Note: Charts below are illustrative placeholders and should be replaced with official series before publication.

Fertility Levels and Trends (Ethiopia focus plus global lens)

Aynalem Adugna, October 2025

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4.1) Concepts, Measures & Data for Fertility Levels

What this section does. Defines core measures of period fertility, maps Ethiopia's main data sources, and lists quick quality checks. Formulas here underpin Chapters 4.2–4.9; detailed differentials/determinants are in Chapter 5.

Table 4.1-A. Period fertility measures and formulas (plain)

Measure	Formula (plain text)	Notation	Interpretation
Crude Birth Rate (CBR)	CBR = B / P × 1,000	B: births in a year; P: mid-year population	Crude; sensitive to age structure
General Fertility Rate (GFR)	GFR = B / W(15–49) × 1,000	W(15–49): women aged 15–49 mid-year	Controls for sex/age structure
Age-Specific Fertility Rate (ASFR)	ASFR_x = b_x / W_x	b_x: births to women x–x+4; W_x: women x–x+4	5-year age groups 15–49
Total Fertility Rate (TFR)	TFR = 5 × Σ ASFR_x (15–49)	Multiply by 5 to convert group rates to per-woman	Births per woman if current rates persist
Gross Reproduction Rate (GRR)	GRR = TFR × p_f	p_f ≈ 0.488 if SRB≈105	Daughters per woman (ignores mortality)
Net Reproduction Rate (NRR)	NRR = 5 × Σ l_x × ASFR_x × p_f	l_x: survivorship to age x (life table)	Accounts for female mortality; ≈1 is replacement

Illustrative diagnostics (replace with official calculations for publication)

Figure . Whipple’s index trend from census/surveys (illustrative)

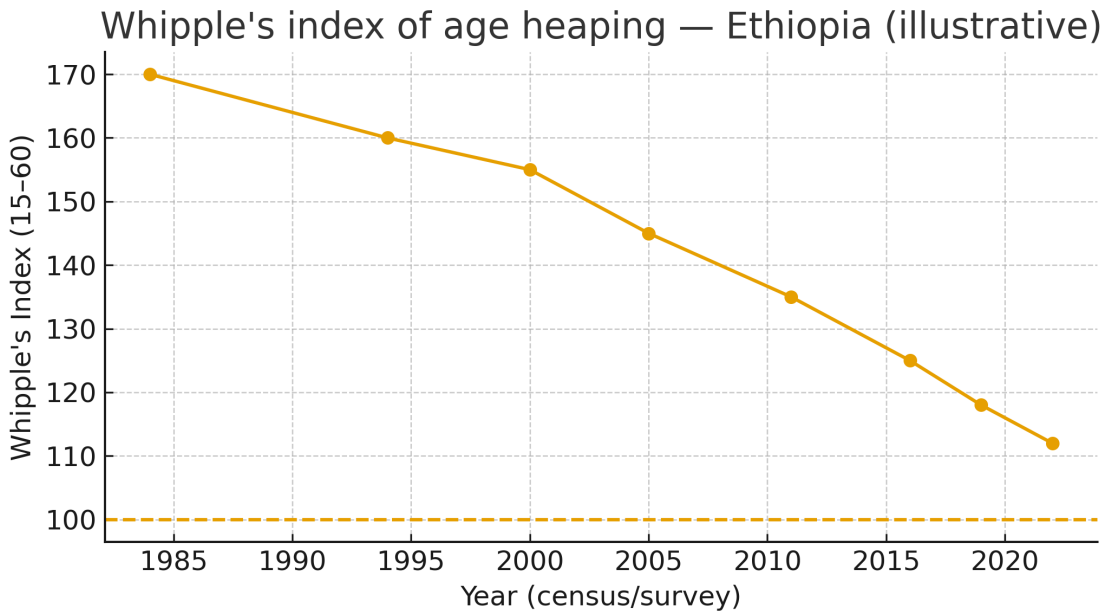

Figure . Why CBR can mislead: CBR vs GFR vs TFR (illustrative)

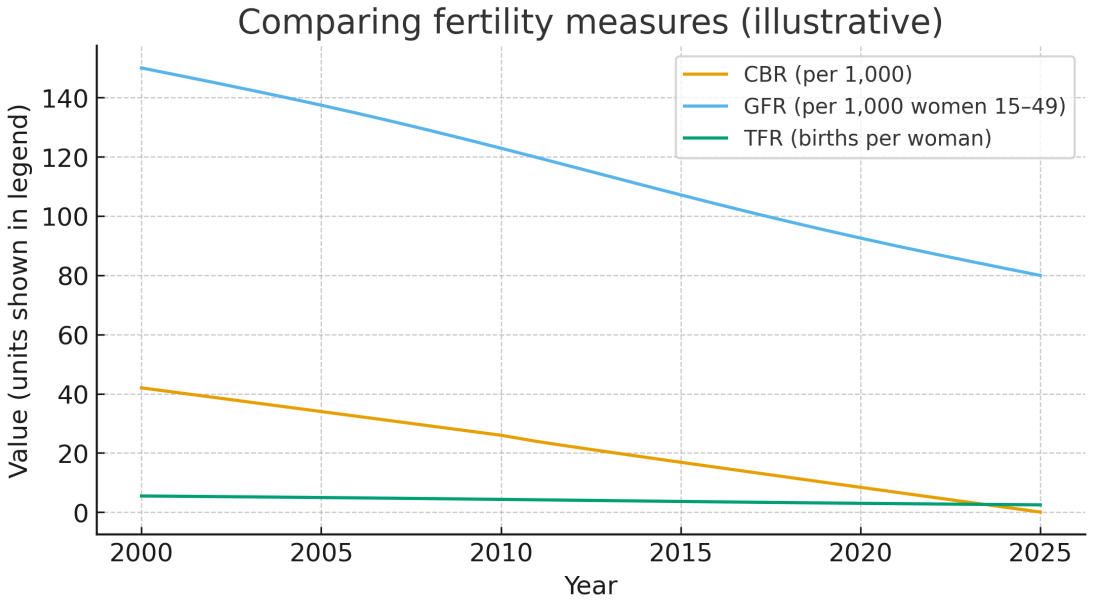

Table 4.1-B. Ethiopia data sources for fertility levels

Source	Key variables	Use & cautions
CRVS (where functioning)	Registered births by month/region; mother's age; parity (often incomplete)	Level/trend checks; completeness & delays
Household sample surveys (DHS, MIS, MICS, LSMS)	Full birth histories; recent births; WRA denominators; weights	Compute ASFR/TFR; sampling & displacement rules
Population & Housing Censuses (CSA)	Children ever born; births last year; age–sex structure	Indirect checks (P/F ratio); age heaping; omissions
Health facility HMIS	Facility deliveries; ANC; PNC; family planning uptake	Service-based proxy; coverage bias
UN DESA WPP / World Bank	Harmonized TFR/ASFR; life tables; metadata	Comparability across countries/years

Table 4.1-C. Quick quality checks and fixes

Issue	Indicator/diagnostic	Action for analysis
Age heaping/age misreporting	Terminal-digit bars; Whipple's/Myles index; digit preference	Flag if Whipple's > 175; smooth before rates
Birth omission/displacement	Heaping at 12/24 months; DHS calendar displacement	Compare 'last year' vs full histories; heaping diagnostics
Denominator issues	Sex/age structure anomalies; migration	Prefer GFR/ASFR to CBR for comparisons
Seasonality/reporting delays	Monthly registered births vs survey recall	Use moving averages; adjust for backlog releases
Geocode masking/safety	DHS cluster displacement; facility privacy	Aggregate to safe levels; don't over-map small areas

Notes on computation & reproducibility

• Use seven 5-year age groups (15–19 … 45–49). Multiply the ASFR sum by 5 to convert to births per woman (TFR).

• When possible, compute NRR with female survivorship from a consistent life table vintage.

• Always state dataset vintages (e.g., DHS 2016, 2019; WPP 2024) and any smoothing/heaping adjustments used.

References — Section 4.1

- United Nations, Department of Economic and Social Affairs (UN DESA). World Population Prospects (latest vintage). Methods and Metadata.

- Rutstein, Shea O., and Rojas, G. (2006). Guide to DHS Statistics. The DHS Program.

- Shryock, H. S., Siegel, J. S., & Associates (1976). The Methods and Materials of Demography. U.S. Bureau of the Census.

- Bongaarts, J., & Feeney, G. (1998). On the Quantum and Tempo of Fertility. Population and Development Review.

- Preston, S., Heuveline, P., & Guillot, M. (2001). Demography: Measuring and Modeling Population Processes.

4.2) Period Fertility: ASFR, TFR, GFR, CBR

Purpose. Define and compute Ethiopia's period fertility measures from standard data sources, illustrate divergences among CBR, GFR and TFR, and provide a worked example for replication.

Table 4.2-A. Core period fertility measures (definitions & formulas)

Measure	Formula (plain text)	Notation	Interpretation
Crude Birth Rate (CBR)	CBR = B / P × 1000	B: births in year; P: mid-year population	Crude; affected by age structure
General Fertility Rate (GFR)	GFR = B / W(15–49) × 1000	W(15–49): women aged 15–49	Controls for female age structure
Age-Specific Fertility Rate (ASFR)	ASFR_x = b_x / W_x	b_x: births to women x–x+4; W_x: women x–x+4	Estimated for seven 5-yr groups

Total Fertility Rate (TFR)	TFR = 5 × Σ ASFR_x (15–49)	×5 converts 5-yr group rates to per-woman	Births per woman if current rates persist
Mean age at childbearing (period)	MAC = (Σ a × ASFR_a) / (Σ ASFR_a)	a: age-group midpoints	Timing indicator for period data

Figures (replace with official series for publication)

Figure . Age-specific fertility schedule — Ethiopia (illustrative)

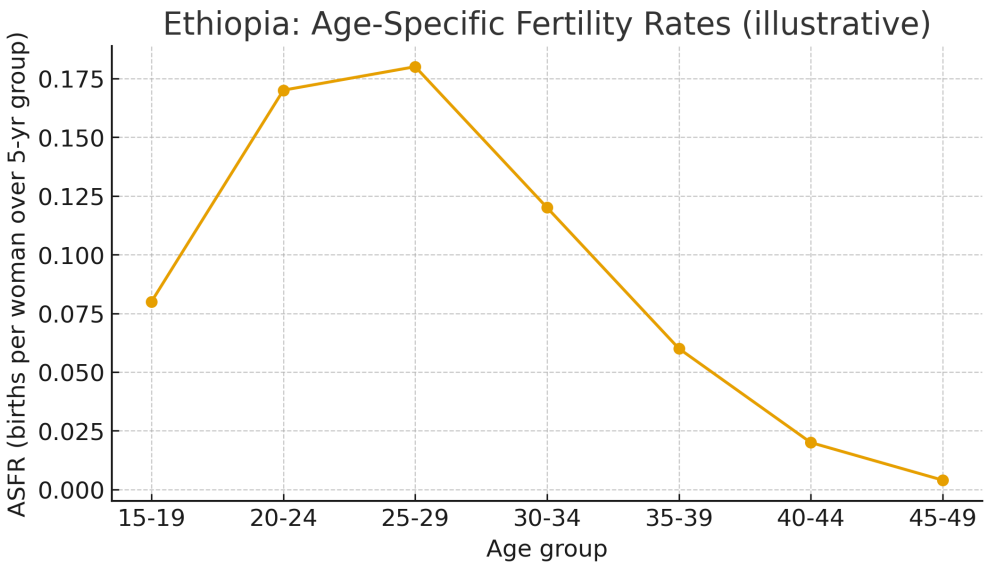

Figure . Total Fertility Rate (period trend) — Ethiopia (illustrative)

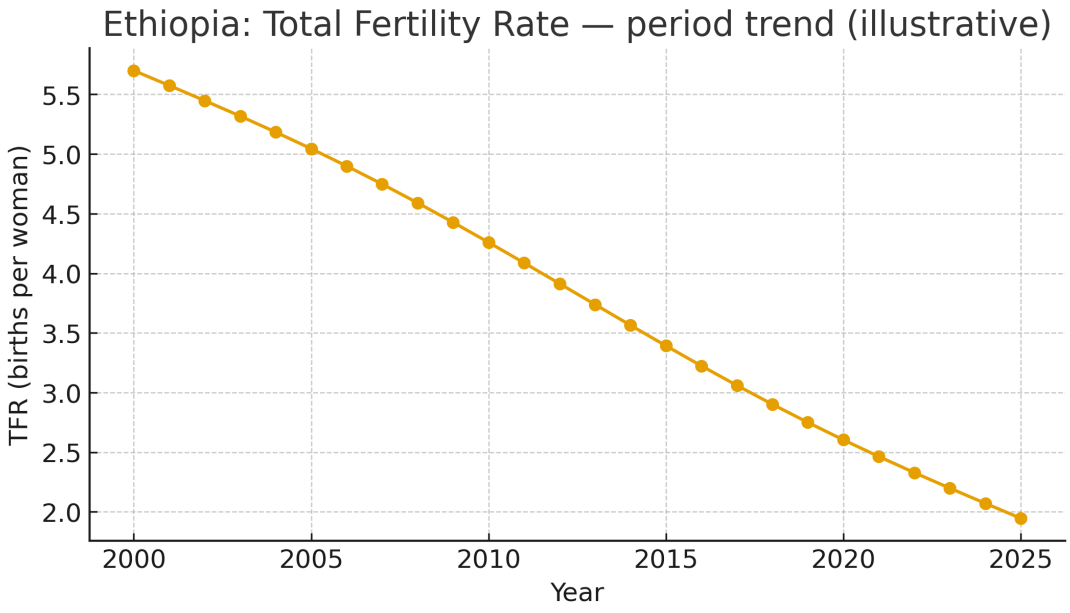

Figure . Comparing GFR and CBR — Ethiopia (illustrative)

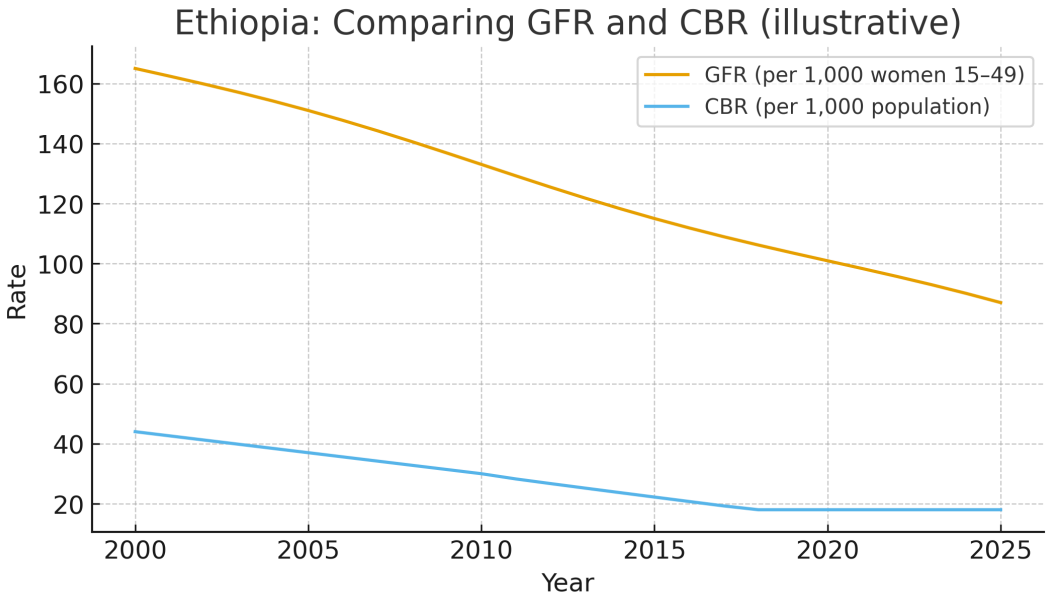

Table 4.2-B. Worked example: computing ASFR, TFR, and GFR from age-group counts

Age group	Women W_x	Births b_x	ASFR_x = b_x / W_x	Contribution 5×ASFR_x
15-19	1000000	78000	0.078	0.39
20-24	920000	156000	0.16957	0.848
25-29	880000	160000	0.18182	0.909
30-34	820000	98000	0.11951	0.598
35-39	760000	46000	0.06053	0.303
40-44	700000	14000	0.02	0.1
45-49	640000	2500	0.00391	0.02
—TOTAL—	5720000	554500		
—TFR—				3.17
—GFR—			96.9 per 1,000 women	
—CBR (proxy)—			49.4 per 1,000 pop	

Notes & computation tips

• Use women aged 15–49 as denominators for ASFR and GFR; ensure weights are applied for survey data.

• For TFR, multiply the sum of 5-year ASFRs by 5. Show uncertainty bands (e.g., via bootstrap) when using samples.

• CBR is sensitive to age structure; prefer GFR/TFR for comparing fertility levels across regions or over time.

• Period measures reflect current rates; cohort analyses are presented in Section 4.3.

References — Section 4.2

- Rutstein, S. O., & Rojas, G. (2006). Guide to DHS Statistics. The DHS Program.

- United Nations, Department of Economic and Social Affairs (UN DESA). World Population Prospects (latest vintage). Methods and Metadata.

- Preston, S., Heuveline, P., & Guillot, M. (2001). Demography: Measuring and Modeling Population Processes.

- Hinde, A. (1998). Demographic Methods. Arnold.

4.3) Cohort Fertility & Quantum–Tempo

Why cohorts? Cohort indicators track the fertility actually experienced by women born in the same years. They separate long-run ‘quantum’ (how many children) from ‘tempo’ (timing) effects that can distort period TFR.

Table 4.3-A. Key cohort measures and tempo adjustment (plain)

Measure	Formula (plain text)	Notes
Completed fertility (CF) for cohort c	CF_c = 5 × Σ ASFR_{c,a} (ages 15–49)	Children ever born by age 45–49 (approx.).
Mean age at childbearing (MAC) for cohort c	MAC_c = (Σ a × ASFR_{c,a}) / (Σ ASFR_{c,a})	a are age-group midpoints.
Parity progression ratio (PPR)	PPR_k = P(parity k → k+1 | reached k)	From birth histories; conditional probability.
Tempo-adjusted TFR (period)	TFR* = TFR / (1 − r)	r = annual change in MAC (years/year). Approximation.

