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Gerd Grözinger

An interesting epidemiological article of De Vogli et al. presented an analysis of regional life expectancy in Italy for the year 2001.[1] While the findings of the contribution corroborated nicely with a whole array of similar works over the past three decades, showing in many cases a positive relationship between inequality and mortality, the presented evidence was not without critics. But the most recent overview of the literature came to the conclusion that from the 168 studies featuring this question, a solid majority of nearly three quarters confirmed the position of such link.[2] And of the remaining works, there are methodological reasons to be named for the defect, e.g. the choice of a too narrow definition of the relevant regional level for the frame of reference.

However, most studies refer either to international comparisons or US data. The first one have the well-known double-problem that cross national analysis may miss relevant intervening variables due to unknown country specifics and that the full comparabability of the data is not always given. And relying on the situation in the United States is not satisfying from a European perspective for at least two reasons: the different type of welfare state and the specific ethnic composition of the populace with respective different patterns of morbidity and mortality make generalizations difficult.

Therefore, collecting more information of the situation in European countries should be useful. To enable a direct comparison with the De Vogli et al. findings, a comparable methodological approach was used. De Vogli et al. worked on the level of 20 Italian regions and included three variables to explain regional differences in life expectancy: inequality, per capita income and educational attainment. The last two have been added because they were used by critics of the inequality hypotheses as an alternative explanation.[3][4] Here, the two variables were also included.

The outcome of the Italian study strongly supported the relative income hypotheses. Inequality, measured by the standard Gini index, had a negative impact on life expectancy. Educational attainment had a positive impact. Per capita income, a variable that would support the absolute income hypotheses, was also positive associated with life expectancy, but lost its influence when combined with the two other variables.

In the same year another study about regional income inequality and mortality in Italy was published, done by a different team of authors and for the years 1994 - 1996.[5] And not life expectancy but mortality was to be explained. Compared with De Vogli et al., the outcome was less strong. The Gini index did have some influence in the expected direction, but only in the poorer parts of Italy. The regional income level was negatively associated with mortality. However, this analysis did not include an education variable, which may have a stronger influence and could therefore be able

to neutralize the influence of the regional per capita income (see below). In sum, a comparison with the De Volgi et al. study is more appropriate.

But there are also some minor differences of the here presented research to the study of De Vogli et al. The first is about the questionable appropriateness of describing the re-united Germany as one single nation with sufficient similarities. The second pertains to the deplorable situation, that in the German case direct regional inequality data are not available. The third addresses slightly different measures of education. And the forth one is about male-female differences, since the German but not the Italian situation allows such a differentiation. These four questions are in the following shortly addressed.

From an epidemiological point of view the question might be raised: is there one or are there in fact still two Germanys? Some years ago, the answer would have been rather straight-forward. The life expectancy in the former socialist part was indeed very different from the Western provinces. Presumably due to a mixture of grave environmental grievances, a medical system with fewer resources and also different individual habits with an impact on health (smoking, for example) the average mortality in the East was higher. And in the beginning, the turmoil after re-unification even worsened the situation.[6] But the lag has dramatically shrunken since then: the average difference started with 3.2 years for men and 2.3 years for women, but in 1999/2001 it dropped to 1.6 years for men and 0.6 for women.[7] And the margin continued to narrow: in 2002 1.4 and 0.5 years (see below). We can therefore safely conclude that there is now only one Germany left where mortality data are concerned, at least for the time being. But, many other differences still exist, especially when it comes to the question of regional unemployment. Therefore, the analysis is done in two ways, first for the whole of Germany and then again for the West alone, since this area resembles the situation in Italy as a long-term Western capitalist country more closely.

In Italy, life expectancy was reported for both sexes together. In Germany the data refers to men and women separately. Most studies report a lower connection between socio-economic variables and life expectation for females, although usually fail to include the private living conditions properly.[8] Reviews discussing the research about gender inequality in mortality in respect to belonging to higher or lower status groups show at least partly a stronger influence on men. However, the gender relation to regional inequality measures is less directly addressed.[9] Even less clear is the association to education, yielding usually a stronger influence on mortality for men in Europe, and a more parallel one in the US.[10] It is thus welcome to have another look at the situation in a European country.

As the measure for educational attainment in Italy the percentage of persons 19 years old with a high school diploma was used. In Germany, finishing high school is for the vast majority of those with such a diploma only a first step in academic study. Many young people opt for the alternative three years of vocational training, mostly pursued by pupils without high school. To take this different situation into account, a comprehensive human capital variable was constructed for Germany, where all years of education were aggregated into one scale.

