The Effect of Regional Occupational Structure on Mortality in a Transition Economy—Individual versus Spill-Over Effects

Iliana Kohler*

June 12, 2002

Abstract

Objectives. In this paper, we investigate the importance of individual and contextual living and working environment as determinants of the risk of death in Bulgaria during the early transition in 1993. In particular, we focus on the question to which extent geographical differences in Bulgarian mortality may be explained by differences in employment and occupational structure persisting across administrative regions. *Methods.* The analysis is based on the unique individual-level dataset that is obtained from a link between the 1992 Bulgarian population census and the death certificates for the period December 5, 1992—December 31, 1993. We apply a piecewise-constant proportional survival model that is estimated separately for the adult (30–60 years) and elderly (60–80 years) old men and women. *Results.* Our results show that on individual level, the branch of employment predicts the risk of death. In particular, being employed in the heavy (for men) and light (for women) industry increases the risk of death compared to those people employed in the service sector. In addition, regions characterizes by heavy industry may be associated with a lower risk of death. *Conclusions.* We find a strong individual effect of occupation, and a spill-over effect of prevailing heavy industry in the region.

Paper to be presented at the IUSSP workshop on 'Determinants of Diverging Trends in Mortality', Rostock, June, 19—June, 21 2002.

Very preliminary version—please do not quote

(*this version:* iussp-regpaper.tex)

*Research scientist, Max Planck Institute for Demographic Research, Doberaner Str. 114, 18057 Rostock, Germany. *Tel:* +49-381-2081-125, *Fax:* +49-381-2081-425, *Email:* iliana.kohler@demogr.mpg.de.

1 Introduction

Understanding the increase of mortality in the early 1990s remains one of the primary challenges for researchers investigating the mortality dynamics in the countries of Central and Eastern Europe. Among the various hypotheses that have been proposed to explain the prevailing unfavorable mortality patterns, researchers have pointed out to the effect of high levels of environmental pollution due to the concentration of heavy industries in certain geographic regions combined with poor environmental standards and norms, or the decline of established industrial sectors that is accompanied by a deterioration of living standards, dramatically increasing unemployment/underemployment and widely spreading socioeconomic deprivation in those regions mostly affected by the transition (Bobak and Leon 1992; Bobak and Marmot 1996; Hertzman 1995; Hertzman et al. 1996; Hertzman and Siddiqi 2000; Krzyzanowski and Wojtyniak 1982; Peters et al. 2000). Despite the apparent plausibility that these factors have contributed importantly to the mortality dynamics during the 1990s, very little micro-evidence exists on these hypotheses, and virtually almost no evidence exist whether the regional and temporal variation of mortality in Central and Eastern European countries can be explained by the variation of contextual factors, such as differences in supply of infrastructure, differential occupational structures across regions, or alternatively, by the immediate individual environment that determines for the most part the risk of death.

In this paper, we investigate the importance of contextual and individual living and working environment as determinants of the risk of death in the early transition period in Bulgaria in 1993. In particular, we focus on the question of whether the geographic variation in Bulgarian mortality during the early to mid 1990s was related to differences in employment and occupational structure persisting across administrative regions. This investigation is of a particular interest as the variation in occupational structure (including also level of unemployment) across regions correlates with several aspects of the social environment observed in these geographic areas. For example, the variation in occupational structure by regions is connected to differential exposures to environmental hazards such as levels of trace elements in the soil and drinking water or air pollutants. In addition, regional variation in occupational structure also implies differences in the supply of infrastructure. For example, similarly to other former socialist countries, Bulgaria is characterized by a fast industrialization, and by a rapid growth of the heavy and light industries, especially during the 1950s and 1960s. This past economic development was complemented by a rapid urbanization process in the regions accommodating these new industrial branches, which was respectively accompanied by the development of housing conditions, social infrastructure, schooling, health care system, etc. in these areas in order to cope with the demand of the local population.

In summary, the effects of occupational structure may operate along multiple dimensions, and it is not straightforward how these translate into people's health. Basically, we can differentiate between two main effects: *contextual effects* of regional occupational structure and *individual effects* in the sense of being directly exposed to hazardous occupational conditions. The contextual effects of the prevailing occupational structure in a certain region may be mediated through environmental hazards (i.e., high concentrations of air, soil, and water pollutants), or through the socioeconomic environment in these areas that depends on high or low concentration of certain industries in a region even without being employed in this sector. In the Bulgarian case for example, industrial regions are usually characterized by a better infrastructure, availability of health care, etc. as compared to poor and under-developed agricultural regions during the pre-1989 period. During the transition period after 1989, however, the contextual effects of regional occupational structure may exert negative impact on the health status of the population: due to the collapse of the local—and especially traditional—industries, in many areas unemployment has risen, living conditions and infrastructure have deteriorated, and this can give rise to adverse socioeconomic characteristics in these areas (i.e., dramatic increase of unemployment in some regions accompanied by a rapid improverishment of the people living there).

On the other side, the individual effect of regional occupational structure may be direct consequence of being employed in a certain industrial sector, rather then a contextual effect in the sense of depending on high or low concentration of particular industries in a region. Occupation and branch of employment define the immediate environment in which persons are exposed to hazardous working conditions, exposure to pollutants, emotional stresses, and other professional risks (see for example Geyer and Peter 1999; Gregorio et al. 1997; Hemström 1999; Valkonen and Martelin 1988).

