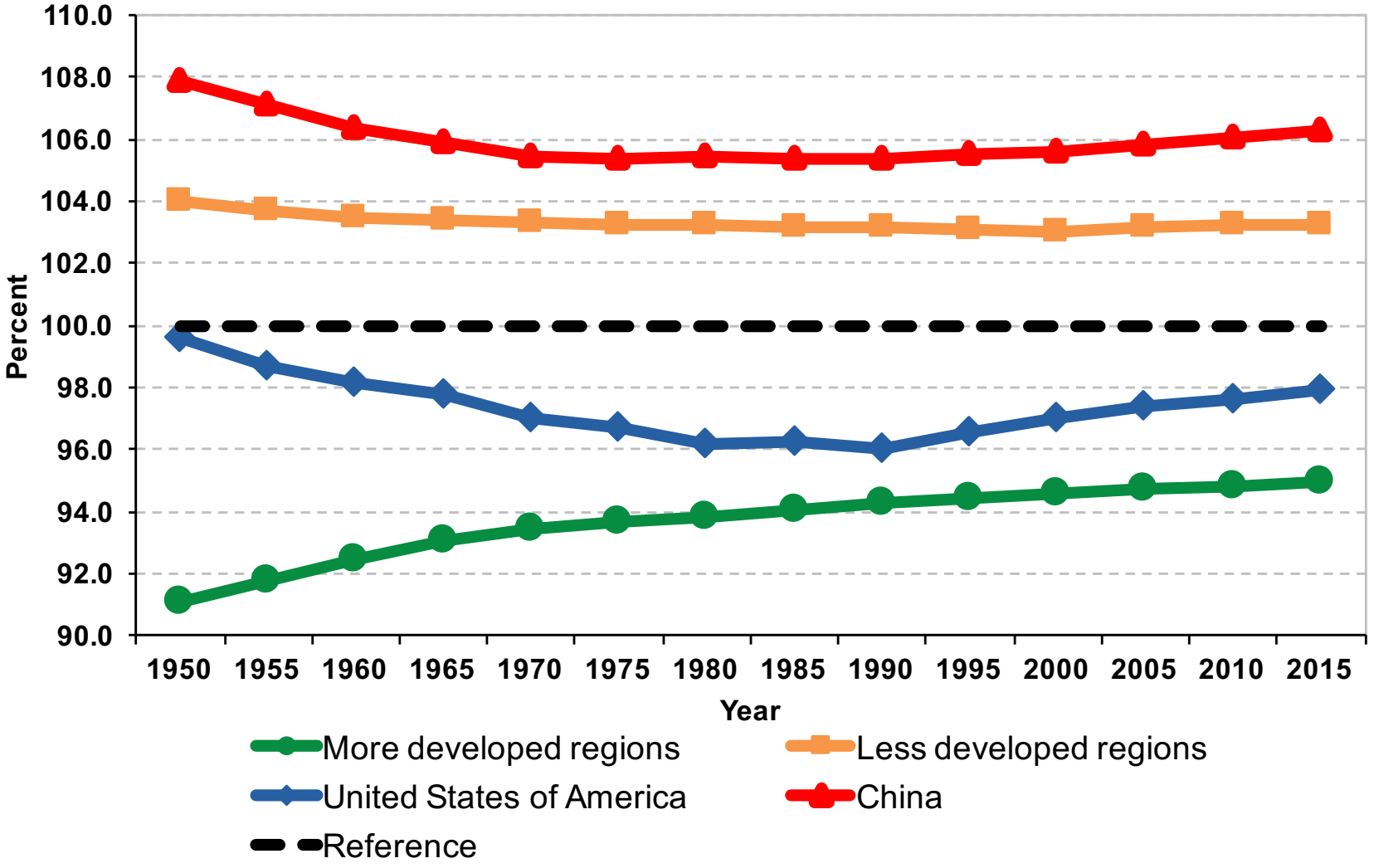
Sex structure

- The sex ratio (SR) is the most popular index of sex composition in demographic analyses
  - It is defined as the number of males per 100 females
  - SR above 100 indicates an excess of males
  - SR below 100 indicates an excess of females

