



Data Evaluation with Consecutive Censuses: Census Coverage

United Nations Statistics Division



Outline

1. The Population Balancing Equation
2. Intercensal Cohort Survival Rates
3. Cohort Component Method



Population Balancing Equation

Census coverage



Population balancing equation

If a country has:

- A relatively complete system of vital registration
- A fairly reliable estimate of the degree of under-registration

- Information on the number of intercensal births, deaths and net international migrants can be used in conjunction with the results of a previous census to evaluate the coverage of a subsequent or current census.



Population balancing equation

$$P_1 = P_0 + B - D + M$$

Where:

P_1 = the population enumerated in the census being evaluated

P_0 = The population enumerated in a previous census

B = the number of births in the period between the two censuses

D = the number of deaths in the period between two censuses

M = the number of net international migrants in the period

$$M = I \text{ (Immigrants)} - E \text{ (Emigrants)}$$



Population balancing equation

- ❑ The population balancing equation is the most fundamental equation in demographic analysis and is also used to estimate population growth.
- ❑ It is based on the logic that:
 - The population of a country can increase or decrease between any two points in time only as a result of births, deaths and movement of population across national boundaries
 - > Births and immigration add to the population
 - > Deaths and emigration reduce the population



Population balancing equation

- ❑ For census evaluation purposes, there is a residual (e) needed to make the equation balance exactly
- ❑ “ e ” in the equation is referred to as the “error of closure” and represents the balance of errors in the data on births, deaths, net migration, and the coverage of the two censuses:

$$P_1 = P_0 + B - D + M + e$$

- *If a negative residual quantity e , P_1 is under-enumerated relative to P_0*
- *If a positive residual is required to balance the equation, P_1 is over-enumerated relative to P_0*



Population balancing equation – Data required

- ❑ The population enumerated in two consecutive censuses
 - > P_1 : the census under evaluation
 - > P_0 : previous census

- ❑ The number of births, deaths and net international migration (immigrants-emigrants) during the intercensal period, adjusted for under-registration (to the extent possible)



Population balancing equation – Computational Procedure

1. Compile registered numbers of intercensal births, deaths and migrants
 - ❑ Vital registration system
 - ❑ Immigration record system (residence permit, border records, etc.)
 - Adjustment based on under-coverage of these systems including indirect estimates

2. Calculation of the “expected” census population ($E(P_1)$)

$$E(P_1) = P_0 + B - D + M$$

3. Calculation of the residual error or error of closure

$$e = P_1 - E(P_1)$$



Population balancing equation – Interpretation of “e”

- ❑ If P_0 has been adjusted for net coverage error, the estimated residual error (e) will represent an estimate of net coverage error in P_1
 - > If “e” is positive, P_1 is over-enumerated
 - > If “e” is negative, P_1 is under-enumerated

- ❑ If P_0 is not adjusted, “e” will represent an estimate of the relative level of net coverage error in P_1 in comparison with P_0



Population balancing equation – Example Sri Lanka, 1971 and 1981 Censuses (1)

For an unadjusted census:

$$\begin{aligned} E(P_1) &= P_0 \text{ (unadjusted)} + B_{\text{adj}} - D_{\text{adj}} + M_{\text{adj}} \\ &= 12,689,897 + 3,716,878 - 1,002,108 + (-446,911) \\ &= 14,957,756 \end{aligned}$$

$$\begin{aligned} e &= P_1 - E(P_1) \\ &= 14,848,364 - 14,957,756 \\ &= -109,392 \text{ } 0.7\% \text{ of } E(P_1) \end{aligned}$$

P_1 is under-enumerated relative to P_0

Source: U.S. Census Bureau (1985)



Population balancing equation – Example Sri Lanka, 1971 and 1981 Censuses (2)

For an adjusted census count:

$$\begin{aligned} E(P_1) &= P_0 \text{ (adjusted)} + B_{\text{adj}} - D_{\text{adj}} + M_{\text{adj}} \\ &= 12,849,796 + 3,716,878 - 1,002,108 + (-446,911) \\ &= 15,117,655 \end{aligned}$$

$$\begin{aligned} e &= P_1 - E(P_1) = 14,848,364 - 15,117,655 \\ &= -269,291 \text{ } 1.8\% \text{ of } E(P_1) \end{aligned}$$

P₁ is under-enumerated

Source: U.S. Census Bureau (1985)



Population balancing equation – Limitations

- ❑ Incomplete and defective data on the components of population change are very common
 - Applicability of the method is limited to countries with good vital registration coverage and migration data
- ❑ It is generally not useful for obtaining estimates of net census coverage error for sub-national populations (for example regions, provinces).
 - In addition to the components of population change considered, internal migration has to be considered.
 - For most practical purposes, the use of the population balancing equation is limited to analysis of net coverage error at the national level.



Cohort Survival Ratios

Mortality and census coverage



Cohort survival ratios

- ❑ This technique is based on a comparison of the size of birth cohorts enumerated in successive censuses
- ❑ In the absence of census errors, the ratio of the number of persons in a cohort enumerated in the second census to the number enumerated in the first census should approximate the survival rate that would be expected on the basis of mortality conditions
 - E.g. we have a cohort of males aged 40 – 44 at the time of the first census, say in 2000
 - If the next census is held exactly 10 years later, in 2010, this cohort will be aged 50 – 54
 - In the absence of other factors, we expect their numbers to have been reduced only by the life table quantity ${}_{10}d_x = l_x - l_{x+n}$, the number of deaths to those aged x over the subsequent 10 years

Source: U.S. Census Bureau (1985); Moultrie et al. (2013)