The investigation of individual versus contextual effects on mortality is of a particular importance for us to understand the dynamics of mortality patterns and their determinants in transition economies. The objective of the analysis in this paper is therefore to examine whether there is a systematic relation between the regional variation in Bulgarian mortality on the one hand, and the variation in occupational structure and regional socioeconomic development observed across different parts of the country on the other hand. In most former socialist countries this type of analysis is, however, problematic due to the lack of suitable data, and Bulgaria offers therefore an unsurpassed chance to investigate this issues. This analysis is based on a unique individual-level dataset, which allows to disentangle to which extent mortality patterns in Bulgaria are determined by the individual socioeconomic context, and to which extent the risk of death depends on the broader contextual settings that vary by regions.

The remainder of this paper is organized as follows. In the next section, we provide an overview of the regional mortality differentials in Bulgaria in 1993. The following Section 3 presents the unique Bulgarian mortality dataset and discusses the method applied for the further analysis in this paper. Section 4 presents the results on individual and contextual effects of occupational structure on the risk of death, and the last section summarizes and discusses the results.

2 Background—Regional Mortality Differentials in Bulgaria in 1993

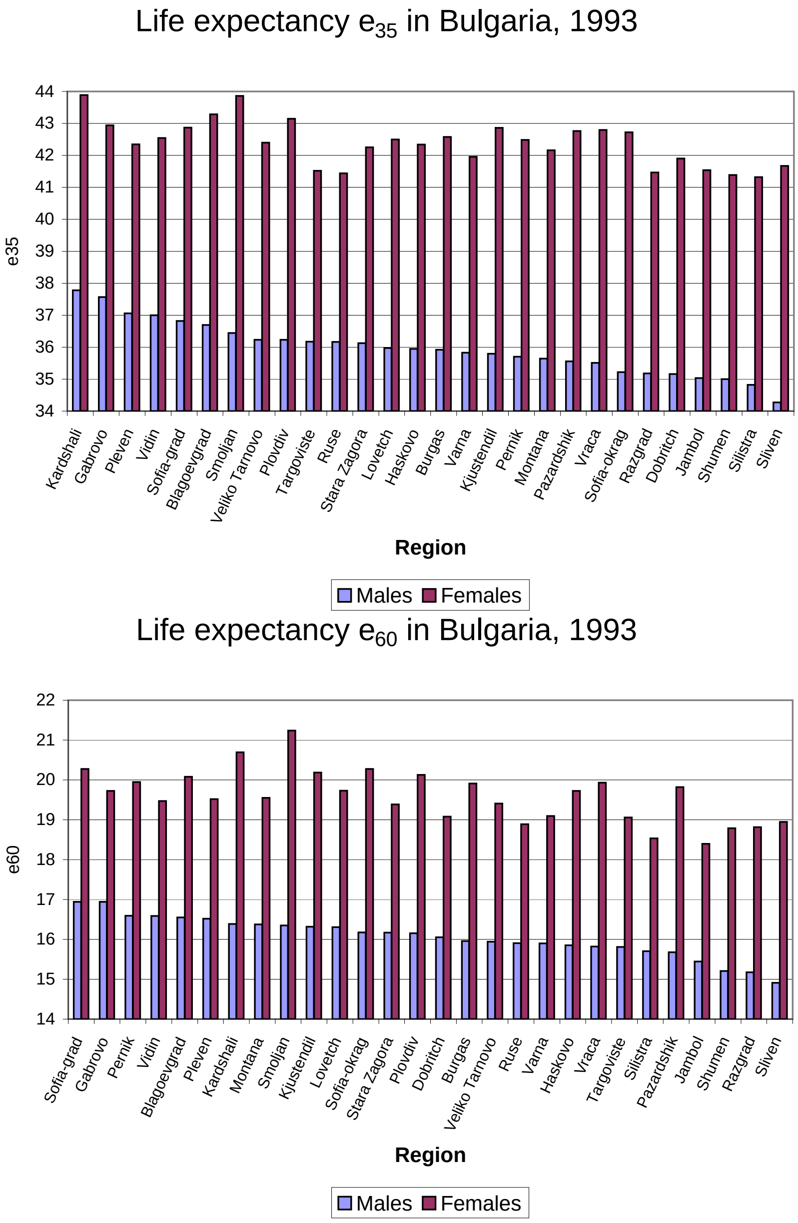
The aim of this section is to give an overview of the observed regional mortality differentials by sex in Bulgaria in 1993. Figure 1 summarizes the differences in life expectancy for two age groups– the young population at working age (e_{35}) and the elderly men and women at age 60 (e_{55}).[1] The upper graph of Figure 1 shows that the difference in male life expectancy e_{35} between the region with the highest value (Kardshali) and the region with the lowest observed life expectancy (Sliven) is 3.5 years. For females, this difference between the region with the highest (Kardshali) and the one with the lowest life expectancy (Silistra) is lower and equals 2.6 years. Moreover, as the figure clearly illustrates, male and female life expectancy do not follow the same pattern by region: for example, the region with the lowest male life expectancy is not the region in which we observe the lowest female life expectancy. In addition, the regions are characterized by quite substantial difference in life expectancy by sex. The largest difference in male versus female life expectancy is observed in the region Sofia-okrag (that is the region surrounding the capital Sofia), where young females at age 35 live on average 7.5 years longer then young men. In the region Ruse, we observe the lowest male-female difference in life expectancy at age 35 (5.27 years).

The lower graph of Figure 1 shows that similar pattern of regional differentials is observed also at older ages. The difference in male life expectancy e_{60} between the region with the highest (Sofia) and the lowest values (Sliven) is 2.03 years. For elderly women this difference between the best (Smoljan) and the worst (Jambol) region is 2.84 years. Similarly to the results shown in the upper graph of Figure 1, male and female life expectancy at older ages (i.e., age 60) do not necessarily follow the same regional pattern, and the region in which men have the highest life expectancy in Bulgaria is not the region, in which also females do best.