Figures (replace with official series for publication)

Figure . Ethiopia: Cohort completed fertility (CF) and mean age at childbearing (MAC) — illustrat

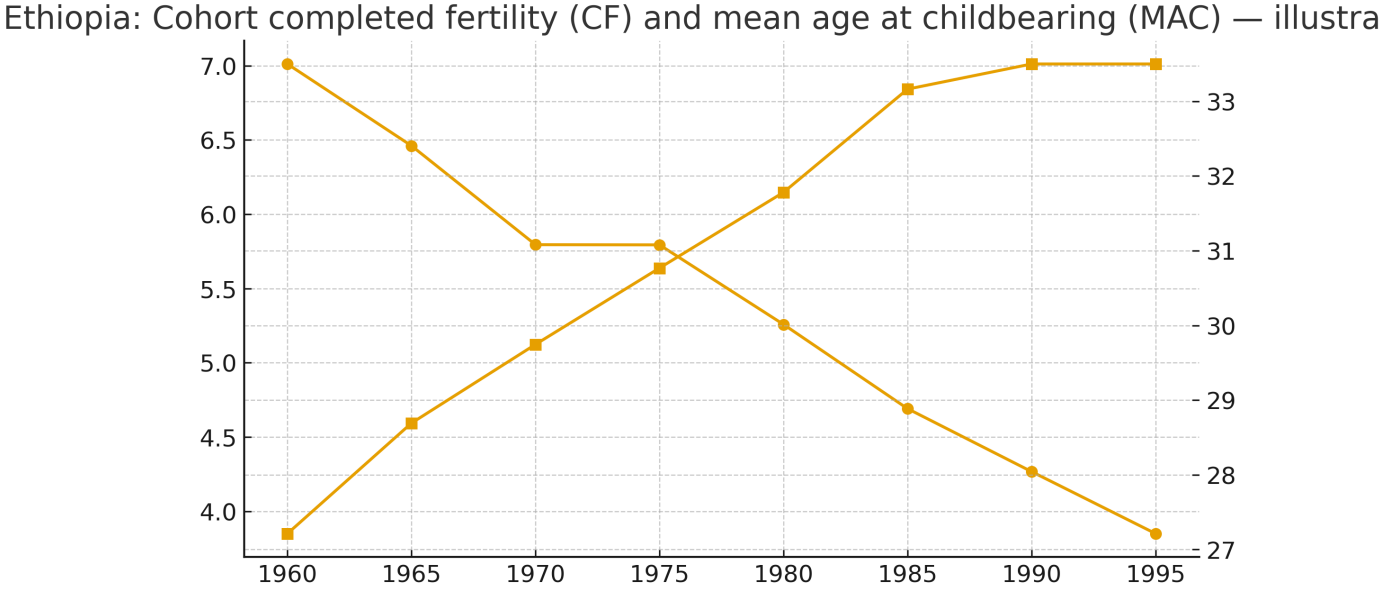

Figure . Tempo effect on period TFR and tempo-adjusted TFR* — illustrative

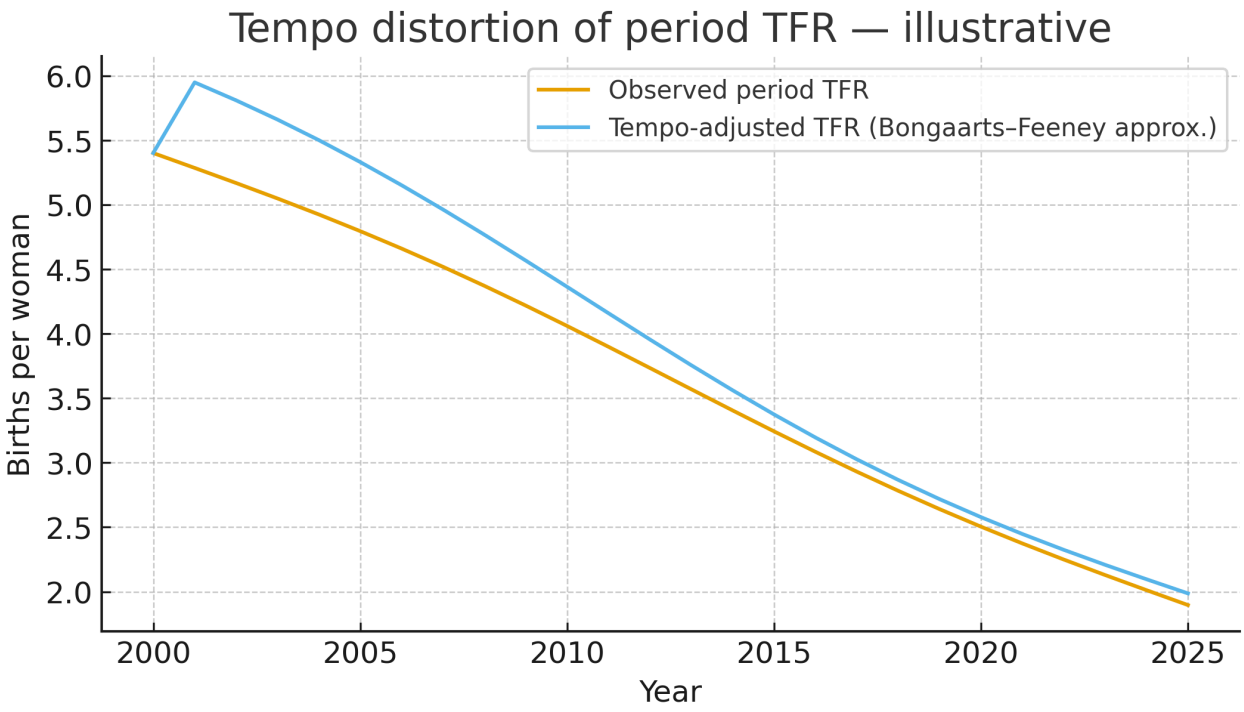

Figure . Cohort parity progression ratios (PPR) — illustrative

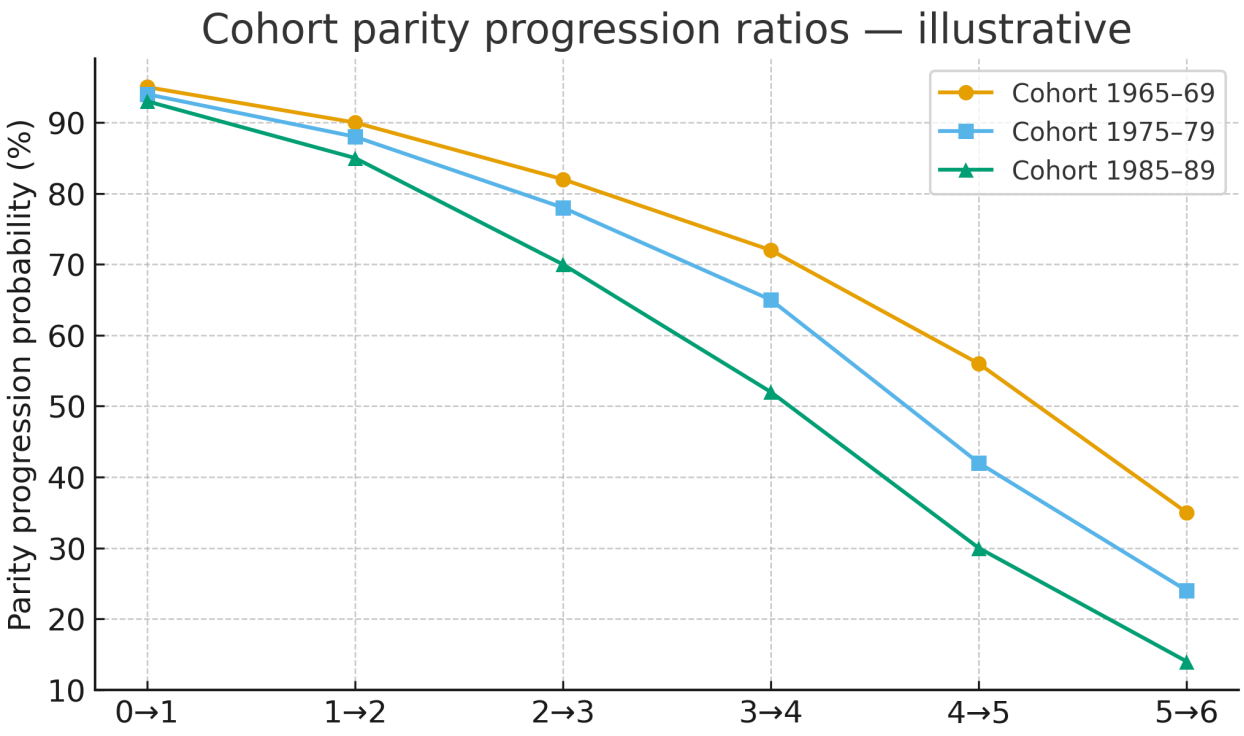

Figure . Cohort ASFR schedules at different completed fertility levels — illustrative

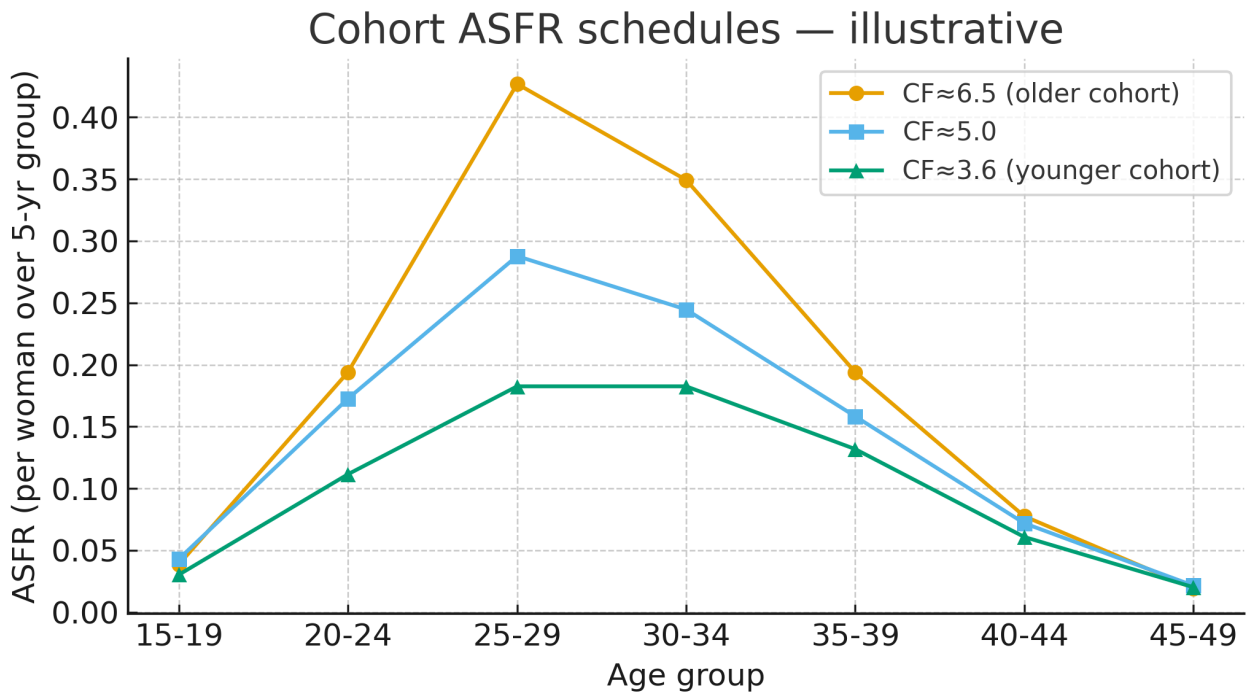

Figure . Quantum vs tempo components of period TFR — illustrative

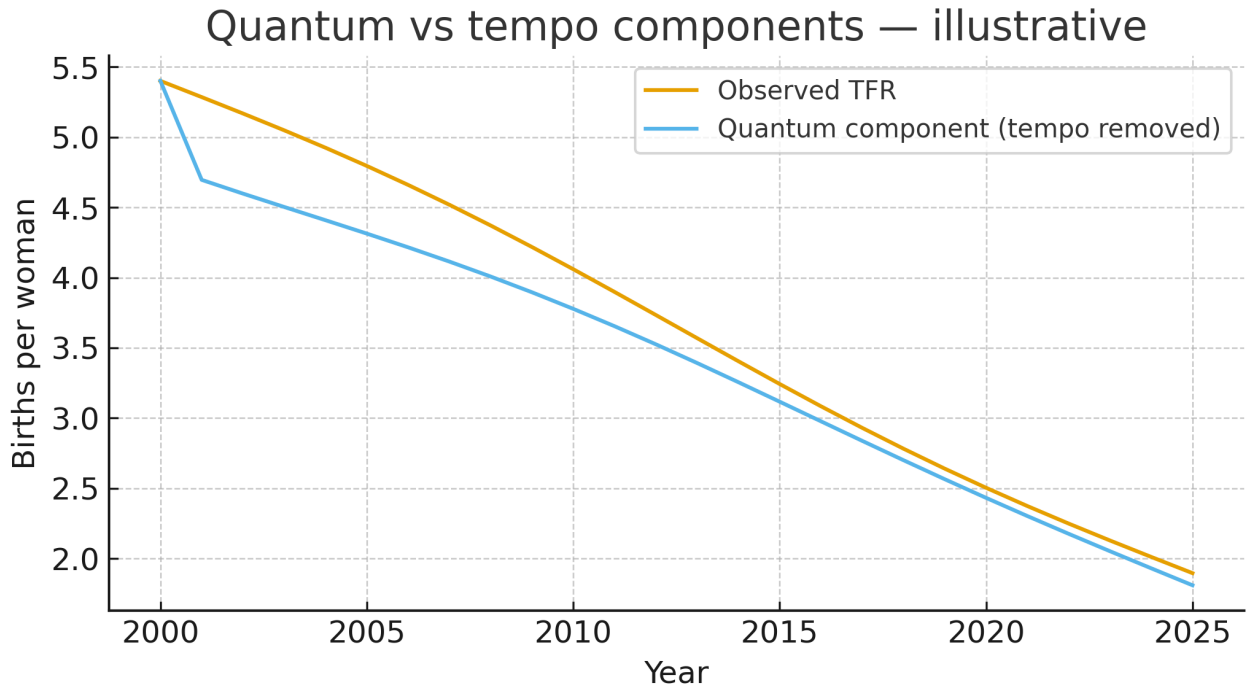

Table 4.3-B. Worked example: parity progression ratios → implied completed fertility (illustrative)

Parity step	Cohort 1965–69 PPR	Cohort 1975–79 PPR	Cohort 1985–89 PPR
0→1	0.95	0.94	0.93
1→2	0.9	0.88	0.85
2→3	0.82	0.78	0.7
3→4	0.72	0.65	0.52
4→5	0.56	0.42	0.3
5→6	0.35	0.24	0.14
—Implied CF—	3.39	3.05	2.66

Notes & cautions

• Tempo adjustment shown uses a simplified Bongaarts–Feeney approximation with r = annual MAC change. Use parity-specific methods where possible.

• Cohort measures require long observation windows; use synthetic cohorts cautiously and document assumptions.

• Report uncertainty bands when estimating CF from truncated histories or modelled ASFRs.

References — Section 4.3

- Bongaarts, J., & Feeney, G. (1998). On the Quantum and Tempo of Fertility. Population and Development Review.

- Sobotka, T., Lutz, W., & Philipov, D. (2011). Reproductive decision-making in a macro-micro perspective. (Tempo and quantum).

- Preston, S., Heuveline, P., & Guillot, M. (2001). Demography: Measuring and Modeling Population Processes.

- Keilman, N. (1994). Translation of period into cohort fertility rates. (Conceptual notes).

4.4) National Trends Since 1980

Overview. This section tracks Ethiopia's fertility levels since 1980, using comparable period indicators (CBR, GFR, TFR) and timing (MAC). It shows shifts in the age pattern of childbearing, the urban–rural gap, and parity structure. Replace the illustrative series with official CSA/DHS/WPP values for publication.

Figures (illustrative — replace with official series)

Figure . TFR, GFR and CBR since 1980 — Ethiopia

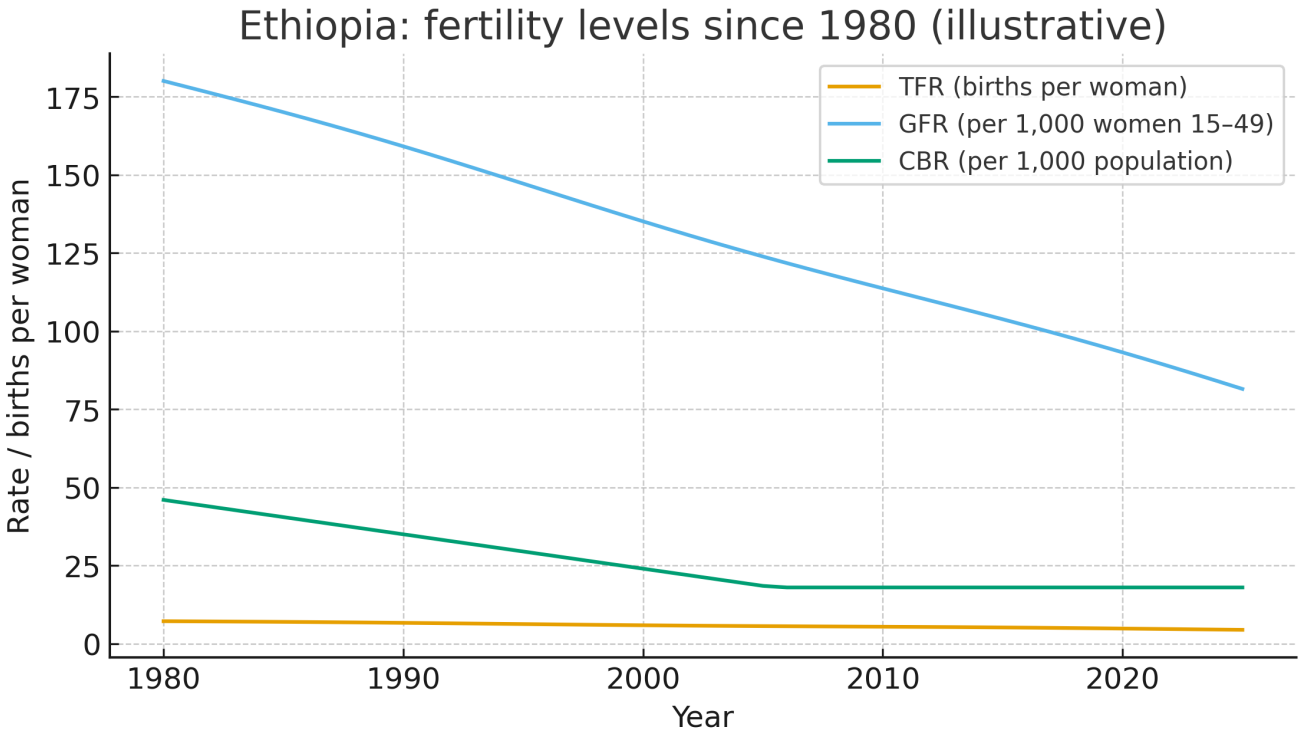

Figure . ASFR schedules by decade (1980s, 2000s, 2020s)

