Lecture 5
Assessing the Completeness of Death Registration
One Census Methods

Michel Guillot
University of Pennsylvania & French Institute for Demographic Studies
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Outline

- One-census methods
  - Brass Growth Balance Method
  - Preston & Coale

Data requirements and assumptions for both methods

- Data requirements:
  - Age distribution of the population (e.g., census)
  - Age distribution of deaths during the year of census
- Main assumptions
  - The population is stable (i.e., fertility and mortality have been constant for the past 70-80 years)
  - Completeness of death registration constant with age
  - No international migration

Brass Growth Balance method - theory

- In any closed population, between time t1 and t2:
  - CGR = CBR – CDR (or r = b – d)
- This expression also holds for open-ended age segments *x*+, deaths being the deaths at ages *x* and over, "births" being birthdays at age *x,* and the denominators being the population aged *x* and over
  - r(x+) = b(x+) – d(x+)
    - b(x+) = N(x)/N(x+)
    - d(x+) = D(x+)/N(x+)
- In stable populations, r(x+) is constant at all ages
  - r(x+) = r
  - r = b(x+) – d(x+) at any open-ended age interval starting at x

Brass Growth Balance method - theory

- Assume that deaths are registered with a completeness c, constant at all ages: $d^r(x+)=d(x+)*c$
  - $d(x+)$ = true death rate at ages x+
  - $d^r(x+)$ = recorded death rate at ages x+
- $d(x+) = d^r(x+)/c$
- $r = b(x+) – d^r(x+)/c$

- $b(x+) = r + \frac{1}{c} * d^r(x+)$

Brass Growth Balance method - theory

- $b(x+) = r + \frac{1}{c} * d^r(x+)$

- This equation is the equation of a straight line, intercept *r* and slope (1/*c*), the reciprocal of completeness of death recording.
- Calculating the entry rate *b(x+)* from a population census (or other representative source) and death rate *d(x+)* from deaths by age and the same census offers the opportunity to estimate (1/*c*) and *r* by linear methods

Brass Growth Balance method – data requirements

- Number of deaths of women (men), by five year-age group, and for open age interval A+ (with A as high as possible), over a specific period.
- Number of women (men), by five-year age group, and for open age interval A+, at or close to the period over which the deaths were measured.

Brass Growth Balance method - steps

- Step 1: cumulate population and deaths downwards
- Population: $N(x+) = \sum_{y=x}^{A-5} {}_5N_y + {}_\infty N_A$
- Same for deaths D(x+)

Brass Growth Balance method - steps

- Step 2: Calculate the person-years of life lived, PYL(x+)

PYL(x+) = t*N(x+)

with t = length of period over which the deaths have been measured

- Step 3: Calculate the number of people who turned x in the population, N(x)

$$N(x) = \frac{t}{5}\left({}_5N_{x-5} \times {}_5N_x\right)^{\frac{1}{2}}$$

Brass Growth Balance method - steps

- Step 4: Calculate partial 'birth' and death rates, b(x+) and d(x+)

$$b(x+) = \frac{N(x)}{PYL(x+)}$$

$$d(x+) = \frac{D(x+)}{PYL(x+)}$$

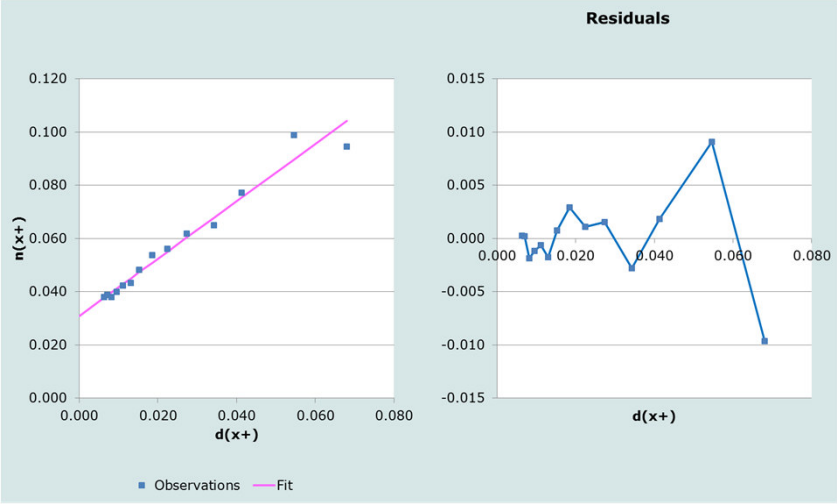
Brass Growth Balance method - steps

- Step 5: Plot graph, fit line and estimate slope *a* and intercept *b*
- Estimate completeness c:

$$c = \frac{1}{b}\exp(a(t_c - t_m))$$

  - Where a = intercept, t_c = time of census and t_m= mid-point of period over which deaths have been recorded.
  - c = 1/b if census is at mid-point

