Some biases which hide the Gompertz law of mortality at old ages and some statistical evidences that life expectancy will plateau.

Longer abstract

After the huge decrease of infectious diseases which had reached very low levels by the end of the XXth century, the force of mortality began to fit more closely a Gompertz law (strait line in semi-logarithmic scale). However the age at which the Gompertz line began to be the best fit has decreased from 35 years a century ago to 25 today.

Controversy on longevity ?

o Controversy on the possible inflection and even a decrease of the force of mortality at oldest ages (120) denying the Gompertz law.

The consequence of this belief is a prediction of highly growing population of super centenarians (>110 years) at long term (2050-2100)

o What consequences of the behaviour of the mortality at age 110 on short term (2020) ?

few, very few consequences in comparison to other consequence of the constant mortality decline which is the massive increase of the population aged 85-90 with needs for long term care.

Difficulties to measure the force of mortality at old ages

o Both deaths and populations at risk are few (<200).

o Population estimated by the census (even by the new census method in France) give wrong estimates (age >95)

o Wrong declaration of age at deaths which can't be checked with the birth certificate. Only at very high ages, when the number of survivors is small, the check is done.

o Extinct cohort method, which is the unique method, also shortens the period of estimation reducing the horizon of the forecast.

Uncertainty and consequences of the Gompertz law

o Hyp A: Gompertz law fits old ages.

Question: If the current world population of 7 billions was 90 years old today, how many survivors could reach the age of 120?

o Hyp B: Force of mortality is plateauing at 0.2 per year since the age of 90.

Same question

Answers to the question:

hyp. A : even not a single person, 1/10 person!

hyp. B : a few millions!

Biases in a French centenarians survey induced an artificial plateau.

o January to May 1990 : Identification of 2859 probably centenarians (born before 1890) living in France. (Identification via a network of GP and geriatricians.

o Up to April 1991: only 907 medical exams (entries in the follow-up). Reasons invoked for the attrition:

o Double or triple counts

o Mortality (25%)

o Do not apply to the protocol, refusals

o Size of the final sample: 756 centenarians followed up to 31 December 1995 (or to death)

If we “believe” in the validity of the Gompertz law, the mean delay 1.5 months between the census (by the GP) and the first exam must be shorter for oldest centenarians. Without this age specific delay the bias induced by the deaths occurring before the exam, will not only lower the mortality but also induce an artificial plateau.

o adjusting a Gompertz law from the IPSEN survey at age 100+ with robust analyses of mortality in France from vital statistics at ages <90 doesn't deny the validity of the Gompertz law if the Calment case is suppressed from the sample.

Projections of mortality in France

o Data available until 2009. Extinguished cohorts method from oldest ages up to age 95.
Mortality after 2002 is thus unknown at oldest ages.
o Only cohorts of a minimum size can be involved in the regression.
The regression model and its results show a slow increase of the slope of the Gompertz which is not in contradiction with older trends described even in the early UN model life tables of Valaoras as well of Ledermann for Europe.

Summing deaths amongst various cohorts even at the same age are inducing a plateau because as mortality declines, more recent cohorts are at lower risks of dying than former cohorts. The heterogeneity created in these super cohorts induces an artificial plateau.

Aggregating cohorts of different countries as well as increasing the age range in order to increase the statistical power of the estimates are at the price of an artificial plateau.

Heterogeneity among individuals in a cohort is clearly an important factor which can be measured by sex, social class or education level, health status etc., although these inequalities reduce at higher ages due to attrition of the most frail. Despite this attrition, the total observed law of mortality is still a Gompertz law, in France at least without, a deceleration of probability of dying with increasing age. This means that the “natural” law of mortality amongst an homogeneous cohort is probably a kind of accelerating exponential increase with age.

Conclusions
Validity of the Gompertz law can't be rejected after suppressing some biases.Thus, reaching the age of 120 doesn't seem plausible for humans.

The slope of the Gompertz line increases slightly when mortality declines (coherent with the increase of the modal age in period life tables)
Higher slope amongst women (lower mortality) than men.
=> Rectangularization and no pure shift.
=> Slow evolution (projections until 2100 !), like in Model life tables