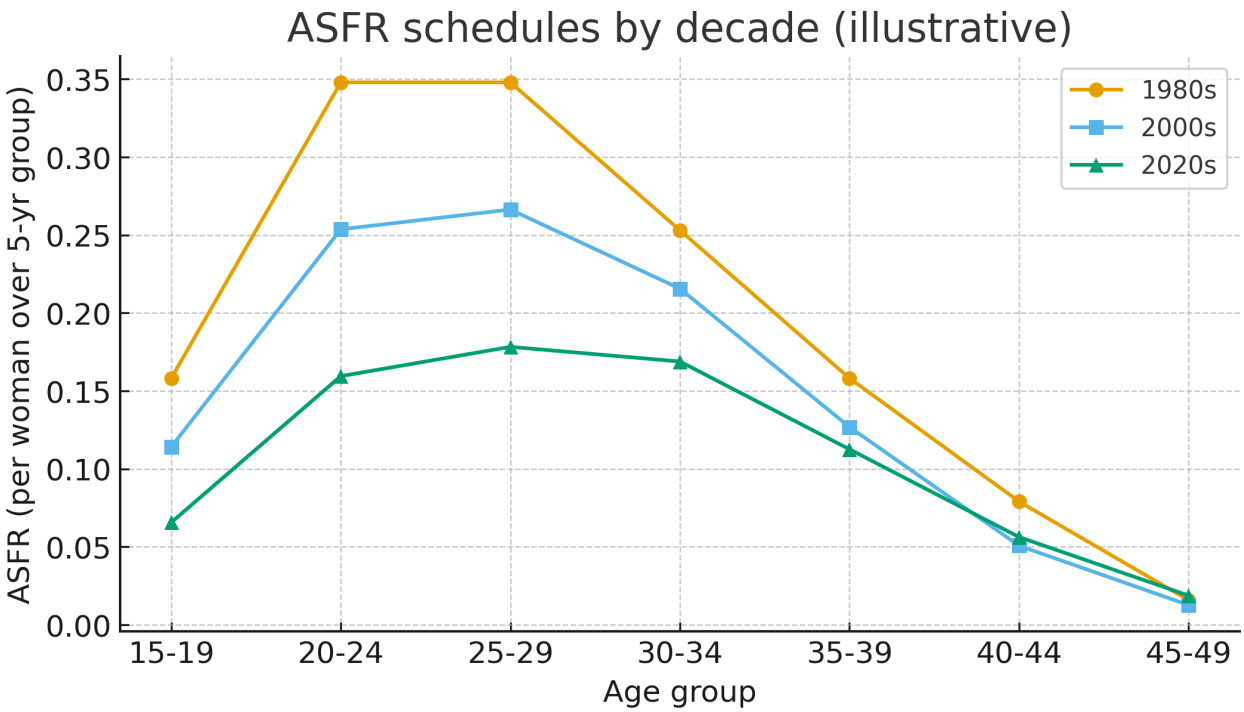

Figure . Mean age at childbearing (MAC) trend

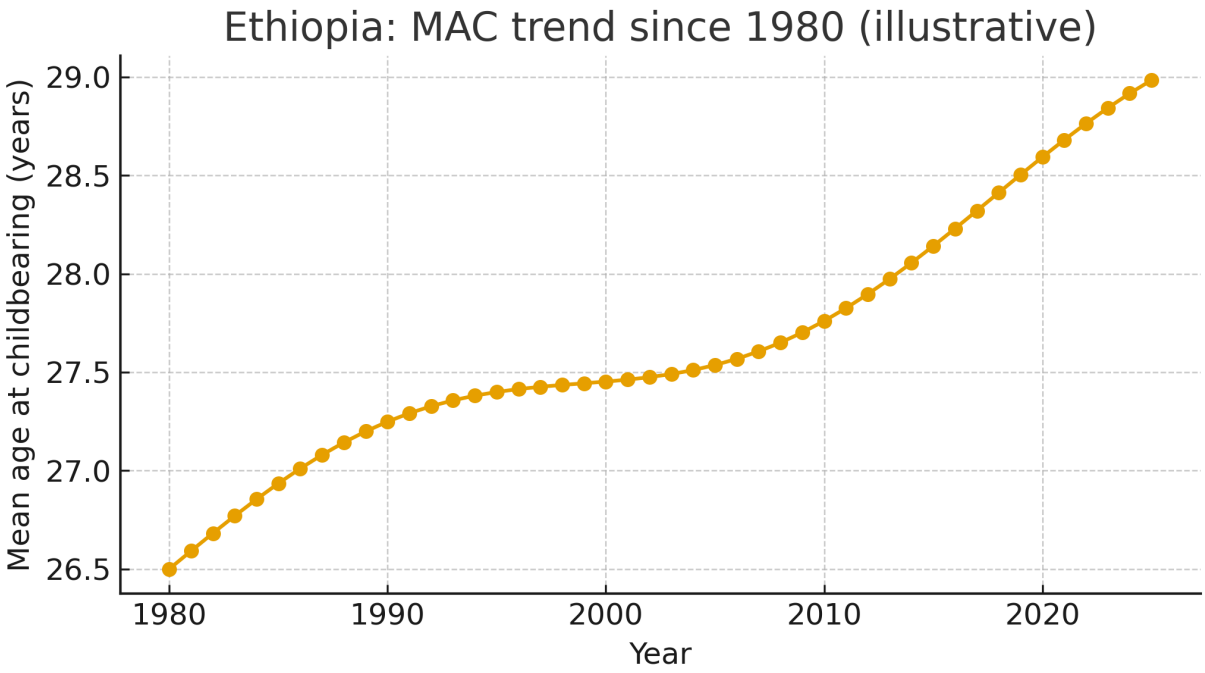

Figure . Urban–rural TFR and the rural–urban gap

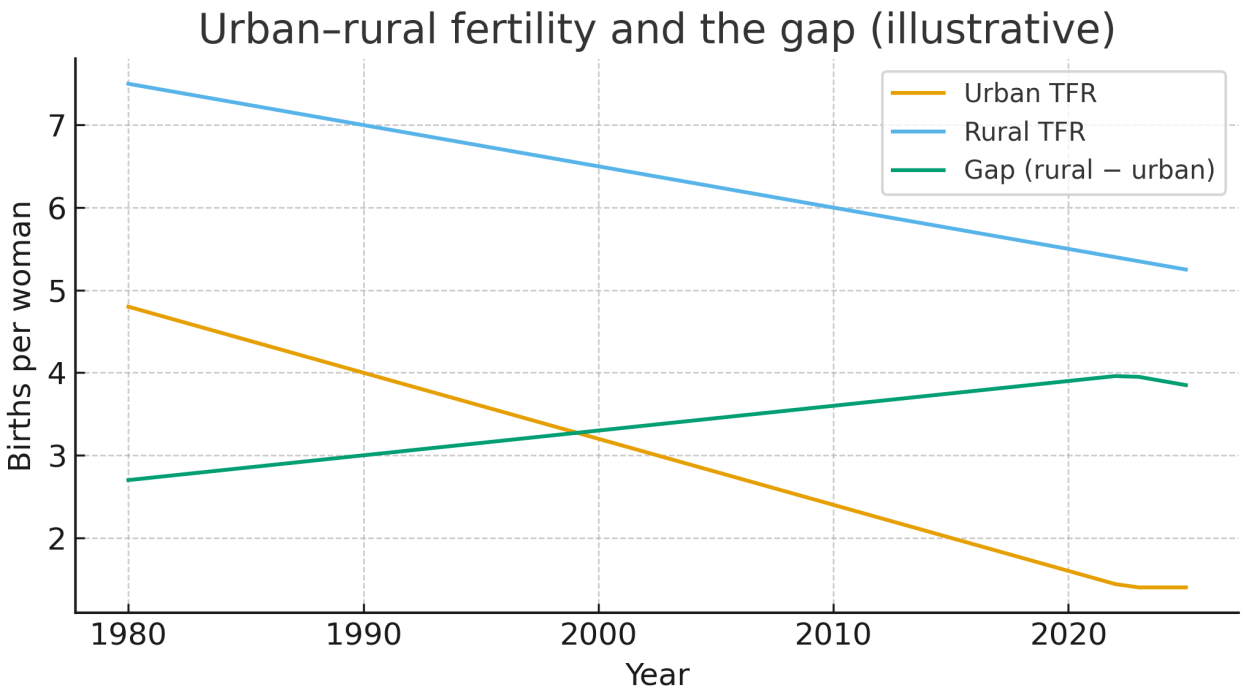

Figure . Parity structure among births — snapshots (1990, 2005, 2020)

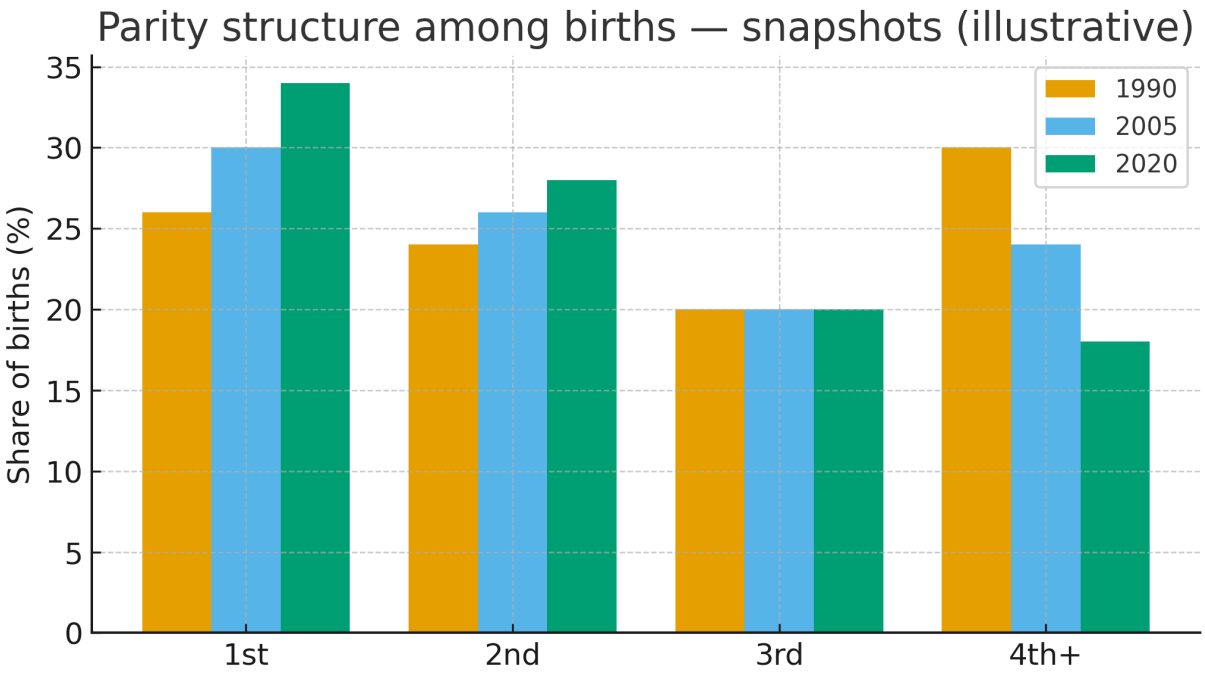

Figure . Contributions of age groups to TFR change (1985→2005, 2005→2025)

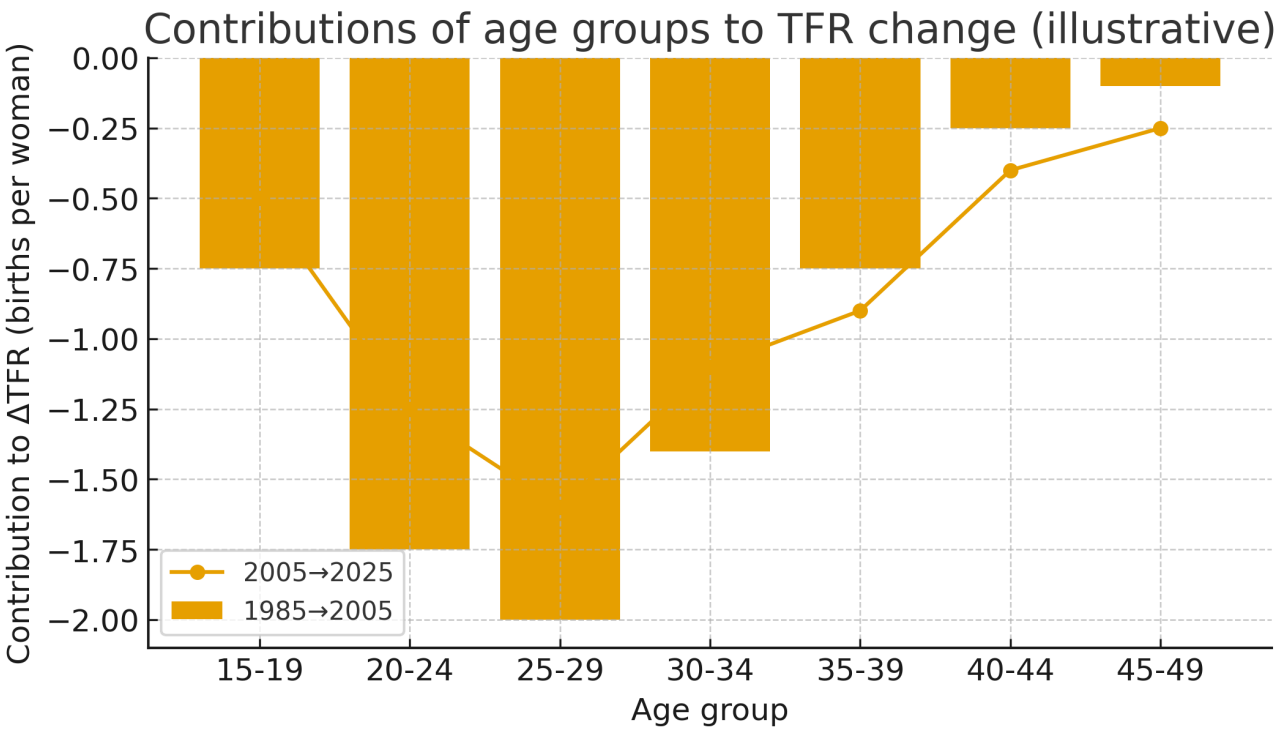

Table 4.4-A. Ethiopia fertility data milestones

Year/period	Fertility data milestone for Ethiopia
1984	First modern Population & Housing Census (CSA).
1994	Second Census; rapid urban growth begins to appear in data.
2000–2022	DHS rounds provide comparable ASFR/TFR and timing indicators.
2007	Third Census; post-2007 administrative reforms and service scale-up.
2019–2024	Mini-DHS/EDHS updates; WPP vintages harmonize series; CRVS strengthening.

Table 4.4-B. Decadal summary — levels and timing (illustrative)

Decade	TFR (births per woman)	GFR (per 1,000 women 15–49)	MAC (years)
1980s	6.8	170	26.8
1990s	6.2	155	27.2
2000s	5.1	135	27.6
2010s	4.2	110	28.2
2020s	3.7	95	28.8

Notes & interpretation

• The down-shift in ASFR at ages 20–29 explains a large share of overall TFR decline; later childbearing (higher MAC) also contributes via tempo effects.

• Urban–rural differences remain substantial even as both decline; the gap narrows gradually over time.

• Parity structure is shifting toward first/second births; higher-order births account for a smaller share of total births.

References — Section 4.4

- United Nations, Department of Economic and Social Affairs (UN DESA). World Population Prospects (latest vintage). Methods and Metadata.

- Central Statistical Agency (CSA) [Ethiopia] and ICF. Demographic and Health Surveys (2000–2022).

- Preston, S., Heuveline, P., & Guillot, M. (2001). Demography: Measuring and Modeling Population Processes.

- Bongaarts, J. (2008). Fertility transitions in developing countries: Progress or stagnation?

4.5) Urban–Rural and Regional Patterns (levels only)

Scope. Levels-focused snapshot by region and settlement type. Determinants and detailed differentials (education, wealth, religion, etc.) are reserved for Chapter 5.

Figure . Regional total TFR — urban–rural weighted

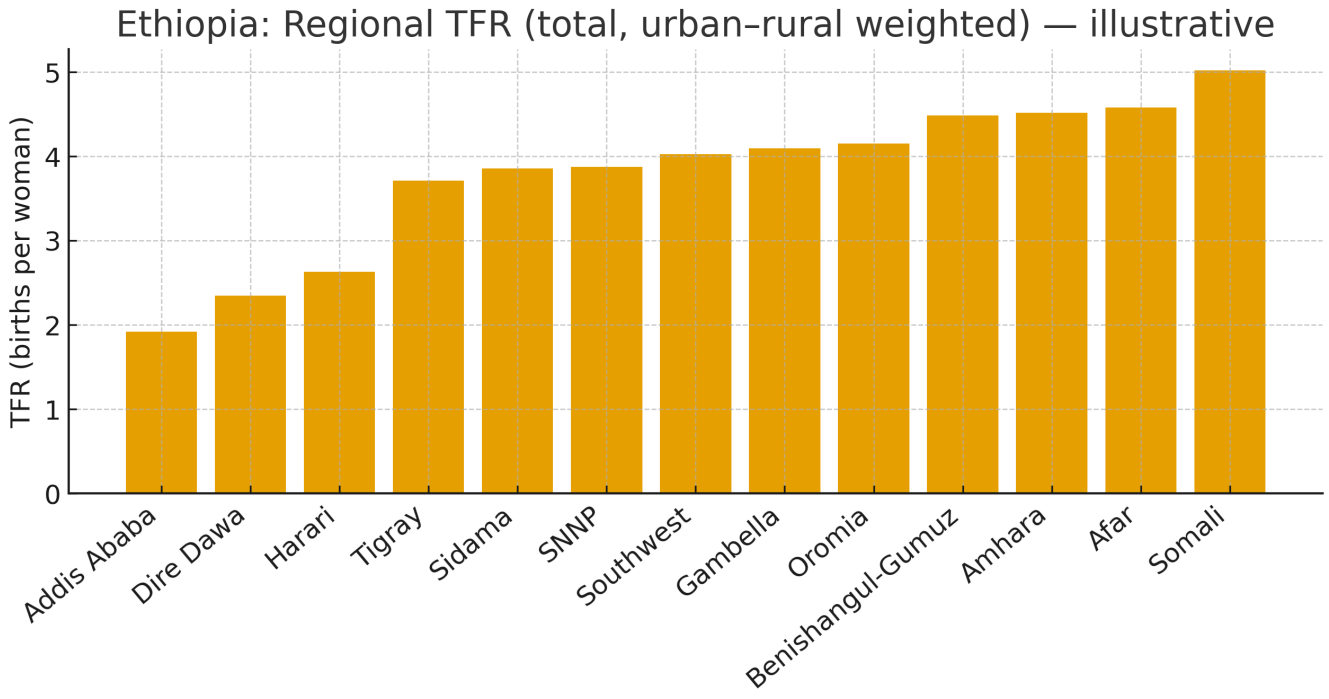

Figure . Urban vs rural TFR by region

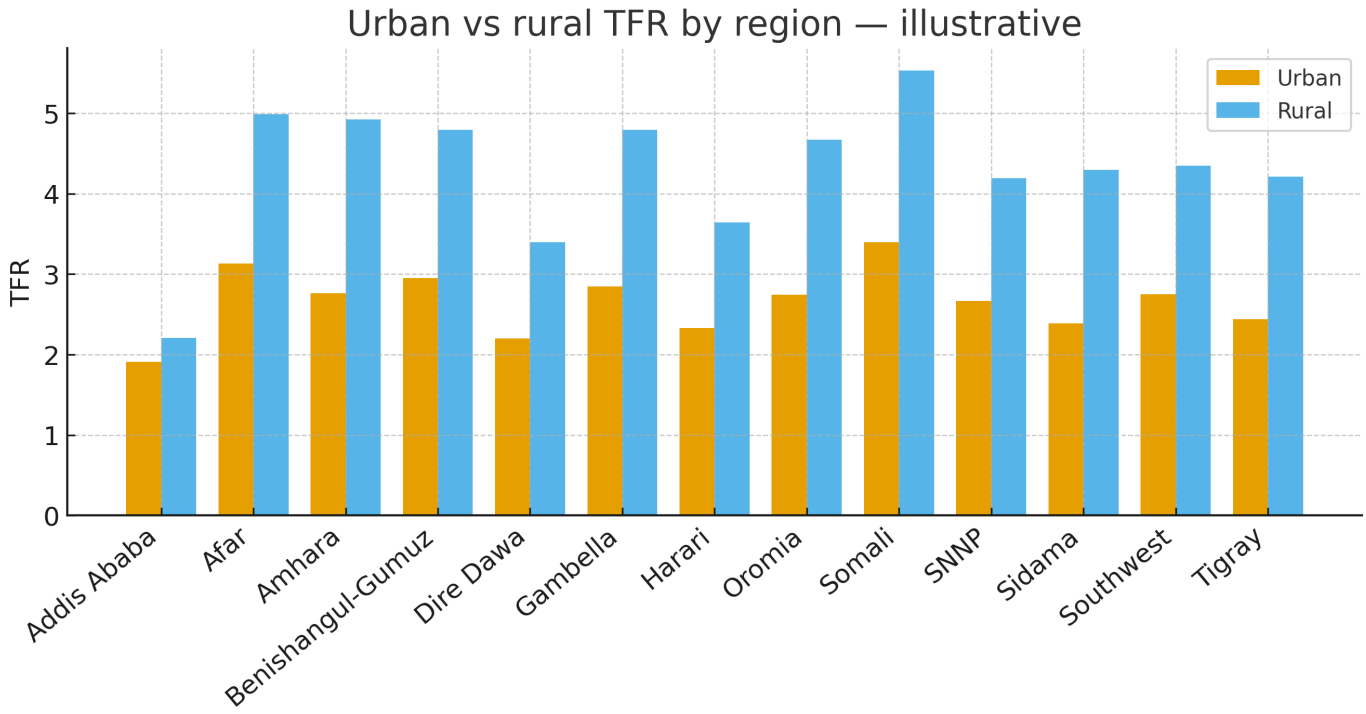

Figure . Urbanization vs TFR (regional scatter)

