United Nations Statistics Division

Evaluation of Fertility Data Collected from Population Censuses

United Nations Statistics Division

United Nations Workshop on Census Data Evaluation for English Speaking African Countries
Kampala, Uganda
12 – 16 November 2012

Outline

1. Fertility data collected in censuses
    1. Children ever born
    2. Recent births
    3. Age-sex structure of population
    4. Micro data on mothers and own-children
2. Quality assessment
    1. Data collection errors, coverage and completeness
    2. Patterns of average parities and parity distributions
    3. Age-specific fertility rates from data on births
    4. Methods for deriving fertility estimates
    5. Comparing estimates from multiple independent sources

Children ever born (summary birth histories)

- Measure of <u>all live</u> births a woman has had in her lifetime
- Asked to all women age 15 and older
- 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

Children ever born

- Recommended question sequence to improve completeness of data:
  1. Total number of sons ever born alive during the lifetime of the woman
  2. Total number of sons living (surviving) at the time of the census
  3. Total number of sons born alive who died before the census date
  4. Total number of daughters ever born alive during the lifetime of the woman
  5. Total number of daughters living (surviving) at the time of the census
  6. Total number of daughters born alive who died before the census date

Source: *Principles and Recommendations for Population and Housing Censuses, Rev.2,* United Nations, 2008

Children ever born – When is it used?

- Widely used for over 50 years both for measures of fertility and for child mortality (next session)
- Very important for countries without or with incomplete birth registration
- Also important for countries with complete birth registration
  - Allows for the study of fertility by detailed socio-economic characteristics

Recent births

- Measure of recent fertility
- Asked to all women age 15 – 50 at the time of the census who reported at least one live birth in their lifetime
- **Preferred question:** Date of birth of last child born alive (day, month and year)
- **Alternative question:** Births in the last twelve months to the woman or in the household
  - More error-prone than exact date of birth, although both are subject to under-reporting
  - Date of birth can be converted to births in last 12 months during data processing (will miss only small percentage of cases in which woman had multiple births in a year)

Fertility data – possible errors

Both methods: enumerator's error

1. **Enumerators' failure to reach individuals**
   a) The not-at-home error: information provided by neighbors
   b) Coverage error: omit an area or forgot to record the answer

2. **Recording error**
   a) Answer is recorded incorrectly by the enumerator
   E.g., Childless women mis-classified into parity not stated

Children ever born – possible errors

1. Errors because the respondent did not understand the question
   a) Mortality error: reported only children living rather than ever-born
   b) Non-resident error: did not report surviving children living elsewhere
   c) Marriage error: women not reporting her children born from previous marriage or children born out of wedlock
2. Errors because of respondents' lapse of memory or neglect
   a) Memory error: respondent forgot some children
   - Believed to be more common among older women
3. Age misreporting
   a) Teenage mothers may exaggerate their age
   b) Age misreporting if this results in a systematic over- or under-stating of age

Recent births – possible errors

1. Reference period errors
   a) Uncertain of the exact date of birth relative to the reference period
   b) Incorrectly moving birth into or out of the reference period
2. Births missed because mother not located
   a) Women had a birth recently but died or migrated before the census
   b) Household had a birth recently but the household dissolved before the census
   c) Not significant in most cases, however could become an issue when many deaths occurring in a short period (HIV/AIDS) or when there is significant migration

Standard fertility measures

Average Parity/Children Ever Born – average number of children had by women in an age group

Parity Distributions – distribution of women in each age group by number of children they have had

Age Specific Fertility Rates (ASFR) – indicates the age pattern of fertility in a society

$$nFx = \frac{{}_nB_x}{{}_nW_x}$$

${}_nB_x$ =Births to women age x to x+n during period

${}_nW_x$ =Mid-period population of women age x to x+n

Total Fertility Rate (TFR) – number of children a woman would have in her lifetime if she lived her whole life under today's fertility conditions (ASFRs)

$$TFR = n \Sigma \, {}_nF_x$$

Census fertility data – what can we get?

	Parity Distribution	Average Parity	ASFR	TFR
Children Ever Born	Y	Y	Y*	Y*
Recent Fertility	N	N	Y	Y

*With one census under constant fertility, otherwise with two censuses

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Evaluating fertility data using standard fertility measures

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CEB – quality assessment (Step 1)

- Initial assessment of data quality and missing values
  - Any missing values in children ever born data?
  - Missing value for any relevant variables? (age of mother, sex of child, survival status of the child)
  - Was imputation, hotdecking or any other method used to clean the data?
    - If so, should have a good understanding of the rules followed

CEB – quality assessment

Table 2.11 Proportion of women whose parity data was not subject to logical imputation or hotdecking, by age and population group, Census 2001

Age group	*African*	*Coloured*	*Indian/Asian*	*White*
12-14	65.2	53.5	61.4	46.2
15-19	73.5	63.7	68.8	55.9
20-24	82.5	78.5	79.1	73.9
25-29	88.2	87.6	88.0	85.4
30-34	90.9	91.2	92.2	90.2
35-39	91.9	92.6	93.5	91.3
40-44	91.4	92.5	93.3	91.5
45-49	89.9	91.3	91.9	90.4

Source: *Estimation of fertility from the 2001 South Africa census data*, Tom Moultrie & Rob Dorrington, Centre for Actuarial Research, University of Cape Town

CEB – quality assessment (Step 2)

Tabulation of children ever born

- Number of children should not be grouped, except for the last open category (usually no lower than 9+ or 10+ children)
- Children ever born *not stated* should be distinguished from *no children (parity "0")*
- Are parities reasonable?
  - Quick rule-of-thumb: maximum parity should be one child every 18 months from age of 12
  - E.g. by exact age 20 (end of 15 – 19 age group) maximum children should be 5

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

CEB – quality assessment

Swaziland 1997 Census - Children Ever Born

Parity	15 - 19	20 - 24	25 - 29	30 - 34	35 - 39	40 - 44	45 - 49
0	48,289	15,331	5,761	2,575	1,640	1,075	763
1	6,687	14,368	6,558	3,326	1,992	1,248	878
2	1,081	9,100	8,277	4,256	2,612	1,587	1,116
3	150	3,579	7,059	4,602	3,106	1,811	1,274
4	35	1,196	4,632	4,535	3,320	2,087	1,474
5	3	[illegible]	2,382	3,736	3,116	1,980	1,497
6	4	115	1,067	2,801	2,915	1,989	1,584
7	1	54	436	1,694	2,494	1,925	1,603
8 - 9	0	47	277	1,387	3,074	3,015	2,774
10+	0	10	68	430	1,285	2,206	2,602
Unknown	1,331	2,150	1,379	826	603	417	345

Data source: United Nations Demographic Yearbook

Parities 6 and 7 are obviously wrong

Parity 8 and 9 should not have been grouped

Unknown separate from parity "0"

CEB – quality assessment

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Swaziland 1997 Census - Children Ever Born

Parity	15 - 19	20 - 24	25 - 29	30 - 34	35 - 39	40 - 44	45 - 49
0	48,289	15,331	5,761	2,575	1,640	1,075	763
1	6,687	14,368	6,558	3,326	1,992	1,248	878
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3	150	3,579	7,059	4,602	3,106	1,811	1,274
4	35	1,196	4,632	4,535	3,320	2,087	1,474
5	3	337	2,382	3,736	3,116	1,980	1,497
6	0	115	1,067	2,801	2,915	1,989	1,584
	0	54	436	1,694	2,494	1,925	1,603
	0	47	277	1,387	3,074	3,015	2,774
	0	0	68	430	1,285	2,206	2,602
	1,336	2,160	1,379	826	603	417	345
en	57,581	46,287	37,896	30,168	26,157	19,340	15,910
T	9,454	51,242	87,216	107,218	119,321	101,200	90,637
P U	0.0232	0.04667	0.03639	0.02738	0.02305	0.02156	0.02168
Proportio childless	.83863	0.33122	0.15202	0.08536	0.0627	0.05558	0.04796
Average parity	0.16419	1.10704	2.30144	3.55401	4.56172	5.23265	5.69686

Total children … = … hat

Proportion with unknown p… s…

Proportion childless should decrease with age

Average parity should increase with age

CEB – quality assessment

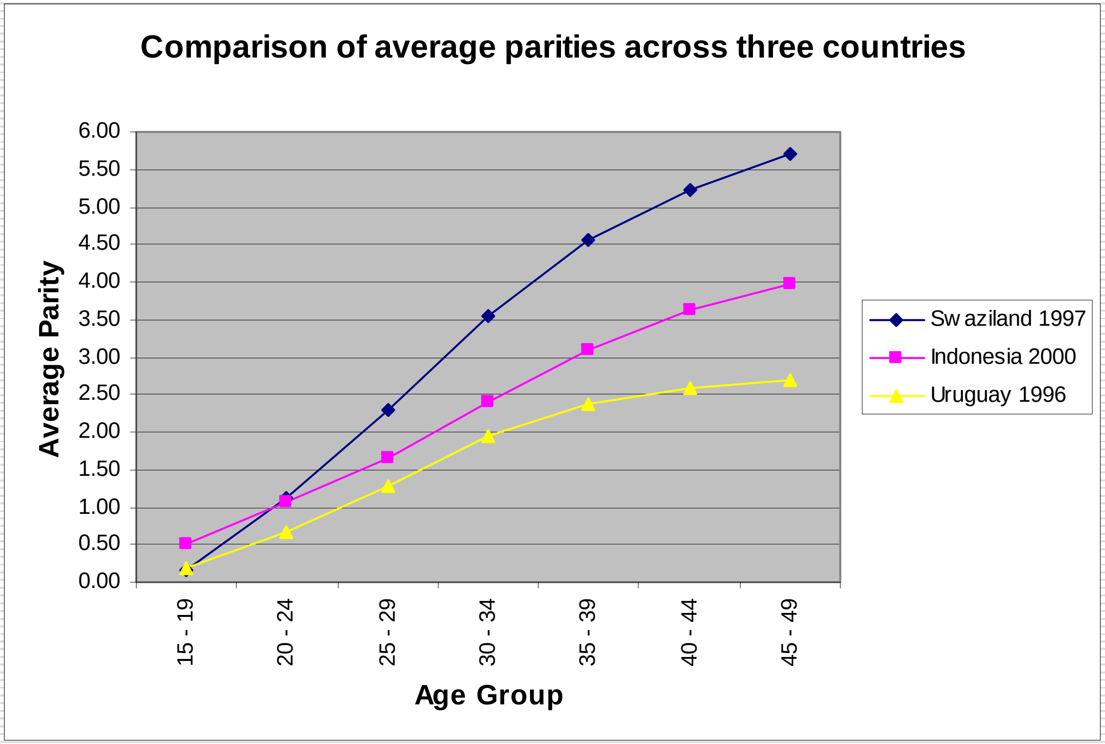
Average parity at age *x*:

