Fertility

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Outline

- Introduction
  - Conceptualization and measurement of fertility
- Framework for predicting fertility
- World fertility trends and patterns
- Fertility changes in the United States
  - Adolescent fertility
  - Nonmarital fertility
  - Childlessness
  - COVID-19 and fertility
- Male fertility

Introduction

- Intercourse, conception, and fertility are all influenced by social and cultural factors

- Several types of fertility analysis
  - **Cross-sectional (period) perspective:** based on a particular point or period of time
  - **Cohort analysis:** based on fertility patterns of a group (cohort) of women who go through childbearing years at the same time
  - **Micro analysis:** fertility analysis of persons
  - **Macro analysis:** fertility analysis of groups, e.g., countries

Conceptualization and measurement of fertility

- Fertility: actual production of male and female births
- Reproduction: actual production of female births
- Fecundity: biological capability of producing live births
- Childbearing years
  - Women in age group 15–49: these are the main ages when women are able to give birth
  - Sometimes the age group of 15–44 is used, especially in developed countries, because so few births occur to women ages 45–49

Fertility terms

- Fertility: actual production of births
- Infertility: childlessness either voluntary or involuntary
- Fecundity: ability to reproduce
  - Subfecund: definitely sterile, probably sterile, semifecund, and fecundity indeterminate
- Infecundity: sterility
- Menarche: beginning of the female reproductive period (first menstrual flow)
- Menopause: end of reproductive period (termination of menstruation)
- Postpartum: period of infecundability following a pregnancy; a function of the duration and intensity of lactation

Types of rates

- Birth rates = (girls + boys) / (women + men)
- Fertility rates = (girls + boys) / women
- Reproduction rates = girls / women

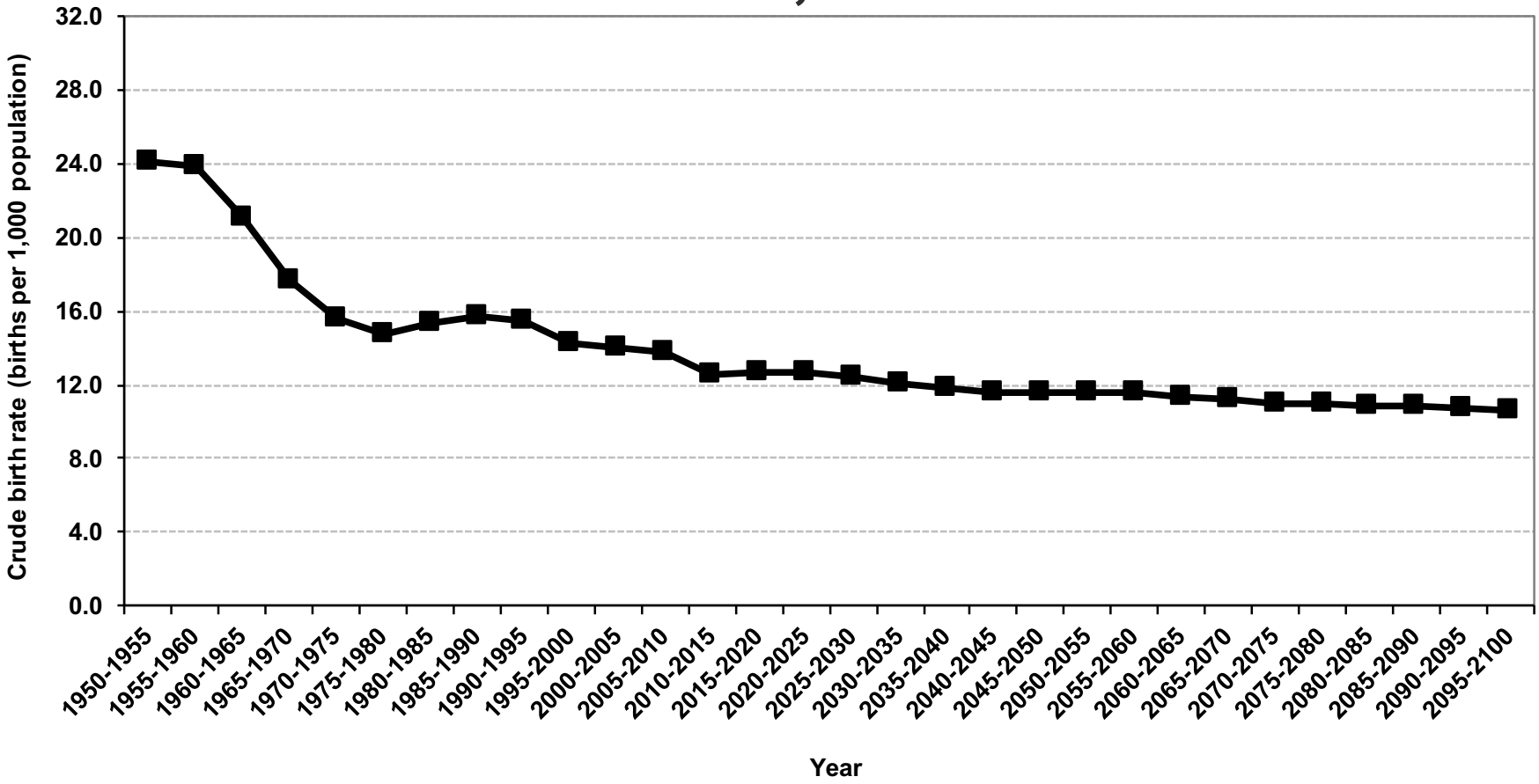
Crude birth rate (*CBR*)

- Cross-sectional

- The number of births occurring in a population in a year per 1,000 persons

CBR = number of births/midyear population*1,000

Crude birth rates, United States, 1950–2100



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

General fertility rate (*GFR*)

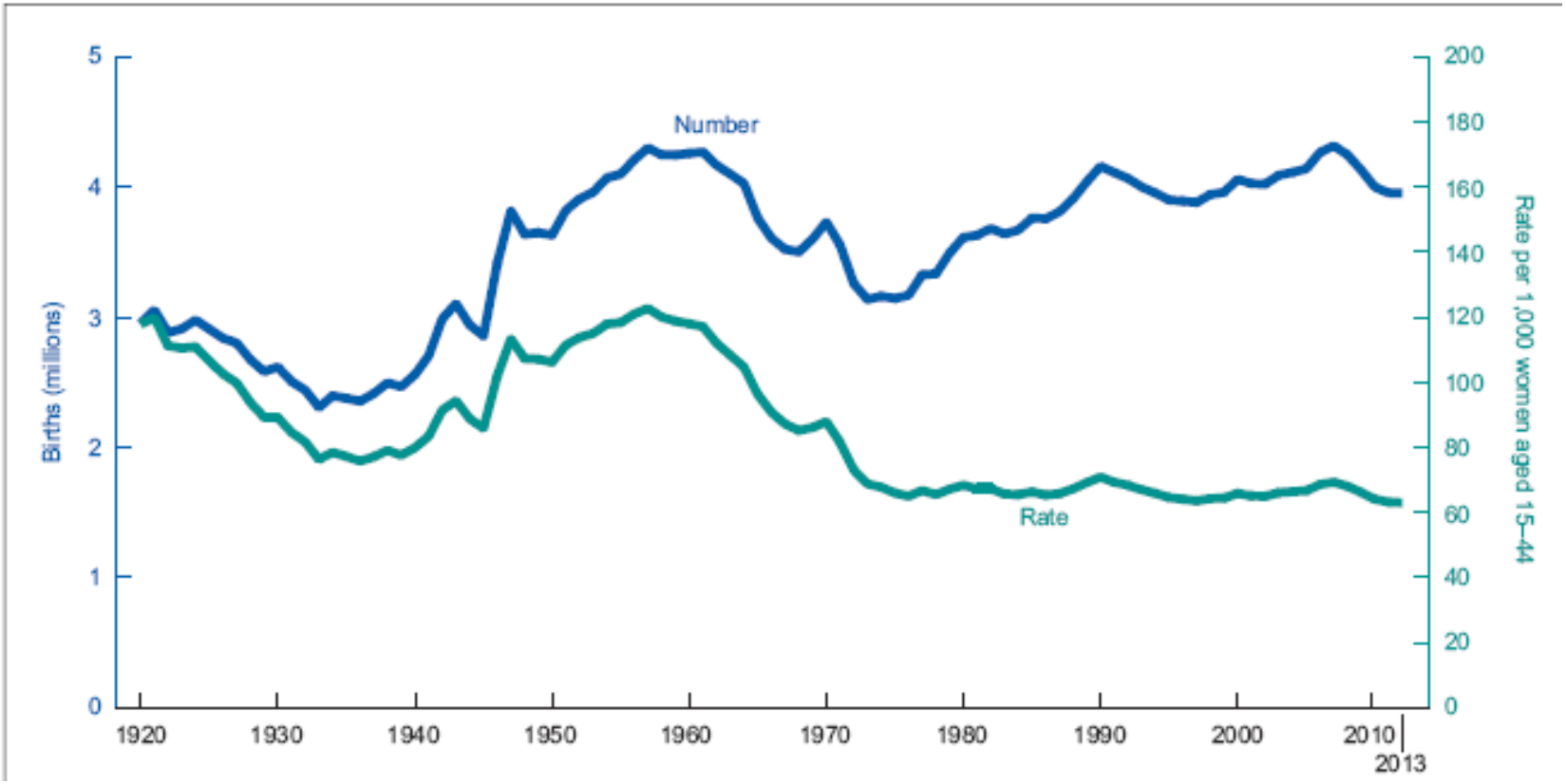
- Cross-sectional

GFR = number of births/midyear female population aged 15–49*1,000

GFR = *CBR**4.5, if data for *CBR* are only available

Live births and *GFR*, United States

Live Births and General Fertility Rates,* 1920 to 2013



*The denominator of the General Fertility Rates is women aged 15-44.
Source: Martin, Hamilton, and Osterman, 2015: 3.