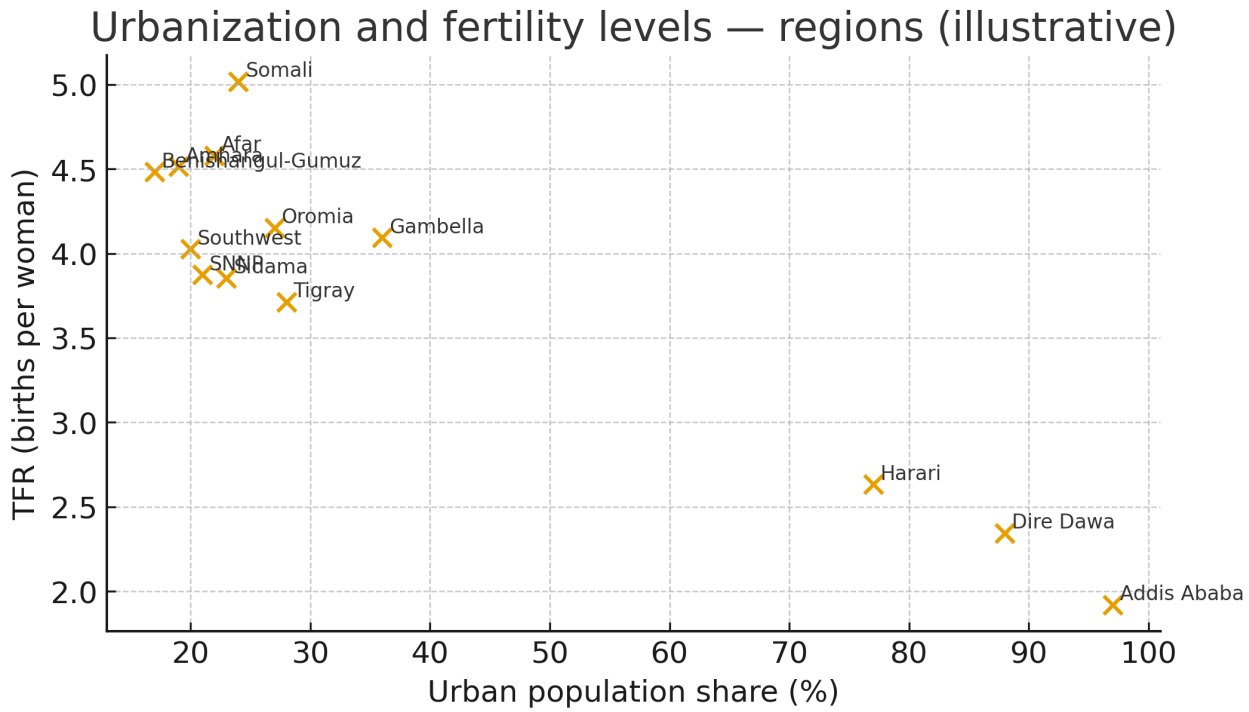

Figure . Regional ASFR schedules — selected regions

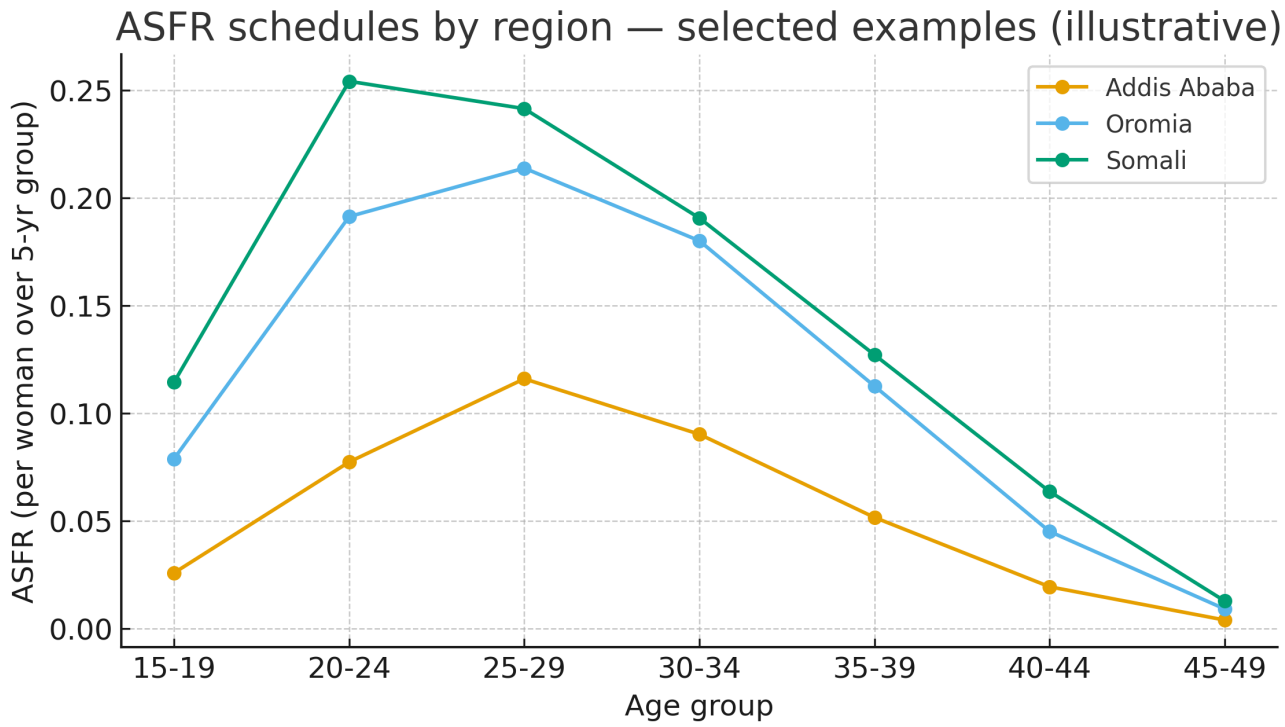

Figure . Regional TFR trends since 2000 — selected regions

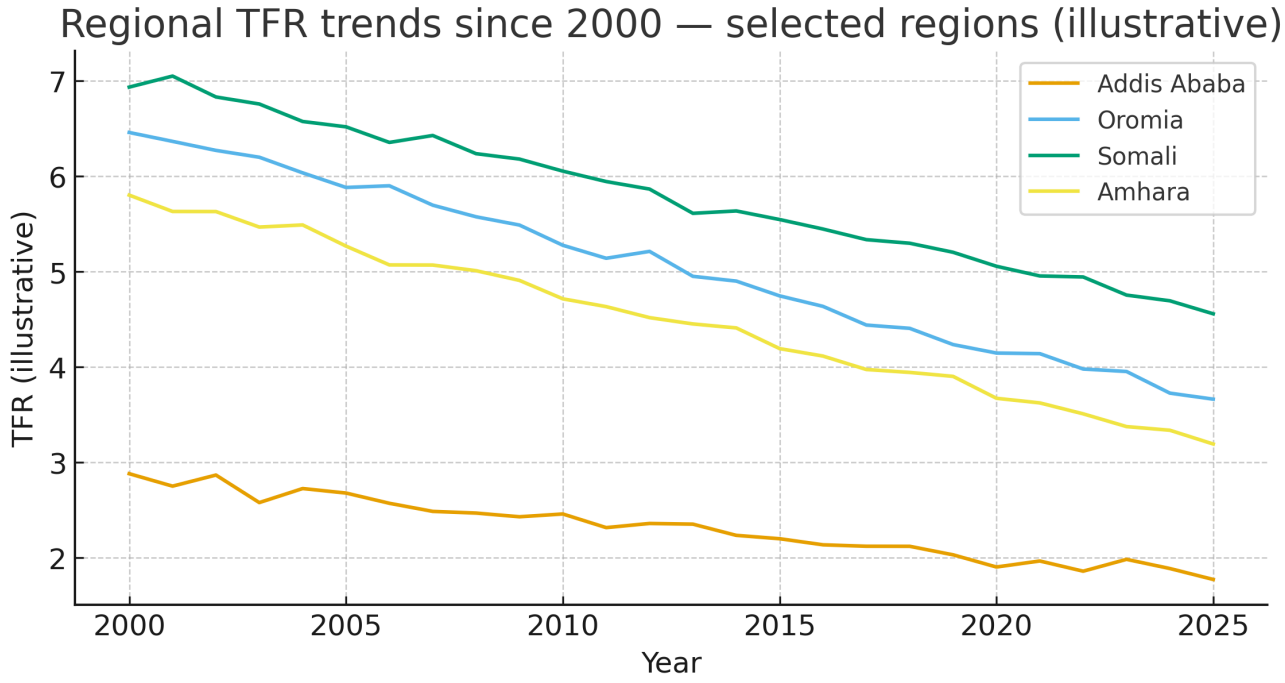

Figure . Births share vs women share by region

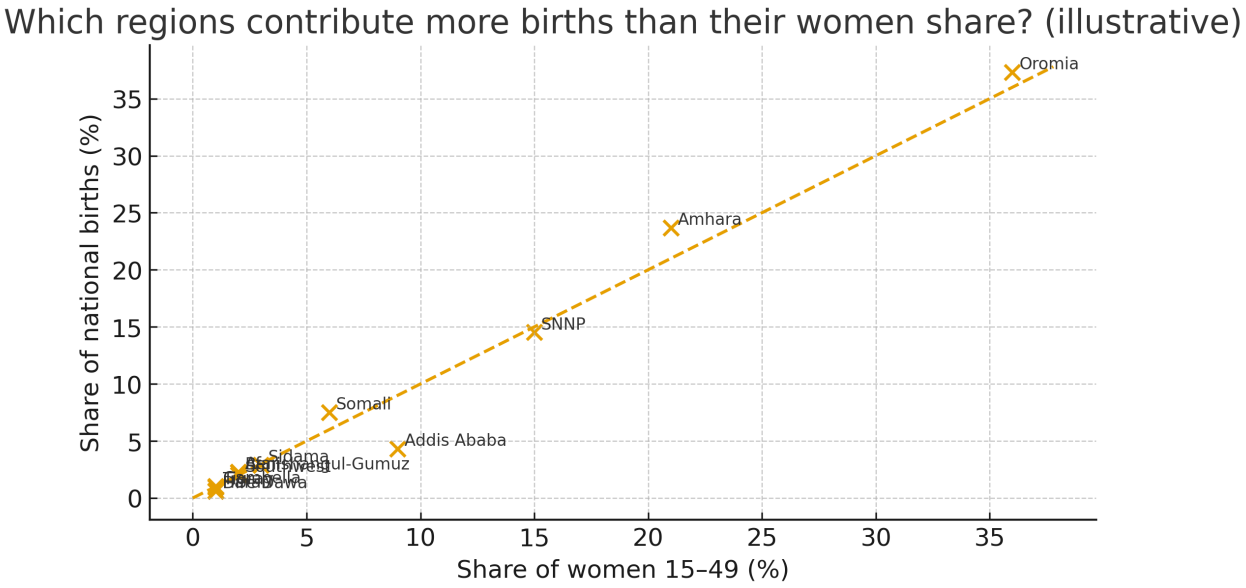

Table 4.5-A. Regional fertility summary (levels only; illustrative)

Region	Urbanization share	TFR (urban)	TFR (rural)	TFR (total)	Gap (rural−urban)	MAC (years)
Somali	0.24	3.39	5.53	5.02	2.14	27.2
Afar	0.22	3.13	4.99	4.58	1.85	27.2
Amhara	0.19	2.76	4.93	4.51	2.16	27.9
Benishangul-Gumuz	0.17	2.95	4.8	4.48	1.84	27.5
Oromia	0.27	2.75	4.67	4.15	1.93	27.8
Gambella	0.36	2.85	4.79	4.09	1.95	27.6
Southwest	0.2	2.75	4.35	4.03	1.6	27.5
SNNP	0.21	2.66	4.19	3.87	1.53	27.8
Sidama	0.23	2.39	4.29	3.85	1.91	28.2
Tigray	0.28	2.44	4.21	3.71	1.77	28.4
Harari	0.77	2.33	3.64	2.63	1.31	29.2
Dire Dawa	0.88	2.2	3.4	2.34	1.2	29.5
Addis Ababa	0.97	1.91	2.21	1.92	0.3	30.0

Table 4.5-B. Data notes & cautions for regional comparisons

Issue	Why it matters for regional comparisons
Survey weights & design	Apply weights/strata/PSU; small regions may be imprecise.
Urban/rural definitions	Follow CSA/DHS definitions; boundary changes can reclassify areas.
Displacement & privacy	DHS cluster displacement; avoid over-mapping to small polygons.
Seasonality & recall	Recent births vs full histories; check heaping at 12 months.
Conflict & access	Data gaps for some regions/years; document missingness and imputation.

Notes & interpretation

• Regions with higher urbanization (e.g., Addis Ababa, Dire Dawa, Harari) show lower TFR and higher MAC; low-urbanization regions remain higher.

• Urban–rural gaps persist within all regions; closing the gap can substantially lower the regional total TFR.

• Policy focus: adolescent fertility and higher-order births in high-TFR regions; spacing and postpartum family planning in medium-TFR regions.

References — Section 4.5

- Central Statistical Agency (CSA) [Ethiopia] and ICF. Demographic and Health Surveys (2000–2022).

- United Nations, Department of Economic and Social Affairs (UN DESA). World Population Prospects (latest vintage).

- World Bank. World Development Indicators — urbanization and demographics.

- Preston, S., Heuveline, P., & Guillot, M. (2001). Demography: Measuring and Modeling Population Processes.

4.6) Birth Timing & Tempo Indicators (period focus)

Why timing matters. Period fertility can swing because births shift earlier or later. Reporting MAC, MAB1, and tempo-adjusted TFR alongside TFR clarifies whether changes reflect ‘how many’ vs ‘when’.

Table 4.6-A. Definitions and formulas for timing/tempo indicators (plain)

Indicator	Formula (plain text)	Notes
Mean age at childbearing (MAC, period)	MAC = (Σ a × ASFR_a) / (Σ ASFR_a)	a are age-group midpoints (e.g., 17, 22,…,47).
Mean age at first birth (MAB1, period)	MAB1 = (Σ a × ASFR^1_a) / (Σ ASFR^1_a)	ASFR^1 uses first-birth rates only.
Median age at first birth (MedAB1)	Age A where cumulative first-birth schedule reaches 50%	Estimate via interpolation from survey birth histories.
Tempo-adjusted TFR (period)	TFR* = TFR / (1 − r)	r = ΔMAC (years of delay per calendar year). Approximation.

