Evaluation of Child Mortality Data from Population Censuses

United Nations Statistics Division

Outline

1. **Life tables**
   a) Constructing empirical life tables
   b) Model life tables
2. **Survival of children ever born** (Brass type estimates)
   a) Information required
   b) Checking data quality
   c) Data evaluation using MortPak
   d) Assumptions, violations, and assessing quality of estimates

Life tables

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 whole life under 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.

Calculating the period life table

nMx = age-specific period-mortality rate

$$\frac{\text{\# deaths among those aged } x \text{ to } x+n}{\text{mid-period population aged } x \text{ to } x+n}$$

nqx = probability of dying within next n years for those who reach age x

lx = number of people from the original cohort who live to their x^{th} birthday

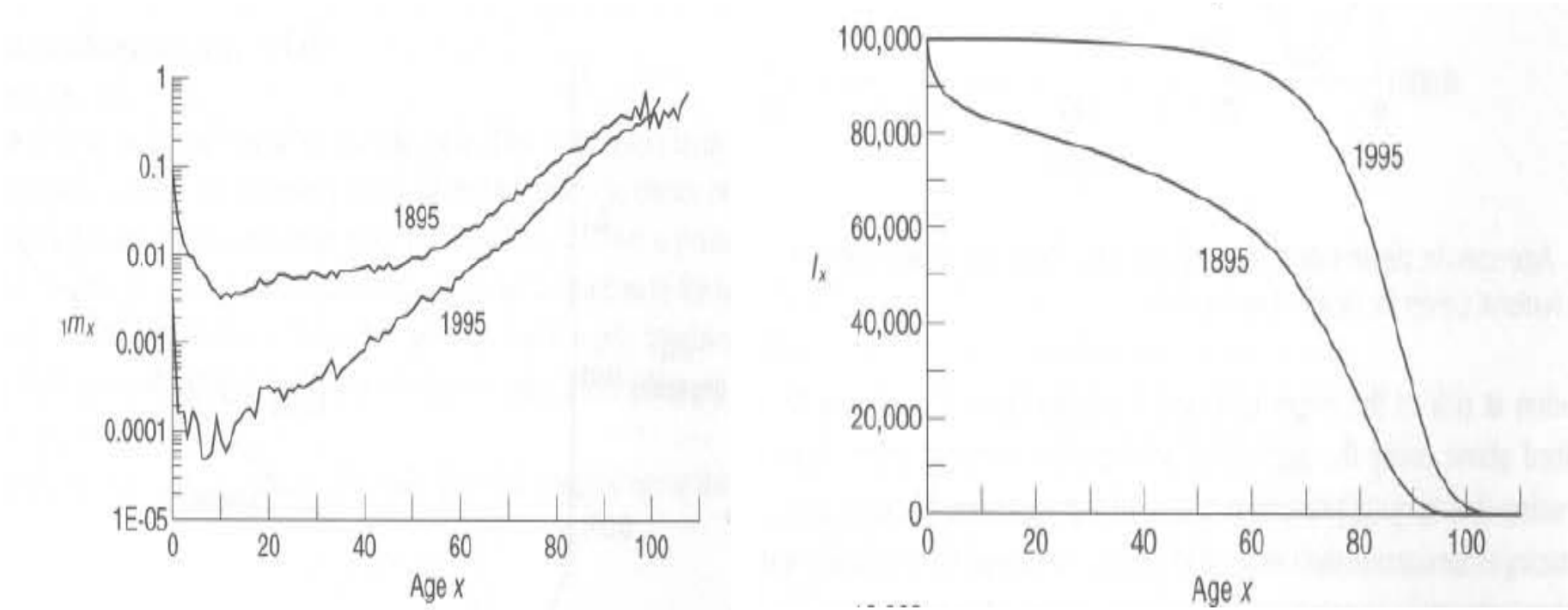
*Survivors at age x+n = survivors at age x * (1 – nqx)*

nLx = number of person-years = lived between exact ages x and x+n

ex = life expectancy at age x = (the average number of years that people have left to live when they are at age x)

Sum of all nLx from age x to maximum age ÷ lx

Data checks: does the life table make sense?



Source: Swedish females, 1895 vs 1995, *Demography,* Preston et. al. 2001

Example - using MortPak LIFTB

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

File Edit View Application Run Chart Window Help

Input File Name: C:\Program Files\MORTPAK4\Untitled.MPL
When last updated: 25 November 2013

Construction of a life table.

TITLE: TIMOR-LESTE, 2004 Census

Sex: Males
Data Type: m(x,n)
(Output) open age group: 80+

Age Group	m(x,n)
0 - 1	0.10718
1 - 5	0.00739
5 - 10	0.00200
10 - 15	0.00131
15 - 20	0.00229
20 - 25	0.00332
25 - 30	0.00336
30 - 35	0.00372
35 - 40	0.00460
40 - 45	0.00618
45 - 50	0.00886
50 - 55	0.01327
55 - 60	0.01975
60 - 65	0.02934
65 - 70	0.04478
70 - 75	0.07049
75 - 80	0.11130
80 - 85	0.19869
85 - 90	
90 - 95	
95 -100	

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	0.10718	0.10000	100000.	10000.	93300.	0.89278	5727820.	57.278	0.330
1	0.00739	0.02899	90000.	2609.	353090.	0.97399	5634520.	62.606	1.352
5	0.00200	0.00995	87391.	870.	434780.	0.99175	5281430.	60.435	2.500
10	0.00131	0.00653	86521.	565.	431194.	0.99148	4846650.	56.017	2.500
15	0.00229	0.01139	85956.	979.	427519.	0.98590	4415456.	51.369	2.689
20	0.00332	0.01647	84977.	1399.	421490.	0.98325	3987937.	46.929	2.573
25	0.00336	0.01666	83578.	1392.	414432.	0.98262	3566447.	42.672	2.517
30	0.00372	0.01843	82185.	1515.	407228.	0.97965	3152015.	38.352	2.558
35	0.00460	0.02275	80671.	1835.	398942.	0.97376	2744787.	34.025	2.596
40	0.00618	0.03045	78835.	2401.	388472.	0.96364	2345845.	29.756	2.624
45	0.00886	0.04339	76435.	3317.	374349.	0.94694	1957373.	25.608	2.641
50	0.01327	0.06433	73118.	4704.	354485.	0.92173	1583025.	21.650	2.639
55	0.01975	0.09432	68414.	6453.	326738.	0.88603	1228539.	17.957	2.624
60	0.02934	0.13708	61961.	8494.	289499.	0.83347	901801.	14.554	2.609
65	0.04478	0.20208	53467.	10805.	241288.	0.75353	612302.	11.452	2.589
70	0.07049	0.30042	42662.	12816.	181818.	0.64120	371014.	8.697	2.543
75	0.11130	0.43476	29846.	12976.	116582.	0.38380	189196.	6.339	2.484
80	0.23233	...	16870.	16870.	72613.	...	72613.	4.304	4.304

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(75+,5) = T(80) / T(75)

Data Source: NSD & UNFPA (2008), Mortality Monograph according to the 2004 census

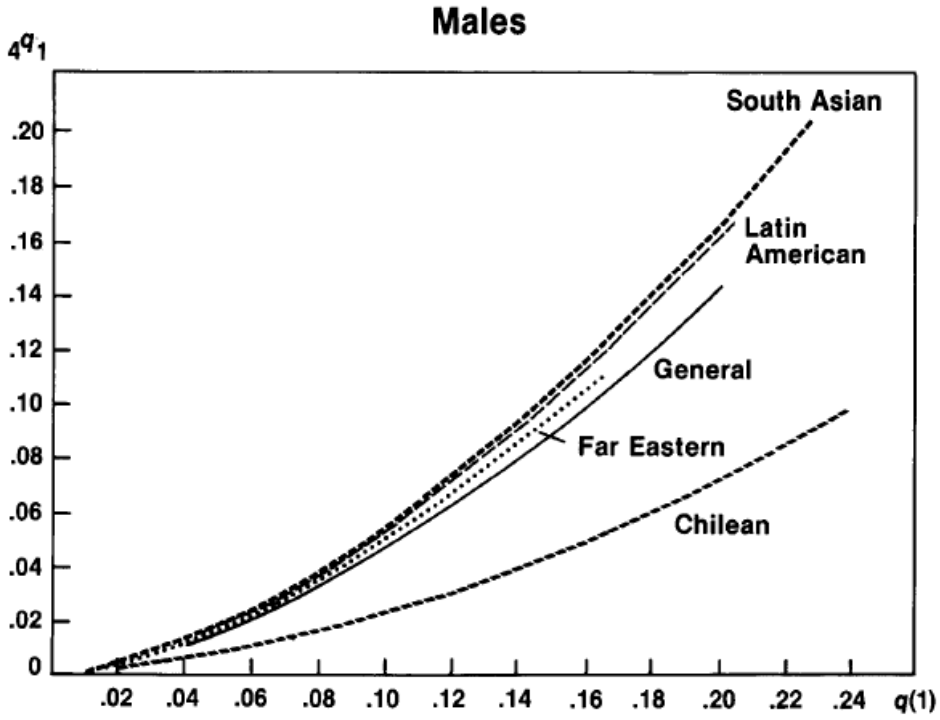
Model life tables

- 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 (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)