Regarding the inequality measure, De Vogli et al. had access to household data for Italy, and were able to calculate a Gini coefficient on a basis of at least 500 subjects per region. Since the number of regions analyzed in Germany is much higher than in Italy—97 vs. 20—this could not be repeated with the same level of

security. Even the best database, the German Socio-Economic Panel[11] with now more than 20,000 persons interviewed, does not yield enough cases when broken down into regions. Instead of a then rather unreliable Gini coefficient, the regional unemployment figure was used here. This must not necessarily mean a second-rate solution. In a comparison of the regional situation of the US and Canada, it was found, that the Gini coefficient was significant for explaining mortality in the US, while the unemployment rate was not.[12] But in Canada exactly the opposite was true. This was explained by the fact that labor markets work quite differently in the neighboring nations. In the US, it is easier to find a job, but quite often with a very low wage, whereas in Canada social exclusion means finding no employment at all. Since the German type of labor market more resembles that of Canada, unemployment could therefore be the better choice of an inequality variable, even if both are available.

All in all, the above named methodological differences of the two studies still allow a useful close comparison. And Italy as another large European country and longstanding member of the European Union is an appropriate mirror for discussing German experiences. To my knowledge, this is the first such analysis for Germany. Although Wilkinson's 1996 study,[13] one of the milestones of the discussion, has been translated into German (2001), and in a recent article I myself explored the question in a comprehensive survey,[14] an empirical test about a possible connection between inequality and life expectation has not been undertaken until now. Mortality does not figure very high in the discussions of German epidemiologist, social scientists and demographers, who are nowadays more concerned with questions of individual health-impacting behavior, fertility, and migration.[15] It is significant, that in a recent special issue on the sociology of health in one of Germany's most prestigious sociological journals, the relative income hypotheses is hardly mentioned and no contribution tested it on a regional or international basis.[16]

In this paper, the relation between unemployment and life expectancy at birth in Germany is analyzed, using data from 97 regions. It is also examined whether this connection is the result of variation in per capita income or educational attainment. In order to take into account the special situation in eastern Germany, the analysis is repeated for western Germany alone. The outcome is then discussed in comparison with the Italian case.

METHODS

Germany

The regional level are planning regions, so-called 'Raumordnungsregionen'. All districts and cities in Germany are aggregated into 97 such regions. Each region shows a certain homogeneity in basic features, defined e.g. as a "metropolitan area" or a "rural area with low density." There are eight such categories. Since the functionality of the region is the aggregating principle, the regions are fairly different in both physical and population size. The smallest region has 966 km^2, whereas the biggest comprises 7.020 km^2. And in terms of number of inhabitants, the spread is between 236,000 and 3,390,000. The data come from official sources and are available as a yearly published electronic source: the so-called INKAR-CD. From the CD in the 2004 edition the data on life expectancy, unemployment and GDP per capita was extracted. Life-expectancy is differentiated by sex, the two other variables

are not. But the average income level in a region pertains to men and women likewise, and the regional labor market condition can be seen as fairly similar.

The data on educational attainment stem from a different source, from a regionalized 2 percent sample of all employees with a social security number.[17] Therefore there are no self-employed persons and no tenured civil servants in the dataset, two minor groups in Germany. However, unemployed persons are included. A research project initiated by the author and financed by the Rat fuer Sozial- und Wirtschaftsdaten yielded average years of education and vocational training.[18] The last possible year to construct an educational measure on this basis was 2001, whereas the other data refer to 2002. Here again, separate calculations for men and women were possible. And this differentiation is quite useful, because the correlation between the regional averages of educational years for the sexes yields a positive and high value, but is still far from perfect (in the unweighted version $r = .815$; $p<0.001$).

For the analysis of western Germany, the region of Berlin was excluded, since this area is the only mixed one in the dataset, comprising the former West Berlin and East Berlin. A check however revealed that an inclusion of the Berlin region in western Germany would not have altered the relevant outcome.

Statistical analysis

For the bivariate analysis Pearson correlation coefficients were calculated to measure the association between life expectancy and unemployment, per capita income, and educational attainment. To study the common relationship between these variables in regard to life expectancy multivariate linear regression was employed. To test for colinearity, the variance inflation factor (VIF) was calculated. In all regressions VIF-values below the standard critical threshold of 10 were found.