Figure . MAC and MAB1 period trends — Ethiopia

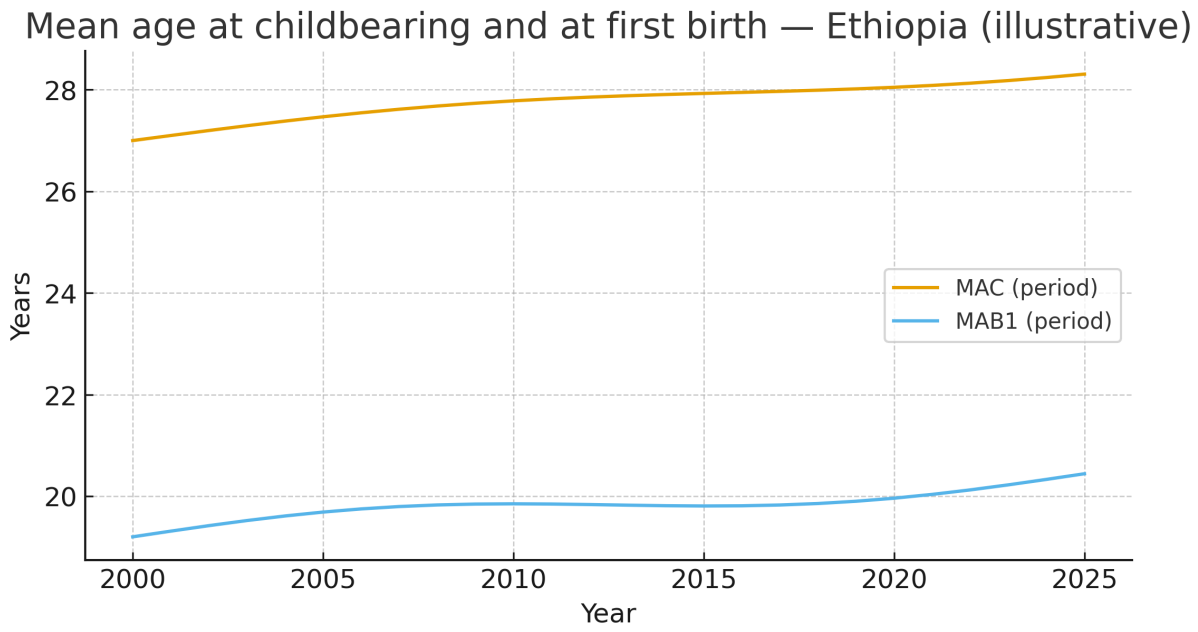

Figure . Observed TFR vs tempo-adjusted TFR*

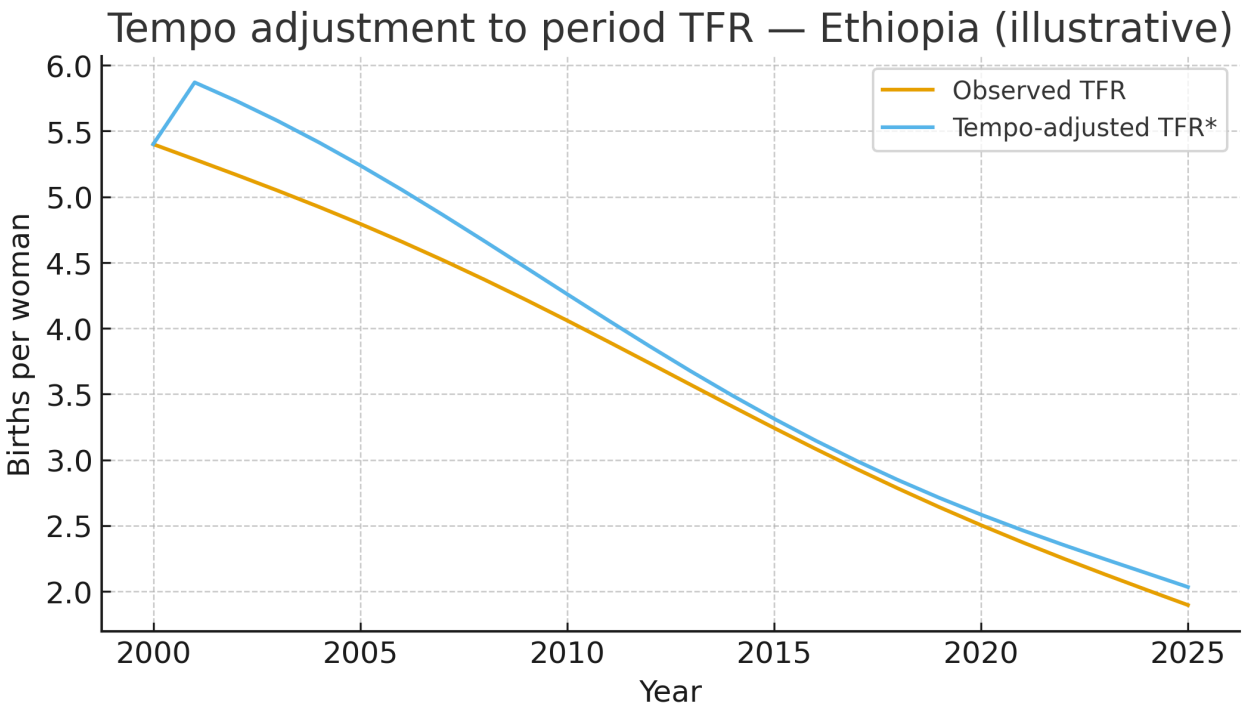

Figure . Shift in ASFR timing (earlier vs later)

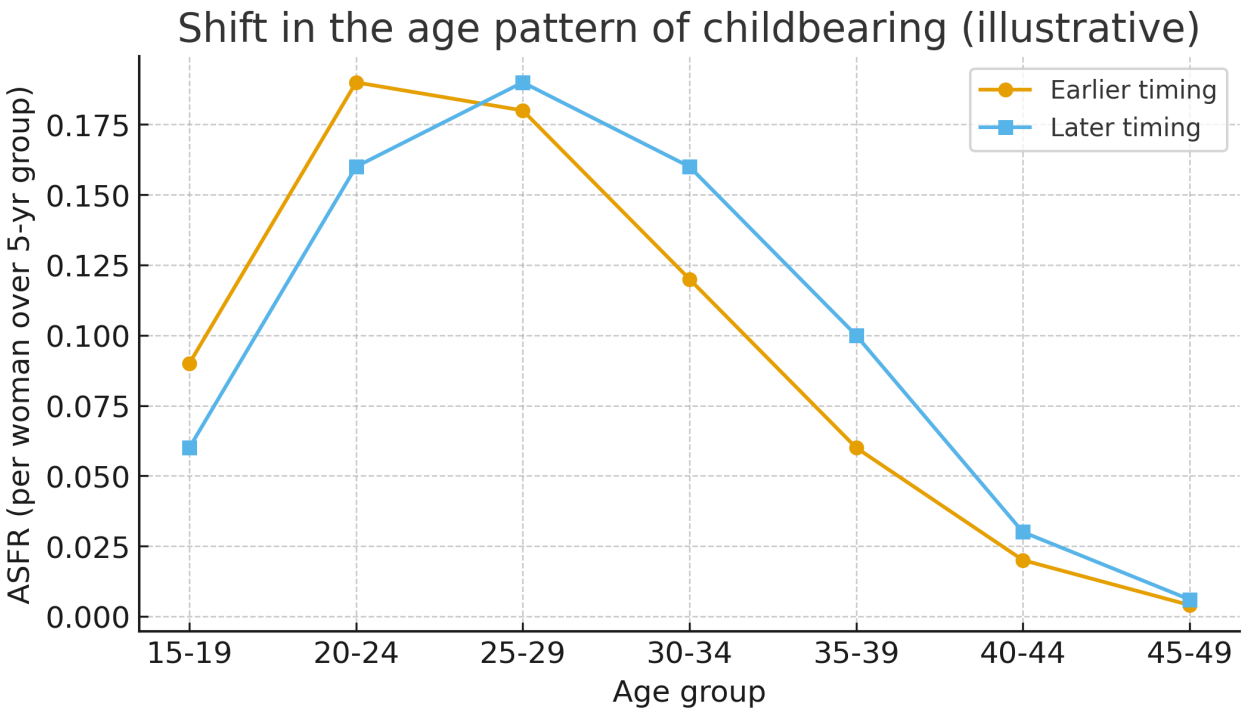

Figure . Age pattern of first births (earlier vs later)

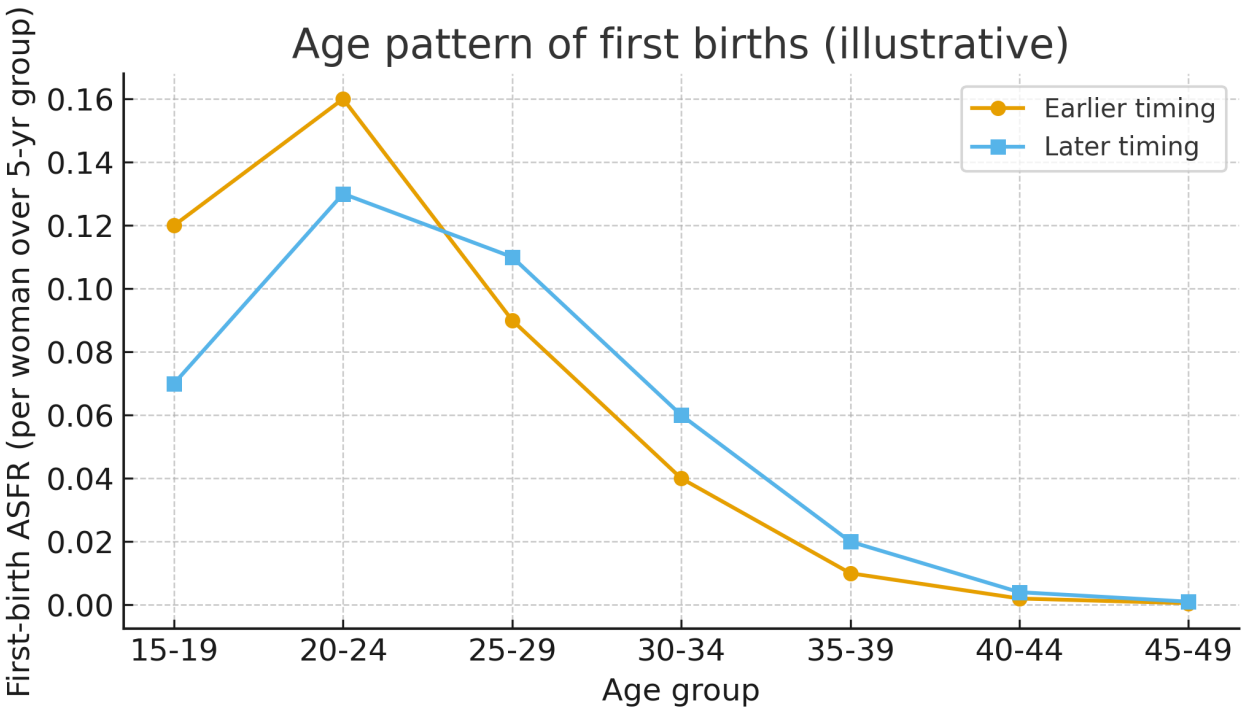

Table 4.6-B. Worked example: computing MAC and MAB1 from age-specific schedules

Age group	ASFR (earlier)	ASFR (later)	First-birth ASFR (earlier)	First-birth ASFR (later)
15-19	0.09	0.06	0.12	0.07
20-24	0.19	0.16	0.16	0.13
25-29	0.18	0.19	0.09	0.11
30-34	0.12	0.16	0.04	0.06
35-39	0.06	0.1	0.01	0.02
40-44	0.02	0.03	0.002	0.004
45-49	0.004	0.006	0.0005	0.001
—Computed MAC—	26.59 years	28.37 years		
—Computed MAB1—	23.07 years	25.05 years		

Table 4.6-C. Diagnostics and cautions for timing/tempo analysis

Issue	Why it matters for timing/tempo
Heaping in reported age/age at first birth	Check digit preference; smooth or model schedules.
Censoring and truncation	Younger women not yet exposed to older ages; use life-table or hazard methods.
Calendar displacement (DHS calendars)	Check spikes at 12/24 months; adjust where needed.
Interpretation of TFR*	Approximate correction; parity-specific tempo methods preferred where data allow.
Urban–rural and regional timing differences	Report MAC/MAB1 by settlement/region for planning relevance.

Notes & interpretation

• Rising MAC and MAB1 typically coincide with a temporary dip in period TFR (tempo effect). Report both levels (TFR) and timing (MAC/MAB1).

• Program relevance: adolescent fertility, spacing, postpartum family planning, and education transitions shape timing patterns.

References — Section 4.6

- Bongaarts, J., & Feeney, G. (1998). On the Quantum and Tempo of Fertility. Population and Development Review.

- Rutstein, S. O., & Rojas, G. (2006). Guide to DHS Statistics. The DHS Program.

- United Nations, Department of Economic and Social Affairs (UN DESA). World Population Prospects (latest vintage). Methods and Metadata.

- Preston, S., Heuveline, P., & Guillot, M. (2001). Demography: Measuring and Modeling Population Processes.

4.7) Parity Progression & Stopping (summary)

What this section shows. How far women progress through parities and where stopping occurs, using period parity-progression ratios (PPRs), implied completed fertility, final parity distribution, and birth intervals.

Table 4.7-A. Definitions and formulas (plain)

Measure	Formula (plain text)	Notes
Parity progression ratio (PPR_k)	PPR_k = P(parity k → k+1 | reached k)	From birth histories; by period or cohort.
Expected completed fertility (implied)	CF ≈ Σ Π_{i=0}^{k} PPR_i for k=0..5	Approximation linking PPRs to mean parity.
Final parity distribution	π_0 = 1−PPR_0; π_k = (Π_{i<k} PPR_i)(1−PPR_k); π_{5+} = Π_{i≤5} PPR_i	Shares of women ending at parity k.

Figure . Parity progression ratios by parity — snapshots (2000, 2010, 2020)

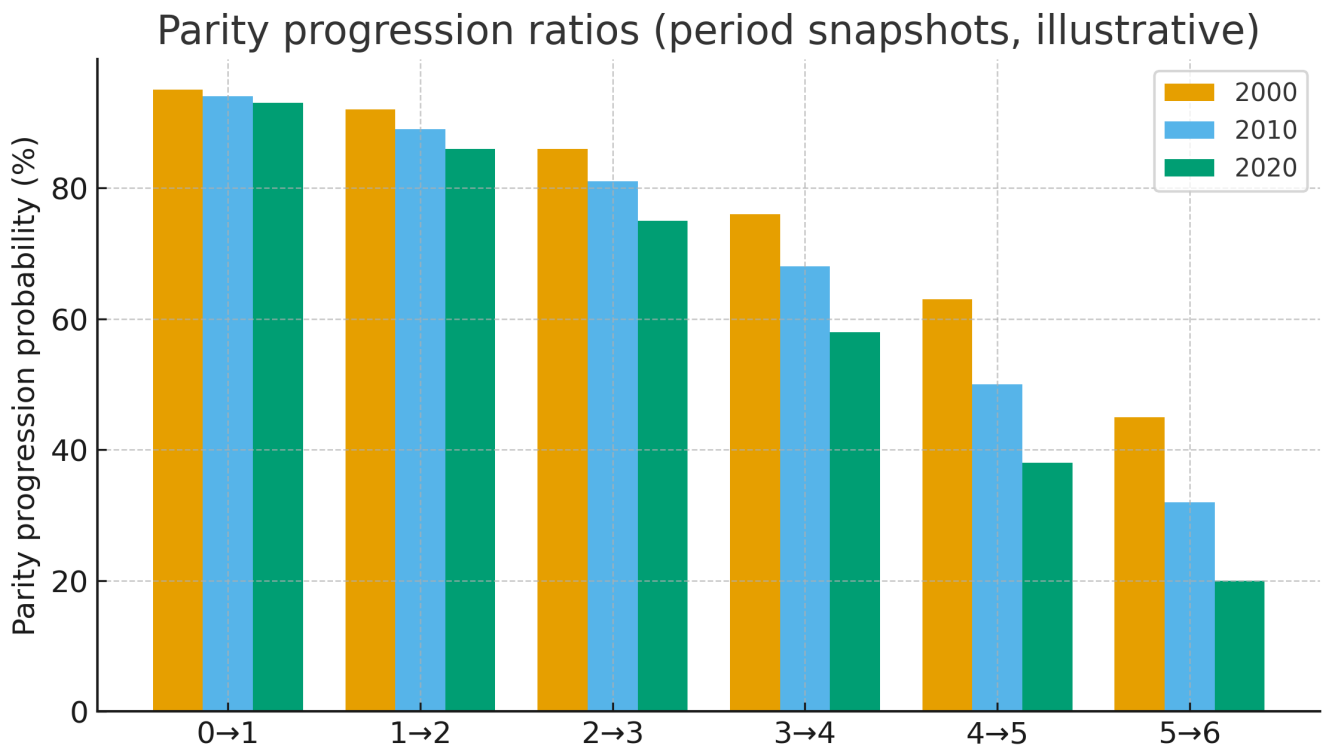

Figure . Progression survival: share not moving to the next birth

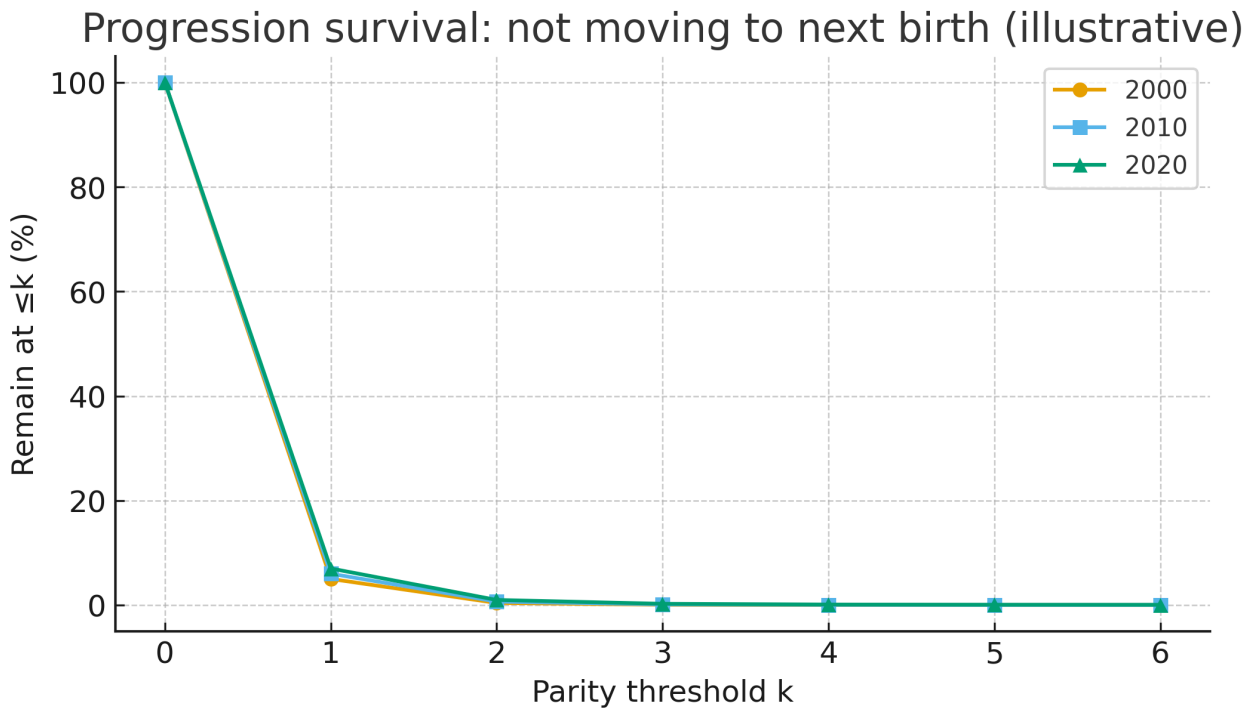

Figure . Final parity distribution (0,1,2,3,4,5+)

