Methods - Rehearsel

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Demography of developing countries ECON 3710

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Recommended reading

Rowland, Donald.T (2003). *Demographic Methods and Concepts*. Oxford: Oxford University Press.

- Sections 1.5, 1.6, 6.3, 7.3 - 7.6

Population handbook at www.prb.org/pdf/PopHandbook_Eng.pdf

- Chapters 2-5, 7, 8, Appendix A

Cf. handout

Stocks vs flows

Norway:

Population size	1 Jan 2006	4 640 219
	1 Jan 2007	4 681 134
Live births 2006		58 545
Deaths 2006		41 253

Stocks: one point in time (census time, 1 January etc.)

Flows: during a certain period (one year, five years, between two censuses etc.)

Flows (population level) ←→ events (individual level)

e.g. birth, death, migration (total population), or marriage, divorce (sub-population)

Rates

Intensity of an event is expressed by means of a RATE

Definition: Ratio of the number of events to exposure time for population at risk

Unit of measurement: # events pr. person pr. year

Cf. Poisson rate in statistics (= expected # events pr. unit of time)

Crude death rate

Pop	1 Jan 2006	4 640 219
	1 Jan 2007	4 681 134
Deaths 2006		41 253

Mid-year population (4640219 + 4681134)/2 = 4 660 676½

Death rate = 41253/4660676½ = 0.0089 deaths per person per year (or 8.9 per thousand persons per year)

This death rate is commonly known as the Crude Death Rate, abbreviated as CDR

Mid-year population approximates exposure time

1 Jan 2006: 4 640 219 exposed to death risk

1 Jan 2007: 4 681 134 exposed to death risk

On average during the year

(4640219 + 4681134)/2= 4 660 676½ persons were exposed to death risk during one whole year

Exposure time expressed as «person years» or «person years of exposure»

When period shorter/longer than one year: multiply ”mid-period” population by period length to find exposure time

1000 persons exposed during 1 year = 1000 person years

200 persons exposed during 5 years = 1000 person years

Crude birth rate (CBR)

Pop	1 Jan 2006	4 640 219
	1 Jan 2007	4 681 134
Live births 2006		58 545

Mid-year population (4640219 + 4681134)/2 = 4 660 676½

CBR = 58545/4660676½ = 0.0126 or 12.6 per thousand

Types of demographic measures

- Rate: # events/exposure time
- Ratio: one number relative to one other number. Example: sex ratio
- Proportion (fraction, share): numerator is part of the denominator. Examples: proportion women in a population, proportion elderly
- Probability: # events in a pop/initial pop size
  - easy to compute in a population that is closed for migration
  - open population: use formula that transforms rate into probability (see Table 6.5)

