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# Convergence of the Health Status at the Local Level: Empirical Evidence from Austria

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## Abstract

In comparisons of the welfare of individuals and socioeconomic aggregates of individuals (regions, states,...) the health status is an important dimension. In the following paper we focus on the question whether the health status between geographical subunits (local communities) converged/diverged in the time period 1969 - 2004 in Austria. We use age standardized mortality rates as indicators for the health status and analyse the convergence/divergence of overall mortality for (i) the whole population, for (ii) females, for (iii) males and for (iv) the gender gap in overall mortality. Convergence/Divergence is studied by applying different concepts of cross-regional inequality (weighted standard deviation, coefficient of variation, Theil-Coefficient of inequality). Various econometric techniques (weighted OLS, Quantile Regression, Kendall's Rank Concordance) are used to test for absolute and conditional beta-convergence in mortality. We find mixed results for the inequality measures applied. Absolute and conditional beta-convergence are confirmed both in weighted OLS as well as in quantile regression estimations, but we also find strong evidence for the existence of convergence clubs in mortality.

**JEL classification:** I1, I3

**Keywords:** mortality, convergence, gender, health status, life expectancy, Austria

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# 1 Introduction

From an economic perspective the individual health status unfolds a triple effect. Firstly, it affects individual utility directly. Secondly, the health status changes the utility individuals derive from consuming goods and services. And finally, the health status is an important precondition to earn income, which again increases the capacity to consume. Thus, to some extent a good individual health status is important for a successful individual life. Based on these threefold effects normative approaches within the health sciences conclude that the distribution of the health status and the distribution of institutions for its improvement (f. e. financing and provision of health care services) have to fulfil specific standards of equity and fairness (see f. e. the review by Williamson/Cookson 2000).

In line with this reasoning, Sen (1998, 1999) argues that social opportunities are one of the five types of „instrumental freedoms“ that contribute to the overall freedom of individuals. Thereby social opportunities are understood as the arrangements a society makes, for example for health and education, which (i) influence individual's „substantive freedom“ to live better, and (ii) are important not only for the success of private lives, but also for a more effective participation in economic and political activities. Sen concludes, that in comparisons of well being we should raise our awareness to elements that affect individual well-being and freedom which are not captured by regular income statistics. Life expectancy and mortality are key components in such a broader perspective.

Several empirical studies suggest that since the late 19th century gains in health have contributed more to human well-being than income growth. Becker et al. (2005) find that the total lifetime value (measured by the willingness to pay) of the life expectancy gains correspond to permanent increases of more than 10% in annual income for the US, and more than 50% for Chile and Egypt. In fact, it is difficult to conceive of a more remarkable global human achievement in the last 200 years than the more-than-doubling of life expectancy on a world wide scale. This global trend appears to be accelerated in recent decades with life expectancy increasing more than 10 years between 1963 and 2003. Continued improvements of life expectancy are expected, with global life expectancy projected to reach 81 years by the year 2100. Until the mid of the eighties of the last century, these improvements were accompanied (i) by a strong convergence in life expectancy within and between countries (ii) by an increase of the gender gap in life expectancy in favor of females and (iii) by a substantial epidemiological transformation of the cause-of-death patterns. However, studies based on more recent data show that the general improvement in longevity masks considerable cross country heterogeneity in several respects. Mayer-Foulkes (2001) finds that life expectancy dynamics appear to generate a number of „convergence clubs“. McMichael et al. (2004) identify three groups of countries: (i) those that have experienced

rapid improvements, (ii) those that have experienced relative stagnation, and (iii) those that have experienced an erosion of life expectancy. Bloom/Canning (2004) argue that the life expectancy data reflect a dynamic pattern that is more complex than a simple convergence process. They show that the distribution of health in the world is bimodal, with a group of healthy, low-mortality countries and a group of unhealthy, high-mortality countries. Ram (2006) tests the convergence hypothesis using data for 163 countries over the period 1980 - 2000 by measuring cross-country inequality and by estimating least-squares and quantile-regressions. His findings suggest that the dynamics of the cross-country distribution of life expectancy between 1980 - 2000 seem markedly different from those in the preceding decades: in contrast to the sharp convergence noted until the 1980s, there is a lack of convergence and an indication of divergence, especially since the 1990s. The spread of HIV/AIDS has probably been a significant factor in generating divergence in this period (see also Neumayer 2004). In their study of life expectancy, Moser et al. (2005) present findings with similar results. They conclude that the switch in the late 1980s from global convergence of life expectancy at birth to divergence indicates that progress in reducing mortality differences between many populations is now more than offset by the scale of reversals in adult mortality in others.