$$P_x = \frac{B_x}{W_x} = \frac{\sum_j jW_{j,x}}{\sum_j W_{j,x}}$$

where

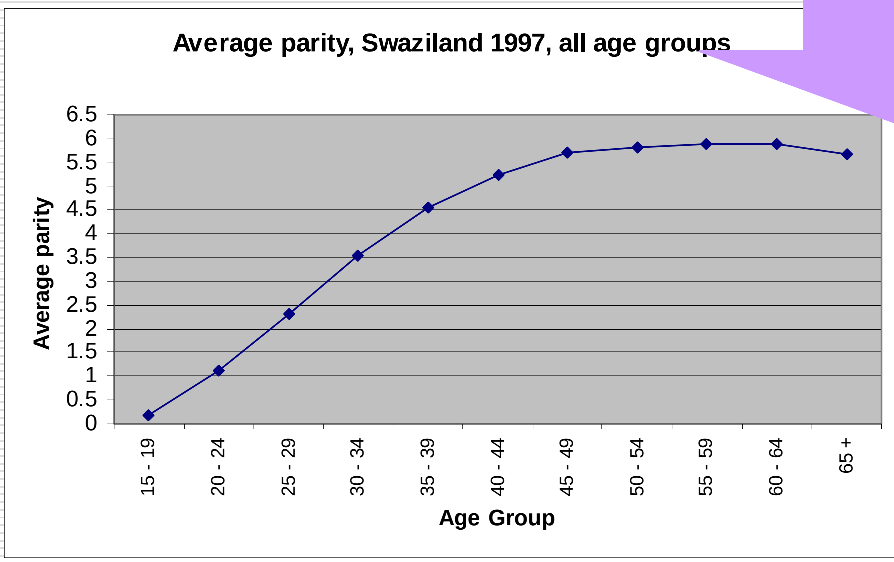
B_x - number of births

$W_{j,x}$ - number of women at parity j

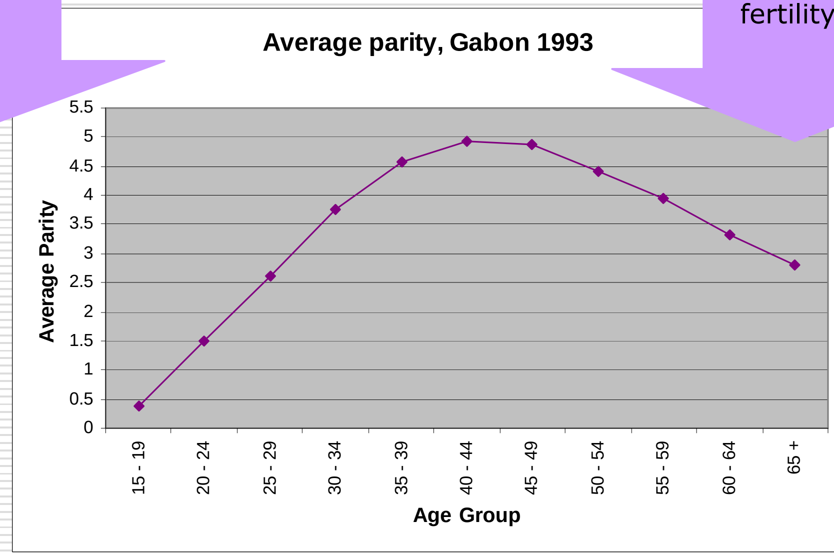


CEB – quality assessment

Underreporting at higher ages?



Misreporting? Rising fertility?



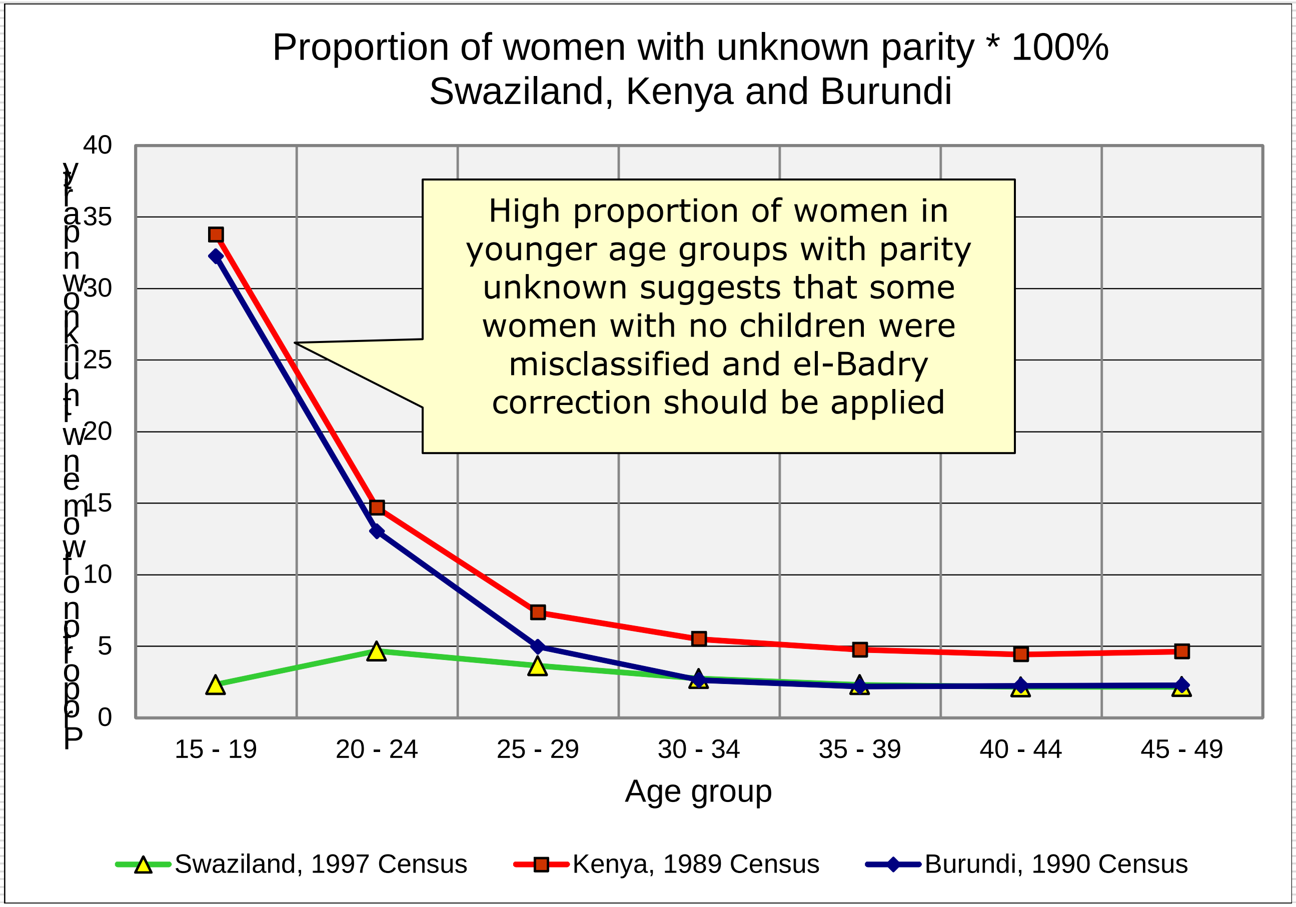
The El-Badry Correction

- El-Badry correction is applied to adjust reported data on children ever born any further analysis
- A common problem with CEB data is that enumerators may incorrectly code women of zero parity as "parity unknow" or "parity not stated"
- The El-Badry method corrects for this by apportioning those women with parity 'reportedly' unkown between those whose parity is 'truly' unknown and those who have no children
- Method is based on assumption that proportion of women whose parity is 'truly' unknown does not depend on age

Application

- Check if proportion of women with parity unknown is high and going down with age
- If parity unknown is less than 2% of each age group it is safe to assume that the data are not affected and no correction is needed

Identifying when to use El-Badry method



El-Badry: Step 1

Calculate proportion of women in each age group with a) parity missing and b) parity = 0

a) Parity unknown:

$$U_i = N_{i,u} / N_i$$

Where:

Ui = proportion unknown in age group

Ni,u = number unknown in age group

Ni = total women in age group

b) Parity 0:

$$Z_i = N_{i,0} / N_i$$

Where:

Zi = proportion parity 0 in age group

Ni,0 = number parity 0 in age group

Ni = total women in age group

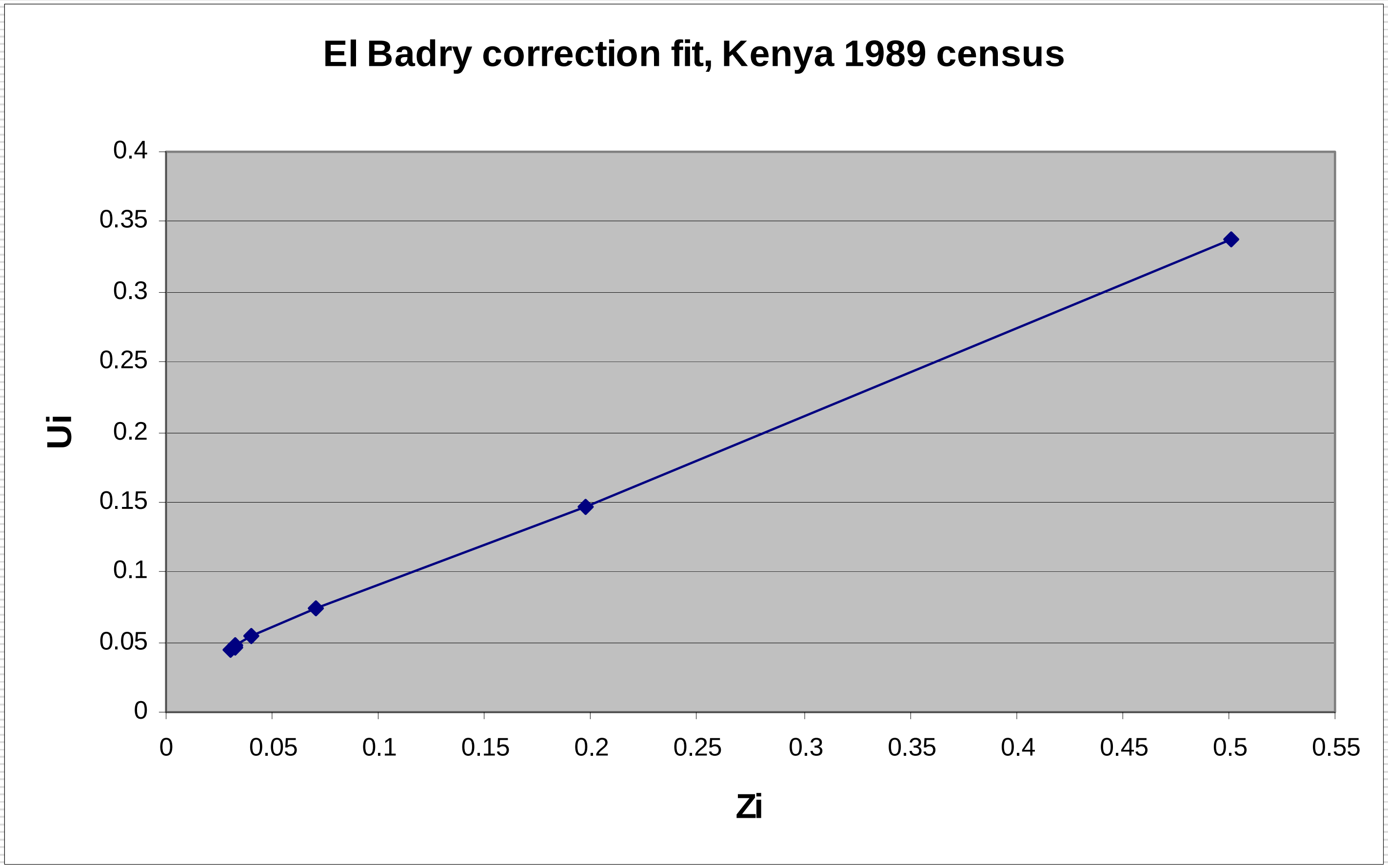
El-Badry: Step 1

Parity data, Kenya 1989 Census

United Nations Statistics Division

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
0	**597,560**	**198,600**	**59,400**	**23,120**	**14,580**	**11,040**	**9,560**
1	134,700	224,660	83,140	26,140	13,620	9,460	7,740
2	38,120	202,300	120,940	38,340	19,180	13,240	9,280
3	11,120	126,500	150,500	53,880	28,020	17,000	12,440
4	6,820	59,700	146,500	73,280	37,340	21,400	14,800
5	1,740	33,720	102,300	87,720	48,140	28,980	18,560
6	0	12,480	58,980	83,580	56,520	35,260	26,280
7	0	0	57,180	91,800	56,240	41,260	28,640
8	0	0	0	64,740	56,560	42,700	32,920
9	0	0	0	0	40,780	39,480	33,000
10	0	0	0	0	26,840	32,240	27,920
11	0	0	0	0	14,920	22,840	21,920
12	0	0	0	0	8,280	14,660	14,720
13	0	0	0	0	3,740	7,900	8,920
14	0	0	0	0	2,180	4,080	4,900
15+	0	0	0	0	3,160	5,400	7,180
U	**402,780**	**147,540**	**61,920**	**31,580**	**21,480**	**16,060**	**13,540**
Total women	1,192,840	1,005,500	840,860	574,180	451,580	363,000	292,320
Ui	**0.338**	**0.147**	**0.074**	**0.055**	**0.048**	**0.044**	**0.046**
Zi	**0.501**	**0.198**	**0.071**	**0.040**	**0.032**	**0.030**	**0.033**