A weighting by population size, as done by Vogli et al., is not without problems. The multiplying of regions with many inhabitants has a strong influence on significance. So, for the main analysis, no weighting was done here. However, in order to make direct comparisons with the Italian case easier, additional outcomes will be given, which refer to a weighted version. Since the differences in regional population were quite large in Germany the weighting produced much more cases, even when the downscaling principle was chosen, that the region with the lowest number of inhabitants is exactly one time represented. The number of cases then increases from 97 to 349.

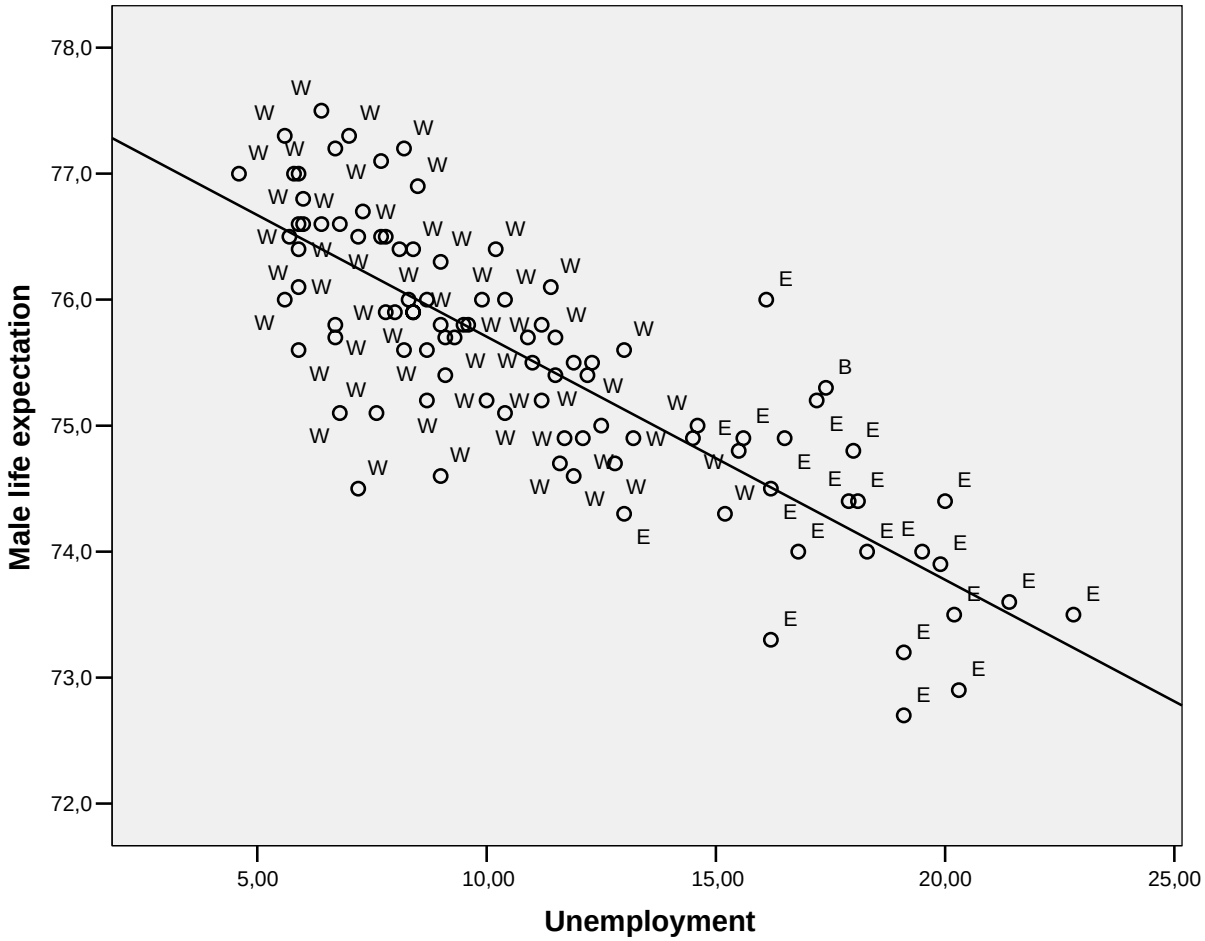
RESULTS

Figure 1A shows the relationship between unemployment and life expectancy across German regions for men. Unemployment had a strong negative correlation with life expectation ($r = -0.830$; $p<0.001$). Figure 1B gives the same picture for women with an identical scaling. The correlation for women is weaker but still highly significant ($r = -0.665$; $p<0.001$). The W's refer to western German, the E's to east German regions and the single B stands for the mixed region of Berlin. The graph shows clearly that the eastern part of Germany has higher unemployment rates than the western area, with nearly no overlap.