The majority of research on the convergence of life expectancy/mortality is focused on between-country-convergence on a worldwide or a world region level (for Europe see Mesle/Vallin 2002). This holds particularly true for the long term perspective. Vallin and Mesle (2004) conclude their cross country study with the suggestions that it would be a useful purpose in taking it further to see how far it might apply to trends and differences in the mortality observed within countries, either in terms of internal geographical variations or even in terms of economic, social, cultural, gender, and other differences.

In this paper we follow the suggestion of Vallin and Mesle and study the convergence of within state mortality. Following this route of research clearly does not mean that we neglect the already existing research on this topic on the local and regional level. Several empirical studies focused on differences in the health status between regions within countries thereby applying different theoretical and statistical approaches. In this line of research, several authors studied differences and trends in regional and local (small area) mortality (see Illsey/Le Grand 1993, Robertson/ECOB 1999, Congdon 2004, Brown/Rees 2006 for the UK, Ocana-Riola/Mayoral-Cortes 2010 for Andalusia, for a discussion of the reliable indicators of mortality see Julious et al. 2001). Additionally, there is an even broader literature which studies the determinants of regional mortality and life expectancy (see f. e. Robertson/ECOB 1999, Langford/Bentham 1996), thereby also taking account of the specific problems of ecological, contextual, multilevel analysis in epidemiological studies, the problem of spatial autocorrelation of mortality, the neighborhood problems and

boundary issues (see Robert 1999, Diez Roux 2003, Flowerdew et al. 2008, Malmström et al. 2001, Roos et al. 2004, Lebel et al. 2007, Coombes 2000, Lupton 2003, Pickett/Pearl 2001). However, studies which test for convergence/divergence in the health status between regions using the methods well established in other scientific fields (e.g. convergence of indicators of economic activities) are rare. Recently, Montero-Granados et al. (2007) studied the convergence/divergence of the population health status among the Spanish provinces and regions using the concepts of sigma and beta convergence in order to analyse possible effects of the decentralisation process in the management of the health care sector in Spain starting in 1981.

In this paper we use different measures of inequality, the concepts of sigma convergence and absolute and conditional beta convergence to study health status convergence/divergence in Austria based on local (small area) information in the time period 1969 - 2004. As an indicator for the health status we use overall standardized mortality rates. We focus on four indicators of mortality, namely (i) overall mortality of the whole population, (ii) overall mortality of females, (iii) overall mortality of males and (iv) the gap in the overall mortality between males and females. Our study results are important from several perspectives. In a long term perspective Austria experienced a substantial improvement in the health status of the population in the last 40 years, starting from a low level compared with countries of similar socioeconomic levels (f. e. EU-15 countries). Only very limited systematic evidence is available so far whether this impressive improvement in the health status in Austria is accompanied by a convergence or divergence of local mortality in the above mentioned specifications (i) - (iv). Thus, we add within-country-evidence to the already existing between-country-evidence, as suggested by Vallin/Mesle (2004). This is especially promising as the between-country comparison excludes considerable heterogeneity in the dependent and independent variables. One would for example argue, that the within-state movements are taking part within the same stage of epidemiological change. Our results could also figure as partial/selective answer to the question whether the efforts to guarantee minimum standards of living - instrumental freedoms in the concepts of Sen (1998) - irrespective of the individual location were successful. This was a widely agreed principle of health and regional policy in Austria in the 1970s. Finally, by testing for conditional convergence we are able to gain insights into the production functions of the health status for the total population and important sub-aggregates of the population (females, males) at the local level.

The structure of the paper is as follows. Section two presents the methodological framework, indicators and data used in the paper. Section three presents the empirical results including several robustness checks and a discussion of the limitations of the study and directions for future research. Concluding remarks are offered in the final section.

