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Evaluation of Mortality Data

François Pelletier
Population Estimates and Projections Section

www.unpopulation.org

Outline

1. **Measures of mortality**
   a) Crude death rates, infant and under five mortality "rates", age specific mortality rates and life expectancy at birth
2. **Life tables**
   a) Constructing empirical (abridged) life tables
   b) Model life tables
   c) Deriving mortality indicators from life tables components
3. **Survival of children ever born** (Brass type estimates)
   a) Information required
   b) Checking data quality
   c) Estimation using MortPak (Qfive)
   d) Assumptions, violations, and assessing quality of estimates

Measures of mortality

Crude Death Rate (CDR)

$$CDR\,[0, T] = \frac{\text{Number of deaths in the population between times 0 and } T}{\text{Number of person-years lived in the population between times 0 and } T}$$

Usually,

$$Crude\ Death\ Rate = \frac{Number\ of\ deaths\ in\ a\ year}{Mid - year\ population} \cdot 1000$$

$$CDR = \frac{D}{\bar{P}} \cdot 1000$$

with $\bar{P} = \frac{(P_1 + P_0)}{2}$

>> Crude rate as no reference to smaller groups which might better represent the population likely to experience the event

>> Influence of age structure

Source: Preston et al. (2001: 22)

Sweden, females, 1992					*Kazakhstan, females, 1992*				
Age group i	*Mid-year population*	*Deaths during year*	*Death rate*	*Proportion in age category*	*Age group i*	*Mid-year population*	*Deaths during year*	*Death rate*	*Proportion in age category*
	N_i^{Sw}	D_i^{Sw}	M_i^{Sw}	C_i^{Sw}		N_i^{K}	D_i^{K}	M_i^{K}	C_i^{K}
0	59,727	279	0.00467	0.0136	0	174,078	3,720	0.02137	0.0200
1–4	229,775	42	0.00018	0.0524	1–4	754,758	1,220	0.00162	0.0868
5–9	245,172	31	0.00013	0.0559	5–9	879,129	396	0.00045	0.1011
10–14	240,110	33	0.00014	0.0548	10–14	808,510	298	0.00037	0.0929
15–19	264,957	61	0.00023	0.0604	15–19	720,161	561	0.00078	0.0828
20–4	287,176	87	0.00030	0.0655	20–4	622,988	673	0.00108	0.0716
25–9	311,111	98	0.00032	0.0709	25–9	733,057	752	0.00103	0.0843
30–4	280,991	140	0.00050	0.0641	30–4	732,312	965	0.00132	0.0842
35–9	286,899	197	0.00069	0.0654	35–9	612,825	1,113	0.00182	0.0704
40–4	308,238	362	0.00117	0.0703	40–4	487,996	1,405	0.00288	0.0561
45–9	320,172	643	0.00201	0.0730	45–9	284,799	1,226	0.00430	0.0327
50–4	242,230	738	0.00305	0.0552	50–4	503,608	2,878	0.00571	0.0579
55–9	210,785	972	0.00461	0.0481	55–9	301,879	3,266	0.01082	0.0347
60–4	216,058	1,640	0.00759	0.0493	60–4	374,317	5,212	0.01392	0.0430
65–9	224,479	2,752	0.01226	0.0512	65–9	256,247	6,866	0.02679	0.0295
70–4	222,578	4,509	0.02026	0.0508	70–4	154,623	6,182	0.03998	0.0178
75–9	184,102	6,745	0.03664	0.0420	75–9	149,917	8,199	0.05469	0.0172
80–4	140,667	9,587	0.06815	0.0321	80–4	88,716	9,013	0.10159	0.0102
85+	110,242	17,340	0.15729	0.0251	85+	58,940	10,627	0.18030	0.0068
All	4,385,469	46,256	0.01055	1.0000	All	8,698,860	64,572	0.00742	1.0000
CDR		10.55 p. 1,000			*CDR*		7.42 p. 1,000		

Measures of mortality

Infant Mortality Rate(IMR)

- One of the best-known and widely used available measure of mortality in early life

$$Infant\ mortaliy\ rate = \frac{Deaths\ under\ age\ 1\ during\ year\ t}{Total\ live\ births\ in\ year\ t} \cdot 1000$$

- Denominator is live births (not than the mid-year population as in $ASDR$)
- Majority of infant deaths occurs in the first days and weeks or life

  >> Deaths not evenly distributed over the first 12 months, mid-year population is not a valid indicator of average size of the population at risk of infant mortality

Measures of mortality

Under-Five Morality Rate (or 'Child Mortality')

Widely used to measure, assess and monitor the progress of countries with respect to child survival

>> MDG-4: Reduce child mortality, Target 4.A: Reduce by two thirds, between 1990 and 2015, the under-five mortality rate

>> IGME (Interagency group for child mortality estimation) estimates available at www.childmortality.org

Definition

Under-five mortality rate is the ***probability*** per 1,000 that a newborn baby will die before reaching age five, if subject to age-specific mortality rates of the specified year

Measures of mortality

Age-specific death rate ($ASDR$)

$$Age\ specific\ death\ rate = \frac{Number\ of\ deaths\ in\ a\ year\ at\ age\ x}{Mid - year\ population\ at\ age\ x} \cdot 1000$$

$${}_nM_x = \frac{{}_nD_x}{{}_nP_x}$$

- $ASDR$ measures the incidence of death at each age
- $ASDR$ may refer to single age or to grouped ages (e.g. 20-24, 25-29)
- Death rate is relatively high for infants under one year declines to its lowest levels for children and slowly increase thereafter

Measures of mortality

Life expectancy at birth (e_0)

>> The expectation of life at exact age x, i.e. the average number of years lived by a person from exact age x

Life tables

Life tables

- One of demography's most influential "innovation"
- Life tables are useful to examine how many survive to successive ages and to determine the length of life
- Essential tool for population estimates and projections
- Important measure of progress
- Indicates whether the goal of long life for all is achieved
- Most widely known indicator: **Life expectancy at birth** (e_0)

Life tables

- Contain several functions that represent the effects of mortality on a population
  - Life expectancy, age-specific mortality rates, probability of dying by age x
- **Cohort life tables** trace the experience of a single birth cohort (e.g. all those born in 1950)
  - Have to wait for entire cohort to die to have full data
- **Period life tables** use a *synthetic cohort* to represent prevailing mortality conditions at present time
  - As if a cohort lived their whole life under the current mortality conditions

The period life table – Example (Preston et al. 2001)

Age x	${}_nN_x$	${}_nD_x$	${}_nm_x$	${}_na_x$	${}_nq_x$	${}_np_x$	l_x	${}_nd_x$	${}_nL_x$	T_x	e_x^o
0	47,925	419	0.008743	0.068	0.008672	0.991328	100,000	867	99,192	7,288,901	72.889
1	189,127	70	0.000370	1.626	0.001479	0.998521	99,133	147	396,183	7,189,709	72.526
5	234,793	36	0.000153	2.500	0.000766	0.999234	98,986	76	494,741	6,793,526	68.631
10	238,790	46	0.000193	3.143	0.000963	0.999037	98,910	95	494,375	6,298,785	63.682
15	254,996	249	0.000976	2.724	0.004872	0.995128	98,815	481	492,980	5,804,410	58.740
20	326,831	420	0.001285	2.520	0.006405	0.993595	98,334	630	490,106	5,311,431	54.014
25	355,086	403	0.001135	2.481	0.005659	0.994341	97,704	553	487,127	4,821,324	49.346
30	324,222	441	0.001360	2.601	0.006779	0.993221	97,151	659	484,175	4,334,198	44.613
35	269,963	508	0.001882	2.701	0.009368	0.990632	96,492	904	480,384	3,850,023	39.900
40	261,971	769	0.002935	2.663	0.014577	0.985423	95,588	1,393	474,686	3,369,639	35.252
45	238,011	1,154	0.004849	2.698	0.023975	0.976025	94,195	2,258	465,777	2,894,953	30.734
50	261,612	1,866	0.007133	2.676	0.035082	0.964918	91,937	3,225	452,188	2,429,176	26.422
55	181,385	2,043	0.011263	2.645	0.054861	0.945139	88,711	4,867	432,096	1,976,988	22.286
60	187,962	3,496	0.018600	2.624	0.089062	0.910938	83,845	7,467	401,480	1,544,893	18.426
65	153,832	4,366	0.028382	2.619	0.132925	0.867075	76,377	10,152	357,713	1,143,412	14.971
70	105,169	4,337	0.041238	2.593	0.187573	0.812427	66,225	12,422	301,224	785,699	11.864
75	73,694	5,279	0.071634	2.518	0.304102	0.695898	53,803	16,362	228,404	484,475	9.005
80	57,512	6,460	0.112324	2.423	0.435548	0.564452	37,441	16,307	145,182	256,070	6.839
85	32,248	6,146	0.190585	5.247	1.000000	0.000000	21,134	21,134	110,889	110,889	5.247

Data source: United Nations, 1994.

Definition of the life table functions

Function	Definition
l_x	Number of persons surviving to exact age *x* (out of the original 100,000)
${}_nq_x$	Probability of dying between exact ages x and $x+n$
${}_np_x$	Probability of surviving from exact age x to exact age $x+n$
${}_nd_x$	Number of deaths between ages x and $x+n$
${}_nL_x$	Average number alive in the interval between exact ages x and $x+n$. It also denotes the number of person-years lived in the interval between exact ages x and $x+n$
T_x	Total population aged x and over, or the total number of person-years lived from exact age x
e_x	Expectation of life at exact age x, i.e. the average number of years lived by a person from exact age x

Life table – Point and interval measures

Functions referring to exact age x	Functions referring to the interval between exact ages x to $x+n$
l_x	${}_nq_x$
T_x	${}_np_x$
e_x	${}_nd_x$
	${}_nL_x$

Formatting conventions

l_x, d_x, L_x, and T_x >> whole number of persons

M_x, q_x, and p_x >> five decimal places for rates and probabilities

e_x >> two decimal places for life expectancy

Source: Rowland (200

Calculating the period (abridged) life table

1. Age-specific death rate (${}_nM_x$) ⟶

$$ {}_nM_x = \frac{{}_nD_x}{{}_nN_x} $$

2. Probability of dying between ages x and $x+n$ (${}_nq_x$)

>> assuming that persons dying in the interval do so, on average, half-way through the interval

$$ {}_nq_x = \frac{2n \cdot {}_nM_x}{2 + n \cdot {}_nM_x} $$

For open-ended age group ⟶

$$ {}_\infty q_x = 1 $$

3. Probability of surviving from one age to the next (${}_np_x$)

$$ {}_np_x = 1 - {}_nq_x $$

Calculating the period (abridged) life table

4. Number surviving at exact ages (l_x) →

$$l_{x+n} = l_x \cdot {}_np_x$$

$$l_{x+n} = l_x - {}_nd_x$$

>> At age 0, l_0 = 100,000

5. Deaths between ages x and $x+n$ (${}_nd_x$) →

$${}_nd_x = l_x \cdot {}_nq_x$$

$${}_nd_x = l_x - l_{x+n}$$

Calculating the period (abridged) life table

6. Average number alive between exact ages x and $x+n$ ($_nL_x$)

$$\rightarrow \quad {}_nL_x = \frac{n}{2} \cdot (l_x + l_{x+n})$$

For L_0, $\rightarrow$ $L_0 = 0.3l_0 + 0.7l_1$

For open-ended age group $\rightarrow$ $${}_\infty L_x = \frac{l_x}{{}_\infty M_x}$$

7. Total population aged x and over (T_x) $\rightarrow$ $$T_x = \sum_{i=x}^{\infty} {}_nL_i$$

For open-ended age group $\rightarrow$ $T_x = {}_\infty L_x$

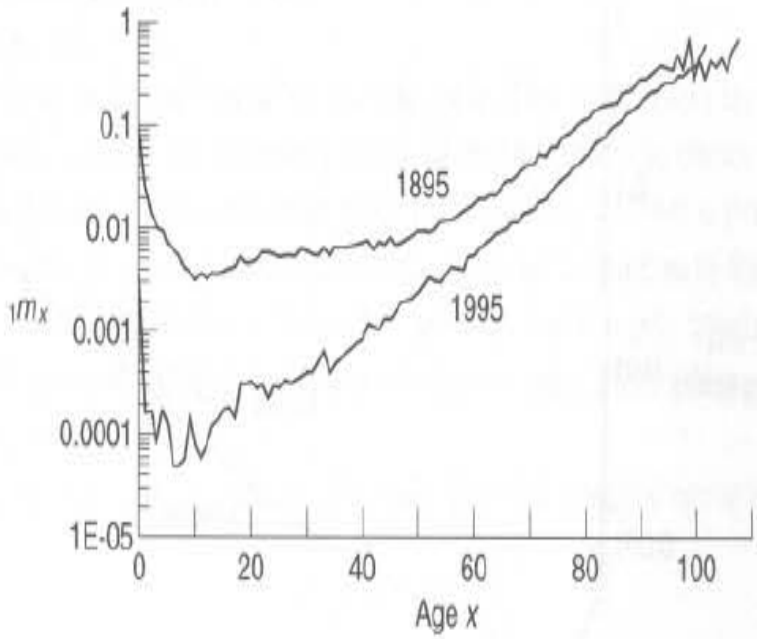
Working from the bottom of the life table $\rightarrow$ $T_x = T_{x+n} + {}_nL_x$