Per capita income was positively related to life expectancy for men (r = -0.635; p<0.001) and women likewise (p = 0.454; p<0.001). Again, the influence on women was less influential. There are large variations between the regions. Per capita income ranges from € 14,200 to € 45,000, showing a higher spread than in Italy.

The educational variable yield a positive association with life expectancy in the male case, but without significance (r = 0.115; n.s.), and a negative one for females (r = -0.262; p<0.001). The regional spread of educational attainment is much more compressed. For men the extremes are 12.96 and 13.61 years, for women there is a discrepancy between 11.64 and 13.04 years.

Figure 1



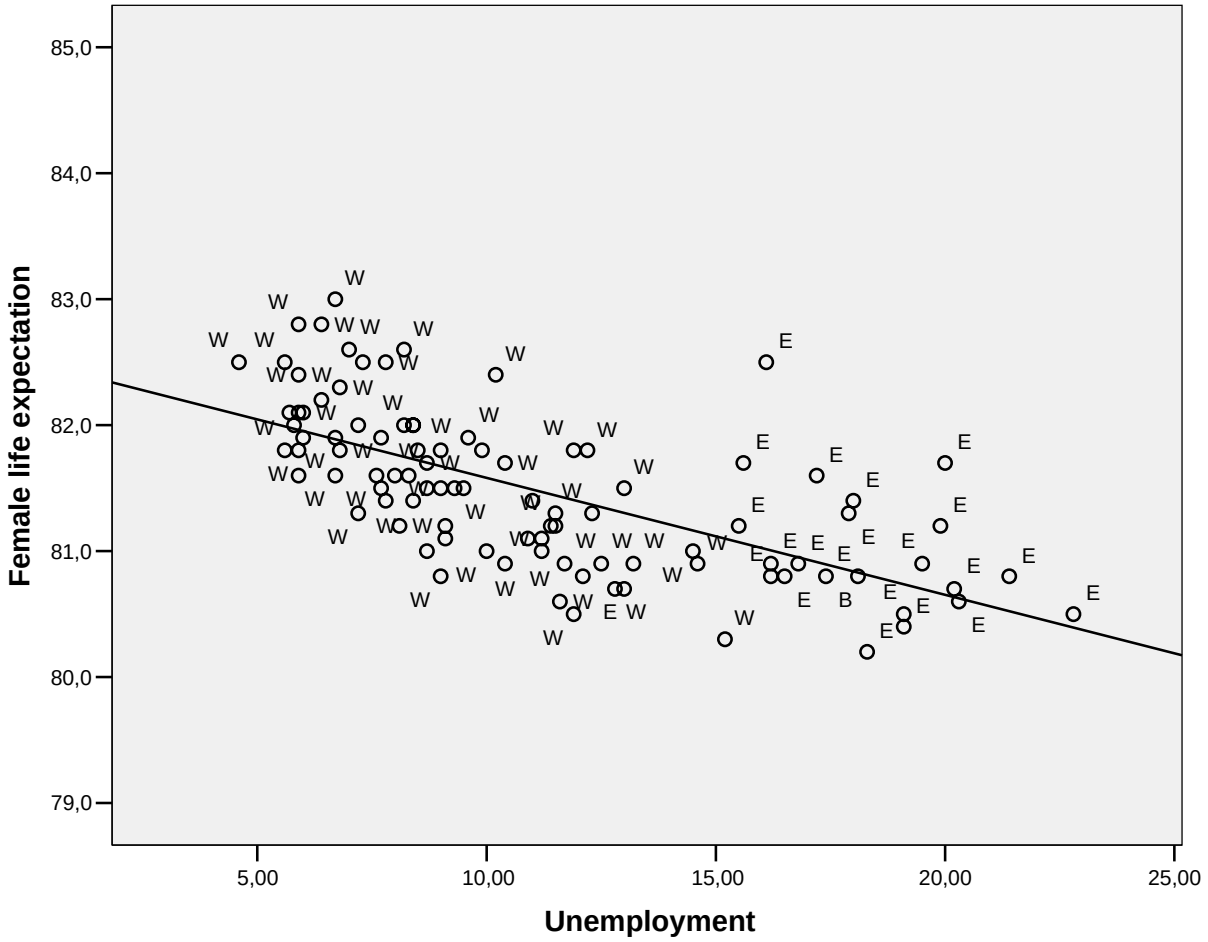


Figure 1 (A) Male life expectancy and unemployment in German regions (97). r (crude) = -0.830; p < 0.001. (B) Female life expectation and unemployment in German regions (97) r (crude) = 0.665; p < 0.001. Data points with a W denote western German regions, with an E eastern German regions, and a B stands for Berlin, the only mixed region.

As many studies have shown, bi-variate correlations are not sufficient for a thorough analysis, since the characteristics of regions tend to form special clusters only seen in a multivariate approach. Table 1 shows the results from the linear regressions for men. Following De Vogli et al., all model versions are documented. In addition, the values for the weighted version are included and printed in italics directly below the corresponding unweighted outcome.

Table 1 Linear regression on male life expectancy across German regions (n = 97)

	Standardized β coefficients						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Unemployment	-0.830***	-	-	-0.699***	-0.902***	-	-0.966***
	*-0.810****	-	-	*-0.653****	*-0.893****	-	*-0.945****
Per capita income	-	0.635***	-	0.223***	-	0.710***	-0.088
	-	*0.644****	-	*0.288****	-	*0.742****	*-0.177****
Education	-	-	0.115	-	0.319***	-0.181**	0.370***
	-	-	*0.305****	-	*0.371****	*-0.157****	*0.490****
Constant	77.637	72.777	70.674	76.344	64.443	80.050	62.841
	77.799	*73.337*	*65.348*	*76.344*	*65.312*	*78.301*	*62.215*
R^2, adj.	0.686	0.397	0.003	0.716	0.781	0.418	0.781
	0.656	*0.414*	*0.090*	*0.712*	*0.792*	*0.427*	*0.799*
Model statistics F (df, N)	210.6***	64.2***	1.6	121.8***	172.1***	35.5***	115.3***
	*662.4****	*246.7****	*35.6****	*432.5****	*663.3****	*130.8****	*463.3****
	(1, 97)	(1, 97)	(1, 97)	(2, 97)	(2, 97)	(2, 97)	(3, 97)