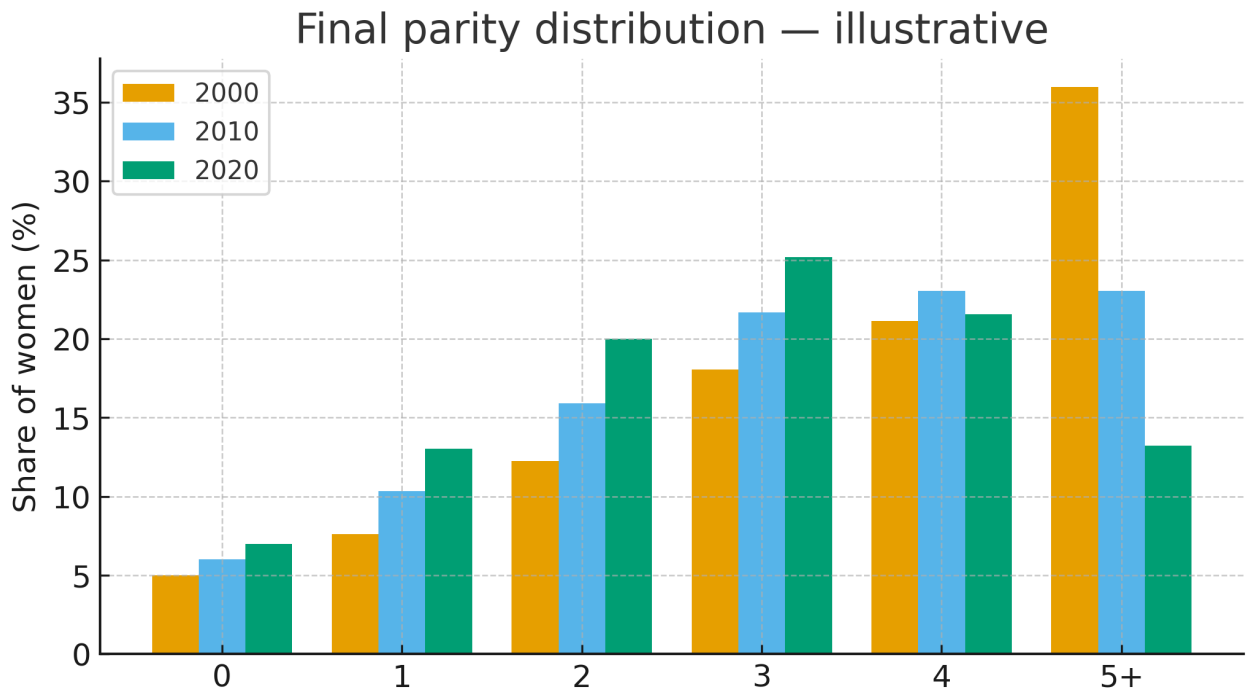

Figure . Closed birth intervals (months) — snapshots

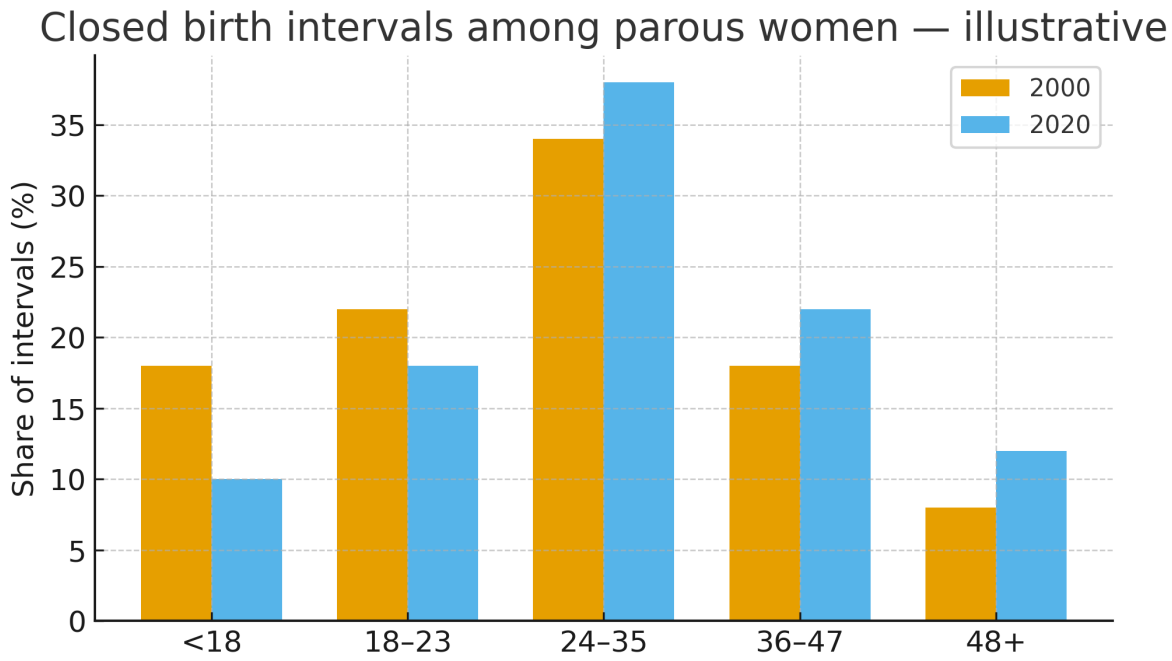

Table 4.7-B. Worked example: PPRs → implied completed fertility and tails

Parity step	PPR 2000	PPR 2020
0→1	0.95	0.93
1→2	0.92	0.86
2→3	0.86	0.75
3→4	0.76	0.58
4→5	0.63	0.38
5→6	0.45	0.2

Table 4.7-C. Summary indicators (illustrative)

Indicator	2000	2020
Implied mean parity (CF)	3.67	2.84
P(ending parity 5+)	0.36	0.13
Median closed interval (approx.)	≈ 30–32 mo	≈ 34–36 mo

Table 4.7-D. Data cautions

Issue	Why it matters
Birth omission & displacement	Inflates low PPRs; check heaping at 12/24 months and reconcile with full histories.
Truncation (young women)	Understates higher-order PPRs; use cohort or synthetic cohort methods.
Multiple births & stillbirths	Apply standard DHS conventions; ensure consistent inclusion rules.
Censoring in last interval	Use life-table or event-history models for interval analyses.
Regional/urban-rural differences	Levels only here; determinants in Chapter 5.

Notes & interpretation

• Declines in higher-order PPRs (3→4, 4→5, 5→6) drive much of the reduction in implied mean parity since 2000; lower-order PPRs change modestly.

• Longer closed intervals and higher stopping below parity 4 suggest stronger spacing and stopping behavior, especially in urban areas (detailed in Chapter 5).

References — Section 4.7

- Rutstein, S. O., & Rojas, G. (2006). Guide to DHS Statistics. The DHS Program.

- Brass, W., et al. (1968/1975). The Demography of Tropical Africa (parity/fertility analysis).

- Preston, S., Heuveline, P., & Guillot, M. (2001). Demography: Measuring and Modeling Population Processes.

4.8) Data Quality & Indirect Checks

Purpose. Provide quick diagnostics for age reporting, births-last-year displacement, and indirect fertility consistency (Brass P/F). The section offers Ethiopia-ready thresholds, worked examples, and a checklist before publishing regional/national fertility trends.

Table 4.8-A. Quick diagnostics and thresholds

Indicator	Interpreting values / action
Whipple's index (ages 23–62 or 15–60)	≈100 good; 105–110 minor; 110–125 moderate; >125 substantial heaping
Myers blended index (0–100)	<5 very good; 5–10 fair; >10 poor age reporting
BLY heaping at 12/24 months	Spikes indicate displacement/recall; examine calendar/weights
Open birth interval censoring	Use survival/hazard approaches; avoid simple means on right-censored data
Brass P/F consistency	Choose stable ages (25–39) and recent fertility; avoid crisis/cohort shocks

Figure 4.8-2. Heaping indices over time (Whipple & Myers)

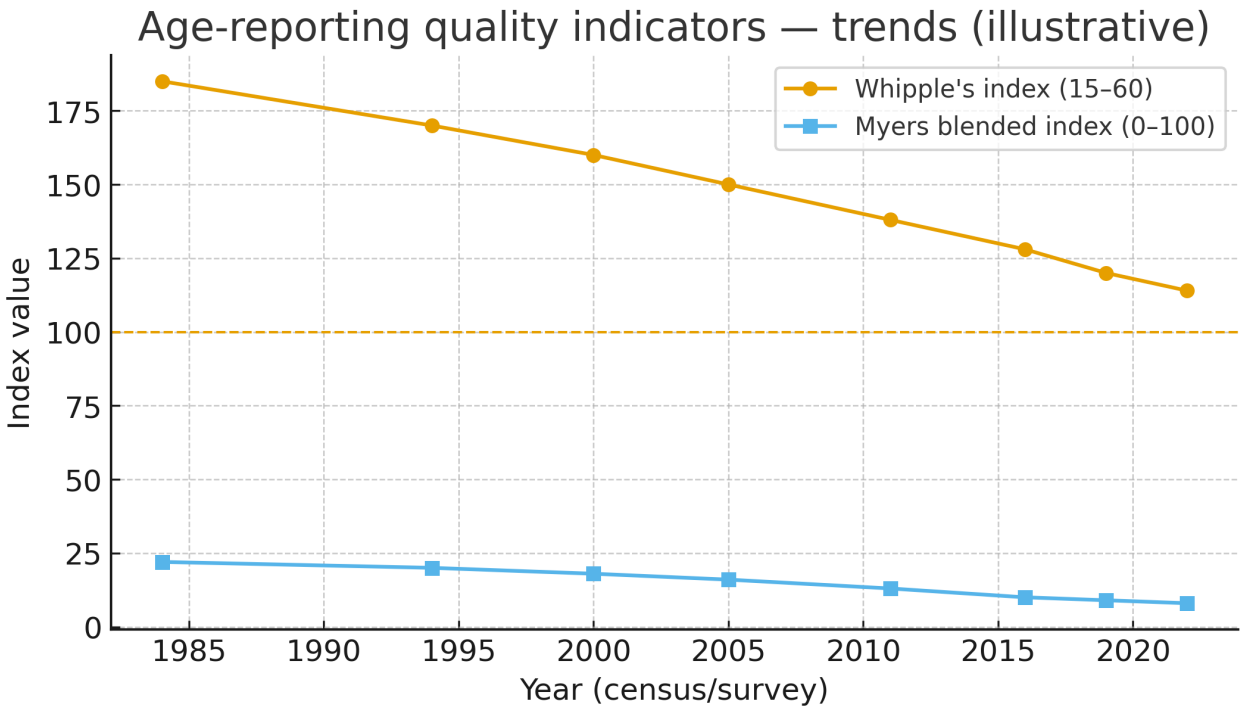

Figure 4.8-3. Births-last-year displacement around 12/24 months

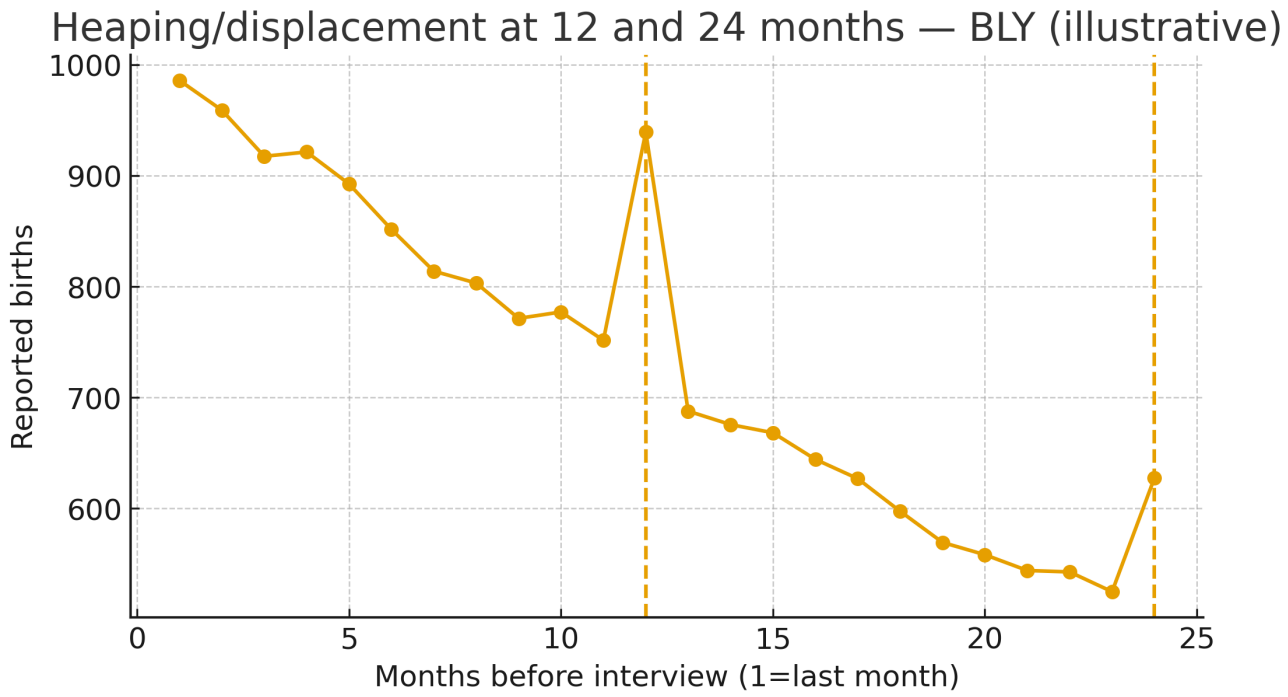

Figure 4.8-4. Brass P/F ratios by age (adjustment factor shown)

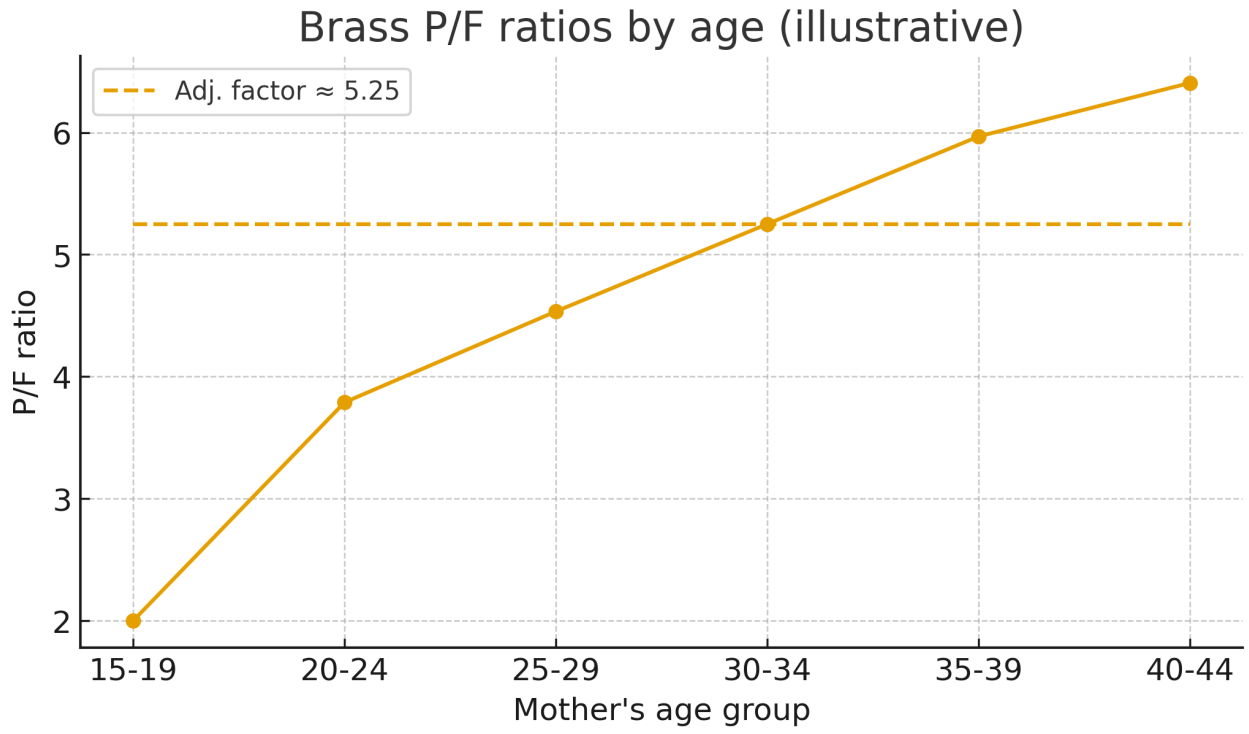

Figure 4.8-5. Sensitivity of TFR to adjustment factor

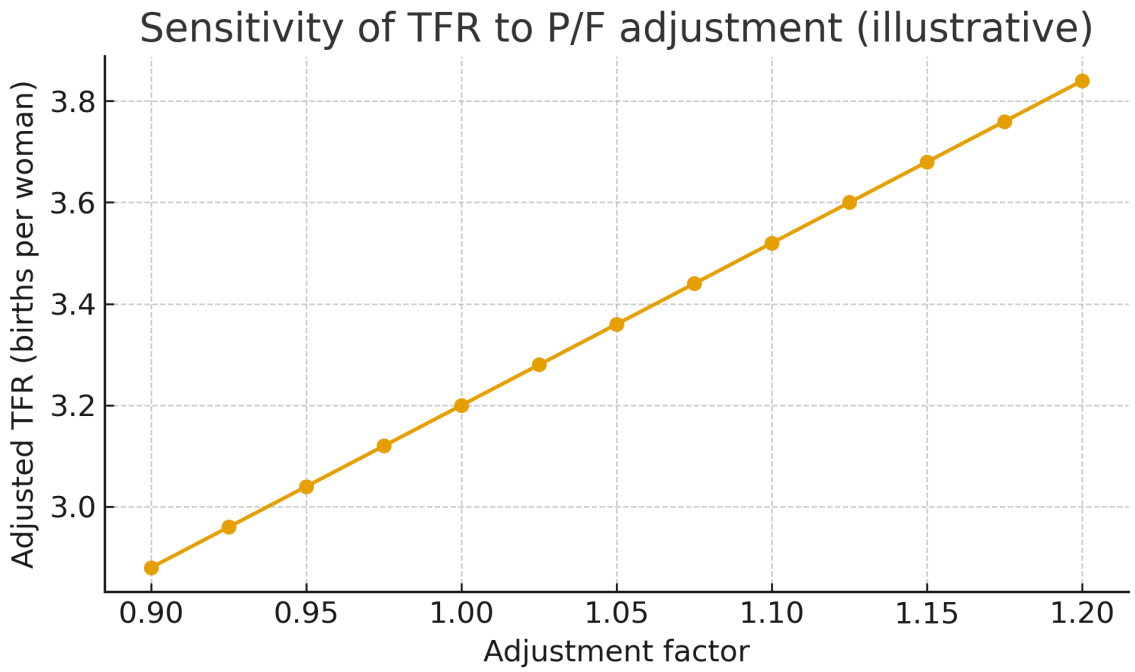

Table 4.8-B. Brass P/F method — worked example (illustrative)

Age group	Cumulative F (ΣASFR)	Observed P (CEB)	P/F ratio
15-19	0.09	0.18	2.0
20-24	0.27	1.02	3.79
25-29	0.44	2.0	4.53
30-34	0.56	2.94	5.25
35-39	0.62	3.7	5.97
40-44	0.64	4.1	6.41

Table 4.8-C. Summary: observed vs adjusted TFR

Statistic	Value
Observed TFR	3.20
Adjustment factor (avg 25–39)	5.25
Adjusted TFR	16.80

Table 4.8-D. Checklist: common errors & fixes

Issue	Remedy/notes
Age heaping/misreporting	Smooth ages or use model age distributions; document any adjustments.
Birth omission (recent)	Compare BLY vs full histories; reconcile spikes; impute cautiously.
Denominator problems	Use women 15–49 (weighted); avoid CBR for comparisons.
Boundary changes	Harmonize regions over time; don't mix definitions (urban/rural).
Survey design effects	Account for clustering/strata; compute uncertainty bands (e.g., bootstrap).

