

Fertility

Ernesto F. L. Amaral

February 22–March 1, 2019
Population and Society (SOCL 312)



TEXAS A&M
UNIVERSITY.

Outline

- Introduction
- Conceptualization and measurement of fertility
- Proximate determinants of fertility
- World fertility trends and patterns
- Fertility changes in the United States
- Adolescent fertility
- Nonmarital fertility
- Childlessness
- 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

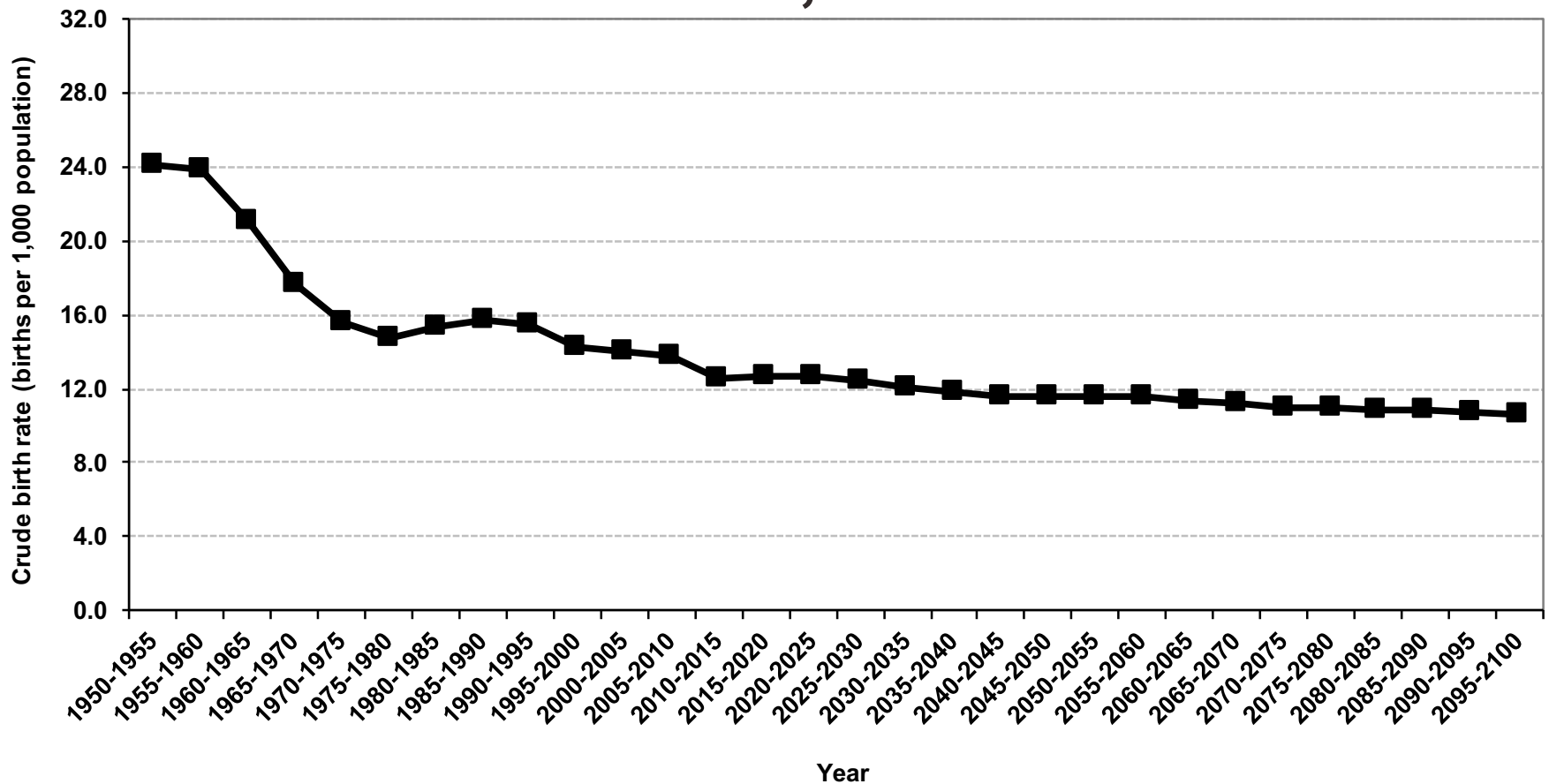


Crude birth rate (CBR)

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

$$\text{CBR} = \text{number of births} / \text{midyear population} * 1,000$$

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)