El-Badry: Step 2



El-Badry: Step 3

- Regress Ui on Zi (in excel can use SLOPE and INTERCEPT) functions

In our example, get intercept (β) of .0275, suggesting 2.7% of data of each age group is truly missing

To correct data:

Parity truly missing=

$$U`_i = N_i * \beta$$

Parity 0 =

$$N`_{i,0} = N_i (Z_i + U_i - \beta)$$

El-Badry: Step 4

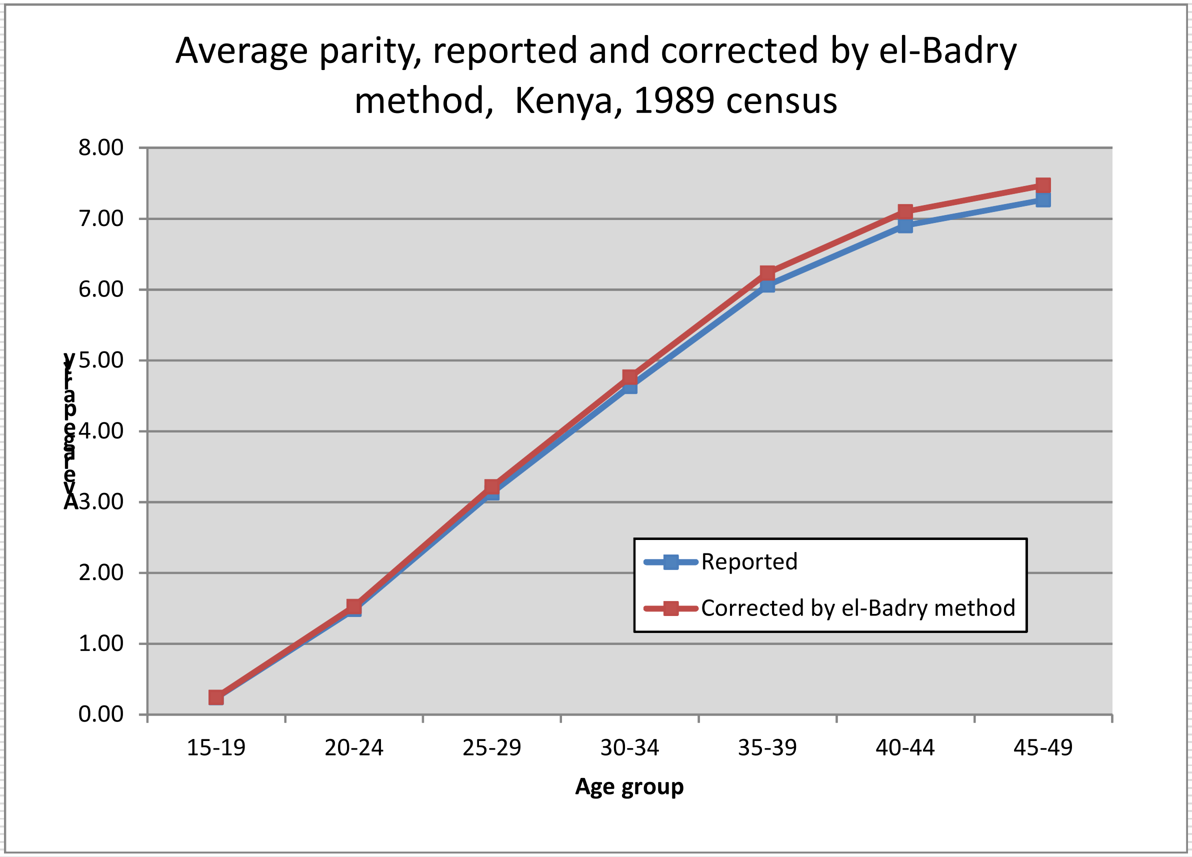
Revised figures for women with unknown and 0 parity, Kenya 1989 census with El Badry correction

	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Ni,0	597,560	198,600	59,400	23,120	14,580	11,040	9,560
Ui	402,780	147,540	61,920	31,580	21,480	16,060	13,540
Total women	1,192,840	1,005,500	840,860	574,180	451,580	363,000	292,320
Ui	0.338	0.147	0.074	0.055	0.048	0.044	0.046
Zi	0.501	0.198	0.071	0.040	0.032	0.030	0.033
U\`i = Ni * β	**32,803**	**27,651**	**23,124**	**15,790**	**12,418**	**9,983**	**8,039**
N\`i,0 = Ni (Zi + Ui – β)	**967,537**	**318,489**	**98,196**	**38,910**	**23,642**	**17,118**	**15,061**

Recalculation of average parity after El-Badry

- If the el-Badry method has been applied, average parities should be calculated *excluding* the remaining ("true") number of women with unknown parity from the denominator
  - This will increase the average parities by $1/(1+\beta)$ because women formerly considered missing are now classified as parity 0
- When missing data is more than 2% but the correction is not applied (e.g. due to violation of linearity), women of unknown parity should be included in the denominator
  - This will lead to underestimation of average parity because the unknown parities are functionally treated as parity 0

El-Badry: revised parities



CEB checks – Parity distribution of women age 45 - 49

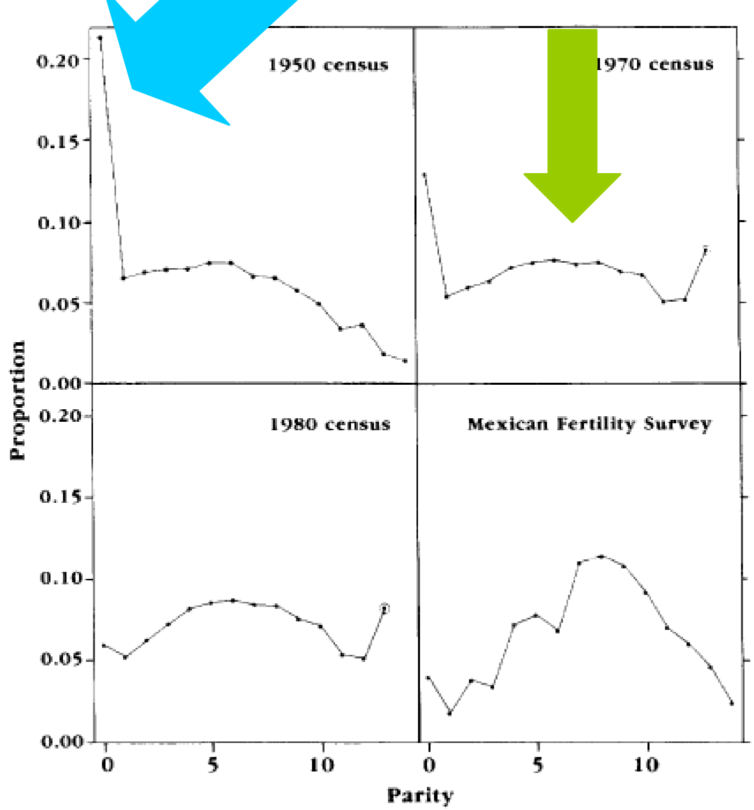
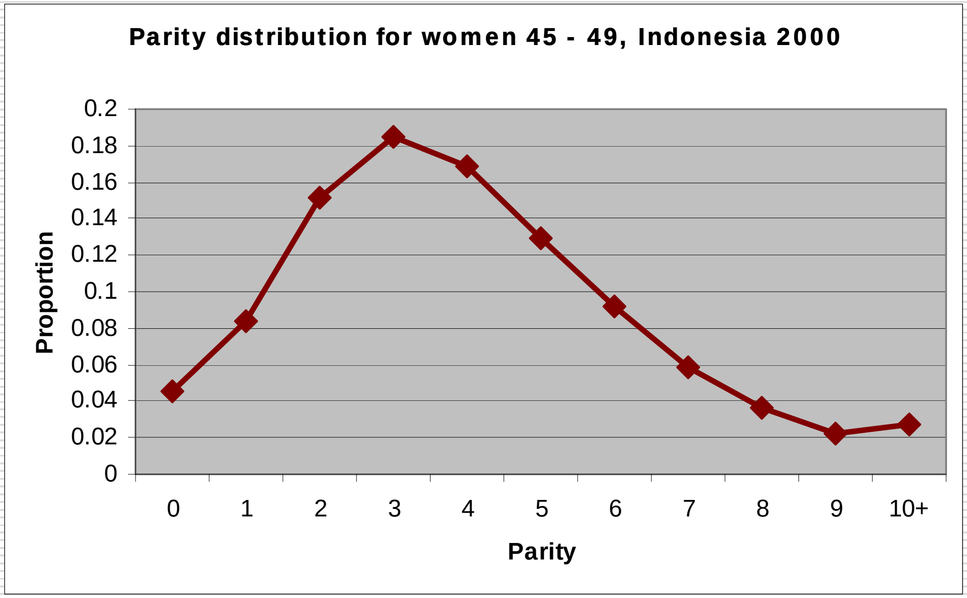


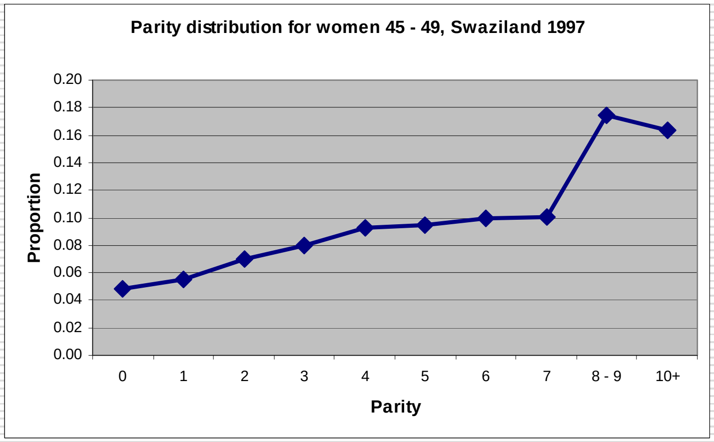
Figure 3. **Completed parity distributions for Mexico, from the censuses of 1950, 1970, and 1980 and from the Mexican Fertility Survey**

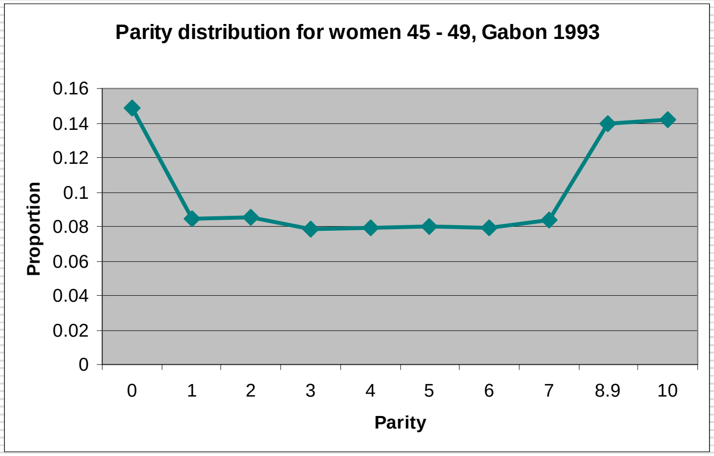
- High level of parity 0 in 1950 and 1970 censuses: possibly groups "not stated" and "0" parity combined. No separate groups unlike as in the 1980 census.
- Flat curve: probably some form of misreporting, seems to be improving over time
- Mexican fertility survey: shape of the curve more plausible (small sample size)

Source: Child survivorship estimation: methods and data analysis, Griffith Feeney, *Asian and Pacific Population Forum*, Vol. 5, Nos. 2-3, 1991

CEB –Checks – Parity distribution of women age 45 - 49







Data source: United Nations Demographic Yearbook

CEB - Additional Checks - Cohort analysis of mean number of children ever born

Figure 5. **Time plot of mean number of children ever born, based on censuses of Thailand, 1960, 1970, and 1980**

Source: Table 3 in this article.