$$Sex\ ratio = \frac{Population\ of\ males}{Population\ of\ females} * 100$$

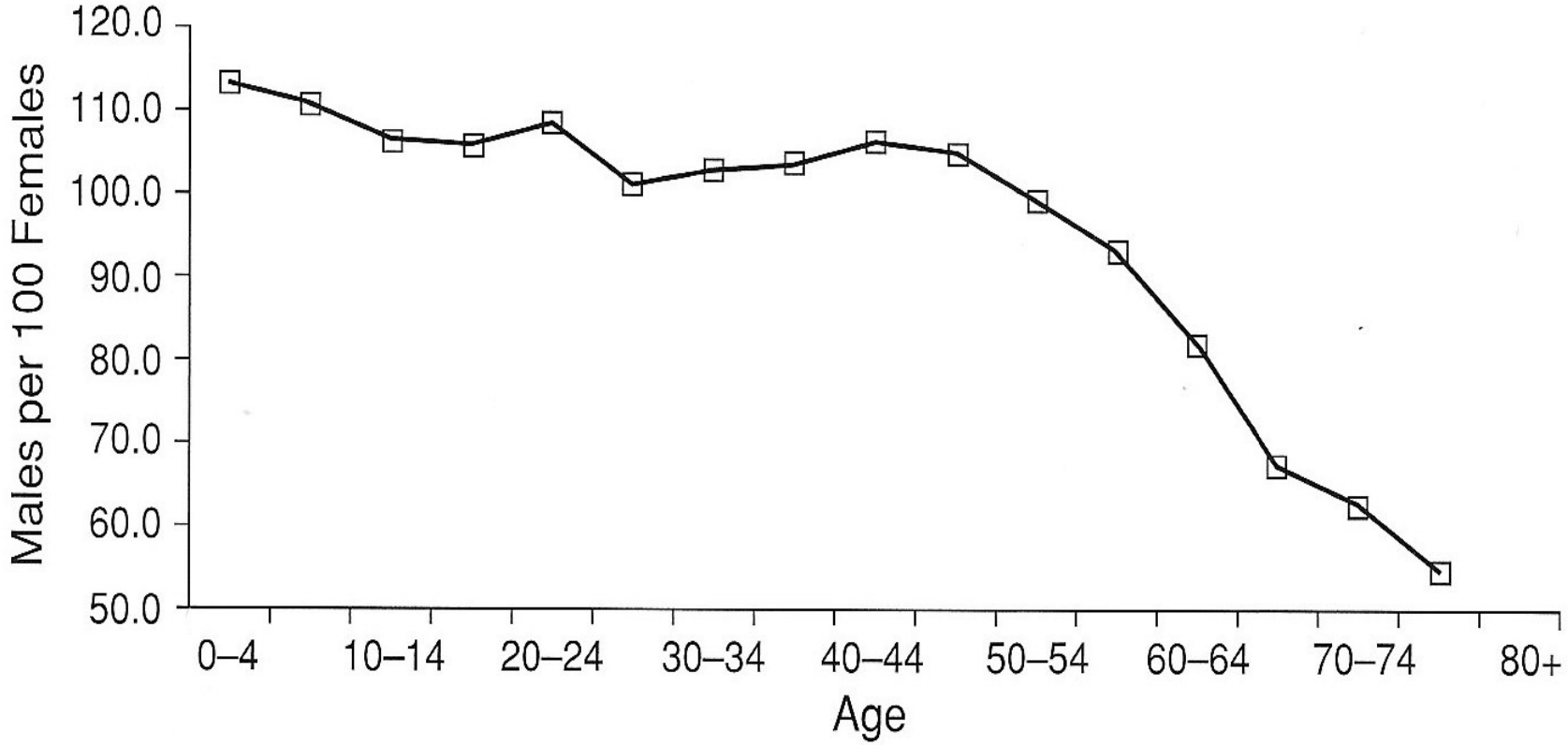
- In general, national sex ratios tend to fall in the narrow range from about 95 to 102
  - National sex ratios outside the range of 90 to 105 should be viewed as extreme