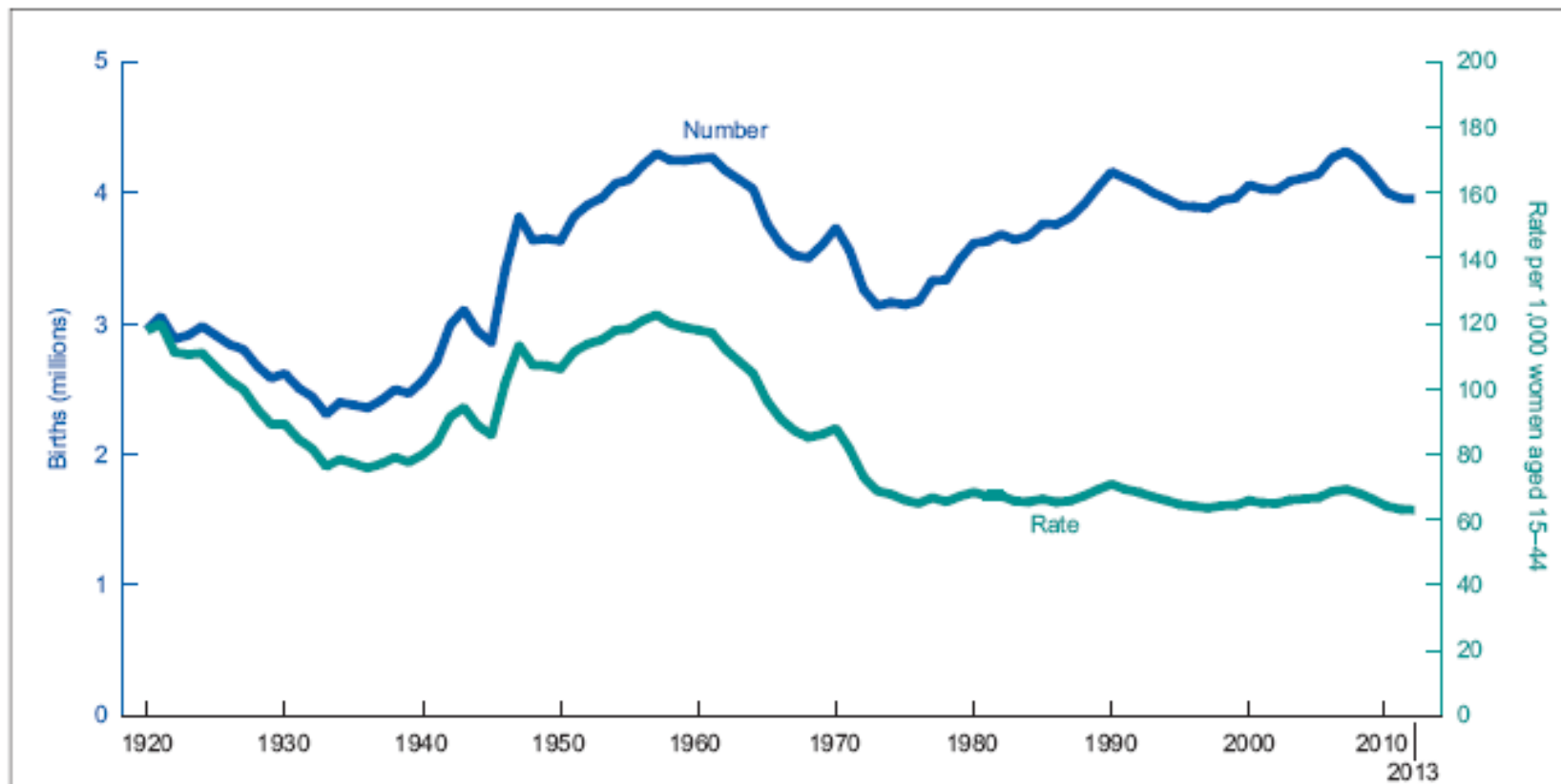
- Cross-sectional

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

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

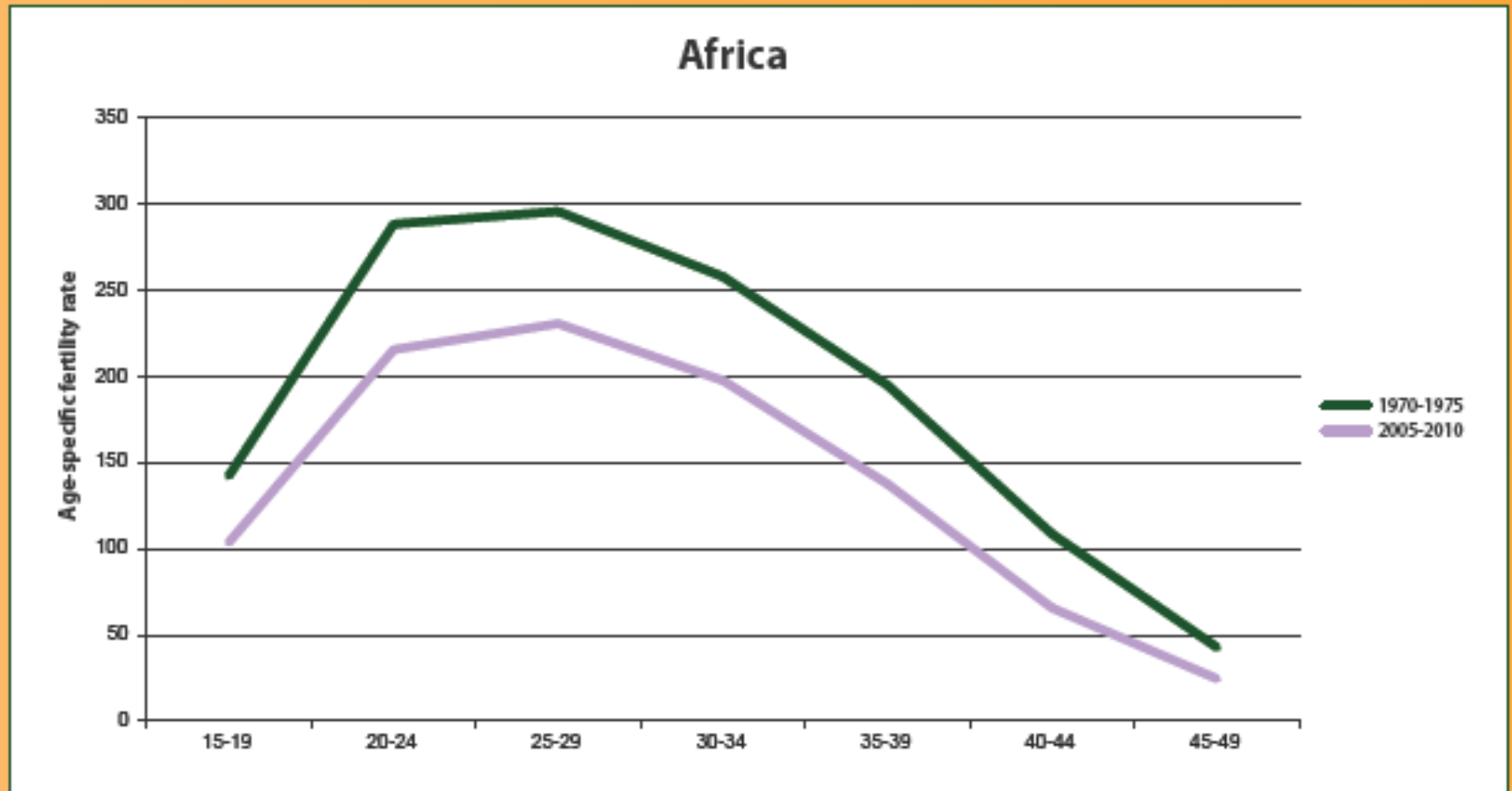
$$\text{ASFR}_{x \text{ to } x+n} = \text{births}_{x \text{ to } x+n} / \text{females}_{x \text{ to } x+n} * 1,000$$