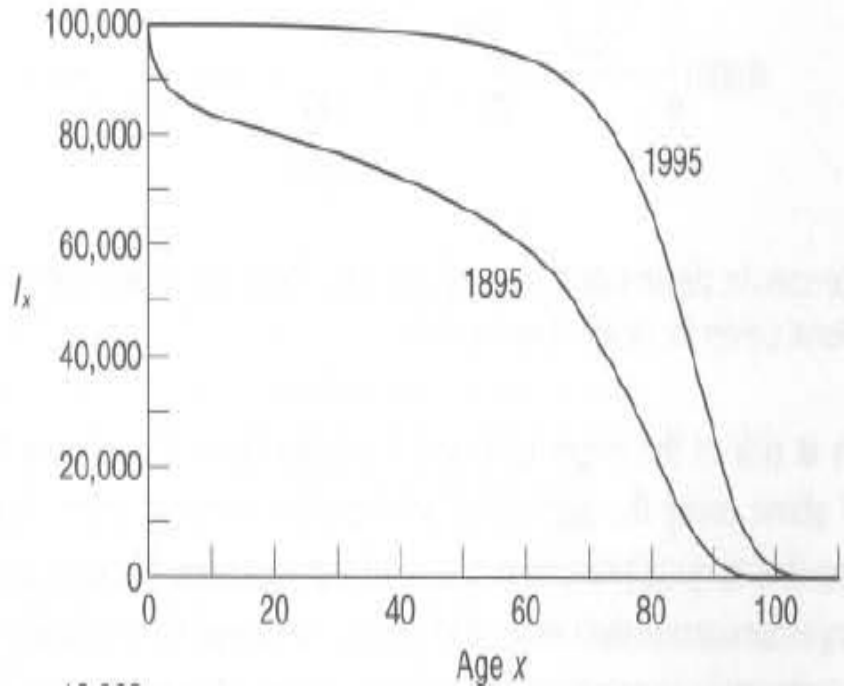
Calculating the period (abridged) life table

8. Expectation of life from age x (e_x) $\longrightarrow$ $$e_x = \frac{T_x}{l_x}$$

$\longrightarrow$ Life expectancy at birth (e_0) $= \frac{T_0}{l_0}$

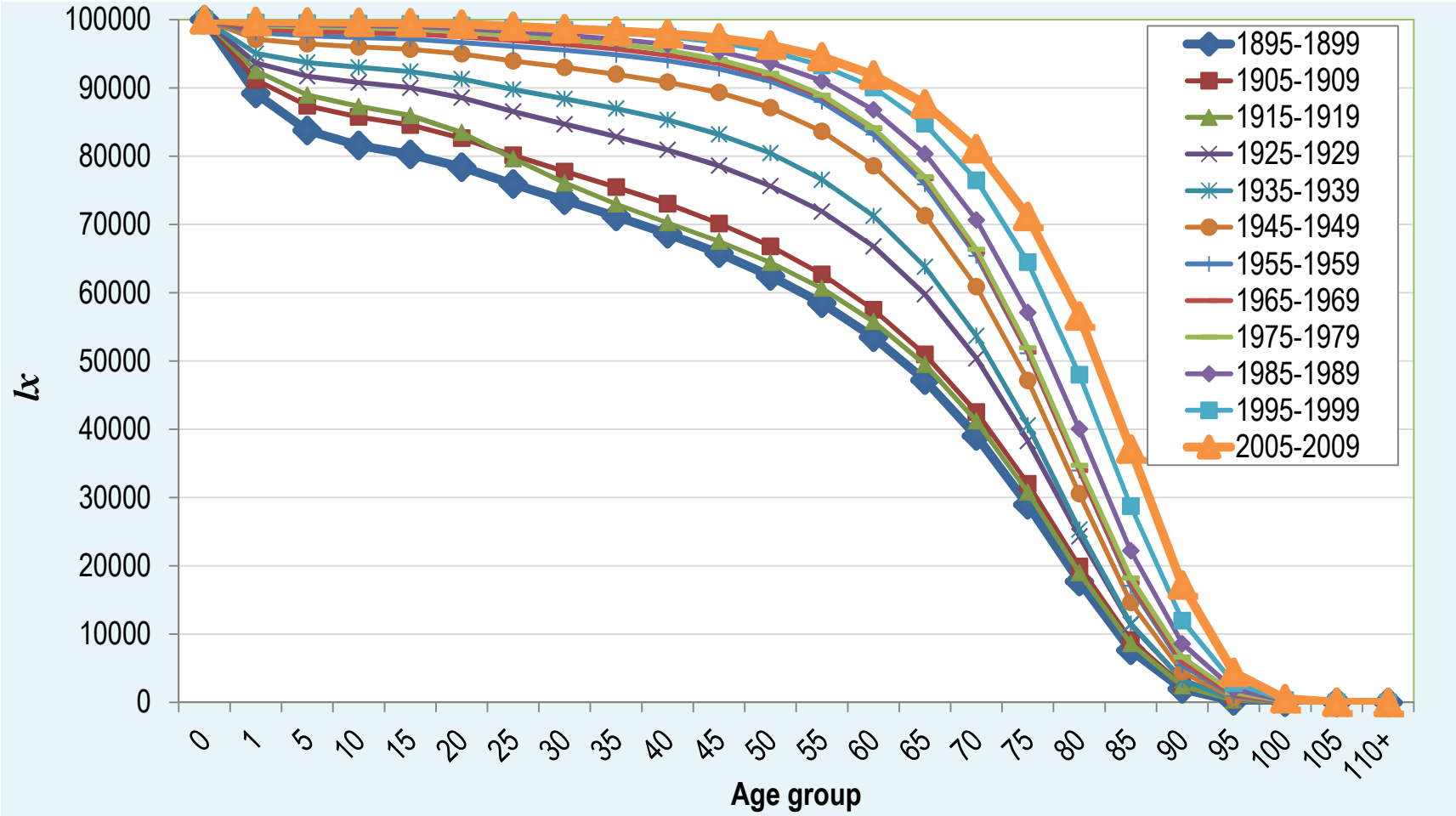
Data checks: does the life table make sense?





Source: Swedish females, 1895 vs 1995 (Preston et. al. 2001)

Rectangularization of the life table, Sweden, Females



Data Source: Human Mortality Database

Example – using MortPak LIFTB
Central African Republic, 1988 Census, Men

MORTPAK FOR WINDOWS - [Selected application is LIFTB (Untitled1)]

File Edit View Application Run Chart Window Help

Input File Name: C:\Program Files (x86)\MORTPAK4\Untitled.MPL
When last updated: 21 September 2015

Data Entry Help
Show Document Output

Construction of a life table.

TITLE: CENTRAL AFRICAN REPUBLIC, 1988 CENSUS

Sex: Males
Data Type: m(x,n)
(Output) open age group: 95+

Age Group	m(x,n)
0 - 1	0.08080
1 - 5	0.01488
5 - 10	0.00361
10 - 15	0.00276
15 - 20	0.00319
20 - 25	0.00394
25 - 30	0.00539
30 - 35	0.00629
35 - 40	0.00816
40 - 45	0.00995
45 - 50	0.01589
50 - 55	0.01940
55 - 60	0.01940
60 - 65	0.02848
65 - 70	0.03209
70 - 75	0.05539
75 - 80	0.06078
80 - 85	0.07171
85 - 90	0.09322
90 - 95	0.13674
95 -100	0.17088

Age	m(x,n)	q(x,n)	l(x)	d(x,n)	L(x,n)	S(x,n)	T(x)	e(x)	a(x,n)
0	0.08080	0.07625	100000.	7625.	94371.	0.90045	5570392.	55.704	0.262
1	0.01488	0.05732	92375.	5295.	355855.	0.95842	5476021.	59.280	1.423
5	0.00361	0.01789	87080.	1558.	431504.	0.98418	5120166.	58.799	2.500
10	0.00276	0.01371	85522.	1172.	424680.	0.98545	4688662.	54.824	2.500
15	0.00319	0.01583	84350.	1335.	418502.	0.98252	4263982.	50.551	2.568
20	0.00394	0.01952	83015.	1620.	411188.	0.97704	3845480.	46.323	2.601
25	0.00539	0.02660	81395.	2165.	401747.	0.97124	3434292.	42.193	2.586
30	0.00629	0.03098	79229.	2454.	390191.	0.96475	3032545.	38.276	2.573
35	0.00816	0.04001	76775.	3072.	376437.	0.95630	2642354.	34.417	2.579
40	0.00995	0.04860	73703.	3582.	359985.	0.93826	2265917.	30.744	2.618
45	0.01589	0.07654	70121.	5367.	337759.	0.91427	1905931.	27.180	2.606
50	0.01940	0.09252	64754.	5991.	308803.	0.90813	1568173.	24.217	2.501
55	0.01940	0.09258	58764.	5440.	280433.	0.88861	1259370.	21.431	2.540
60	0.02848	0.13310	53323.	7097.	249197.	0.86045	978937.	18.359	2.546
65	0.03209	0.14885	46226.	6881.	214423.	0.80657	729740.	15.786	2.572
70	0.05539	0.24347	39345.	9580.	172947.	0.74417	515318.	13.097	2.518
75	0.06078	0.26280	29766.	7823.	128703.	0.72024	342370.	11.502	2.427
80	0.07171	0.30293	21943.	6647.	92697.	0.66610	213667.	9.737	2.440
85	0.09322	0.37631	15296.	5756.	61746.	0.56655	120970.	7.909	2.440
90	0.13674	0.50142	9540.	4783.	34982.	0.40932	59224.	6.208	2.341
95	0.19621	...	4756.	4756.	24242.	...	24242.	5.097	5.097

Summary table

q(0,5)=	0.12920
q(15,20)=	0.08980
q(15,35)=	0.23231
q(15,45)=	0.36783
q(30,40)=	0.50340
q(60,20)=	0.58849

First entry of S(x,n) is for survivorship of 5 cohorts of birth to age group 0-4 = L(0,5) / 500000
Second entry of S(x,n) is for S(0,5) = L(5,5) / L(0,5)
Last entry of S(x,n) is S(90+,5) = T(95) / T(90)

Data Source: Bureau Central du Recensement (1994), Recensement Général de la Population de décembre 1988, Volume II: Rapport d'analyse, Tome 4 : Mortalité, Bangui, p. 30.