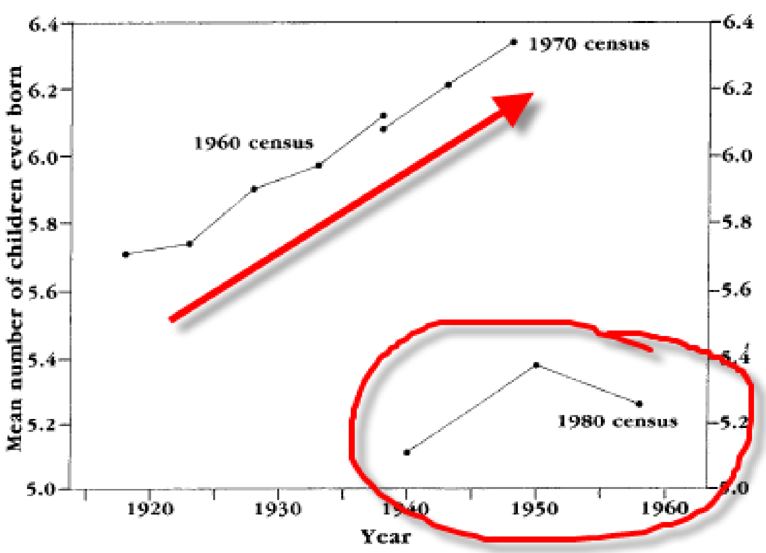


Table 3. **Mean number of children ever born to women of ages 45 and over, by age group: Thailand, Whole Kingdom, censuses of 25 April 1960, 1 April 1970, and 1 April 1980**

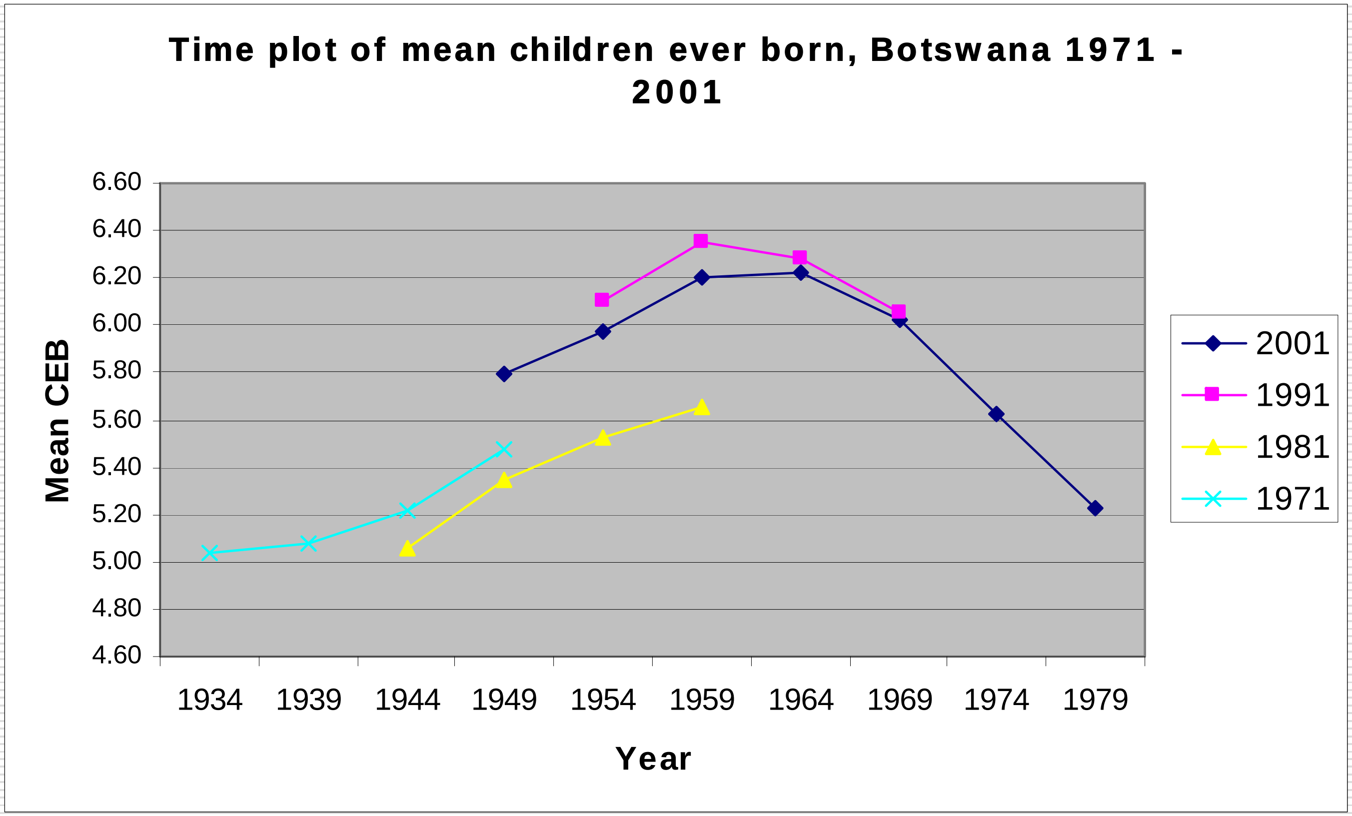
Age group	Mean CEB	Year
1960 census		
45–49	6.12	1938
50–54	5.97	1933
55–59	5.90	1928
60–64	5.74	1923
65–69	5.71	1918
1970 census		
45–49	6.34	1948
50–54	6.21	1943
55–59	6.08	1938
1980 census		
45–49	5.26	1958
50–59	5.38	1950
60–69	5.11	1940

- Simple test for quality of reporting among older women
- Assumes all childbearing at age 25
- Year in time = census year – (age – 25)
- Thailand example: 1960 and 1970 censuses - an increase in fertility

- Erroneous data from 1980 census (conclusion was reached after comparing with data from other surveys)

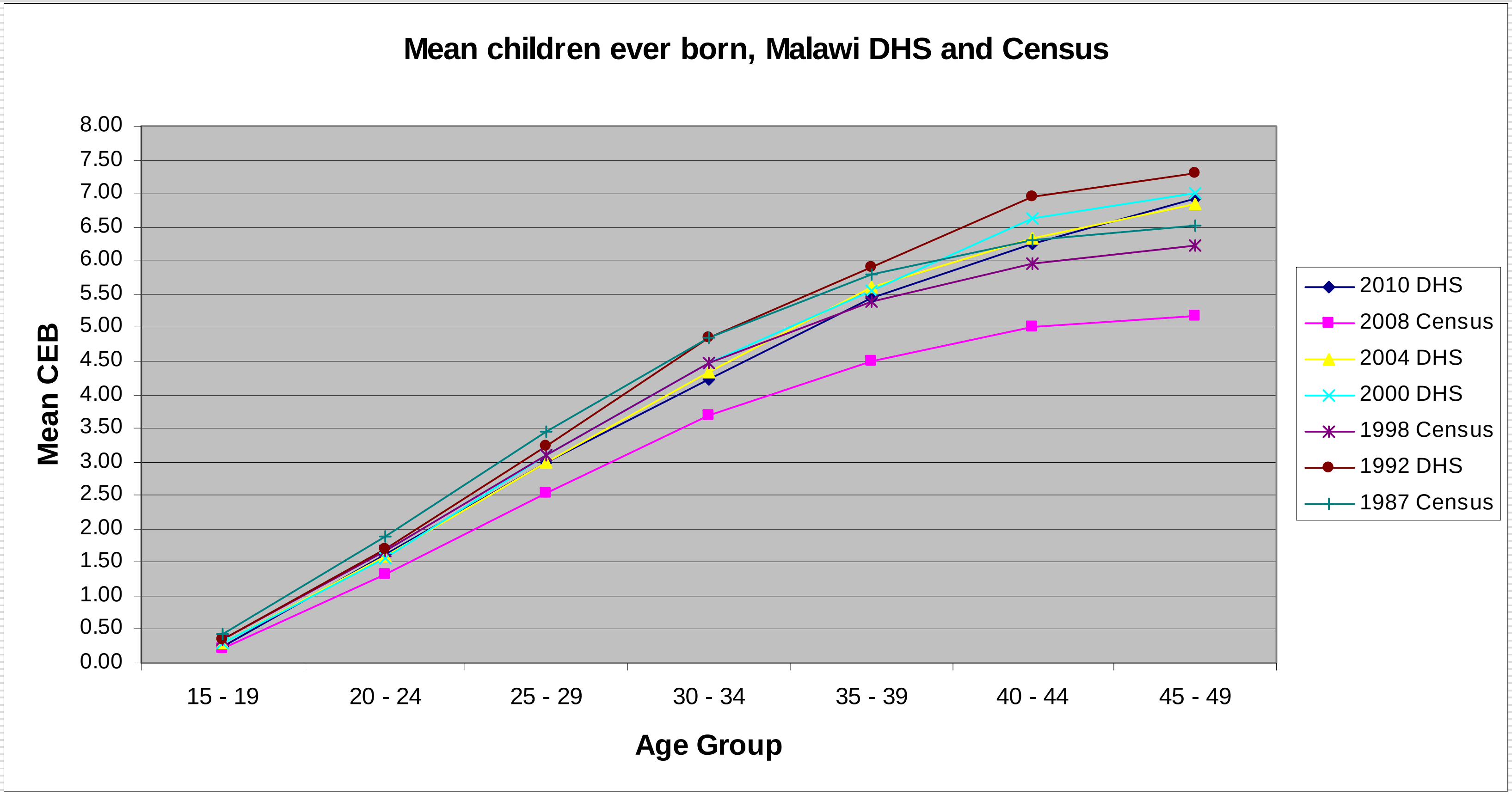
Source: Child survivorship estimation: methods and data analysis, Griffith Feeney, *Asian and Pacific Population Forum*, Vol. 5, Nos. 2-3, 1991