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



ASFR

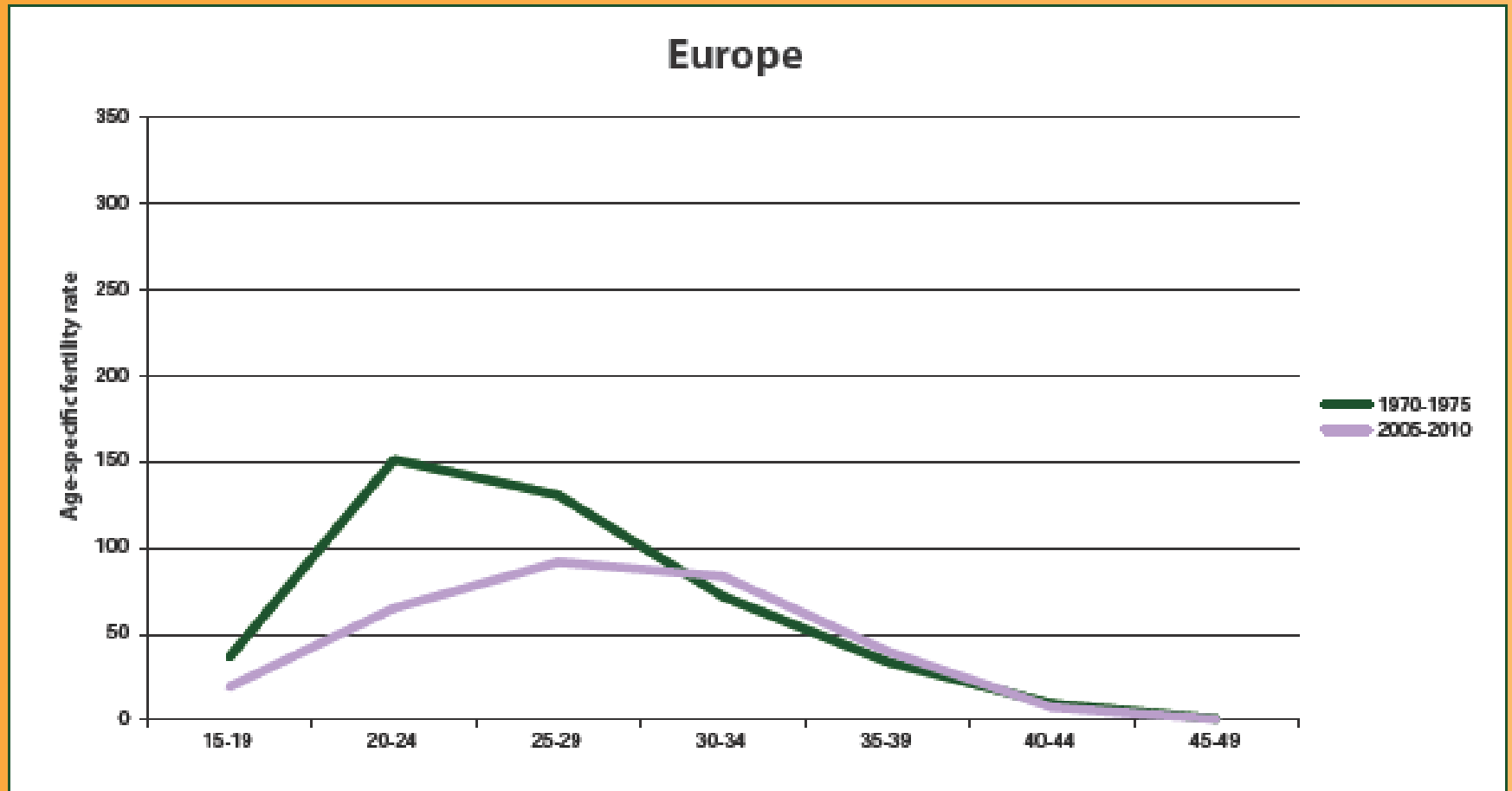
Age-specific Fertility Rates, Africa, 1970-75 and 2005-10