The overview of the life expectancy differentials by age, sex and region suggests that there is a quite substantial variation in mortality in Bulgaria. Moreover, the results indicate that there may be different factors that operate and determine the survival chances of men and women in Bulgaria. In previous research, Kohler (2001) has shown that an important determinant to understand mortality differentials by area of residence is the educational composition of the population that differs quite substantially between regions and residential areas. For example, the capital Sofia attracts better educated people, while other areas are characterized by concentration of people with adverse socioeconomic

[1] The life expectancy is calculated from regional period life tables wit 5-year age groups based on the census dataset described in Section 3.

Figure 1: Variation in male and female life expectancy at age 35 and 60 by region. (The values are sorted by male life expectancy from high to low values. Own calculations of period life tables based on individual-level dataset).



characteristics (e.g., people with low education). However, differences in the educational composition do not explain completely the observed mortality differentials across regions in Bulgaria. As indicated in the introduction, geographical areas in Bulgaria differ also by the level of industrialization and socioeconomic development. A plausible hypothesis is that these latter factors, in fact, may contribute to the observed mortality differentials by regions in Bulgaria. In order to investigate this hypothesis, we proceed with analysis on individual level.

3 Data and Model

3.1 Data

The analysis is based on a unique individual-level dataset that covers death, individual socioeconomic and housing information for the entire Bulgarian population. In particular, the data was obtained from a link between the 1992 population census taken on December 4, and the deaths that occurred in the country in the period December 5, 1992—December 31, 1993. The link between the census and the death records had been performed on the basis of a unique personal identification number that is assigned to each Bulgarian citizen. This number appears on all personal documents for the registration of vital events (i.e., birth, death, marriage and divorce certificates) as well as on other individual records and documents.[2] In the period of observation that covers 392 days of exposure, a total number of 116,611 deaths occurred in Bulgaria. The death certificates of 108,070 (92.68%) individuals were successfully linked to their census records. This individual-level dataset is the first linked dataset of this type in Bulgaria and in any other Eastern European country. Beside the fact that the dataset covers detailed mortality information for the entire Bulgarian population, a major advantage of this census data is that it allows for investigating whether the observed mortality differentials across residential areas in Bulgaria are an aggregation of individual characteristics, or alternatively they reflect merely the effect of factors that operate on contextual level.

[2] Detailed description of the Bulgarian statistical system can be found in Kohler et al. 2002.

In this paper, we restrict the analysis to individuals who were at least 30 years old when the census was taken and who were not older than 80 years at the end of the observation period or at death. This sample includes a population of 4,858,119 individuals, of whom 2,344,138 (48.25%) are male and 2,513,981 (51.75%) female. During the period of 392 days of observation, 44,528 (1.90%) of all males and 27,742 (1.10%) females died. The sample excludes members of the army and inhabitants of prisons, but includes institutionalized individuals (e.g., people living in nursing homes, monasteries, etc.).

3.2 Model

The analysis of individual and contextual effects on mortality are based on the event-history approach applying a piecewise-constant proportional survival model. The mortality hazard is held constant within 2 year age intervals, and the model specification allows the hazard to vary across these age intervals.[3] We estimate relative risks of death associated with individual and regional characteristics (observed on the census day). The model is estimated separately for men and women, as well as for the population at working ages (30 to 60 year old) and the elderly population (60 to 80 year old).

The piecewise-constant survival model is specified as follows:

$$\mu(x) = h_0(x) \exp(\Sigma_{i=1}^{K} \beta_i x_i), \tag{1}$$

where $h_0(x)$ is the piecewise-constant specification of the baseline hazard with constant mortality risks in two-year age intervals, and x_i for $i = 1, \ldots, K$ are additional individual or aggregated regional characteristics observed on the census day.

The individual characteristics are mostly binary variables such as having high, medium, low or no education, or being employed in the heavy or light industry, agriculture or working in the service branch. The regional characteristics are aggregation from the individual-level characteristics and are calculated as the mean of the observed individual characteristics separately for each of the 28 administrative regions in Bulgaria. For the

[3]In the following analysis, this baseline hazard is not reported. The baseline hazard, however, conforms well with the well-established age pattern of mortality that could also estimated via Gompertz, logistics, or related parametric functions.

Table 1: Summary statistics of the aggregated regional indices for occupational structure in Bulgaria, 1993.

Aggregated Regional Index (N=28 regional indeces)	**Mean**	**Std. Dev.**	**Min**	**Max**
Employed in heavy industry	0.138	0.054	0.062	0.323
Employed in light industry	0.224	0.031	0.175	0.282
Employed in agriculture	0.124	0.049	0.018	0.222
Other branches of employment (primarily services)	0.362	0.048	0.309	0.554
Index of unemployed and economically unactive population	0.152	0.029	0.082	0.216
Regional unemployment	0.010	0.006	0.001	0.021

Notes: Each index is calculated as the mean of the observed individual characteristics of the working population, age 20–60 years.

retired population above age 60, the branch of occupation/employment is determined on the basis of the person's last occupation. In order to get an appropriate description of the current occupational composition, the aggregated regional indices are calculated on the basis of the individual characteristics of the working population 20 to 60 years old since most persons above age 60 are retired. Table 1 summarized the characteristics of these aggregated indices reflecting the variation in the occupational and employment structure by region.