Age-specific fertility rates (*ASFR*)

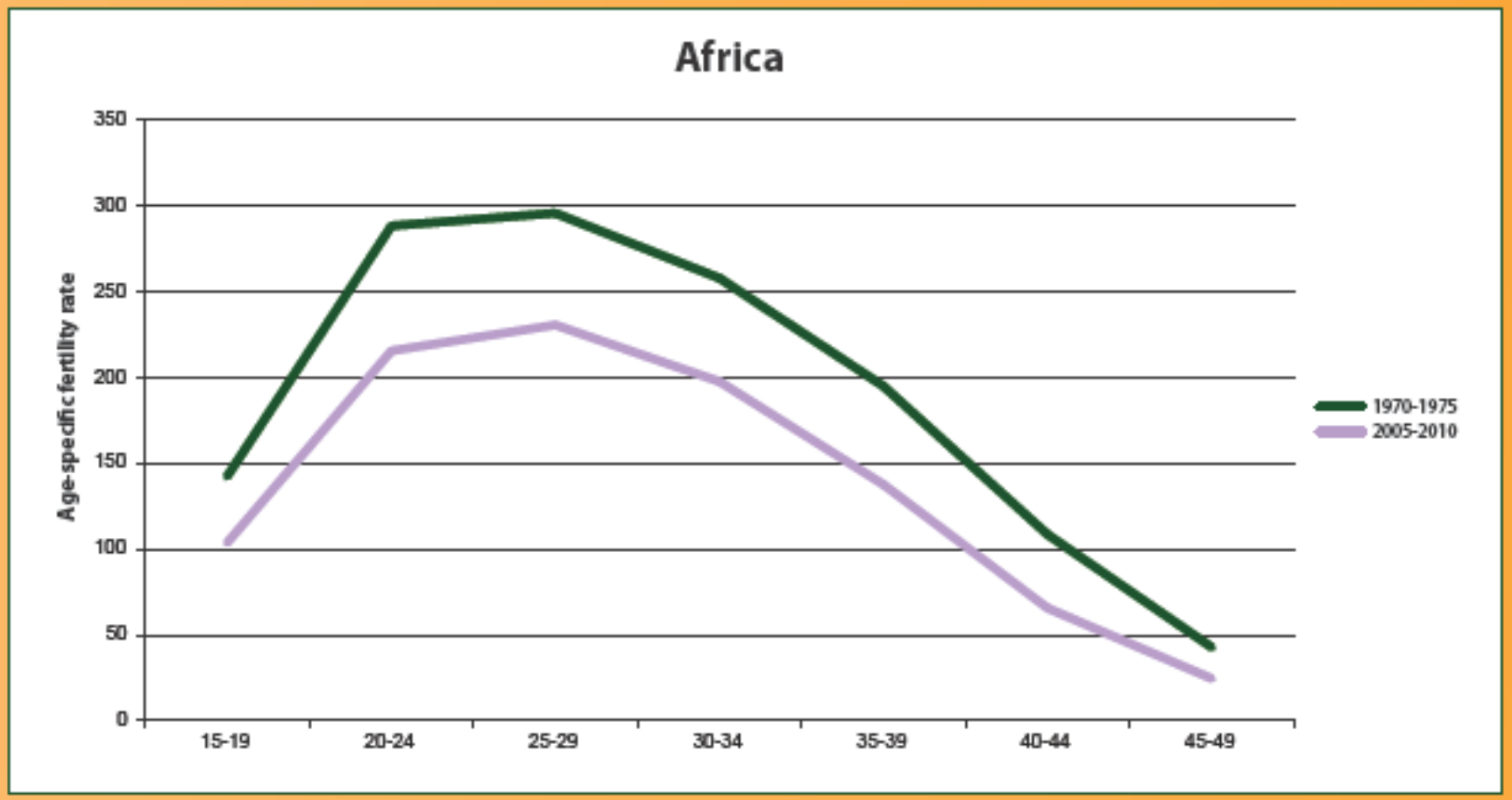
- Births rates of women according to their ages
- Usually calculated for women in each of the seven 5-year age groups
  - 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49
  - Sometimes 35 single-year age groups are used
  - ${}_nASFR_x$ means *ASFR* for age group x to $x+n$

$$ {}_nASFR_x = {}_n\text{births}_x / {}_n\text{females}_x * 1{,}000 $$

- Age curve of fertility: the seven plotted *ASFRs* usually have an inverted U shape

ASFR

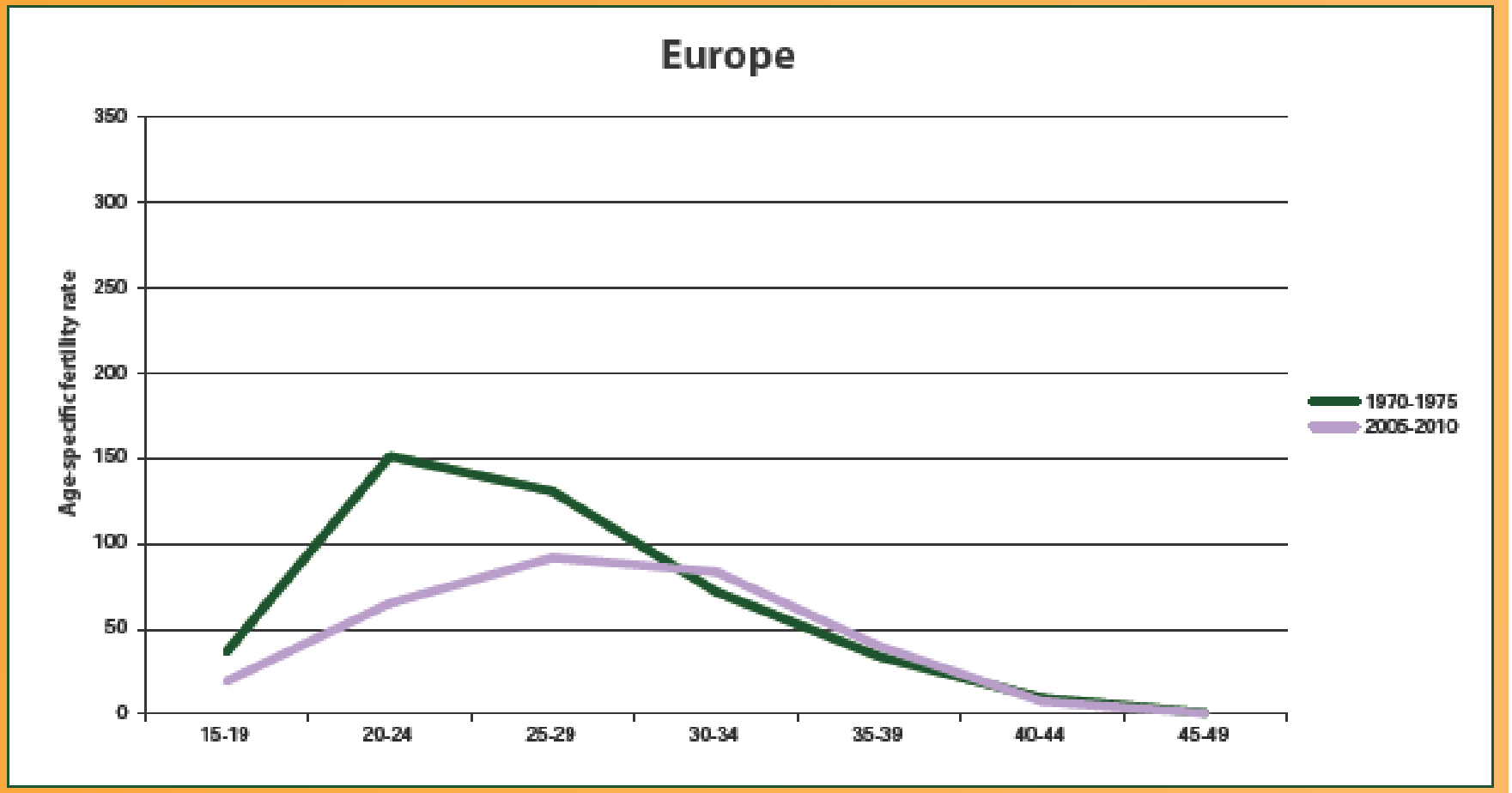
Age-specific Fertility Rates, Africa, 1970-75 and 2005-10



Source: United Nations, 2014a.

ASFR

Age-specific Fertility Rates, Europe, 1970-75 and 2005-10



Source: United Nations, 2014a.

Total fertility rate (*TFR*)

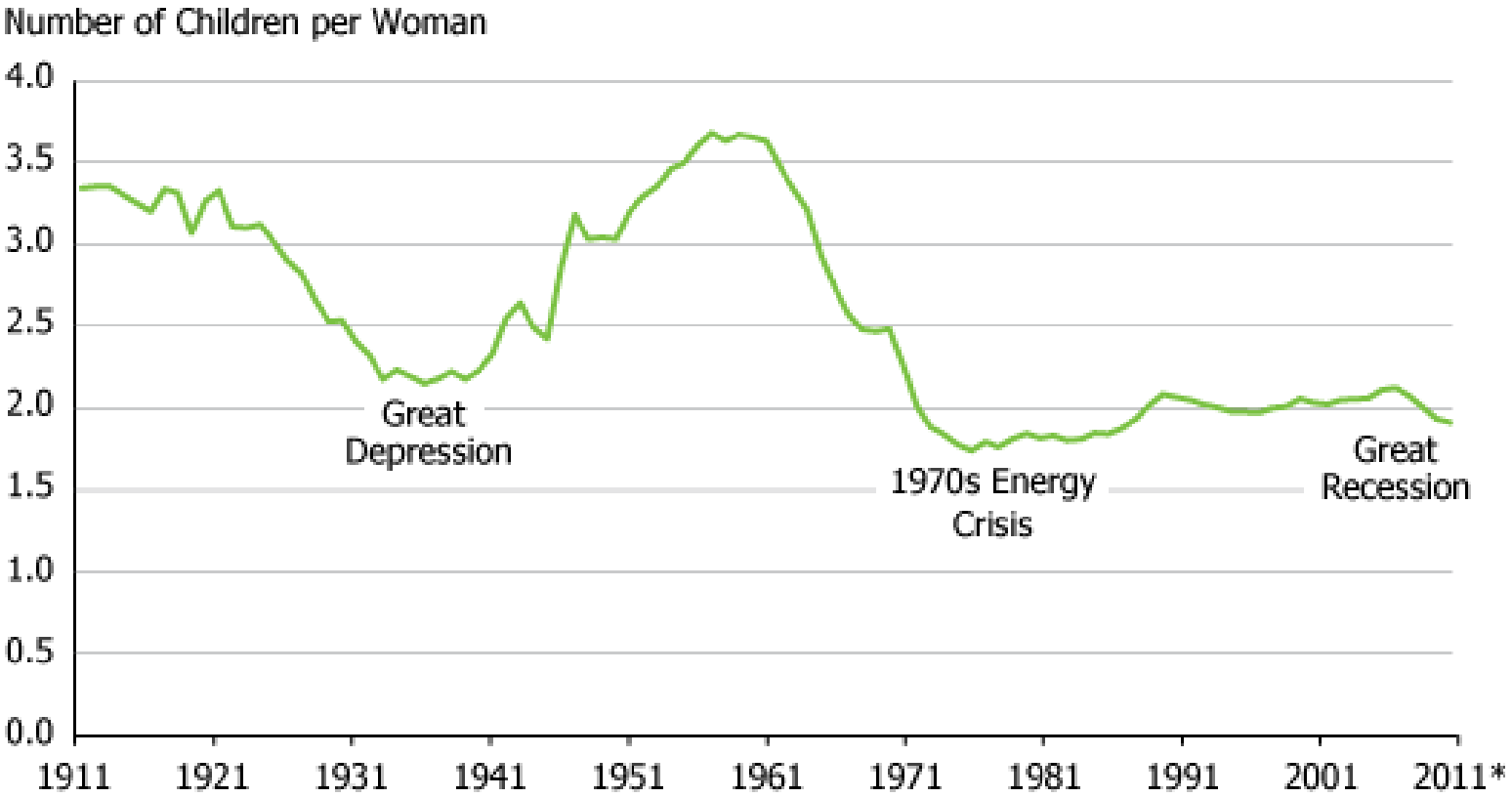
- The most popular measure of fertility
- Mostly cross-sectional, but also calculated for cohorts
- Definition
  - Number of births that a hypothetical group of 1,000 women would produce during their reproductive years
  - Between the ages of 15 and 49

$$TFR = \sum({}_{n}ASFR_{x} * i)$$

  - i (or n) = width of the age group, usually 5
  - *TFR* can be divided by 1,000 to obtain the average number of births to a single woman

TFR

Total fertility rates, United States, 1911 to 2011.



Source: Mather, 2012 (reprinted with permission of the Population Reference Bureau).

