Fertility

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References:

Weeks JR. 2015. Population: An Introduction to Concepts and Issues. 12th edition. Boston: Cengage Learning. Chapter 6 (pp. 189–250).
Wachter KW. 2014. Essential Demographic Methods. Cambridge: Harvard University Press. Chapter 6 (pp. 125–152).

Outline

- The fertility transition
  - Weeks 2015, Chapter 6, pp. 189–250
- Period fertility
  - Wachter 2014, Chapter 6, pp. 125–152

The fertility transition

(Weeks 2015, Chapter 6, pp. 189–250)

- What is the fertility transition?
- How high could fertility levels be?
- Why was fertility high for most of human history?
- The preconditions for a decline in fertility
- Ideational changes that must take place
- Motivations for lower fertility levels
- How can fertility be controlled?
- How do we measure changes in fertility?
- How is the fertility transition accomplished?
- Geographic variability in the fertility transition
- Case studies in the fertility transition

What is the fertility transition?

- Fertility limitation and delayed childbearing
- The shift from high fertility, with minimal individual control, to low fertility, which is entirely under a woman's control
  - A shift from "family building by fate" to "family building by design" (Lloyd and Ivanov 1988)
- It involves a later start to childbearing and an earlier end to childbearing
  - "Not too early, not too close, and not too many"

Biological component (fecundity)

- A fecund person can produce children
- An infecund (sterile) person cannot
- Couples who have tried unsuccessfully for at least 12 months to conceive a child
  - Called "infertile" by physicians
  - "Infecund" by demographers
- 2006–10 National Survey of Family Growth (NSFG)
  - 6% of American couples (where the wife was aged 15 to 44) are infecund/infertile by that criterion

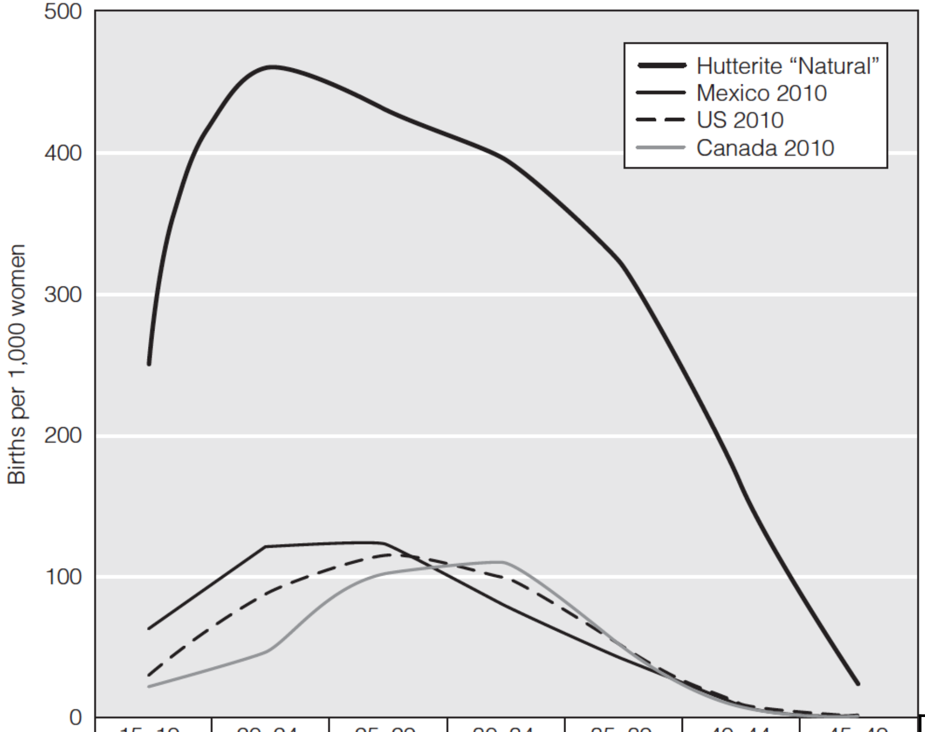
How many children could you have?

- Assume you and partner(s) are fully fecund
- First pregnancy at age 15
- Little less than 9 months per pregnancy (to account for some pregnancy losses, such as miscarriages)
- 18 months between the end of one pregnancy and the start of the next
- Thus, a woman could have a child every 2.2 years between ages 15–49
- This would result in 16 live births (Bongaarts 1978)

Natural fertility

- No known society has ever had 16 births on average
  - Health and mortality experience of mothers
  - Poor nutrition raises age at menarche and produces anovulatory cycles in which no egg is released
- 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 in the 1930s
  - Early age at marriage, good diet, good medical care, regularly engage in intercourse without contraception or abortion

Age-specific fertility rates

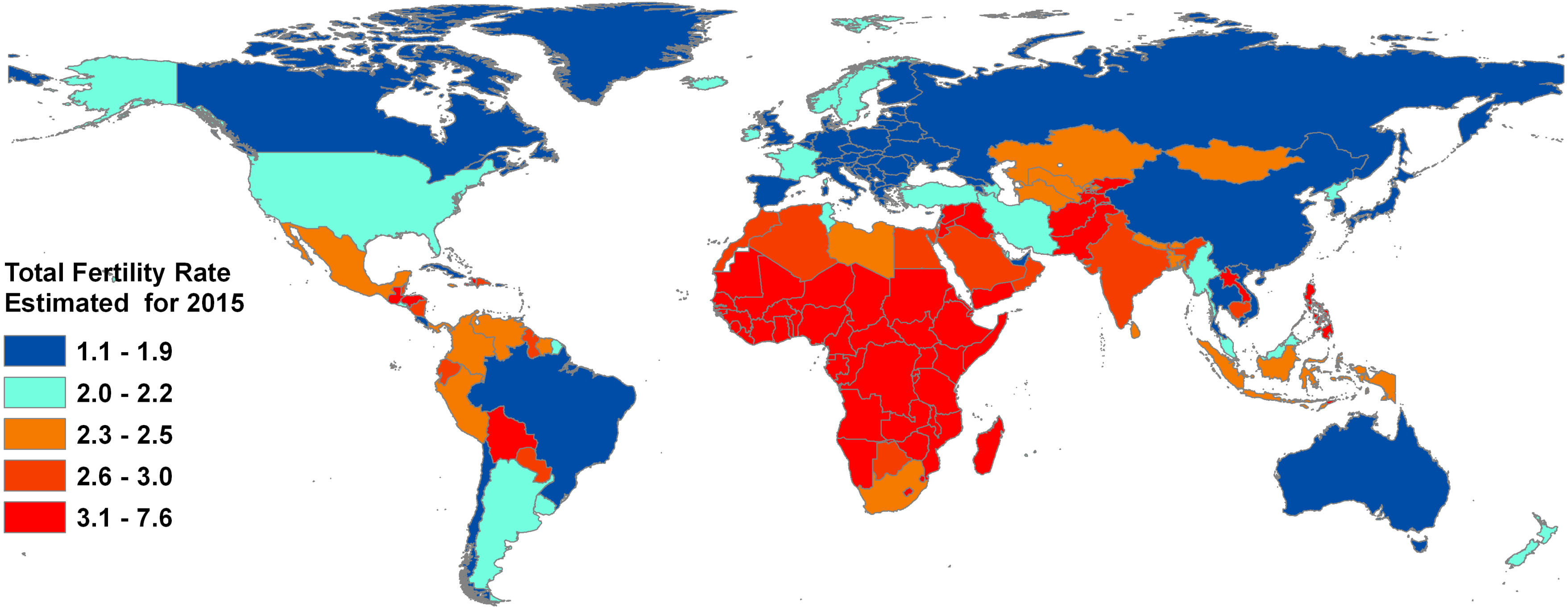


		15–19	20–24	25–29	30–34	35–39	40–44	45–49	TFT
1930	Hutterite “Natural”	250	460	431	396	321	167	24	11.0
	Mexico 2010	63	121	123	80	42	9	2	2.2
	US 2010	31	88	115	99	50	10	1	2.0
	Canada 2010	15	47	102	110	51	8	0	1.7