4 Individual or Spill-Over Effects of Regional Occupational Structure on the Risk of Death during the Early Transition

Figure 2 and Figure 3 show the results obtained from two different specifications of Eq. (1): *a)* the first model specification includes covariates for individual branch of employment such as employed in the heavy or light industry, agriculture, while *b)* the second model specification considers only the covariates measuring the contextual effects of the occupational structure on regional level. The two models are estimated separately of each other. We estimate also two additional models in which we show how the effect of individual and regional occupational characteristics changes when we consider baseline socioeconomic characteristics such as education. This effect of education is also shown in Figure 2 and Figure 3. The models are estimated separately for men and women, as well as for the two age groups (adults at working ages and elderly above age 60). In addition to both figures, Table 2 reports the relative risks and standard errors obtained from the estimation of the models.

We define five main branches of employment, which in our opinion reflect quite well different health hazards associated with occupation: employed in the heavy industry (i.e., mining, metallurgy, etc.), employed in the light industry, employed in agriculture, being unemployed or economically inactive, and the reference category which includes the remaining branches of employment (i.e., various services, administration, post, etc., to which refer in the further analysis as the service sector).

The upper panel of Figure 2 summarizes the estimates for the male population at working ages (30–60 year old). The left graph of the upper panel shows that being employed in the heavy and light industry, agriculture or being unemployed increases considerably the individual risk of death as compared to the reference category (employed in the service sector), and these differences in the risk of death are statistically significant (see Model 1 in Table 2). In particular, men at working ages who are employed in the heavy industry have about 19 per cent higher risk of death, while men at this age working in the light

Table 2: Effects of individual branch of employment and regional index of occupational structure on mortality—relative risks of death obtained from piecewise-constant proportional hazard estimations of mortality (baseline hazard and effect of education are not reported).

Explanatory variable	**Males**		**Females**	
	30–60 yrs.	**60–80 yrs.**	**30–60 yrs.**	**60–80 yrs.**
Model 1—Effect of individual occupation				
Employed in heavy industry	1.19 (0.034)**	1.12 (0.021)**	1.10 (0.044)$^+$	1.10 (0.042)$^+$
Employed in light industry	1.16 (0.026)**	1.10 (0.026)**	1.19 (0.051)**	1.11 (0.0245)**
Employed in agriculture	1.32 (0.049)**	0.99 (0.037)	1.18 (0.066)*	1.06 (0.042)
Unemployed or economically inactive	1.68 (0.055)**	1.25 (0.027)**	1.39 (0.059)**	1.23 (0.024)**
Model 2—Effect of individual occupation controlled for education				
Employed in heavy industry	1.07 (0.038)$^+$	1.04 (0.015)*	1.02 (0.038)	1.04 (0.042)
Employed in light industry	1.02 (0.029)	1.03 (0.020)	1.08 (0.043)	1.05 (0.027)
Employed in agriculture	1.0353 (0.047)	0.89 (0.032)*	0.95 (0.051)	0.95 (0.041)
Unemployed or economically inactive	1.38 (0.047)**	1.11 (0.024)**	1.14 (0.050)*	1.09 (0.026)**
Model 3—Effect of regional occupational structure				
Regional index of heavy industry	1.15 (0.483)	0.94 (0.098)	0.58 (0.176)	0.81 (0.202)
Regional index of light industry	1.13 (0.636)	0.98 (0.286)	0.29 (0.140)$^+$	0.46 (0.225)
Regional index of agriculture	0.89 (0.615)	2.33 (0.590)**	0.25 (0.122)*	1.87 (0.907)
Regional index of unemployment/economically inactive	1.60 (1.456)	0.98 (0.368)	4.14 (3.279)	1.26 (0.831)
Model 4—Effect of regional occupational structure controlled for education				
Regional index of heavy industry	0.56 (0.217)	0.61 (0.073)**	0.39 (0.111)**	0.57 (0.146)$^+$
Regional index of light industry	0.70 (0.371)	0.79 (0.241)	0.24 (0.118)*	0.41 (0.212)
Regional index of agriculture	0.24 (0.172)$^+$	1.05 (0.321)	0.08 (0.050)**	0.91 (0.538)
Regional index of unemployment/economically inactive	0.68 (0.641)	0.55 (0.217)	2.08 (2.054)	0.71 (0.548)

Notes: Standard errors in parentheses. *p-values:* $^+$ $p \leq 0.05$; * $p \leq 0.01$; ** $p \leq 0.001$.

industry have 16 per cent higher risk of death as compared to those employed in the service sector. The risk of death even increases if young men below age 60 are unemployed (68 per cent higher risk of death as compared to the reference group), or they are agricultural workers (32 per cent higher risk of death).

If individual socioeconomic characteristics such as education are considered in the analysis, then the effect of branch of employment diminishes substantially, and the difference in the risk of death between men employed in the light industry or agriculture and those employed in the service sector (the reference category) is not statistically significant anymore (see Model 2 in Table 2). The individual risk of being employed in the heavy industry is reduced in this second model specification to 7 per cent, and remains statistically significant. Unemployed and economically inactive men at working age have 38 per cent higher risk of death as compared to the reference group even when we consider educational differences.

The right graph in the upper panel of Figure 2 shows the effect of the regional occupational structure on the risk of death for men below age 60. None of these regional indices for occupational structure are statistically significant, and as Model 3 in Table 2 shows they have a quite wide confidence interval. When we consider compositional differences by education, then the contextual effect of occupational structure changes, but remains statistically not significant. Only young men below age 60 who live in a region with a prevailing agricultural occupational structure have a lower risk of death as compared to those young men living in a region with a occupational structure characterized by employment in services.