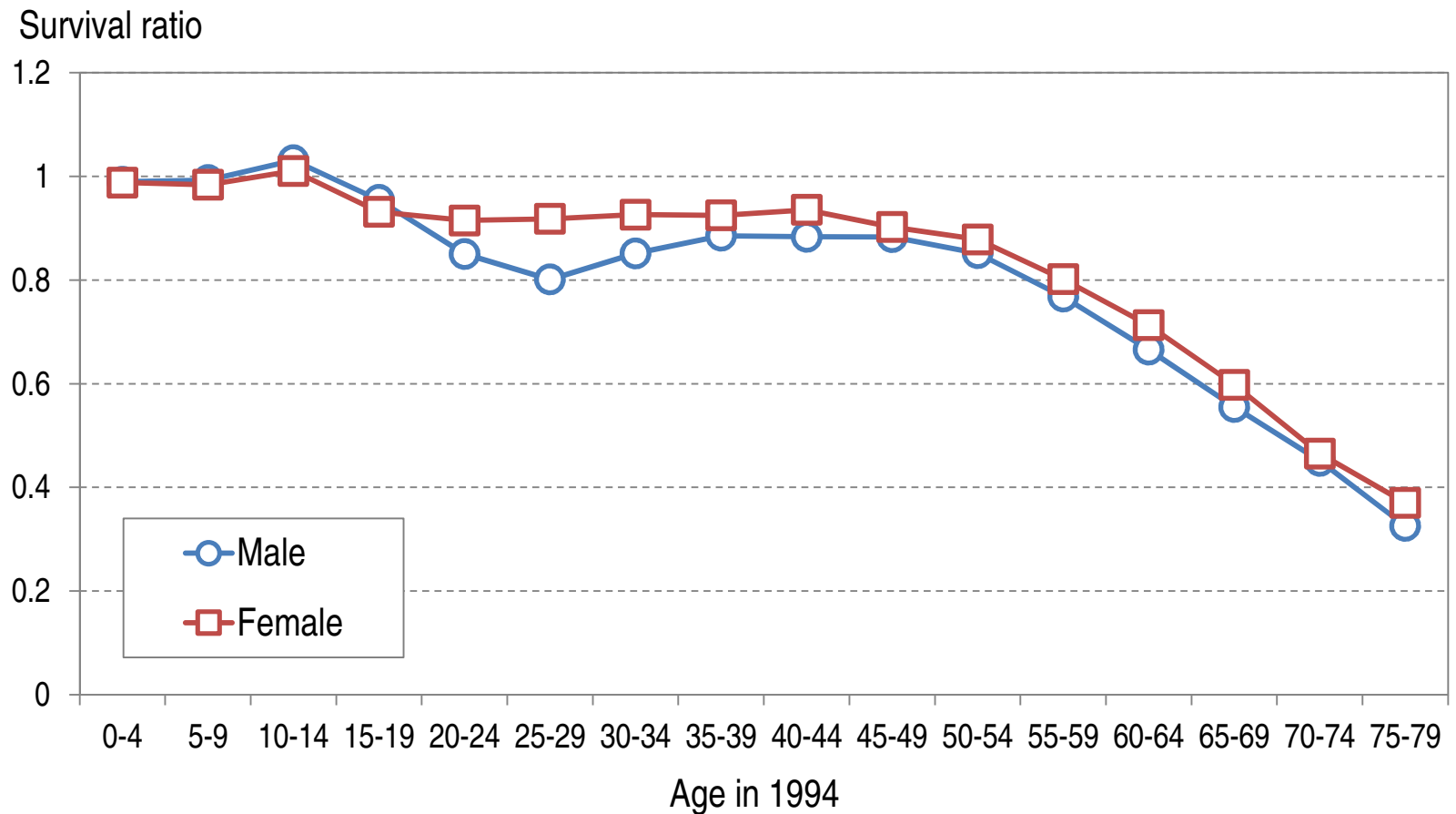


Cohort Survival Ratios: Caveats

- ❑ The method is less useful when other factors make it difficult to determine whether deviations from the expected CSR are due to census error or something else
 - Substantial net migration (unless there are accurate estimates of net migration by age)
 - Changes in country borders between censuses
 - Changes in the population groups included in the two censuses (e.g. active military, nomadic groups) if the size of these groups is substantial

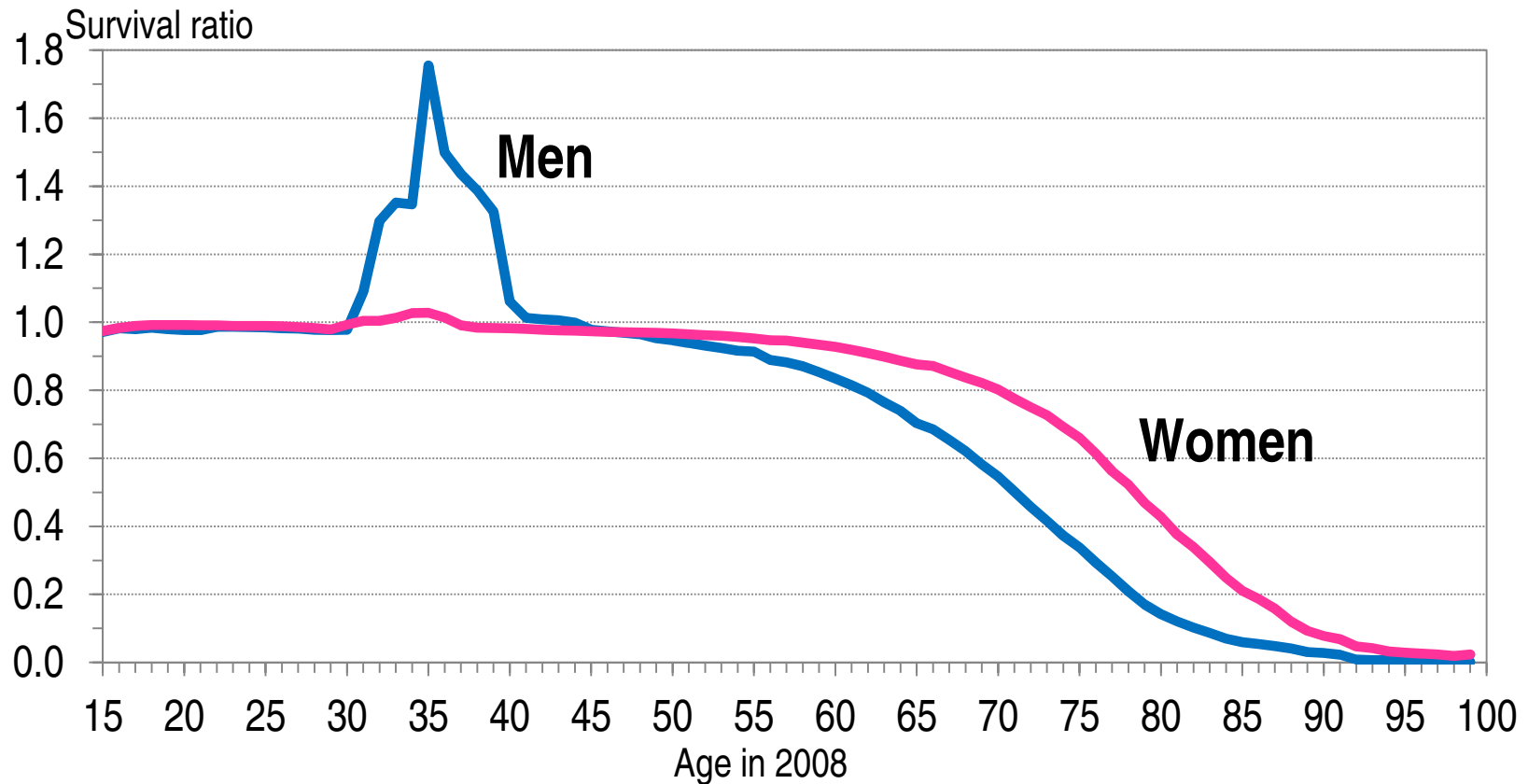


Cohort Survival Ratios: Jordan, 1994 & 2004 Censuses





Cohort Survival Ratios: DPR Korea



Source: Spoorenberg & Schwekendiek (2012).



Calculating CSRs (1)

Intercensal cohort survival rates are defined as:

$${}_n\text{CSR}_x(a) = \frac{{}_n\text{P}_{x+a}(t+a)}{{}_n\text{P}_x(t)}$$

Where:

- t = time of first census
 - a = number of years between censuses
 - ${}_n\text{P}_x(t)$ = size of the cohort at the time of the first census
 - ${}_n\text{P}_{x+a}(t+a)$ = size of the cohort at the time of the second census
-



Calculating CSRs (2)

The ratio of the observed intercensal cohort survival rate to the corresponding life-table survival rate

$${}_nR_x = \frac{{}_nP_{x+a}(t+a) / {}_nP_x(t)}{{}_nL_{x+a} / {}_nL_x}$$

Where:

- ${}_nP_{x+a}(t+a)$ = size of the cohort at time of the second census
- ${}_nP_x(t)$ = size of the cohort at the time of the first census
- ${}_nL_{x+a}$ = life table number of person-years lived in age interval $x+a$ to $x+a+n$ years
- ${}_nL_x$ = life table number of person-years lived in age interval x to $x+n$ years



Cohort Survival Ratio - Interpretation

In the **absence of census error**, the expected value of the ratio (${}_nR_x$) would be **1.0**

Ratio values for any particular cohort which **exceed 1.0** would indicate **over-enumeration** of the cohort in the second census relative to the first census

Ratio values of **less than 1.0** would indicate **under-enumeration** of the cohort in the second census relative to the first census



Cohort survival ratios – Example (1)

Step 1: Adjustment for migration (if appropriate)

- In countries experiencing significant levels of net intercensal immigration, the number of net immigrants in each cohort may either added to the cohort enumerated in the first census or subtracted from the cohort enumerated in the second census
 - In cohorts experiencing net intercensal emigration, the number of net intercensal emigrants can either added to the second census or subtracted from the first census
 - Should be confident that migration data is reasonably accurate before making any adjustments
-



Cohort survival ratios – Example (2)

Step 2: Calculation of census survival rates using two consecutive censuses ${}_n P_{x+a}(t+a) / {}_n P_x(t)$