Crude Death Rate too crude

Risk of dying varies strongly with age

Typical age pattern of mortality

→ Death rates for separate ages/age groups

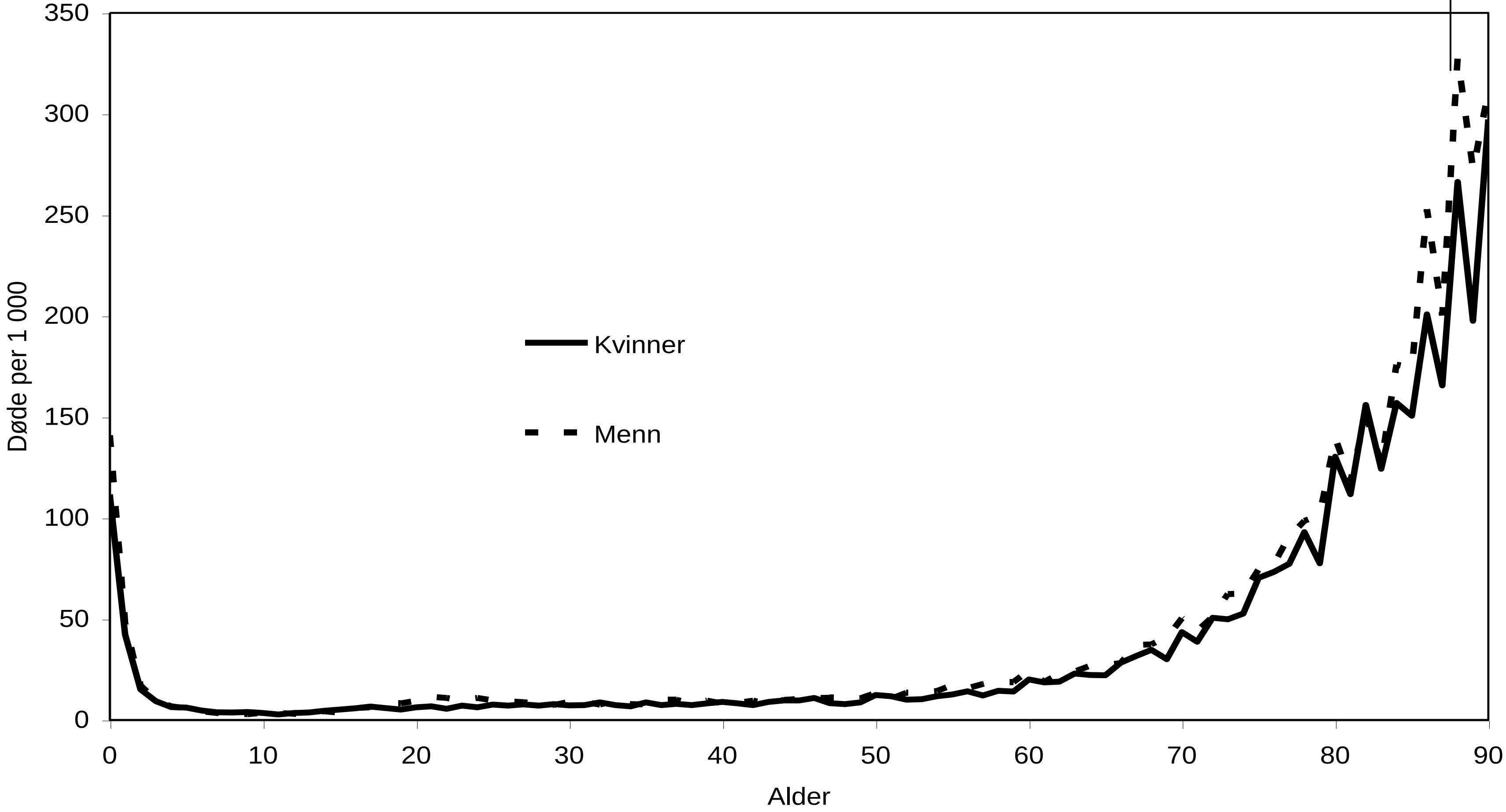
Age specific death rates (ASDR)

ASDR for age x = 1000*deaths at age x/mid.year pop age x

Cf. Example Russian Federation in Table 6.5

0 ≤ ASDR ≤ 2000!

Age specific death rates, Norway 1900



NB: Kvinner = women, Menn = men, alder = age,
Vertical scale: number of deaths per 1000 of mid-year population

Death probability (q) – Formula Table 6.5

Death probability: Probability to be no longer alive at the end of the year, given alive at the beginning of the year

One year: $q = ASDR/(1 + ½ASDR)$

n years : ${}_nq = n.ASDR/(1 + ½.n.ASDR)$

Note: when computing q, take ASDR per 1, not per 1000

Exampe Russian Federation 1995, age 75-79:

ASDR = 106.2 pr 1000 = 0.1062 → ${}_5q = 5*0.1062/(1 + ½*5*0.1052) = 0.4196 = 41.96\%$.

$0 \leq {}_nq \leq 1$!

Life table

Purpose: to summarize the life course of a hypothetical population from birth to death

Based on a given set of age-specific death rates/death probabilities

e.g. men, Malaysia, 1995 (handout) or women, Norway, 2011 (http://www.ssb.no/english/subjects/02/02/10/dode_en/tab-2012-04-19-05-en.html)

Set of age-specific death rates / probabilities often summarized in one number: life expectancy

Some die early, others die later. Life table extends until last person in hypothetical population has died.

Life expectancy equals mean age at death for the hypothetical population.

Life table (cont.)

