Does Tempo-adjusted Life expectancy is more reliable than the conventional Life expectancy : An Analysis from Indian Context

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Abstract

We investigated life expectancy and Tempo-adjusted life expectancy in India and for major states using SRS-data. This analysis has been carried out to know the biasness in conventional measures. These indicators, which are used as period indicators helps us in portraying present health situation of a population. What if these indicators are distorted due to changing in the average-age-of-occurrence. In developing countries like India as the average age of occurrence of an event has changed rapidly over the last two-three decades. Understanding the effects of changes on these conventional measure may helps us to better understand current scenario of region. We calculated from methods proposed by Bongarts and Feeney. This analysis uncovered a distinctive evidences that tempo distortion has not much varying in females but there is a lot of variation in males. Interestingly we found that mortality tempo-effects can cause conventional life expectancy biased by more than 2-3 years.

Keyword: Life expectancy, Tempo-adjusted Life expectancy, Mortality.

Introduction

In Demography developing indicators like total fertility, life expectancy in order to summarize the demographic conditions and to describe the trends and patterns of the conditions through this indicators is the major task. The efforts are still made by the demographers to develop or to refine the present indicators in order to get an efficient and standard measure to analyze, compare and study the population with at most accurately. In Demography there are some standard indicators which describes not only the current situation of the population but are also used to compare situations of the population; among those standard indicators well know indicators are life expectancy, total fertility rate, age at first marriage.

But with the publication of Bongaarts and Feeney (1998), the authors claimed that above indicators are inappropriate for measuring the current demographic conditions. Initially they only argued for TFR as the inappropriate measure, later on they have described for the Mortality, and then they described a general framework of their approach that can work for any kind of demographic event. They said that these indicators are inappropriate when the average age at event is changing and proposed an alternative method for this situation, that they named it as **"tempo-adjusted"**. They defined it as "*that change of period rates for demographic events (births, deaths, marriages, etc.) that solely results from a change of the average age at which the event occurs during the observation period*."

We have two dimensions in study of demography to measure i.e., **cohort measure and period measure**. As we know that cohort measure are on based experience of demography events of a particular cohort over a period of time, this takes accounts of the events of the past that has already happened. Cohort measure by their nature refers to past events, to measure the future they need to include the projected events. But in case of the period measure they measure actual demographic events. Thus, the description of **"current demographic conditions"** and their year-to-year changes which are the most important kinds of information for the majority of users of the demographic data can only be based on the period dimension.

Period measure are mainly used because of two reasons firstly, they measure the year-to-year changes of the demographic events compared to the cohort, where they measure after a time lag. Secondly, period measure require less historical data compared to the cohort and may therefore be calculated for many populations.

Life expectancy is a period measure and believed to be one of the strongest measure which uses almost 100 ADSR's and gives us a single measure, makes our analysis simpler to see the mortality conditions. Many of the scientists believe it as strongest indicator which doesn't need any kind of standardization in order to compare with the other population. But this belief was changed after the statements made by Bongaarts and Feeney (1998).

All existing papers deal solely with theoretical and technical questions, and empirical applications are missing (beside the mentioned Bongaarts and Feeney papers e.g. Vaupel, 2002,2005; Feeney, 2003, 2005;Guillot, 2003b, 2005; Goldstein, 2005; Rodriguez, 2005; Wachter,2005; Wilmoth, 2005). Ryder (1956) is the first person to observe that total fertility rate is distorted when women advance or postpone their births. In his papers he often used the terms like tempo distortion and tempo effects to refer discrepancy of the period indicator from corresponding cohort indicators. Ryder introduced these terms in his series of works towards the study of quantum and tempo measure of fertility. In his work the most important conclusion was that there is a divergence between the total fertility rate and the completed fertility rate, this divergence is due to change in the timing of childbearing of women in that cohorts. Ryder work just established the existence of the tempo distortion in total fertility rate, but he did not provide any kind of adjustments methods to them. Firstly, Bongaarts and Feeney (1998) provided the empirical derivation of the tempo effects for fertility and it has widely accepted by many of the demographer. And then Bongaarts and Feeney (2002) extended their works to the mortality and then concluded a general framework which works for Fertility, Mortality and Nuptiality etc.