Sex ratios, 1950–2015



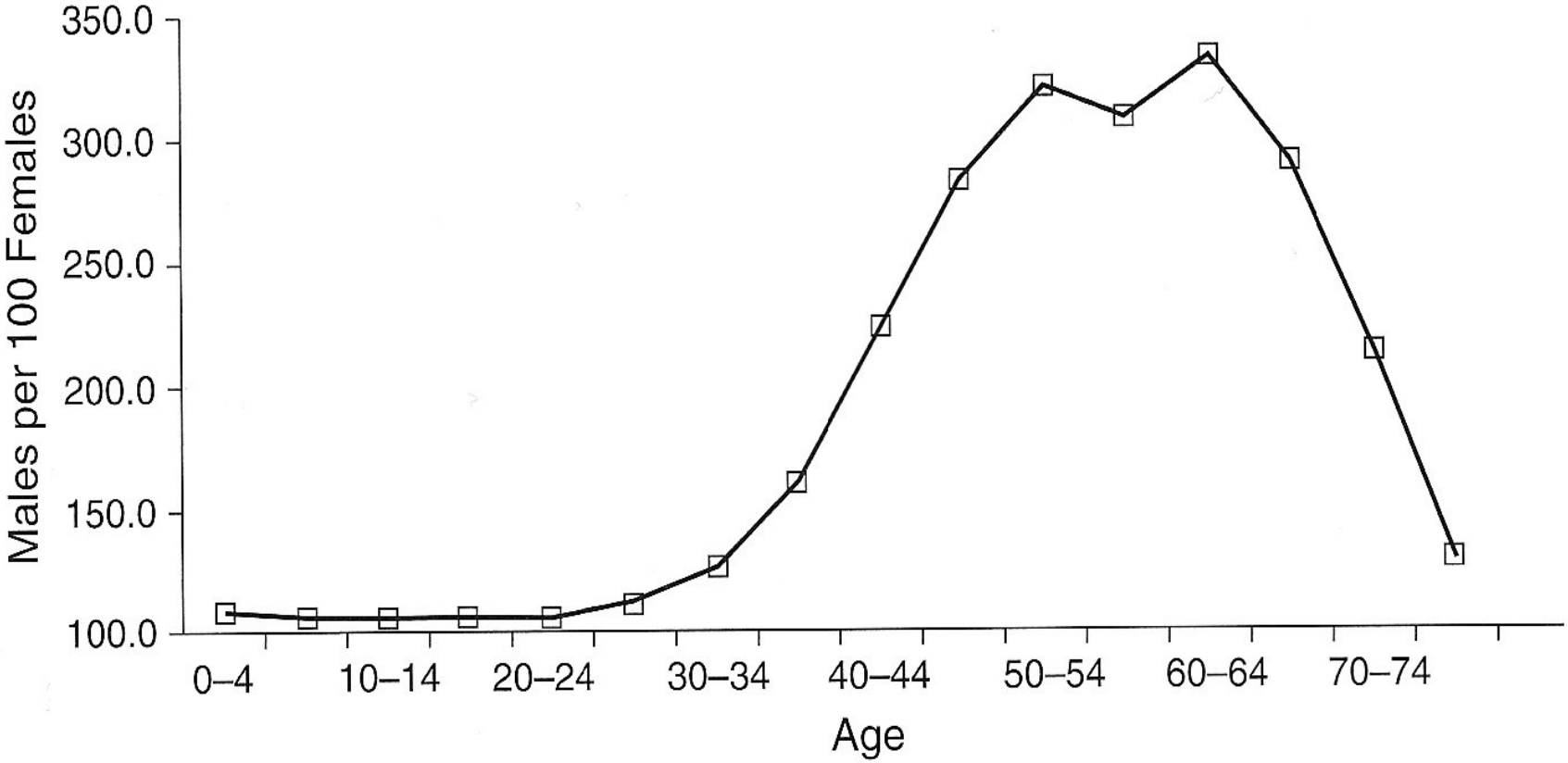
Source: United Nations, World Population Prospects 2017
https://esa.un.org/unpd/wpp/Download/Standard/Population/