The screenshot shows an Excel spreadsheet titled 'CSR.xls' with the following data:

	1 Aug 2000		1 Aug 2010		Cohort Survival Ratio 2000 - 2010	
	Male	Female	Male	Female	Male	Female
0 - 4	8,326,926	8,048,802	7,016,987	6,779,172		
5 - 9	8,402,353	8,139,974	7,624,144	7,345,231		
10 - 14	8,777,639	8,570,428	8,725,413	8,441,348	1.0479	1.0488
15 - 19	9,019,130	8,920,685	8,558,868	8,432,002	1.0186	1.0359
20 - 24	8,048,218	8,093,297	8,630,227	8,614,963	0.9832	1.0052
25 - 29	6,814,328	7,035,337	8,460,995	8,643,418	0.9381	0.9689
30 - 34	6,363,983	6,664,961	7,717,657	8,026,855	0.9589	0.9918
35 - 39	5,955,875	6,305,654	6,766,665	7,121,916	0.9930	1.0123
40 - 44	5,116,439	5,430,255	6,320,570	6,688,797	0.9932	1.0036
45 - 49	4,216,418	4,505,123	5,692,013	6,141,338	0.9557	0.9739
50 - 54	3,415,678	3,646,923	4,834,995	5,305,407	0.9450	0.9770
55 - 59	2,585,244	2,859,471	3,902,344	4,373,875	0.9255	0.9709
60 - 64	2,153,209	2,447,720	3,041,034	3,468,085	0.8903	0.9510
65 - 69	1,639,325	1,941,781	2,224,065	2,616,745	0.8603	0.9151
70 - 74	1,229,329	1,512,973	1,667,373	2,074,264	0.7744	0.8474
75 - 79	780,571	999,016	1,090,518	1,472,930	0.6652	0.7585
80 - 84	428,501	607,533	668,623	998,349	0.5439	0.6599
85 - 89	208,088	326,783	310,759	508,724	0.3981	0.5092
90 - 94	65,117	115,309	114,964	211,595	0.2683	0.3483
95 - 99	19,221	36,977	31,529	66,806	0.1515	0.2044
100 +	10,423	14,153	7,247	16,989		



Cohort survival ratios – Example (3)

Step 3: Calculation of life table survival rates based on the expected level of mortality

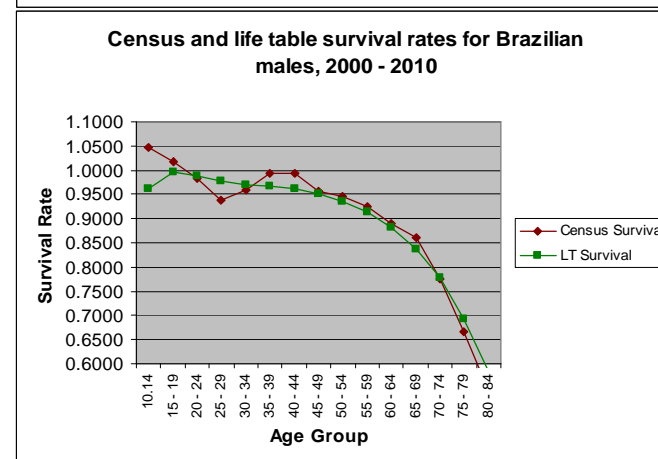
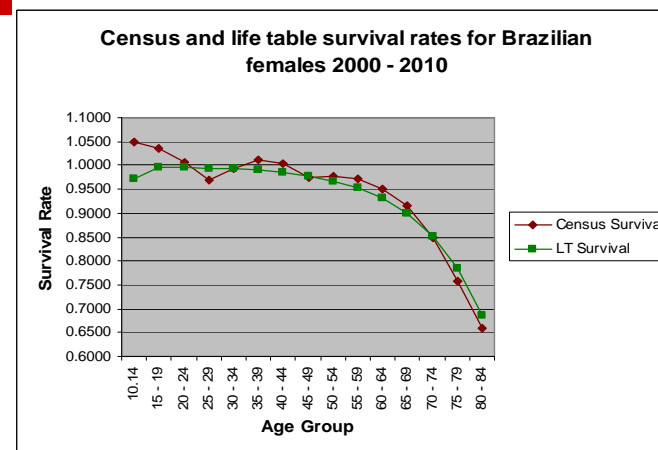
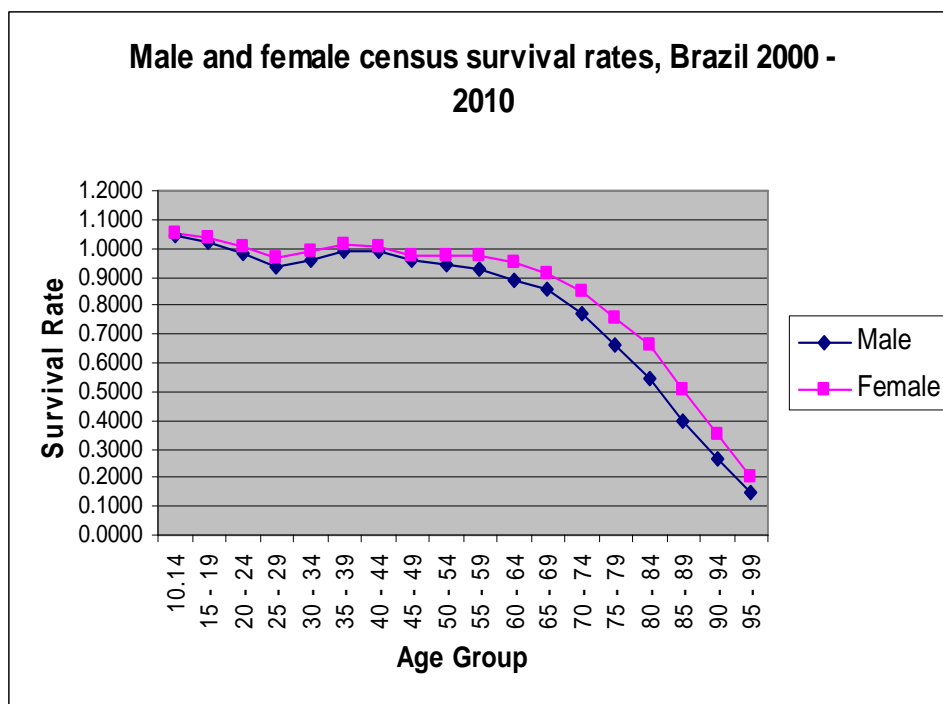
$$nS_x = (nL_{x+a} / nL_x)$$

Step 4: Calculation of cohort survival ratios (nRx)