Approximation for *TFR*

- *TFR* = *CBR* * 4.5 * 30 = *GFR* * 30
  - When only CBR or GFR data are available

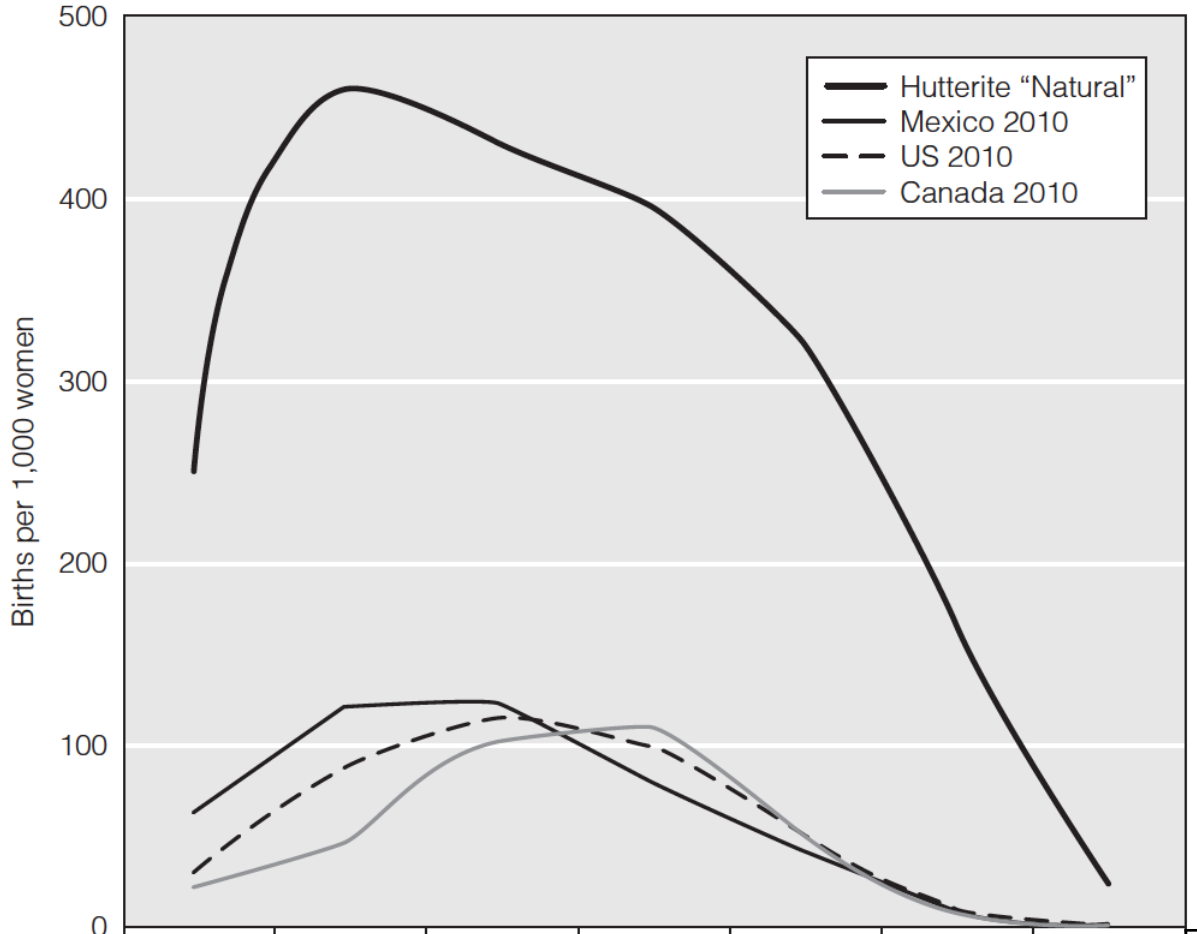
- Period *TFRs* are preferred over cohort *TFRs* due to their currency

Natural fertility

- Natural fertility (Henry 1961, Coale and Trussell 1974)
  - Level of reproduction in the absence of deliberate fertility control
  - Closer to 6 or 7 live births per woman
  - 25% of completed fertility is due to genetics (same as mortality)
- Hutterites had 11 children per woman (1930s)
  - Ethnoreligious group formed in the early 16th century
  - Early age at marriage, good diet, good medical care, regularly engage in intercourse without contraception or abortion
  - Nowadays, almost all live in South Dakota, North Dakota, Montana, and Western Canada

Source: Weeks, 2015.

Age-specific fertility rates



		15–19	20–24	25–29	30–34	35–39	40–44	45–49	TFR
1930	Hutterite "Natural"	250	460	431	396	321	167	24	11.0
	Mexico 2010	63	121	123	80	42	9	2	2.2
	US 2010	31	88	115	99	50	10	1	2.0
	Canada 2010	15	47	102	110	51	8	0	1.7

Source: Weeks, 2015.

Gross reproduction rate (*GRR*)

- Similar to *TFR*, but it includes female births only
  - Based on the concept of population replacement

$$GRR = \sum({}_{n}ASFR_{x}^{f} * i)$$

  - ${}_{n}ASFR_{x}^{f}$: female births per women in age group x to $x+n$
  - i (or n) = width of the age group, usually 5

Approximation to *GRR*

- Approximation to *GRR*

$$GRR = TFR * \text{female births / births}$$

$$GRR = TFR * 0.488$$

  - Constant 0.488 is based on the sex ratio at birth of most countries
  - SRB = 105
  - Proportion of female births (f_{fab})

$$f_{fab} = 1 - \text{proportion of male births}$$

$$f_{fab} = 1 - [105 / (105+100)]$$

$$f_{fab} = 1 - 0.512 = 0.488$$

  - If SRB ≠ 105, another constant should be used

Net reproduction rate (*NRR*)

- It considers the factor of mortality among mothers from the time of births of their daughters
  - Based on the concept of population replacement

$$NRR = \sum({}_nASFR_x^f * {}_nL_x / 5l_0 * i)$$

$$NRR = \sum({}_nASFR_x * 0.488 * {}_nL_x / 5l_0 * i)$$

  - ${}_nASFR_x^f$: female births per women in age group
  - ${}_nL_x$: total number of person-years lived in age group
  - l_0: number of people at age 0
  - ${}_nL_x / 5l_0$: proportion of people who survive from age 0 to the midpoint of each of the seven age intervals
  - i (or n) = width of the age group, usually 5

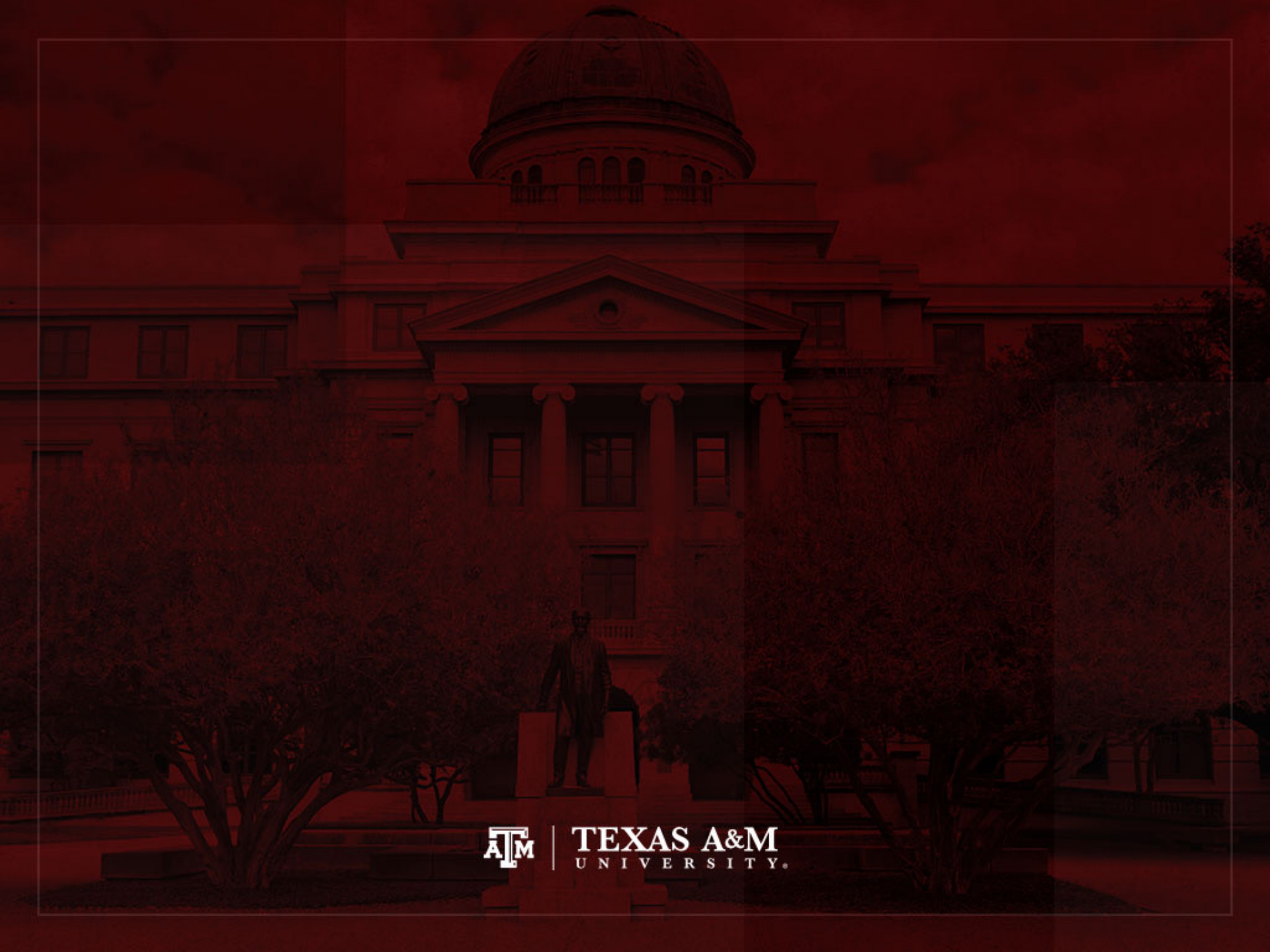
Mean length of a generation

- Mean length of a generation is the mean age of mothers, giving birth to live daughters, with current age-specific fertility and mortality rates

Mean length of a generation =

$$\sum({}_{n}ASFR_{x}^{f} * {}_{n}L_{x} / 5l_{0} * i * \text{mid-point of age group}) / NRR$$

