Mortality Divergence Across Countries

(Extended Abstract)

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Abstract

We propose a new approach to quantify cross-country disparities in health and their convergence/divergence over calendar time. Four basic indexes of relative disproportionality are applied to single-age and -year death rates in selected countries/regions. Those are: Gini coefficient, Theil index, mean logarithmic deviation and squared coefficient of variation. The same four indicators have been used by Goesling and Firebaugh (2004) to measure differences in life-expectancy. These measures can be decomposed to indicate contribution of selected countries, age-groups, and causes of death to total disparity. In the empirical application, based on data for 30 industrialized countries of HMD, we demonstrate that the decade of 1960s was characterized by divergence in health conditions as result of decreasing mortality disparities at the very young ages. In the next decades, we observe constant divergence in health conditions, with growing contribution to the total disparity of the older adult ages.

Introduction

A wide range of measures has been used to quantify disparities in life-expectancy at birth, that is the mean duration of life. The most popular measures are those of average disproportionality: Gini coefficient, Theil index, mean logarithmic deviation, squared coefficient of variation (Goesling and Firebaugh, 2004). The other side of the

coin are inequalities in health that result in differences in life-spans between individuals. For example, Wilmoth and Horiuchi (1999) discusses the following measures of disparity/rectangularity: fixed rectangle, moving rectangle, fastest decline, sharpest corner, quickest plateau, prolate index, standard deviation, interquartile range, Gini coefficient, Keyfitz's H. To our knowledge, Edwards and Tuljapurkar (2005) made the first attempt to measure and discuss convergence/divergence in distributions of ages at death across selected countries. The measure used in this study was the Kullback-Leibler divergence and divergence in mortality between the countries under study is decomposed into the effect of diverging values of life-expectancies and relatively stable effect of variance of age at death. Edwards and Tuljapurkar (2005) choose the distribution of ages at death in Sweden 2002 as the baseline distribution. It can be demonstrated, however, that the fact that distributions of ages at death of selected countries become more similar to the Swedish distribution does not necessarily guarantee divergence of the age-at-death distributions between those countries. Edwards (2011) measures global inequality in the length of life based on standard deviation, interquartile range, Gini coefficient and Theil index. The author discusses also results of a decomposition of the variance and Theil entropy-index into within- and between-country contribution to inequality in life durations. These results concerning divergence in the between-country inequality are based again to differences in the mean duration of life and do not refer to differences in the distribution of ages at death between countries.
In this study we propose a new approach to quantify cross-country (or across some sub-groups of a population) disparities in health and their convergence/divergence over calendar time. The proposed measures, based on inequalities in age-specific death rates, can be decomposed to indicate contribution of selected age-groups, causes of death or single countries, to the total variation in mortality across countries. It is also straightforward to decompose their changes over the calendar time according to the above characteristics. Similar to Edwards (2011), indicators proposed in this study, quantify cross-country disparities in health by taking into account mortality distributions and not only the mean duration of life. The difference from Edwards (2011) approach is that, as we are interested in disparities between countries and not populations, in out measures of disparity we do not apply population weights to the statistics.

The focus on between-country disparities allows us to base our measure on disparities in period death rates across all the ages with equal weights applied to disparities at every age.

Method

Next to comparisons of life-expectancy at birth, differences and similarities in health conditions across countries are often discussed based on comparisons of death rates at selected ages. Hence, similar to the discussion on inequality in life-expectancy across countries, for example by Goesling and Firebaugh (2004), indexes of average disproportionality applied to death rates at age x across countries would measure disparities in mortality at age x and when added-up over the whole age-range, can be used as an indicator of differences in health across countries. As a result of the fact that we are interested in cross-countries differences and not those between individuals, our approach differs from the one proposed by Edwards (2011) in two ways: We do not apply population weights to the statistics and also the mortality ratios are standardized by the mean value separately for each age. The four inequality indexes of relative disproportionality, adapted to the needs of this article after Goesling and Firebaugh (2004, p.135) are:

- Gini coefficient= $\sum_x \sum_j r_{xj}(q_{xj} - Q_{xj})$
- Theil index= $\sum_x \sum_j r_{xj} log(r_{xj})$
- Mean logarithmic deviation (MLD) = $\sum_x \sum_j log(1/r_{xj})$
- Squared coefficient of variation (CV^2) = $\sum_x \sum_j (r_{xj} - 1)^2$

where r_{xj} is mortality rate at age x in country j divided by average mortality rate at age x in the studied group of countries, q_{xj} is proportion of countries where mortality rate at age x is lower than in country j and Q_{xj} is proportion of countries where mortality rate at age x is higher than in country j.
It is straightforward to estimate contribution of selected age-groups to mortality disparities and their change over time, as measured by the four indexes presented above.

An example of those are presented in the "Application" section. By dividing age-specific rates proportionally to contribution of selected causes of death (similar to the process in the decomposition of life-expectancies, compare for example Preston et al. (2001)), one can draw conclusions concerning particular importance of selected diseases for elevated mortality in some countries.

Application

The application section is based on single-age-year death rates derived from life-tables for 30 developed countries downloaded from Human Mortality Database (2011), referred to through this exercise as "industrialised countries". The years of study are limited to the period between 1961 and 2007, when the data is available for the largest group countries. The group consists of: Australia, Austria, Belgium, Bulgaria, Canada, Czech Republic, Denmark, Estonia, Finland, France, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Rusia, Slovakia, Spain, Sweden, Switzerland, UK, USA.

It was only in the first decade (1961-1970) that the values of the four measures of between-country health inequality decreased (Panel A, Table 1), indicating convergence of mortality in the industrialised countries. This convergence in mortality conditions was caused by decrease in disparities in mortality at infant and very young ages since it is not present when mortality at age below 10 years is disregarded (Panel B of Table 1). Since 1970, the trend in the four measures of inequality indicate constant divergence of mortality conditions in the countries under study. The most rapid divergence occurred between 1986 and 1996, as measured by MLD (Figure 2), that coincides with the period of worsening mortality conditions in Eastern Europe.

In the year 1961 the largest contribution of variation of mortality at single age to total disparity was that of age one and and it was result of very high early-life mortality (as compared to other countries) in Portugal. When Portugal was excluded from the value of MLD for the year 1961 decreased by 20% and only at the ages 0-10 years by 54% (not shown in the Tables). In the same year, the relative disparities as measured by MLD at single age-groups were U-shaped at ages 10-42 years and decreased afterward. This u-

shape pattern of contribution to total disparities over the young adult ages was present until the end of the studied period.

In the 1980, disparity in mortality in the industrialized countries is higher at all adult ages as compared to the values in 1961. This is also true in every next decade under study, the contribution of all ages grows from decade to decade with the highest relative growth at the oldest ages.

References

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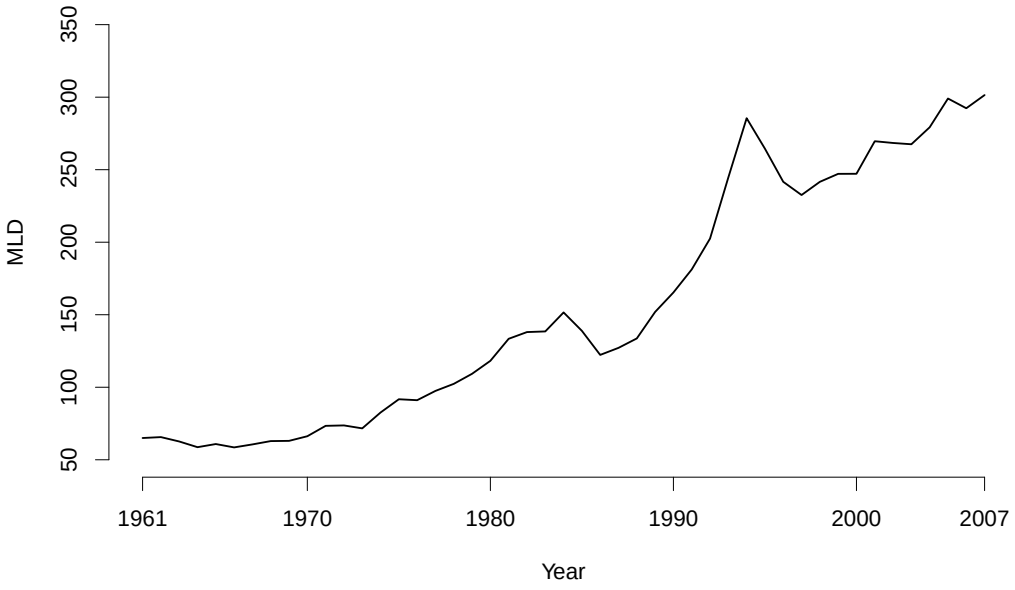
Tables and Figures