CEB - Additional Checks - Cohort analysis of mean number of children ever born



Data source: United Nations Demographic Yearbook

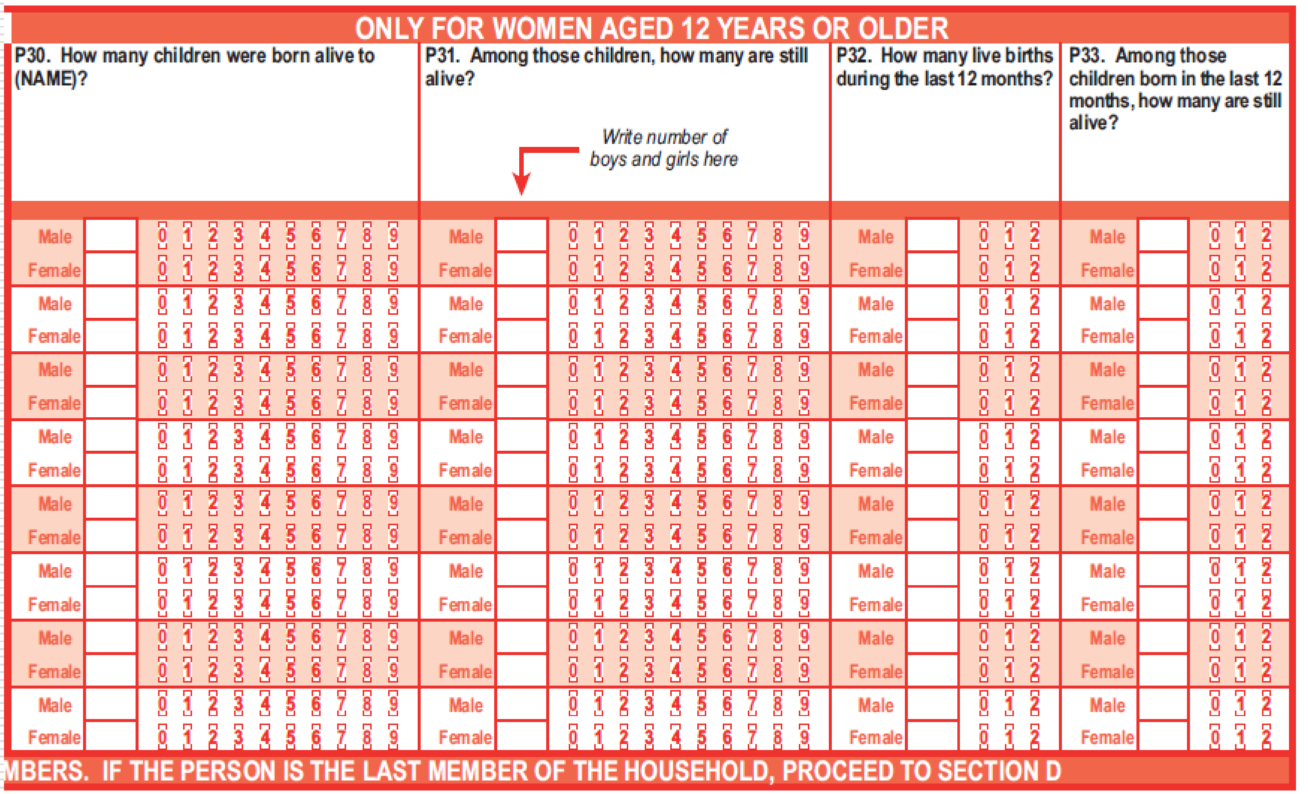
CEB – Additional checks – multiple sources of data



Data source: United Nations *Demographic Yearbook* and the DHS STATcompiler http://www.statcompiler.com/

CEB – Additional checks – multiple sources of data

Malawi census form for 2008 – fertility section



ONLY FOR WOMEN AGED 12 YEARS OR OLDER

P30. How many children were born alive to (NAME)?			P31. Among those children, how many are still alive? *Write number of boys and girls here*			P32. How many live births during the last 12 months?			P33. Among those children born in the last 12 months, how many are still alive?		
Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2	Male		0 1 2
Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2	Female		0 1 2
Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2	Male		0 1 2
Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2	Female		0 1 2
Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2	Male		0 1 2
Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2	Female		0 1 2
Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2	Male		0 1 2
Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2	Female		0 1 2
Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2	Male		0 1 2
Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2	Female		0 1 2
Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2	Male		0 1 2
Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2	Female		0 1 2
Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2	Male		0 1 2
Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2	Female		0 1 2
Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2 3 4 5 6 7 8 9	Male		0 1 2	Male		0 1 2
Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2 3 4 5 6 7 8 9	Female		0 1 2	Female		0 1 2

MBERS. IF THE PERSON IS THE LAST MEMBER OF THE HOUSEHOLD, PROCEED TO SECTION D

Recent births – quality assessment

- Initial assessment
  - Any missing values in data? (month/date/year of birth)
    - Missing data for any relevant variables? (age of mother, sex of child, survival status of the child)
  - Is distribution of reported birth dates reasonable?
  - If possible, compare with civil registration data on live births

Recent births – quality assessment – missing and inconsistent data

Figure 2.3 Distribution of last child born's day of birth by imputation and cleaning method, Census 2001

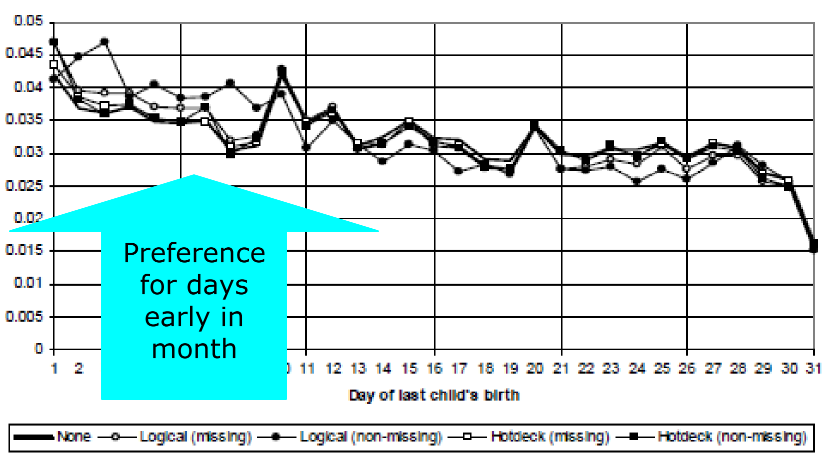


Figure 2.4 Distribution of last child born's month of birth by imputation and cleaning method, Census 2001

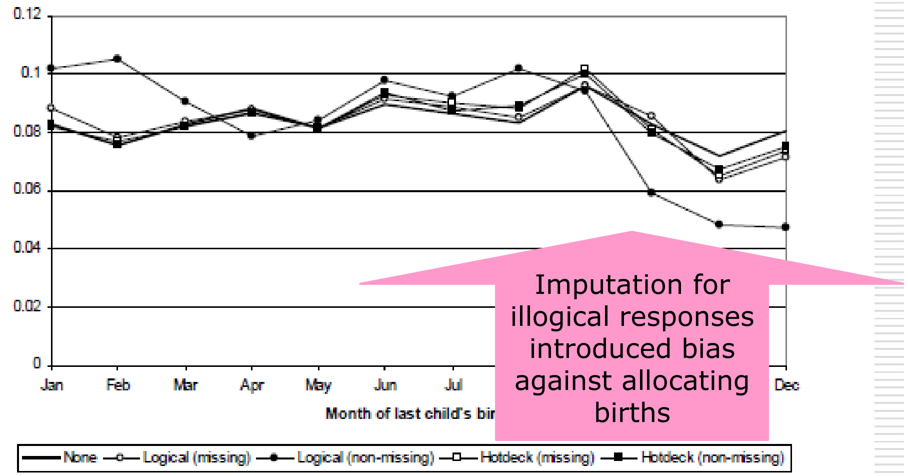
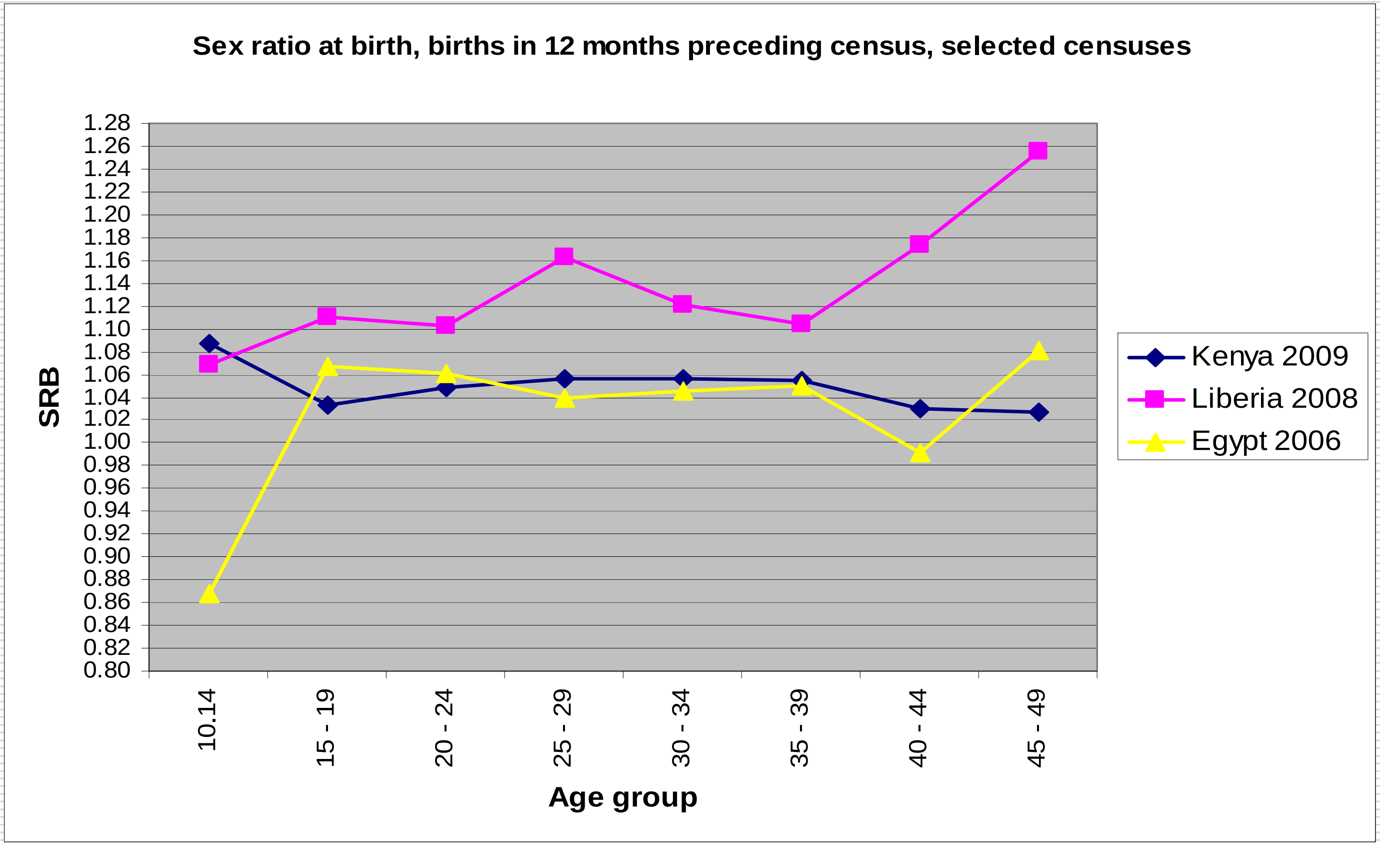


Table 2.9 Distribution of women aged 12 to 49 by imputation flag for response to question on year of last child's birth

	No imputation	*Logical imputation from* missing response	*Logical imputation from* non-missing response	*Hotdeck applied to* missing response	*Hotdeck applied to* non-missing response	*TOTAL*
Women	6560661	604260	391548	734257	165002	8455728
(per cent)	77.6	7.1	4.6	8.7	2.0	77.6

Source: *Estimation of fertility from the 2001 South Africa census data*, Tom Moultrie & Rob Dorrington, Centre for Actuarial Research, University of Cape Town

Recent births – quality assessment - sex ratio



Data source: United Nations Demographic Yearbook

Recent births – quality assessment – age specific fertility rates (ASFR)