The lower panel of Figure 2 shows the estimates for individual versus contextual effects of branch of employment on the risk of death for elderly men, 60 to 80 years old. As most of the people above age 60 are retired in Bulgaria, the census states their last occupation. If we do not consider the effect of individual baseline socioeconomic characteristics such as education, then elderly men who were last employed in the heavy and light industry, as well as those who were unemployed or economically inactive have higher risk of death as compared to those who were employed in the service sector. These differences in the risk of death are statistically significant, while the mortality differential between elderly

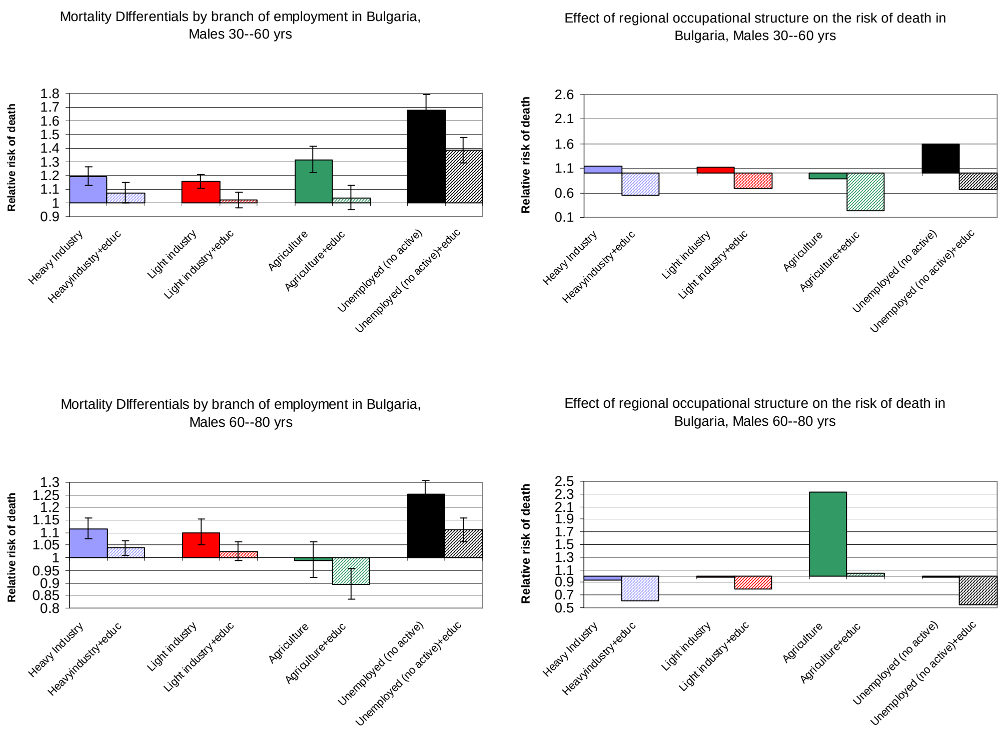


Figure 2: Upper panel: Effects of individual and regional occupational structure on the risk of death for males 30–60 years old, Bulgaria 1993. Lower panel: Effects of individual and regional occupational structure on the risk of death for males 60–80 years old, Bulgaria 1993.

men who were employed in the agriculture and the reference category is not statistically significant in this model specification (see also Model 1 in Table 2).

When we consider the individual's education in the analysis, then the effect of having been employed in the light industry diminishes, while the effect of having been employed in the heavy industry or being unemployed before retirement is substantially reduced. Elderly men who last worked in the heavy industry have about 4 per cent higher risk of death as compared to those who worked in the service sector, while those who were unemployed or economically inactive have about 11 per cent higher risk of death compared to the reference group. Interestingly, when we control for the effect of education, the model shows that elderly men who had been employed in the agricultural sector have about 11 per cent lower risk of death compared to the reference group (employed in he service sector), and this difference is statistically significant.

The right graph of the lower panel in Figure 2 illustrates the contextual effects of occupational structure on the risk of death for elderly men. If we do not consider compositional differences by education in the analysis, none of these aggregated indices is statistically significant with the exception of the index for agricultural occupational structure that is associated with a relative risk factor of two. On the other hand, if we control for the individual education in the analysis, then this effect of agricultural regional occupational structure diminishes, while living in a region with prevailing heavy industry is associated with a lower risk of death for elderly men that is statistically significant (*p-value of the coefficient:* $\leq .001$).

Because the regional indices of occupational structure are continuous variables, the estimates of the relative risks in Table 2 and Figure 2 show the difference in the risk of death between individuals living in a region characterized by the highest (1) versus lowest (0) index. However, such regions do not exist and most regions are clustered around the mean values (see Table 1). It is therefore of a potential interest to estimate how the risk of death changes when moving from a region with an average occupational structure to a region which prevailing occupational structure is one standard deviation above the average, that is moving to a region that is for example more heavily industrialized. For instance, if the occupational structure of a region is characterized by a heavy industry that is one standard deviation above the average, then elderly men above age 60 living in this region have 4 per cent lower risk of death. In other words, if heavy industry prevails in a region, elderly men living there have lower risk of death.[4]

Figure 3 and Table 2 show the estimates obtained from Eq.(1) for females at working ages and elderly women. The upper left graph of Figure 3 reveals that similarly to young men at working ages, women below age 60 employed in the heavy and light industry, or in agriculture as well as those who are unemployed or economically inactive have higher risk of death as women having jobs in the service sector. These differences in the risk of death compared to the reference category are statistically significant. If we however consider the educational attainment of these women, then the mortality differentials observed between the various groups diminish and are not anymore statistically significant. An exception remains the category of unemployed women, who in this second model specification have 14 per cent higher risk of death as compared to young women working in the service sector (see Model 2 in Table 2).