Social component

- Social component explains actual levels of fertility
- For most of human history, fertility was high to replenish society, especially to combat high infant mortality
- Motivating women/couples to have children
  - Children as security and labor (quantity matters more than quality)
  - Lower status for women leads to a desire for sons
  - Children as essential for status and prestige
- Accomplished by
  - Having children early and often (requires control over women)
  - No tolerance for contraception/abortion/infanticide

Total fertility rates, 2015



Preconditions for fertility decline

- Ready, willing, and able (RWA) model (Ansley Coale)
- Ready
  - Acceptance of calculated choice as a valid element in marital fertility
  - Ideational changes, secularization, status of women
- Willing
  - Perception of advantages from reduced fertility
  - Motivation for limiting fertility
- Able
  - Knowledge and mastery of effective techniques of birth control (controlling reproduction)

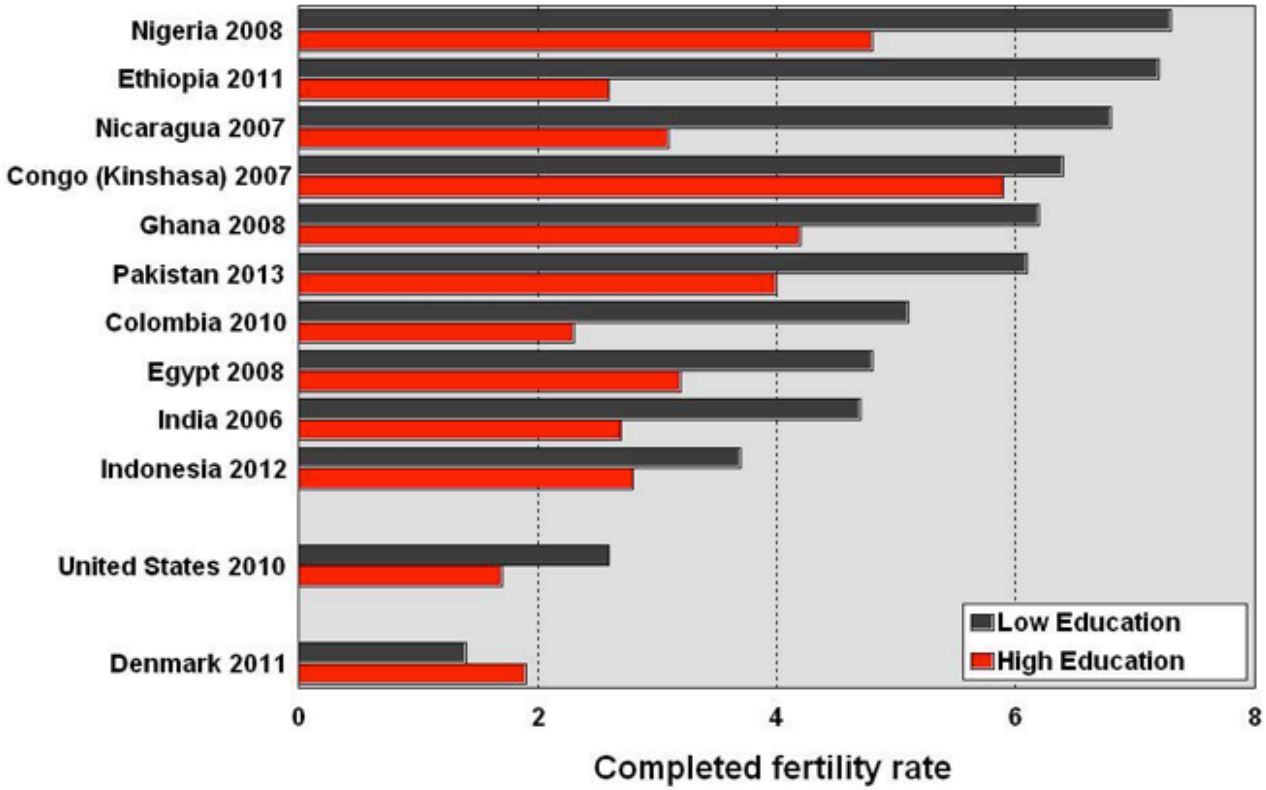
Supply-demand framework

- This framework (new household economics) helps explaining motivations for fertility (Richard Easterlin)
  - Neoclassical economics: rational choices about what people want
- Trade-off between quantity/quality of children (Gary Becker)
  - It emphasizes the need for households to balance supply/demand
  - The demand for children: what are they good for?
  - Time, expectations, and costs of children enter the equation
- Motivation to limit fertility when supply exceeds demand
  - Mortality declines and children cannot be afforded
  - And/or the opportunity costs of children rise
  - Changes from what are they good for, to how good are they?

Education and fertility

- Better-educated women have lower fertility than others
  - Education breaks traditional view of society
  - Increases social mobility, innovative behavior, fertility limitation
  - It reevaluates role of women in society
  - People reassess value of children
- Lowest-low fertility countries, relation gets complicated
  - Better-educated women are in position to have larger families
  - Family-friendly public policies (e.g. daycare) in specific countries encourage higher fertility
  - Gender equality provides environment to combine family and career

Female education can change opportunity costs of having children



Cultural perspective

- Innovation/diffusion influence fertility decline (Brown 1981; Rogers 1995), through social networks (Bernardi, Klärner 2014)
- Two theories of social stratification have strong implications for fertility behavior (Lesthaeghe, Surkyn 1988)
- **Cultural innovation** takes place in higher social strata as a result of privilege, education, and resources
  - Lower social strata adopt new preferences through imitation
- **Rigid social stratification** or closure of class/caste inhibits downward cultural mobility and thus inhibits diffusion of low fertility ideas