* p<0.05; **p<0.01; ***p<0.001

The German pattern basically resembles the Italian picture, when inequality and unemployment are treated as close substitutes. Unemployment alone explains in Germany two thirds of the variation in male life expectancy (model 1). The weakest influence is exhibited by the educational variable, when calculated separately (model 3), whereas the significance of the per capita income in an isolated approach seems to show considerable explanatory power (model 2). But the fit of the regression model improved only when the educational variable was added to unemployment. Both model 5 and model 7 yielded comparably high values for the regression coefficient (with an identical $r^2 = 0.781$) and showed a significant negative influence of unemployment and a positive of educational attainment. Per capita income proved not a very reliable influence in combined models. In the full model 7, the per capita income variable lost its significance, which is also a parallel to the Italian case. However, in the weighted version, it even had a significant negative influence. But this switch of signs may be due to the East/West-divide, which will be discussed later.

For women the situation is only slightly different (results shown in table 2). The most visible distinction is the lower level of significance. Again, unemployment explains most of the female life expectancy, when the calculations are done separately. But now, less than half of the variance in life expectancy is covered, instead of two thirds as in the male case (model 1).

Table 2 Linear regression on female life expectancy across German regions (n = 97)

Standardized β coefficients

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Unemployment	-0.665***	-	-	-0.610***	-0.810***	-	-0.842***
	*-0.668****	-	-	*-0.621****	*-0.770****	-	*-0.900****
Per capita income	-	0.454***	-	0.094	-	0.446***	-0.035
	-	*0.426****	-	*0.087**	-	*0.495****	*-0.155***
Education	-	-	-0.262**	-	0.235 **	-0.249***	0.254**
	-	-	*-0.119***	-	*0.227****	*-0.253****	*0.328****
Constant	82.510	80.314	87.443	82.182	77.380	85.995	77.096
	82.597	*80.529*	*84.155*	*82.322*	*77.669*	*86.052*	*75.978*
$R^{2,}$ adj.	0.437	0.198	0.059	0.437	0.466	0.252	0.461
	0.445	*0.179*	*0.011*	*0.448*	*0.485*	*0.236*	*0.492*
Model statistics F (df, N)	75.5*** 280.0*** (1, 97)	21.6*** 76.9*** (1, 97)	7.0** 5.0** (1, 97)	38.2*** 142.6*** (2, 97)	42.9*** 164.8*** (2, 97)	17.2*** 54.9*** (2, 97)	28.4*** 113.5*** (3, 97)