  - ${}_{n}ASFR_{x}^{f}$: female births per women in age group
  - ${}_{n}L_{x} / 5l_{0}$: proportion of people who survive from age 0 to the midpoint of each of the seven age intervals
  - i (or n) = width of the age group, usually 5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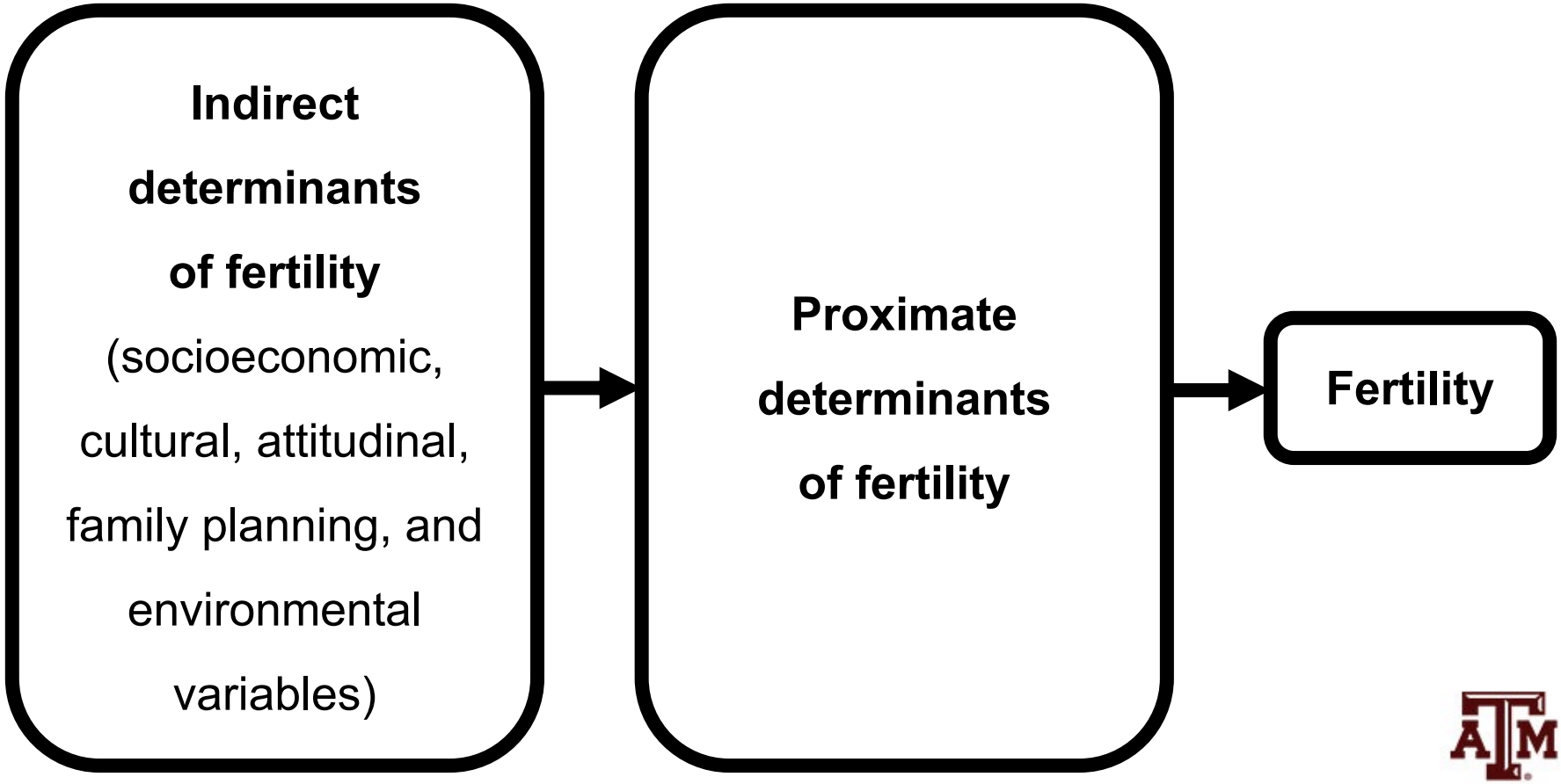
Framework for predicting fertility

Major variables operate through proximate determinants in predicting fertility



Source: Bongaarts (1978, 1982).

Intermediate variables & proximate determinants of fertility

- Means for regulating fertility have been popularly labeled the **intermediate variables** (Davis, Blake 1955)
  - 11 variables through which any social factor influencing the level of fertility will operate
  - 3 phases to fertility (intercourse, conception, gestation)

- **Proximate determinants of fertility** (Bongaarts 1978, 1982)
  - 4 of these variables account for differences in fertility between populations
  - Their importance varies across time and space

Table 6.1 The Proximate Determinants of Fertility—Intermediate Variables through which Social Factors Influence Fertility

Most Important of the Proximate Determinants	Proximate Determinants or Intermediate Variables
	I. Factors affecting exposure to intercourse ("intercourse variables").
	A. Those governing the formation and dissolution of unions in the reproductive period.
✔	1. Age of entry into sexual unions
	2. Permanent celibacy: proportion of women never entering sexual unions.
	3. Amount of reproductive period spent after or between unions.
	a. When unions are broken by divorce, separation, or desertion.
	b. When unions are broken by death of husband.
	B. Those governing the exposure to intercourse within unions.
	4. Voluntary abstinence.
	5. Involuntary abstinence (from impotence, illness, unavoidable but temporary separations).
	6. Coital frequency (excluding periods of abstinence).
	II. Factors affecting exposure to conception ("conception variables")
✔	7. Fecundity or infecundity, as affected by involuntary causes, but including breastfeeding.
✔	8. Use or nonuse of contraception.
	a. By mechanical and chemical means.
	b. By other means.
	9. Fecundity or infecundity, as affected by voluntary causes (sterilization, medical treatment, and so on).
	III. Factors affecting gestation and successful parturition ("gestation variables").
	10. Fetal mortality from involuntary causes (miscarriage).
✔	11. Fetal mortality from voluntary causes (induced abortion).

Sources: Adapted from Kingsley Davis and Judith Blake (1955); and John Bongaarts (1982).

Source: Weeks 2015, p.214.

Intermediate variables

- Intermediate variables proposed by Kingsley Davis and Judith Blake (1956)
  - Behavioral and biological variables directly influencing fertility
  - Other social, economic, cultural, and environmental factors influence fertility by operating through the intermediate variables

Intercourse, conception, gestation

- Davis and Blake identified a set of 11 intermediate variables, which directly affect fertility and are grouped into three factors
  - **Intercourse** is affected by
    - Proportion of persons who marry
    - Length of time married
    - Frequency of sexual intercourse while married
  - **Conception** is affected by
    - Contraception
    - Voluntary or involuntary infecundity
  - **Gestation/parturition:** birth probability depends on
    - Likelihood of miscarriage and abortion

Proximate determinants of fertility

- Proximate determinants of fertility proposed by John Bongaarts (1978, 1982)
  - Operationalized proximate determinants of fertility to incorporate them into quantitative reproductive models
  - Designed to facilitate quantitative specification of variables
  - One of the most useful frameworks for studying fertility

Seven proximate determinants

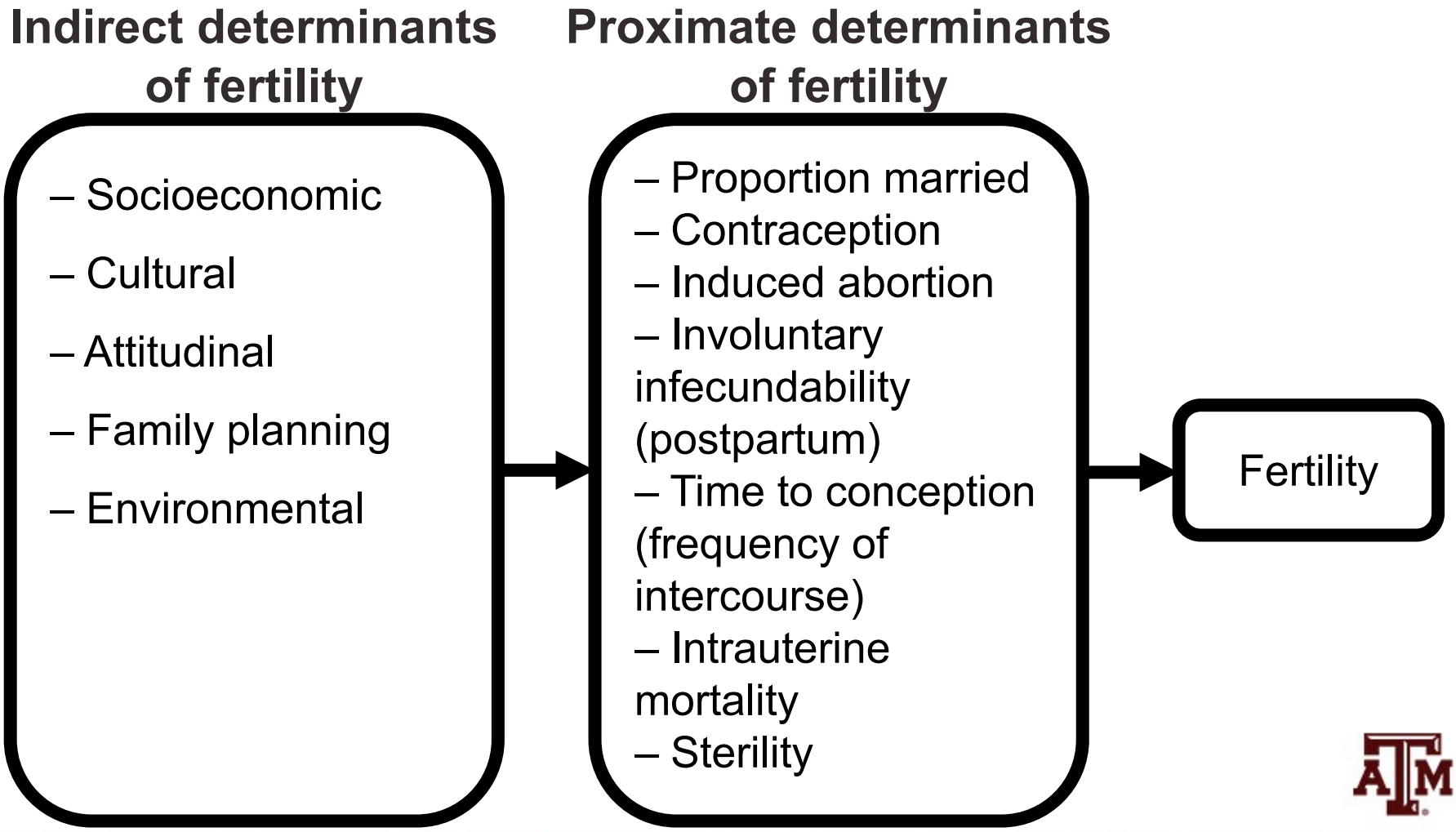
- Marriage and marital disruption
- Contraceptive use and effectiveness
- Prevalence of induced abortion
- Duration of postparturm infecundability
- Waiting time to conception
- Risk of intrauterine mortality
- Onset of permanent sterility

Source: Bongaarts (1978, 1982).