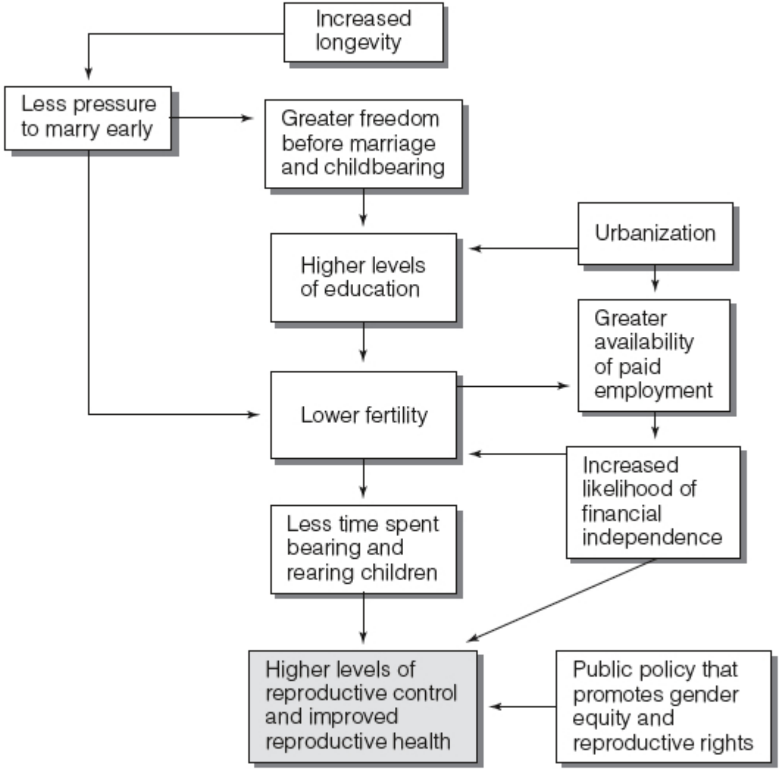
Innovation/diffusion in history

- European fertility history suggests a pattern of geographic diffusion of innovation of fertility limitation within marriage
- Spread across areas with common language and ethnic origin
- Despite varying levels of mortality and economic development
- Some societies are more prone to accept innovation than others (Watkins 1991; Pollack, Watkins 1993)
- To accept innovation and change behavior, one must be "empowered"
  - Believe that it's within your control to alter behavior

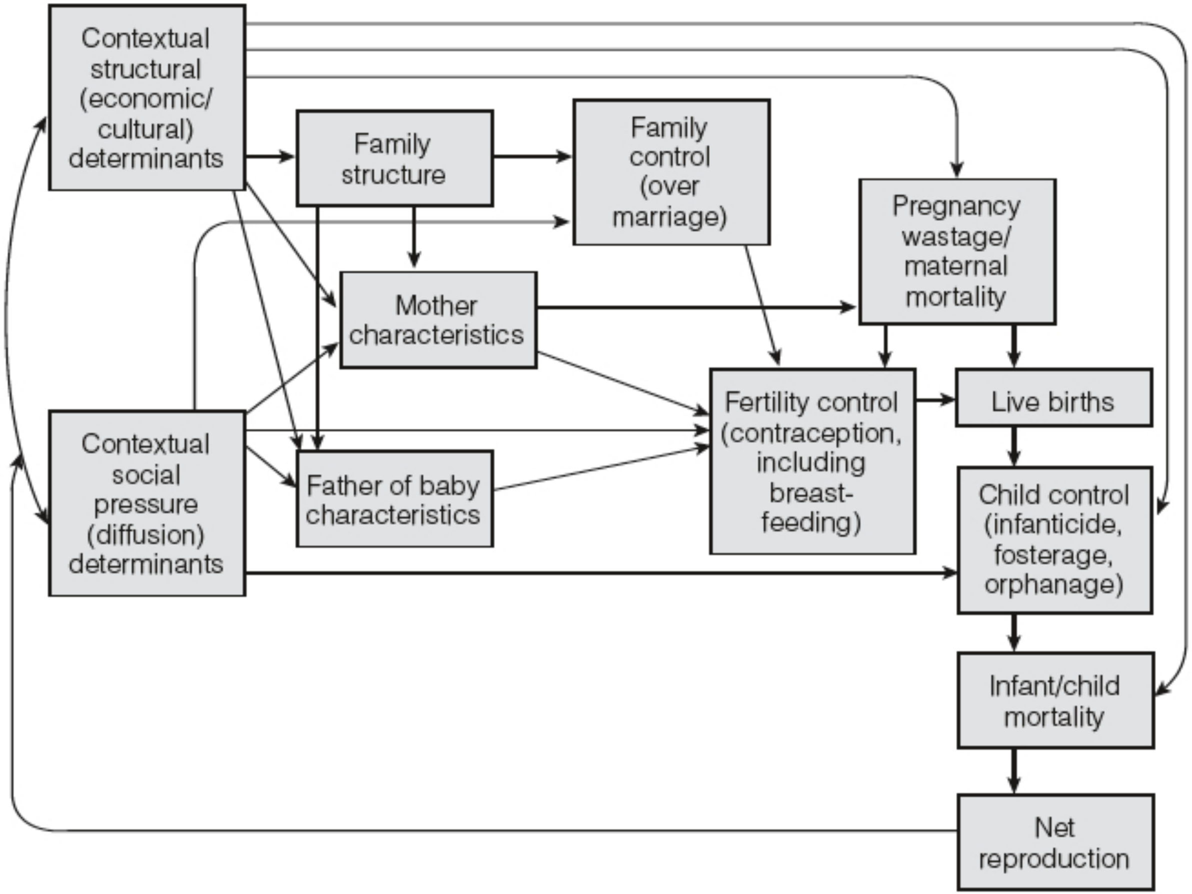
Supply-demand & Innovation-diffusion

- Diffusion of an innovation requires that people believe that they have some control over their life
- This is the essence of the rational-choice model (economic approach to fertility transition)
- Supply-demand model and innovation-diffusion model tend to be complementary
- Couples might influence others if they improve their own and their children's economic and social success by concentrating resources on a smaller number of children

Demographic links between fertility transition and reproductive health



Influences on fertility transition



How can fertility be controlled?

- Dealing with unwanted children in the past
  - Infanticide, general neglect, or inattention that leads to early death
  - Fosterage of child by another family that needs or can afford it
  - Orphanage: involves abandoning a child so she/he is likely to be found and cared for by strangers

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.