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

Figure 4. Relationship between infant mortality, $q(1)$, and child mortality, ${}_4q_1$, in the United Nations mortality models



Source: *Step by step guide to the estimation of child mortality*, 1990, United Nations

Model life tables (3)

2. Level of mortality – each model has several different levels that correspond with a different life expectancies at birth (e0)

United Nations Model Life Tables — Males

Latin American Pattern

AGE	M(X)	Q(X)	l(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)	l(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: *Model Life tables for Developing Countries*, 1982, United Nations

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 (next session): age pattern of mortality
  b) Deaths of younger persons vs. deaths of adults
     - Younger persons: survival of children ever born
     - Adults: household deaths (next session)
- 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 borne in her lifetime.

b) the total number of male children she has borne 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)
50-54	8	q(25)
55-59	9	q(30)

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 contexts where inappropriate to ask unmarried women about childbearing

BANGLADESH CENSUS 1974 RETROSPECTIVE SURVEY OF FERTILITY AND MORTALITY

AGE GROUP OF WOMEN	TOTAL WOMEN	TOTAL BIRTHS	CHILDREN AT HOME	CHILDREN AWAY	CHILDREN DEAD
TOTAL					
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 – unmarried were not included

Source: United Nations (1990), *Step by step guide to the estimation of child mortality*

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, reporting of CS is more likely to be complete than 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		
25-29	88.2	75.6	87.6	75.4	88.0	64		
30-34	90.9	81.2	91.2	82.0	92.2	78		
35-39	91.9	83.2	92.6	84.5	93.5	82		
40-44	91.4	83.3	92.5	84.7	93.3	83.6		
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: *Estimation of mortality using the South African Census 2001 data*, Dorrington, Moultrie and Timæus, Centre of Actuarial Research, University of Cape Town, 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: Tabulated using data fro*Demographic Yearbook*

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 & 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: Timor-Leste, 2004 census (1)

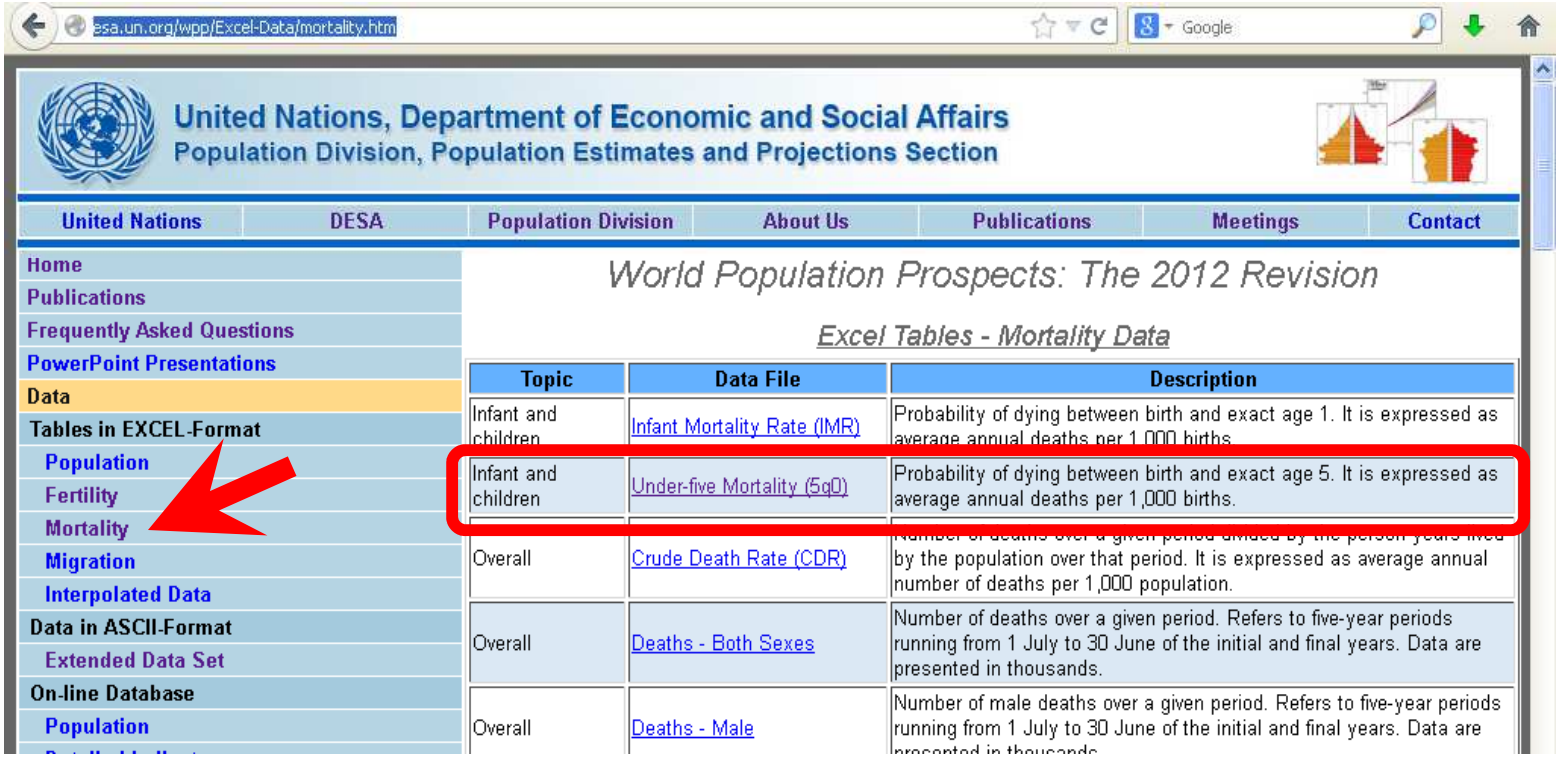
Age group	Total women	CEB	CS	CS/CEB
15 - 19	46,768	5,290	4,504	0.851
20 - 24	37,782	39,624	35,565	0.898
25 - 29	28,609	73,323	64,595	0.881
30 - 34	30,057	115,856	99,662	0.860
35 - 39	23,811	116,718	96,678	0.828
40 - 44	23,366	126,257	98,795	0.782
45 - 49	17,357	91,961	67,192	0.731

A rapid assessment of CEB/CS data: Timor-Leste 2004 census (2)

- Proportion deceased for the 30-34 age group = (1–0.860)=0.140
  - 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 data collection
- Compare with other estimates, e.g., UN Population Division estimates of under-5 mortality
  - 2004 census 'quick' estimates of under-5 child mortality= *140* per 1000 for 1997
  - UN Pop Division=120 per 1000 (for 1995-2000 period)
  - IGME = 123.6 per 1000 (for 1997.5)
  - Possible overestimation of q(5) in census data?