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

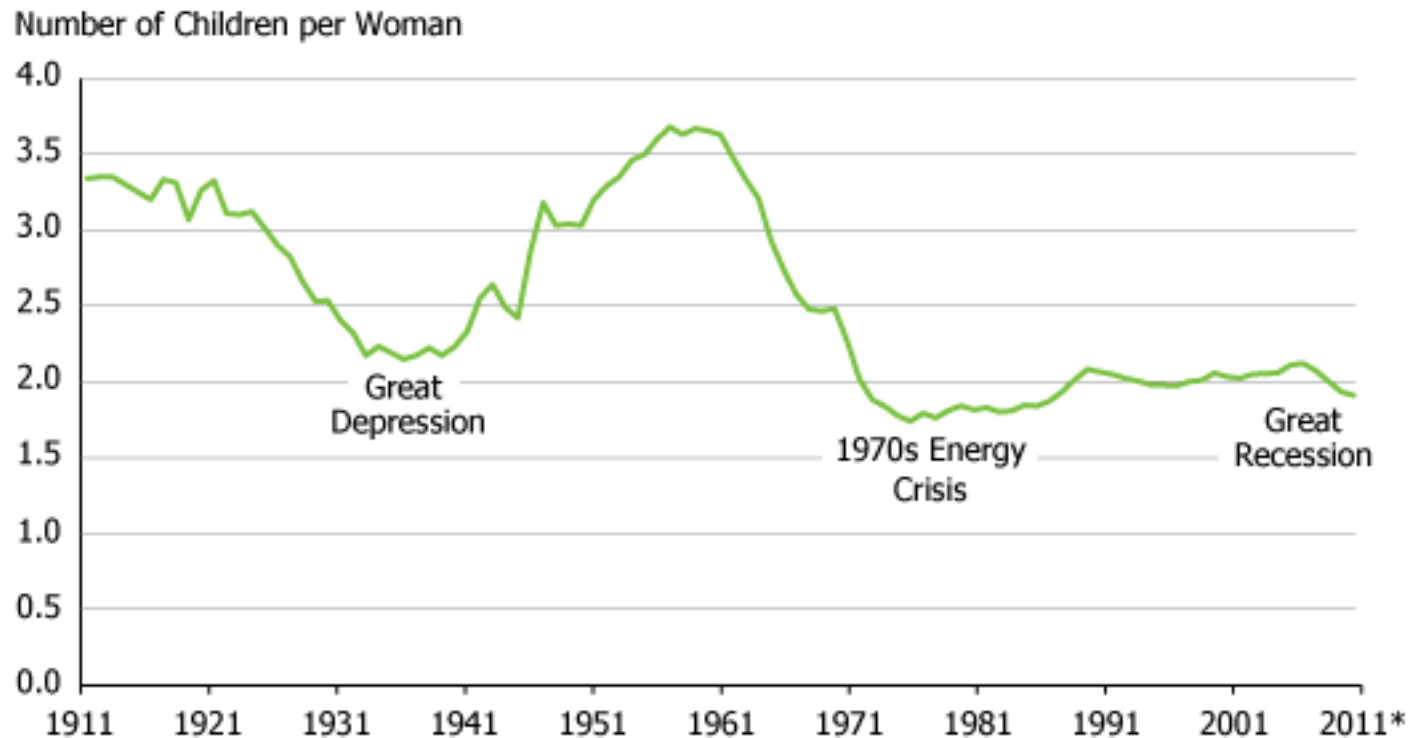
$$TFR = \sum (ASFR_{x \text{ to } x+n} * i)$$

- i = 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).