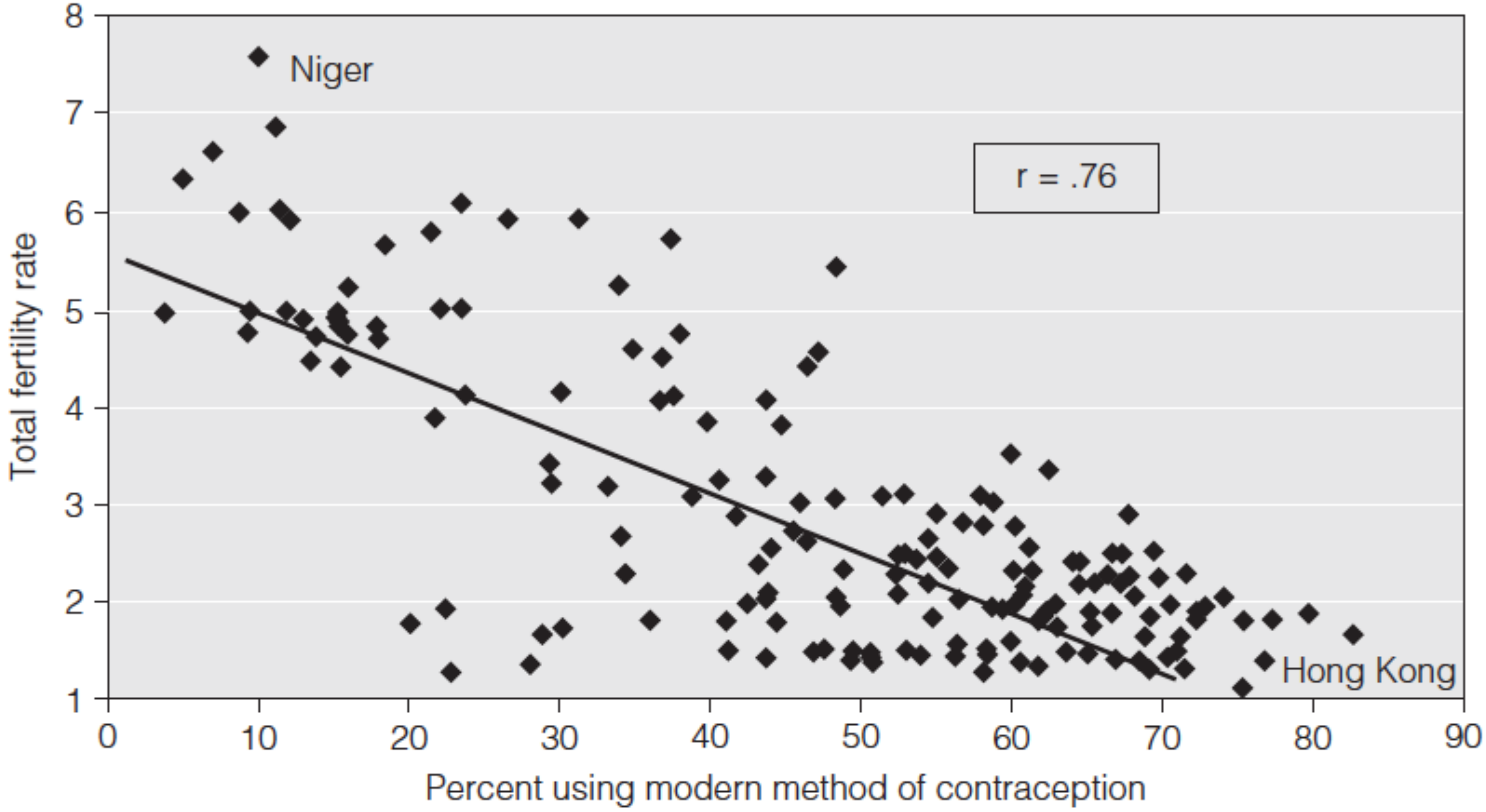
Main proximate determinants

- 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)
- Involuntary infecundity
  - Breastfeeding prolongs postpartum amenorrhea and suppresses ovulation
- Use of contraceptives
- Induced abortion (Hodgson 2009)

Contraceptive use, U.S., 2006–2010

	Age Group							Number of pregnancies per 100 women during first year of use
	15–44	15–19	20–24	25–29	30–34	35–39	40–44	
Currently NOT using contraception:	*37.8*	*69.5*	*41.7*	*34.7*	*30.3*	*25.4*	*24.7*	85.0
Method used by those currently using a method:								
Female sterilization	26.5	0.0	2.6	16.4	30.0	37.4	50.6	0.5
Male sterilization	10.0	0.0	0.9	4.1	9.5	16.6	20.1	0.2
Pill	27.5	53.1	47.0	32.9	25.4	17.0	9.8	9.0
Implant, Lunelle, or contraceptive patch	1.4	2.3	1.9	2.3	1.3	0.7	0.0	0.1
3-month injectable (Depo-Provera)	3.7	11.5	5.7	5.2	2.4	1.3	0.8	6.0
Contraceptive ring	2.1	2.3	4.6	3.7	2.0	0.7	0.5	9.0
Intrauterine device (IUD)	5.6	2.6	5.7	7.2	7.0	6.4	3.2	0.8
Male condom	16.4	20.0	25.6	20.8	15.5	12.1	9.0	18.0
Periodic abstinence—fertility awareness methods	1.2	0.0	0.3	0.8	1.7	1.3	1.5	24.0
Withdrawal	5.1	6.9	5.7	6.3	4.6	5.5	3.5	22.0
Other methods (including emergency contraception and sponge)	0.5	0.7	0.0	0.5	1.7	0.8	0.5	

Contraceptive use and fertility, 2015



Period measures of fertility

- Crude birth rate (CBR)
- General fertility rate (GFR)
- Child-woman ratio (CWR)
- Age-specific fertility rate (ASFR)
- Total fertility rate (TFR)
- Gross reproduction rate (GRR)
- Net reproduction rate (NRR)
- Mean length of generation
- Princeton indices

Crude birth rate (CBR)

- CBR is the number of live births (b) in a year divided by the total midyear population (p)

$$CBR = b/p * 1{,}000$$

- It is usually multiplied by 1,000 to reduce decimals
- It does not take into account which people in the population were at risk of having births
- It ignores age structure of the population, which can affect the number of live births in a year

General fertility rate (GFR)

- GFR is the total number of births in a year (b) divided by the number of women in childbearing ages (${}_{30}F_{15}$)

$$GFR = b \,/\, {}_{30}F_{15} * 1{,}000$$

- It is sometimes called “the fertility rate”
- It uses information about the age and sex structure of a population
- It usually equals to about 4.5 times the CBR

Child-woman ratio (CWR)

- CWR is measures by the ratio of young children (0 to 4) enumerated in the census to the number of women of childbearing ages (15 to 49)

$$CWR = {}_{4}p_{0} \,/\, {}_{35}F_{15} * 1{,}000$$

- It provides an index of fertility that is conceptually similar to GFR, but it relies only on census data

- It uses an older upper limit on women's age, because some of the children (0–4) will have been born up to five years prior to the census

Age-specific fertility rate (ASFR)

- ASFR is the number of births (b) occurring in a year to mothers aged x to x+n (${}_nb_x$) per 1,000 women (p_f or F) of that age

$$ASFR = {}_nb_x / {}_nF_x * 1,000$$

- It is usually calculated in five-year age groups
- It requires comparisons of fertility be done on an age-by-age basis
- We can combine ASFRs into a single fertility index...

Total fertility rate (TFR)

- TFR is the sum of the ASFRs over all ages

$$TFR = \Sigma\, ASFR * 5$$

- Multiplied by 5 only if ASFRs grouped into 5-year intervals
- It is the average number of children born per woman
- **Assumption**: current birth rates remain constant and no woman dies before reaching the end of childbearing years
- **Synthetic cohort**: ASFRs are used to project what could happen if all women went through their lives bearing children at the same rate as women at a given date
- It can be compared across populations, because it takes into account differences in age structure

Gross reproduction rate (GRR)

- GRR is the sum of age-specific birth rates using only female babies ($ASFR_f$), since only female babies will bear children

$$GRR = \Sigma ASFR_f * 5$$

- It is the number of female children that a female just born may expect to have during her lifetime
  - GRR=1; women replace themselves
  - GRR<1; women do not replace themselves
  - GRR>1; next generation of women will be bigger than the present one
- **<u>Assumption</u>**: current birth rates remain constant and no woman dies before reaching the end of childbearing years

Net reproduction rate (NRR)