Bongaarts and Feeney (2003) found that the tempo distortions for France, Sweden and USA equal 2.4, 1.6 and 1.6 years respectively for the period 1980-1995. Further discussion of these relationships are provided in Luy and Wegner (2009) who also provide additional estimates of tempo effects for 2001-2005 for females for 41 countries with Japan having the largest distortion (3.0) years. Luy (2008, 2009) extended these models for demonstrating the consequences of tempo effects in period mortality by comparing two populations with different levels of mortality and different levels of mortality changes. Luy assumes such period distortions caused by tempo effects to be the reason why the trends in mortality differences between Eastern and Western Germany are still largely unexplained Luy (2006). He showed that it is possible that a population in which each cohort has higher mortality than the corresponding cohorts of another population can have lower period mortality rates when tempo effects are not adjusted for. Luy and Wegner (2009) further elaborated this example and demonstrated that such a situation can even occur with total life expectancy, i.e. that a population has a higher period life expectancy than another population although the cohort life expectancy of each cohort living in this period is lower in the population with higher period life expectancy.

The basic question in demography is what measures should be used for comparing two or more populations. We always look for the standard indicators or we develop the standard measures for comparing two or more populations. As we know that life expectancy is one of the important measure which throws a light on mortality conditions, and helps the policy makers to make the policies accordingly with measure. What if these kind of measures are not portraying what they need to be portrayed ? Do this measure really deviating from what it is ? Are there some external factors which made them do deviate ? to clear the above question we have Tempo-adjusted life expectancy. So in this paper we discuss about why Tempo-adjusted life expectancy is more important than the conventional life expectancy.

Objectives

1. To calculate the life expectancy and tempo-adjusted life expectancy for India and its major states from 1971-2007
2. To compare of tempo-adjusted life expectancy and life expectancy of India and its major states

Data Source and Methodology

For calculating life expectancy we need the age-specific death rates of the population. If a large amount of data is available, the age-specific death rates can be simply taken as the mortality rates actually experienced at each age. However it is customary to apply smoothing to iron out as far as possible the random statistical fluctuations from one year of age to the next.
The data of Age-specific deaths in order to calculate life expectancy are entered from the Sample Registration System from 1971 to 2007 in the five year interval gap. To calculate the Age-specific death rates in between years used the technique of interpolation and estimated all the years from 1971 to 2007.The life expectancy (e0(t)) here is calculated by neglecting the under 30 mortality; in order to follow the constant shape assumption proposed by Bongaarts. In order to calculate the tempo-adjusted life expectancy we approached method proposed by the Bongaarts and Feeney (2002), He has given the following equation for the calculation of the tempo adjusted life expectancy at birth $e_0^*(t)$

$$e_0^*(t) = e_0(t)-S(t)$$

where e0(t) is the life expectancy and S(t) is the tempo effect in the life expectancy which can be define as the differences between the observed life expectancy and the tempo-adjusted life expectancy .
we estimate the tempo-adjusted life expectancy of the above equation by the equation by substituting this $(1/(b(t)*L_n)*(1-de^*(t)/d(t))$ in place of S(t) in the above equation.
Based on the assumption that the mortality under age 30 can be neglected and the annual change in the rate follow a shift Makeham function. Older age mortality has been estimated by the above function and value of the b is estimated by fitting the Makeham function to the age-specific death rates. Makeham proposed a small modification to Gompertz' law, noting that although the Gompertz

function represents adequately the progression of mortality in adult ages, it does not accurately reflect the age pattern of mortality at younger ages. The modification involves adding a constant term to the force of mortality.

Preliminary Findings

India it is the second most populous country in the world, with 1.27 million. India has a very rapid population growth from 448 million in 1960 to 1.21 billion in 2011, it has a growth rate of 1.4 percent per year. When it comes to the demography, India's mortality has declined at a sluggish rate especially death rates among infants and young children, these death rates has helped to boost the life expectancy of India from about 50 years in 1970 to the 65 years in 2011.

Among these two populations improvement of life expectancy for females is much earlier and has been constant throughout the period. Tempo distortion S(t) has not much varying in females but there is a lot of variation in males and there is drastic change in the year 1975, from then tempo distortion for males has declined (Table1).

Whereas Tempo-distortion curve of females looks like a decreasing straight line converging to a point. When we see Tempo-distortion maximum 1.8 distortion is found in case of females in the beginning of the years and then it has been continuously converging and ended at the point 0.3, the male tempo-distortion has varied between the range 1.4 to 0.6 .Tempo-distortion for males have less distorted when compared to the females, but the variation in males is much when compared to females. Tempo-adjusted life expectancy $e_0^*(t)$ also rose with an equal pace as the life expectancies for both males and females. The interesting question here arises is how differences in life expectancy developed when compared it with the tempo-adjusted life expectancy during observation period. But the table shows that there is a rapid decrease in differences life expectancy of males and females after 1975 and then this difference has continuously increased at later stages , but in tempo-adjusted life expectancy there is no variations in the differences but they continuously tend to grow at same pace as the differences in life expectancy.

