Why proximate determinants?

Human reproduction is shaped by biology and behavior, but those are themselves influenced by socio-economic and cultural factors. To analyze fertility differentials scientifically, we separate:

Background (Distal) factors: education, employment, urbanization, child mortality, etc.

Proximate determinants: immediate behavioral/biological mechanisms through which the distal factors act.

Bongaarts–Potter Model of Proximate Determinants of Fertility

Davis & Blake (1956) introduced the idea of "intermediate variables." **John Bongaarts (1978)** and **Bongaarts & Potter (1983)** refined these into a compact, operational model with **eight** variables, of which **four** are the principal fertility-inhibiting indices in applied work:

- Marriage/sexual exposure ($\mathbf{C_m}$)
- Contraception (**C_c**)
- Induced abortion (**C_a**)
- Postpartum infecundability ($\mathbf{C_i}$)
- Each index ranges from 0 (maximal inhibition) to 1 (no inhibition). Lower values mean stronger fertility-reducing effect.

The cumulative fertility rates and the chain of indices

1

TF: *Total fecundity*—biological maximum under natural fertility (often ≈ 15.3 births/woman in Bongaarts' calibrations).

2

TN: *Total natural marital fertility rate*—fertility after postpartum infecundability but before contraception/abortion.

3

TMFR: *Total marital fertility rate*—after postpartum infecundability, contraception, and abortion, but assuming all exposure is within marriage.

4

TFR: *Total fertility rate*—the observed overall fertility level.

Relationships:

$$\mathrm{TN} = \mathrm{TF} \times C_i$$

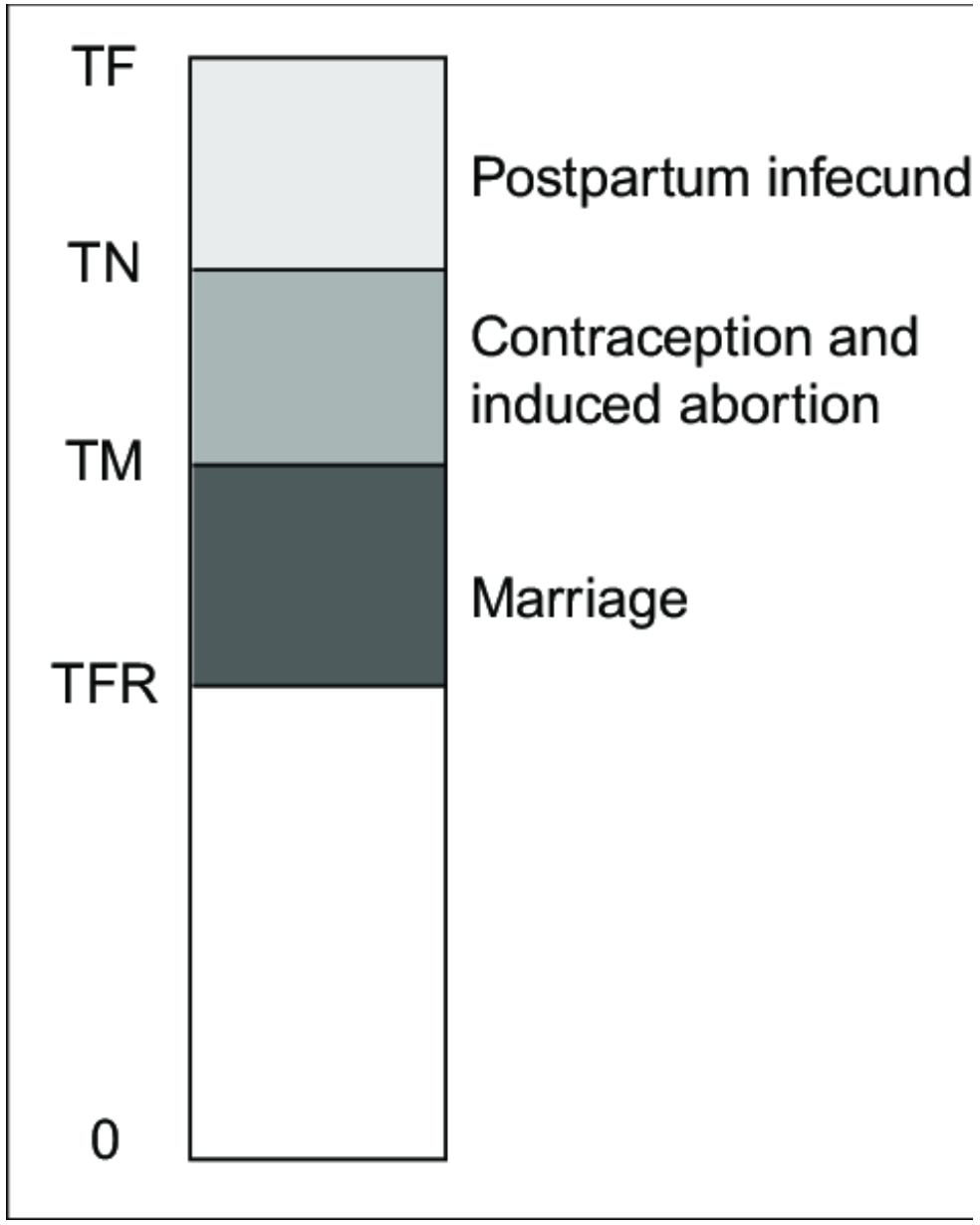
$$\mathrm{TMFR} = \mathrm{TN} \times C_c \times C_a$$