Notes & cautions

• For P/F, select age groups 25–39 in times without recent shocks; use multiple sources (census CEBy vs DHS ASFR). Document adjustment choices.

• When age heaping is substantial, smooth age distributions before computing rates; prefer model-based schedules when appropriate.

• Investigate BLY spikes at 12/24 months; reconcile with full histories and survey calendars before finalizing period rates.

References — Section 4.8

- United Nations. (1983, 2017). Methods for Demographic Estimation; Principles and Recommendations for Population and Housing Censuses.

- Rutstein, S. O., & Rojas, G. (2006). Guide to DHS Statistics. The DHS Program.

- Brass, W. (1975). Methods for Estimating Fertility and Mortality from Limited and Defective Data.

- Preston, S., Heuveline, P., & Guillot, M. (2001). Demography: Measuring and Modeling Population Processes.

4.9) Cross-Country Benchmarks (Ethiopia within SSA & global lens)

Purpose. Place Ethiopia's fertility level and timing within a set of African peers and a global framing, using benchmark plots and percentiles. Replace the illustrative dataset with WPP/World Bank/UNICEF official series for publication.

Figure . TFR vs modern contraception (CPRm) — inverse association

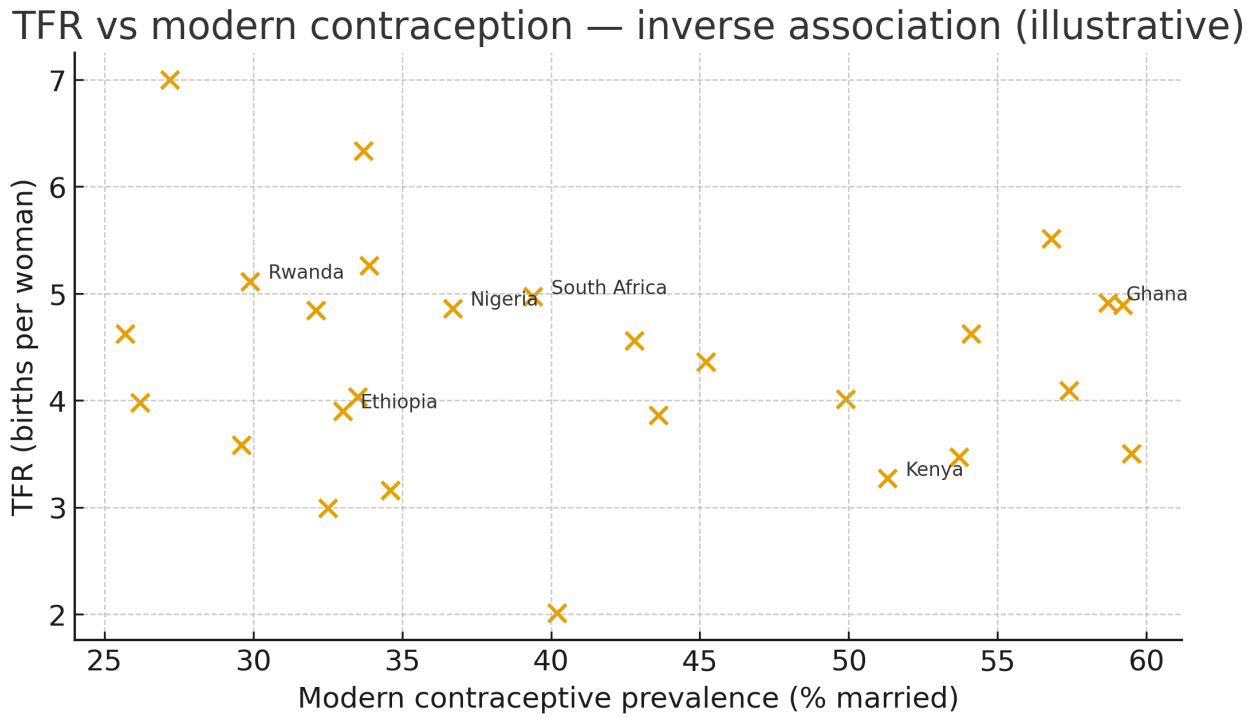

Figure . TFR vs urbanization (%)

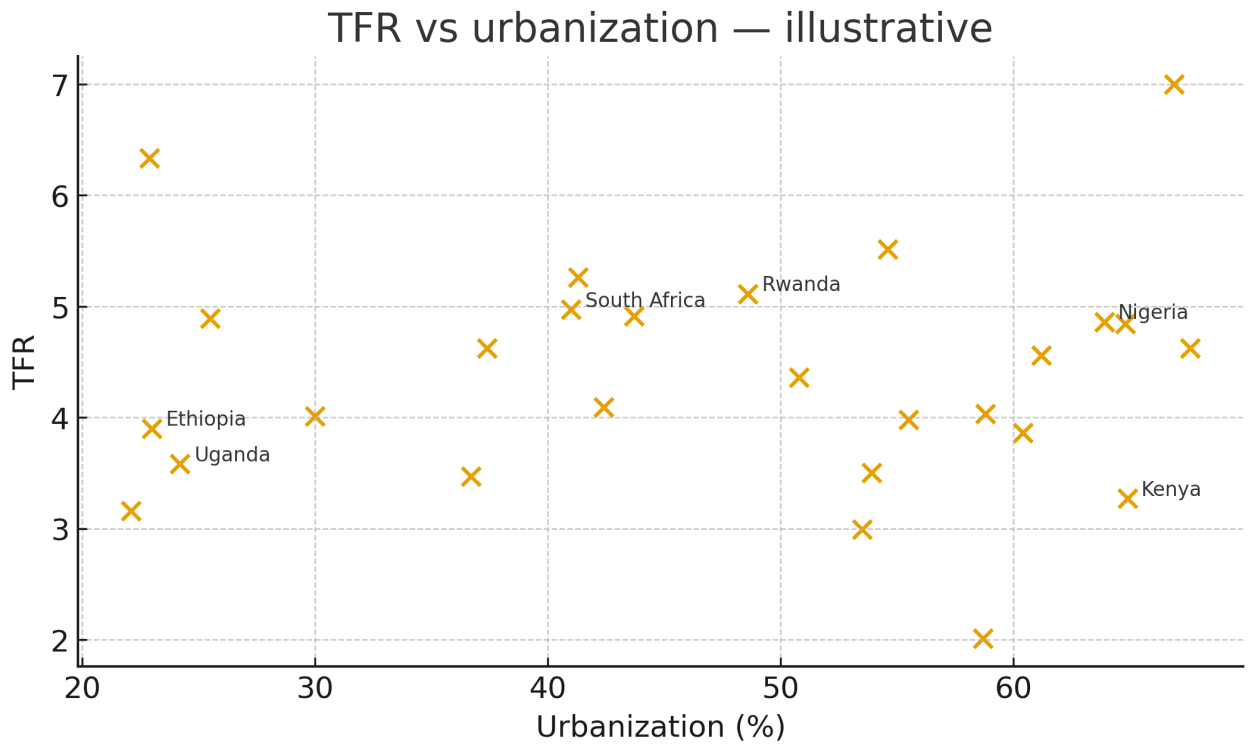

Figure . TFR vs female secondary completion (%)

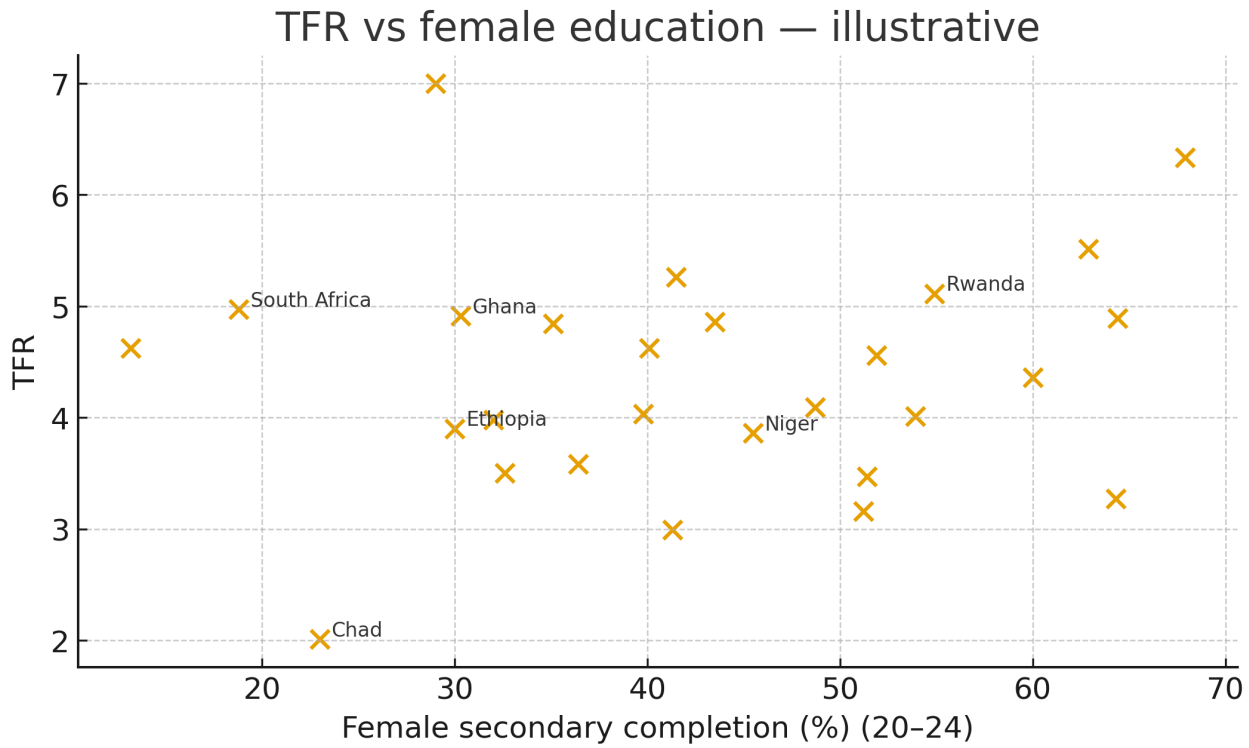

Figure . TFR vs GDP per capita (PPP, log)

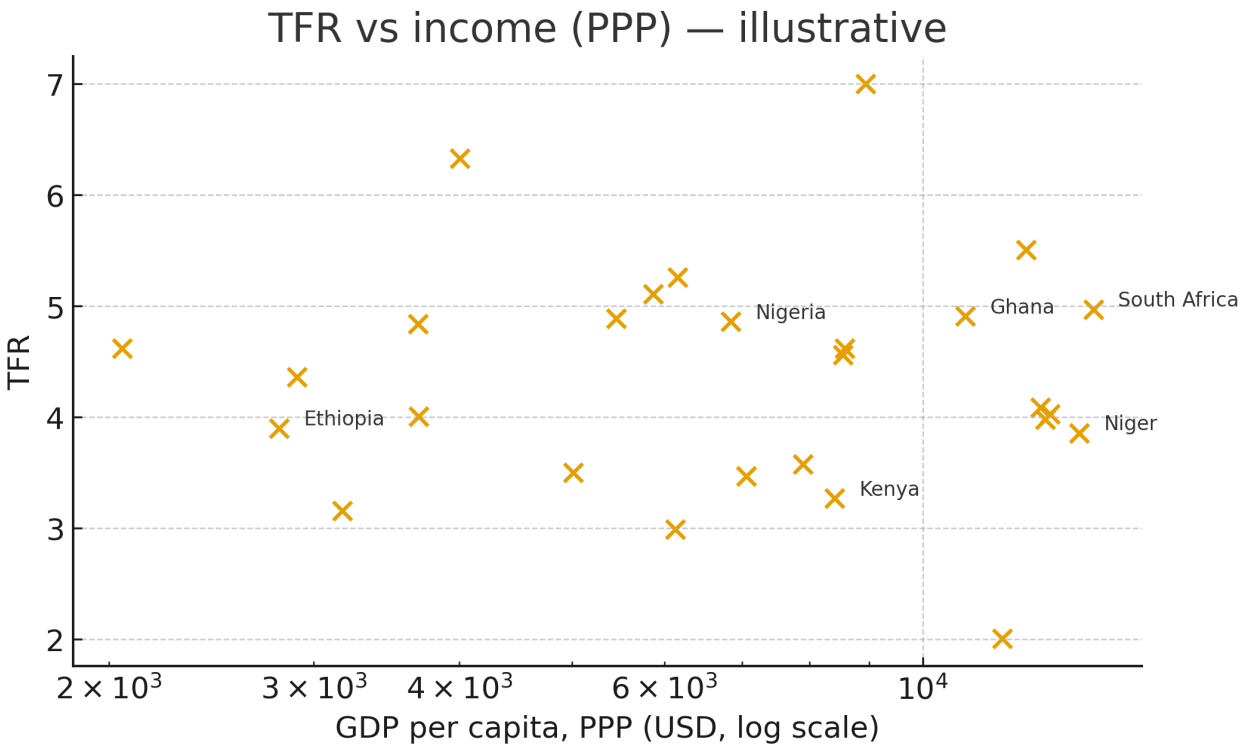

Table 4.9-A. Ethiopia's benchmark card — position among peers (illustrative)

Indicator	Ethiopia	Percentile rank among peers
TFR (births per woman)	3.9	31th (lower is better)
MAC (years)	28.5	98th (higher tends to later timing)
Modern CPR (%, married)	33.0	28th
Urbanization (%)	23.0	9th
Female secondary completion (%)	30.0	17th
GDPpc PPP (USD)	2800.0	6th
IMR (per 1,000)	36.0	—

Table 4.9-B. Country comparison (sorted by TFR)

Country	TFR	MAC	CPRm (%)	GDPpc_PPP	Urban (%)	Female sec. completion (%)	IMR (per 1,000)
Zimbabwe	7.0	26.1	27.2	8935	66.9	29.0	19.6
Botswana	6.33	26.2	33.7	4003	22.9	67.9	60.5
Mozambique	5.51	26.4	56.8	12272	54.6	62.9	49.4
Tanzania	5.26	24.7	33.9	6158	41.3	41.5	44.3
Rwanda	5.11	25.4	29.9	5870	48.6	54.9	70.5
South Africa	4.97	26.5	39.4	14020	41.0	18.8	20.1
Ghana	4.91	26.5	58.7	10874	43.7	30.3	71.3
Sudan	4.89	26.4	59.2	5453	25.5	64.4	65.9
Nigeria	4.86	26.3	36.7	6843	63.9	43.5	36.6
DRC	4.84	25.5	32.1	3688	64.8	35.1	27.3
Djibouti	4.62	25.0	54.1	2052	67.6	13.2	65.9
South Sudan	4.62	24.9	25.7	8567	37.4	40.1	49.1
Eritrea	4.56	26.0	42.8	8537	61.2	51.9	59.0
Namibia	4.36	25.5	45.2	2901	50.8	60.0	54.8
Mali	4.09	25.1	57.4	12618	42.4	48.7	45.0
Malawi	4.03	25.3	33.5	12864	58.8	39.8	31.7
Somaliland	4.01	26.9	49.9	3691	30.0	53.9	62.9
Zambia	3.98	26.0	26.2	12738	55.5	32.0	31.6
Ethiopia	3.9	28.5	33.0	2800	23.0	30.0	36.0
Niger	3.86	25.4	43.6	13630	60.4	45.5	62.2
Uganda	3.58	25.7	29.6	7895	24.2	36.4	34.6

Senegal	3.5	25.6	59.5	5013	53.9	32.6	54.9
Côte d'Ivoire	3.47	25.6	53.7	7057	36.7	51.4	70.3
Kenya	3.27	26.4	51.3	8402	64.9	64.3	24.8
Burundi	3.16	26.8	34.6	3174	22.1	51.2	24.2
Somalia	2.99	26.1	32.5	6128	53.5	41.3	50.7
Chad	2.01	25.2	40.2	11701	58.7	23.0	47.7

Notes & guidance for publication

• Use the latest UN DESA World Population Prospects (WPP) for TFR/MAC and World Bank WDI for GDP/urbanization; DHS/MICS for CPRm and education.

• Keep vintages consistent across sources; where indicators disagree, document definitions (e.g., CPR among married vs all women).

• Consider uncertainty (survey design) and produce simple bands or funnel plots when many countries are compared.

References — Section 4.9

- United Nations, Department of Economic and Social Affairs (UN DESA). World Population Prospects (latest vintage).

- World Bank. World Development Indicators (urbanization, GDP per capita PPP).

- The DHS Program & UNICEF MICS — contraceptive prevalence and female secondary completion.

- OECD/UNESCO — education indicators (definitions and harmonization).

4.10) Policy-Relevant Indicators & SDG Links

Purpose. Translate fertility levels and timing into policy signals tied to SDG targets. Track proximity to replacement, reproduction (NRR), adolescent fertility, family planning coverage, and youth structure to inform planning.