Sex ratios by age group, Republic of Korea, 1995

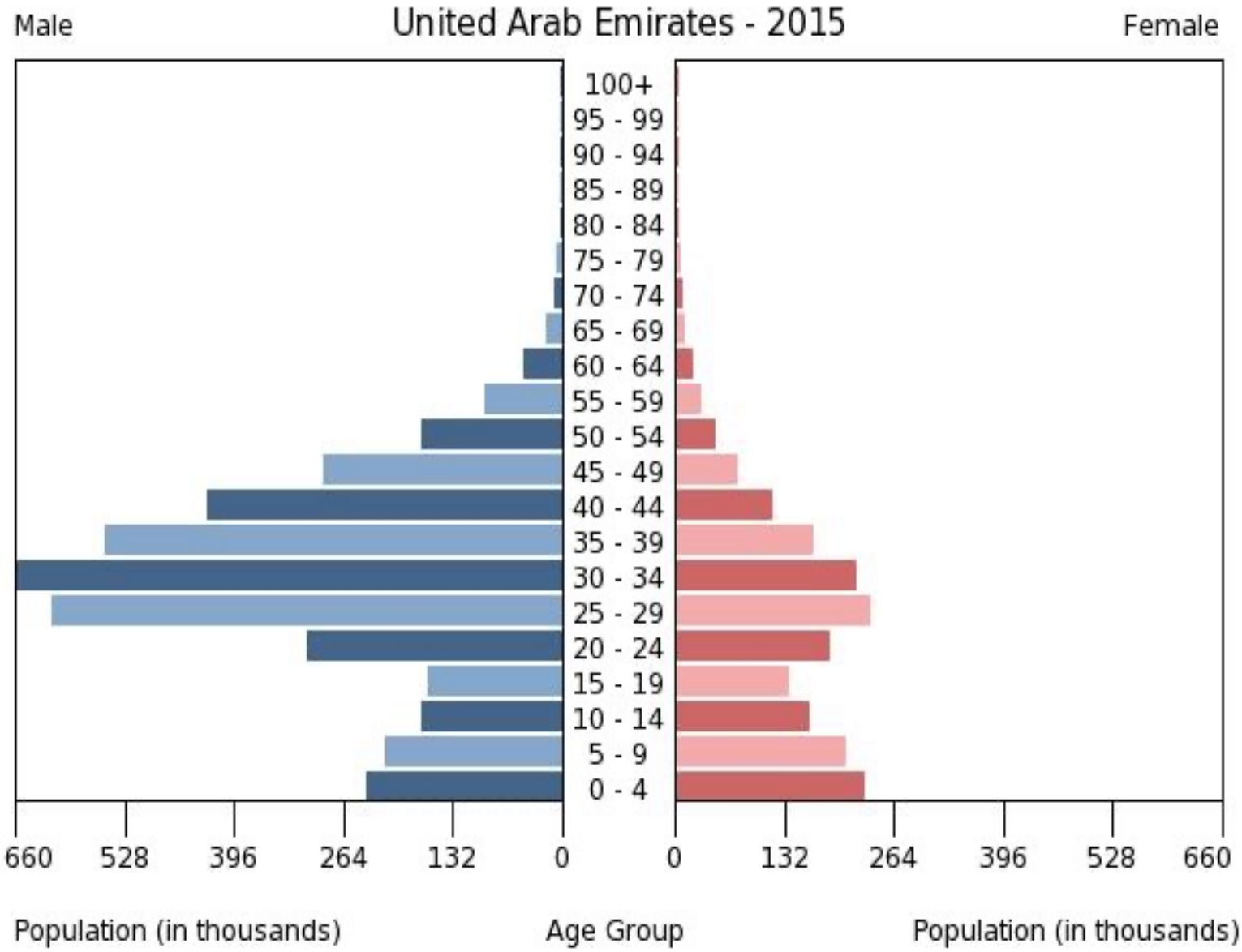


Source: U.S. Bureau of the Census, International Data Base. Figure prepared by Dudley L. Poston.

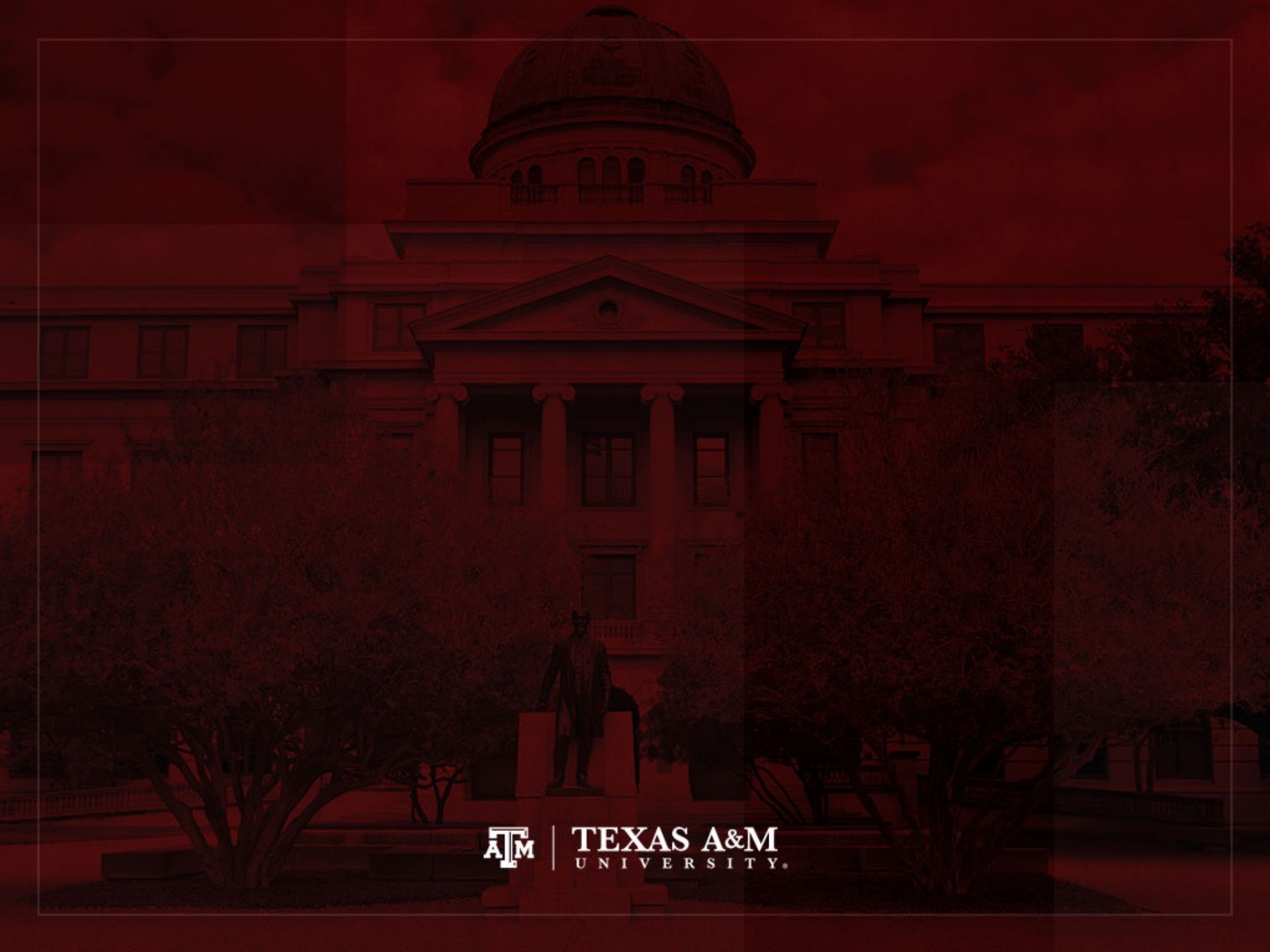
Sex ratios by age group, United Arab Emirates, 2000