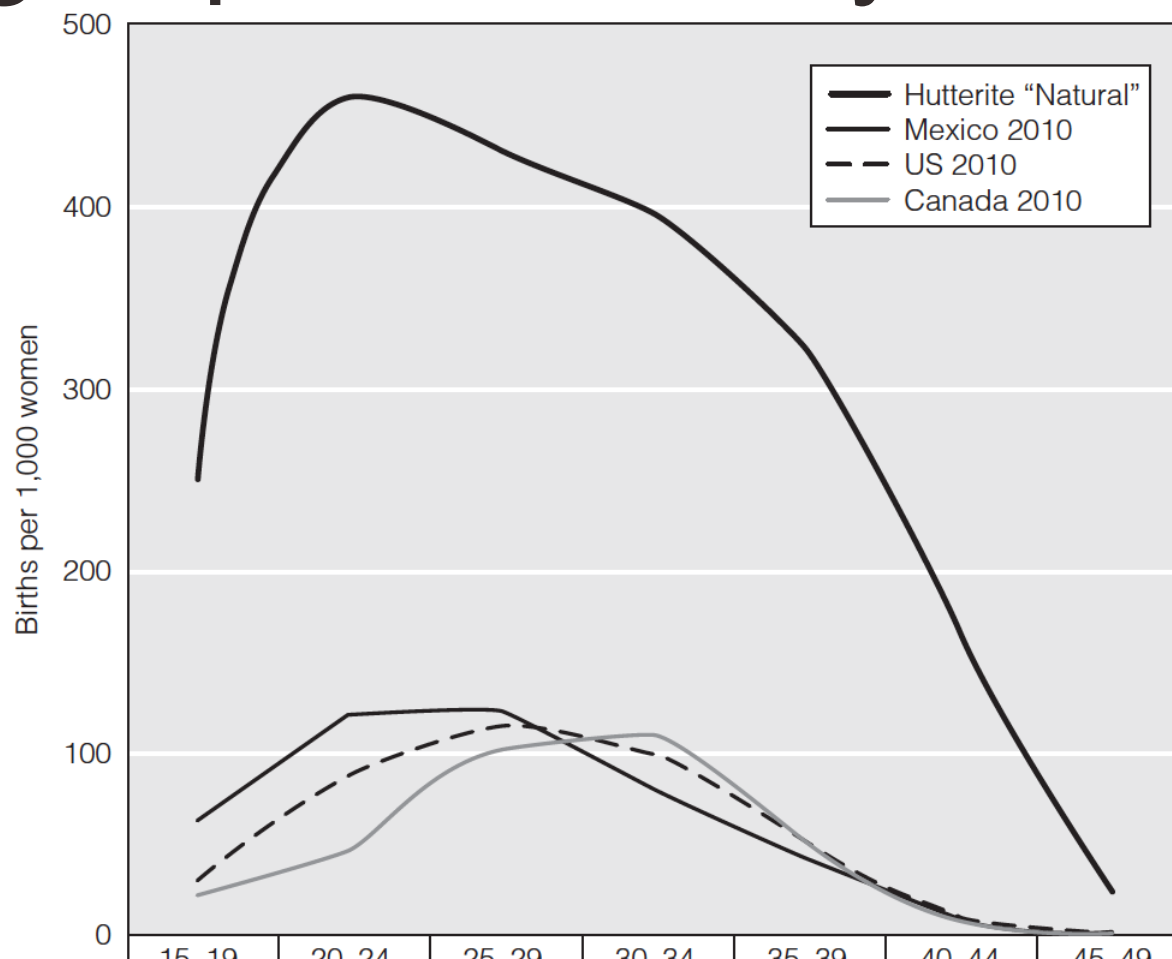
Approximation for TFR

- $\text{TFR} = \text{CBR} * 4.5 * 30 = \text{GFR} * 30$
 - 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

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

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

- $ASFR^f$: female births per women in age group
- i = width of the age group, usually 5

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

$$GRR = TFR * 0.488$$

- The constant 0.488 is based on the sex ratio at birth of most countries
- $SRB = 105 \rightarrow 1 - [105 / (105 + 100)] = 1 - 0.512 = 0.488$
- If $SRB \neq 105$, 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

$$NRR = \sum (ASFR_{x \text{ to } x+n}^f * L_x / 5l_0 * i)$$

$$NRR = \sum (ASFR_{x \text{ to } x+n} * 0.488 * L_x / 5l_0 * i)$$

- $ASFR^f$: female births per women in age group
- L_x : total number of person-years lived in age group
- l_0 : number of people at age 0
- $L_x / 5l_0$: proportion of people who survive from age 0 to the midpoint of each of the seven age intervals
- i = 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 =

$$\sum (\text{ASFR}_{x \text{ to } x+n}^f * L_x / 5l_0 * i * \text{mid-point of age group}) / \text{NRR}$$

- $\text{ASFR}_{x \text{ to } x+n}^f$: female births per women in age group
- $L_x / 5l_0$: proportion of people who survive from age 0 to the midpoint of each of the seven age intervals
- i = width of the age group, usually 5

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
- They identified a set of 11 intermediate variables, which directly affect fertility and are grouped into three factors
 - **Intercourse:** amount of intercourse is affected by the proportion of persons who marry, length of time married, and frequency of sexual intercourse while married
 - **Conception:** probability of conception is affected by contraception and by voluntary or involuntary infecundity
 - **Gestation/parturition:** probability of a birth depends on the likelihood of miscarriage and abortion



Proximate determinants

- 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 postpartum infecundability
 - Waiting time to conception
 - Risk of intrauterine mortality
 - Onset of permanent sterility



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 (C_m): 1 when all women are married and 0 when none are married
 - Contraception index (C_c): 1 when no contraception is used and 0 when all women are using effective contraceptives
 - Abortion index (C_a): 1 when there is no induced abortion and 0 when every pregnancy is aborted
 - Postpartum-infecundability index (C_i): 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

Variables

- Three major kinds of variables operate through proximate determinants in predicting fertility
- Family planning variables
- Socioeconomic variables
- Attitudinal variables

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)



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)
 - $RNI = (\text{Crude birth rate} - \text{Crude death rate}) / 10$
 - 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: $\text{RNI} = -0.5\%$
 - Latvia, Lithuania, Hungary, Ukraine: $\text{RNI} = -0.4\%$
 - Germany: $\text{RNI} = -0.2\%$
 - Italy: $\text{RNI} = -0.1\%$
 - Russia: $\text{RNI} = 0.0\%$
 - 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



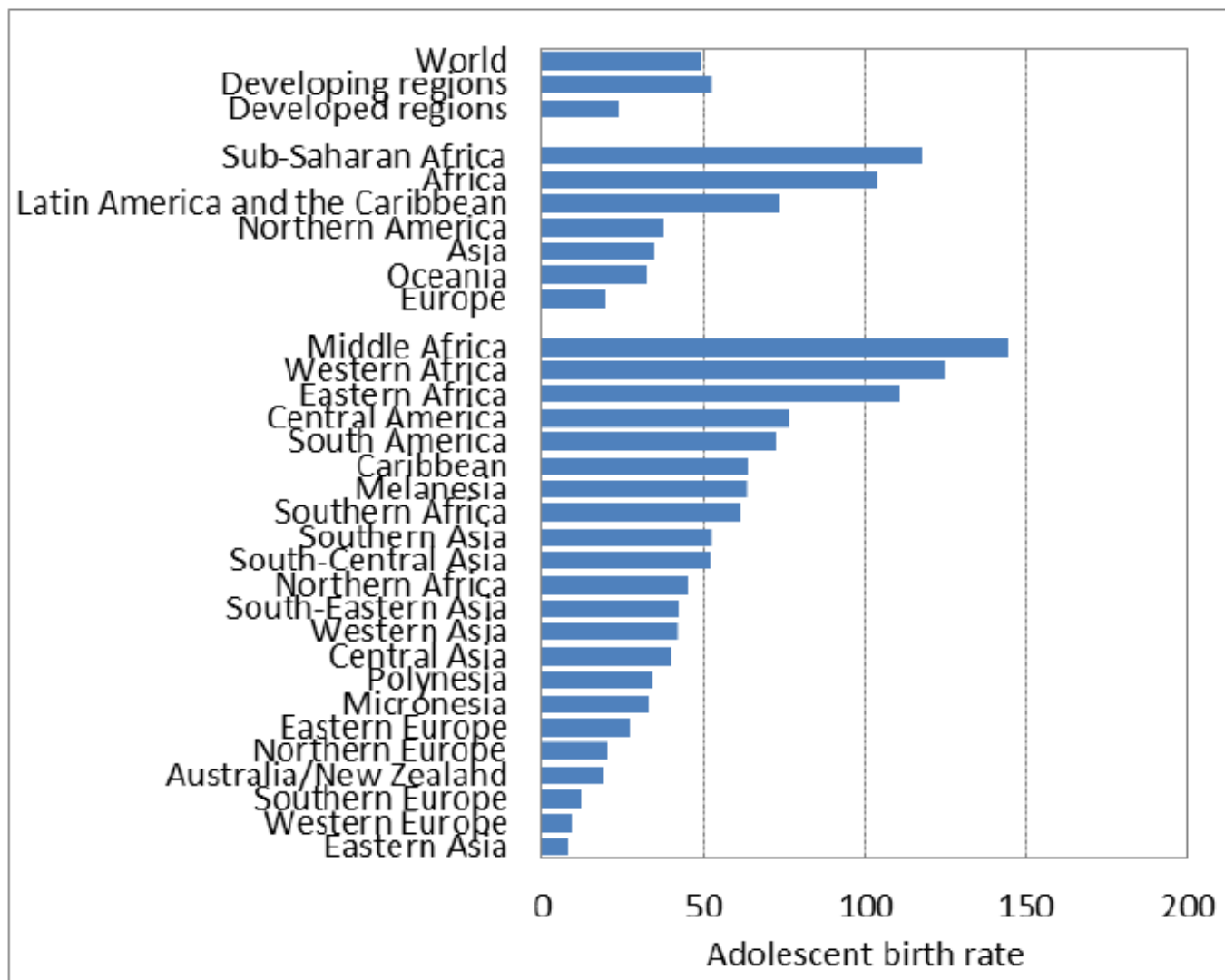
Fertility changes in the U.S.