Example: El Salvador 1961

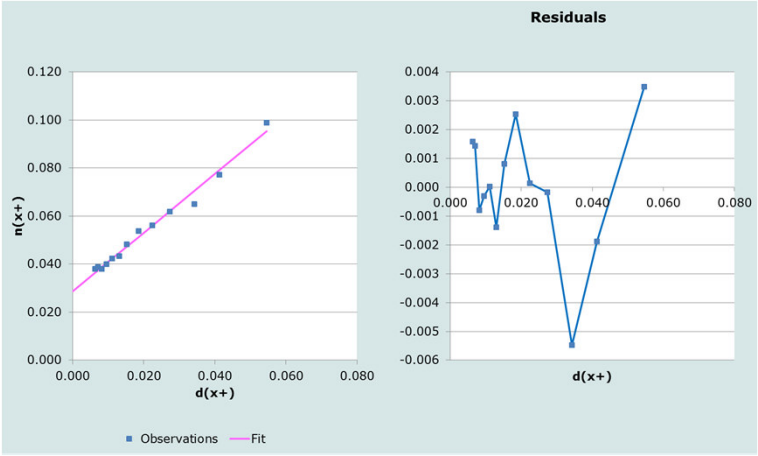


a = 0.031
b = 1.0756

Completeness c = 93%

- Remove points at older ages that depart too much from linearity

Example: El Salvador 1961, after removing last 2 points



a = 0.028733201
b = 1.219702273

Completeness c = 89%

Brass Growth Balance method - limitations

- Results sensitive to departure from stability
  - Especially rapid changes in mortality
  - Will underestimate registration completeness
  - Lower bound for true rate of completeness
- Assumption of no migration
- Assumption of constant coverage by age

Preston and Coale Method - theory

- In a cohort: N(80,t) = D(80,t) + D(81,t+1) + D(82,t+2) + D(83,t+3) …
- In a stable population:
  - D(81,t+1) = D(81,t)*e^{r}
  - D(82,t+2) = D(82,t)*e^{2r}
  - D(80+a,t+a) = D(80+a,t)*e^{ar}
  - N(80,t) = D(80,t) + D(81,t)*e^{r} + D(82,t)*e^{2r} + …
  - More generally: $N_x = \sum_{a=x}^{\varpi} D_a e^{r(a-x)}$

Preston and Coale Method - theory

- In reality we have D_a^r (=recorded deaths) rather than D_a (=true deaths)
- If deaths are not completely recorded, then $D_a^r = c*D_a$, or $D_a = D_a^r/c$
- If we use D_a^r instead of D_a when summing deaths, we obtain:

$$\widehat{N}_x = \sum_{a=x}^{\varpi} D_a^r e^{r(a-x)}$$

- The ratio $\frac{\widehat{N}_x}{N_x}$, where N_x is the true population aged x, gives an estimate of completeness c.

Preston and Coale method – data requirements

- Number of deaths of women (men), by five year-age group, and for open age interval A+ (with A as high as possible), over a specific period.
- Number of women (men), by five-year age group, and for open age interval A+, at or close to the period over which the deaths were measured.

Preston and Coale Method - steps

- Step 1: Set the initial growth rate
  - Use estimate from Brass Growth Balance method (or other sources if available)
- Step 2: Estimate life expectancy at age A and five-year age intervals down to 65
  - Use estimates from Brass Growth Balance method (or other sources if available)

Preston and Coale Method - steps

- Step 3: Estimate the number of people who turned x, and the number of people aged x, x+5, from the reported deaths

$$\widehat{N}_x = \widehat{N}_{x+5}\exp(5r) + {}_5D_x\exp(2.5r)$$

$$\widehat{N}_A = {}_\infty D_A\left(\exp(r \times e_A) - (r \times e_A)^2/6\right)$$

$${}_5\widehat{N}_x = 2.5\left(\widehat{N}_x + \widehat{N}_{x+5}\right)$$

- Step 4: Estimate the number of people who were aged x,x+5 during the period over which the deaths are reported, from the census population (multiply census counts by length of time period)

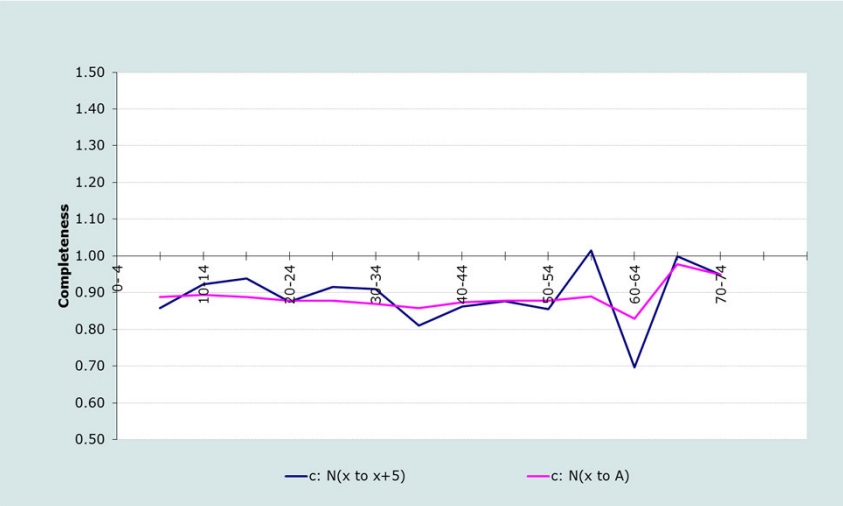
Preston and Coale Method - steps

- Step 5: Calculate the ratios of estimated over observed ${}_5N_x$ as well as and ratios of estimated over observed ${}_{A\text{-}x}N_x$.

$$\frac{{}_5\widehat{N}_x}{{}_5N_x} \; and \; \frac{{}_{A-x}\widehat{N}_x}{{}_{A-x}N_x}$$

- Step 6: Estimate the completeness of reported deaths
  - Adjust growth rate if necessary, using data/solver in spreadsheet
  - Decide about age range of ratios
- More complex procedure using iteration is described in IUSSP volume.

Example: El Salvador 1961



Completeness c = 89%

Preston and Coale vs. Brass Growth Balance

- Preston and Coale more robust to departure from stability than Brass Growth Balance
- But more sensitive to age misreporting
- Use both Preston/Coale and Brass Growth Balance. More confidence in results of both methods agree