Source: U.S. Bureau of the Census, International Data Base. Figure prepared by Dudley L. Poston.



Source: U.S. Bureau of the Census, International Data Base.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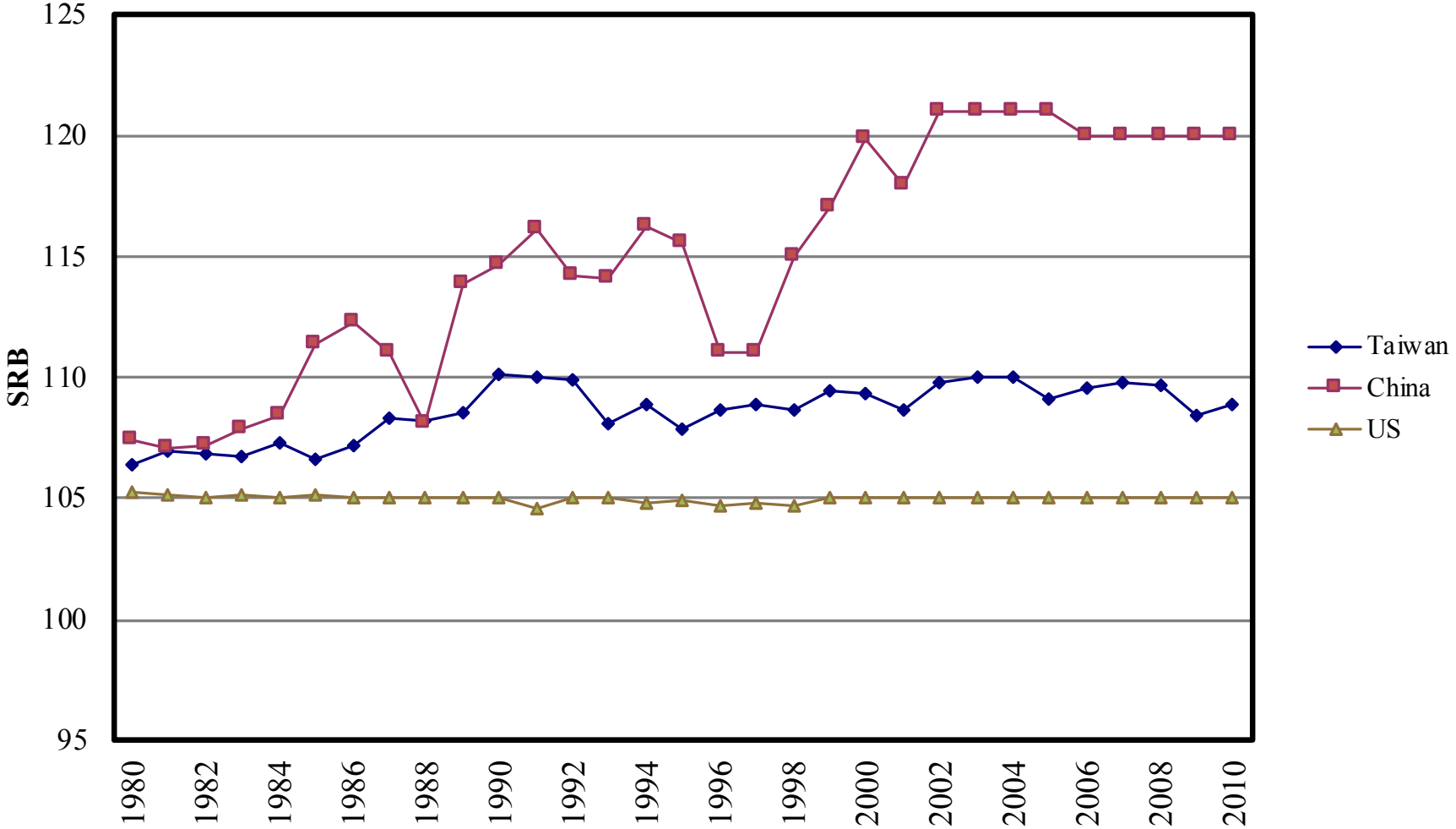
Sex ratio at birth