- 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.

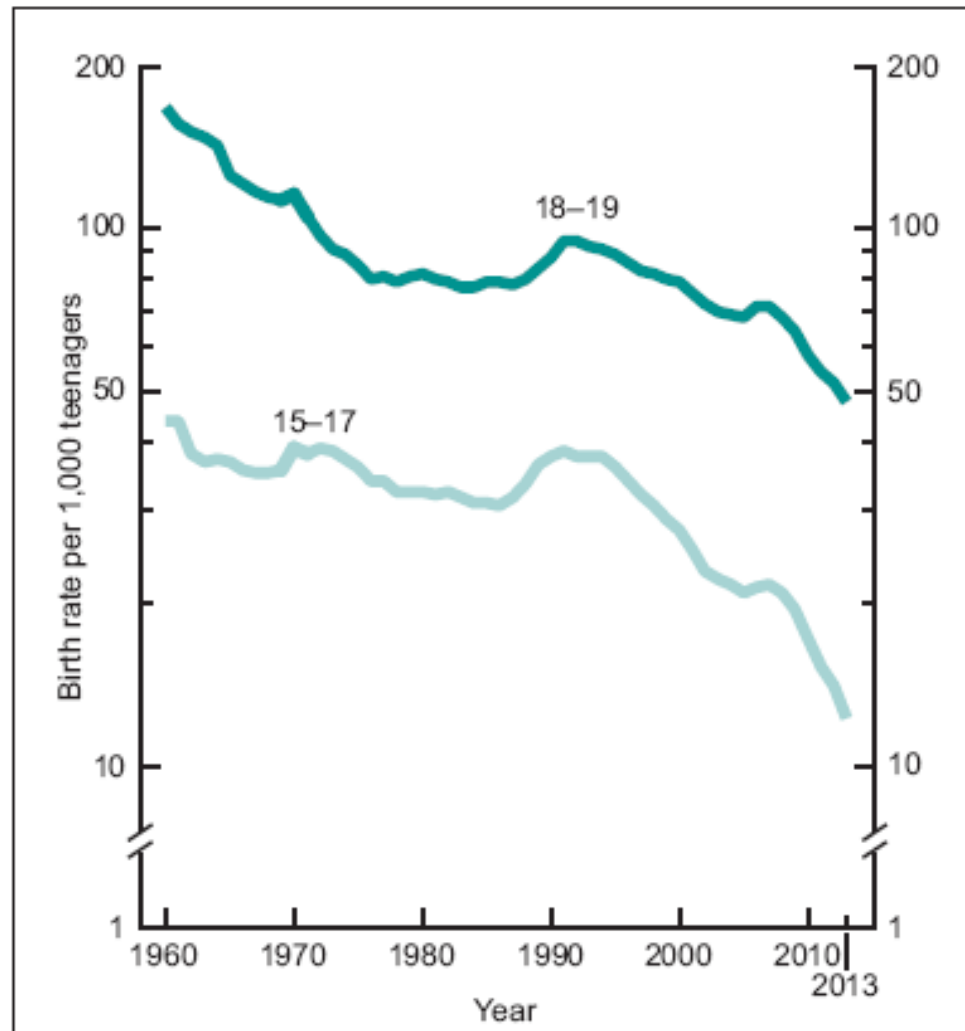


U.S. adolescent fertility

- 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)