1 Aug 2000		1 Aug 2010		Cohort Survival Ratio 2000 - 2010		Life Table Survival Rate		nRx			
Male	Female	Male	Female	Male	Female	Male	Female	Male	Female		
0 - 4	8,326,926	8,048,802	0 - 4	7,016,987	6,779,172						
5 - 9	8,402,353	8,139,974	5 - 9	7,624,144	7,345,231						
10 - 14	8,777,639	8,570,428	10 - 14	8,725,413	8,441,348	1.0479	1.0488	0.9623	0.9722	1.0889	1.0788
15 - 19	9,019,130	8,920,685	15 - 19	8,558,868	8,432,002	1.0186	1.0359	0.9954	0.9970	1.0234	1.0389
20 - 24	8,048,218	8,093,297	20 - 24	8,630,227	8,614,963	0.9832	1.0052	0.9887	0.9960	0.9944	1.0092
25 - 29	6,814,328	7,035,337	25 - 29	8,460,995	8,643,418	0.9381	0.9689	0.9771	0.9940	0.9601	0.9748
30 - 34	6,363,983	6,664,961	30 - 34	7,717,657	8,026,855	0.9589	0.9918	0.9703	0.9920	0.9883	0.9998
35 - 39	5,955,875	6,305,654	35 - 39	6,766,665	7,121,916	0.9930	1.0123	0.9668	0.9892	1.0271	1.0233
40 - 44	5,116,439	5,430,255	40 - 44	6,320,570	6,688,797	0.9932	1.0036	0.9611	0.9850	1.0334	1.0188
45 - 49	4,216,418	4,505,123	45 - 49	5,692,013	6,141,338	0.9557	0.9739	0.9511	0.9780	1.0048	0.9959
50 - 54	3,415,678	3,646,923	50 - 54	4,834,995	5,305,407	0.9450	0.9770	0.9352	0.9672	1.0105	1.0102
55 - 59	2,585,244	2,859,471	55 - 59	3,902,344	4,373,875	0.9255	0.9709	0.9133	0.9521	1.0134	1.0198
60 - 64	2,153,209	2,447,720	60 - 64	3,041,034	3,468,085	0.8903	0.9510	0.8810	0.9304	1.0105	1.0221
65 - 69	1,639,325	1,941,781	65 - 69	2,224,065	2,616,745	0.8603	0.9151	0.8367	0.8982	1.0282	1.0188
70 - 74	1,229,329	1,512,973	70 - 74	1,667,373	2,074,264	0.7744	0.8474	0.7778	0.8520	0.9956	0.9947
75 - 79	780,571	999,016	75 - 79	1,090,518	1,472,930	0.6652	0.7585	0.6930	0.7835	0.9600	0.9681
80 - 84	428,501	607,533	80 - 84	668,623	998,349	0.5439	0.6599	0.5844	0.6843	0.9307	0.9643
85 - 89	208,088	326,783	85 - 89	310,759	508,724	0.3981	0.5092				
90 - 94	65,117	115,309	90 - 94	114,964	211,595	0.2683	0.3483				
95 - 99	19,221	36,977	95 - 99	31,529	66,806	0.1515	0.2044				
100 +	10,423	14,153	100 +	7,247	16,989						



Cohort survival ratios – Example (4)





Cohort Survival: Uses and limitations

- ❑ It is a widely applicable approach for examining error in consecutive censuses
 - ❑ Method requires relatively little information
 - Information on the level of fertility is not required since the method does not assess the coverage of the population born between two censuses
 - ❑ Method is complicated by migration etc. as discussed
 - ❑ When only two censuses are available, the method suffers from the limitations shared by many demographic methods, namely difficulties in separating census errors from real irregularities caused by extraordinary events
 - The utility of census survival approaches increases significantly when three or more censuses are available
-

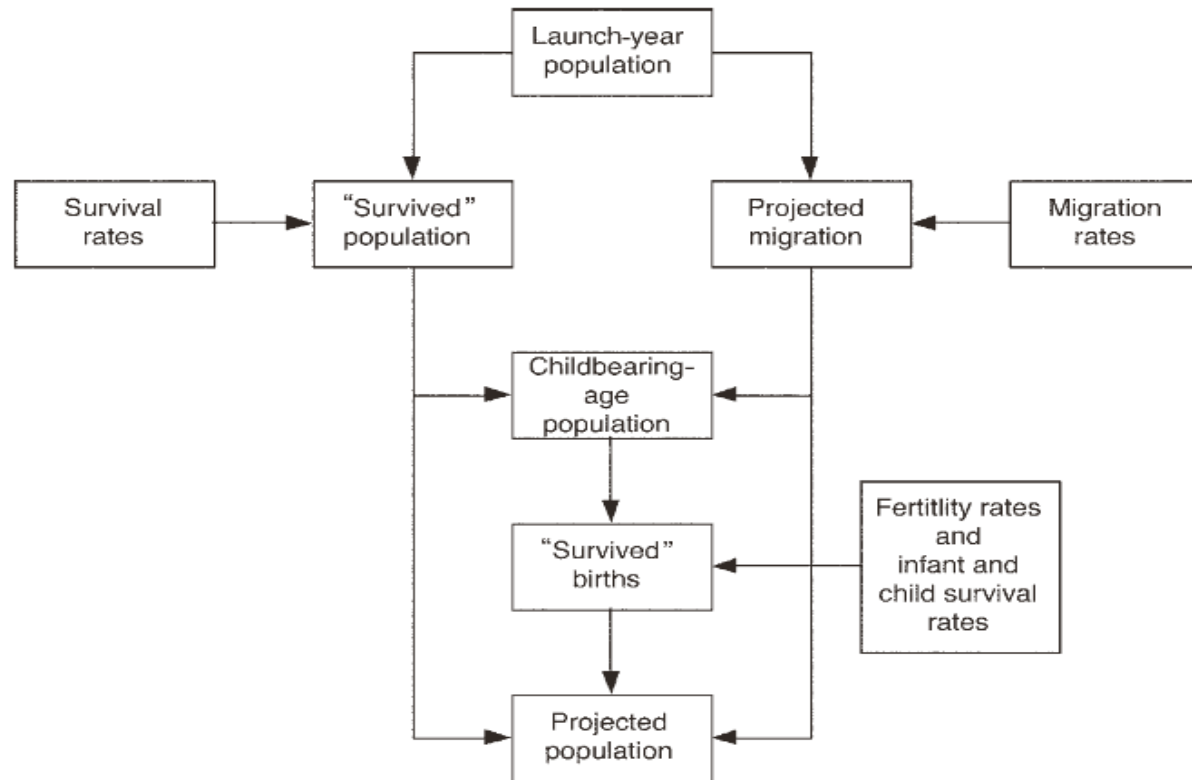


Cohort Component Method

Census coverage



Overview of cohort-component method



Smith, S., J. Tayman, and D. A. Swanson. 2001. *State and Local Population Projections: Methodology and Analysis*. New York: Kluwer Academic/Plenum Publishers.



Cohort component method

- ❑ In this approach, the population enumerated in the first census is projected to the reference date of the second census based on estimated levels and age schedules of fertility, mortality and migration during the intercensal period
 - ❑ The expected population from the projection is then compared with the actual population enumerated in the second census
 - ❑ Data for intercensal births, deaths and migration are taken from estimates and/or assumptions regarding the level and age schedules of these parameters rather than directly available data based on registration systems
-



Cohort component method – data required

1. The population enumerated in two censuses by age and sex
 2. Age specific fertility rates for women aged 15 to 49 (in 5-year age groups), assumed to represent the level and age structure of fertility during the intercensal period
 3. Life table survival rates for males and females, assumed to be representative of mortality conditions during the intercensal period
 4. An estimate of sex ratio at birth
 5. Estimates of the level and age pattern of net international migration during the intercensal period if the level of net migration is substantial
-



Cohort component method – overview of computational steps

1. “Survive” the age distribution at the initial census to the time of the second census
 1. Multiply each age group population by life table survival rates
 2. Open-ended interval requires special handling
 2. Make any necessary adjustments for migration
 3. Calculate the number of births during the period
 1. Average initial and projected population for each age group between 15 – 49 to estimate mid-period female population
 2. Apply age-specific birth rates to these populations to generate total numbers of births during time period
 3. Apply sex ratio factor to get female and male births from total births
 4. Apply life table survivorship to these births to determine number that survive to time of the second census
 5. Compare the estimated female population by age group with the enumerated female population
-



Cohort component method – Step 1 (survive initial age distribution)