* p<0.05; **p<0.01; ***p<0.001

Again, model 5 and model 7 explain most. In both cases unemployment has a strong negative influence, and education a positive. And also similar to the male case, the per capita income loses its significance in the full model 7, even exhibiting a negative sign in the weighted version.

Is the unreliability of the influence of per capita income due to an East-West divide in the dataset and do the found structures hold, when only the Western part is analyzed? Western Germany (without Berlin) has fewer regions, 74 instead of 97 for the whole country. The effect of using this reduced sample is not certain in advance. On the one hand, the smaller numbers could blur the statistical relationships. On the other hand it may now describe a more homogenous area with better associations, whereas East and West combined could have bound together rather distinct parts.

Table 3 shows the values of the calculations for men in western Germany alone. Indeed, R^2 is now somewhat lower than in the full case. But the general picture is quite similar. Best models are again versions 5 and 7, where unemployment and education are combined. Per capita income loses all significance in the full model 7, regardless whether weighted or un-weighted.

Table 3 Linear regression on male life expectancy across West-German regions (n = 74)

	Standardized β coefficients						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Unemployment	-0.686***	-	-	-0.638***	-0.719***	-	-0.738***
	*-0.745****	-	-	*-0.664****	*-0.719****	-	*-0.724****
Per capita income	-	0.388**	-	0.276**	-	0.319*	-0.079
	-	*0.495****	-	*0.336****	-	*0.349***	*-0.093*
Education	-	-	0.331**	-	0.391***	0.093	0.452***
	-	-	*0.470****	-	*0.406****	*0.171*	*0.484****
Constant	77.788	74.420	66.288	76.612	66.456	71.976	65.037
	78.215	*74.315*	*63.857*	*76.850*	*67.631*		*65.975*
R^2, adj.	0.464	0.139	0.097	0.532	0.613	0.131	0.610
	0.553	*0.242*	*0.217*	*0.658*	*0.716*	*0.247*	*0.717*
Model statistics F (df, N)	64.2***	12.8**	8.8**	42.5***	58.7***	6.5**	39.0***
	*295.3****	*77.0****	*67.0****	*230.1****	*301.1****	*40.0****	*201.9****
	(1, 97)	(1, 97)	(1, 97)	(2, 97)	(2, 97)	(2, 97)	(3, 97)

* p<0.05; **p<0.01; ***p<0.001

Table 4 finally gives the outcome for women in western Germany. All calculations where unemployment is included show a satisfying R^2. There are two differences to the male case. First, the restricted data base explains for women more of the variance in life expectancy than the full sample. Second, besides the models 7 and 5 now also the model 4, where unemployment and per capita income is combined, yields satisfying values. However, neither per capita income nor education exhibits a steady influence. For women in western Germany only unemployment is reliable highly significant, showing always the expected negative sign.

Table 4 Linear regression on female life expectancy across western German regions (n = 74)

	Standardized β coefficients						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Unemployment	-0.720***	-	-	-0.691***	-0.759***	-	-0.707***
	*-0.792***	-	-	*-0.754****	*-0.810****	-	*-0.724****
Per capita income	-	0.283*	-	0.161	-	0.493***	0.038
	-	*0.340****	-	*0.159****	-	*0.689****	*-0.093*
Education	-	-	-0.096	-	0.131	-0.373**	0.137
	-	-	*0.014*	-	*0.130***	*-0.484****	*0.484****
Constant	83.167	80.798	83.992	82.635	80.031	89.371	81.794
	83.401	*80.752*	*81.285*	*82.916*	*80.489*	*90.842*	
R^2, adj.	0.511	0.067	0.009	0.530	0.521	0.152	0.525
	0.625	*0.112*	*-0.004*	*0.647*	*0.640*	*0.221*	*0.717*
Model statistics F (df, N)	77.4***	6.3*	0.7	42.2***	40.7***	7.5**	27.8***
	397.6***	30.9***	0.1	219.4***	212.7***	34.7***	201.9***
	(1, 97)	(1, 97)	(1, 97)	(2, 97)	(2, 97)	(2, 97)	(3, 97)