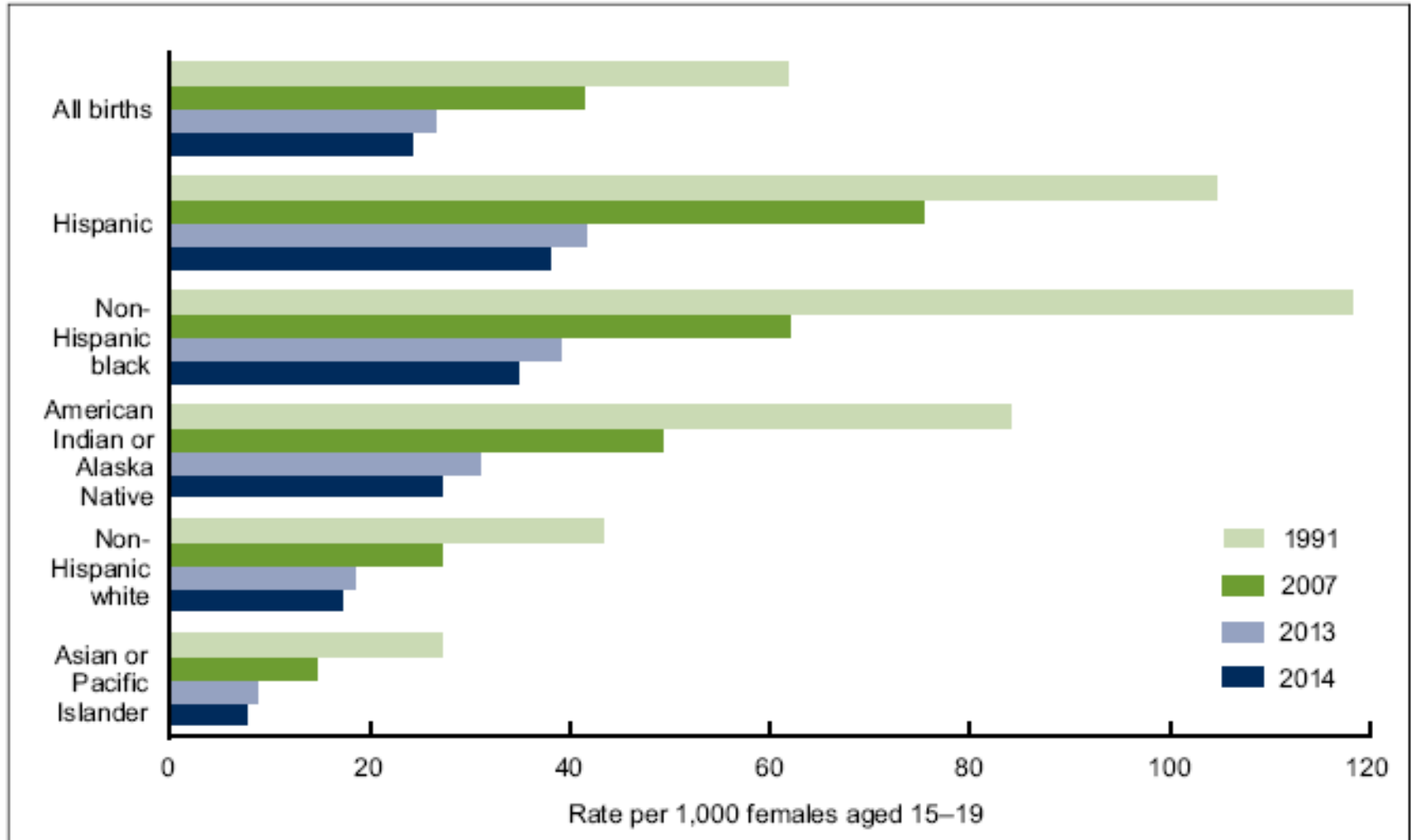
Birth rates for Teenagers (aged 15–17 and aged 18–19): United States, 1960–2013