- NRR is the age-specific birth rates using only female babies ($ASFR_f$) multiplied by the probability that a woman will survive to the midpoint of the age interval

$$NRR = \Sigma\, [(ASFR_f * 5)(nLx / 5{*}l_0)] = \Sigma\, (ASFR_f * nLx / l_0)$$

- The probability that a woman will survive to the midpoint of the age interval equals nLx (number of women surviving to the age interval x to x+n) divided by $5{*}l_0$ (radix multiplied by 5)
- NRR is less than GRR, since some women die before the end of the reproductive period
- NRR=1; each generation of females has the potential to replace itself (generational replacement)

Mean length of generation

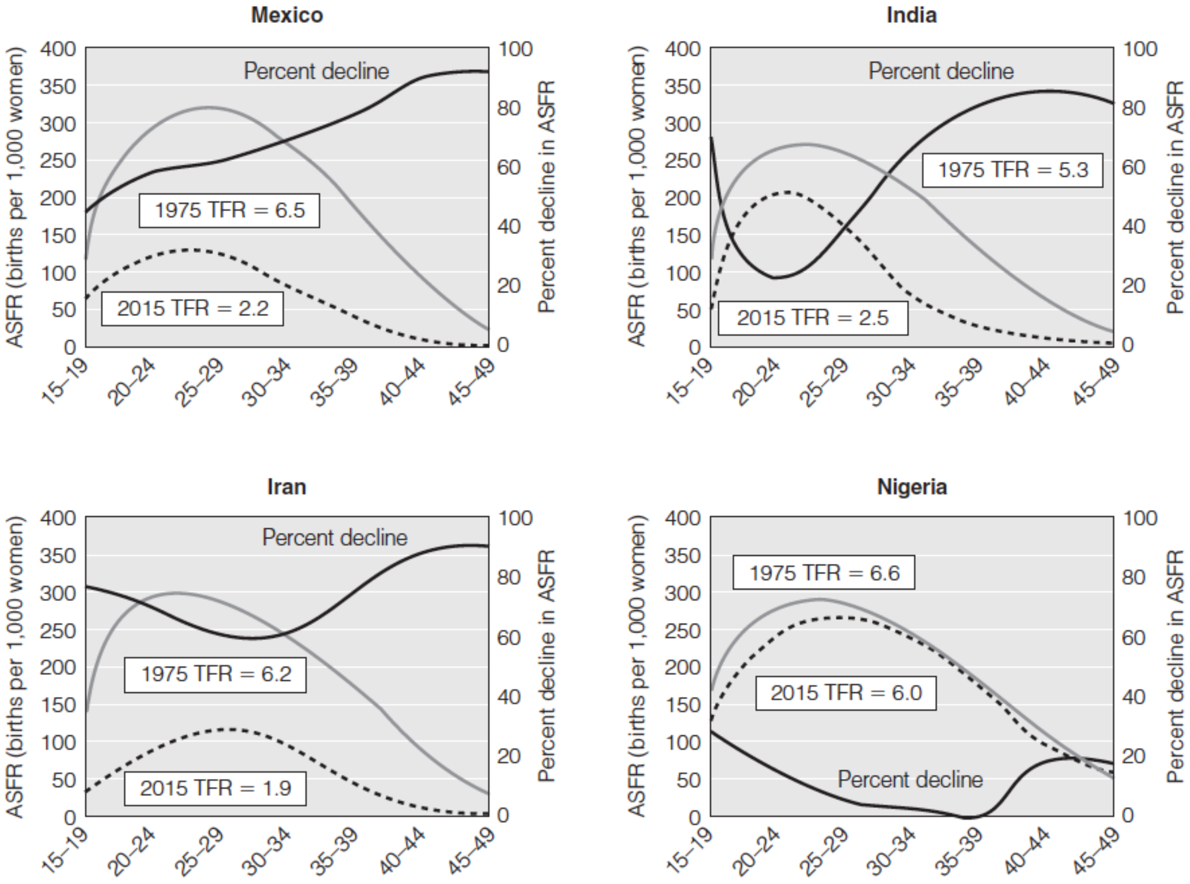
- Mean length of generation is the average age at childbearing
- Multiply the midpoint of each age interval by the surviving daughters per woman for that age interval
- Divide the sum of those calculations by the net reproduction rate (NRR)