Deriving mortality indicators from life table functions (example with Central African Republic)

- **Under five mortality (5q0):** 5q0 $= (l(0) - l(5)) / l(0)$

  $= (100{,}000 - 87{,}080) / 100{,}000 = 0.1292$

- **Adult mortality (45q15):** 45q15 $= (l(15) - l(60)) / l(15)$

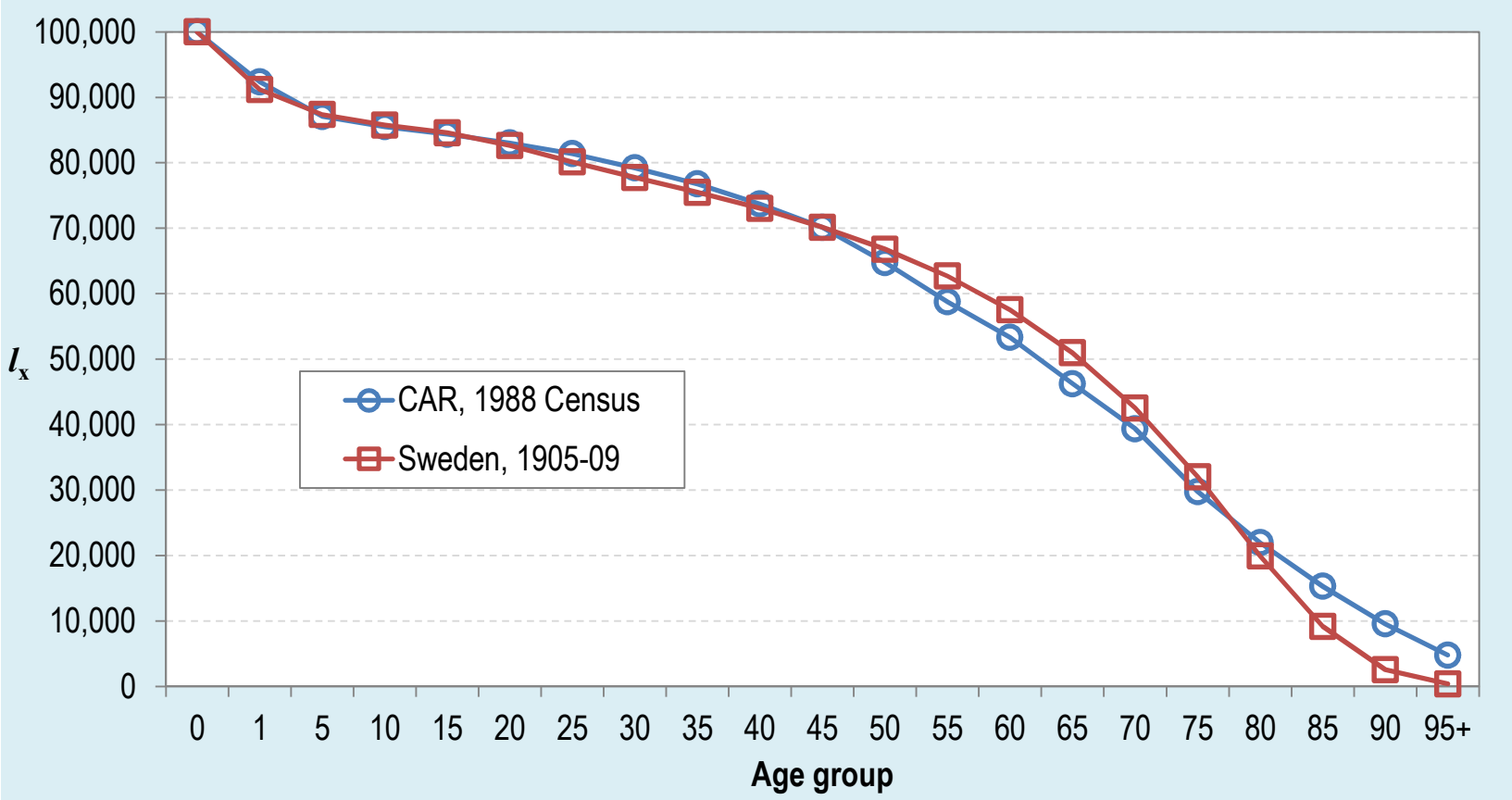
  $= (84{,}350 - 53{,}323) / 84{,}350 = 0.3678$

- **Life expectancy for open age groups**: e(95+) = 1 / (m95+)

  = 1 / 0.19621= 5.097

Example – using MortPak LIFTB

Central African Republic, 1988 Census, Men



Data Source: Bureau Central du Recensement (1994), Recensement Général de la Population de décembre 1988, Volume II: Rapport d'analyse, Tome 4 : Mortalité, Bangui, p. 30.

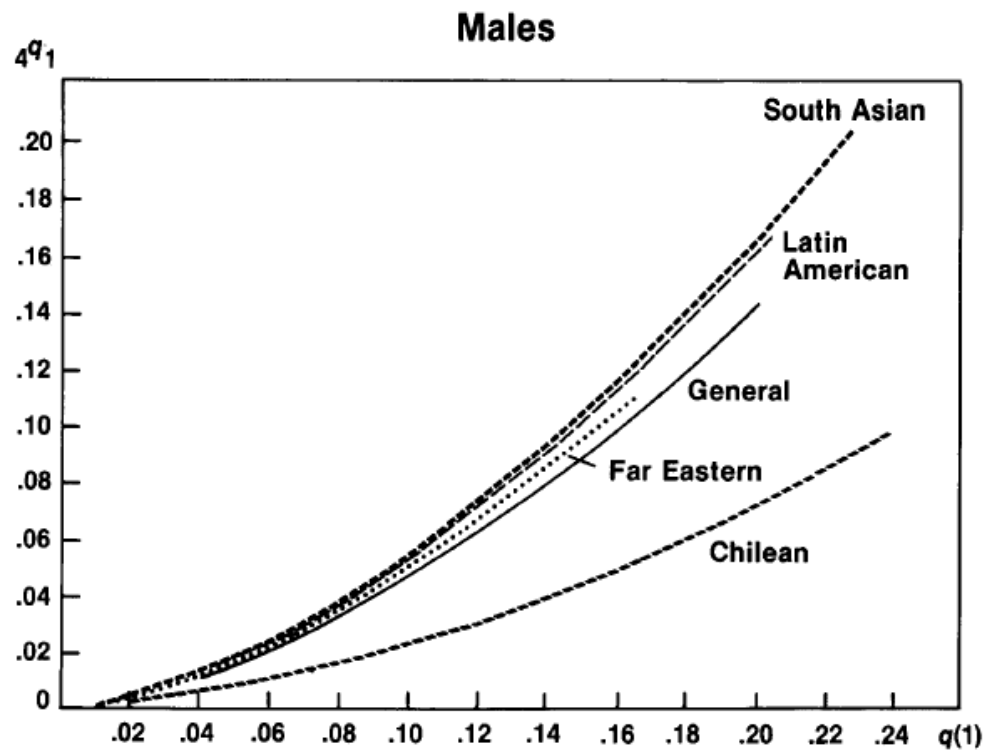
Model life tables

- Represent expected age patterns of mortality
- Created to estimate demographic parameters for countries with limited data
- Built on empirical studies of age-specific mortality patterns in the past
- Two groups of model life tables:
  - Coale-Demeny (1968, 1983): based on European populations
    - North, South, East and West European models
    - West only model based on some non-European life tables
  - United Nations (1982): based on developing countries
    - Latin American, Chilean, South Asian, Far Eastern, General

Model life tables (2)

Age-specific shape of mortality – relative probabilities of dying at different ages

Relationship between infant mortality ($_1q_0$) and child mortality ($_4q_1$)



Source: United Nations (1990)

Model life tables (3)

Level of mortality – each model has several different levels that correspond with different levels of life expectancy at birth (e_0)

United Nations Model Life Tables — Males

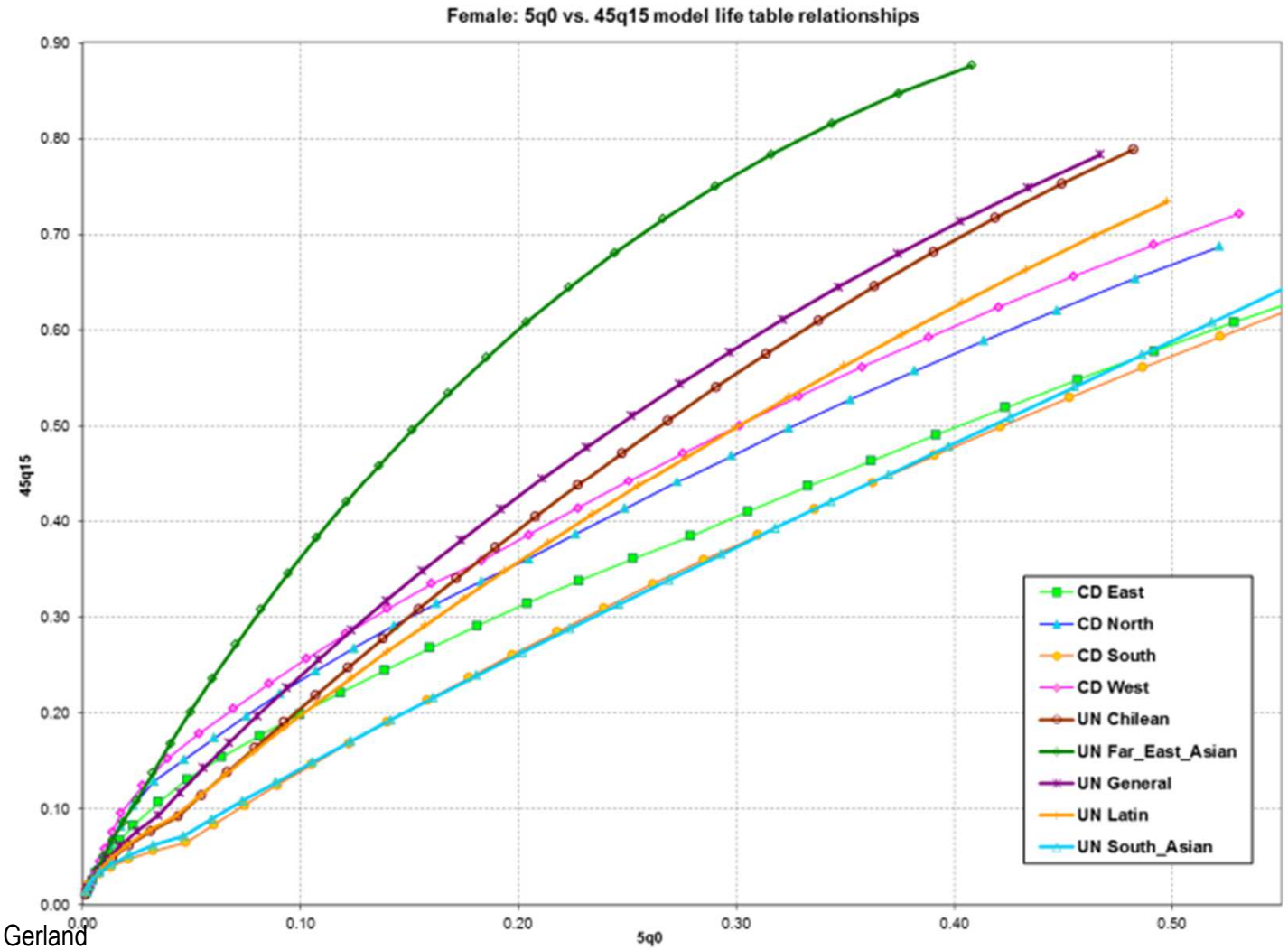
Latin American Pattern

AGE	M(X)	Q(X)	I(X)	D(X)	L(X)	T(X)	E(X)	A(X)
0	.23669	.20429	100000	20429	86313	3500000	35.000	0.330
1	.04672	.16631	79571	13234	283241	3413687	42.901	1.352
5	.00982	.04790	66337	3178	323742	3130446	47.190	2.500
10	.00511	.02522	63160	1593	311817	2806704	44.438	2.500
15	.00697	.03427	61567	2110	302841	2494887	40.523	2.633
20	.01036	.05051	59457	3003	290037	2192046	36.868	2.586
25	.01169	.05679	56454	3206	274346	1902009	33.691	2.528
30	.01332	.06449	53248	3434	257753	1627663	30.567	2.528
35	.01528	.07363	49814	3668	239996	1369910	27.500	2.526
40	.01757	.08418	46146	3885	221132	1129914	24.485	2.529
45	.02092	.09948	42262	4204	200930	908782	21.504	2.531
50	.02517	.11849	38058	4509	179185	707852	18.599	2.538
55	.03225	.14939	33548	5012	155420	528667	15.758	2.542
60	.04241	.19205	28537	5480	129217	373247	13.080	2.543
65	.06056	.26327	23056	6070	100230	244030	10.584	2.520
70	.08574	.35208	16986	5980	69747	143800	8.466	2.461
75	.11840	.45210	11006	4976	42023	74053	6.729	2.386
80	.16226	.56382	6030	3400	20953	32030	5.312	2.295
85	.23745	******	2630	2630	11077	11077	4.211	4.211

AGE	M(X)	Q(X)	I(X)	D(X)	L(X)	T(X)	E(X)	A(X)
0	.22881	.19840	100000	19840	86707	3599999	36.000	0.330
1	.04434	.15871	80160	12723	286952	3513291	43.828	1.352
5	.00933	.04560	67438	3075	329502	3226339	47.842	2.500
10	.00487	.02408	64363	1550	317940	2896838	45.008	2.500
15	.00667	.03281	62813	2061	309189	2578898	41.057	2.634
20	.00992	.04843	60752	2942	296662	2269709	37.360	2.588
25	.01120	.05451	57810	3151	281263	1973048	34.130	2.529
30	.01277	.06192	54658	3384	264933	1691784	30.952	2.530
35	.01470	.07093	51274	3637	247381	1426852	27.828	2.528
40	.01696	.08140	47637	3878	228615	1179470	24.759	2.532
45	.02029	.09663	43759	4228	208371	950856	21.729	2.535
50	.02452	.11564	39531	4571	186413	742484	18.782	2.541
55	.03156	.14644	34960	5119	162227	556071	15.906	2.545
60	.04164	.18889	29840	5637	135367	393844	13.198	2.546
65	.05958	.25961	24204	6284	105456	258477	10.679	2.523
70	.08453	.34804	17920	6237	73786	153022	8.539	2.464
75	.11698	.44810	11683	5235	44753	79236	6.782	2.390
80	.16076	.56044	6448	3614	22479	34483	5.348	2.299
85	.23611	******	2834	2834	12004	12004	4.235	4.235