Series of columns, with rows representing ages / age groups cf. handout (men in Malaysia 1995).

Important:

- ${}_nq_x$ proportion dying in the age interval
  ${}_nq_x$ column (or the death rates underlying them) is input for the life table

- l_x number alive at the beginning of age interval in hypothetical population

- e_x years of life remaining (e_0 is life expectancy)

- e_0 summarizes, in one number, the whole set of rates/probabilities for 100 ages

How to compute a life table is not required reading in this course (it is in ECON 1710)

Life table (cont.)

- Ordinary life tables: one-year age groups (Statistics Norway)
- Abridged life tables: five-year age groups (but 0-<1, 1-5) Malaysia

- Period life table: death rates/probabilities observed for a certain period/calendar year among persons born in different years
- Cohort life table: death rates/probabilities observed for a certain fixed birth for various calendar years

Life expectancy in a period life table is NOT a reliable measure of future mortality

In 1949 (Nico's birth cohort), e_0 for men was 69 years based on data for 1949

Most recent life table (2011) gives 79.0 years for men

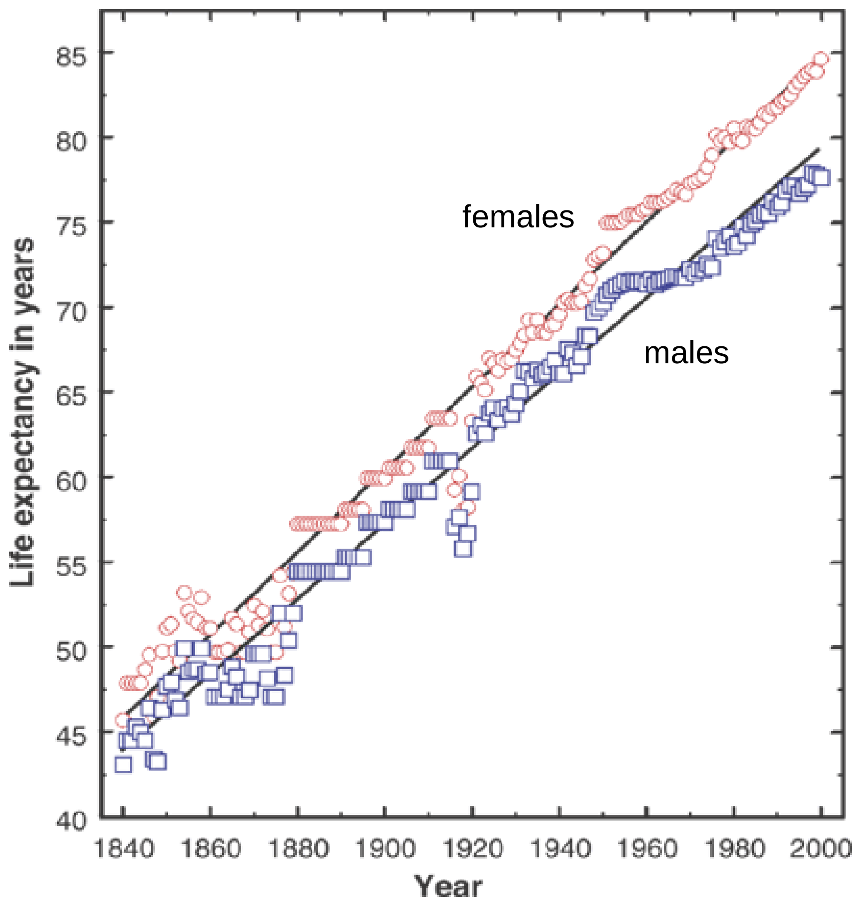
Nico's current (that is, based on data from 2011) remaining life expectancy (e_{63}) is 19.7 years: he can expect to become 63+19.7 = 82.7 years old (with today's mortality)