- Most societies have sex ratios at birth (SRBs) of around 105
  - 105 boys are born for every 100 girls
- But China, Taiwan, South Korea, India, and several other Asian countries have been reporting abnormally high SRBs since the 1980s
  - A main intervention is prenatal sex identification followed by gender-specific abortion

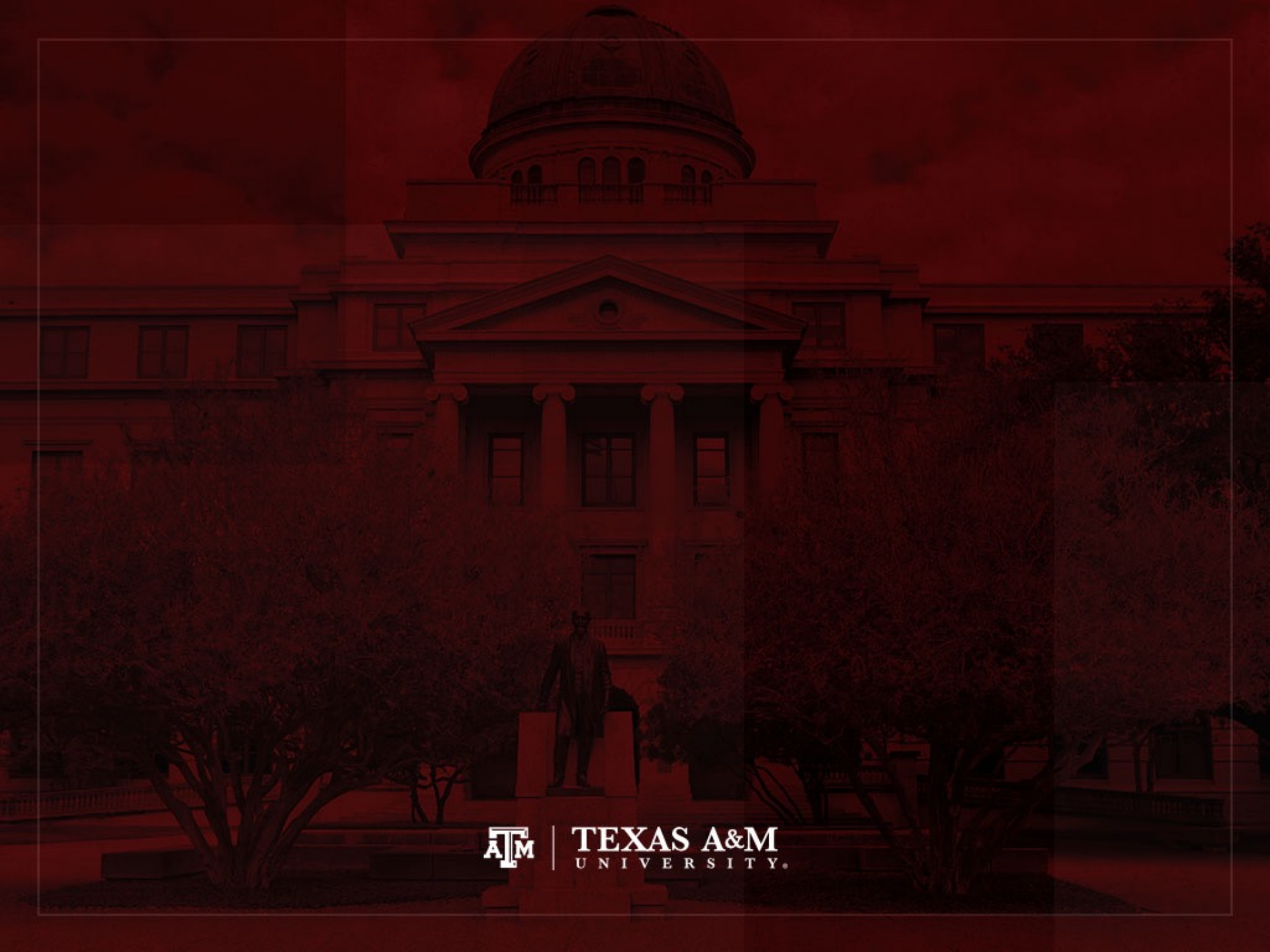
China and Taiwan

- China and Taiwan have a Confucian patriarchal tradition where son preference is strong and pervasive
- Birth-planning policies, socioeconomic changes, and industrial transformations have been responsible for the rapid decline in fertility
- Ultrasound technology enables the prenatal determination of sex