Source: United Nations (1982)

Relationship between 45q15 and 5q0 based on Model life tables



Source: Produced by Gerland

The impact of the HIV/AIDS epidemic on mortality levels and age patterns

- **Spectrum (http://spectrumbeta.futuresinstitute.org/)**

- **No-Aids Scenario**
- **Under five mortality (5q0)**
- **Adult mortality (45q15)**

Survival of children ever born

Indirect estimation of child mortality

Mortality estimates from population censuses: Introduction

- A group of questions can be used to obtain mortality data in a census
- Two distinctions:
  a) Level and trend of mortality *vs* age pattern of mortality
     - Survival of children ever born: level and trend of mortality
     - Household deaths: age pattern of mortality
  b) Deaths of younger persons vs. deaths of adults
     - Younger persons: survival of children ever born
     - Adults: household deaths
- All approaches are to supplement death registration data, not to replace it

Quick review - children ever born data

- Have been used for the past 50 years to collect data on infant and child mortality
- For every woman the following information is collected:

  a) the total number of female children she has had in her lifetime.

  b) the total number of male children she has had in her lifetime.

  c) the number of female children who are surviving

  d) the number of male children who are surviving

Survival of children ever born

- Ever born – Surviving = Children deceased
- Children deceased / Ever born = Proportion deceased
- Life table measures of infant, child and young adult mortality may be derived from the proportion of deceased
  - In combination with data on age of mother

Brass type estimates

- Provide *indirect estimation* of level and trend of mortality for about 20 years prior to a census or survey
- Data required:
  - Number of women by
    - 5 year age group or;
    - Duration of marriage (5 year groups)
  - Total number of children born alive to women in corresponding 5-year groups
  - Total number of children still alive (or deceased) at time of census by corresponding 5-year groups

Brass type estimates (2)

Age group of mother in years	Age group index	Proportion of children dead approximates
15-19	1	q(1)
20-24	2	q(2)
25-29	3	q(3)
30-34	4	q(5)
35-39	5	q(10)
40-44	6	q(15)
45-49	7	q(20)

Brass type estimation – data checks

Women in the age group should include all women, not only those who respond to CEB/CS questions

>>Important to check in the context where it is inappropriate to ask unmarried women about childbearing

BANGLADESH CENSUS 1974 RETROSPECTIVE SURVEY OF FERTILITY AND MORTALITY

TOTAL	AGE GROUP OF WOMEN	TOTAL WOMEN	TOTAL BIRTHS	CHILDREN AT HOME	CHILDREN AWAY	CHILDREN DEAD
	0–14	259 104	6 677	4 866	0	1 811
	15–19	2 019 436	1 160 919	921 227	24 327	215 365
	20–24	2 521 318	4 901 382	3 820 649	83 349	997 384
	25–29	2 573 496	9 085 852	6 927 908	219 989	1 937 955
	30–34	2 003 082	9 910 256	7 126 473	522 587	2 261 196
	35–39	1 766 100	10 384 001	6 974 267	919 566	2 490 168
	40–44	1 473 382	9 164 329	5 472 460	1 276 846	2 415 023
	45–49	1 128 791	6 905 673	3 664 328	1 281 801	1 959 544
	50–54	1 040 877	5 963 087	2 601 163	1 441 061	1 920 863
	55–59	601 625	3 257 428	1 206 148	913 559	1 137 721
	60+	1 631 217	8 136 608	2 102 978	2 800 615	3 233 015
	N.S.	204	0	0	0	0
	TOTAL	17 018 632	68 876 212	40 822 467	9 483 700	18 570 045

Note small number of women in 0-14 age group; un-married women were not included

Source: United Nations (1990)

Brass type estimation – data checks (2)

- Experience has shown that it is possible to get high quality responses to summary birth histories in any data collection exercise, including censuses
  - If both CEB and CS are understated, some cancellation of errors will occur
  - But in practice, the reporting of CS is more likely to be complete than the reporting of CEB
  - Calculated proportions of deceased children are likely to be too low
- Make sure trends in children ever born/surviving/ deceased are consistent
- Check for missing data and/or editing

Brass type estimation – data checks (3)

Example: missing or implausible values of CEB and CS data

Table 5.1 Percentage of cases where no editing of children ever born and children surviving data was required, by population group and age group

	African		*Coloured*		*Indian/Asian*		*White*	
Age	*CEB*	*CS*	*CEB*	*CS*	*CEB*	*CS*	*CEB*	*CS*
12-14	65.2	34.5	53.5	27.2	61.4	19.7	46.2	22.6
15-19	73.5	44.0	63.7	37.2	68.8	24.6	55.9	28.9
20-24	82.5	62.5	78.5	59.5	79.1	40.9	[illegible]	[illegible]
25-29	88.2	75.6	87.6	75.4	88.0	64[illegible]	[illegible]	[illegible]
30-34	90.9	81.2	91.2	82.0	92.2	78[illegible]	[illegible]	[illegible]
35-39	91.9	83.2	92.6	84.5	93.5	82[illegible]	[illegible]	[illegible]
40-44	91.4	83.3	92.5	84.7	93.3	83.6	91.5	82.7
45-49	89.9	82.3	91.3	83.7	91.9	82.6	90.4	82.2

80.3 per cent need to be edited

Source: Dorrington & Moultrie (2001).

Brass type estimation – data checks (4)

Average CEB should be realistic given country TFR and typical ages at childbearing

Unless fertility or child mortality are increasing, average CD should increase with age group

Turkey, 2000

Age group of women	Total women	Total CEB	Average CEB	Total CS	Average children deceased (CD)	Proportion deceased (CEB-CS)/CEB
15 - 19	3518257	294628	0.08	281296	0.003789	0.045
20 - 24	3263432	2078364	0.64	1991445	0.026634	0.042
25 - 29	2918825	4522719	1.55	4312404	0.072055	0.047
30 - 34	2457285	5700038	2.32	5395143	0.124078	0.053
35 - 39	2400808	7036619	2.93	6563946	0.196881	0.067
40 - 44	1985225	6707033	3.38	6131544	0.289886	0.086
45 - 49	1658012	6394157	3.86	5722904	0.404854	0.105

Unless fertility has been rising, average CEB should increase with age group

Source: UN *Demographic Y*

Brass type estimation – data checks (5)

- Check sex ratio at birth implied by the CEB data for different mother age groups if gender is disaggregated (from age and sex structure)
  - Is it plausible?
  - Can help to identify underreporting of female births
- Is proportion of children surviving/deceased plausible?
  - Compare with other sources on child mortality

A rapid assessment of CEB/CS data: Central African Republic, 1988 census (1)

Age group	Total women	CEB	CS	CS/CEB
15 - 19	131,066	63,993	52,767	0.825
20 - 24	116,171	195,571	163,269	0.835
25 - 29	103,544	290,398	241,083	0.830
30 - 34	78,005	302,869	247,719	0.818
35 - 39	62,179	277,866	220,937	0.795
40 - 44	51,230	239,595	182,832	0.763
45 - 49	47,250	216,587	158,773	0.733

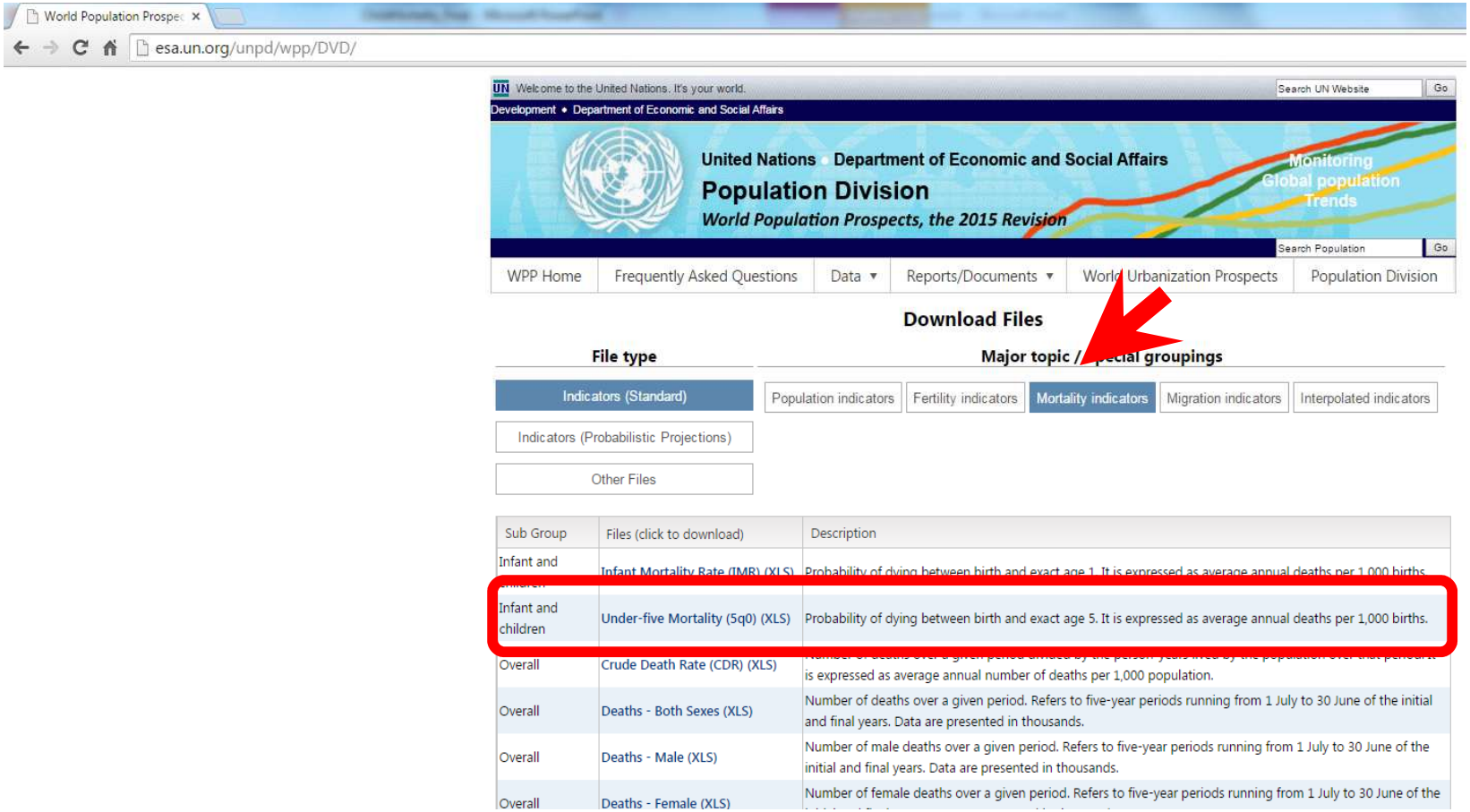
A rapid assessment of CEB/CS data: Central African Republic, 1988 census (2)

- Proportion deceased for the 30-34 age group =(1–0.818)=0.182
  - Proportion of children deceased born to mothers of 30-34 years of age approximates q(5), the proportion of children born who die before their 5th birthday, about 7 years before the data collection

- Compare with other estimates (e.g., UN Population Division)
  - 1988 census 'quick' estimates of q(5) = *182* per 1000 for 1981
  - UN Pop Division=183 per 1000 (for 1980-1985 period)
  - IGME = 183.5 per 1000 (for 1980.5)
  - Possible overestimation of q(5) in census data?