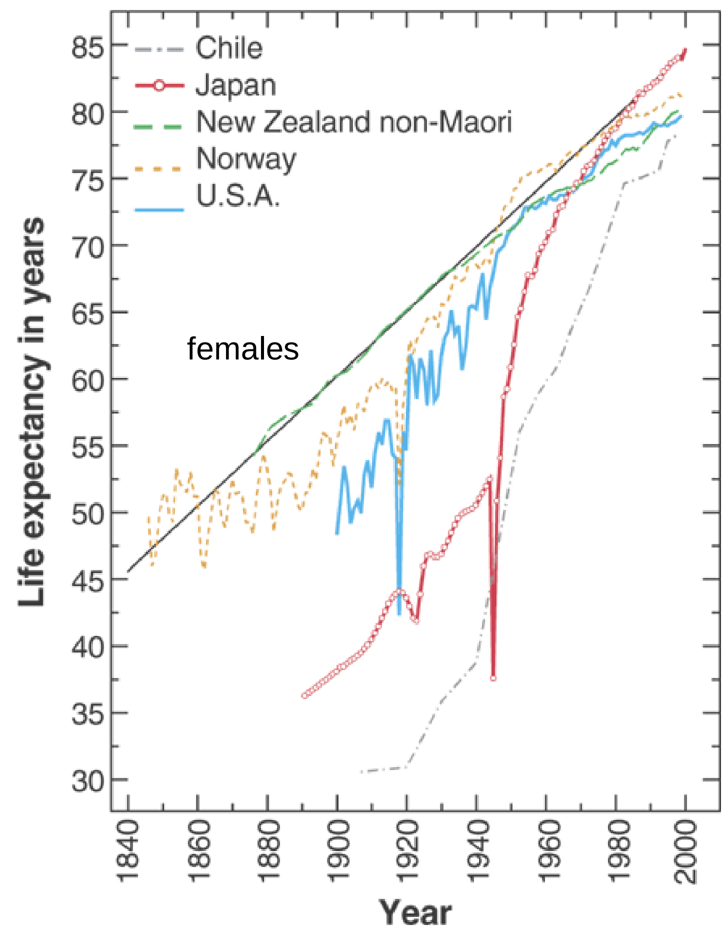
But we «know» that mortality will decrease the next 20 years

Nico can expect to be older than 82.7 years – an e_{63} equal to 19.7 years is an underestimation of the «real» e_{63} (that is, the e_{63} for birth cohort 1949

Record life expectancy

has increased linearly in 160 years (~3 mnths. pr. year / ~2.5 years pr. decade)