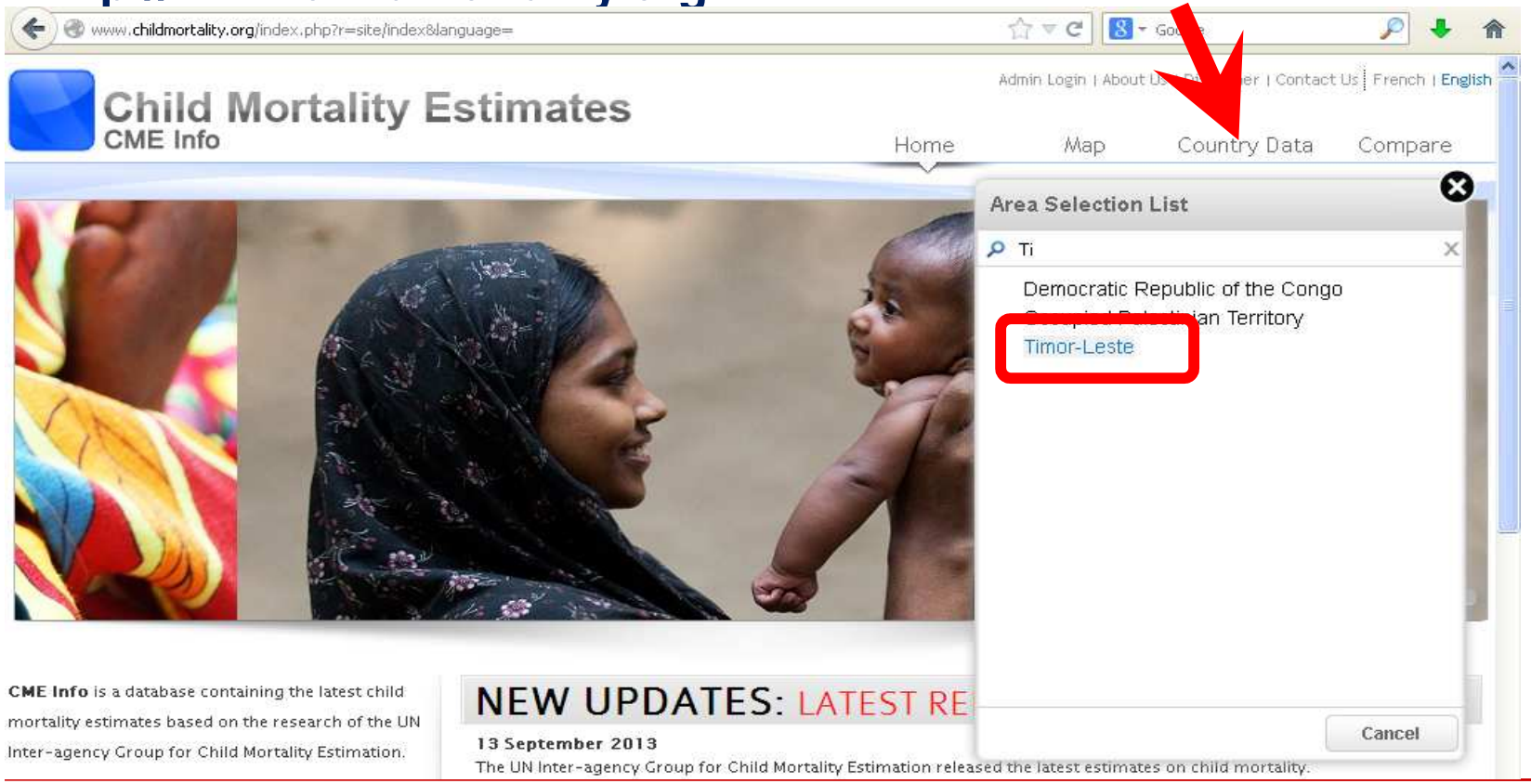
UN Population Division: World Population Prospects