UN Population Division: World Population Prospects

http://esa.un.org/unpd/wpp/DVD/



IGME: Child mortality estimates

http://www.childmortality.org

IGME: Child mortality estimates (www.childmortality.org)

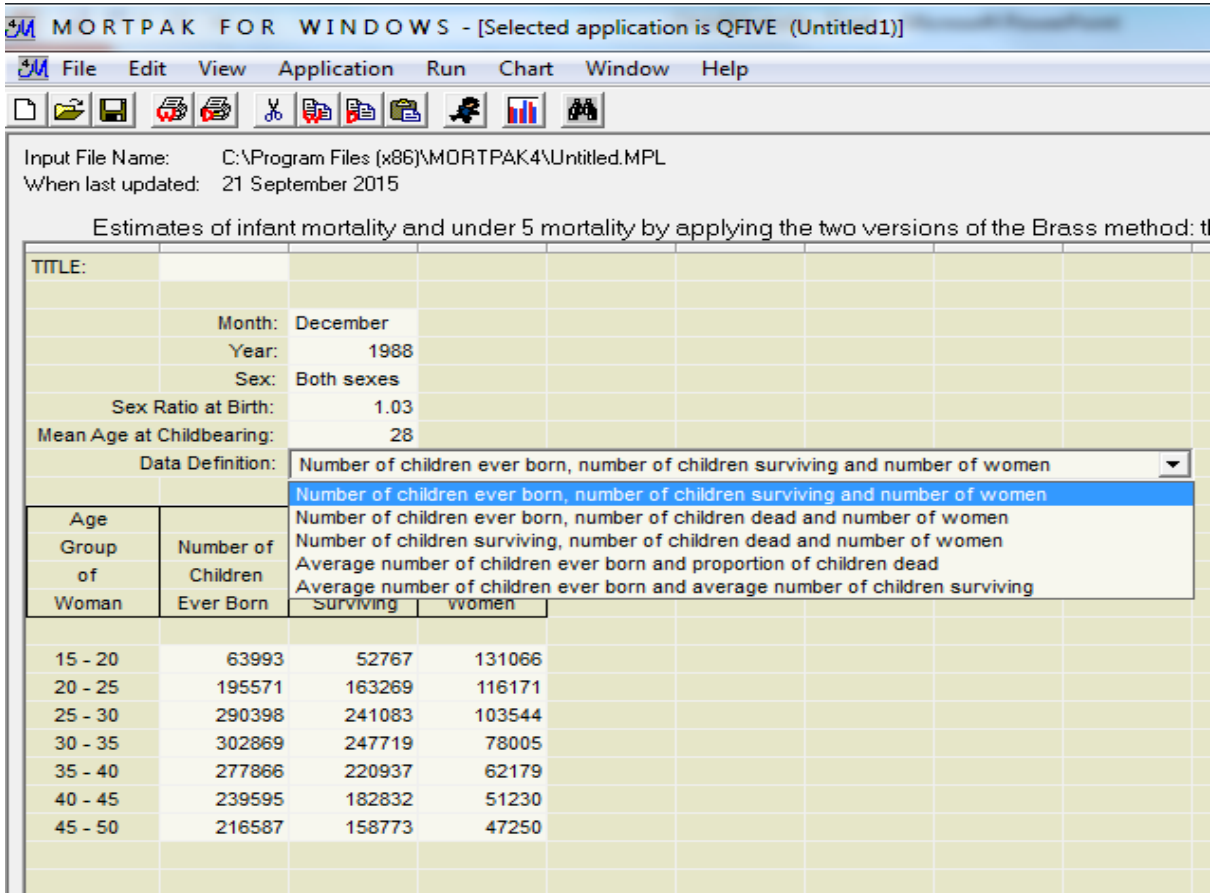
Brass type estimation with MortPak **QFIVE**

- Calculate the sex ratio at birth
  - If not available, can use standard 1.05
- Calculate the mean age of childbearing (only for UN model life tables)

$$M = \frac{17.5 \cdot B_{15-19} + 22.5 \cdot B_{20-24} + \cdots + 47.5 \cdot B_{45-49}}{B_{15-19} + B_{20-24} + \cdots + B_{45-49}}$$

where $B_{x,\ x+n}$ = Births in past year to women age x to $x+n$

Brass-type estimation with QFIVE (input)



1. Enter the requested data (Month, Year, Sex…)
2. Select type of inputs based on data available
3. Click 'Run' or 
4. The results will appear on the far right of the screen (see next slide)

Brass output with QFIVE in MortPak

9 Models:

5 United Nations; 4 Coale-Demeny

Indicators:

- q(0)
- q(1, 4)
- q(5)
- e(0)

MORTPAK FOR WINDOWS - [Selected application is QFIVE (Untit

File Edit View Application Run Chart Window Help

Input File Name: C:\Program Files (x86)\MORTPAK4\Untitled.MPL
When last updated: 21 September 2015

Estimates of infant mortality and under 5 mortality by applying th vers

Data Entry Help
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gman version based

Age Group of Woman	United Nations Models (Palloni-He quations)										Coale-Demeny Model (Trussel ons)					
	L rican		Chilea		South A		F East		General		West		North		East	
	Ref. Date	q(x)	Ref. Date	q(x)	Ref. Date	q(x)	Ref. Date	q(x)	Ref. Date	q(x)	Ref. Date	q(x)	Ref. Date	q(x)	Ref. Date	...
Infant mortality rate (probability of dying between ages 0 and 1): q(1)																
15 - 20	1987.9	0.155	1987.6	0.175	1987.9	0.154	1987.6	0.162	1987.8	0.159	1987.4	0.143	1987.5	0.136	1987.4	0.152
20 - 25	1986.2	0.122	1985.9	0.147	1986.1	0.124	1986.0	0.128	1986.1	0.127	1985.9	0.126	1986.0	0.112	1985.8	0.137
25 - 30	1984.2	0.115	1983.9	0.142	1984.1	0.118	1984.1	0.120	1984.2	0.119	1983.7	0.120	1984.0	0.105	1983.7	0.133
30 - 35	1982.1	0.115	1981.8	0.145	1981.9	0.120	1982.0	0.119	1982.0	0.119	1981.4	0.121	1981.7	0.105	1981.3	0.135
35 - 40	1979.8	0.120	1979.5	0.154	1979.6	0.127	1979.8	0.123	1979.8	0.125	1978.9	0.128	1979.4	0.109	1978.7	0.145
40 - 45	1977.2	0.126	1976.8	0.166	1976.9	0.137	1977.3	0.129	1977.2	0.131	1976.3	0.138	1976.8	0.116	1975.9	0.158
45 - 50	1973.6	0.133	1973.2	0.173	1973.0	0.145	1974.0	0.130	1973.7	0.136	1973.5	0.143	1974.1	0.119	1972.8	0.166
Probability of dying between ages 1 and 5: q(1,4)																
15 - 20	1987.9	0.132	1987.6	0.067	1987.9	0.119	1987.6	0.121	1987.8	0.120	1987.4	0.083	1987.5	0.109	1987.4	0.062
20 - 25	1986.2	0.089	1985.9	0.049	1986.1	0.083	1986.0	0.081	1986.1	0.082	1985.9	0.070	1986.0	0.085	1985.8	0.053
25 - 30	1984.2	0.080	1983.9	0.046	1984.1	0.076	1984.1	0.073	1984.2	0.074	1983.7	0.065	1984.0	0.076	1983.7	0.051
30 - 35	1982.1	0.080	1981.8	0.048	1981.9	0.078	1982.0	0.072	1982.0	0.074	1981.4	0.066	1981.7	0.077	1981.3	0.052
35 - 40	1979.8	0.087	1979.5	0.053	1979.6	0.085	1979.8	0.076	1979.8	0.080	1978.9	0.071	1979.4	0.081	1978.7	0.057
40 - 45	1977.2	0.094	1976.8	0.061	1976.9	0.098	1977.3	0.082	1977.2	0.086	1976.3	0.078	1976.8	0.089	1975.9	0.065
45 - 50	1973.6	0.103	1973.2	0.066	1973.0	0.107	1974.0	0.084	1973.7	0.093	1973.5	0.082	1974.1	0.092	1972.8	0.070
Probability of dying by age 5: q(5)																
15 - 20	1987.9	0.267	1987.6	0.230	1987.9	0.255	1987.6	0.264	1987.8	0.260	1987.4	0.214	1987.5	0.230	1987.4	0.205
20 - 25	1986.2	0.200	1985.9	0.189	1986.1	0.197	1986.0	0.199	1986.1	0.198	1985.9	0.187	1986.0	0.187	1985.8	0.183
25 - 30	1984.2	0.186	1983.9	0.181	1984.1	0.185	1984.1	0.184	1984.2	0.184	1983.7	0.177	1984.0	0.173	1983.7	0.176
30 - 35	1982.1	0.186	1981.8	0.185	1981.9	0.188	1982.0	0.182	1982.0	0.184	1981.4	0.179	1981.7	0.174	1981.3	0.180
35 - 40	1979.8	0.197	1979.5	0.199	1979.6	0.201	1979.8	0.190	1979.8	0.194	1978.9	0.190	1979.4	0.182	1978.7	0.194
40 - 45	1977.2	0.208	1976.8	0.217	1976.9	0.222	1977.3	0.201	1977.2	0.205	1976.3	0.205	1976.8	0.195	1975.9	0.213
45 - 50	1973.6	0.222	1973.2	0.228	1973.0	0.236	1974.0	0.203	1973.7	0.217	1973.5	0.213	1974.1	0.201	1972.8	0.225
Life expectancy at birth: e(0)																
15 - 20	1987.9	41.385	1987.6	43.963	1987.9	46.498	1987.6	33.496	1987.8	39.534	1987.4	46.088	1987.5	44.291	1987.4	49.563
20 - 25	1986.2	48.990	1985.9	49.025	1986.1	52.737	1986.0	40.710	1986.1	46.629	1985.9	49.002	1986.0	48.935	1985.8	51.792
25 - 30	1984.2	50.773	1983.9	49.985	1984.1	54.067	1984.1	42.570	1984.2	48.409	1983.7	50.099	1984.0	50.606	1983.7	52.521
30 - 35	1982.1	50.753	1981.8	49.486	1981.9	53.746	1982.0	42.797	1982.0	48.428	1981.4	49.908	1981.7	50.541	1981.3	52.135
35 - 40	1979.8	49.399	1979.5	47.801	1979.6	52.226	1979.8	41.842	1979.8	47.108	1978.9	48.722	1979.4	49.600	1978.7	50.691
40 - 45	1977.2	48.080	1976.8	45.540	1976.9	50.003	1977.3	40.487	1977.2	45.744	1976.3	47.045	1976.8	48.137	1975.9	48.778

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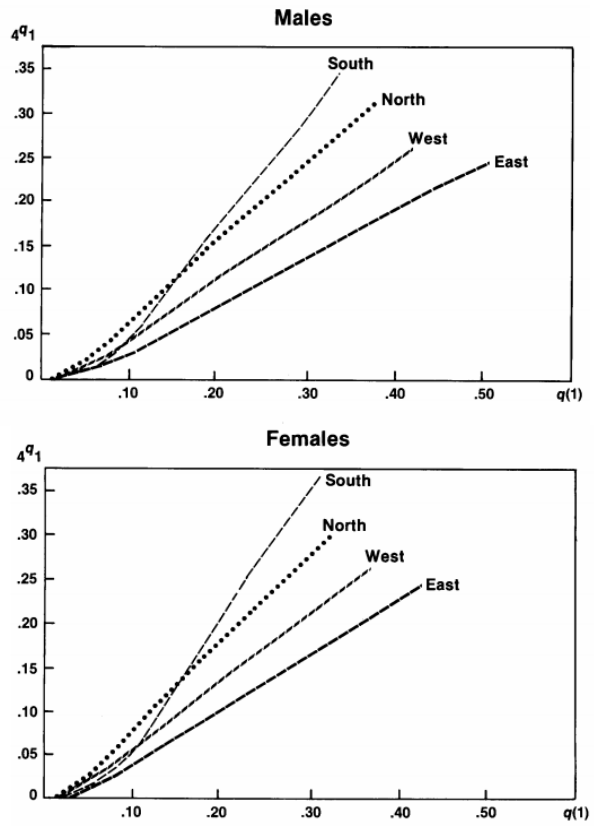
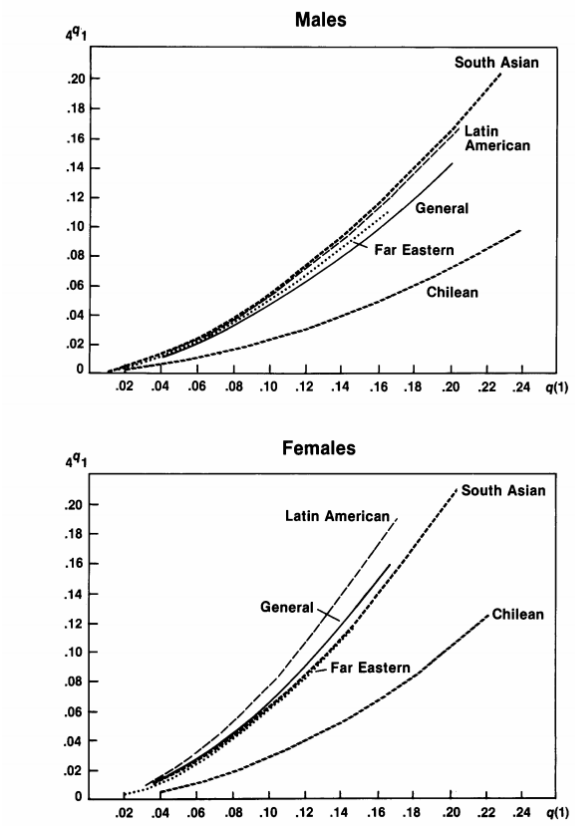
How to identify the right model life table (1)

Relationship between mortality risk during the first year of life and between ages 1-4