Source: Oeppen and Vaupel (2002) *Science*

Crude Birth Rate too crude

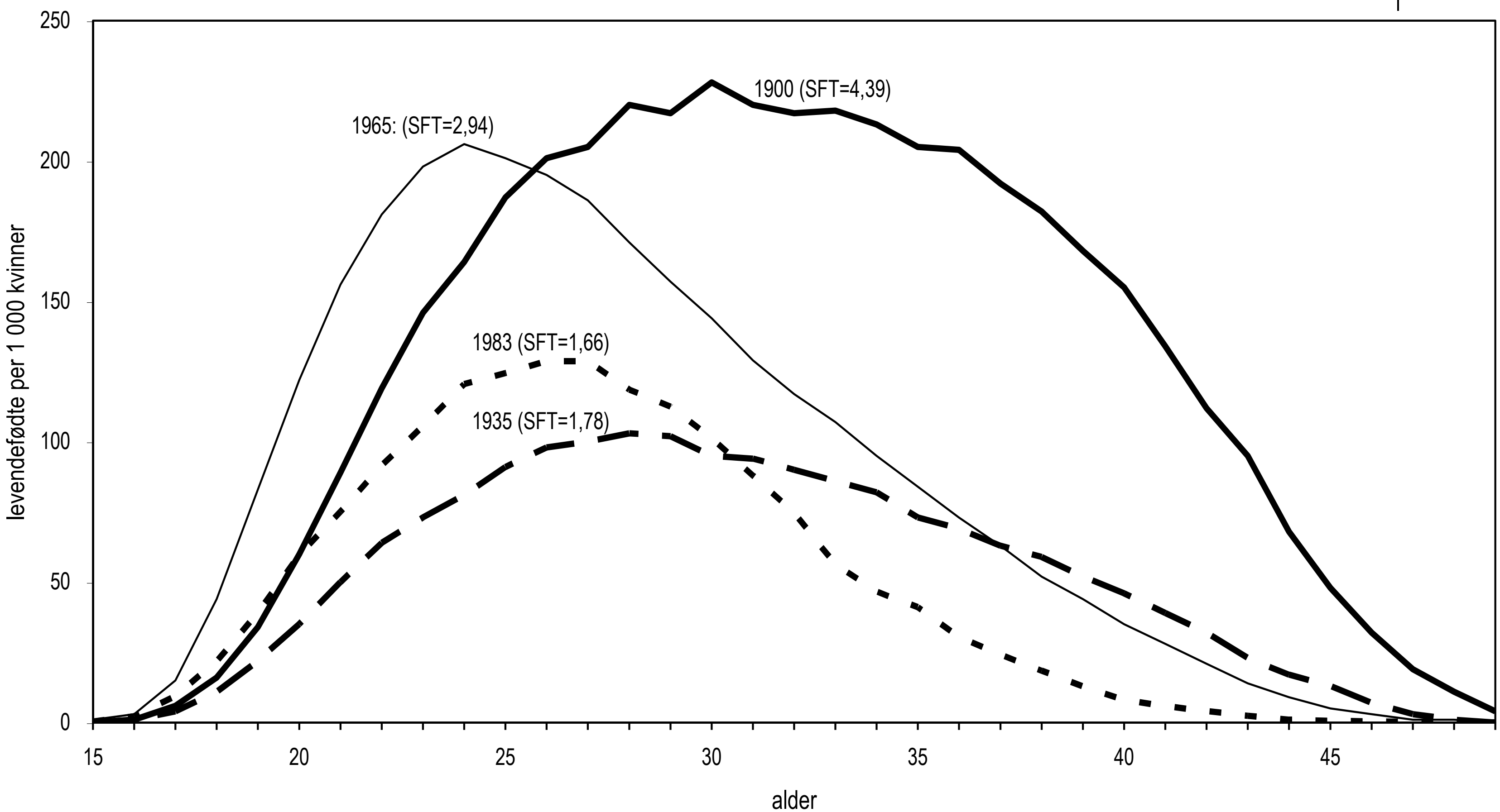
Age specific fertility rate ASFR

- one-year age groups (x,x+1) 15, 16, 17, …, 49
- five-year age groups (x,x+5) 15-19, 20-24, … 45-49

$$\text{ASFR} = \frac{\text{\# births to women in age group}}{\text{mid-year population of women in age group}} .1000$$

See example Russian Federation in Table 7.1

Age specific fertility rates, Norway, selected years



NB SFT = Total Fertility Rate ("Samlet fruktbarhetstall")
Horizontal scale: age. Vertical scale: live births per 1000 women.

Total Fertility Rate (TFR)

TFR = sum, over all ages, of ASFR/1000

Average number of children a young girl eventually will have provided that current ASFR's remain constant, no mortality

When ASFR's are given for five-year intervals:

TFR = 5 x (sum, over all ages, of ASFR/1000)

Total Fertility Rate (TFR)

Period TFR : based on ASFR’s observed in one particular year/period for women born in different years → synthetic measure

Cohort TFR: based on ASFR’s for women born in one particular year/period, observed in different years → actual # children