Main proximate determinants

- Proportion married (limiting exposure to intercourse)
  - Younger woman (less sexual intercourse)
  - Household with both mother and father (closer surveillance)
  - Mother well-educated (awareness of costs of pregnancy)
  - Later age at marriage (lower levels of fertility)
- Use of contraceptives
- Induced abortion (Hodgson 2009)
- Involuntary infecundity
  - Breastfeeding prolongs postpartum amenorrhea and suppresses ovulation

Framework for proximate determinants of fertility



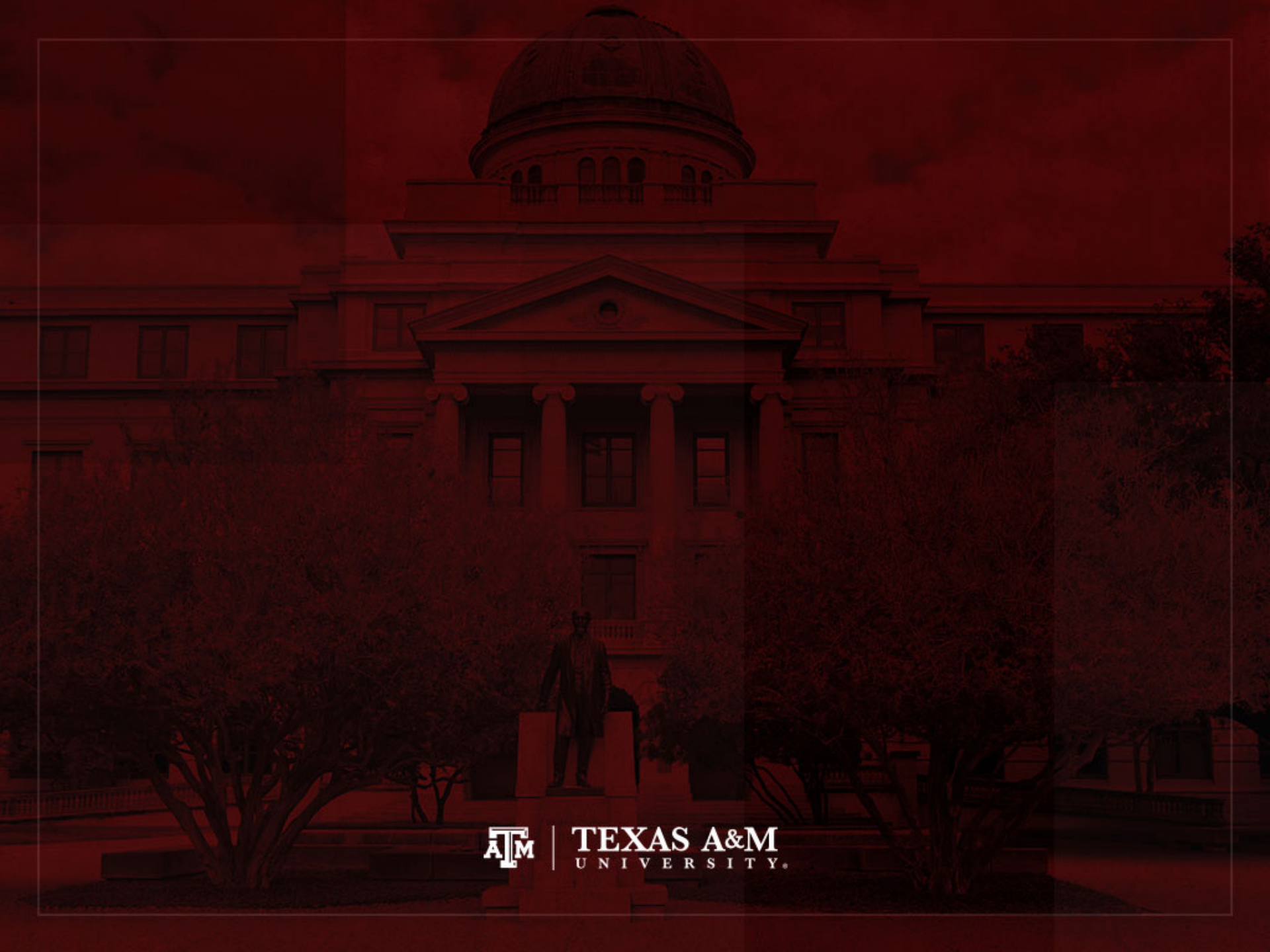
Source: Bongaarts (1978, 1982).

Indices

- Indices of the first four proximate determinants for women in their reproductive years
- Indices range from 0 (the greatest inhibiting effect on fertility) to 1 (no inhibiting effect)
  - **Marriage-pattern index (*Cm*)**: 1 when all women are married and 0 when none are married
  - **Contraception index (*Cc*)**: 1 when no contraception is used and 0 when all women are using effective contraceptives
  - **Abortion index (*Ca*)**: 1 when there is no induced abortion and 0 when every pregnancy is aborted
  - **Postpartum-infecundability index (*Ci*)**: 1 when no women are in the period of postpartum infecundability and 0 when all women are

Stover

- Stover's (1998) modifications and extensions to the Bongaarts model to consider demographic realities of modern societies
- Use of sexual activity instead of marriage as the indicator of exposure to pregnancy
- Extension of the sterility index to measure infecundity from all causes
- Revision of the contraception index to consider the fact that users of sterilization could become infecund before the age of 49
- Change of the estimate of total fecundity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World fertility trends and patterns

- High-fertility countries with TFRs higher than 3.2
  - Mostly sub-Saharan African countries
  - Gradual decreases expected in a couple of decades

- Low-fertility countries with TFRs of 2.0 or less
  - European, Asian, Latin American, and Caribbean countries
  - Slight increases expected in the lowest-low fertility rates in next two decades
    - Some of the previous decline (period effect) was a result of postponement of fertility (tempo effect)

Source: United Nations, 2013.

Low levels of fertility

- Billari, Kohler (2004)
- "Low" fertility: TFRs between 2.1 and 1.6
  - 43 countries in 2013
- "Very low" fertility: TFRs between 1.5 and 1.3
  - 27 countries in 2013
- "Lowest low" fertility: with TFRs under 1.3
  - 9 countries in 2013, including South Korea, Taiwan, Poland, Portugal, Singapore, Hong Kong, and Macao

Depopulation

- Depopulation is the decline in population size
  - Projected to occur in most countries in 50–100 years
- Based on rate of natural increase (RNI)
  - RNI = (Crude birth rate − Crude death rate) / 10
  - Where CBR and CDR are in per thousand form
- No population growth in Europe in 2014
  - Rate of natural increase (RNI) of 0.0%

RNI examples

- Examples of countries with zero or negative RNI
  - Bulgaria, Serbia: RNI = –0.5%
  - Latvia, Lithuania, Hungary, Ukraine: RNI = –0.4%
  - Germany: RNI = –0.2%
  - Italy: RNI = –0.1%
  - Russia: RNI = 0.0%
    - Depopulation in Russia expected from 143.7 million (2014) to 134.1 million (2050)

Replacement-level fertility

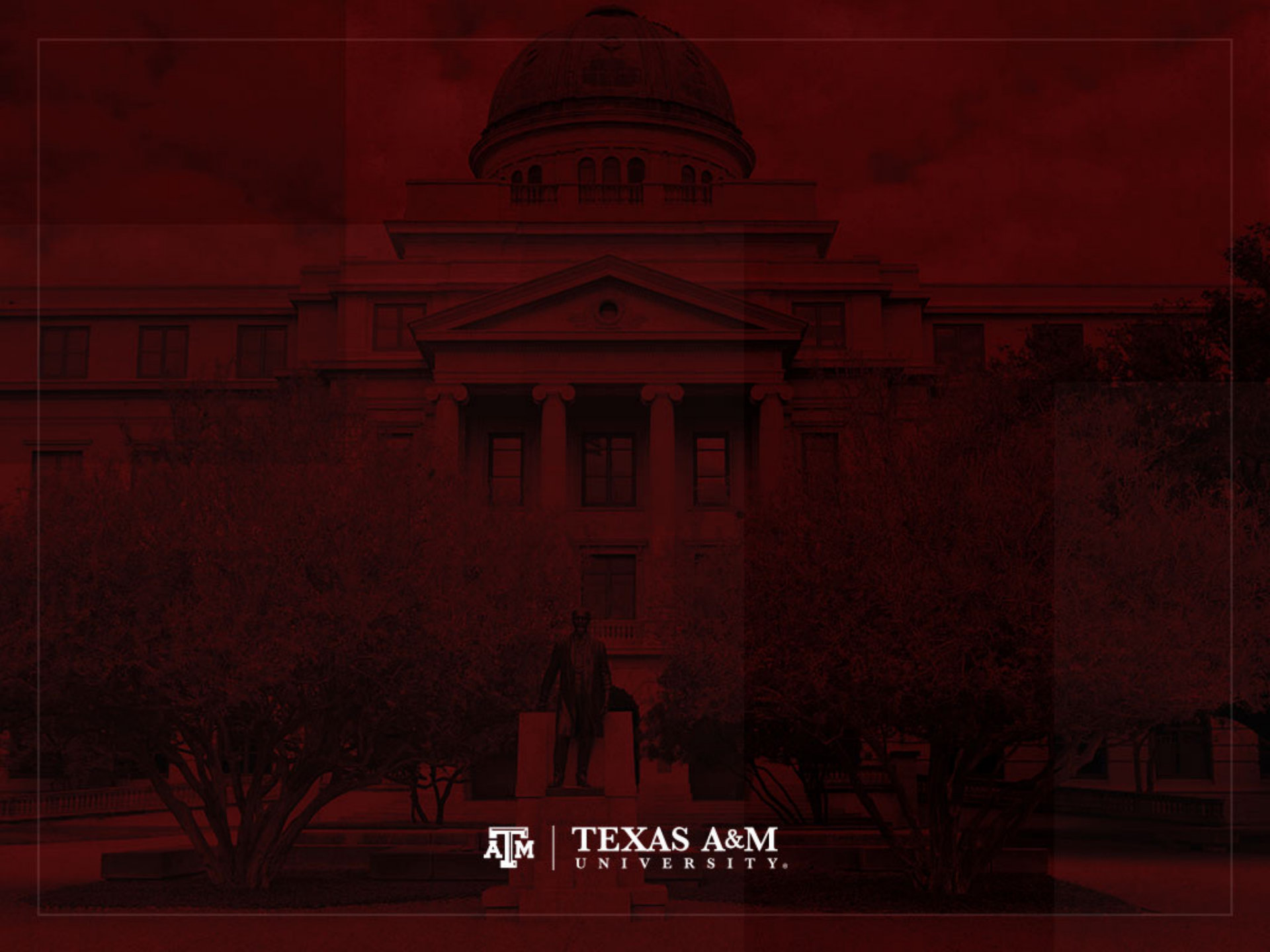
- TFRs at or near replacement of 2.1 are needed for a population to remain stable
  - In 2013, 79 countries with TFRs at or lower than the replacement level of 2.1
- Some countries with low TFRs do not experience depopulation
  - There are still large numbers of women in childbearing years due to past high fertility

African countries

- Lower rates of fertility in African countries
- Lower rates of mortality and immigration
- This trend will be responsible for depopulation even in some African countries in the next 50 years or so