* p<0.05; **p<0.01; ***p<0.001

DISCUSSION

Regional differentiation in life expectancy is quite high in Germany. For men, there is a spread between 72.7 and 77.5 years: a span of 4.8 years difference. For women, the difference is somewhat smaller, with a regional minimum of 80.2 and a maximum of 83 years, or 2.8 years difference. To put the numbers in perspective, a comparison with a longitudinal change may be appropriate. For example, the female life expectancy for the birth cohort 1955 increased by just 3.5 years compared with the birth cohort 30 years earlier.[19]

This research showed that the dominant explanation in regional variation both for men and women alike was unemployment. Although unemployment's manifold impact on morbidity and mortality has been shown,[20] the effect of the regional unemployment rate on life expectancy cannot be fully explained by different shares of unemployed persons with higher mortality. It must also have negative effects on others, on direct family members or indirectly on fellow citizens. Following De Vogli et al. in their explanation for the differences between the Italian provinces, material deprivation and psychosocial stress alike contribute to this outcome. To add an additional information for the complex ways, how inequality can work its way, it is useful to have a look at IQ data. Psychologists from Germany's Bundeswehr regularly test all men 18 years of age. To their surprise they found that after controlling for other factors, the IQ varies negatively with the regional unemployment rate.[21]

The relevance of education for life expectancy is in principle high. An longitudinal analysis for Germany on the basis of the Socio-economic Panel yielded

that approximately two thirds of t he improvement between relevant birth cohorts of the 20's and the 50's can be attributed to the increase in educational years for the younger.[19] However, in comparison to regional unemployment education comes second in all calculations.

Per capita income finally was not really helpful to improve the model, when combined with unemployment and education. In the ongoing debate on whether absolute or relative income exerts the main effect on life expectation, this analysis for Germany shows clear support for the latter position.

Quite interesting is the gender difference. As known from many other countries, women in Germany too seem to react less to socio-economic conditions than men. This was found in this analysis for regional unemployment and partly also for education. Such an outcome is consistent with individual data. Usually it is maintained, that women are less integrated in the labor market, and many are financially more dependent on a male income than on one's own.[20] This may to a certain extent still be true. But women are also on average more long lived and when the majority of death cases occur, they are more far away from the last paid job. An analysis about absolute income found out, that in Germany not only the mortality of men in comparison with women is more afflicted by personal income but that its influence is completely lost after reaching the age of 70.[22] Such a mechanism may also work in the relative income sphere and weaken the relationship between income and life expectancy for women.

In addition to gender, ethnicity is also often relevant. One could argue that an alternative explanation of the regional differentiation in life expectancy is a different share of migrants. Migrants are less educated, work in positions with less status and show a much higher rate of unemployment than German citizens. So, if migrants have a higher mortality, this would contribute to the empirically found pattern: regions with high unemployment and low educational attainment show a low average life-expectancy. However, such an explanation is not substantiated by the results. First, the negative relationship for unemployment is also visible for eastern Germany, where are virtually no migrants. Second, the by far most common nationality for migrants is Turkish. But both Turkish men and women show, presumably due to self-selection processes, a lower mortality than German citizens of the same age.[23]

Finally, a standard critique against the use of aggregate data is the ecological fallacy argument. Can one be sure that regional structures do transfer into individual behavior and moods, or are there relevant omitted variables which are falsely not taken into account? One test is to look directly for a confirmation in individual data. In another study, I (in collaboration with Wenzel Matiaske) explored the effect of regional unemployment on life and on health-satisfaction was analyzed. The database for the analysis on subjective well-being was the Socio-economic Panel for Germany for the year 2000, which is very close to the years used here. It was found, that besides the usual relevant variables such as age, marital situation, income, and occupational status, the regional unemployment rate exerted a highly significant negative influence on both satisfaction indicators.[24] Health satisfaction is especially relevant for the life expectation dimension, since it was shown, that mortality and personal health rating are highly correlated in many countries.[25] The same is true for Germany.[26]

This research thus confirms the findings of De Vogli et al. about Italy. Inequality, especially labor market inequality, has a strong negative influence on life expectancy. This is true even in Europe with its relatively high welfare state standards.

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