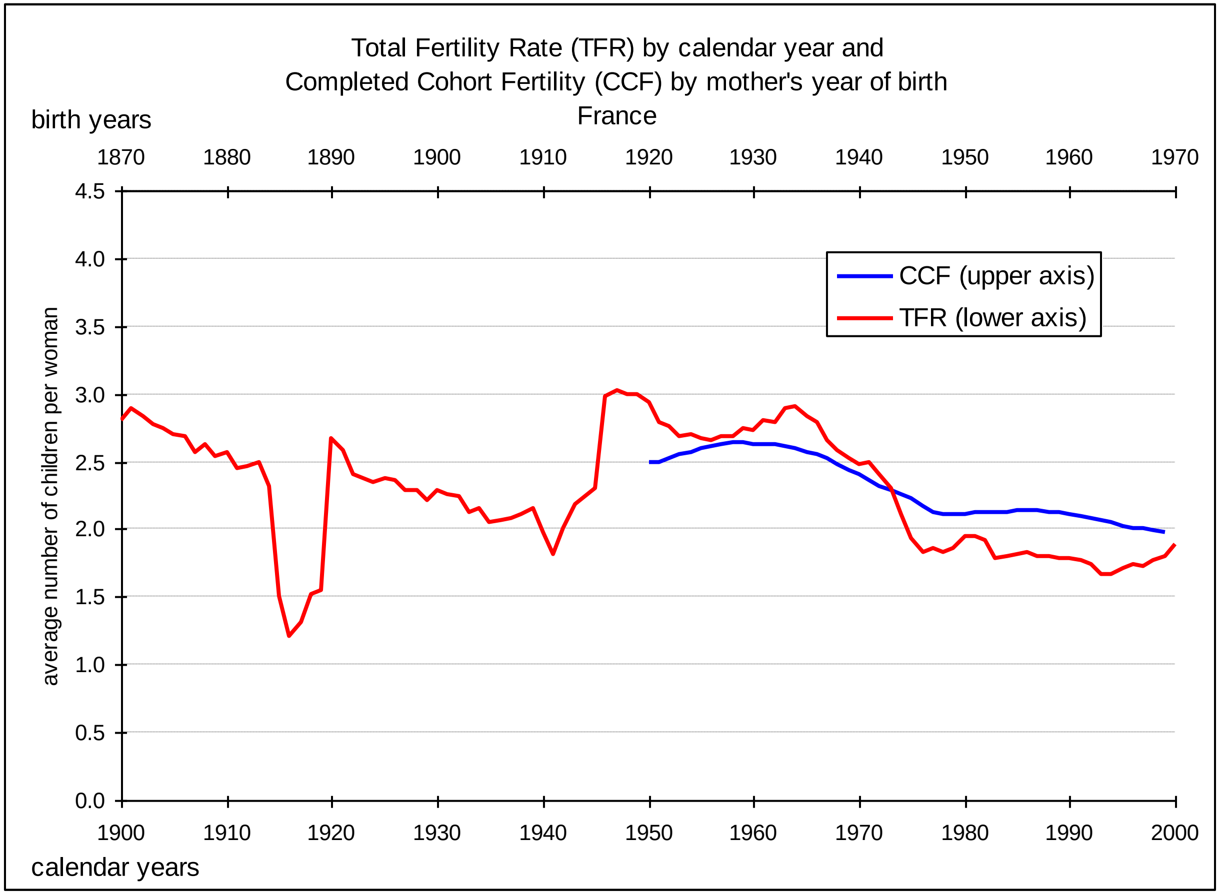
Cohort TFR also called Completed Cohort Fertility (CCF)

Period TFR synthetic measure

Period TFR's are poor predictors of the number of children a woman ultimately will have

Based on unrealistic assumption that ASFR's will remain constant over time

Period TFR influenced by postponement and catching up effects in the timing of births



Total Fertility Rate (TFR) by calendar year and
Completed Cohort Fertility (CCF) by mother's year of birth
France
birth years
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
average number of children per woman
CCF (upper axis)
TFR (lower axis)
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
calendar years

Gross Reproduction Rate (GRR)

GRR = TFR x (proportion girls among live births)

Average number of daughters a woman will have when she experiences childbearing as given by the set of ASFR's that underly the TFR – ignoring mortality

Extent to which a group of women reproduces itself by daughters

Proportion girls among live births

Usually around 0.485 in Western countries

Lower in some developing countries

Net Reproduction Rate (NRR)

Takes mortality into account

Given: ASFR's for one year – fertility rates

ASDR's for women for one year – mortality rates

NRR = Average number of daughters a woman will have when she experiences childbearing and mortality as given by the set of ASFR's and ASDR's

Western countries: little difference between GRR and NRR

Developing countries: big differences

	GRR 1993	NRR 1993
Burkina Faso	3.50	2.41
United Kingdom	0.86	0.85

NRR = 1

Fertility is at replacement level

When NRR = 1 for a long time, then population size will become constant eventually (ignoring migration)

NRR > 1 (< 1)

Fertility is over (under) replacement level

Long run: increasing (falling) population