Implications of low fertility

- Fertility decline: birth cohorts become smaller
- This pattern and increases in life expectancy lead to aging of a population
  - Larger proportion of the population that is older than age 65
  - Smaller proportion in working ages
- Between 2005 and 2050 (United Nations, 2005)
  - Old-age dependency ratio will double in developed countries from 22.6 to 44.4 percent
  - Healthcare and pension programs not well equipped to handle large increases of elderly population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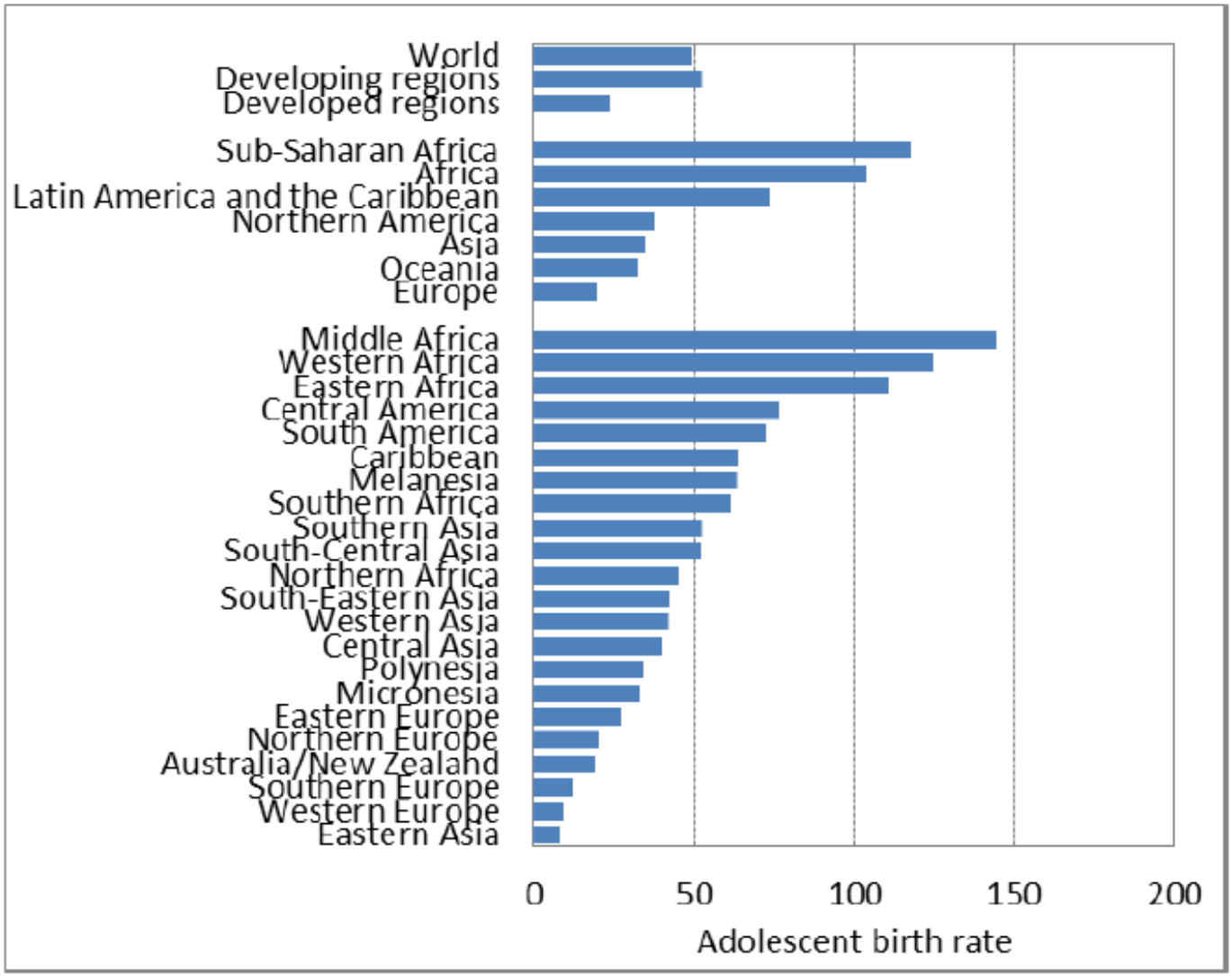
Fertility changes in the U.S.

- Rapid decrease of TFR from 7 to under 4 between 1800 and 1900
- Early 20th century: sustained fertility decline
  - Rapid economic transition, industrialization, and urbanization
- Declining TFR to be just around 2
  - Since the peak at 3.7 in the late 1950s
- RNI of 0.4% in 2014
  - The highest RNI of any of the developed countries
- Aging population as a whole

Adolescent fertility

- ASFR for women aged 15–19
- Potential impacts of early childbearing on women
  - Ending up having more births
  - Premature end to schooling
  - Loses in economic potential
  - Poor health expected for their children
- Adolescent fertility rate (2005–2010)
  - World: 48.9 per 1,000
  - Developed countries: 23.6
    - Switzerland (4.5), United States (39.7), Bulgaria (42.1)
  - Developing countries: 52.7
    - North Korea (0.6), Niger (209.6)

Adolescent Birth Rates by Development Groups, Regions and Subregions of the World, 2005-2010

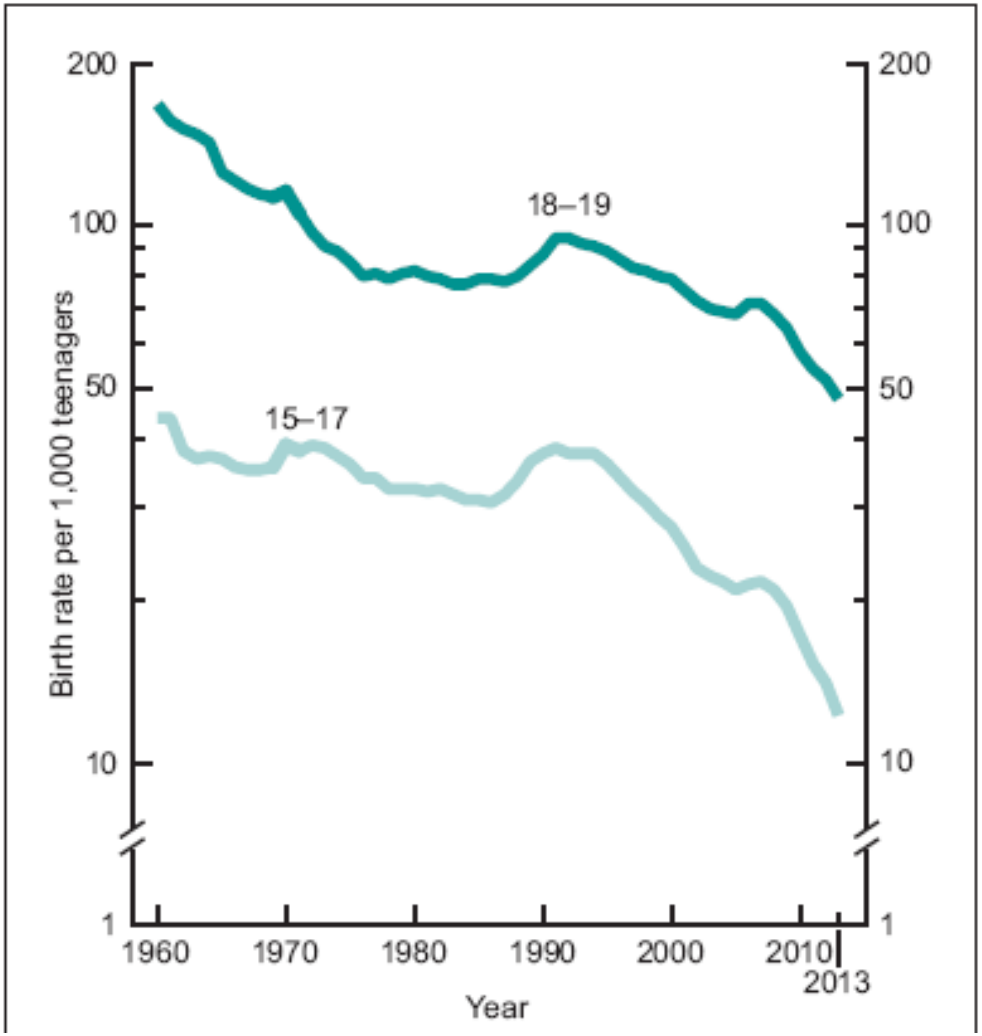


Source: United Nations, 2013a: 4.

U.S. adolescent fertility

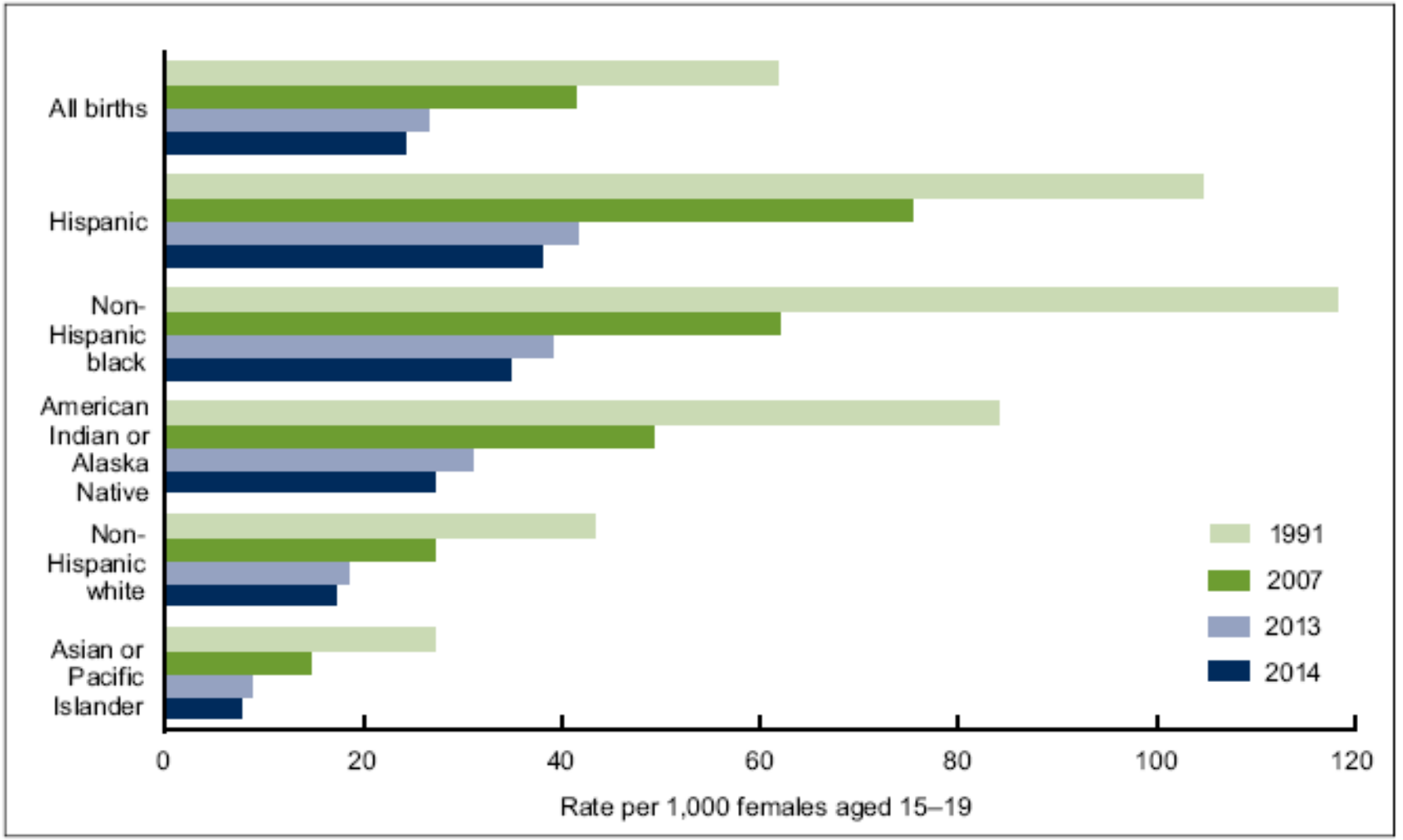
- Downward trend since 1940, possibly due to increases in contraception use
- Among teenagers, significant increase in the percentage of births to unmarried teenagers
  - 14% (1940) to 89% (2013)
- Fertility of younger teenagers (15–17) and older teenagers (18–19) in 2013
  - 12.3 per 1,000 and 47.3 per 1,000, respectively
- Differentials by race/ethnicity (2014)
  - Asian and Pacific Islander (7.7 per 1,000)
  - Hispanics (38 per 1,000)

Birth rates for Teenagers (aged 15–17 and aged 18–19): United States, 1960–2013



Source: Ventura, Hamilton, and Mathews, 2014: 3.