Age Specific Fertility Rate (ASFR)

$$nFx = \frac{nBx}{nWx}$$

nBx =Births to women age x to x+n during period

nWx =Mid-period population of women age x to x+n

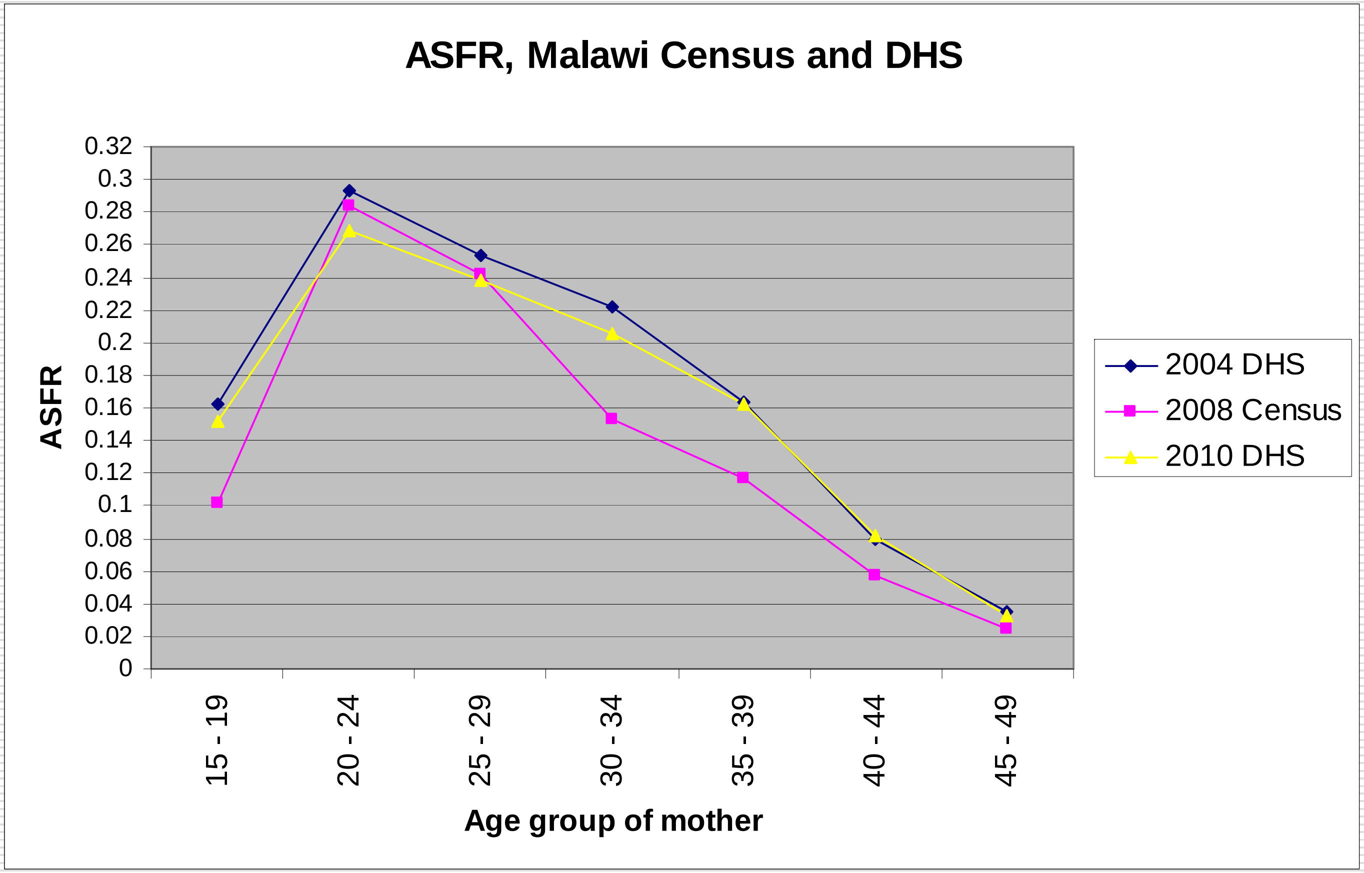
Are births be classified by age of mother at birth of her child or by age of mother at the survey/census date?

If not known, assume the latter, almost universally, in censuses, data are classified by age of mother at time of census. In this case, ASFRs are shifted by ½ year as mothers were ½ year younger at the time of birth.

Malawi, census June 2008

Age group	Births in 12 months preceding census	Total women in age group	ASFR
14.5 – 19.5	70,737	699,155	0.10117
19.5 – 24.5	169,406	596,363	0.28407
24.5 – 29.5	130,331	539,482	0.24159
29.5 – 34.5	79,232	517,345	0.15315
34.5 – 39.5	43,747	374,526	0.11681
39.5 – 44.5	15,956	276,264	0.05776
44.5 – 49.5	5,599	224,100	0.02498

Recent births – quality assessment – comparing ASFRs



Data source: United Nations Demographic Yearbook and DHS STATcompiler

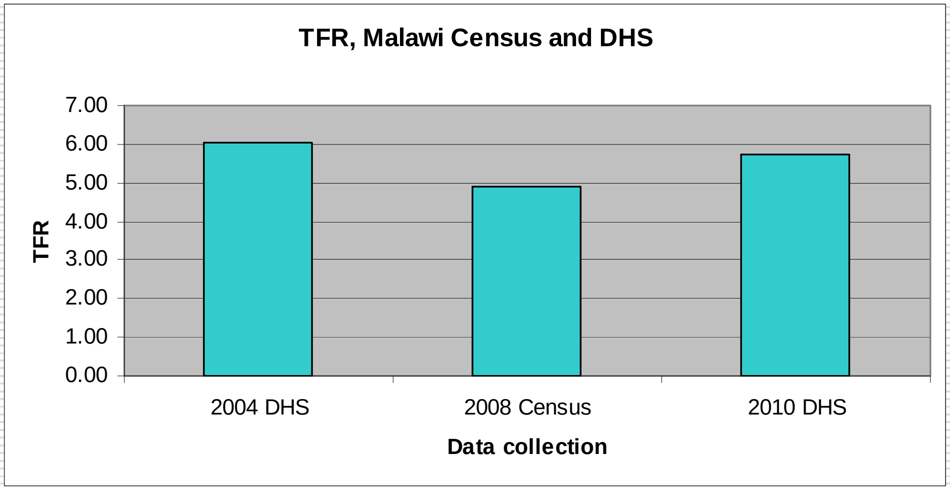
Recent births – quality assessment – comparing TFRs

Total fertility rate

$$TFR = 5\ \Sigma\ {}_5F_x$$

Malawi TFR comparison

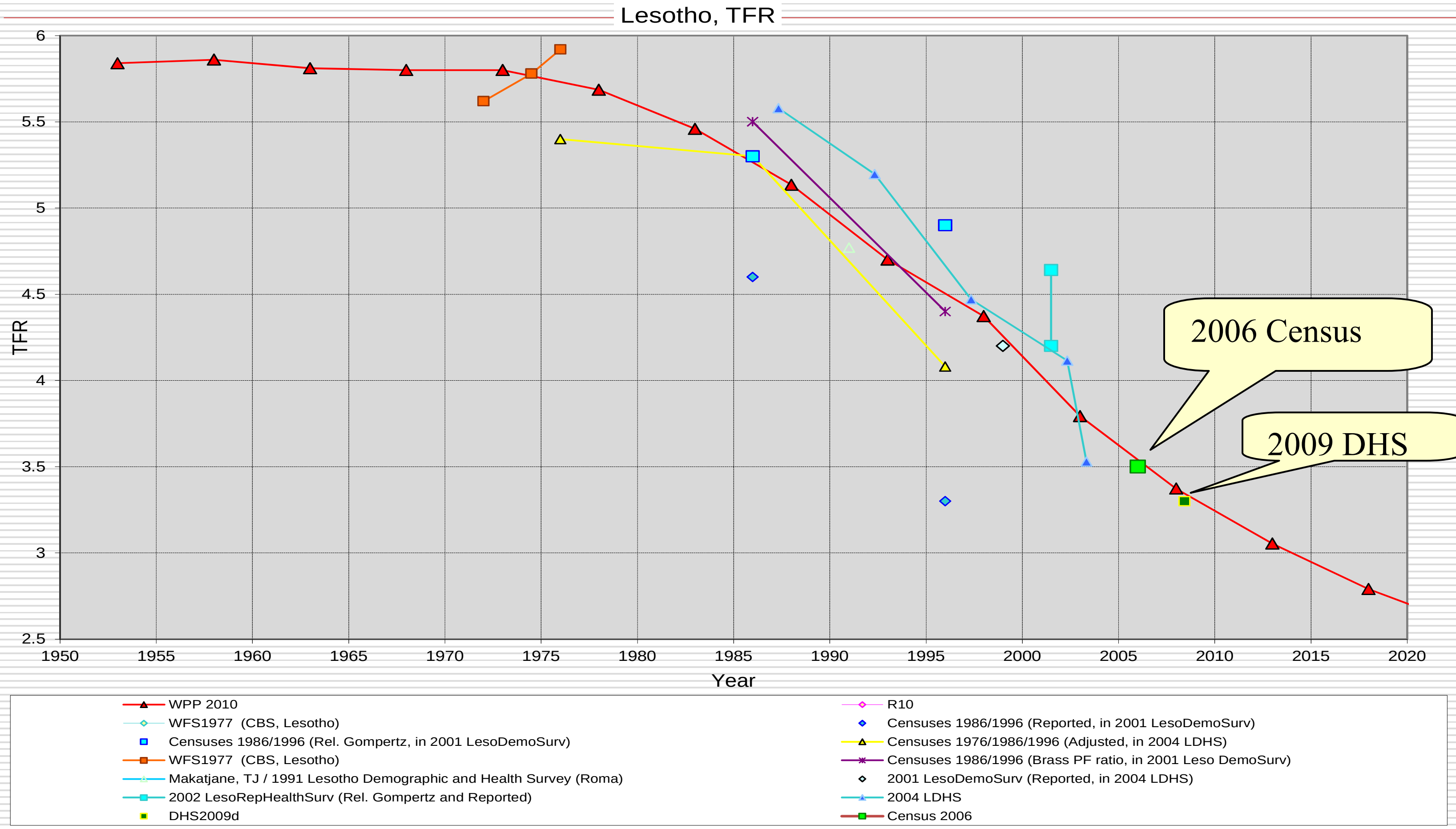
Age group	2004 DHS	2008 Census	2010 DHS
15 - 19	0.810	0.506	0.760
20 - 24	1.465	1.420	1.345
25 - 29	1.270	1.208	1.190
30 - 34	1.110	0.766	1.030
35 - 39	0.815	0.584	0.810
40 - 44	0.400	0.289	0.410
45 - 49	0.175	0.125	0.165
TFR	6.05	4.90	5.71



Estimating fertility from data collected in censuses

- To obtain new estimates of fertility
- To compare estimates from the current census with estimates available from other sources e.g. surveys

Lesotho, fertility estimates from different sources



Methods for estimating fertility

- Interpolation of average parities (Mortara, 1949)
- Brass P/F method and its variations and extensions, e.g. Arriaga (1983), Relational Gompertz model
- Methods based on population structure: Reverse Survival and Own Children Method
- Methods based on data from two or several censuses: Arriaga (1983), synthetic relational Gompertz model, parity increments

Interpolation and backdating average parities

Average parity at ages x,x+n by definition:

$$ {}_{n}P_{x} = \int_{x}^{x+n} F(a)da $$

where *F* is cohort cumulative fertility function.