1. "Survive" the age distribution at the initial census to the time of the second census

$${}_nS_x = \frac{{}_nL_{x+a}}{{}_nL_x}$$

		Census Enumeration 1 Aug 2000		Life table survival rates		Expected Population in 2010	
		Male	Female	Male	Female	Male	Female
1	Brazil						
2	B07 Population by age, sex and urban/rural residence						
3							
4							
5							
6	0 - 4	8,326,926	8,048,802				
7	5 - 9	8,402,353	8,139,974				
8	10 - 14	8,777,639	8,570,428	0.99281	0.99503	8,267,036	8,008,838
9	15 - 19	9,019,130	8,920,685	0.99276	0.99666	8,341,531	8,112,748
10	20 - 24	8,048,218	8,093,297	0.98297	0.99500	8,628,127	8,527,591
11	25 - 29	6,814,328	7,035,337	0.97325	0.99298	8,777,887	8,858,106
12	30 - 34	6,363,983	6,664,961	0.96850	0.99068	7,794,673	8,017,830
13	35 - 39	5,955,875	6,305,654	0.96426	0.98730	6,570,784	6,946,002
14	40 - 44	5,116,439	5,430,255	0.95656	0.98179	6,087,561	6,543,601
15	45 - 49	4,216,418	4,505,123	0.94364	0.97290	5,620,207	6,134,792
16	50 - 54	3,415,678	3,646,923	0.92494	0.96004	4,732,385	5,213,261
17	55 - 59	2,585,244	2,859,471	0.89822	0.94100	3,241,000	3,528,156
18	60 - 64	2,153,209	2,447,720	0.86000	0.91000	2,500,000	2,838,000
19	65 - 69	1,639,325	1,941,781	0.80000	0.85000	1,300,000	1,500,000
20	70 - 74	1,229,329	1,512,973	0.70000	0.75000	800,000	940,000
21	75 - 79	780,571	999,016	0.60000	0.65000	400,000	500,000
22	80+	731,350	1,100,755				
23							
24							
25							
26							
27							



Cohort component method – Step 1 (survive initial age distribution)

2. For the oldest age category (open-ended)

$$wS_x = \frac{wT_{x+a}}{wT_x}$$

w = the oldest age attainable in the population

a = the length of the projection interval

wS_x = the life table survival ratio for the population aged x and above

wT_x = the number of life table persons lived at ages x and above

wT_{x+a} = the number of life table person-years lived at ages $x+a$ and above

		Census Enumeration 1 Aug 2000		Life table survival rates		Expected Population in 2010	
		Male	Female	Male	Female	Male	Female
6	0 - 4	8,326,926	8,048,802				
7	5 - 9	8,402,353	8,139,974				
8	10 - 14	8,777,639	8,570,428	0.99281	0.99503	8,267,036	8,008,838
9	15 - 19	9,019,130	8,920,685	0.99276	0.99666	8,341,531	8,112,748
10	20 - 24	8,048,218	8,093,297	0.98297	0.99500	8,628,127	8,527,591
11	25 - 29	6,814,328	7,035,337	0.97325	0.99298	8,777,887	8,858,106
12	30 - 34	6,363,983	6,664,961	0.96850	0.99068	7,794,673	8,017,830
13	35 - 39	5,955,875	6,305,654	0.96426	0.98730	6,570,784	6,946,002
14	40 - 44	5,116,439	5,430,255	0.95656	0.98179	6,087,561	6,543,601
15	45 - 49	4,216,418	4,505,123	0.94364	0.97290	5,620,207	6,134,792
16	50 - 54	3,415,678	3,646,923	0.92494	0.96004	4,732,385	5,213,261
17	55 - 59	2,885,244	2,859,471	0.89822	0.94193	3,787,266	4,243,528
18	60 - 64	2,153,209	2,447,720	0.86007	0.91534	2,937,715	3,338,156
19	65 - 69	1,639,325	1,941,781	0.80924	0.87668	2,092,085	2,506,838
20	70 - 74	1,229,329	1,512,973	0.73828	0.82033	1,589,662	2,007,940
21	75 - 79	780,571	999,016	0.64175	0.73737	1,052,036	1,431,809
22	80+	731,350	1,100,755	0.39246	0.43807	482,460	662,789



Cohort component method – Step 2 (adjust for migration)

If net international migration is substantial, the “survived” cohort population must be adjusted to reflect the effects of migration

- The introduction of net migrants by age group at the mid-point of the projection period and the survival of net migrants to the end of the period:

$${}_n\hat{M}_{x+i} = \frac{1}{4} {}_nM_x (1 + {}_nS_x) + \frac{1}{4} {}_nM_{x+i} (1 + {}_nS_{x+i})$$

Assumptions: i) An equal distribution of net migrants across years of the intercensal period, ii) Migrants have the same fertility and mortality level as the enumerated population



Cohort component method – Step 3 (calculate births)

1. Calculate the average number of women in each childbearing age group (15 – 49) during the intercensal period in order to estimate the number of births during the projection period

$${}_n\bar{P}_x = \frac{{}_nP_x^0 + {}nP_x^1}{2}$$

${}_nP_x$ = average number of females aged x to $x+n$ in the projection period

${}_nP_x^0$ = number of females aged x to $x+n$ at the beginning of the projection period

${}_nP_x^1$ = projected number of females aged x to $x+n$ at the end of the projection period



Cohort component method – Step 3 (calculate births)

2. Calculate total births during the period

$$B = \sum_{x=15}^{49} (\bar{n}P_x * n f_x) \text{ for 1-year projection}$$

$$B = 5 * \sum_{x=15}^{49} (\bar{n}P_x * n f_x) \text{ for 5-year projection period}$$

B = the estimated number of births during the projection period

$\bar{n}P_x$ = the average number of women in the age group x to $x+n$ years during the projection period

$n f_x$ = the age specific fertility rate (per woman) for women age x to $x+n$ years during the projection period

	A	B	C	D	E	F	G
1	Brazil Cohort Component Method - Fertility Calculations						
2							
3		Female pop 2000 (actual)	Female pop 2005 (projected)	Mid-period female pop	ASFR	Births	
4	15 - 19	8,920,685	8,553,526	8,737,106	0.0860	3,756,999	
5	20 - 24	8,093,297	8,893,637	8,493,467	0.1311	5,567,468	
6	25 - 29	7,035,337	8,060,964	7,548,150	0.1109	4,185,449	
7	30 - 34	6,664,961	6,997,692	6,831,326	0.0690	2,356,842	
8	35 - 39	6,305,654	6,615,729	6,460,692	0.0375	1,211,315	
9	40 - 44	5,430,255	6,236,906	5,833,581	0.0130	379,124	
10	45 - 49	4,505,123	5,341,348	4,923,236	0.0026	64,051	
11						17,521,248	
12							
13							
14							
15							



Cohort component method – Step 3 (calculate births)

3. Calculate proportion of male and female births

$$B^f = 1 - \frac{SRB}{1 + SRB}$$

$$\begin{aligned} B^f &= 1 - (1.05)/(1+1.05) = .488 \\ &= .488 * 17,521,248 = 8,550,369 \end{aligned}$$

$$B^m = \frac{SRB}{1 + SRB}$$

$$\begin{aligned} B^m &= (1.05)/(1+1.05) = .512 \\ &= .512 * 17,521,248 = 8,970,879 \end{aligned}$$



Cohort component method – Step 4 (survive intercensal births)