Table 1: Trend in between-country health inequality, both sexes, 1961-2007

	Theil index	MLD	CV^2	Gini coefficient
		Age 0-100		
1961	88	81	222	184
1970	77	74	170	161
1980	127	122	282	321
1990	171	168	371	421
2000	272	249	665	540
2007	330	303	819	612
		Age 10-100		
1961	53	54	108	126
1970	59	58	124	120
1980	106	100	234	266
1990	138	137	295	352
2000	227	205	560	456
2007	285	259	715	525

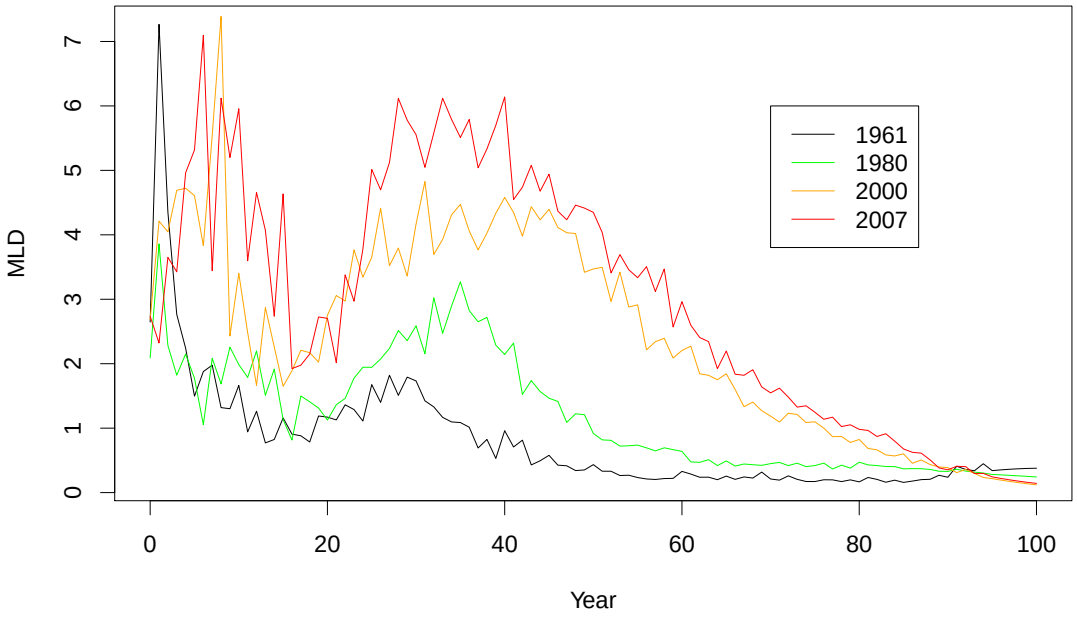
Data source: Human Mortality Database (2011)

Figure 1: Trend in between-country health inequality, both sexes, 1961-2007, measured by mean logarithmic deviation



Data source: Human Mortality Database (2011)

Figure 2: Age-specific disparities in mortality, both sexes, measured by mean logarithmic deviation



Data source: Human Mortality Database (2011)