Calculation of fertility rates, U.S., 2012

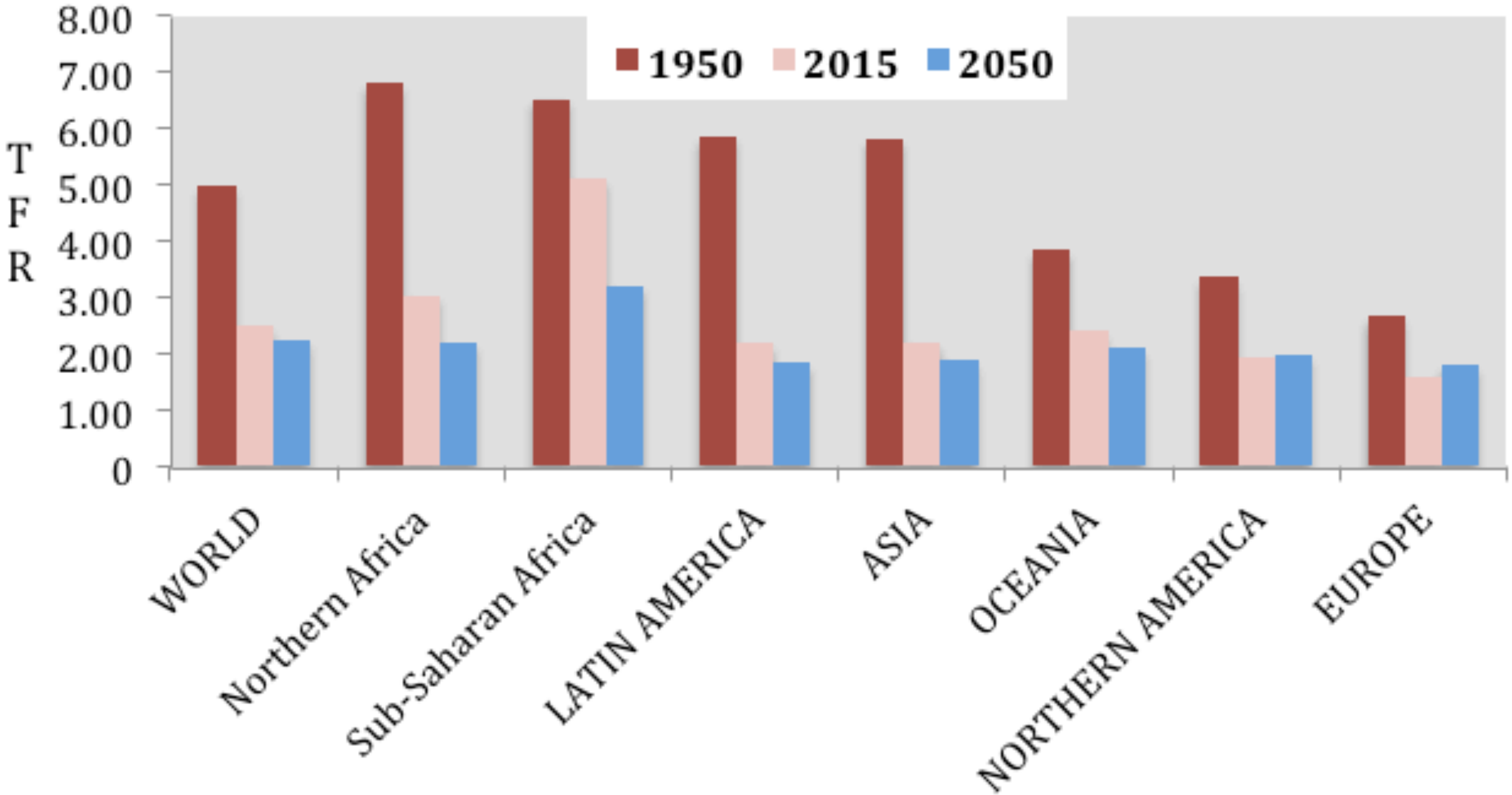
1	2	3 F	4 b	5 ASFR	6 bf	7 ASFRf	8	9	10	11	12
Age group	Mid-point of age group	Number of women in age group	Number of births to women in age group	Age-specific fertility rate	Number of female births to women in age group	Female births per women	nLx	Proportion of female babies surviving to midpoint of age interval	Surviving daughters per woman during 5-year interval	Column (2) x Column (10)	Verify Column (10)
10-14	12.5	10,102,004	3,672	0.0004	1,794	0.0002	496,173	0.9923	0.0009	0.0110	0.0009
15-19	17.5	10,397,841	305,388	0.0294	149,182	0.0143	495,615	0.9912	0.0711	1.2444	0.0711
20-24	22.5	11,033,747	916,811	0.0831	447,862	0.0406	494,662	0.9893	0.2008	4.5176	0.2008
25-29	27.5	10,553,440	1,123,900	0.1065	549,025	0.0520	493,440	0.9869	0.2567	7.0594	0.2567
30-34	32.5	10,417,089	1,013,416	0.0973	495,054	0.0475	491,925	0.9839	0.2338	7.5978	0.2338
35-39	37.5	9,773,586	472,318	0.0483	230,727	0.0236	489,852	0.9797	0.1156	4.3365	0.1156
40-44	42.5	10,569,227	109,579	0.0104	53,529	0.0051	486,656	0.9733	0.0246	1.0475	0.0246
45-49	47.5	10,962,854	7,157	0.0007	3,496	0.0003	481,639	0.9633	0.0015	0.0730	0.0015
Total		**83,809,788**	**3,952,241**	**0.3760**	**1,930,669**	**0.1837**			**0.9051**	**25.8872**	**0.9051**
			GFR (15-44) = sum of column (4) / sum of column (3) for ages 15-44 x 1,000 = **62.8**	**TFR (10-49) =** sum of column (5) x 5 = **1.88**		**GRR (10-49) =** sum of column (7) x 5 = **0.918**	Radix = 100,000		**NRR (10-49) =** sum of column (10) = **0.905**	**Mean length of generation (10-49) =** sum of column (11) divided by NRR = **28.6**	

Source: Data from Table 6.3 (Weeks 2015, p. 225). Only nLx from Table 5.3 (Weeks 2015, p.174).