3. Apply life table survivorship to these births to determine number that survive to time of the second census

$${}_5P_0^f = B^f * {}_5S_0$$

$${}_5S_0 = 484,129/500,000 = .968$$

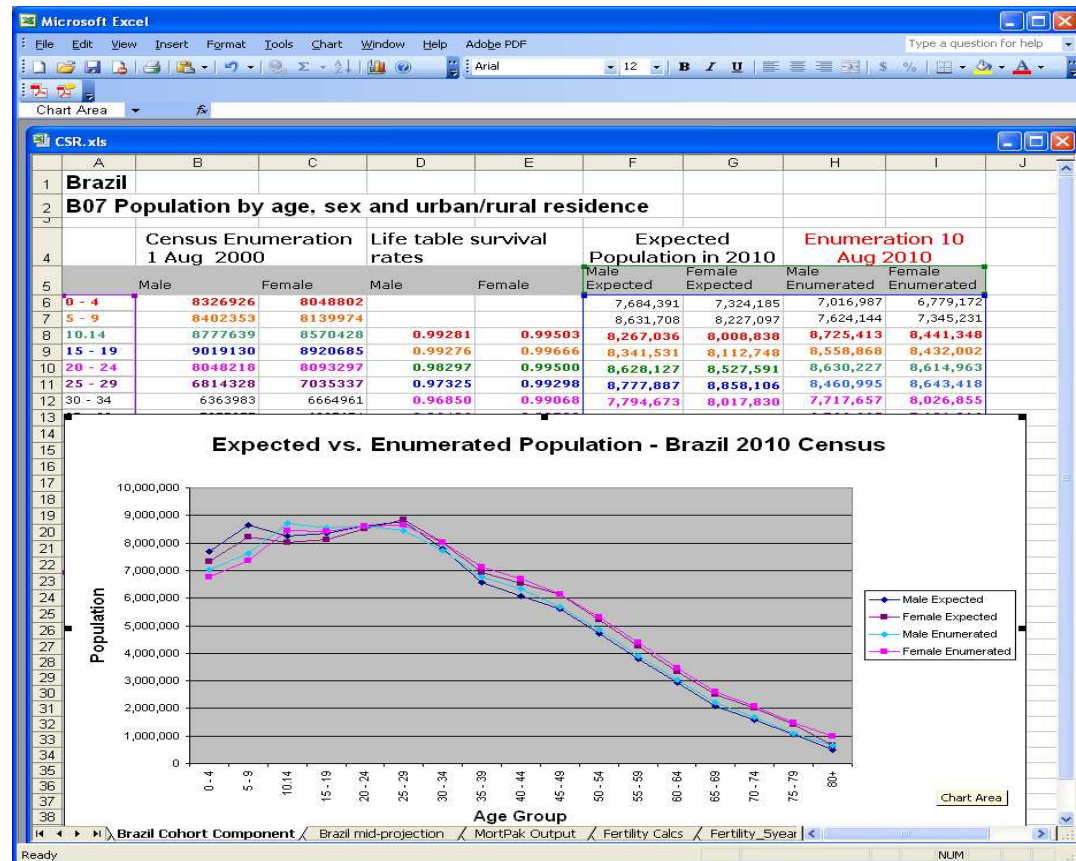
$${}_5S_0 = \frac{{}_5L_0}{5 * I_0}$$

$${}_5P_0^f = .968 * 8,550,369 = 8,276,757$$



Cohort component method – Step 5 (compare with enumerated population)

Final step in procedure is to compare the enumerated population by age and sex in the second population with the expected population





Cohort component method in MortPak (1)

Selected application is PROJCT (Brazil_PROJCT.mpl)

Input File Name: C:\Documents and Settings\Maia.Sieverding\My Documents\Census Eval
When last updated: 01 August 2012

Single-year population projection based on cohort-component technique.

TITLE: Brazil 2000 - 2010

Year of Base Population (4 digits): 2000
Month of Base Population: August
Day of Base Population: 01
End Year of Projection: 2010
Display/Print Projection Results Every: 1 Year

Open Age Group of Base Population: 80+
Sex Ratio at Birth (e.g. 1.05): 1.05
Model Life Table Pattern: User-Defined Model
Title for User Defined Model: Brazil LT

Enter data below only if "User-Defined Model" was selected as the model life table pattern.

Age Group	Males	Females
0 - 1	0.02967	0.02183
1 - 5	0.00625	0.00460
5 - 10	0.00218	0.00151
10 - 15	0.00246	0.00145
15 - 20	0.00882	0.00256
20 - 25	0.01422	0.00347
25 - 30	0.01571	0.00458
30 - 35	0.01776	0.00623
35 - 40	0.02150	0.00879
40 - 45	0.02796	0.01334
45 - 50	0.03793	0.01975
50 - 55	0.05068	0.02876
55 - 60	0.07192	0.04206
60 - 65	0.09849	0.06237
65 - 70	0.13727	0.09135
70 - 75	0.19677	0.13768
75 - 80	0.27248	0.20644
80 - 85		

Derived e(0): 67.95000 75.62000

MORTPAK for Windows (version 4.0)

Data required for PROJCT

Title: A data description of up to 40 characters, to be included in the heading at the top of the page of output.

Year of base population: Indicates the year for the starting date of the projection; for example, 1985.

Month of base population: Indicates the month for the starting date of the projection.

Day of base population: Indicates the day of the month for the starting date of the projection. Value must be between 1 and 31.

End year of projection: Indicates the ending year of the projection; for example 2000.

Display/print projection results every x years: Indicates the print cycle for the projection results. For example, if a value of 5 is given, projections results are printed every fifth projection year.

Final open-age group of base population: Indicates the final open-age group for the male and female population. The population open-age group must be at a minimum of 65+ and at a maximum of 85+.

Sex ratio at birth: Sex ratio at birth (e.g., 1.05). The sex ratio at birth must be between 0.75 and 1.5.

Model life-table pattern: Indicates the model life-table pattern to be used. The choices are:

- User-defined model
- United Nations Latin American model
- United Nations Chilean
- United Nations South Asian
- United Nations Far East Asian
- United Nations general
- Coale-Demeny West
- Coale-Demeny North
- Coale-Demeny East

Migration Pattern by Age and Sex

Migration Females

0

0

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Cohort component method in MortPak (2)

MORTPAK FOR WINDOWS

Selected application is PROJECT (Brazil_PROJECT.mpl)

Input File Name: C:\Documents and Settings\Maia Sieverding\My Documents\Census Eval
When last updated: 01 August 2012

Single-year population projection based on cohort-component technique.

SELECT YEAR TO DISPLAY: 2010

Population by single year			Population in five-year age groups: 1 Aug 2010						Vital Statistics Summary: 1 A...				
Age	Males	Total	Age	Males	Females	Total	Males	Females	Total	Males	Females	Total	
0	1565532	3064476	0	8023614	7696333	15719947	8.56	7.92	8.23	Births	1604739	1528323	3133061
1	1584282	3103533	5	8357924	8029750	16387673	8.91	8.26	8.58	Deaths	720370	567093	1287463
2	1605520	3146146	10	8268591	8006239	16274830	8.82	8.24	8.52	Migrants	0	0	0
3	1625500	3185772	15	8344680	8111077	16455757	8.90	8.34	8.62	Growth	884368	961230	1845598
4	1642779	3220021	20	8642999	8524849	17167848	9.22	8.77	8.99				
5	1656938	3248125	25	8779813	8852899	17632712	9.36	9.11	9.23				
6	1667571	3269291	30	7780340	8012890	15793231	8.30	8.24	8.27				
7	1674751	3283712	35	6569571	6941450	13511021	7.01	7.14	7.07				
8	1678745	3291916	40	6107912	6538418	12646330	6.51	6.73	6.62				
9	1679918	3294629	45	5655145	6130654	11785798	6.03	6.31	6.17				
10	1684197	3319803	50	4764478	5208109	9972587	5.08	5.36	5.22				
11	1681670	3270606	55	3807072	4233113	8040185	4.06	4.35	4.21				
12	1645464	3236956	60	2945144	3323514	6268658	3.14	3.42	3.28				
13	1638228	3222531	65	2082686	2489215	4571901	2.22	2.56	2.39				
14	1639033	3224934	70	1570776	1990428	3561204	1.67	2.05	1.86				
15	1645799	3239844	75	1037225	1428460	2465685	1.11	1.47	1.29				
16	1656482	3263148	80+	1040648	1693633	2734281	1.11	1.74	1.43				
17	1668859	3290403	Total	93778618	97211031	190989649	100.00	100.00	100.00				
18	1681118	3318011											
19	1692423	3344351											
20	1702988	3369935											
21	1713949	3397136											
22	1726848	3429144											
23	1742078	3465816											
24	1757136	3504818											
25	1772688	3544254											
26	1781731	3570707											
27	1774798	3564853											
28	1747069	3516701											
29	1703527	3436196											
30	1655564	3346113											
31	1608594	3257609											
32	1558184	3162468											
33	1505567	3063443											
34	1452444	2962500											