The upper right graph shows how the characteristics of the regional occupational structure, where women live, affect their risk of death. According to this analysis, women living in regions with prevailing light industry or agricultural regions have lower risk of death, and this difference is statistically significant. The effect of regions with heavy industry or large number of unemployed people on the risk of death of young women living there is not statistically significant. If we however control for baseline socioeconomic characteristics (i.e., education), then our model estimates that women below age 60 living in regions with prevailing heavy and light industries, or agricultural regions have lower risk of death (and this difference is statistically significant) compared to women living in regions with a prevailing service sector, while the level of unemployment in the region is not significant. For example, if a young woman lives in a region with a heavy industry which industrialization is one standard deviation above the average, her risk of death is reduced by 10 per cent. If she lives in an agricultural region once standard deviation above the average, her risk

[4]The change in the relative risk of death by moving to a region that is one standard deviation above the average is calculated as $\mu(x) = (\exp(\beta))^{\sigma}$, where $\mu(x)$ is the relative risk of death, β is the respective coefficient for a single characteristic estimated via a piecewise-constant survival model, and σ denotes the standard deviation of this characteristics.

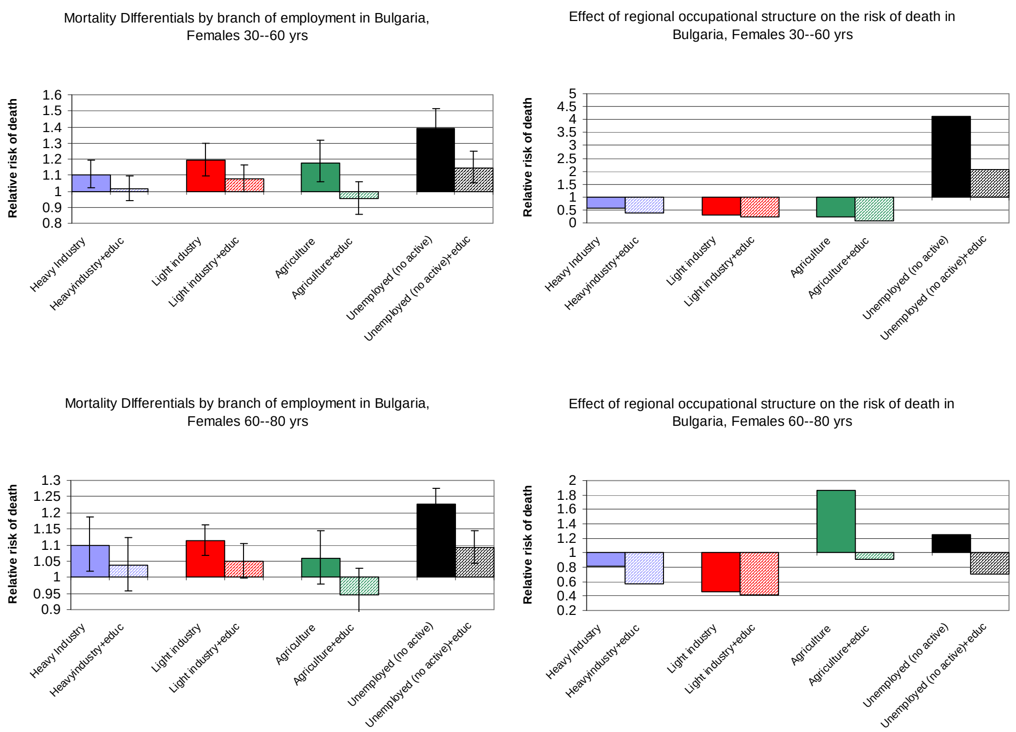


Figure 3: Upper panel: Effects of individual and regional occupational structure on the risk of death for females 30–60 years old, Bulgaria 1993. Lower panel: Effects of individual and regional occupational structure on the risk of death for females 60–80 years old, Bulgaria 1993.

of death is reduces by about 12 per cent.

Similar pattern for the risk of death associated with the individual occupation is estimated also for elderly women above age 60 (lower left panel of Figure 3): elderly women who had been last employed in the heavy and light industry, or who had been last unemployed or economically inactive have higher risk of death compared to those who worked in the service sector. This differences are statistically significant. If we include the education of these women in the analysis, the differences to the reference category diminish and only women who were unemployed have significantly higher risk of death.

The effect of regional occupational structure on the risk of death of elderly women is not statistically significant if we do not control for education (see Model 3 in Table 2). If we, however, consider the effect of education in the analysis (Model 4 in Table 2), the model estimates that elderly women living in a region with a heavy industry one standard deviation above the average have about 8 per cent lower risk of death compared to a woman living in a region with average prevalence of heavy industry.

The above results indicate, quite surprisingly, that living in a region with high industrialization and higher level of heavy industry (as measured by the prevailing occupational structure) may be associated with a lower risk of death. A plausible explanation is that these regions may be characterized by better living conditions, which were developed parallel to the industrialization process, when these industries were established. In order to investigate this hypothesis—namely whether the above pattern in fact reflects differences in standards of living conditions—we consider in the further analysis the effect of individual living conditions and living conditions on regional level.