Figure . TFR vs replacement threshold (given survivorship)

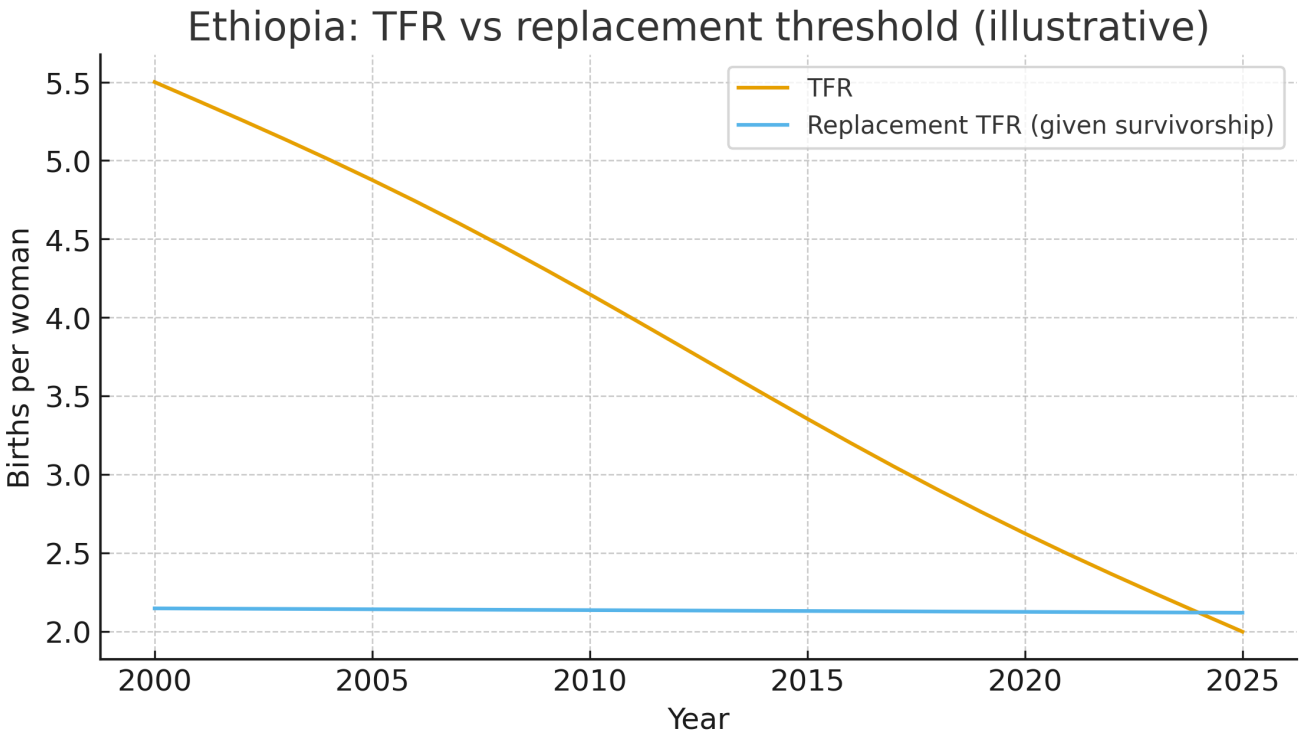

Figure . Net reproduction rate (NRR) and the replacement line (NRR=1)

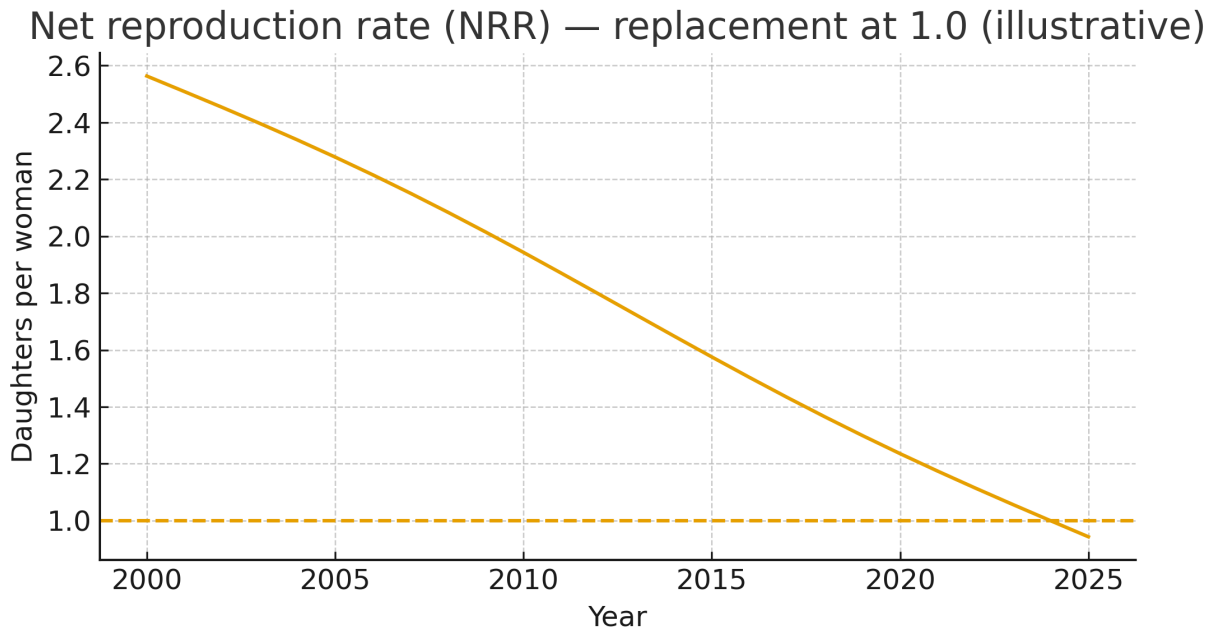

Figure . SDG 3.7 indicators — adolescent birth rate, modern CPR, unmet need

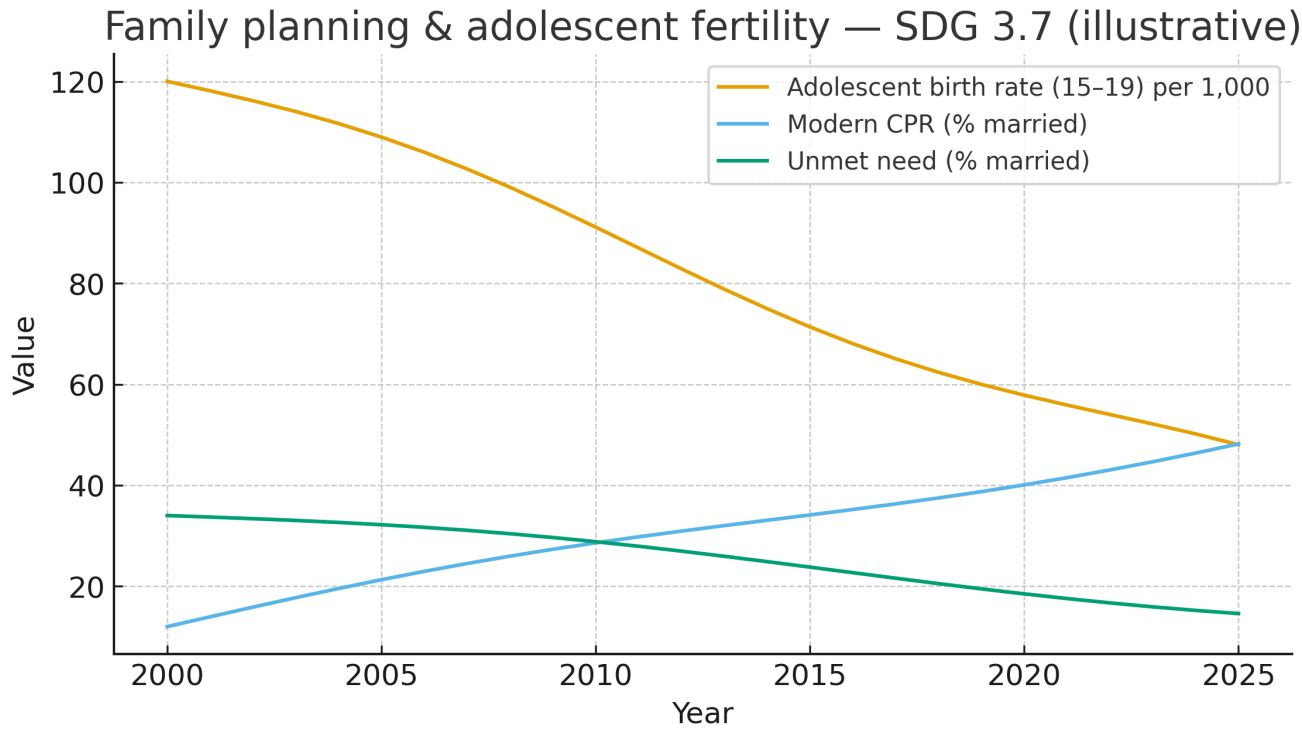

Figure . Youth structure and dependency

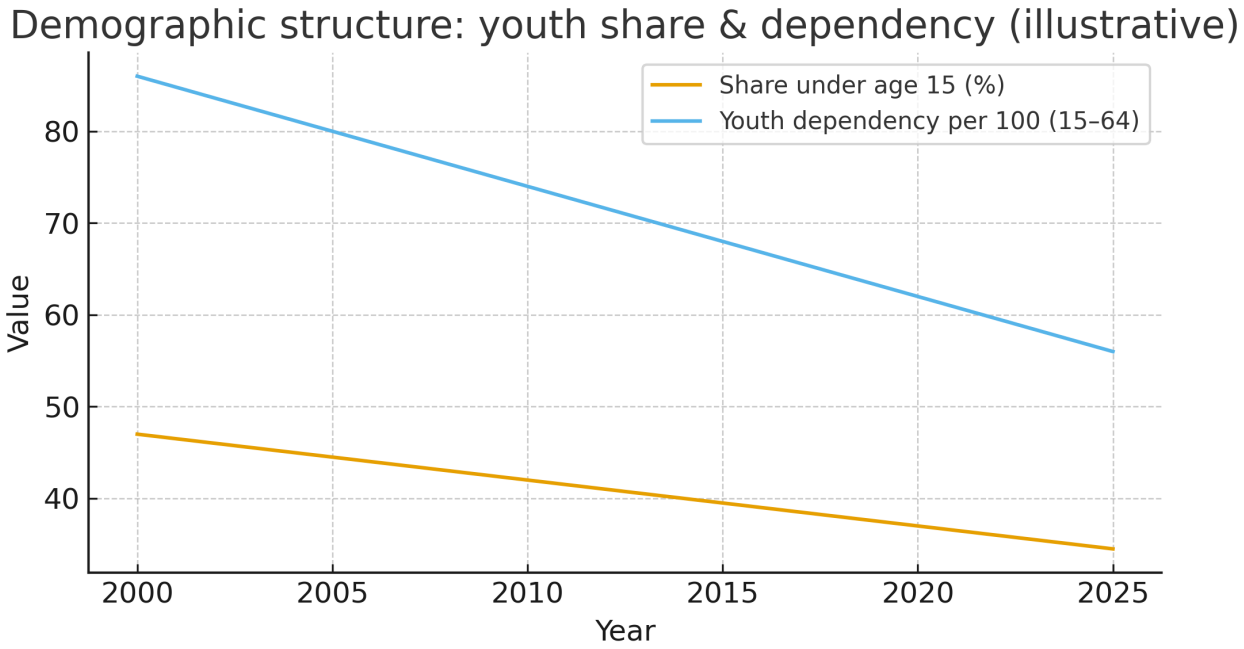

Table 4.10-A. SDG link map — fertility-relevant indicators

Target/Concept	Indicator	Definition (short)	Policy relevance
SDG 3.7.1	Demand satisfied by modern methods	% of women (15–49) with need for FP satisfied by modern methods	Primary FP access/service indicator; monitor equity
SDG 3.7.2	Adolescent birth rate	Births per 1,000 women aged 15–19	Adolescent health & schooling; target at-risk districts
SDG 5.6	Universal access to SRH/rights	Composite/qualitative; legal and service environment	Enabling environment for FP and informed choice

Table 4.10-B. Policy levers & illustrative actions

Priority area	Illustrative policy actions
Adolescent fertility (ABR high)	Scale CSE, delay early marriage, expand youth-friendly services; keep girls in school.
Spacing & stopping (high higher-order births)	Postpartum FP, LARC access, community outreach, male engagement.
Method mix & choice	Broaden method availability; reduce stock-outs; manage side-effects support.
Equity & geography	Prioritize low-use regions; mobile/outreach in pastoral & remote areas.
Data systems	Harmonize DHS/CRVS/HMIS; routine dashboards; subnational disaggregation.

Table 4.10-C. Latest snapshot (illustrative)

Indicator	Value (2025)
TFR	2.00
NRR	0.94 daughters/woman
Replacement TFR (given survivorship)	2.12 births/woman
Adolescent birth rate (15–19)	48 per 1,000 girls 15–19
Modern CPR (married)	48%
Unmet need (married)	15%
Share under 15 (%)	34.5%
Youth dependency (per 100 15–64)	56 per 100

Notes & interpretation

• Replacement depends on survivorship during childbearing; use NRR and replacement TFR consistently from the same life table cohort.

• Track SDG 3.7 indicators at regional/district levels to target highest-need areas (adolescents, postpartum women, pastoral/remote settings).

• Youth structure implies momentum; even near-replacement fertility, population can grow if the base is broad. Plan for schooling, health, and jobs accordingly.

References — Section 4.10

- United Nations, Department of Economic and Social Affairs (UN DESA). World Population Prospects (latest vintage).

- United Nations Statistics Division. SDG Indicators Metadata (Targets 3.7, 5.6).

- The DHS Program. Indicator definitions for FP, adolescent fertility, and unmet need.

- World Bank. World Development Indicators — dependency ratios and age structure.

4.12) Methods & Reproducibility

Goal. Enable end-to-end reproducibility of Chapter 4 figures and tables for Ethiopia, with clear data provenance, version control, quality checks, and export procedures.

Figure . Analysis pipeline — from ingest to outputs

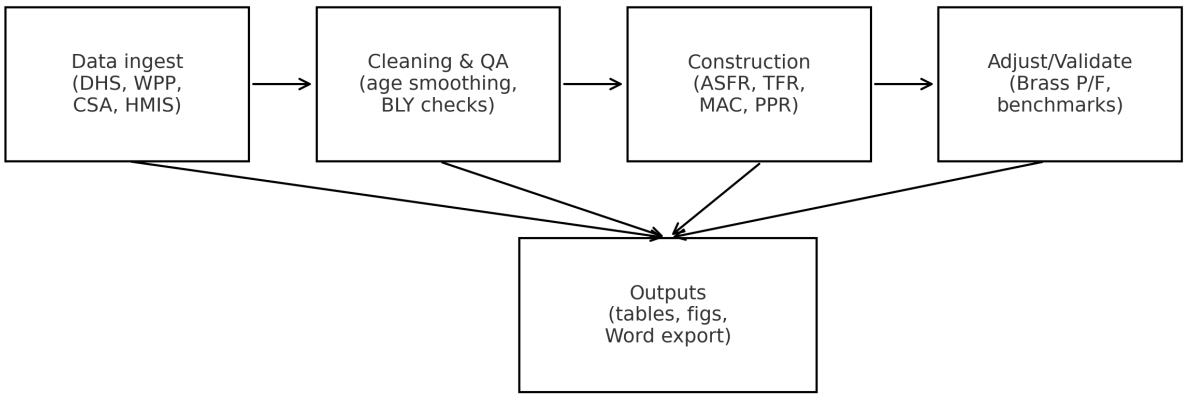

Figure . Data vintages timeline — Censuses, DHS, WPP

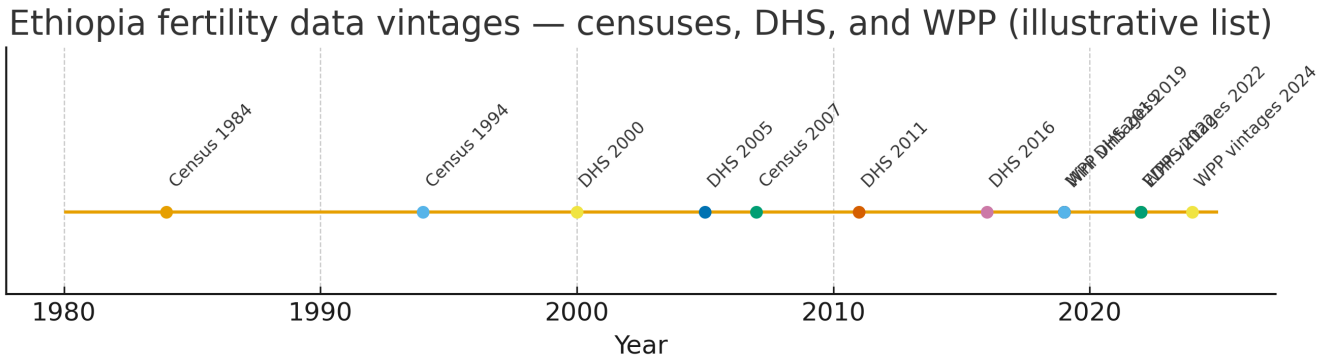

Table 4.12-A. Data provenance & datasets

Dataset/source	Artifacts used	Indicators derived	Publisher/owner	Versioning/vintage

DHS/EDHS/Mini-DHS	Microdata (birth histories), reports, recode manuals	ASFR, TFR, MAB1/MAC, PPR, ABR, CPR	The DHS Program	Specify round (e.g., 2016, 2019 Mini, 2022)
CSA Censuses	Census microdata, summary tables	Age-sex structure, CEB, BLY, smoothing	CSA Ethiopia	1984, 1994, 2007; note any updates
UN DESA WPP	WPP time-series and metadata	Harmonized TFR/ASFR, MAC, NRR	UN DESA/Population Division	Use single vintage (e.g., 2024) for a chapter

Table 4.12-B. Suggested file structure for reproducible builds

Folder	Description
data/raw/	Unmodified downloads by source and vintage
data/processed/	Harmonized files (document transformations)
analysis/notebooks/	Exploratory notebooks (locked to read-only data)
analysis/scripts/	Deterministic scripts (ETL, computations)
figures/	Auto-generated PNG/SVG at 300–600 dpi
outputs/word/	Assembled .docx sections (with date stamp)
metadata/	Provenance logs, codebook, variable maps
release/	Final assets and checksums (SHA-256)

Table 4.12-C. Computation environment

Component	Specification / guidance
Language/runtime	Python 3.x (record minor version)
Key libraries	pandas, numpy, matplotlib, python-docx
Random seeds	Set seeds for synthetic examples; document for sampling procedures
Reproducible runs	Single make-like entry point to rebuild figures/tables
Export formats	PNG (web), SVG (web), DOCX/PDF (print)

Table 4.12-D. QA checklist

Check	Action
Age heaping & smoothing	Compute Whipple/Myers; smooth if > thresholds; document
BLY vs full histories	Check spikes at 12/24 months; reconcile
Brass P/F consistency	Use ages 25–39; avoid crisis periods; show sensitivity
Weights/design	Apply strata/cluster weights; show uncertainty bands
Cross-source coherence	Compare DHS vs WPP vs Census; explain divergences

Table 4.12-E. Uncertainty & sensitivity reporting

Dimension	How to present
Sampling variance	Replicate weights/bootstraps for survey estimates
Model/adjustment uncertainty	Ranges for P/F factor; alternative smoothing choices
Temporal alignment	Sensitivity to pooling windows (e.g., 3- or 5-year)
Small area estimation	Borrowing strength flagged; validate against held-out regions

Table 4.12-F. Citation templates

Source	Template reference
DHS	Central Statistical Agency (CSA) [Ethiopia] and ICF. YEAR. Ethiopia Demographic and Health Survey YEAR. Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF.
WPP	United Nations, Department of Economic and Social Affairs, Population Division. YEAR. World Population Prospects YEAR, Online Edition.
Census	Central Statistical Agency (CSA). YEAR. Population and Housing Census of Ethiopia YEAR. Addis Ababa: CSA.

Release & versioning notes

• Maintain a CHANGELOG with dates, data vintages, and major edits; tag releases by chapter version (e.g., ch4-v1.0-2025-10-08).

• Store checksums (SHA-256) for source data and exported figures/tables. Archive raw downloads for auditability.

• Include a REPRODUCE.md that documents the exact commands to rebuild outputs from scratch.

References — Section 4.12

- United Nations. (2017, 2022). Principles and Recommendations for Population and Housing Censuses.

- The DHS Program. Recode manuals and Guide to DHS Statistics.

- UN DESA. World Population Prospects (methods & metadata).

- Gentzkow, M. & Shapiro, J. (2014). Code and Data for the Social Sciences: A Practitioner’s Guide.