Is the Mortality Convergence between East and West Germany a Result of Selection?

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Abstract

Immediately after the unification East Germany experienced an unexpected large decline in mortality. Lagging behind West Germany for years, this gap has almost closed until today. Several factors were judged to be causal, but it is still unknown how much of the increase can be explained by them. This is especially true for the immediate changes. This paper will use the theory of unobserved heterogeneity as another possible part of the explanation, which has been ignored until now. The basis of this theory is the assumption that every population is heterogeneous, some people are weaker than others. The frailer tend to die first, which results in a cohort compound by the stronger ones.

Since the mortality in East Germany was higher it is possible that the selection happened faster in East than in West Germany. The result would be a mortality convergence, as it was observed. By using a frailty model it is possible to take unobserved heterogeneity into account. First results suggest that the consequences of the selection are totally different for East and West Germany. While strong composition effects affect the mortality in East Germany and force a convergence of the overall mortality, for West Germany only slight selection effects were found.

Background

After decades of stagnating the mortality in East Germany started to decrease nearly immediately after the reunification. So that the life expectancy gap between East and West, which arises in the meanwhile, was almost closed until 2005. Until today the question, why the mortality was affected so abruptly by the unification, is unsolved. Many different factors were judged to be causal, but most of them only have a longterm impact on mortality (Diehl, 2008).

The increase of life expectancies in the first years, was mainly caused by mortality changes in older ages. Over 80% of the overall increase in female life expectancy at birth of 1.43 years in the time between 1989 and 1993 was caused by changes above age 60. Still 50% can be explained by mortality reductions in ages beyond 75. For males the older ages were even more important. Without mortality changes beyond age 75 the life expectancy would have been an decreased by 0.14 years, due to an increasing mortality caused by external causes of death in the ages between 15 and 45. Only due to changes in the ages beyond 75 years the life expectancy at birth was increasing by 0.18 Years.

Looking at the cohort specific mortality (firgure 1) for cohorts between 1900 and 1915, you clearly see that the mortality before 1990 is higher for the eastern cohorts than for western cohorts . But with going forwards in time, the pace of the increase becomes smaller and in the end the hazard of all four cohorts converges to the hazard in the western part of Germany. Such an flattening out of the hazard is not necessarily the result of a change in mortality. It can also be the effect of an inner selection process. As it was described theoretically by Vaupel et al. (1979) and Vaupel and Yashin (1985). This selection is the result of the unobserved heterogeneity. Every human populations is heterogeneous (Vaupel et al., 2007, 159). In other words, a population (e.g. a cohort) is a composition of subgroups or individuals which differ from each other. Some individuals are more frail than others (Vaupel et al., 1979). Since the weakest persons die first a selection takes place and the proportion of strong individuals increases. So that average hazard tends towards the hazard of the strongest. The best known real examples for such a selection effect are the convergence of mortality in the highest age groups (Gampe, 2010) and the mortality cross over of black and white mortality in US (Manton et al., 1987; Markides and Machalek, 1984).

It is maybe not plausible that the converging hazard is only caused by selection but it can not be ignored, like it is done until today.

Introduction of the Model

Vaupel et al. (1979) developed a simple relative risk model to take frailty into account. In this model the individual hazard is the product of the individual frailty z and baseline hazard.

$$\mu(x) = \mu(x, 1) \cdot z \ . \tag{1}$$

Following this relationship the authors showed further that the observed hazard of populations is equal to the baseline hazard times the average frailty at age x.

$$\bar{\mu}(x) = \mu(x, 1) \cdot \bar{z}(x) \ . \tag{2}$$

To solve this model assumption about the distribution of the frailty and the standard hazard must be made. Several authors showed that assuming a Gompertz baseline hazard and a

gamma distribution for the frailty is a very good approximation (Steinsaltz and Wachter, 2006; Finkelstein and Esaulova, 2006; Missov and Finkelstein, 2011).