- By using interpolation one can compute age-specific fertility rates from average parities, P, assuming that fertility was more or less constant before the census
- For ages with completed fertility, e.g. age > 45, we can assume that P $\approx$ TFR, total fertility for a given cohort
- By plotting P $\approx$ TFR at years defined by the census date and mean age at childbearing, one can produce estimates of historical TFR trends (Feeney, 1991, see slide presented before)
- Software: FERTCB procedure, Mortpak, UN

The P/F ratio method: Rationale

- The P/F method aims to balance out the strengths and weaknesses of CEB and recent fertility data by comparing:
  1. Cumulative fertility equivalent derived from recent fertility data "F" (trusting the age pattern of fertility but not level)
  2. Life-time average parities "P" (trusting the overall level but not the age distribution)
- The method is typically used to adjust estimates of current fertility level (computed from data on recent births or from incomplete civil registration)
- The method is also used to assess the quality of CEB data and, sometimes, the age reporting of the mother
- Works well if fertility was constant before the census (improbable now); no severe problems with the data

Source: United Nations, *Manual X*

P/F Method: Data requirements

- Total number of children ever born by 5-year age group of mother
- Recent fertility by 5-year age group of mother, measured either by:
  - Births in past year question on census
  - Births registered in year of census from vital registration
- Total number of women in each 5-year age group

P/F Method: Assumptions

- Assumptions:
  - Mis-reporting of current fertility is constant across all age groups
  - Increasing under-reporting of parity (children ever born) by age of women
  - Constant fertility (most important for youngest age groups – up to 35 or so)
    - Can be relaxed through a modification of the original P/F ratio method that uses two consecutive censuses or fertility rates derived from vital registration or another data source

P/F Method: Computational procedure

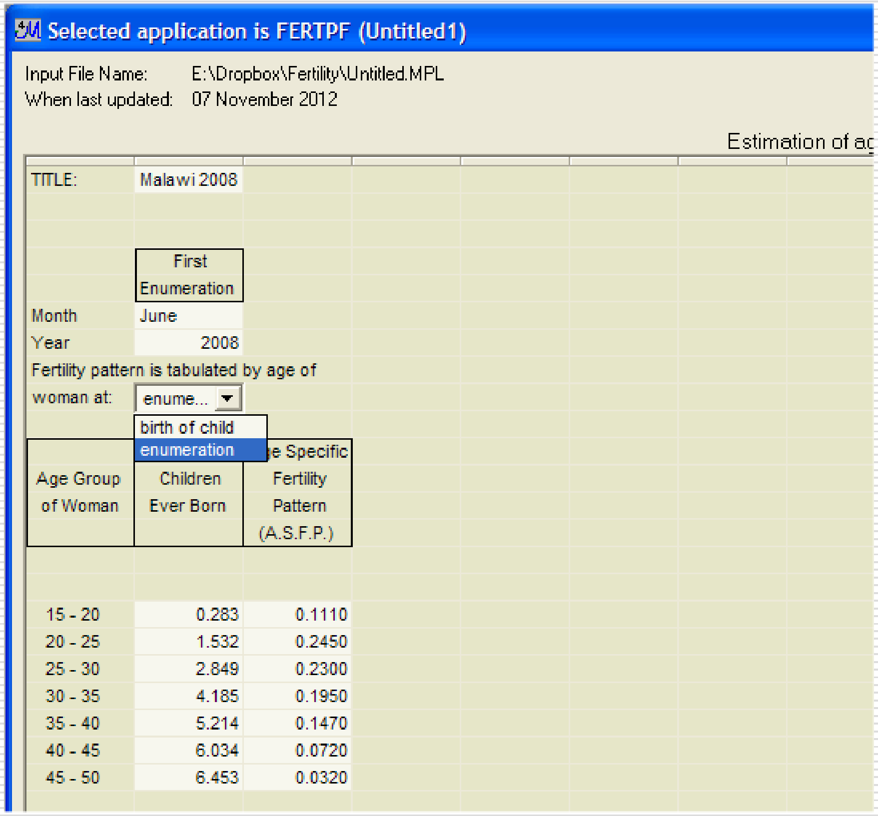
- Procedure described here follows Arriaga (1983) which is implemented in MortPak

0	1	2	3	4	5		6
Age Group	p(i)	f(i)	p*(i)	f*(i)	P(i)	F(i)	P/F
	Average CEB as shown	ASFRs as shown	CEB transformed into age-specific rates	ASFR adjusted for time of census enumeration	Cumulated P(i) and F(i)		Adjustment factor for fertility rates, usually ages groups 20-24, 25-29 or 30-35 as the most reliable

P/F method: Interpretation

- Typical "look" of P/F ratios:
  - With perfect data, ratio should be the same for all age groups and close to 1
  - In practice, ok if ratios for 20 – 24, 25 – 29 and (less important) 30 – 34 are close
- Typically, P/F ratio will decrease with women's age
- Deviation from the above typical pattern: indicates either violations of the assumptions or different patterns of under-reporting

Example in MortPak: Malawi 2008 Census


Selected application is FERTPF (Untitled1)

Input File Name: E:\Dropbox\Fertility\Untitled.MPL
When last updated: 07 November 2012

Estimation of ag

TITLE: Malawi 2008

	First Enumeration
Month	June
Year	2008

Fertility pattern is tabulated by age of woman at: enume...

birth of child
enumeration

Age Group of Woman	Children Ever Born	Age Specific Fertility Pattern (A.S.F.P.)
15 - 20	0.283	0.1110
20 - 25	1.532	0.2450
25 - 30	2.849	0.2300
30 - 35	4.185	0.1950
35 - 40	5.214	0.1470
40 - 45	6.034	0.0720
45 - 50	6.453	0.0320

Example in MortPak: Malawi 2008 Census (2)

Selected application is FERTPF (Untitled1)

Input File Name: E:\Dropbox\Fertility\Untitled.MPL
When last updated: 07 November 2012

Data Entry Help
Show Document Output

Estimation of age-specific fertility rates from data on children ever born and the age pattern of fertility, at one or two points in time.

TITLE: Malawi 2008
Arraiga's approach for estimation of ASFR for one point in time and the age pattern of fertility (Brass)

	First Enumeration
Month	June
Year	2008
Fertility pattern is tabulated by age of woman at:	enumeration

In the present case the adjustment factors for age groups 20-25, 25-30 and 30-35 are fairly consistent leading to similar levels of adjusted TFRs.

p*(i) f*(i) P(i) F(i)

Age Group of Woman	Children Ever Born	Age Specific Fertility Pattern (A.S.F.P.)	Fertility Consistent with C.E.B. (A.S.F.R.)	Fertility Pattern by Age at Survey Date	Fertility Pattern by Age at Birth of Child	Cumulation of A.S.F.R.	Cumulation of Fertility Pattern by Age at Birth	Adjustment Factors	Age Specific Fertility Rates Based on Adjustment Factor for the Age Group 20 - 25	25 - 30	30 - 35
June 2008											
				Recorded	Calculated						
15 - 20	0.283	0.1110	0.1643	0.1110	0.1320	0.1643	0.1320	1.2451	0.1527	0.1530	0.1528
20 - 25	1.532	0.2450	0.2756	0.2450	0.2482	0.4399	0.3802	1.1571	0.2872	0.2877	0.2874
25 - 30	2.849	0.2300	0.2645	0.2300	0.2276	0.7044	0.6077	1.1591	0.2633	0.2638	0.2635
30 - 35	4.185	0.1950	0.2474	0.1950	0.1908	0.9518	0.7986	1.1920	0.2208	0.2212	0.2210
35 - 40	5.214	0.1470	0.1706	0.1470	0.1411	1.1224	0.9396	1.1945	0.1632	0.1635	0.1634
40 - 45	6.034	0.0720	0.1131	0.0720	0.0663	1.2355	1.0059	1.2283	0.0767	0.0768	0.0768
45 - 50	6.453	0.0320	0.0409	0.0320	0.0261	1.2764	1.0320	1.2369	0.0302	0.0302	0.0302
Mean Age of Childbearing:			27.3075		26.8758						
Total Fertility Rate:			6.3822		5.1600				5.9707	5.9811	5.9759

P/F Method: Interpretation

- Example 1: a **declining trend in the P/F ratios** by age of women could indicate that 1) fertility has been increasing or 2) that reported data on children ever born suffer from progressively increasing omissions of children as age of women increases
- Example 2: **large fluctuations in the P/F ratios** may reflect either differential coverage by age or selective age misreporting by women
- Example 3: a **rising trend in the P/F ratios** by age of women indicates that fertility could have been decreasing in the past

Variants on the P/F method

- P/F method for first births – not affected by fertility decline through higher-parity control
- Two-census methods, deriving age schedule of fertility from the two censuses or an additional source (such as vital registration)
  - Can be implemented in MortPak FERTPF by adding optional data for second census
- The Relational Gompertz model uses the same data as the P/F model, but
  - Does not require an assumption of constant fertility
  - Compares/replaces recent fertility data with model fertility schedules to check accuracy
  - Relies on parity data for all age groups (not just younger ones)

Sources: *Estimation of fertility from the 2001 South Africa census data, Manual X, and IUSSP Demographic Estimation*

Relational Gompertz model

- An improved and more versatile version of the Brass P/F method with the same input data
- Shape of fertility distribution adheres to Gompertz relational model
- Level is estimated from average parities
- Robust
- Can be used for smoothing and extrapolation of fertility schedule
- Can be used with different standard patterns

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

Reverse Survival

- Census population by age and sex is 15-year back projected (reverse survived)
- TFR for years y-1, y-2, … y-15 computed to match births obtained by reverse survival

Assumptions

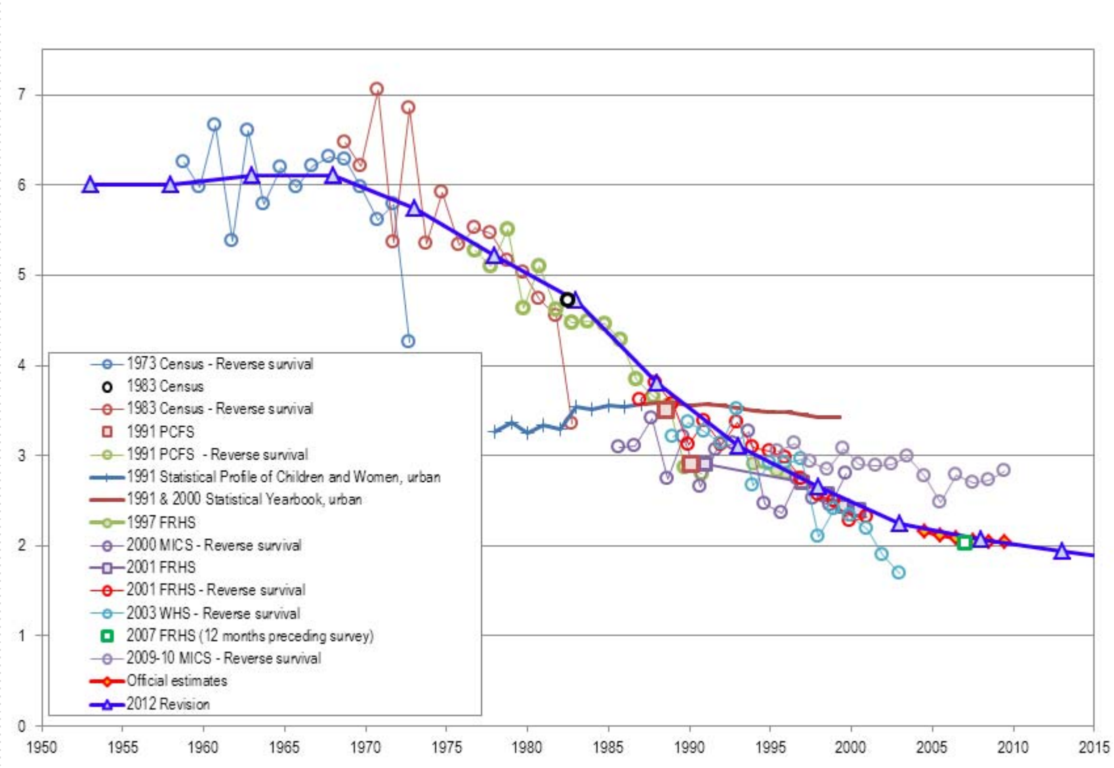
- Population by age and sex is free of errors
- Estimates of mortality are available for the period before census
- Reasonably good assumptions can be made about age pattern of fertility (PASFR)