A limitation of the individual dataset described in Section 3 is that it does not contain direct information on individual income and wealth, which probably best reflect the individual's living environment. However, the data include information on various household/dwelling characteristics that measure the standard of living conditions. Several studies have shown that the intermediate living environment is a good proxy of income distribution, availability of economic resources, etc. (Valkonen 1987, 1998). Hence, in these analyses we assess living standards with an index based on the summation of several household characteristics included in the census questionnaire. The index, denoted *index* *of living conditions*, comprises the following six binary indicators: whether the household has an access to a central water supply in the dwelling versus water supply outside of the dwelling, an access to a central hot water supply, availability of bath room in the dwelling, availability of a central sewerage system, flash toilette versus other substandard toilette types, heating system (e.g., central heating supply versus heating with wood, coal, etc.). These variables capture very well the socioeconomic differences between households in Bulgaria. The living conditions index is scored from *zero* to *one*, where *one* indicates a wealthy household that has an access to all six indicators.[5] The index is calculated for each individual from his/her household characteristics at census, so that it reflects the level of individual living conditions as measured by household indicators. This index can be considered as not only a summation of the level of personal deprivation as measured by the living standards, but it also reflects the quality of the individuals' intermediate health environment. The index of living conditions has a mean of .673 and a standard deviation of .343.

In addition to this individual level index of living conditions, we also estimate a corresponding index on regional level that is calculated considering the entire population. This measure reflects the overall distribution of wealth across the provinces. The regional index of living conditions has a mean of 0.649 and a standard deviation of 0.103. The index on individual and regional level is the only one measure of social deprivation which can be derived from the census information. It picks up quite well the main characteristics of the individuals' social environment, e.g. whether the individuals live in a wealthy and healthy household environment.

Table 3 shows the relative risks of death obtained from a model in which we estimate jointly the effect of individual occupation and the effects of the regional occupational structure. In addition to these occupational indicators, the estimation includes an index for living conditions on individual and regional level, and controls for the educational composition of the population. The model is estimated separately for men and women, and for the population at working ages (30–60 years old) and elderly people (60–80 years).

[5]Each household can receive a maximum of six scores. For an easier interpretation of the index, I divide the total number of scores by the number of items, so that the deprivation index varies from *zero* to *one*.

Table 3: Effects of individual branch of employment and regional index of occupational structure on mortality—relative risks of death obtained from a piecewise-constant proportional hazard estimation of mortality (baseline hazard of mortality is not reported).

Effect of explanatory variable	**Males**		**Females**	
	30–60 yrs.	**60–80 yrs.**	**30–60 yrs.**	**60–80 yrs.**
Effects of individual branch of employment				
Employed in service sector	1	1	1	1
Employed in heavy industry	1.08 (0.032)*	1.05 (0.015)**	1.02 (0.038)	1.05 (0.043)
Employed in light industry	1.04 (0.027)	1.03 (0.020)	1.10 (0.042)$^{+}$	1.06 (0.027)$^{+}$
Employed in agriculture	0.98 (0.038)	0.89 (0.034)*	0.95 (0.047)	0.97 (0.047)
Unemployed or economically inactive	1.32 (0.042)**	1.10 (0.025)**	1.13 (0.063)$^{+}$	1.13 (0.029)**
Individual index of living conditions	0.59 (0.026)**	0.90 (0.024)**	0.76 (0.053)**	1.03 (0.034)
Effects of regional indices of occupational structure				
Regional index of heavy industry	0.33 (0.129)*	0.55 (0.098)**	0.25 (0.095)**	0.53 (0.205)
Regional index of light industry	0.45 (0.267)	0.81 (0.291)	0.14 (0.071)**	0.4 (0.229)
Regional index of agriculture	0.12 (0.078)*	0.95 (0.298)	0.04 (0.023)**	0.81 (0.460)
Regional index of unemployment/economically inactive	0.16 (0.213)	0.43 (0.245)	0.66 (0.941)	0.55 (0.693)
Regional index of living conditions	0.77 (0.262)	1.05 (0.213)	0.67 (0.290)	0.98 (0.375)
Medium education	1.35 (0.071)**	1.23 (0.024)**	1.10 (0.056)	1.14 (0.039)**
Low education	1.81 (0.094)**	1.40 (0.036)**	1.43 (0.066)**	1.39 (0.036)**
No education	2.69 (0.237)**	1.85 (0.078)**	2.65 (0.189)**	1.92 (0.089)**

Notes: Standard errors in parentheses. *p-values:* $^{+}$ $p \leq 0.05$; * $p \leq 0.01$; ** $p \leq 0.001$.

The results obtained from this additional model specification confirm the pattern of mortality estimated in the previous analysis. The results show that for men at working ages, being employed in the heavy industry increases the risk of death by about 8 per cent compared to those who have a job in the service sector. Similar effect is estimated also for elderly men who were last employed in this branch. Being employed in the light industry is also associated with a higher risk of death for men in both age groups, however the difference to the reference category is not statistically significant. In contrast to the male pattern, the results show that the difference in the risk of death for women who are or have been last employed in the heavy industry and women holding jobs in the service sectors is not statistically significant. In opposite to that, women employed in the light industry have 6 (for elderly women) to 10 (for women below age 60) higher risk of death compared to the reference group.

A more surprising pattern is revealed by the results showing the effect on the risk of death, when a person is employed in the agriculture: even though the difference is not statistically significant, our model estimates a trend that men and women employed in agriculture may experience lower mortality (about 2 to 5 per cent lower risk of death compared to the reference group). Moreover, for elderly men above age 60 who were last employed in the agricultural sector, the risk of death is reduced by 11 per cent and this difference is statistically significant.

In contrast, people who are unemployed or economically not active are characterized throughout both sex and age groups by higher risk of death that is significantly different from the reference category. In particular, men at working ages who are unemployed experience about 32 per cent higher risk of death, while for elderly men the difference is only 10 per cent.

In addition to the relative risks of death associated with the individual branch of employment, we estimate that men and women who live in a wealthier household as measured by the individual index of living conditions experience lower risk of death that varies from 10 per cent for elderly men to about 40 per cent for young men. Only for elderly women, the result differs from this pattern (3 per cent higher risk of death), but is not statistically significant.