Birth Rates for Teenagers (aged 15–19),
By Race and Hispanic Origin:
United States, 1991, 2007, 2013, 2014

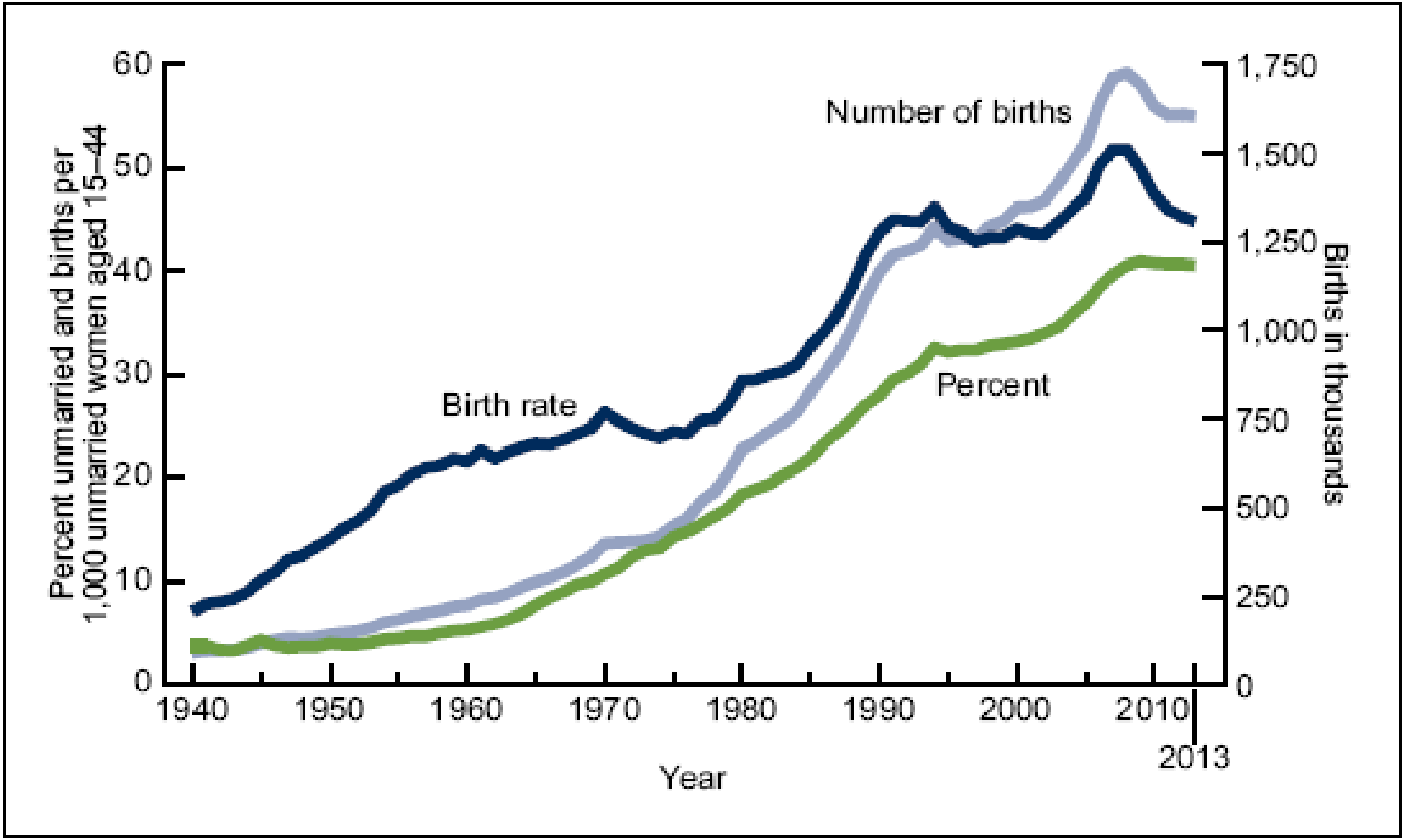


Source: Martin, Hamilton, and Osterman, 2015.

Nonmarital fertility

- Fertility of women who are not married, widowed, or divorced
  - Used to be called “illegitimate fertility”
- Marital status of the mother
  - Marker of financial, social, and emotional resources
- In 2013, 41% of nonmarital births out of the total number of all births
  - Gradual increase since the 1940s when it was very low (4%)
- Differentials by race/ethnic groups
  - Asians: the lowest, 17% of all Asian births
  - Blacks: the highest, 71% of all Black births
- Nonmarital births include births to women in cohabiting unions and unmarried women not cohabiting

Number of Births, Birth Rate, and Percentage of Births to Unmarried Women, United States, 1940-2013

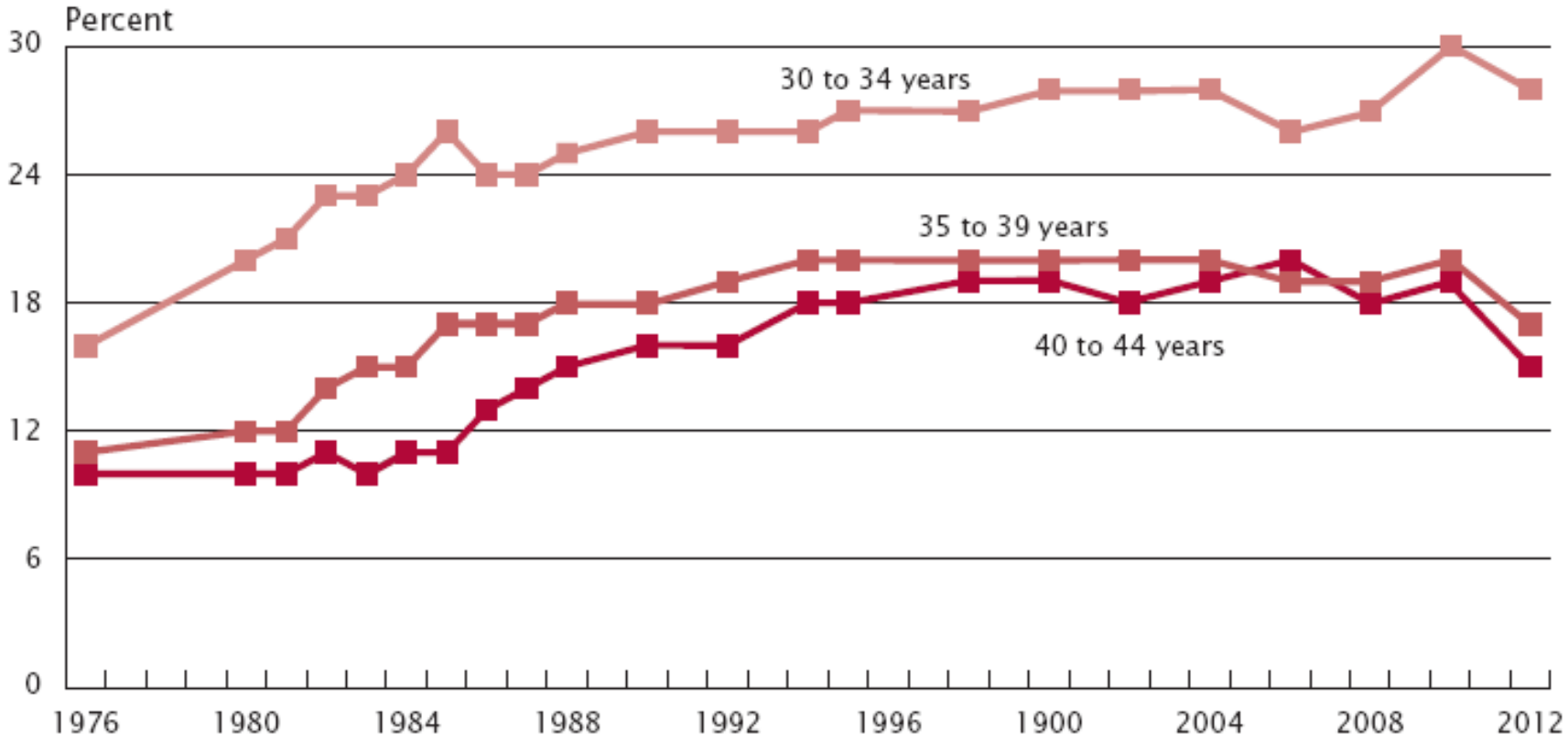


Source: Curtin, Ventura, and Martinez, 2014: 1.

Childlessness

- Women having no children voluntarily or involuntarily
- Voluntary childlessness almost nonexistent between the 1950s and 1960s
- Increasing childlessness in the U.S. since the 1970s
- Mainly due to voluntary childlessness
- Attitudes and norms toward childlessness becoming more positive overall with changes in gender norms

Percentage Rates of Childlessness for Women Aged 30 to 44, United States, 1976-2012



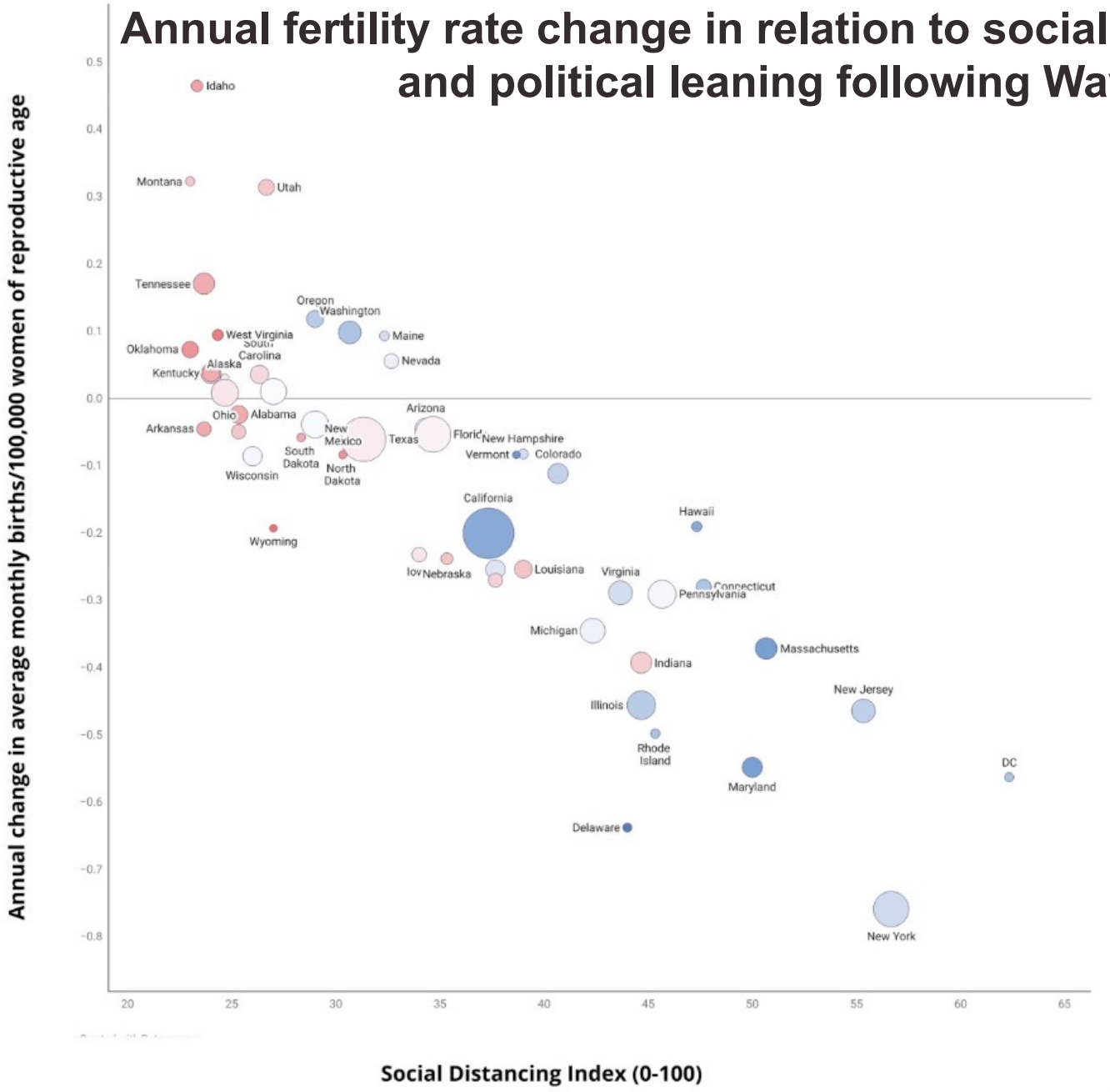
Source: Monte and Ellis, 2014: 7

COVID-19 and fertility

- How did COVID-19 affect fertility in the U.S.?
  - Wave 1: First peak for each state after February 2020
  - Wave 2: Second peak, during Fall/Winter 2020–2021
- Fertility fell and recovered on a national level
  - Shifts were not uniform across states and were influenced more by state-level economic, racial, political, and social factors than by COVID-19 severity
  - Authors suggest individual-level analysis after their ecological study (state level)
  - Correlation between social distancing index and fertility rate change: Possibly individual and state concerns to mitigate pandemic...