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

Fertility estimates by Reverse Survival for Myanmar

Myanmar, Total Fertility Rate

TFR



Year

Own-children method

- Based on the same idea as reverse survival
- Produces estimates of both TFR and age pattern of fertility

Data requirements

- Distribution of own children by age and by age of mother
- Estimates of mortality for the period before census

Software

- East-West CENTER http://www.eastwestcenter.org/research/research-program-overview/population-and-health/demographic-software-available-from-the-east-west-center

Reference

Manual X: Indirect Techniques for Demographic Estimation, 1983, United Nations (Chapter 2) http://www.un.org/esa/population/publications/Manual_X/Manual_X.htm

Step 1

Obtain distribution of own children by age and by age of mother:

TABLE 161. OWN-CHILDREN DATA, WITH CHILDREN CLASSIFIED BY SINGLE YEAR OF AGE AND SINGLE YEAR AGE OF MOTHER, COLOMBIA, 1978

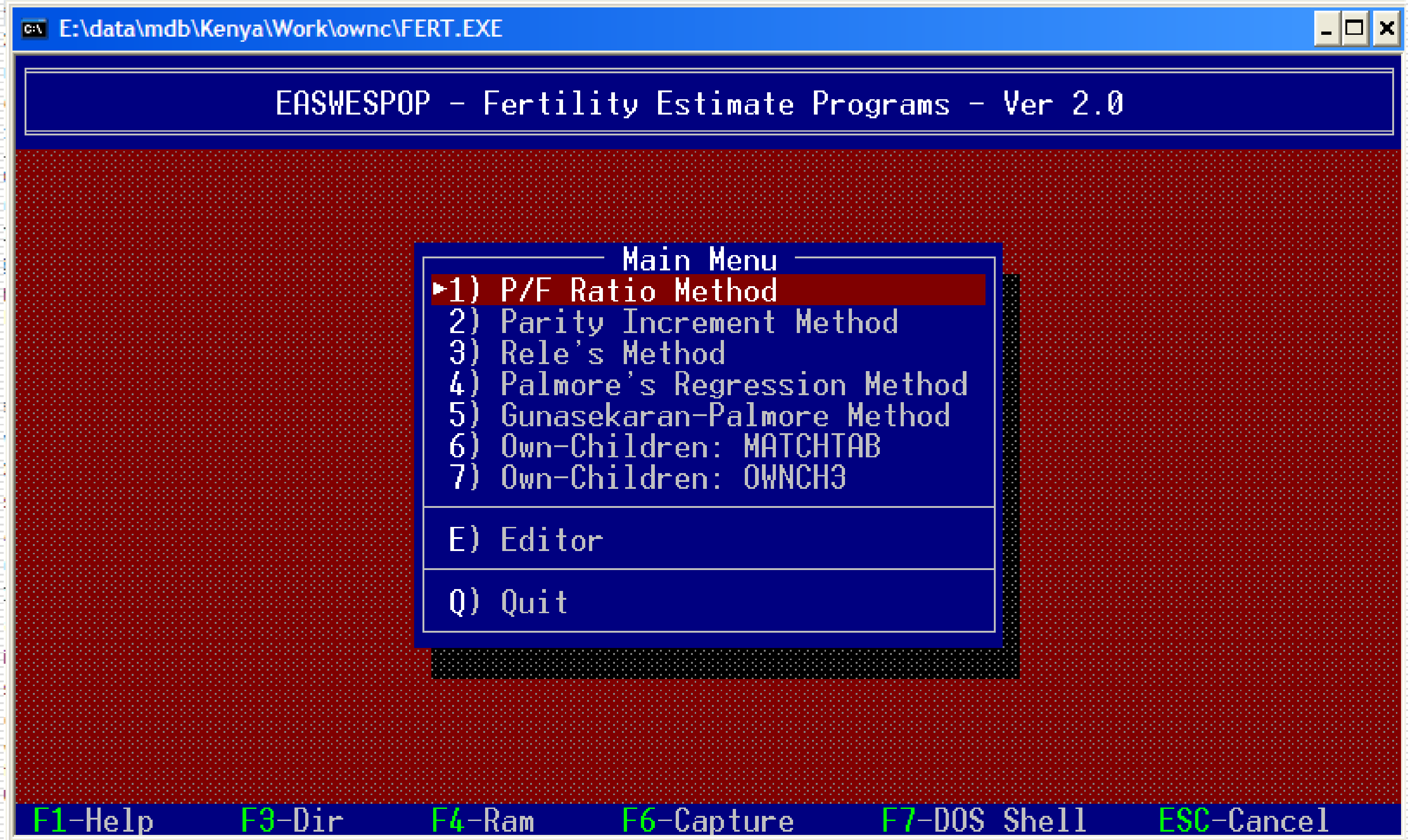
Age of mother	Number of children, by age of child																Number women
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
15	13	7	0	2	2	2	1	4	3	4	2	1	3	1	3	3	755
16	12	3	0	2	0	2	1	1	1	0	0	0	2	0	0	1	696
17	23	16	6	1	0	0	0	0	0	0	1	0	0	0	0	0	686
18	58	36	17	3	0	3	1	2	0	0	0	0	0	0	0	0	706
19	66	46	24	13	11	1	3	1	0	0	0	0	1	0	0	1	538
20	77	55	45	33	19	12	2	1	0	2	2	1	1	1	0	0	602
21	78	71	56	47	48	17	7	5	3	0	1	2	1	1	0	0	488
22	84	80	76	73	46	26	18	15	3	0	0	0	0	0	1	0	534
23	84	85	80	84	61	53	29	24	7	9	1	2	0	2	1	0	488
24	93	63	78	72	56	48	45	34	17	9	8	3	0	1	1	1	411
25	91	84	87	83	69	71	55	52	31	21	5	5	2	1	0	0	464
26	73	67	65	70	66	70	61	55	41	24	17	11	1	1	2	0	393
27	58	61	70	58	63	79	64	64	47	28	27	16	11	5	2	1	339
28	83	71	77	81	94	80	87	91	80	60	42	34	16	8	3	2	442
29	48	58	52	59	68	64	77	75	61	66	48	50	23	23	6	4	330
30	46	60	70	62	82	86	86	86	82	74	69	50	45	31	20	8	403
31	42	39	42	36	44	44	55	66	63	56	57	46	43	24	12	8	243
32	45	50	67	54	66	65	73	82	79	91	78	64	63	66	38	30	343

Usually requires tabulations of microdata. Algorithms for matching mothers and own children can be fairly complicated.

Step 2

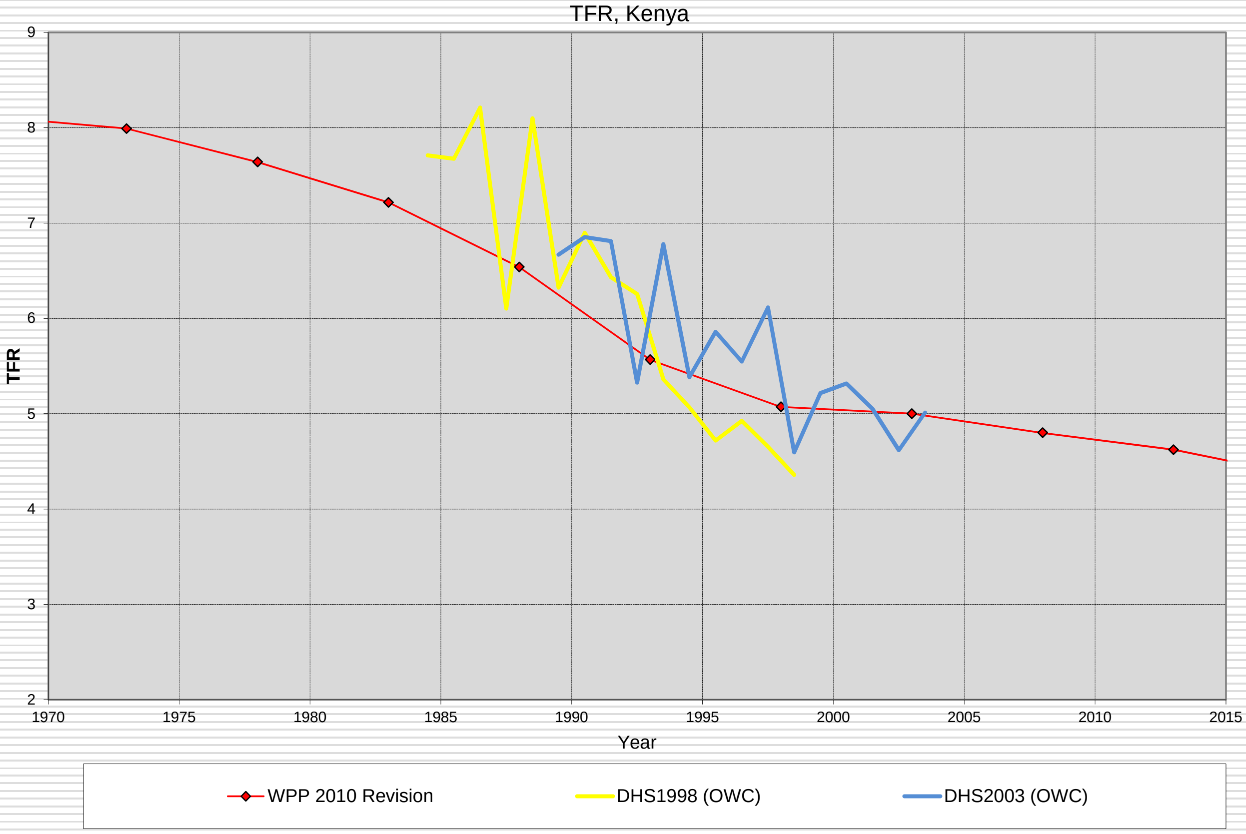
Apply reverse survival techniques to the distribution obtained at the previous step to estimate shape and level (TFR) of fertility in the last 15 year

Own-children method: FERT software



United Nations Statistics Division

Fertility Estimates by Own-Children Method, Kenya



Using DHS microdata with recorded information on mothers. Not using matching algorithm for linking mothers and own children.

References

Arriaga, EE 1983. *Estimating Fertility from Data on Children Ever Born by Age of Mother*. International Research Document No. 11. US Bureau of the Census, Washington, DC

Child survivorship estimation: methods and data analysis, Griffith Feeney, *Asian and Pacific Population Forum*, Vol. 5, Nos. 2-3, 1991

Estimation of fertility from the 2001 South Africa census data, Tom Moultrie & Rob Dorrington, Centre for Actuarial Research, University of Cape Town

IUSSP Tools for Demographic Estimation (in progress, see chapter on fertility) http://demographicestimation.iussp.org/

Manual X: Indirect Techniques for Demographic Estimation, 1983, United Nations (see Chapter 2)

http://www.un.org/esa/population/publications/Manual_X/Manual_X.htm

Cho, Lee-Jay, Robert D. Retherford, and Minja Kim Choe, 1986. *The Own-Children Method of Fertility Estimation.* Honolulu: University of Hawaii Press.

MortPak manual (accompanies software)

East-West Center (www.eastwestcenter.org) (software)

THANK YOU …..