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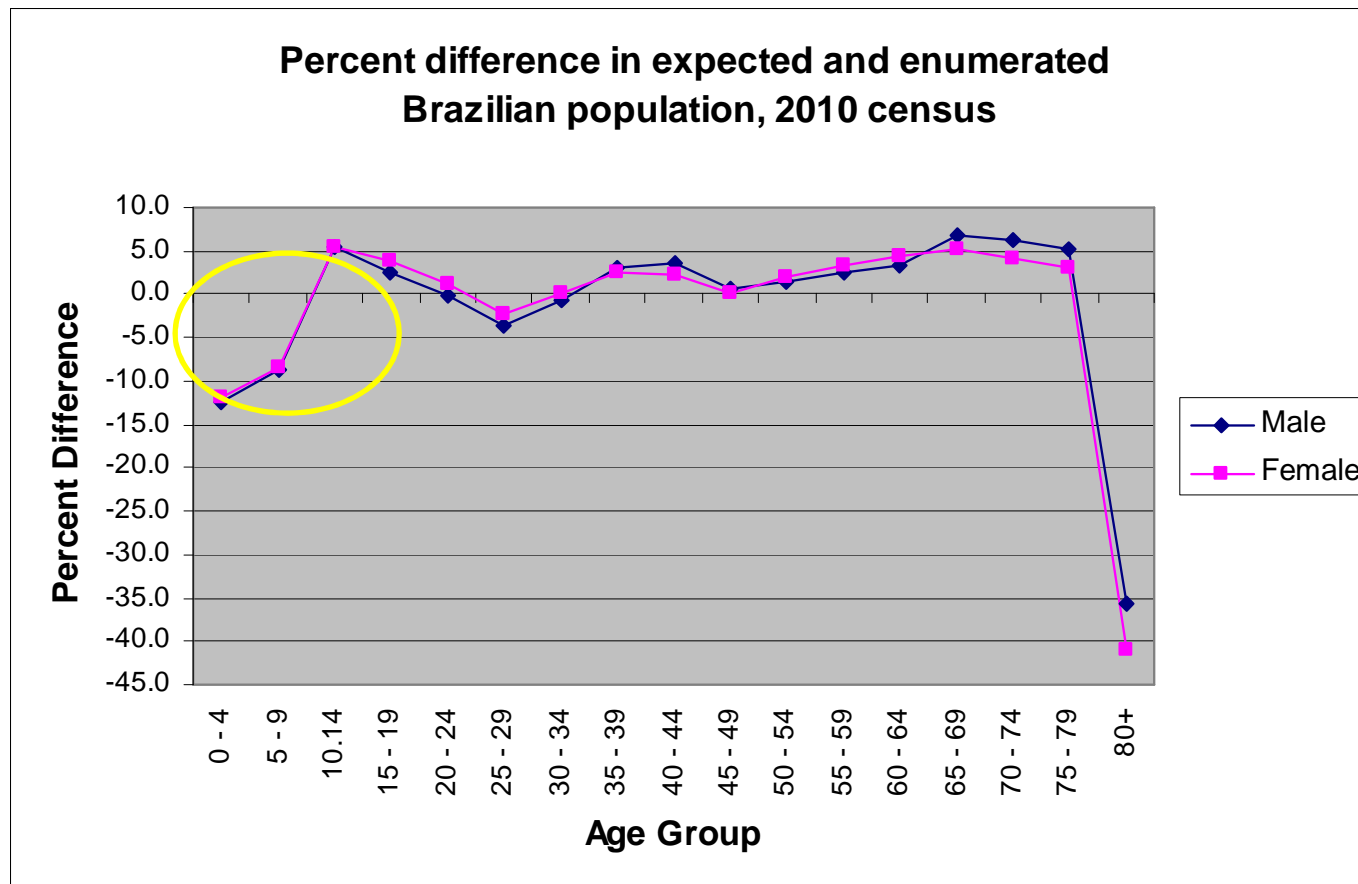
Brazil Example with MortPak - Results

The screenshot shows an Excel spreadsheet with the following data:

	A	B	C	D	E	F	G	H	I
1		Acutal Enumeration 10 Aug 2010		MortPak Projections		Absolute Difference (Enumerated - Expected)		Percent Difference (Absolute Difference/Expected * 100)	
2	Age	Male Enumerated	Female Enumerated	Male Projected	Female Projected	Male	Female	Male	Female
3	0 - 4	7,016,987	6,779,172	8,023,614	7,696,333	-1,006,627	-917,161	-12.5	-11.9
4	5 - 9	7,624,144	7,345,231	8,357,924	8,029,750	-733,780	-684,519	-8.8	-8.5
5	10 - 14	8,725,413	8,441,348	8,268,591	8,006,239	456,822	435,109	5.5	5.4
6	15 - 19	8,558,868	8,432,002	8,344,680	8,111,077	214,188	320,925	2.6	4.0
7	20 - 24	8,630,227	8,614,963	8,642,999	8,524,849	-12,772	90,114	-0.1	1.1
8	25 - 29	8,460,995	8,643,418	8,779,813	8,852,899	-318,818	-209,481	-3.6	-2.4
9	30 - 34	7,717,657	8,026,855	7,780,340	8,012,890	-62,683	13,965	-0.8	0.2
10	35 - 39	6,766,665	7,121,916	6,569,571	6,941,450	197,094	180,466	3.0	2.6
11	40 - 44	6,320,570	6,688,797	6,107,912	6,538,418	212,658	150,379	3.5	2.3
12	45 - 49	5,692,013	6,141,338	5,655,145	6,130,654	36,868	10,684	0.7	0.2
13	50 - 54	4,834,995	5,305,407	4,764,478	5,208,109	70,517	97,298	1.5	1.9
14	55 - 59	3,902,344	4,373,875	3,807,072	4,233,113	95,272	140,762	2.5	3.3
15	60 - 64	3,041,034	3,468,085	2,945,144	3,323,514	95,890	144,571	3.3	4.3
16	65 - 69	2,224,065	2,616,745	2,082,686	2,489,215	141,379	127,530	6.8	5.1
17	70 - 74	1,667,373	2,074,264	1,570,776	1,990,428	96,597	83,836	6.1	4.2
18	75 - 79	1,090,518	1,472,930	1,037,225	1,428,460	53,293	44,470	5.1	3.1
19	80+	668,623	998,349	1,040,648	1,693,633	-372,025	-695,284	-35.7	-41.1
20	Total	92,942,491	96,544,695	93,778,618	97,211,031	-836,127	-666,336	-0.9	-0.7
22	Combined Sex				190,989,649		-1,502,463		-0.8



Brazil Example with MortPak - Results





Main findings from Brazil example

- ❑ Suggests underenumeration by about 1.5 million people, or 0.8% of the population
- ❑ Significant underenumeration of youngest two age groups, particularly children 0 - 4
- ❑ Some overenumeration of 10 - 14 year olds - could be a result of the underenumeration of this group (as 0 - 4 year olds) in the original census in 2000
- ❑ Seeing same under-enumeration of 25 - 29 year olds of both sexes as when we calculated by hand - needs to be explored
- ❑ Consistent but fairly low level of overenumeration of adults age 35 - 39 to 75 - 79
 - Could potentially indicate in-migration, ideally want to incorporate migration data
- ❑ Significant overenumeration of older people
 - Very likely that there is age exaggeration
 - Also might consider that our life table is not accurate for these ages