http://esa.un.org/wpp/Excel-Data/mortality.htm

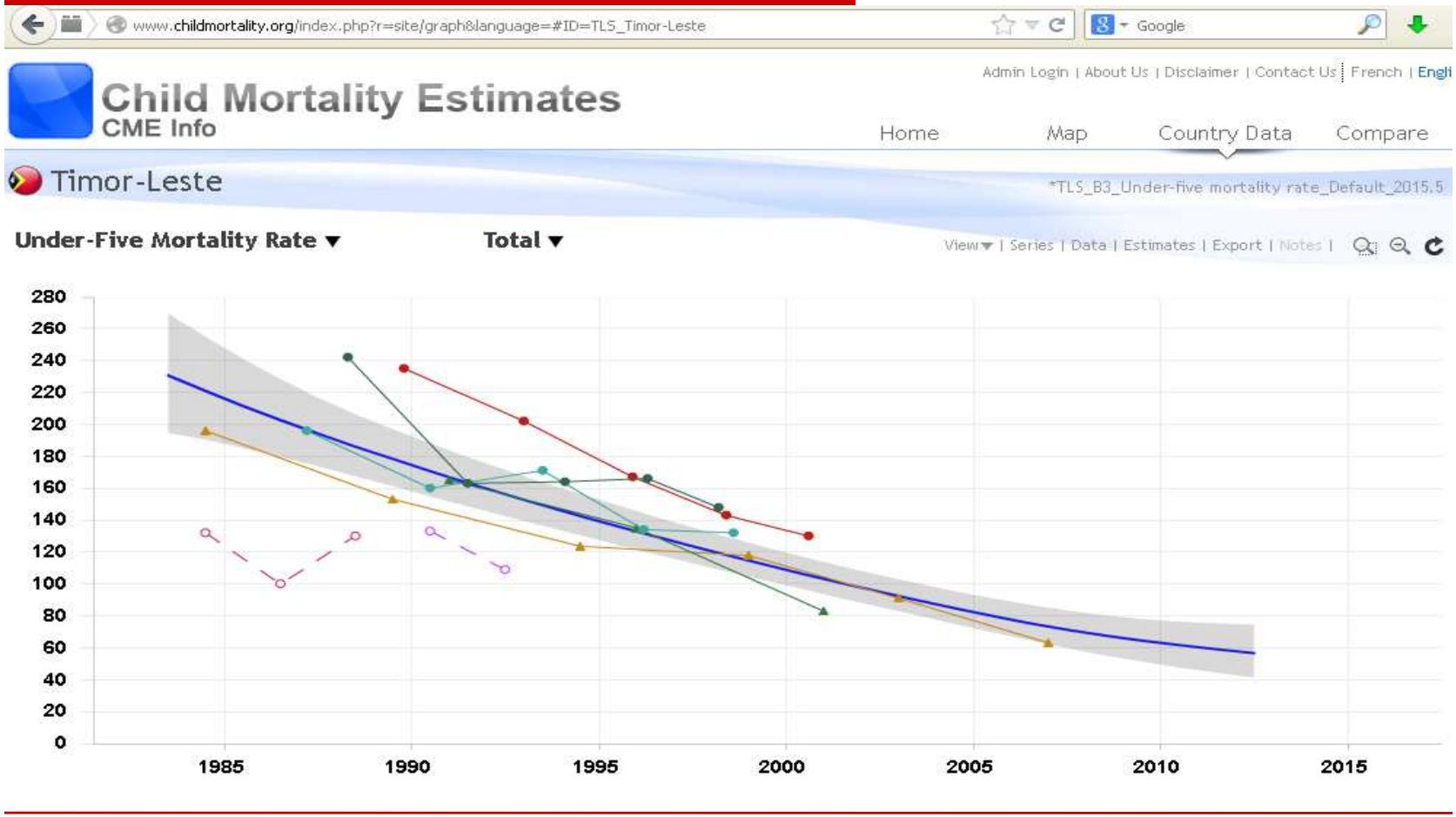


IGME: Child mortality estimates

http://www.childmortality.org



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



Brass type estimation with MortPak QFIVE

Calculate the sex ratio at birth

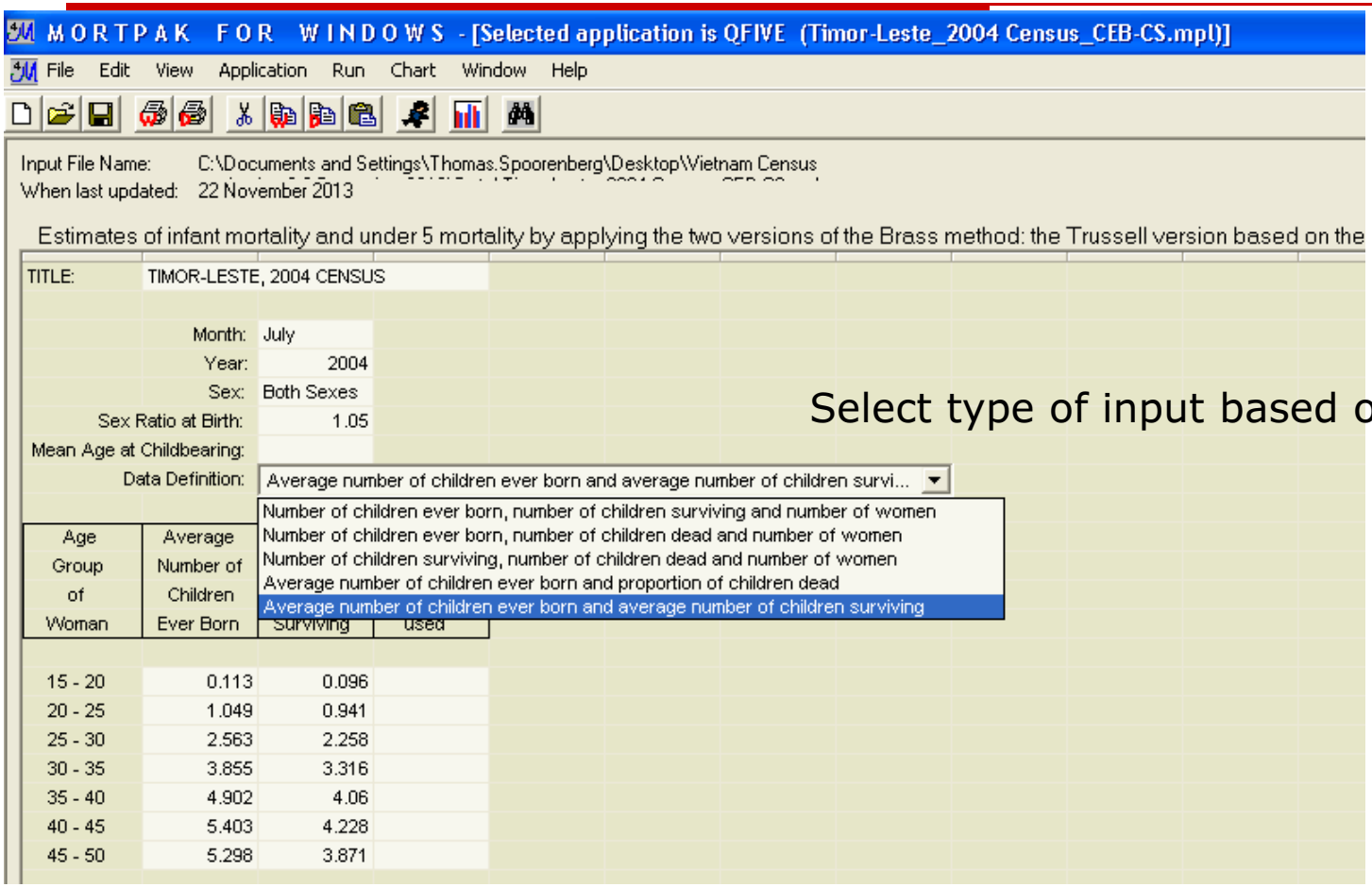
If not available, can use standard 1.05

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

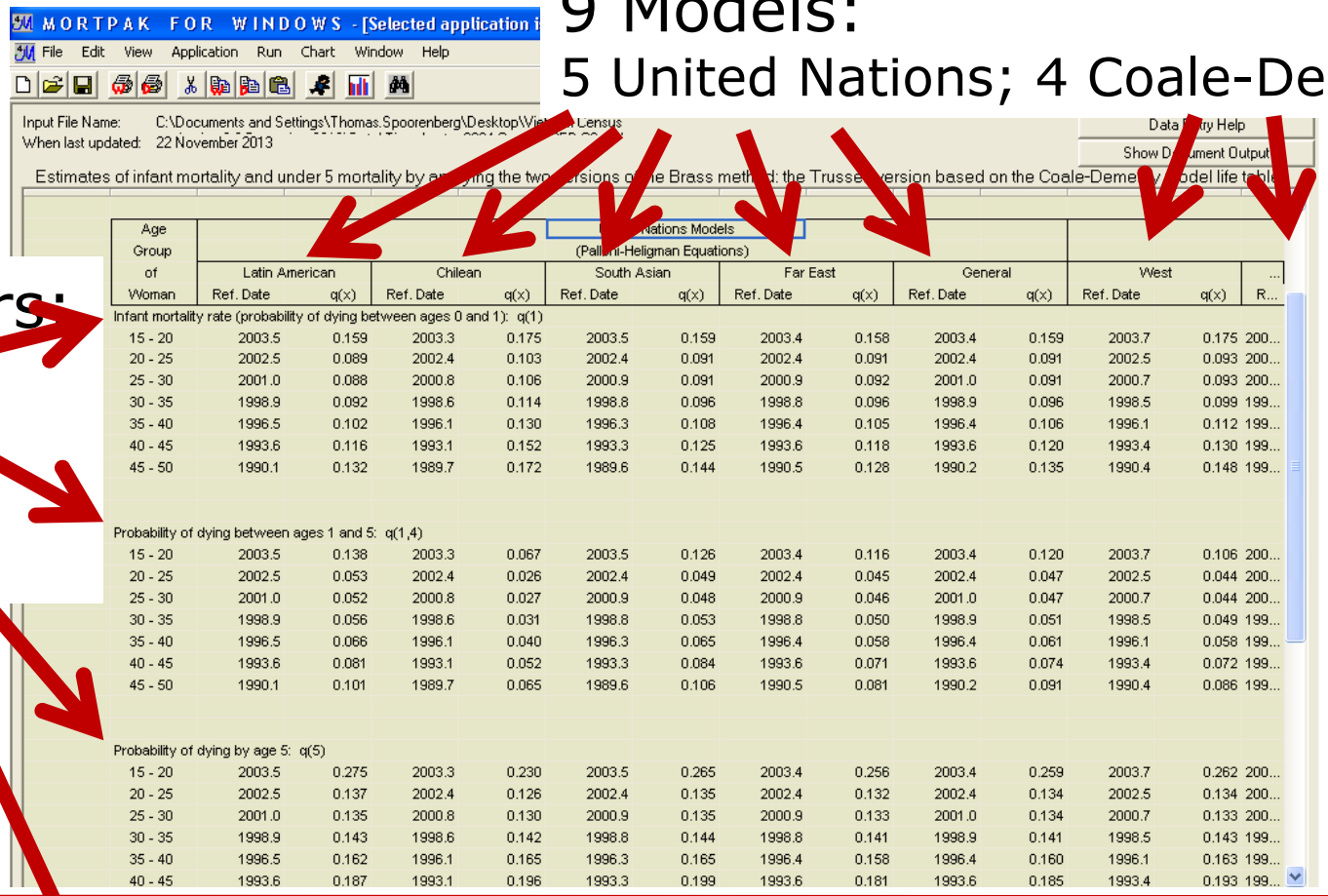


Select type of input based on data available

Brass output with QFIVE

9 Models:

5 United Nations; 4 Coale-Demeny



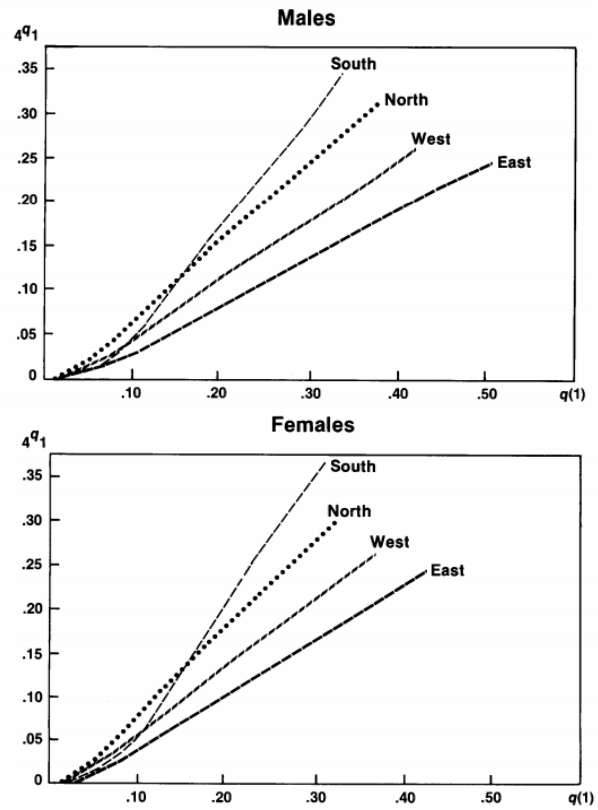
Indicators:

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

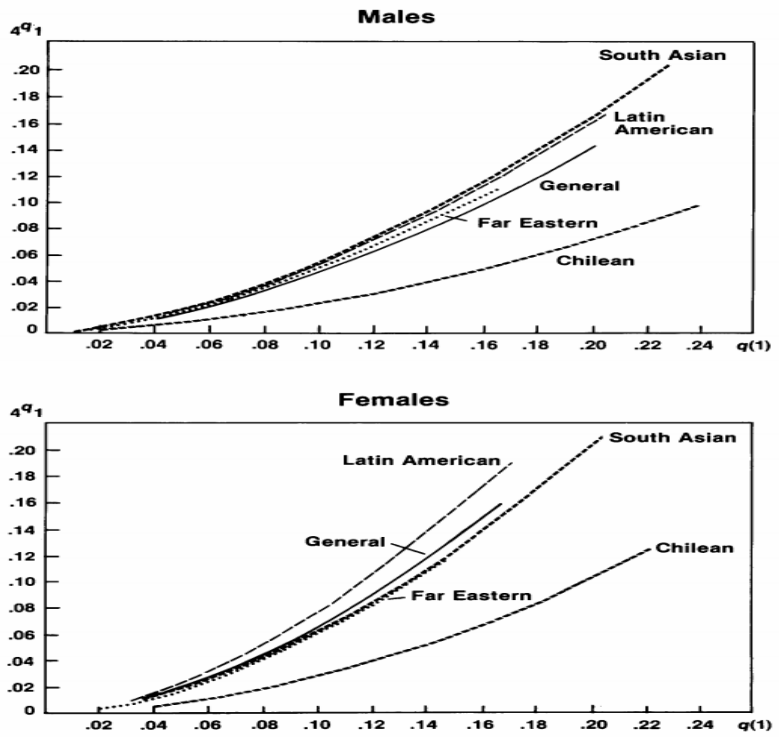
How to identify the right model life table (1)