The estimates in Table 3 show that in contrast to the individual effects of occupation, the aggregated indices corresponding to the variation of occupational structure by region with few exceptions do not have a significant impact on the risk of death of men and women in Bulgaria. For example, neither the regional level of unemployment nor the prevailing living conditions in the region determine significantly the individual's risk of death. However, the model reveals an interesting pattern of mortality associated with a regional occupational structure characterized by heavy industry and agriculture. For instance, if men and women at working ages live in a region that is characterized by heavy industry one standard deviation above the average (i.e., the region is more industrialized), their relative risk of death declines by about 14 per cent. This effect is considerably lower for elderly men (only 6 per cent decline of the risk of death by moving to a more industrialized region), while for elderly women there is no significant effect. Similar (beneficial) effect for the risk of death below age 60 can be found by moving to more agricultural regions (i.e., one standard deviation above the average). The model indicates that young men and women who live in more agricultural region may benefit in terms of health despite differences in regional living standards.

5 Conclusions

The above analysis reveal an interesting pattern of mortality differentials by individual and regional occupational structure in Bulgaria in the early 1990s. Our results show that there is an individual effect of occupation on the risk of death in Bulgaria that is observed for both men and women. Moreover, this individual effect persists also at older ages. The individual branch of employment is associated with health hazards, and in particular, people who are employed in the heavy industry (especially for men), or women who are or were employed in the light industry have a higher risk of death compared to those having a job in the service sector. This result is not surprising as both heavy and light industry expose people to physically demanding and stressful working conditions. Several other studies have also shown that individual working environment contributes to excess mortality (see for example Hemström 1999). Moreover, our results indicate that the individual occupational differences in Bulgaria cannot be fully explained by other traditional measures of socioeconomic status such as education, but there is a systematic effect of occupation associated with a higher risk of death.

In addition to the individual effects of occupation, in this paper we also investigate whether the regional occupational structure contributes to the mortality differentials observed by regions in Bulgaria. That is, we investigate whether there are contextual effects of occupational structure on mortality. We find that men and women who live in a region with a prevailing heavy industry (as measured by the regional occupational structure) may have a lower risk of death. This pattern indicates a spill-over effect that could not be systematically found for the other regional indices. However, this spill-over effect is in a contrast to our initial expectation that heavily industrialized regions may be characterized by higher mortality, and our initial hypothesis was that this effect may emerge on the basis of differences in living conditions. In contrast, this pattern has been confirmed in the analysis, in which we control for the effect of individual and regional living conditions. Our results show, however, that regional differences in living conditions do not explain the spill-over effect that people living in a region with heavy industry have lower risk of death. In our opinion, this pattern reflects some additional regional differences in socioeconomic development and infrastructure. For example, heavy industry was strongly favored in the past as one of the primary sectors of economic development. A plausible explanation is that the infrastructure development associated with heavy industry in these regions maintained a positive effect on the risk of death even in the early 1990s, when this sector was a subject to rapid decline.

References

Bobak, M. and D. A. Leon (1992). Air pollution and infant mortality in the Czech Republic. *The Lancet 340*, 1010–1014.

Bobak, M. and M. Marmot (1996). East-West mortality divide and its potential explanations: proposed research agenda. *British Medical Journal 312*, 421–425.

Geyer, S. and R. Peter (1999). Occupational status and all-cause mortality: A study with health insurance data from Nordrhein-Westfalen, Germany. *European journal of public health* (9), 114–118.

Gregorio, D. I., S. J. Walsh, and D. Paturzo (1997). The effects of occupation-based social position on mortality in a large American cohort. *American Journal of Public Health 87*(9), 1472–1475.

Hemström, O. (1999). Does the work environment contribute to excess male mortality? *Social Science and Medicine 49*, 879–894.

Hertzman, C. (1995). *Environment and Health in Central and Eastern Europe.* Washington, D.C.: The World Bank.

Hertzman, C., S. Kelly, and M. Bobak (Eds.) (1996). *East-West Health Divide and Potential Explanations*, Dordrecht/Boston/London. Kluwer Academic Publishers.

Hertzman, C. and A. Siddiqi (2000). Health and rapid economic change in the late twentieth century. *Social Science and Medicine 51*(6), 809–819.

Kohler, I. (2001). *Adult and Old-Age Mortality Dynamics in Bulgaria and Russia.* Dissertation, Faculty of Social Sciences, University of Southern Denmark, Odense.

Kohler, I., J. Kaltchev, and M. Dimova (2002). Integrated information system for demographic statistics ESGRAON-TDS in Bulgaria. *Demographic Research* [online available at http://www.demographic-research.org] *6*(12), 325–354.

Krzyzanowski, M. and B. Wojtyniak (1982). Ten-year mortality in a sample of an adult population in relation to air pollution. *Journal od Epidemiology and Community Health 36*, 262–268.

Peters, A., J. Skorkovsky, F. Kotesovec, J. Brynda, C. Spix, E. H. Wichmann, and J. Heinrich (2000). Associations between mortality and air pollution in Central Europe. *Environmental Health Perspectives 108*(4), 283–287.

Valkonen, T. (1987). Social inequality in the face of death. pp. 201–261. IUSSP/EAPS/FINNCO.

Valkonen, T. (1998). Die Vergrösserung der sozioökonomischen Unterschiede in der Erwachsenenmortalität durch Status und deren Ursachen. *Zeitschrift für Bevölkerungswissenschaft* (3), 263–292.

Valkonen, T. and T. Martelin (1988). Occupational class and suicide: an example of the elaboration of a relationship. *Research Reports Nr. 222*.