Coale-Demeny Models



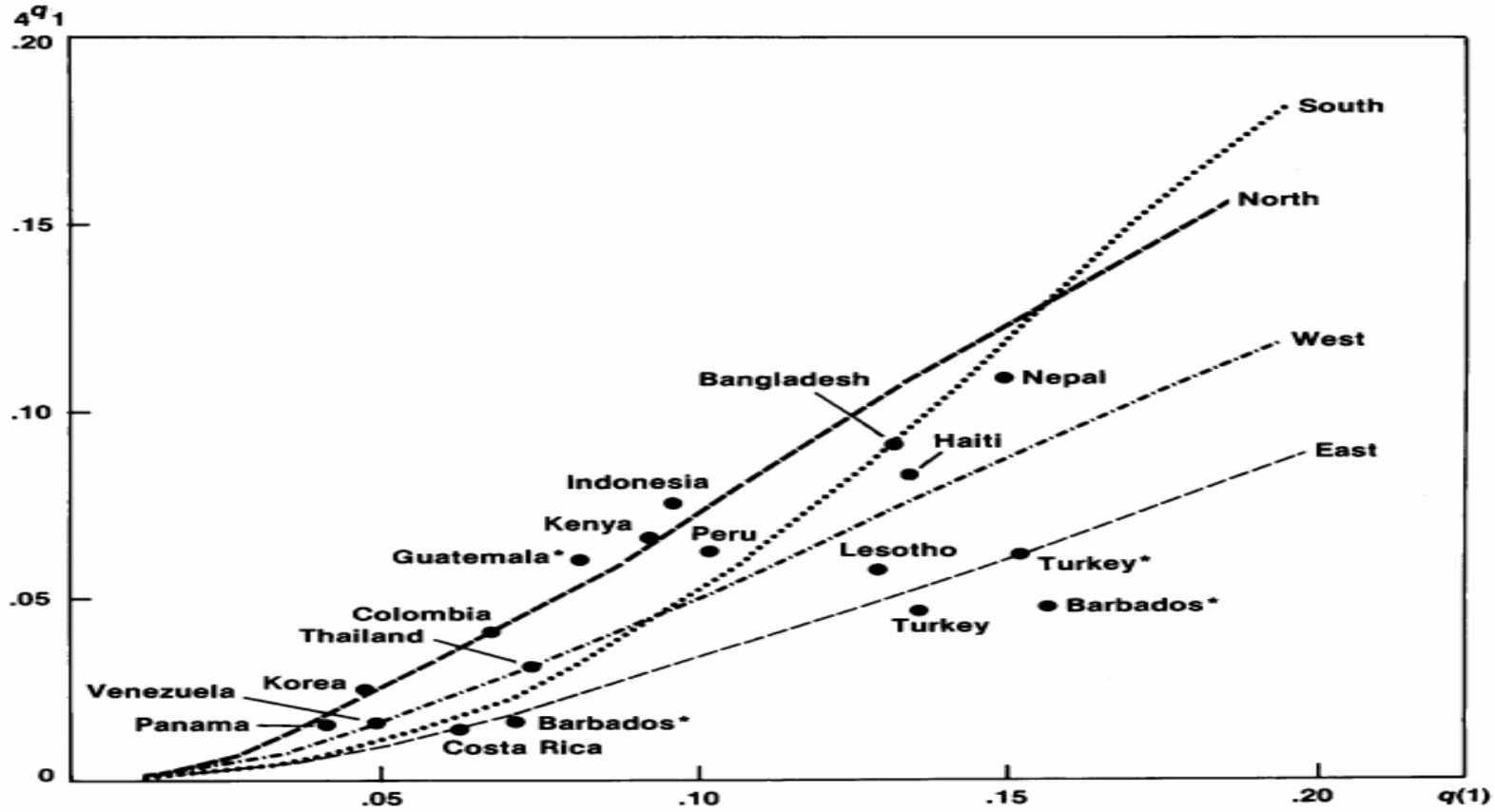
United Nations Models



Source: United Nations (1990)

How to identify the right model life table (2)

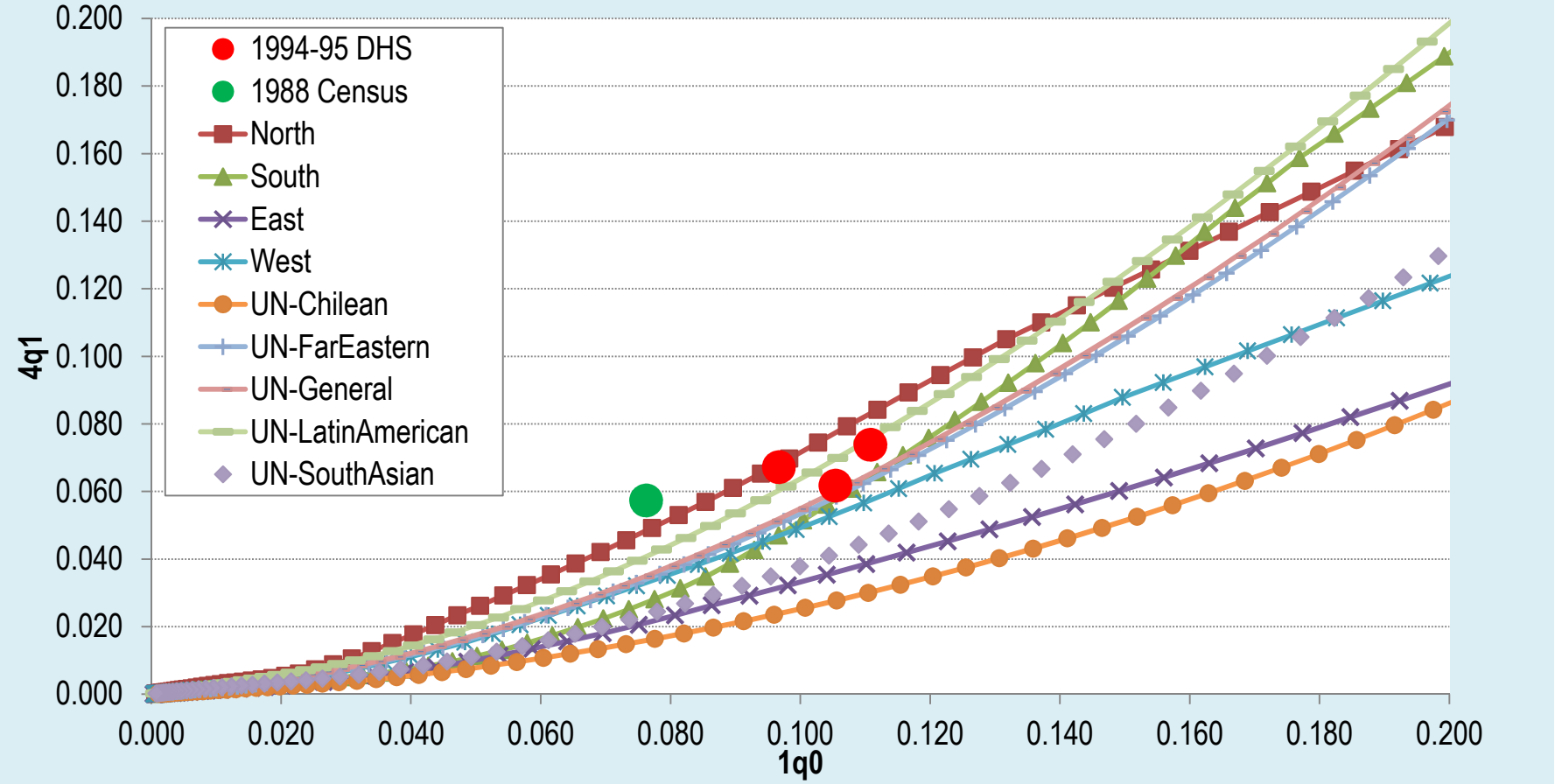
Comparison of q(1) & q(1,4) estimates with Coale-Demeny models



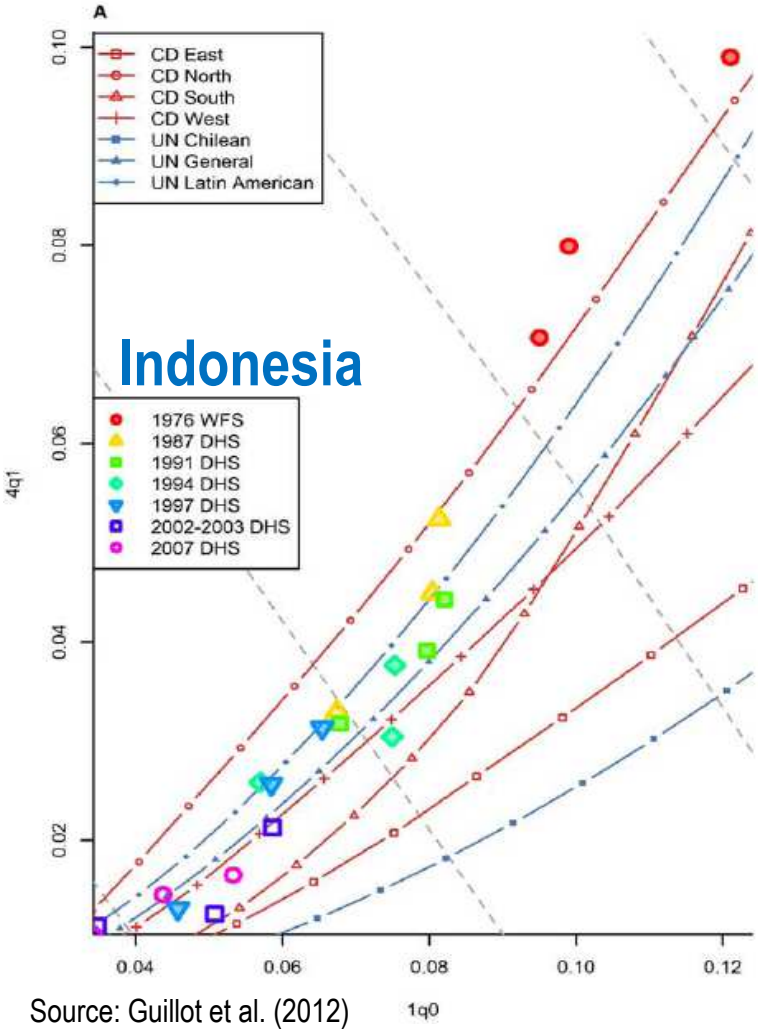
Source: United Nations (1990)

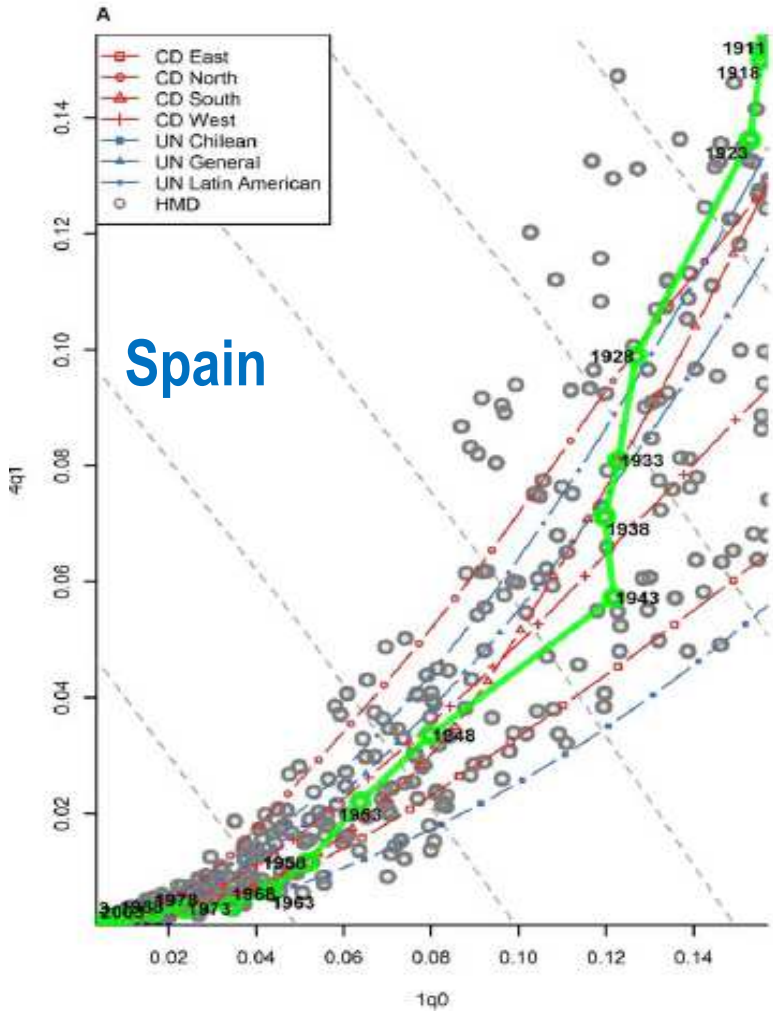
How to identify the right model life table (3)