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

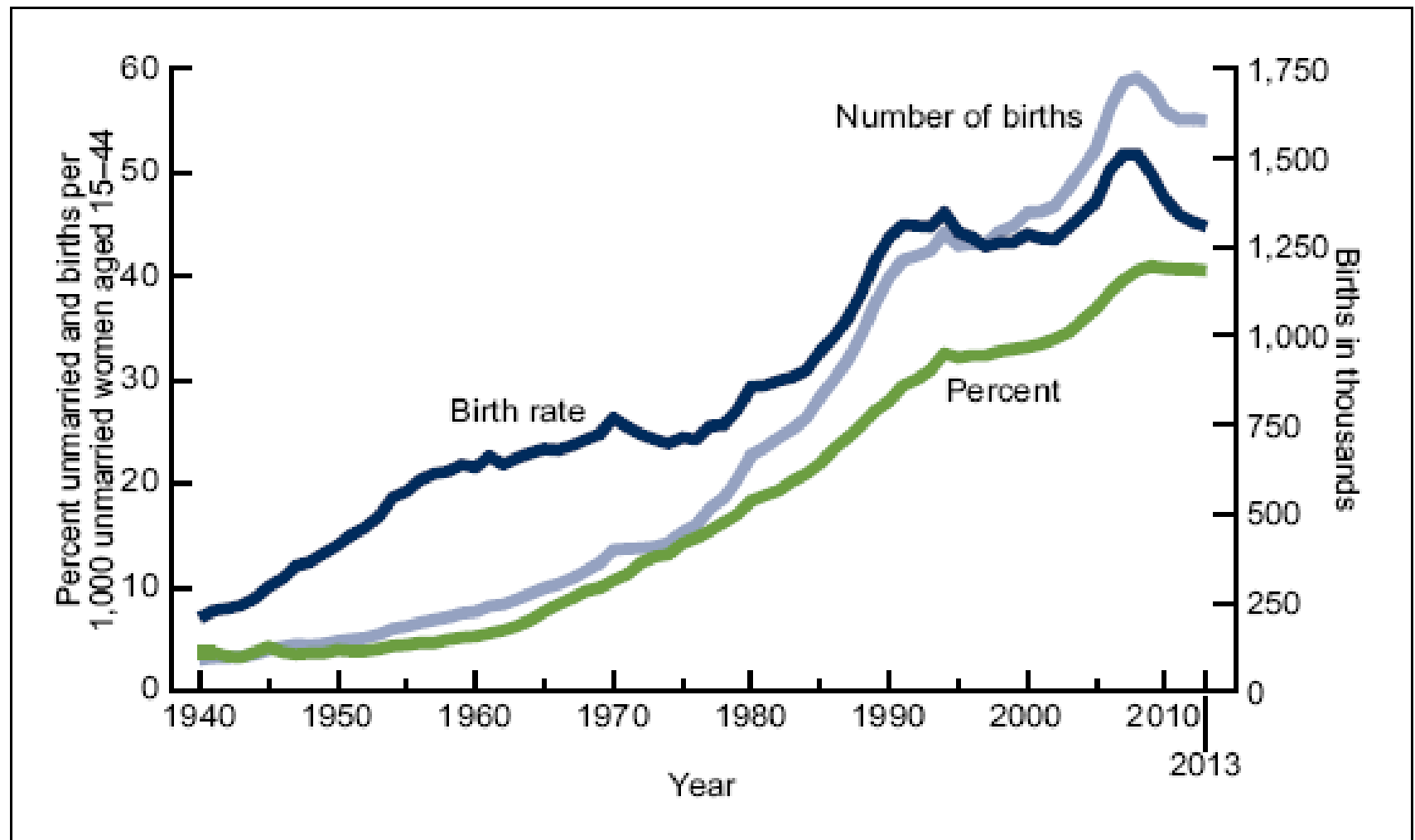


Source: Martin, Hamilton, and Osterman, 2015.

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 also 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



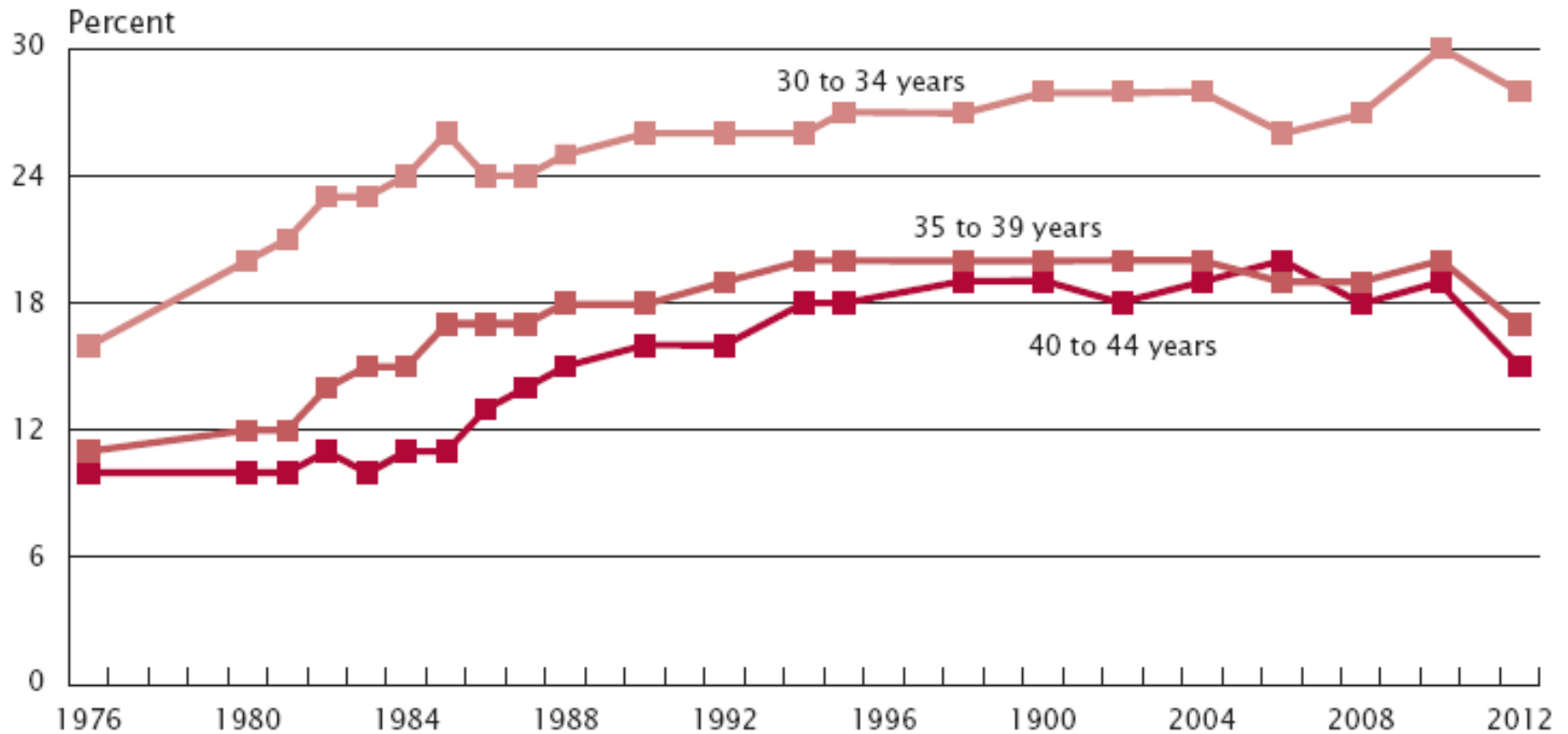
Source: Curtin, Ventura, and Martinez, 2014: 1.

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

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 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 their marital and 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 and stopping much later than that of females
 - Male TFRs higher than female TFRs especially in countries with male and female TFRs higher than 2.2

Male and female patterns

- Different cohabitation and marriage patterns
 - Higher tendency of women to cohabit, among those who previously lived alone, are foreign-born, and live in fragmented families, compared to men
 - 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
- Much-needed incorporation of gender studies into demography
 - Fertility and parenting involving both men and women

References

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).



TEXAS A&M
UNIVERSITY.