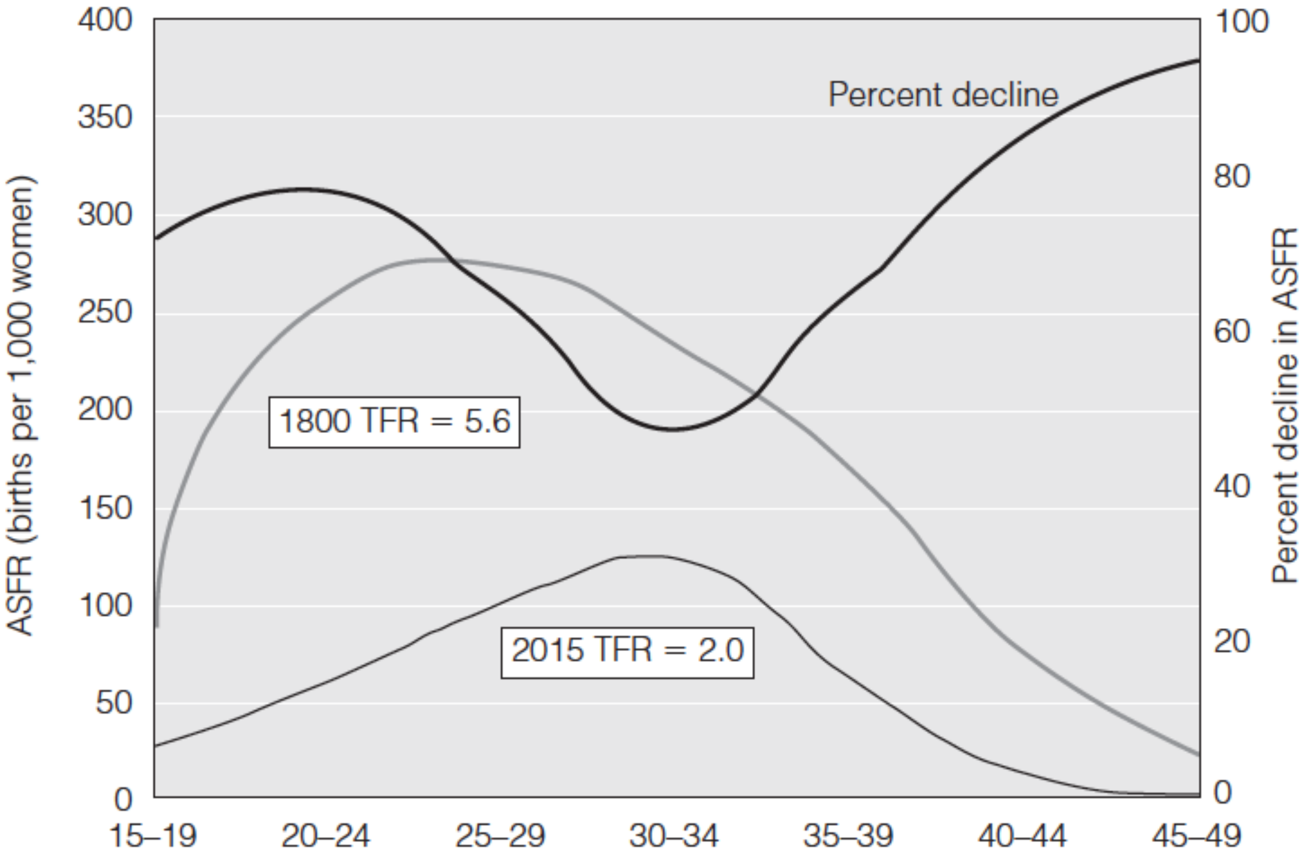
Accomplishing fertility transition



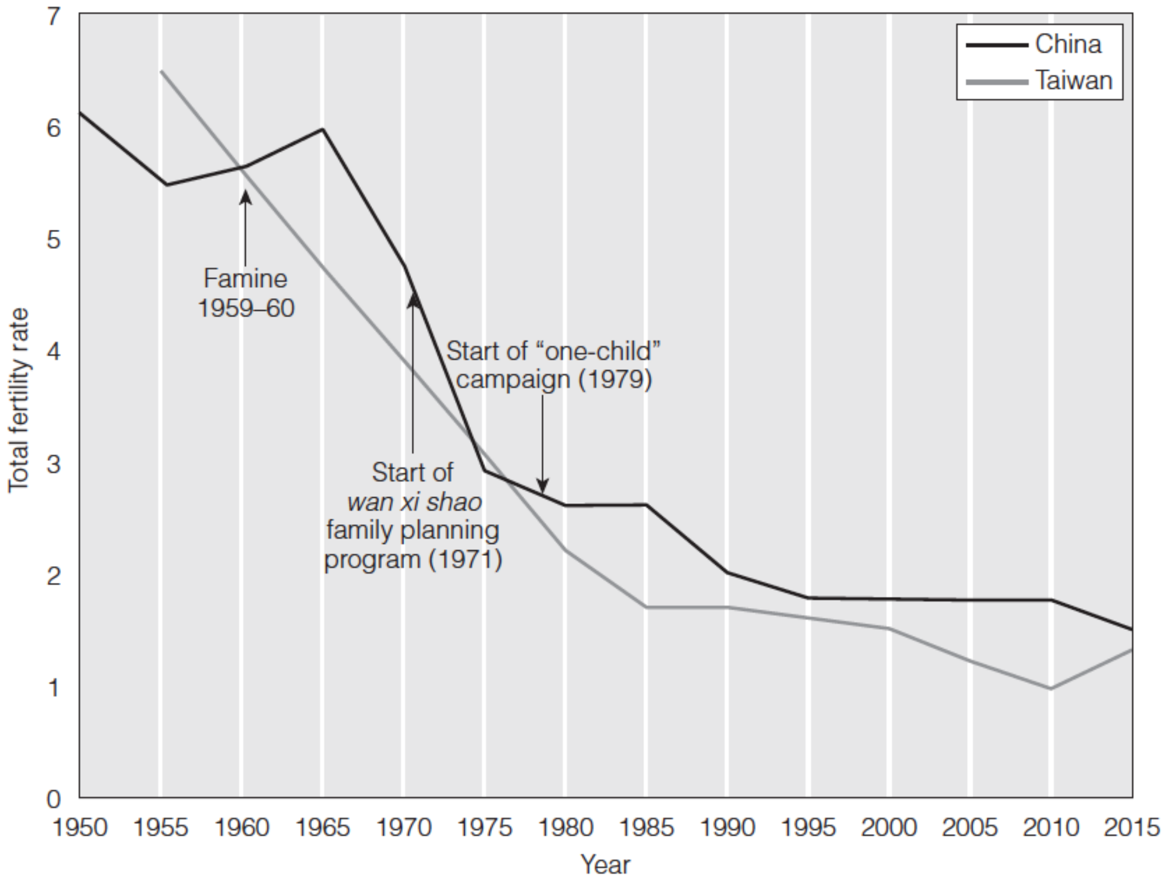
Regional differences in fertility transition, 1950–2050