Direct estimates of q(0) and q(1,4) from Central African Republic 1988 Census and 1994-95 DHS, and the relationships to Coale-Demeny and UN model life tables



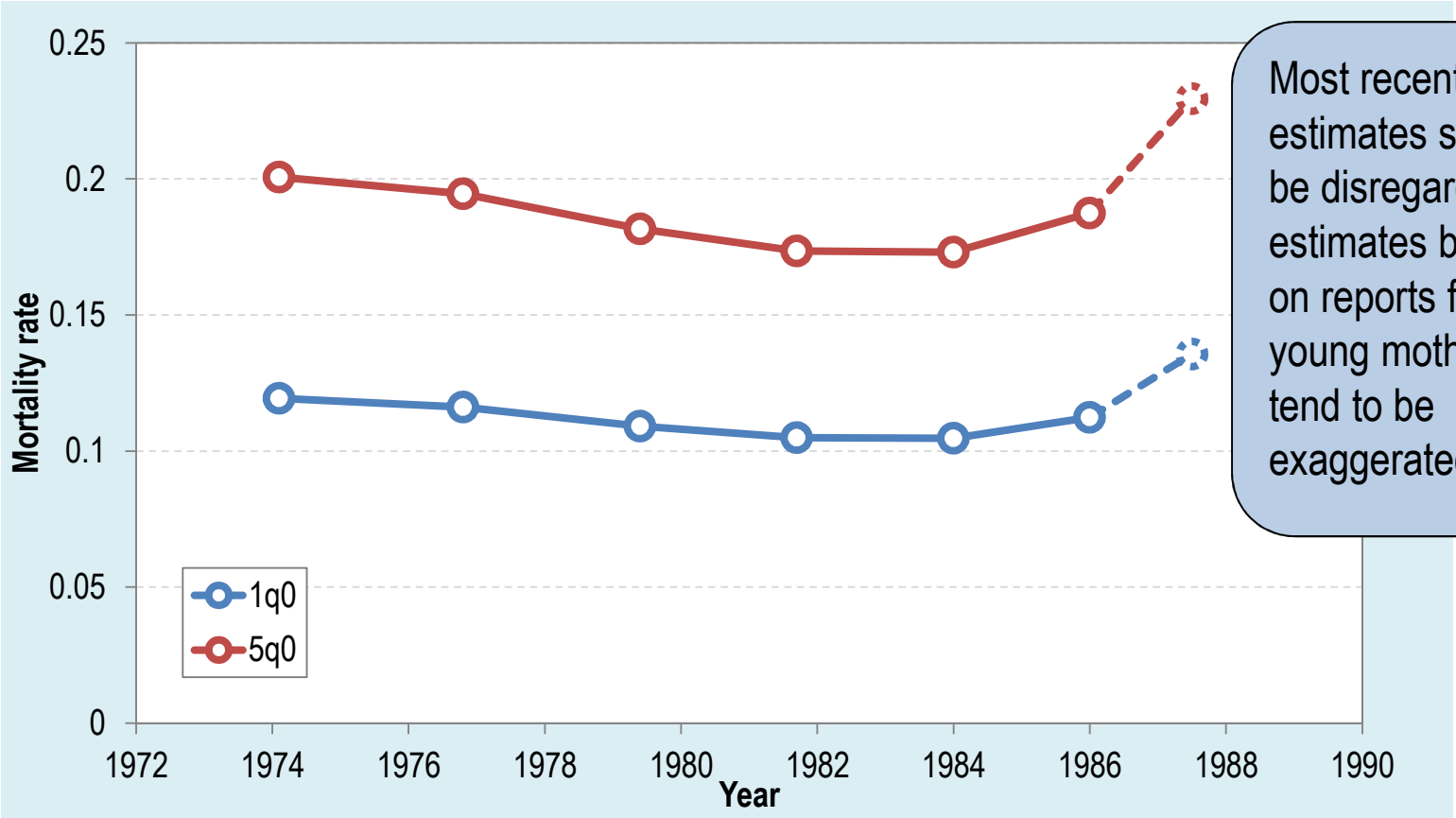
Change of families of Model Life Table through time





Source: Guillot et al. (2012)

Estimated ${}_1q_0$ and ${}_5q_0$ over time (CD Model North)
Central African Republic, 1988 census

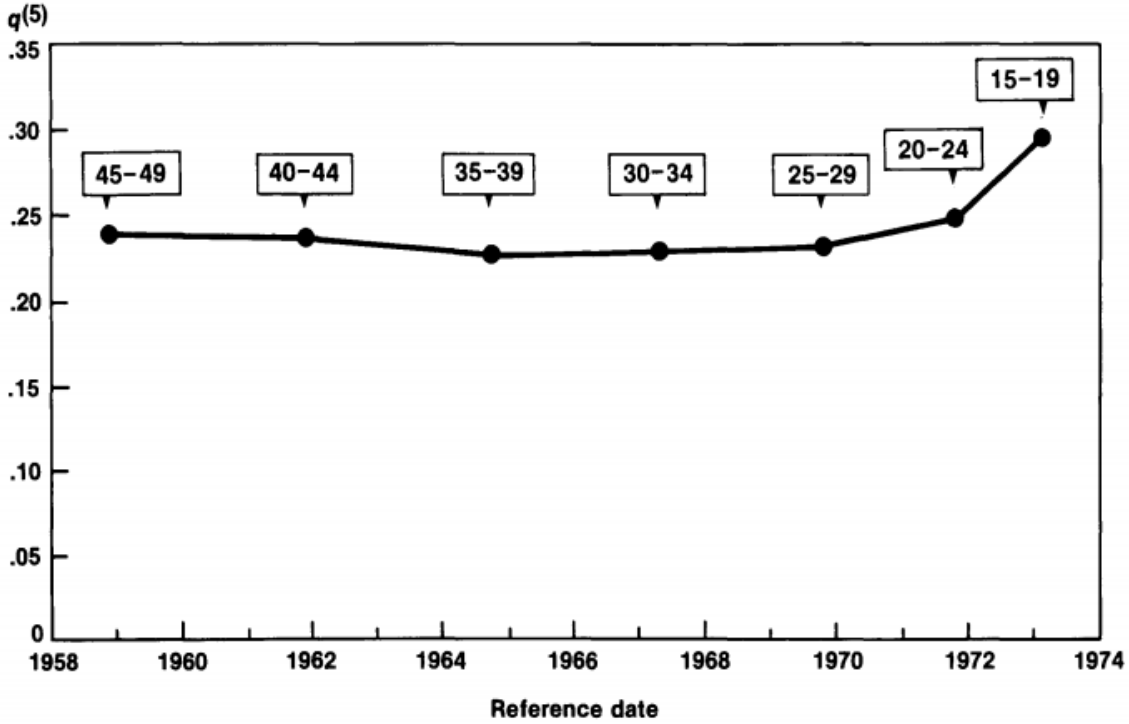


Most recent estimates should be disregarded as estimates based on reports from young mothers tend to be exaggerated

Brass: relationship of mother's age and timing of the under-5 mortality estimates

Bangladesh, 1974 Retrospective Survey of Fertility and Mortality

Figure 7. Under-five mortality, $q(5)$, for both sexes in Bangladesh, estimated using model South and the Trussell version of the Brass method



Source: United Nations (1990)

Brass: Assumptions, violations (1)

1. In any time period, mortality of children does not vary by five-year grouping of mothers
   - This assumption is usually violated for the mother age group 15 -19, and to a lesser extent for the age group 20-24, because children of young mothers are known to have higher risk of mortality
   - Why?
     - First births have higher mortality risk than higher-order births and children of younger mothers are more likely to be first births
     - Youngest mothers tend to be socio-economically disadvantaged

Source: Moultrie et al. (2013)

Brass: Assumptions, violations (2)

2. No correlation exists between mortality risks of children and survival of mothers in the population
   - This is a problem when certain mothers are not captured in the data (because of mortality or migration) whose children might also have higher mortality risk
   - Most common case is countries with high HIV prevalence – results in downward bias in estimates
     - Younger mother age groups (20-24, 25-29) less likely to be biased
     - Upward adjustment of 3 points per 1000 for every 10 percentage points of HIV prevalence (Hill 2013, based on Ward and Zaba 2008)

Source: Moultrie et al. (2013)

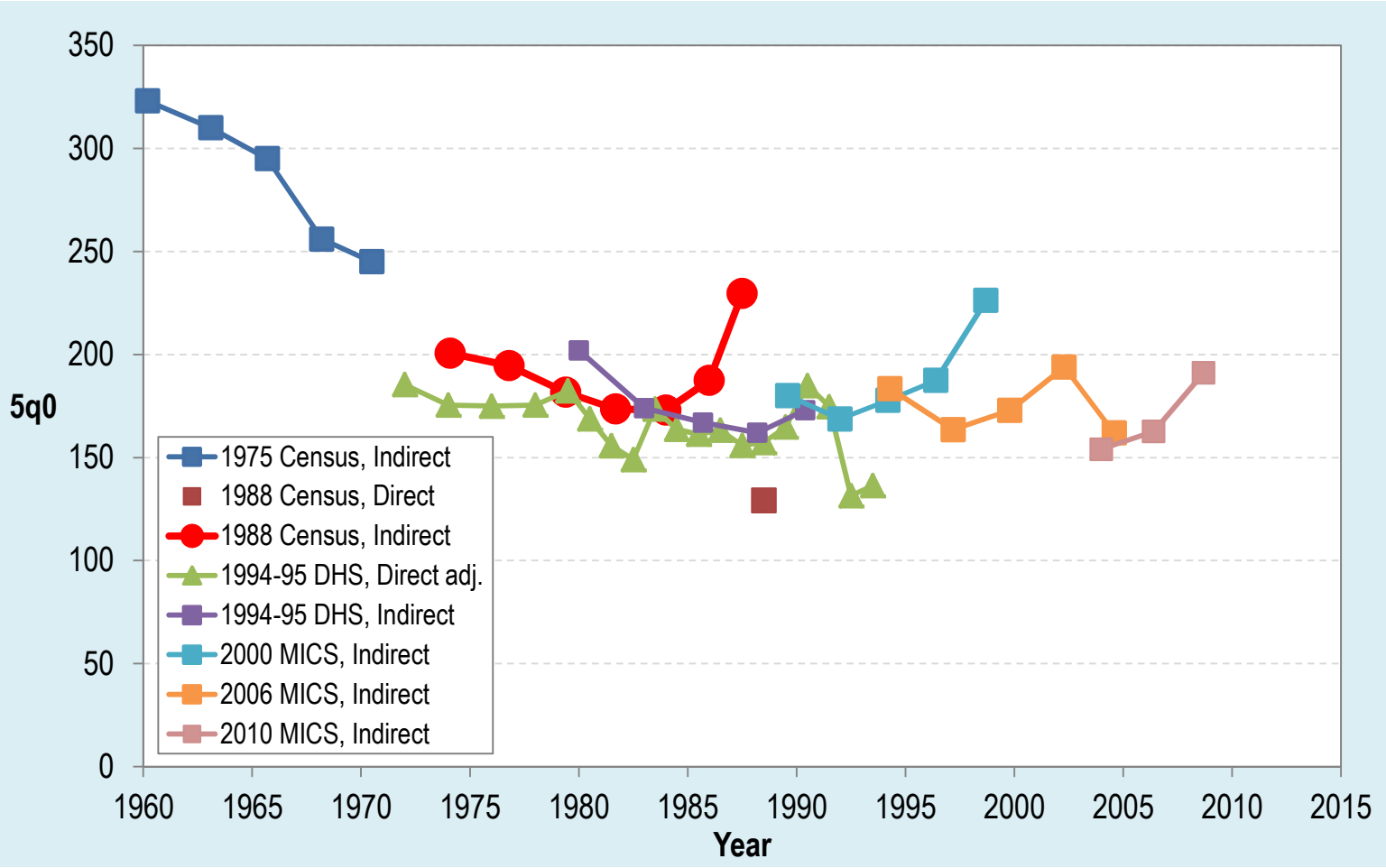
Brass: Assumptions, violations (3)

3. Population age patterns of fertility and child mortality are adequately represented by the model patterns used in developing the method
4. Any changes in child mortality in the recent past have been gradual and unidirectional
5. Cross-sectional average numbers of children ever born by age adequately reflect cohort patterns of childbearing

