

## Notes for the Extended Model Life Tables (version 1.3)

tolerance (1/2). (2) \* simple seven-term moving average " as performed after the application of the pchip method to smooth the estimated probabilities of death  ${}_1q_x$ . The smooth " as performed iteratively to ensure the constraint noted in (1). (3) We then estimated  ${}_1m_x$  from  ${}_1q_x$  by assigning an initial value of 0.4 to the  ${}_1a_x$  for each single year of age (as per the Human Mortality Database method protocol; see Wilmoth et al. 2003). We then estimated  ${}_4m_x^1$  to verify whether the  ${}_4m_x^1$  " as equal to the original  ${}_4m_x$  from the model life table of the version 2. If not, iterations for  ${}_1a_x$  " were performed to ensure  ${}_4m_x^k$  to be as close as possible to  ${}_4m_x$  after  $k^{\text{th}}$  iterations. In this step,  ${}_1a_x$  " as also updated. (4) Then  ${}_4m_x^k$  " as estimated (i.e.,  ${}_1m_x^k$  " as estimated). We re-calculated the average probability of death for each of five-year age groups and re-implemented the procedures (3) and (4) until the changes of estimates " were smaller than the specified tolerance between adjacent iterations (1/2).

- 1.) Ages from 0 to 75 we applied the Gompertz model to estimate  ${}_1m_x$  for ages between 25 and 75 based on  ${}_4m_x$  for ages 4/4, 44/4, 24/2, 24/2, 24/2, and 4/4 from the version 1.2. The Gompertz function  $\mu_x = a e^{bx}$  is from the formula presented in Chapter 7 of the book *Estimation of Mortality at Ages 0 to 125* by Thatcher, Mannisto, and Haupel (1999) (available at <http://www.demogr.mpg.de/Papers+working/monograph4/start.htm>). Here  $a$  and  $b$  are parameters and  $\mu_x$  is the force of mortality at exact age  $x$ . The model " as fitted by the maximum likelihood method using the formula of  $L(x) = -D(x) \log(q_x) - (N - D) \log(1 - q_x)$  " here  $L(x)$  is the likelihood function,  $D$  is number of persons " ho survive to age  $x$  but die before they reach age  $x+n$ ,  $N$  is number of persons " ho reach age  $x$ ,  $q_x$  is estimated probability of dying from age  $x$  to  $x+n$ . Then  $\mu_x$  is fi

1.2.3 In a final round, minor adjustments were made for  ${}_1m_x$  (and thus also for  ${}_1a_x$ ) proportionally according to the distribution of  $dx$  to ensure that  $\tau_s$  equals to 1. Here 1 is a given level of life expectancy at birth. We used Matlab to implement this process.

#### 1. Abridged model life tables

Abridged life tables were constructed from the completed life table. The main reason we used the approach described above to reconstruct the model life tables (i.e., generating abridged model life tables using completed model life tables) is that we have detected noticeable biases for  ${}_4a_x$  in the abridged life table using Greville's

formula :  ${}_n a_x = \frac{n}{2} - \frac{n^2}{12} \left( {}_n m_x - \frac{\ln({}_n m_{x+n} / {}_n m_{x-n})}{2n} \right) < \text{then } {}_4 a_x$

United Nations (2013). Mortality for "indians" (version 3.5). Mor 7 United Nations Population Division.

<http://www.un.org/en/development/desa/population/publications/pdf/mortality/mortalitymanual.pdf>

8 Ilmoort L. \*ndreev @. danov D. and 9 lei D. \* (with the assistance of +oe , , +ubenheim G. Philipov D. Ah olni ov H. and Ha#hon P.) (2008). Methods protocol for the human mortality database.

<http://www.mortality.org/Publications/MethodsProtocol.pdf>

## Notes for the Extended Model Life Tables (version 1.0)

Two sets of standard model life table families (Coale/Demeny 1966 and 1980) and United Nations 1982 are commonly used to derive a variety of mortality indicators and as underlying mortality patterns for estimation and projection by the United Nations and the demographic research community at large. But these two sets of model life tables were designed primarily to be used in developing countries or for historical populations over mortality patterns only for a life span from ages 25 to 75. The first extension of these model life tables was produced by Thomas Vaubertner in 1980. He extended the initial sets of model life tables from age 75 up to age 120 using both a limit life table as an asymptotic pattern and the classical Lee-Carter approach to derive intermediate age patterns (Vaubertner 1982).

With the extension of the projection horizon for all countries up to 2100 and as part of the 2012 Revision of the United Nations World Population Prospects, it was necessary to allow life expectancy at birth to go beyond 120 years. In addition