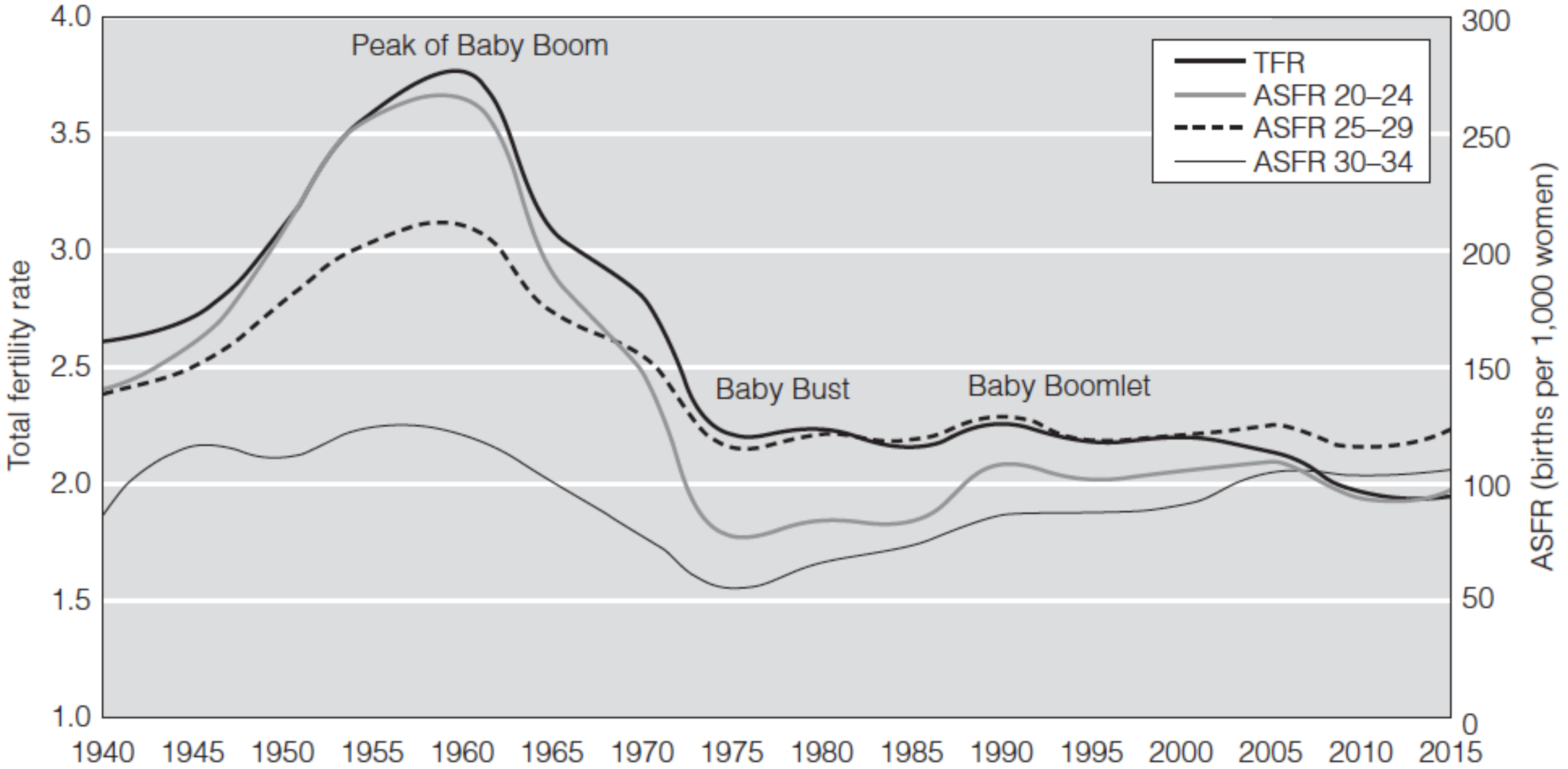
Fertility transition in England



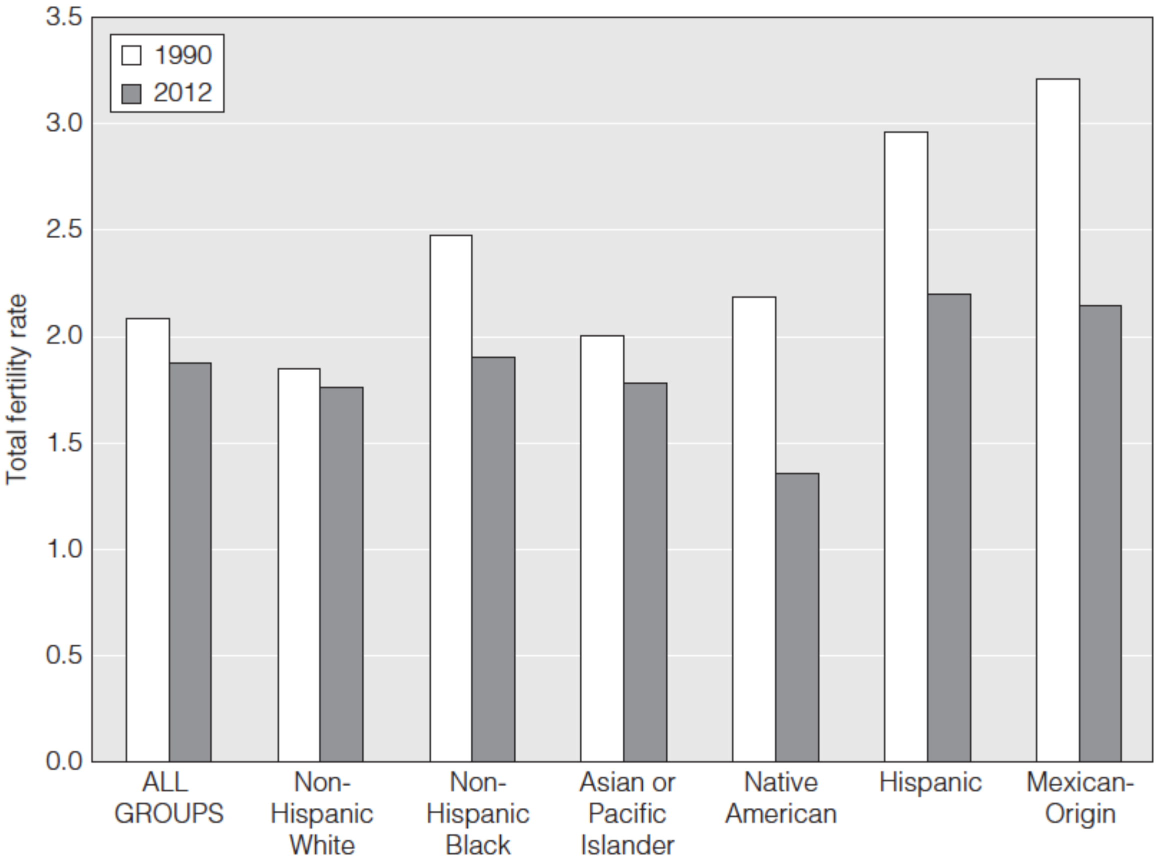
Fertility transition in China and Taiwan



Recent fertility trends, U.S.



Fertility by race/ethnicity, U.S.



Princeton indices

- The Princeton European Fertility Project proposed
  - Overall index of fertility (I_f)
  - Index of marital fertility (I_g)
  - Index of marriage (I_m)
  - Index of non-marital fertility (I_h)
- Data
  - Counts of births at local levels broken down by marital status of mothers (birth registration systems)
  - Counts of women by age and marital status (national censuses)

Source: Wachter 2014.

Applicability of Princeton indices

- Can be calculated with data widely and uniformly available at a provincial or local level across Europe since the mid-1800s
- Measure how favorable the patterns of age at marriage are to high fertility
- Separate out the effects of changing ages of marriage from changes in fertility within marriage

Source: Wachter 2014.

Hutterite rates as standard

- Princeton indices are a form of indirect standardization
- Take a standard schedule of age-specific fertility rates (Hutterites)
- Compare the number of births that a population actually has in a period with the number that the population would have had if their fertility rates had been equal to the Hutterite rates

Source: Wachter 2014.

Overall index of fertility (I_f)

- Numerator
  - Births to all women observed in the actual population ($B^{overall}$)
- Denominator
  - Hypothetical total of implied births
  - Multiply actual counts of women (${}_nK_x$) by standard Hutterite rates (${}_5F_{x,Hutt}$)

$$I_f = B^{overall} / [\Sigma({}_5K_x)({}_5F_{x,Hutt})]$$

Source: Wachter 2014.

Index of marital fertility (I_g)

- Numerator
  - Births to married women in the actual population ($B^{marital}$)
- Denominator
  - Hypothetical implied births within marriage
  - Multiply actual counts of married women (${}_nK_{x,married}$) by standard Hutterite rates (${}_5F_{x,Hutt}$)

$$I_g = B^{marital} / [\Sigma({}_5K_{x,married})({}_5F_{x,Hutt})]$$

Source: Wachter 2014.

Data for Berlin, 1900

Age *x*	Hutterite Rates	Overall Women	Implied Babies	Married Women	Implied Babies
15	0.300	91,358	27,407	1,538	461
20	0.550	114,464	62,955	28,710	15,791
25	0.502	99,644	50,021	55,417	27,819
30	0.407	88,886	36,177	62,076	25,265
35	0.406	75,729	30,746	55,293	22,449
40	0.222	66,448	14,751	47,197	10,478
45	0.061	54,485	3,324	36,906	2,251
Total		591,014	225,381	287,137	104,514

- Also know: 49,638 births of which 42,186 within marriage

Source: Wachter 2014, p.143.

Calculating I_f and I_g for Berlin, 1900

- Overall index of fertility

$$I_f = B^{overall} / [\Sigma({}_5K_x)({}_5F_{x,Hutt})] = 49{,}638 / 225{,}381 = 0.220$$

  – Limitation overall was well advanced by 1900 in Berlin

- Index of marital fertility

$$I_g = B^{marital} / [\Sigma({}_5K_{x,married})({}_5F_{x,Hutt})] = 42{,}186 / 104{,}514 = 0.404$$

  – Fertility within marriage was not wholly responsible for limitation

Source: Wachter 2014.

Index of marriage (I_m)

- Measures how conducive marriage pattern is to high fertility
- Numerator
  - Take the denominator from I_g
  - Hypothetical implied births within marriage
- Denominator
  - Take the denominator from I_f
  - Hypothetical total of implied births

$$I_m = [\Sigma({}_5K_{x,married})({}_5F_{x,Hutt})] / [\Sigma({}_5K_x)({}_5F_{x,Hutt})]$$

$$= 104{,}514 / 225{,}381 = 0.464$$

  - Low proportions marrying contribute to low levels of overall fertility

Source: Wachter 2014.

Index of non-marital fertility (I_h)

- It is rarely employed, when illegitimate fertility is a small part of overall fertility
- Numerator
  - Observed births out of wedlock
- Denominator
  - Hypothetical births that unmarried women in the population would have had at Hutterite rates
- When non-marital fertility is small, I_h can be neglected, and I_f is close to the product of I_g with I_m

$$I_f = (I_g)(I_m) + (I_h)(1 - I_m) \approx (I_g)(I_m)$$

Source: Wachter 2014.

RAND
CORPORATION