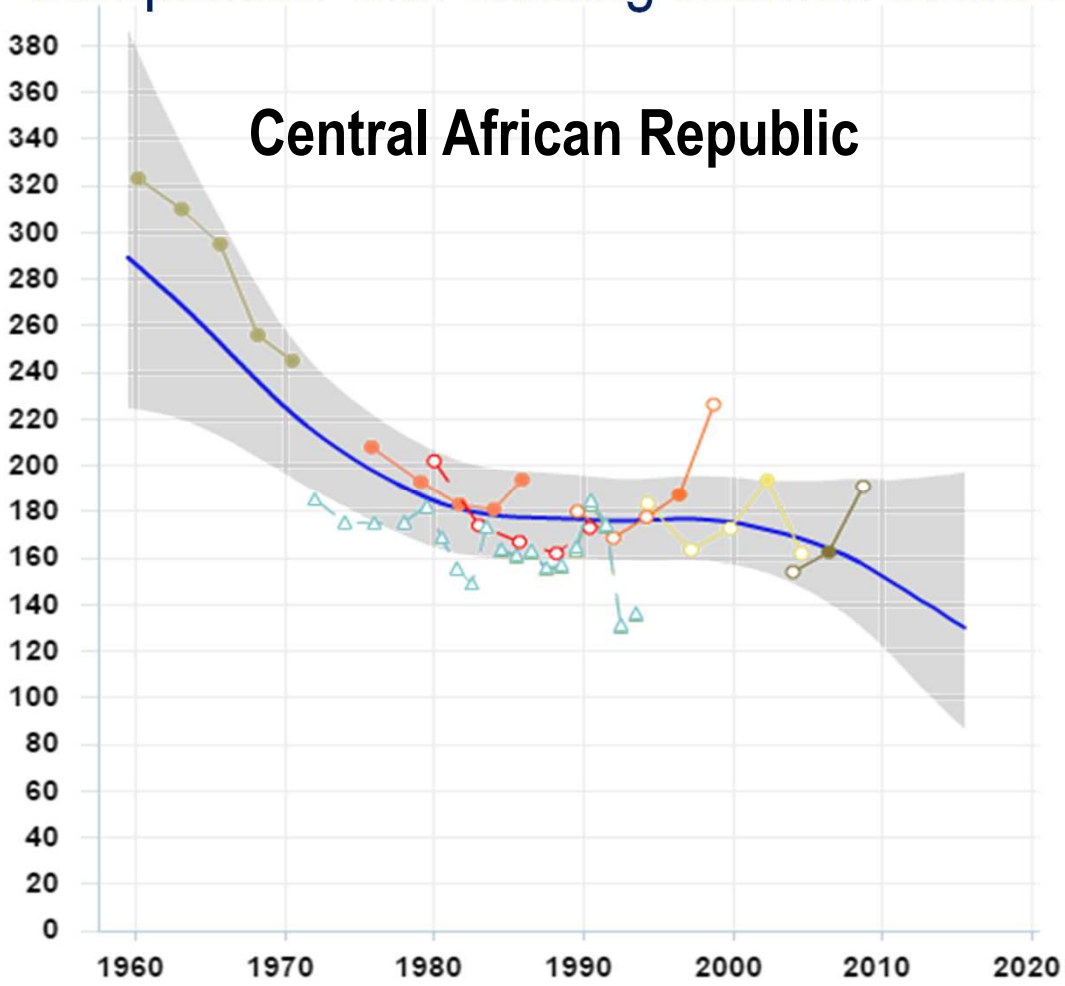
- Note that when fertility has been changing (falling) rapidly, the Brass method will tend to over-estimate child mortality
- Variants of the technique grouping mothers by duration of marriage or time since first birth have been developed to address some of these issues

Source: Moultrie et al. (2013)

Quality of estimates: Checking multiple sources



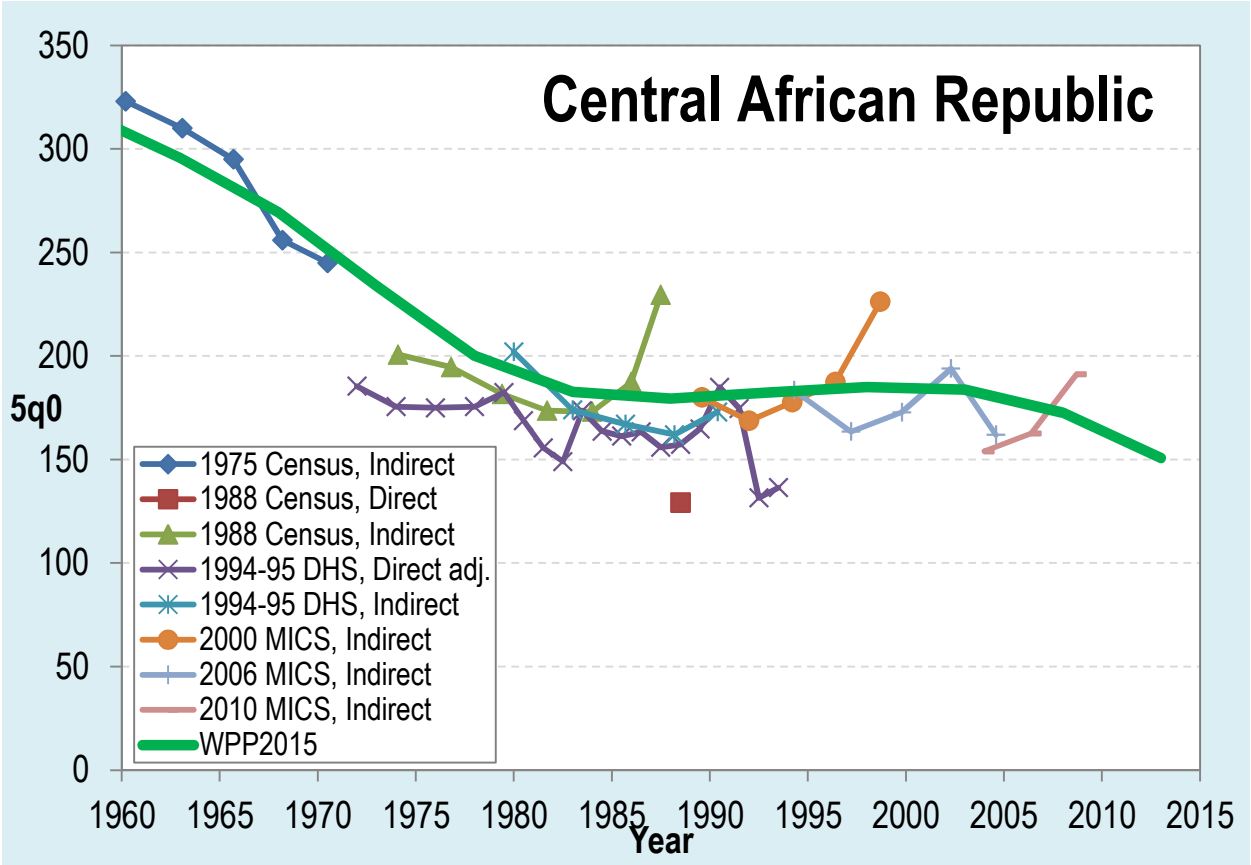
Quality of estimates:
Comparison with existing external sources



IGME estimates

Source: www.childmortality.org

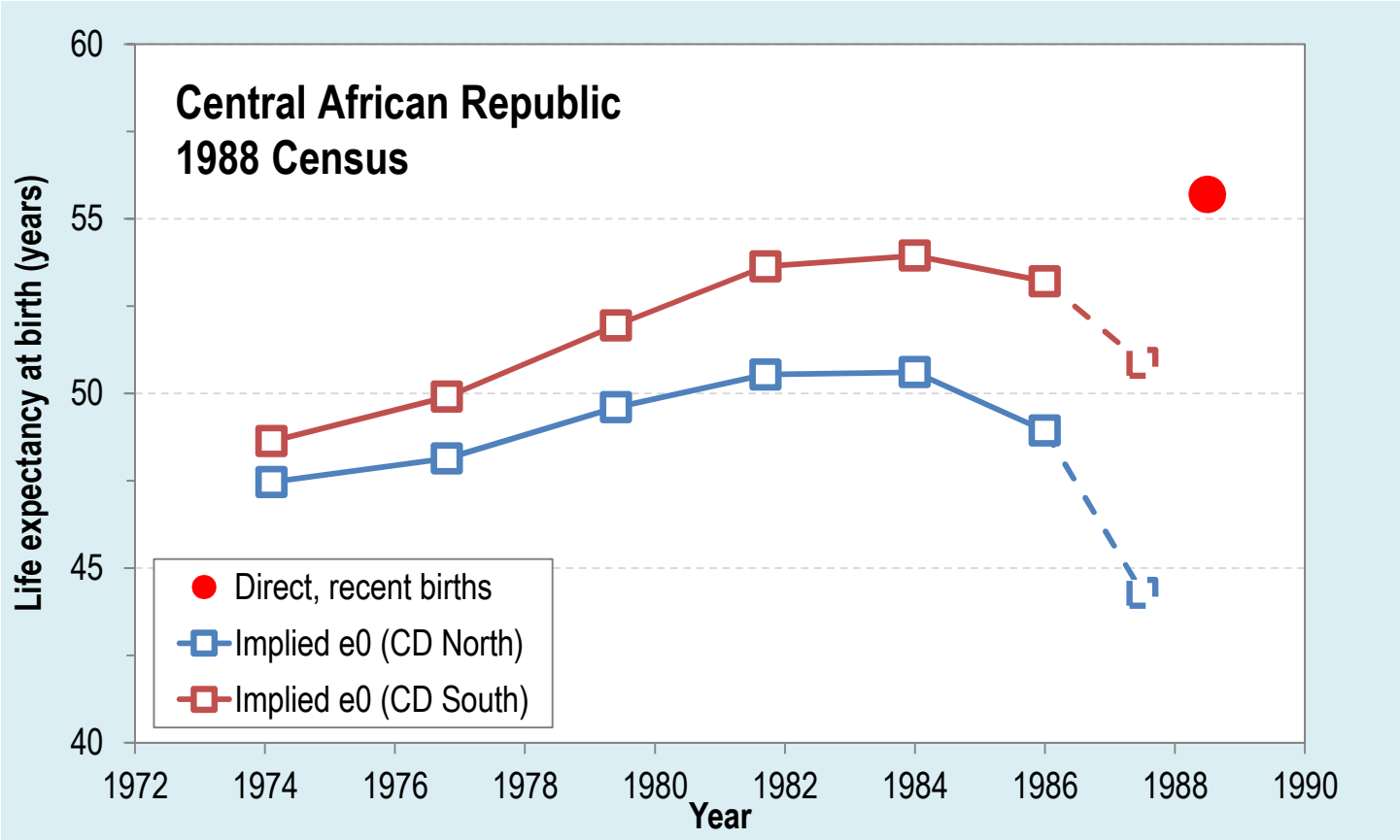
Quality of estimates:
Comparison with existing external sources



UN Population Division (World Population Prospects)

Source: http://esa.un.org/unpd/wpp/DVD/

Quality of estimates:
Implied life expectancy at birth using Model Life Tables



CORMOR in MortPak

CORMOR >> "Corresponding Mortality Indicators"

- Give corresponding probabilities of dying for various pre-selected age groups in the 9 model life table families

MORTPAK FOR WINDOWS - [Selected application is CORMOR (Untitled1)]

File Edit View Application Run Chart Window Help

Input File Name: C:\Program Files (x86)\MORTPAK4\Untitled.MPL
When last updated: 22 September 2015

Calculation of corresponding mortality indicies.

TITLE: Central African Republic

Sex: Males

The desired model life table
has a value of: 0.184
for column: q(x,n)
at ages (x,n): 0 5

Variable	Probability of Dying From Age X to X+N (i.e. nQx)								
	United Nations Models (Palloni-Heligman Equations)					Coale-Demeny Model (Trussell Equations)			
	Latin Am.	Chilean	So. Asian	Far East	General	West	North	East	South
1q0	0.12100	0.14786	0.11975	0.12377	0.12590	0.12888	0.11401	0.14157	0.12181
4q1	0.07168	0.04241	0.07299	0.06873	0.06647	0.06327	0.07899	0.04943	0.07082
5q0	0.18400	0.18400	0.18400	0.18400	0.18400	0.18400	0.18400	0.18400	0.18400
20q15	0.09700	0.10995	0.04553	0.16600	0.10865	0.11180	0.12055	0.08222	0.07708
35q15	0.22230	0.26957	0.13476	0.38470	0.25727	0.24982	0.24627	0.19196	0.17297
45q15	0.35832	0.43231	0.27584	0.59237	0.42104	0.39925	0.37483	0.33374	0.29421
40q30	0.53211	0.62640	0.50468	0.79353	0.62241	0.58545	0.53158	0.53421	0.47746
20q60	0.70176	0.77042	0.72299	0.89616	0.78570	0.76848	0.72237	0.76095	0.73022

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Thank you

Questions?

>> until 9 October:

>> After 9 October: pelletierf@un.org
spoorenberg@un.org