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

Coale-Demeny Models



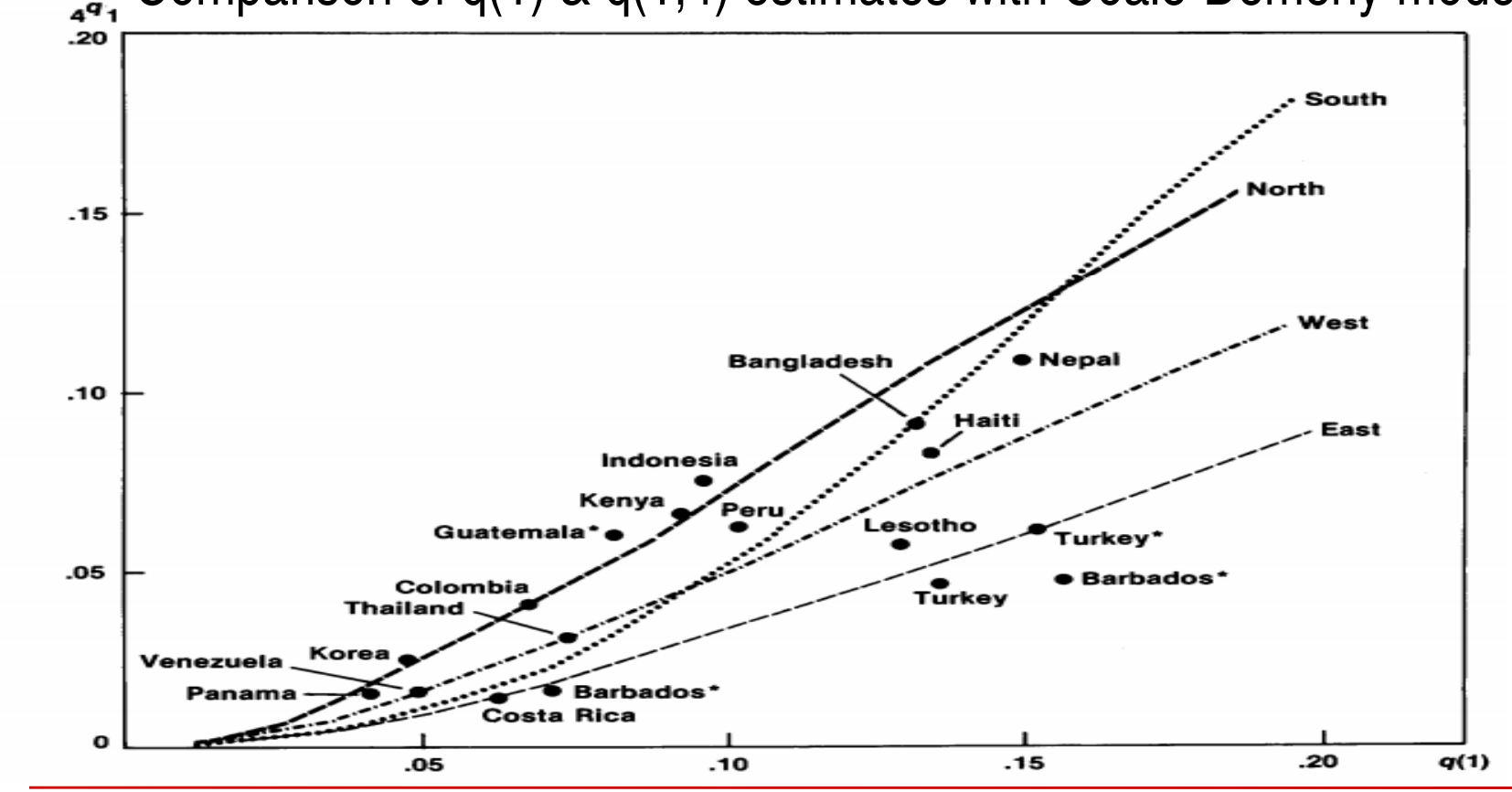
United Nations Models



Source: United Nations (1990)

How to identify the right model life table (2)

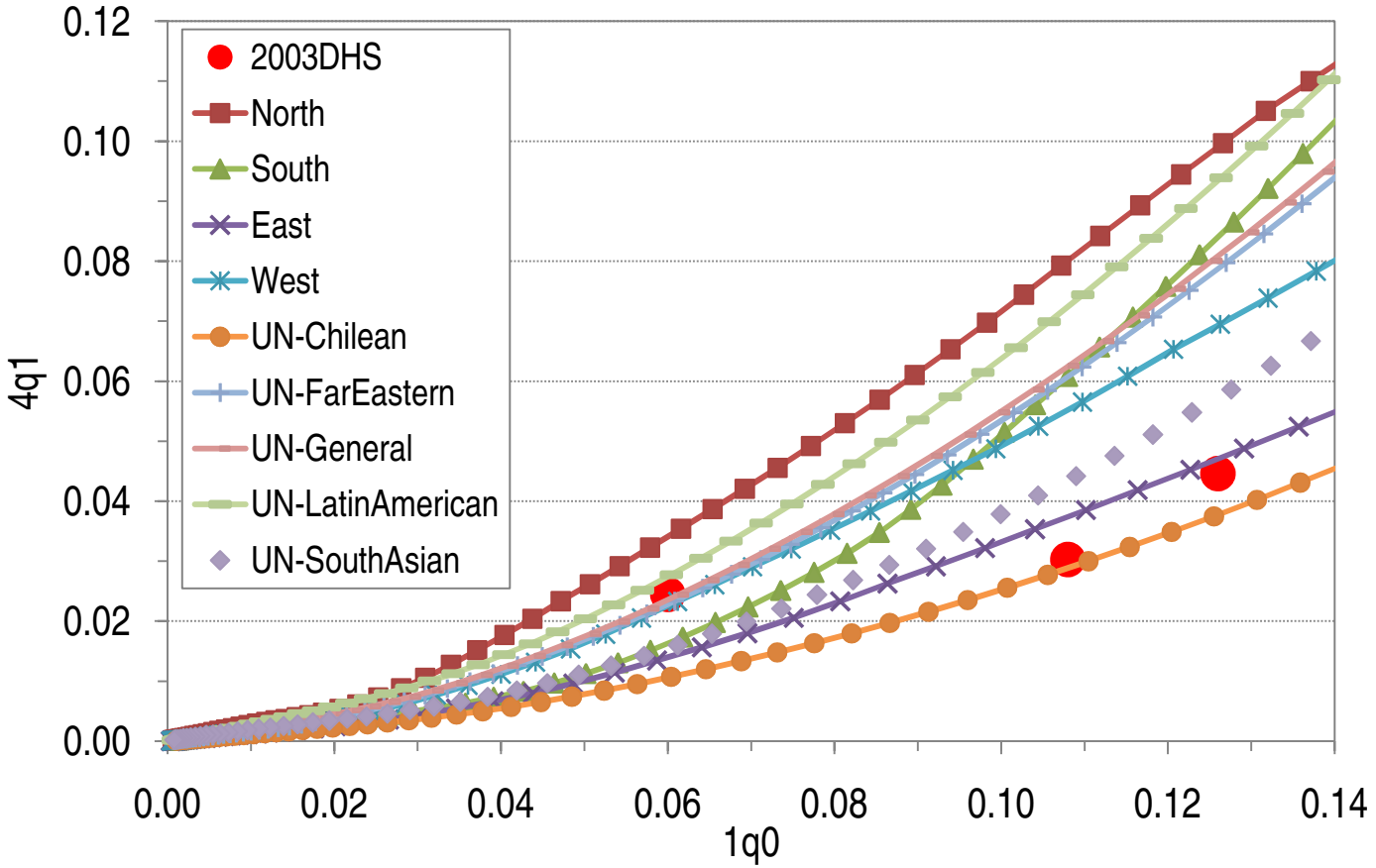
Comparison of q(1) & q(1,4) estimates with Coale-Demeny models