Conclusion

With the preliminary analysis at India level we can conclude that Tempo effects exist and occur as do age composition effects. Both life expectancy and tempo-adjusted life expectancy standardize for these tempo effects. However, the two measures differ in the way they standardize. Life expectancy deals with tempo effect- caused postponed deaths as if there were no tempo effects, whereas tempo-adjusted life expectancy takes tempo effects explicitly into account. These preconditions raise the questions about the purposes of period measures and how these purposes are addressed by the two standardization procedures. In our opinion, period indicators should measure only period conditions including the effects of changes which are independent of past and future assumptions (technical purpose). Furthermore, a period measure of mortality should reflect the current mortality conditions of the real cohorts in order to allow conclusions for political or medical interventions (practical purpose).

From the findings presented in this paper we conclude that tempo- adjusted period life expectancy does fulfil our demands on a period measure and is an adequate way of standardizing period mortality conditions for the compositional effects of age and postponement of deaths. In above section we showed with empirical data that mortality tempo effects can cause conventional life expectancy to being biased by more than 2-3 years . Thus, tempo effects can lead to distortions which are strong enough to severely influence the estimation of life expectancy differences between populations and sub-populations and consequently also the analysis of determinants of mortality differentials.

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Appendix

Table 1 : Showing Life expectancy and tempo-adjusted life expectancy for Male and females

Year	**Male**				**Female**			
	$e_0(t)$	$e_0^*(t)$	Parameter	difference	$e_0(t)$	$e_0^*(t)$	Parameter	difference
1971	69.61	67.61	0.12	2.00	66.60	64.60	0.20	2.00
1972	69.39	67.82	0.20	1.57	66.81	64.94	0.19	1.87
1973	68.91	68.09	0.29	0.82	67.04	65.23	0.17	1.80
1974	68.45	68.30	0.37	0.15	67.28	65.50	0.15	1.78
1975	68.00	68.35	0.45	-0.35	67.55	65.74	0.13	1.81
1976	67.57	68.18	0.52	-0.61	67.84	65.95	0.11	1.89
1977	67.86	67.80	0.47	0.06	67.89	66.14	0.06	1.75
1978	68.16	67.83	0.42	0.33	67.95	66.25	0.14	1.70
1979	68.47	67.96	0.36	0.51	68.00	66.46	0.16	1.54
1980	68.78	68.13	0.30	0.65	68.07	66.67	0.17	1.39
1981	69.09	68.31	0.24	0.78	68.13	66.89	0.18	1.25
1982	69.34	68.48	0.18	0.86	68.32	67.09	0.18	1.23
1983	69.60	68.62	0.14	0.99	68.51	67.29	0.17	1.22
1984	69.90	68.75	0.12	1.15	68.70	67.48	0.16	1.22
1985	70.21	68.87	0.10	1.34	68.90	67.66	0.16	1.23
1986	70.60	69.00	0.09	1.60	69.09	67.84	0.16	1.25
1987	70.81	69.14	0.12	1.67	69.21	68.02	0.17	1.19
1988	70.98	69.33	0.15	1.66	69.32	68.20	0.17	1.12
1989	71.15	69.55	0.18	1.59	69.44	68.37	0.18	1.07
1990	71.29	69.81	0.21	1.48	69.56	68.55	0.18	1.01
1991	71.42	70.08	0.02	1.34	69.67	68.72	0.19	0.96
1992	71.60	70.10	0.02	1.50	69.77	68.88	0.19	0.89
1993	71.78	70.13	0.19	1.64	69.88	69.04	0.20	0.83
1994	71.94	70.40	0.15	1.54	69.98	69.20	0.20	0.78
1995	72.10	70.61	0.12	1.49	70.08	69.34	0.21	0.74
1996	72.26	70.77	0.07	1.49	70.19	69.49	0.21	0.70
1997	72.38	70.88	0.05	1.51	70.40	69.63	0.21	0.77
1998	72.51	70.94	0.02	1.56	70.62	69.78	0.21	0.85
1999	72.63	70.97	0.12	1.67	70.85	69.94	0.20	0.92
2000	72.76	71.16	0.15	1.61	71.09	70.11	0.20	0.98
2001	72.89	71.37	0.19	1.52	71.34	70.28	0.20	1.05
2002	73.19	71.63	0.21	1.56	71.42	70.47	0.20	0.96
2003	73.48	71.91	0.23	1.57	71.52	70.64	0.20	0.87
2004	73.77	72.21	0.24	1.56	71.61	70.80	0.21	0.81

2005	74.07	72.52	0.26	1.55	71.70	70.96	0.21	0.75
2006	74.37	72.85	0.27	1.53	71.80	71.10	0.21	0.70
2007	74.00	73.18	0.19	0.82	71.64	71.24	0.22	0.40

Source : Authors calculation