Kenya (1) – 2009 census

Microsoft Excel

File Edit View Insert Format Tools Chart Window Help Adobe PDF

Chart Area

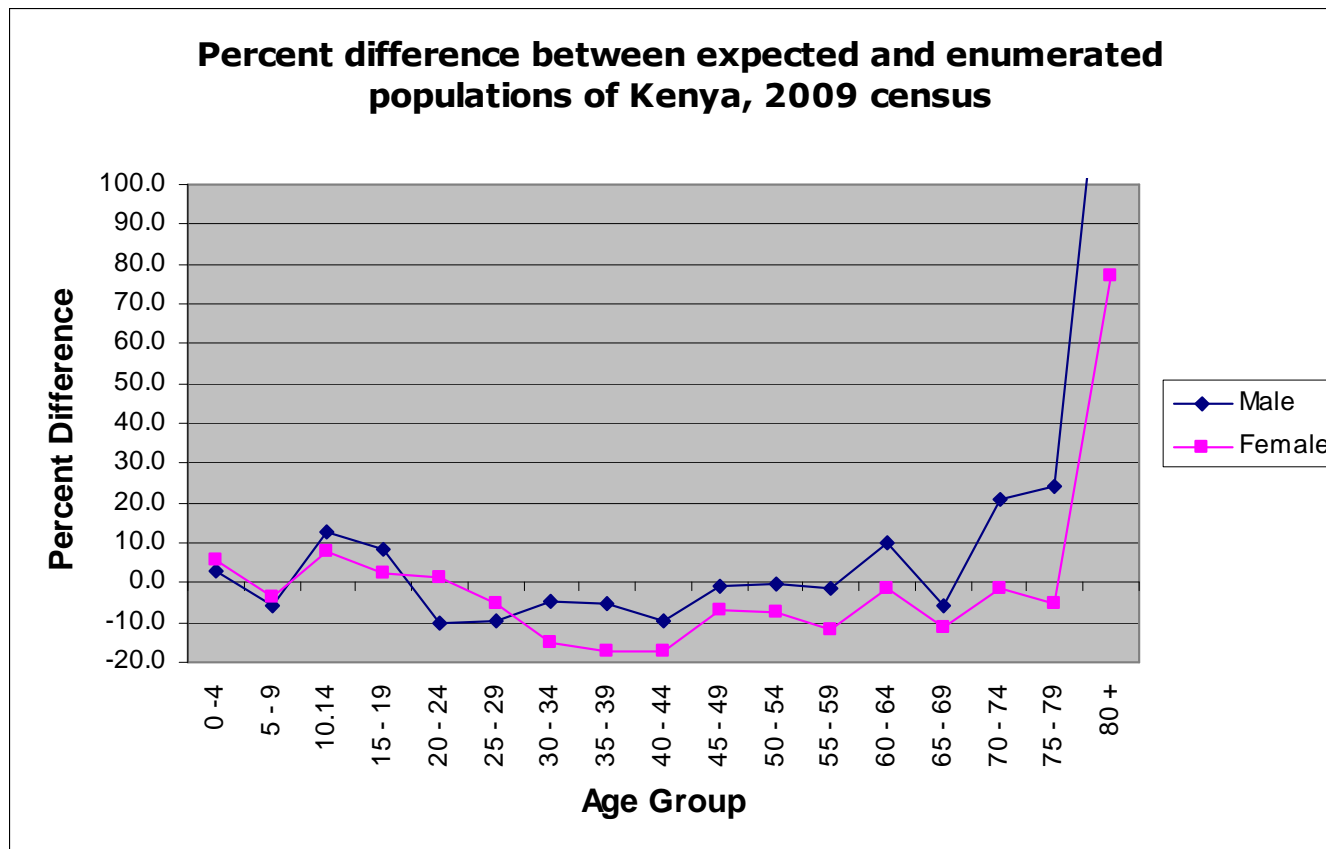
Cohort_component.xls

Kenya Cohort Component Analysis 1999 - 2009											
Age Group	Enumerated Pop 1 Jul 1999		Enumerated Pop 24 Aug 2009		MortPak Projections		Absolute Difference (Enumerated - Expected)		Percent Difference (Absolute Difference/Expected * 100)		
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	
0 - 4	2,342,576	2,366,559	3,617,282	3,543,961	3,516,567	3,362,901	100,715	181,060	2.9	5.4	
5 - 9	1,987,900	2,028,015	2,832,669	2,765,047	3,010,305	2,863,182	-177,636	-98,135	-5.9	-3.4	
10 - 14	1,995,510	2,034,447	2,565,313	2,469,542	2,272,991	2,287,239	292,322	182,303	12.9	8.0	
15 - 19	1,740,730	1,820,619	2,123,653	2,045,890	1,956,541	2,000,494	167,112	45,396	8.5	2.3	
20 - 24	1,379,948	1,560,951	1,754,105	2,020,998	1,957,961	1,997,245	-203,856	23,753	-10.4	1.2	
25 - 29	1,124,732	1,280,910	1,529,116	1,672,110	1,689,959	1,763,593	-160,843	-91,483	-9.5	-5.2	
30 - 34	885,768	940,088	1,257,035	1,262,471	1,320,253	1,491,082	-63,218	-228,611	-4.8	-15.3	
35 - 39	703,401	728,140	1,004,361	1,004,271	1,059,470	1,212,626	-55,109	-208,355	-5.2	-17.2	
40 - 44	534,186	551,737	743,594	732,575	821,909	886,654	-78,315	-154,079	-9.5	-17.4	
45 - 49	418,546	431,630	635,276	637,469	642,699	685,708	-7,423	-48,239	-1.2	-7.0	
50 - 54	322,763	334,748	478,346	477,860	478,976	517,700	-630	-39,840	-0.1	-7.7	
55 - 59	254,342	270,412	359,466	352,487	364,886	400,689	-5,420	-48,202	-1.5	-12.0	
60 - 64	199,299	227,383	295,197	298,581	268,479	303,404	26,718	-4,823	10.0	-1.6	
65 - 69	155,091	180,878	183,151	207,612	194,901	233,991	-11,750	-26,379	-6.0	-11.3	
70 - 74	117,522	137,336	160,301	179,000	132,320	181,158	27,981	-2,158	21.1	-1.2	
75 - 79	82,970	90,346	99,833	118,675	80,356	125,127	19,477	-6,452	24.2	-5.2	
80 +	96,925	126,616	159,125	224,576	61,616	126,791	97,509	97,785	158.3	77.1	
Total			19,797,823	20,013,125	19,830,190	20,439,582	-32,367	-426,457	-0.2	-2.1	
Combined Sex Total				39,810,948		40,269,773		-458,825		-1.1	

Ready



Kenya (2)





Kenya (3)

- ❑ Overall suggests net undercount of 1.1%, about 460,000 people
- ❑ Most of undercount is coming from males aged 20-45 and females aged 25-59
 - Migration may account for some of this difference
 - The life table used (based on Kenya 1999) census may not accurately represent changing mortality conditions over the 10 year period due to the HIV/AIDS epidemic
 - There may be a 'true' undercount of these age-sex groups

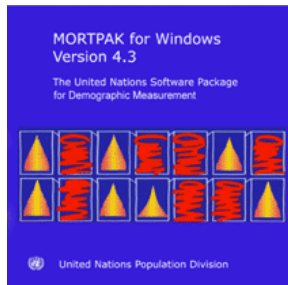


Cohort component method – uses and limitations

- ❑ It is applicable when registration data are not-existent or deficient to such an extent that satisfactory adjustment is not possible
 - ❑ Sufficient information to derive estimates of fertility and mortality levels should be available
 - Mortality estimates can be complicated by HIV/AIDS – with a generalized epidemic, one life table is generally not sufficient to model mortality patterns over a 10 year period
 - ❑ Lack of information on international migration is often a problematic issue when applying this method
 - ❑ In case where sufficient information exists to derive reliable estimates of demographic parameters, the method is perhaps the most powerful among the alternative demographic approaches for the evaluation of censuses, since it provides age and sex specific estimates of net census error
-



Tools



PROJECT application in MORTPAK – The United Nations software package for demographic measurement, available online:

<http://www.un.org/en/development/desa/population/publications/mortality/mortpak.shtml>

DemProj module in Spectrum, available online at:

<http://www.futuresinstitute.org/spectrum.aspx>

- DemProj is recommended for projection in contexts in which HIV/AIDS prevalence exceeds a few percent – better modeling of mortality conditions
- Requires more data input, including prevalence and treatment estimates for HIV/AIDS
- Data input options somewhat less flexible than MortPak



References

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