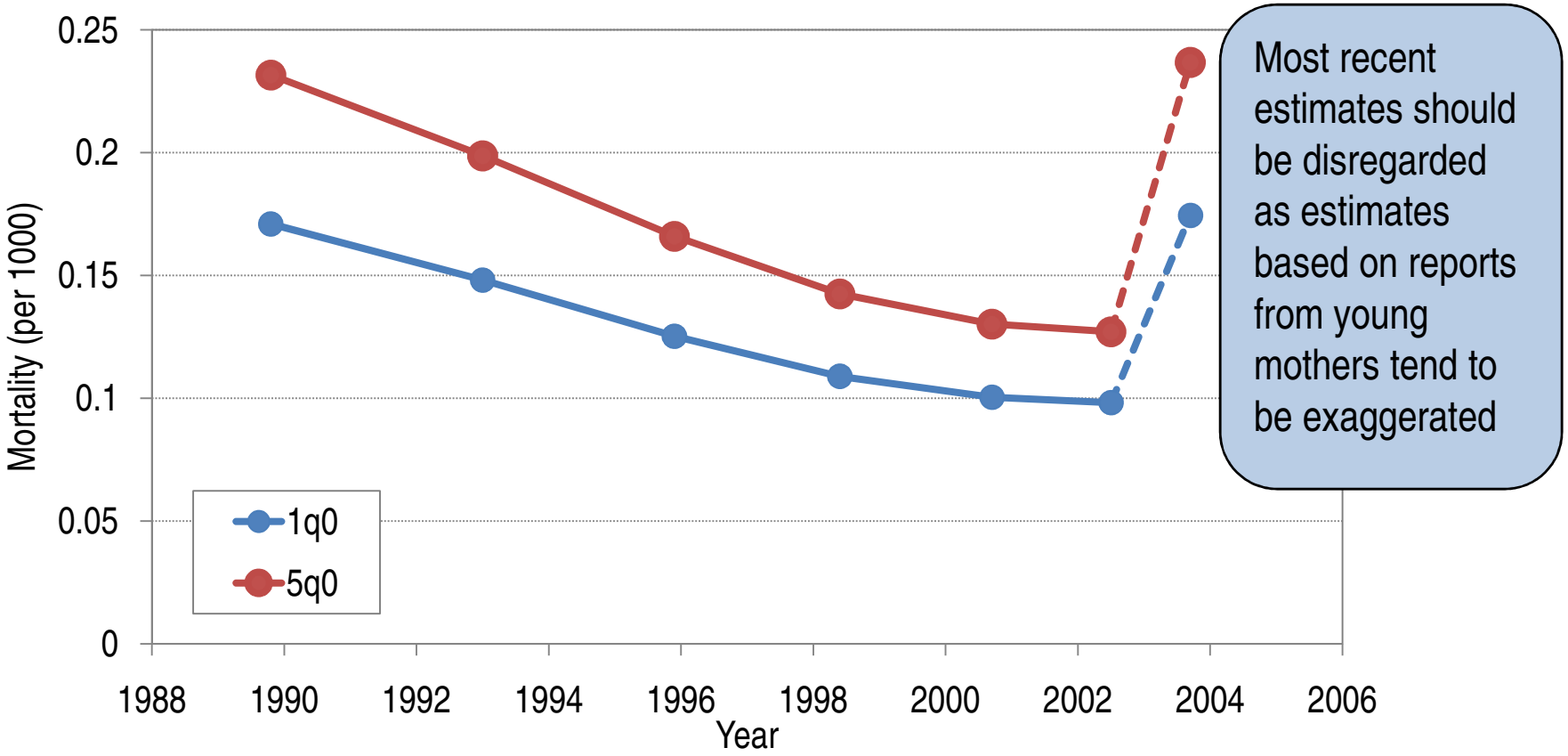
Source: United Nations (1990)

How to identify the right model life table (3)

Direct estimates of q(0) and q(1,4) from Timor-Leste 2003 DHS, and the relationships to Coale-Demeny and UN model life tables



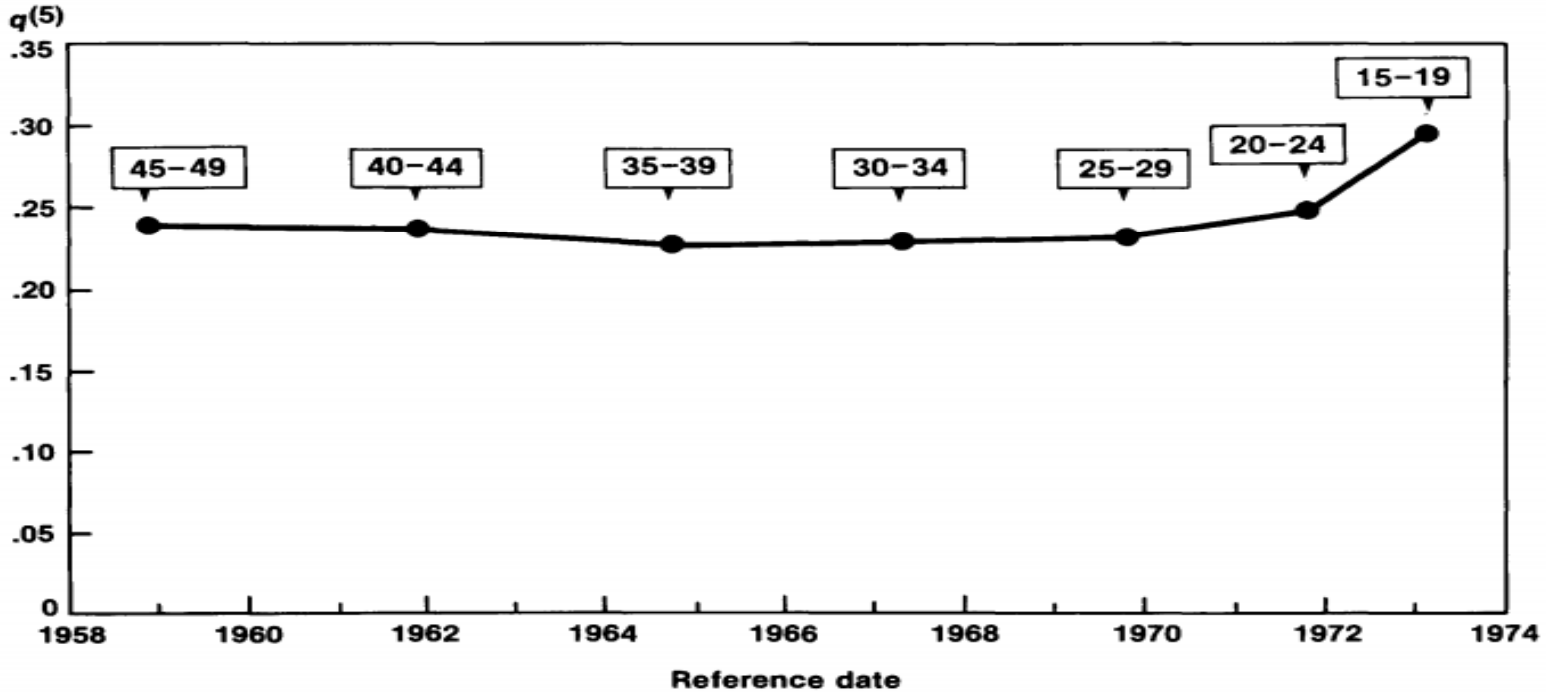
Estimated under five and under one mortality over time, Timor-Leste 2004 census



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: *IUSSP Tools for Demographic Estimation* http://demographicestimation.iussp.org/

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
     - See for adjustment techniques: http://demographicestimation.iussp.org/content/effects-hiv-methods-child-mortality-estimation

Source: *IUSSP Tools for Demographic Estimation* http://demographicestimation.iussp.org/

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: *IUSSP Tools for Demographic Estimation* http://demographicestimation.iussp.org/

Brass: q(5) more robust to model life table choice than q(1)

Figure 12. Infant and under-five mortality for both sexes in Bangladesh, estimated using the four Coale-Demeny mortality models