## 2 Methology and Data

### 2.1 Methodology

To study the convergence/divergence of the health status we use age standardized mortality rates (SMR) for (i) overall mortality of the whole population of a community, (ii) overall mortality of females, (iii) overall mortality of males, and (iv) the gap in overall mortality between males and females. Three aggregated indicators of between-community inequality are computed. These measures enable us to track the course of inequality in these health status dimensions and to judge the existence of sigma-convergence or divergence, respectively. The three indicators used are the weighted standard deviation (SD), the coefficient of variation (CV) and a slightly adapted Theil-index of inequality (L). Weighted standard deviations are calculated by the root of the weighted squared deviations from a community's mortality from the (weighted) mean in the sample. To adjust for the decrease in the mortality mean the CV is calculated from cross section information by dividing a variable's standard deviation  $\sigma$  by its mean  $\mu$  where  $\sigma$  and  $\mu$  are averaged over all weighted observation units:

$$CV_t = \frac{\sigma_t}{\mu_t} \quad (1)$$

The Theil-index L is defined in the following way:

$$L = \sum_{i=1}^n p_i * \ln\left(\frac{p_i}{x_i}\right) \quad (2)$$

where  $p_i$  is the population share of the local community i,  $\ln$  denotes the natural logarithm, and  $y_i$  is the share of the region in the aggregated variable (mortality).  $x_i$  is defined as:

$$x_i = \frac{P_i * y_i}{\sum_{i=1}^n P_i * y_i} \quad (3)$$

where  $P_i$  denotes the population in local community i and  $y_i$  refers to its mortality.  $L = 0$  signals equality,  $L > 0$  inequality. A decrease (increase) in L therefore indicates an increase (decrease) in convergence.

The concepts of (absolute and conditional) beta-convergence were first developed within the framework of neoclassical growth models within the institutional setting of free markets to explain the convergence in aggregate output between states (regions) (see for example

Barro and Sala-i-Martin 1992). In this models a common steady state in the economic development (absolute convergence) in the end results from the decreasing returns to scale of capital inputs. The results of a voluminous empirical work (See Sala-i-Martin 1997), however, questioned this proposition of the neoclassical growth theory by stressing the role of productivity differences and the speed of technological change caused by factors such as institutional rigidities, the quality of the education system as well as the political regime. These enlargements resulted in the concepts of conditional convergence and convergence clubs. Both concepts deny common steady states in the economic development but propose multiple steady states. To apply the concept of beta-convergence to the evolution of mortality in an appropriate way one has to show that the life expectancy development in its different dimensions (f. e. gender gap) can be modeled using theories of economic growth. Mayer-Folkes (2001) presents the basic ingredients of such an approach. He stresses, that (i) there exists a strong link between life expectancy and aggregate outputs (income) and (ii) that life expectancy is an excellent measure of the standard of living. As a measure of population welfare it is probably better than income, because it is more sensitive to differences in the production capacities available. This allows us to model life expectancy (overall mortality) as a function of the main underlying economic variables and to present the dynamics of life expectancy in terms of the theories of economic growth. We do not present the extended version of the model in this text, but we account for possible inputs in the health production function when testing for conditional convergence in mortality.

The following statistical model is suggested to measure absolute beta convergence in a cross section of local communities:

$$\ln\left(\frac{y_{i,T}}{y_{i,0}}\right) = \alpha + \beta * \ln(y_{i,0}) + \epsilon_i \quad (4)$$

Thereby  $y_{i,T}$  is the mortality (mortality gap) in local community  $i$  at final time  $T$ ,  $y_{i,0}$  is the level of mortality in the starting period.  $i$  stands for the local community as the cross sectional unit and  $\beta$  pictures the convergence coefficient, where  $\epsilon_i$  represents an error term. Equation (4) examines convergence/divergence in the cross section.<sup>1</sup> Conditional beta-convergence is estimated by the following equation:

$$\ln\left(\frac{y_{i,T}}{y_{i,0}}\right) = \alpha + \beta * \ln(y_{i,0}) + \gamma * z_{i,0} + \epsilon_i \quad (5)$$

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<sup>1</sup>Note that the dependent variable refers to the growth rate from period 0 to period  $T$ . The speed of beta-convergence can be calculated from the regression coefficient  $\beta$  on the initial level  $y_0$ . For example for the specification at hand, the speed of convergence equals  $-\ln(1 + \beta)/T$ .