Sex ratios at birth, Taiwan, China, U.S., 1980–2010



Source: Poston, Bouvier (2017).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Population aging

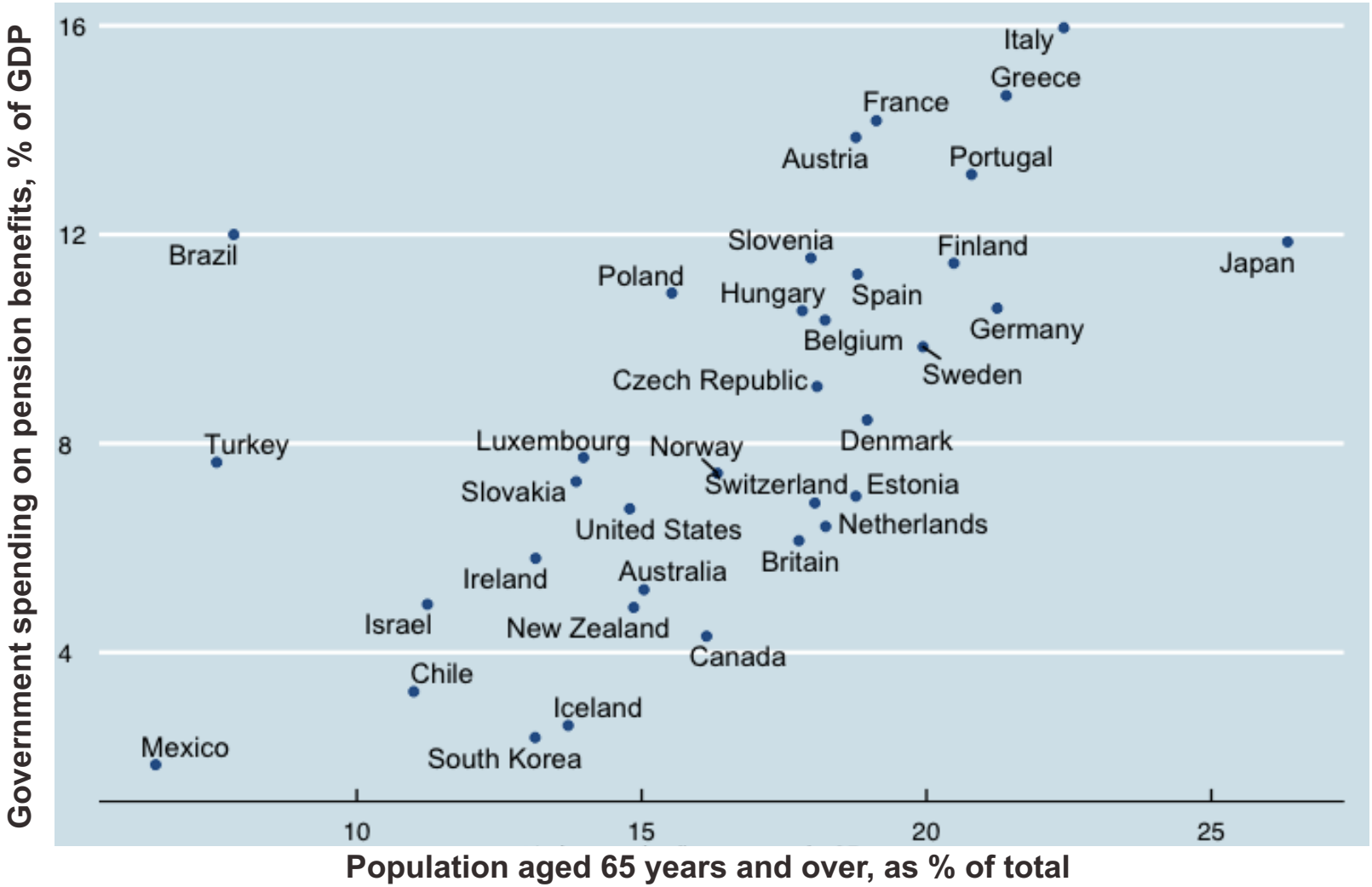
- Large numbers of elderly persons are not a problem if there are large numbers of producers
  - It is a problem when the ratio of elderly to producers becomes high, generating socioeconomic problems
- By 2050, projections indicate more than two billion older persons (60+) in the world
  - 22.1% in China and 5.1% in the US
- By 2050, projections indicate almost 450 million oldest-old people (80+)
  - 25.5% in China and 6.9% in the US