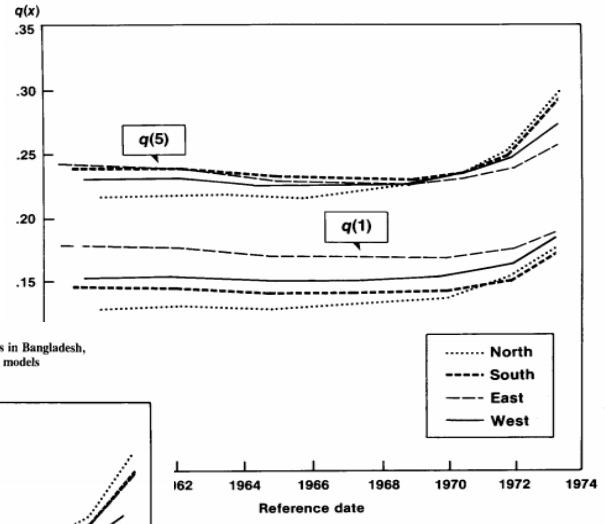
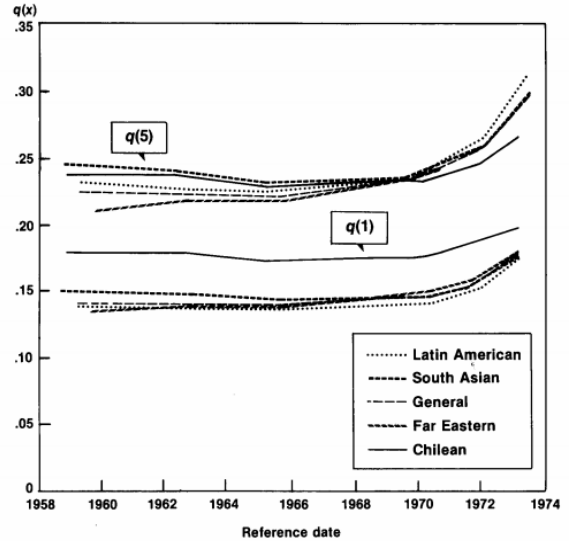
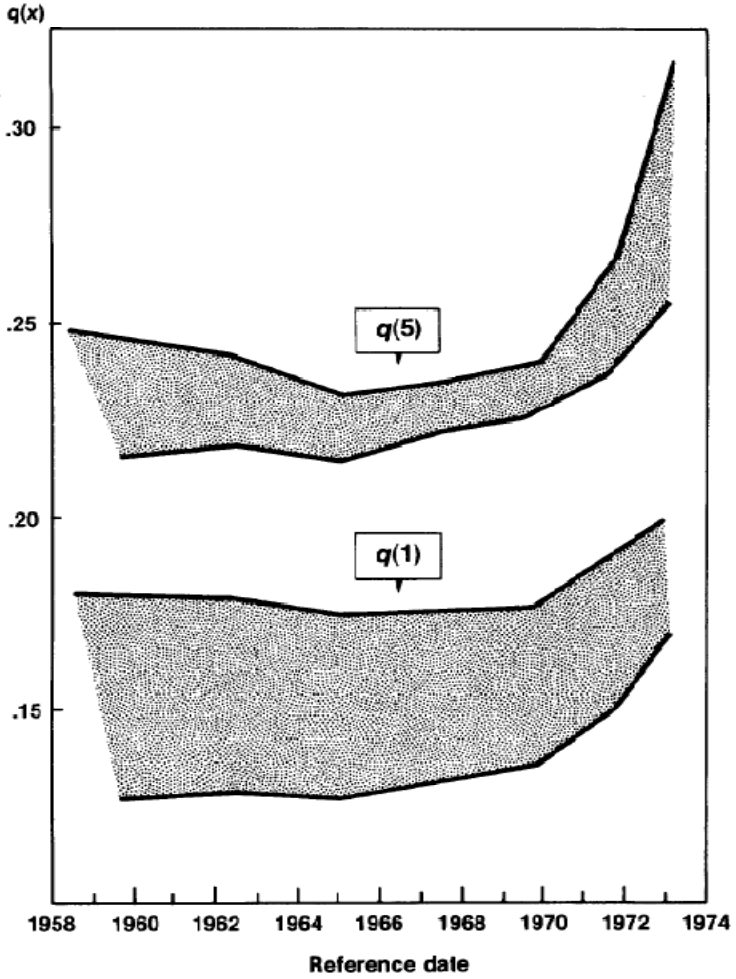


Figure 13. Infant and under-five mortality for both sexes in Bangladesh, estimated using the five United Nations mortality models



Source: Table 17.

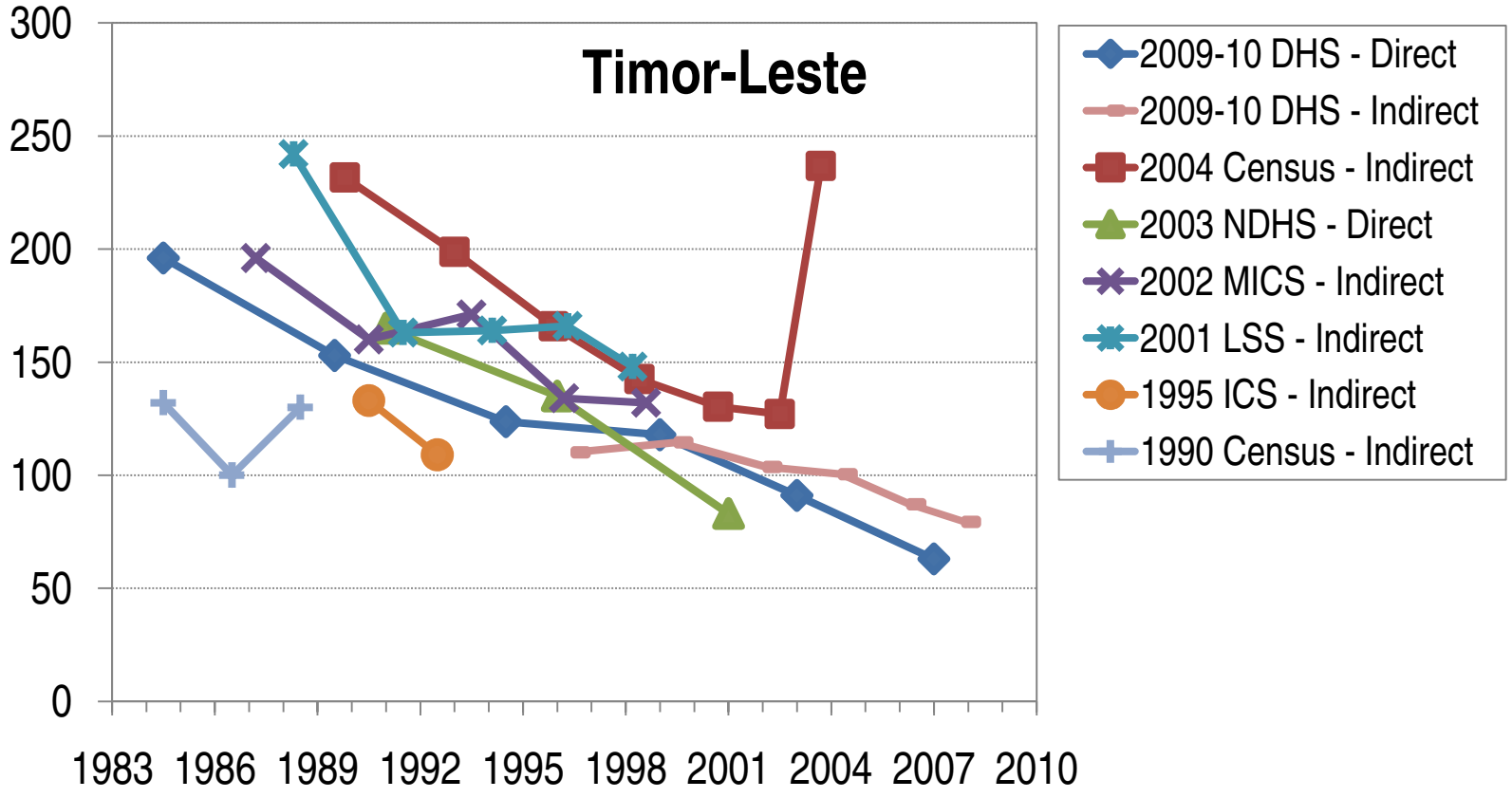
Figure 14. Range of variation of the possible estimates of infant and under-five mortality for both sexes in Bangladesh