To fit such gamma Gompertz model some further assumptions are necessary. By assuming that the average frailty at the starting age is equal to 1 the average frailty at age x can be substituted the the cohort survivorship at age x to the of γ (eq. 3), where γ is equal to the variance of the gamma distribution (Vaupel et al., 1979)

$$\bar{\mu}(x) = ae^{bx} \cdot S_c(x)^{\gamma}, \tag{3}$$

With this gamma Gompertz model it is possible to estimate the effects of selection on the increase of the average hazard as well as the frailty distribution of the survivors and the dead at any age (Vaupel et al., 1979; Vaupel and Zhang, 2010).

Preliminary Results

Fitting the gamma-Gompertz frailty model (eq. 3), suggests big differences in the strength of the selection effects between East and West Germany. For the East German cohort the selection effect seems to be more dominating. It affects the course of the hazard much earlier and stronger than for the Western cohorts.

These strong selection effect lead to a change of the frailty distribution over time. The preliminary results suggests that in older East German cohorts the weakest ones died already before unification and the frailty distribution is shifted to the stronger ones. For the western cohorts the shift of the frailty distribution seems to be not so strong. A greater proportion of individuals with higher frailty are still alive compared to East Germany.

This suggests that the convergence of the mortality in East Germany after unification is not only the result of a changing environment but also caused by the selection effects in these heterogeneous populations. Further it can be concluded that this is especially true for the oldest cohorts, which have already been affected by the population dynamics before unification.

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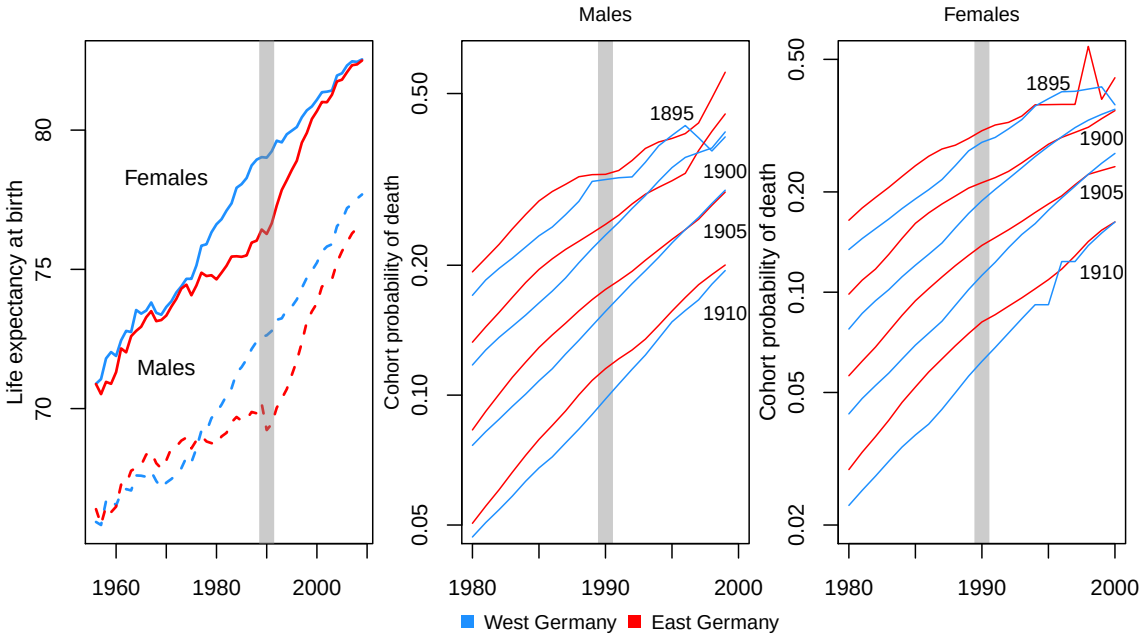
Figures & Tables

Figure 1: Life expectancy from 1980 to 2009 and annual cohort probability of death for the cohorts born between 1895 and 1910 in for East and West Germany



Source: HMD