World, China, United States

World			
Year	Total	Older (60+)	Oldest-Old (80+)
2010	6,866,054,000	771,641,000	106,177,000
2020	7,631,072,000	1,047,071,000	148,476,000
2030	8,315,758,000	1,403,525,000	209,296,000
2040	8,896,845,000	1,741,939,000	315,576,000
2050	9,376,417,000	2,082,998,000	446,610,000
China			
Year	Total	Older (60+)	Oldest-Old (80+)
2010	1,330,141,000	171,050,000	19,658,000
2020	1,384,545,000	245,028,000	28,729,000
2030	1,391,491,000	349,324,000	42,482,000
2040	1,358,519,000	411,150,000	70,138,000
2050	1,303,723,000	459,525,000	113,890,000
United States			
Year	Total	Older (60+)	Oldest-Old (80+)
2010	309,326,000	57,466,000	11,301,000
2020	333,896,000	76,986,000	13,163,000
2030	358,471,000	92,228,000	19,459,000
2040	380,016,000	98,962,000	27,615,000
2050	399,803,000	106,087,000	30,942,000

Source: Poston, Bouvier (2017).

Government spending on pensions by population 65+



Source: Figure elaborated by Jairo Nicolau with data from The Economist (2017).

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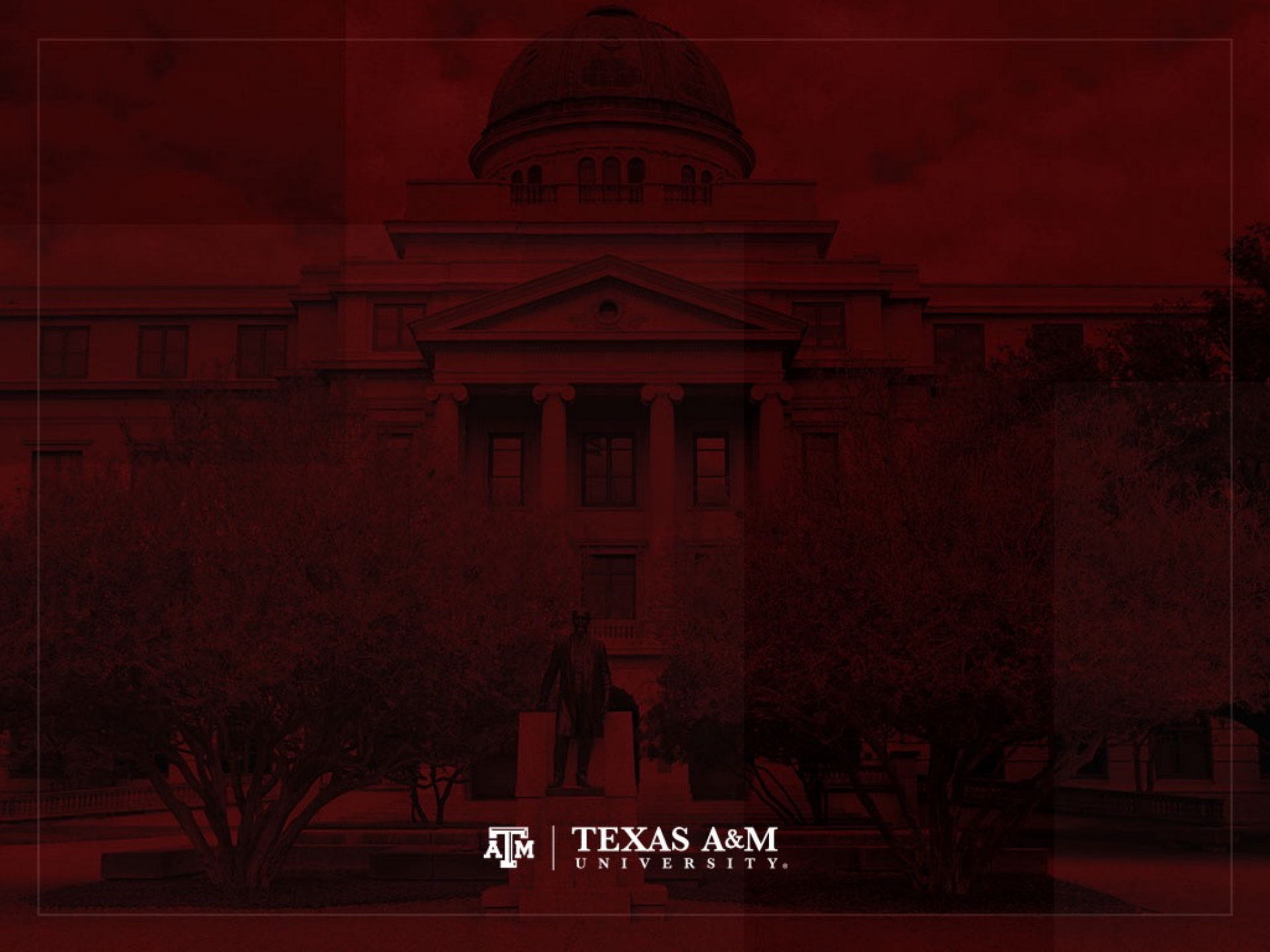
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