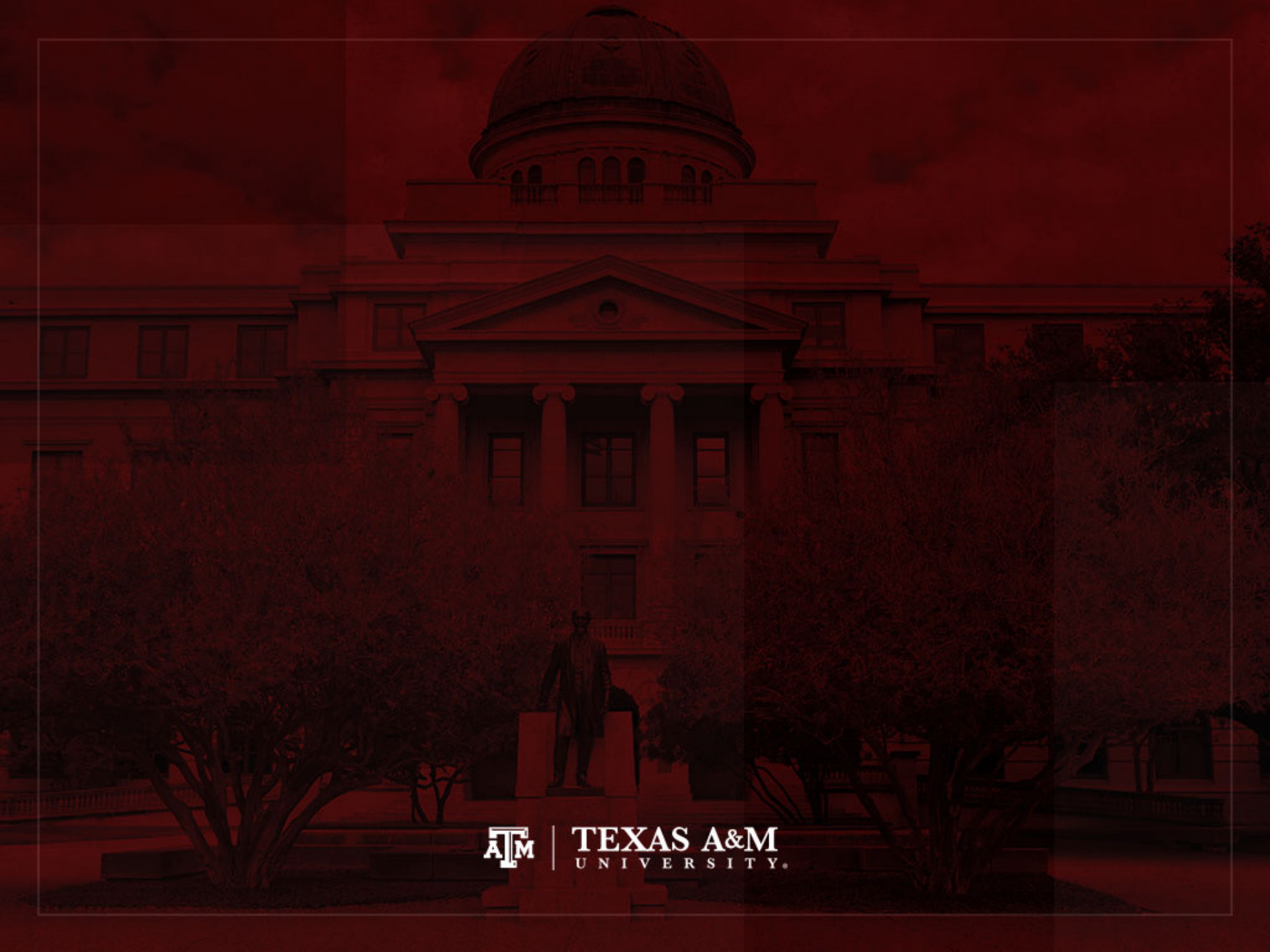
Source: Adelman et al. 2023 (https://doi.org/10.1093/humrep/dead055).

Annual fertility rate change in relation to social distancing index and political leaning following Wave 1



- Political leaning
  - Republican
  - Democrat
- Point size
  - Number of women of reproductive age, 2020

Source: Adelman et al. 2023 (https://doi.org/10.1093/humrep/dead055).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Male fertility

- Rarely examined in fertility studies
- Reasons for the exclusion of males from fertility studies
  - **Biological:** a wider range of childbearing years (ages 15–79) for males; theoretically no limitation of the number of children males can have
  - **Methodological:** less data available for males than for females (i.e. father's data often missing on birth-registration certificates)
  - **Sociological:** males often regarded as breadwinners, with little involvement in fertility except for impregnating women

Importance of male fertility

- Greater variance within males
- Marriage as a fertility determinant
- Different patterns of male fertility

Greater variance within males

- Greater variance contributed by the male sex than the female sex to the next generation
- Most females reproduce
- Some males don’t
- Other males have large number of offspring

Marriage as a fertility determinant

- Male fertility is likely to be influenced by
  - Marital status
  - Employment status

- Married and employed men usually have higher number of children ever born

Different patterns of male fertility

- Age-specific fertility beginning a little later among men
- Age-specific fertility stopping much later among men than among women
- Male TFRs higher than female TFRs
  - Especially in countries with male and female TFRs higher than 2.2

Cohabitation patterns by sex

- Higher tendency of women to cohabit than men
- This difference is more evident among women
  - Who previously lived alone
  - Are foreign-born
  - Live in fragmented families

Marriage and fertility patterns

- Different marriage and fertility patterns by sex
- Stronger negative effects of educational attainment on fertility among women, compared to men
- Unemployment is related to men's postponement of marriage
- Stronger religion effect among women than men

More research needed

- Much-needed incorporation of gender studies into demography
- Fertility and parenting involving both men and women

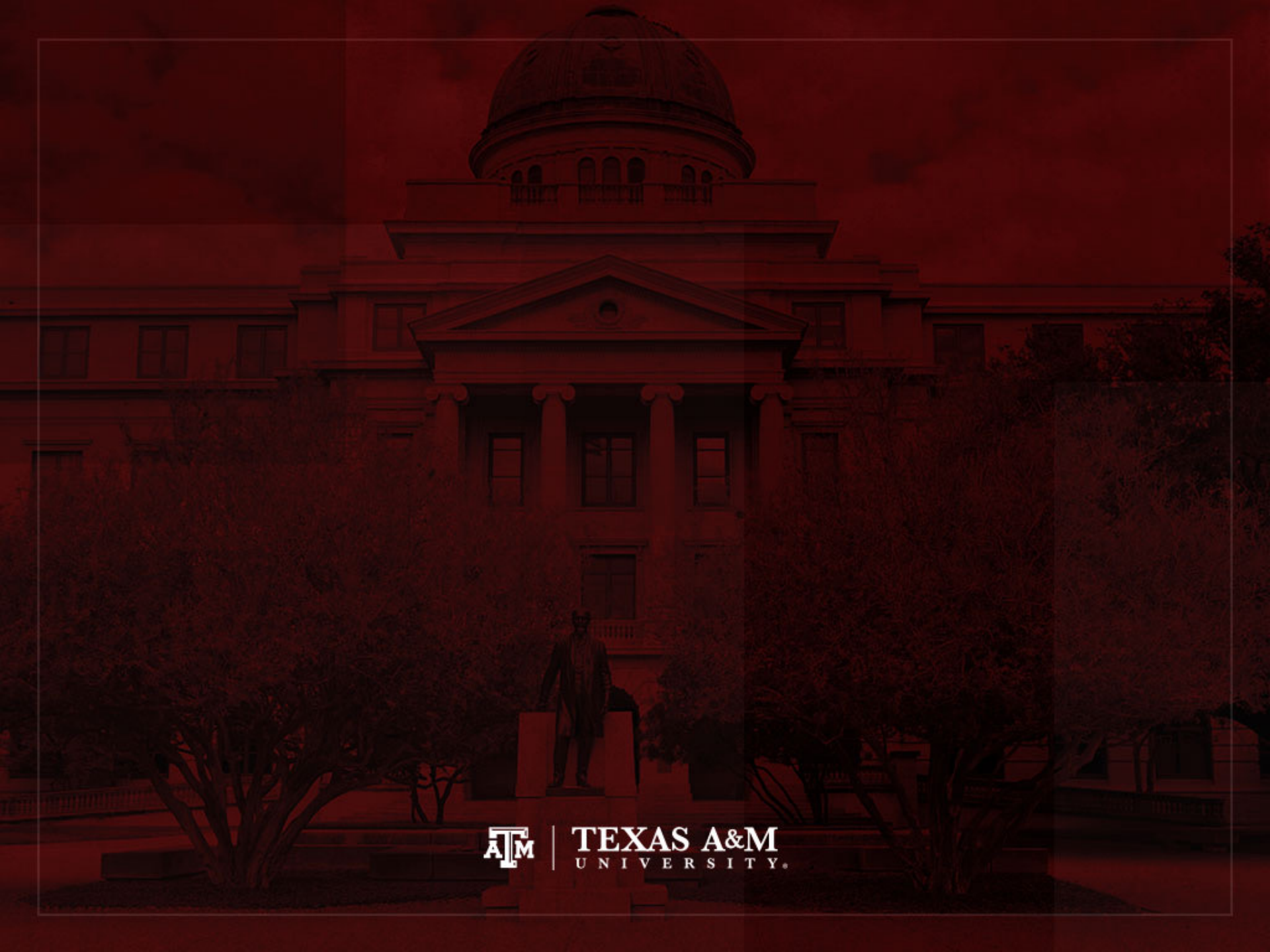
References

Adelman S, Charifson M, Seok E, Mehta-Lee SS, Brubaker SG, Liu M, Kahn LG. 2023. "State-specific fertility rate changes across the USA following the first two waves of COVID-19." Human Reproduction, 38(6): 1202–1212. (https://doi.org/10.1093/humrep/dead055)

Poston DL, Bouvier LF. 2017. Population and Society: An Introduction to Demography. New York: Cambridge University Press. 2nd edition. Chapter 4 (pp. 59–94).

Wachter KW. 2014. Essential Demographic Methods. Cambridge: Harvard University Press. Chapter 6 (pp. 125–152).

Weeks JR. 2015. Population: An Introduction to Concepts and Issues. Boston: Cengage Learning. 12th edition. Chapter 6 (pp. 189–250).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