Thereby  $z_{i,0}$  features characteristics of the local communities (education level, socioeconomic level) at time  $t = 0$  as further explanatory variables. Thus, they allow the convergence of regions to different steady states.

Health policy to some extent is focused (should be focused) on the health status of marginal groups. It is known from previous empirical research that the tails of the mortality distribution might develop in different directions and standard regression methods do not show developments which might be important - f. e. the existence of convergence clubs separated by different levels of the dependent and independent variable. One way to check for this is to estimate quantile regressions for different segments of the conditional distributions of the change in mortality. The two segments on which this study focuses in this respect are the top (75 percent) and bottom quartiles (25 percent) of the distribution (for the technical details of quantile-regression see, for instance, Deaton 1997).

## 2.2 Data

As already mentioned in section two, we use standardized mortality rates (SMR) overall and disaggregated by gender as an indicator for the health status to check for convergence or divergence, respectively. Age-standardized mortality rates are available at the local community level from the *Atlas of Mortality in Austria by Causes of Death* (Statistik Austria 2007).<sup>2</sup> Official death records include the information on the place of residence, age, sex and cause of death. This information is combined with the results of the population census (1971 and 2001) to calculate the corresponding SMR.<sup>3</sup> To avoid a high dispersion in the SMR (and thus, random variation) caused by small numbers, mortality rates sorted by age and gender are calculated for longer time periods, namely 16 years for the first period (1969-84) and 17 years for the second period (1988-2004). This procedure also leads to the exclusion of year specific effects. It also masks possible developments within the two observation periods. The difference in the age structure between regions and between different time periods are accounted for by age-standardization.<sup>4</sup> In the case of Vienna,

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<sup>2</sup>Following the NUTS-classification the local community level is LAU2. Vienna is counted as 23 local communities mirroring the districts of Vienna. In the Austrian political system local communities act as agents in the administration of public functions of the central state and the states (f. e. several public health tasks) and fulfil several tasks self-governed. The mean size (population) of the communities in period two (population census 2001) is 3373, the median is 1575. The number and size of communities is based on historical contingencies and only partially the result of an optimal spatial organisation of public policy (f. e. in the health care sector)

<sup>3</sup>For each death case the registrar must formulate a death certificate which is to be filled in by the coroner stating the cause of death. This death certificate has to be forwarded to Statistics Austria, where these data are centrally processed and codified. The data files on deaths cover persons listed in the resident population who have died in Austria.

<sup>4</sup>For mortality data at the community level, the method of indirect standardization was used. This method weights the age-specific reference rates with the age structure of the investigated population (instead of the WHO standard population) and calculates an expected number of deaths within a community.



we used mortality data at the district level from the period 1978-84 in order to split up Vienna into its 23 districts.

Subsequently, we check for sigma-convergence (calculation of the weighted standard deviation, the coefficient of variation and the Theil-index of inequality) and for absolute and conditional beta-convergence using weighted OLS regression on cross section data. For this purpose, we merged the data set with socioeconomic characteristics at the community level from the census in 1971. We apply population weighted regressions to account for the effects of the differing size of local communities.<sup>5</sup>

To test for conditional convergence we control for factors in the health care production function which might lead to multiple steady states. More precisely, we include additional variables from the population census 1971 (at  $t = 0$ ) explained below as explanatory variables. We measure an average mortality over two longer time periods. This smoothing of year-specific effects should be accounted for in the selection of explanatory variables. Thus, we focus on variables with low fluctuations over time. More precisely, we test for the level of education, the household structure and social attachments, the population origin, the economic development, the attractiveness of the region and the distribution of genetic characteristics.<sup>6</sup>