$$\mathrm{TFR} = \mathrm{TMFR} \times C_m$$

Combining:

$$\mathrm{TFR} = \mathrm{TF} \times C_i \times C_c \times C_a \times C_m$$

Final model



Marriage (or sexual exposure) index, $\mathbf{C_m}$

Captures reduced exposure to childbearing due to late/non-marriage or marital disruption.

- Formula (weighted by exposure at childbearing ages):

$$C_m = \frac{\sum_x (ASMFR_x)\,\pi_x}{\sum_x (ASMFR_x)}$$

where π_x is the proportion currently married at age x and $ASMFR_x$ are age-specific marital fertility rates.

- Equivalent and very handy identity:

$$C_m = \frac{TFR}{TMFR}$$

Interpretation:

- $C_m = 1$: everyone is exposed (married/sexually active) at the ages when marital fertility is highest.
- Lower C_m: later marriage, more never-married, or more disruption.

Contraception index, **C_c**

Reflects the fertility-reducing impact of contraceptive use and its **method mix effectiveness**.

- Core formula:

$$C_c = 1 - 1.08\,u\,e$$

where u = proportion of currently married women using any contraception;
e = average *use-effectiveness* of the method mix.

- Average effectiveness from method mix:

$$e = \frac{\sum_m u_m e_m}{\sum_m u_m} = \frac{\sum_m u_m e_m}{u}$$

with u_m = proportion using method m, e_m = use-effectiveness for method m.

- Suggested e_m values (Bongaarts & Potter):
  - Oral pill = 0.90
  - IUD = 0.95
  - Sterilization = 1.00
  - Periodic abstinence = 0.80
  - Condom = 0.90
  - Other traditional methods = 0.70

Postpartum infecundability index, C_i

Represents the extension of the non-susceptible period after a birth due to lactational amenorrhea and postpartum abstinence.

- Standard formula:

$$C_i = \frac{20}{18.5 + i}$$

where i = average duration (months) of postpartum infecundability (amenorrhea/abstinence).

- Estimating i from breastfeeding duration b_d:
  Bongaarts & Potter provided an empirical mapping using 21-country data:

$$i = 1.753\, e^{(0.1396\, b_d - 0.001872\, b_d^2)}$$

Induced abortion index, C_a

Captures births averted by induced abortion (net of replacement).

Two operational options:

1. **Improved Bongaarts form (preferred when TAR is available):**

$$C_a = \frac{TFR}{TFR + 0.4(1+u)\,TA}$$

- TA = Total Abortion Rate (average number of induced abortions per woman over her lifetime)
- u = proportion using contraception

2. **Simple approximation (when only a rough TAR is available):**

$$C_a = 1 - \alpha\, TAR \quad (\alpha \approx 0.4)$$

Practical caution: TAR is under-reported in many settings. If credible estimates are unavailable, analysts often set $C_a \approx 1$ and conduct **sensitivity analyses**.

Interpreting changes and decomposing differences

Lower C_m	→ later marriage, more time in schooling/work.
Lower C_c	→ higher contraceptive prevalence and/or shift to more effective methods.
Lower C_i	→ extended breastfeeding/abstinence norms (public-health benefits, but also interaction with family planning).
Lower Ca	→ more abortions (sensitive; interpret in context of legality and access)