# Declining air pollution and its effect on mortality Findings from East Germany after reunification.

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**Abstract**

The negative association between air pollution and human mortality is well established. Short episodes as well as continued exposure to high concentrations of sulphur dioxide ($SO_2$) or nitrogen dioxide ($NO_2$) are related to increased mortality mainly from circulatory and respiratory diseases. East Germans before reunifcation suffered from consistently high levels of air pollution which dropped dramatically after the fall of the iron curtain. At the same time mortality declined and eventually converged to the West German level. This study seeks to quantify the impact of dropping $SO_2$ and $NO_2$ concentrations on all-cause, circulatory and respiratory mortality as well as mortality from neoplasms and its contribution to converging life expectancy between East and West Germany.

# 1 Background:

The negative association between high concentrations of air pollutants and human health and mortality is well established. Short term studies have associated high concentrations of $SO_2$ with increased risks of cardiovascular and respiratory events (Wong et al., 1999). Other studies showed that exposure to high levels of $NO_2$ are also linked to acute and chronic health problems (Chauhan et al., 2003). Likewise long term exposure to these pollutants were further linked to bronchitis, asthma attacks, lung cancer, heart dysfunctions, respiratory infections in children and respiratory diseases in general (Kampa and Castanas, 2008; Miller et al., 2007; Gauderman et al., 2004). These results emphasise that long term exposure may cause severe health problems on the long run while shorter episodes of excess pollution are associated with the harvesting hypothesis (Brunekreef, 2007).

Based on the negative association between high concentrations of air borne pollutants and mortality, this analysis seeks to contribute to the exisiting literature by focusing on the effect of dropping levels of air pollution on mortality. To test this potential reverse relationship it uses the German reunification as a natural experiment and the subsequent convergence of East German life expectancy to the higher levels in the West. Before reunification, the southern regions of East Germany were considered atop of the most polluted areas of Europe (Renner, 2002). I assume, if pollution played a crucial role in the convergence, that regions in which pollution levels declined first, or were already low, caught up first to the western level. The positive effect of declining ambient air pollution for human health and mortality was found mainly for children (Tang et al., 2008; Bayer-Oglesby et al., 2005; Heinrich, 2003). However, the effect of a sudden decline of $SO_2$ and $NO_2$ concentration on adult mortality is less studied.

# 2 Data and Method

I use causes of death and population counts at a district level provided by the statistical offices of the five eastern German states and West Germany as a whole. In the analysis, I cover the period from 1982 to 2007 and estimate the contributions of single causes of death to the East-West German life expectancy gap by region. The death and population counts for West Germany as a whole were provided by the German Federal Statistical Office and cover the same period.

Information on pollution levels for $SO_2$ and $NO_2$ were obtained from the German Federal Environment Agency for the years 1990 to 2011. In the analysis, I use yearly

averages of $\mu g$ of $SO_2$ and $NO_2$ per $m^3$ of air as well as the number of the hours on which pollution levels go beyond the recommended WHO threshold (World Health Organization, 2006).

To test my hypothesis, I analyse three differently polluted areas in East Germany: the 'black triangle' region at the border to the Czech Republic and Poland, the 'chemical triangle' a region with high concentration of chemical industries around the cities of Leipzig and Halle as well as the agricultural state of Mecklenburg-Pomerania. I group causes of death and population counts for the districts within each of these regions together and assign the pollution monitoring stations accordingly. Thus, I calculate average pollution and cause specific mortality levels for each region. Accordingly, I use the industrial western state of North-Rhine Westfalia and West Germany as a whole as reference groups. Finally, I decompose the life expectancy convergence by age and cause of death to estimate the contribution of air pollution on the mortality convergence (Pollard, 1988).

The second step of the analysis aims at quantifying the magnitude of declining pollution levels directly. I use Poisson regressions to estimate the different effect of $SO_2$ and $NO_2$ pollution on mortality in each region. Additionally, the regression controls for demographic factors and seeks to include socioeconomic variables on the regional level in the final analysis.

## 3 Preliminary Results

The descriptive approach reveals that, following reunification, there was a simultaneous decline of air pollution and improving mortality from circulatory and respiratory diseases. So far, I sought to test for the potential association between the post-reunification life expectancy increase and the reduction of $SO_2$ and $NO_2$ levels. Figure 1 reveals that in the black triangle and the chemical triangle region, $SO_2$ levels heavily exceeded the recommended WHO annual threshold of 30 $\mu$g per $m^3$ of air (World Health Organization, 2006). Furthermore, the graphs put the concentration levels in association with the increase in life expectancy for each single region after German reunification. Each data point shows the association between life expectancy and pollution for every year and every region between 1990 and 2007. For both sexes, it becomes apparant that every year the average yearly concentration of $SO_2$ declines. Simultaneously, life expectancy at birth increases. I further tested for the direction and magnitude of the association by using the correlation coefficient *Kendall's Tau* which allows for the assumption that the association is non-linear and that the underlying distribution is different from a normal

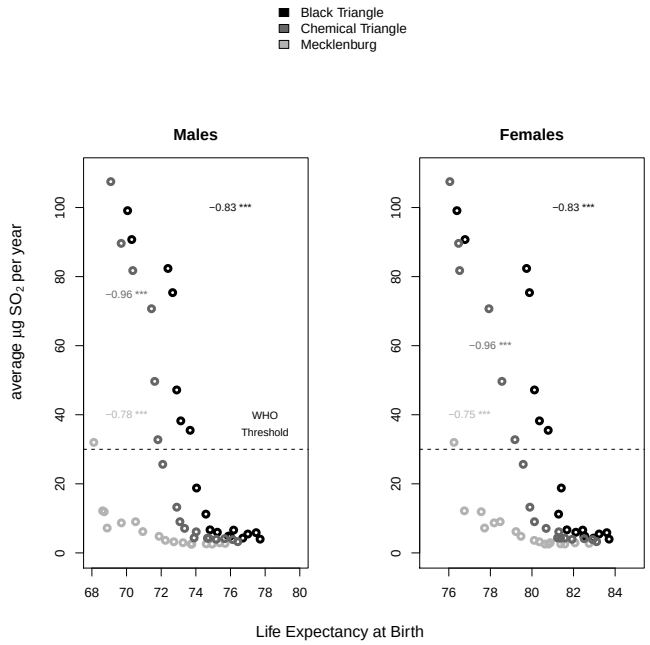


Figure 1: Association between life expectancy at birth and yearly $SO_2$ concentrations, Significance levels of the correlation, '***' 0.00001, '**' 0.001, '* ' 0.1

distribution. It reveals that there is a strong negative association between $SO_2$ exposure and life expectancy. Yet, as a preliminary result, it seems that the decline in air pollution was less helpful then expected. In 1990, men and women in the region with the lowest conentration of $SO_2$ lagged by more than 1 year behind the average life expectancy in the more polluted areas. Additionally, both triangle regions increased their average life expectancy faster than Mecklenburg-Pomerania. The future analysis seeks to shed more light on the influence of $SO_2$ and $NO_2$ levels on mortality and will include detailed causes of death and West Germany as a control group.

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