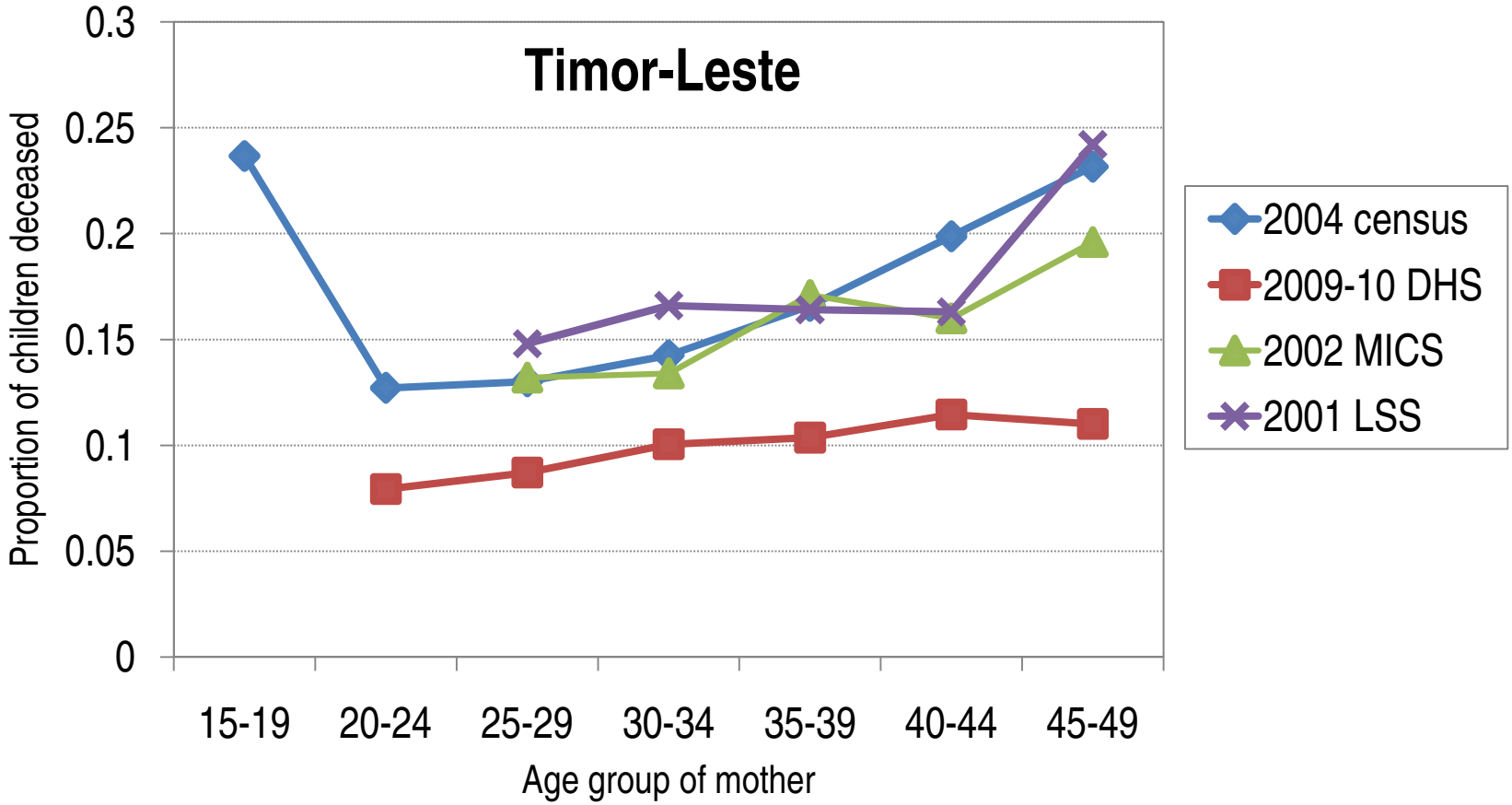
Source: Tables 16 and 17.

Source: *Step by step guide to the estimation of child mortality*, 1990, United Nations

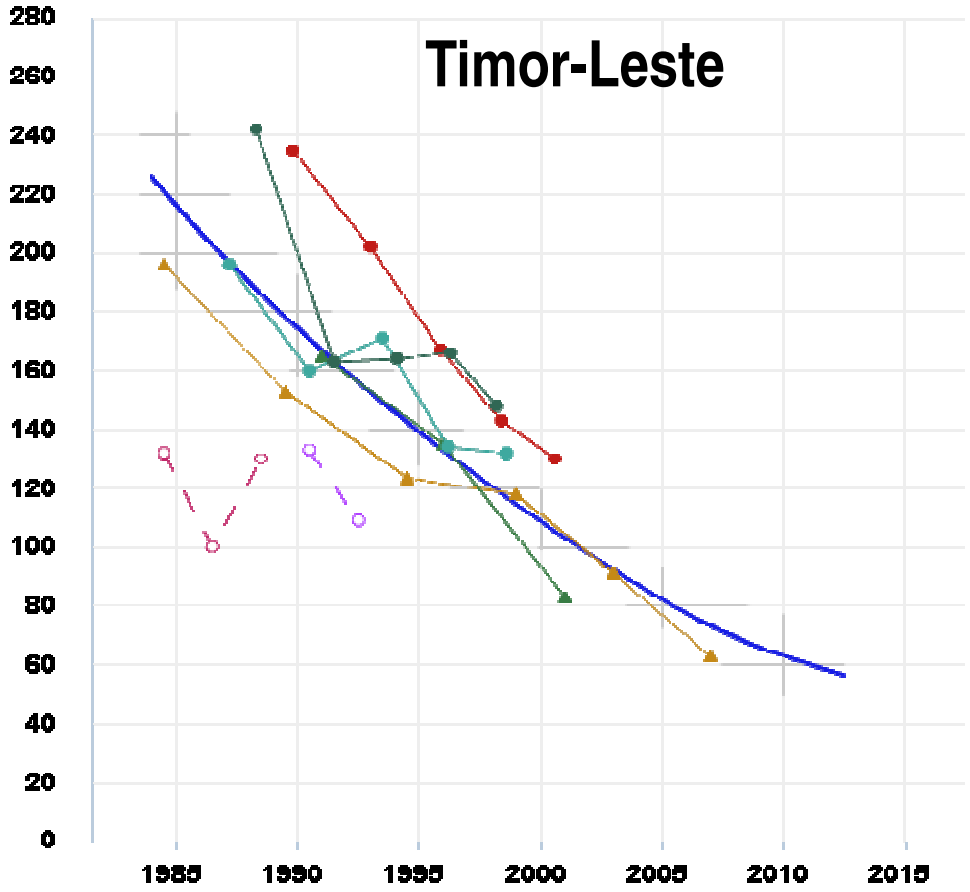
Quality of estimates: Checking multiple sources



Quality of estimates: Comparing age patterns of proportion of children deceased



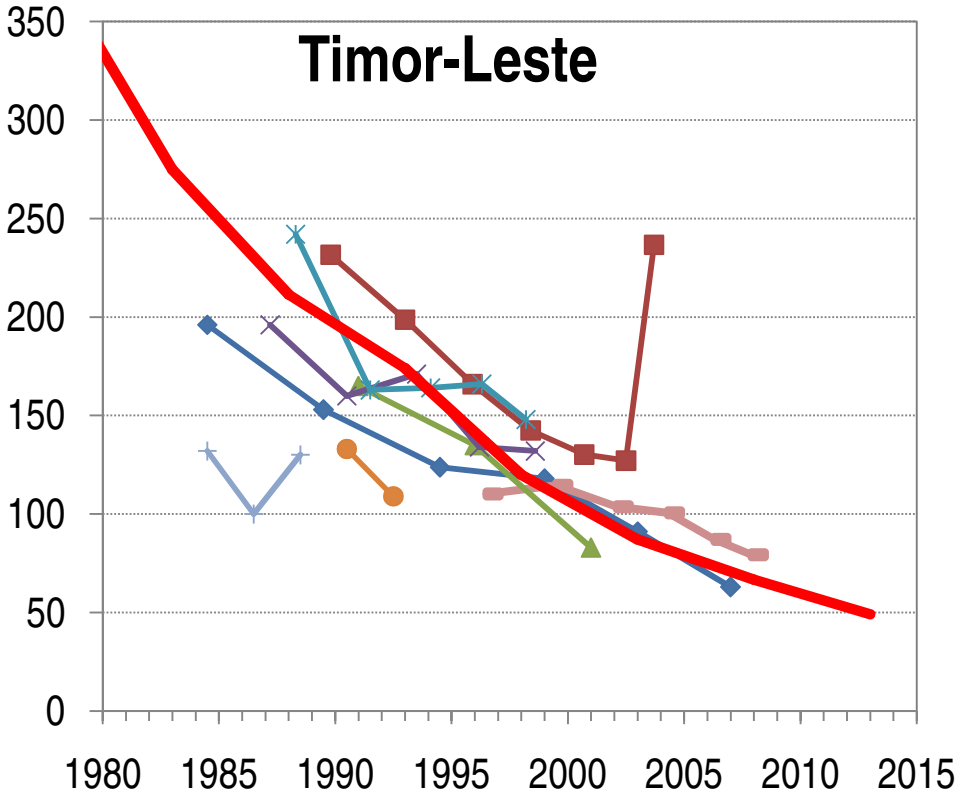
Quality of estimates: Comparison with existing external sources



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/wpp/

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धन्यवाद

terima kasih

Ташаккур

Рахмат!

Рахмет!

THANK YOU …

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