- **Level of education:** To control for the impact of education on mortality, we consider five groups of educational levels. To calculate the average education level in the local community, we multiplied the numbers of persons in each group with the corresponding level of education, and divided the sum of the subgroups by the population above 15 years, as indicated in equation (6),

$$Edu = \frac{\sum_{L=1}^5 POP_L * L}{POP_{15}} \quad (6)$$

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Subsequently, the SMR is then calculated by the ratio of observed to expected death incidences. However, as the study population at the community level was chosen gender-specific (the gender-specific SMR in the community relative to the gender-specific average of the whole population), these SMR are not appropriate to compare mortality rates of males and females. Thus, we calculated ratios of the SMR to the gender-specific average by dividing the SMR by the national average by gender. Thereby we get comparable mortality rates for males and females and are able to calculate the gender mortality gap at the community level. For details about the direct standardization method of SMR see Statistik Austria (2007).

<sup>5</sup>All our regression results are weighted by the community size (population) to account for random variation in our sample. Other weighting procedures have been proposed in the literature, such as an „intermediate“ solution between unweighted and fully weighted regressions, as suggested by Pocock et al. (1981). More precisely, they take account of three sources of variation in death rates, namely sampling error, explanatory variables and unexplained differences between areas. However, as the sampling component is so large in our case, leading to similar results of the two methods, we chose the simpler weighting matrix based on the community size only.

<sup>6</sup>We do not present detailed arguments on the shape of the relationship between mortality (the mortality gap) and the included variables. There exist a voluminous theoretical and empirical literature on these interactions on the individual and aggregated level. For a comprehensive review see Gächter et al. 2010).

where  $L$  corresponds to the level of education,  $POP_L$  is the population in each subgroup, and  $POP_{15}$  is the overall population above 15 years. The factors used for the educational level were (1) compulsory school, (2) apprenticeship or secondary education, (3) higher school certificate (general qualification for university entrance), (4) an additional education after this school-leaving certificate (e.g. a polytechnic education or a college) excluding university education, and finally (5) a university degree or equivalent.<sup>7</sup> Thus, we get an index measuring the average educational level, (theoretically) ranging from 1 to 5 within regions where increasing values indicate a higher level of education, respectively. Subsequently, the same procedure was applied to gender-specific educational levels.

- ***Household structure and social attachments:*** There exists a broad literature on the effect of different familial networks on mortality. To control for these effects at the local community level, we proceeded in the following way. We selected the following family related variables from the census 1971, namely

- the average number of people living in a household,
- the share of one-person households,
- the share of households comprising a couple with children,
- the share of households comprising a couple without children, where the woman is 40 or older,
- the share of single-households with children,
- the average number of children per family,
- the share of divorced women, in percent of the ever married, and
- the share of female singles, age 40-59.

As expected, we observe a high correlation between those dimensions. Thus, a principal component analysis seems to be appropriate to convert the various characteristics into one single variable. As we included eight variables in our analysis, and the eigenvalue of the first factor amounts to 5.45, the resulting factor explains approximately 68% of the total variance. Average household size, couples with children and the average number of children per family are negatively correlated with the factor, while the remaining variables mentioned above influence the factor in the reverse direction (one-person households, couples without children, single with children, the share of

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<sup>7</sup>As the Austrian education system differs quite strongly from other countries, we also included in this „highest“ level of education the degrees for primary and secondary school teachers and similar educations which formally do not belong to university degrees in Austria, but would yield a bachelor’s degree according to international standards.

divorced women and the share female singles in the age between 40 and 59). To sum up, traditional family structures including a couple with children or more people living in a household exercise a negative influence on the factor. On the contrary, one-person households, couples without children, singles with children and a higher share of divorced or single women increase the resulting factor. By reversing the factor (multiplying it by -1) we are able to interpret the resulting variable as „Social and familial attachments“, with increasing values of the factor indicating a higher level of social attachments and familial solidarity, respectively (see Anson 2003 for a similar approach).

- ***Population origins:*** Although it was rarely considered in earlier studies on mortality or life expectancy convergence, we include the share of foreigners as an explanatory variable. Previous research shows that mortality is significantly lower in regions with a higher share of immigrants or foreigners (see, for instance, Anson 2003, Abraido-Lanza et al. 1999 or Gächter et al. 2010). Common explanations (see Anson 2003) range from selection effects (immigrants might be healthier) to the meaning of voluntary migration (taking control of one’s life) and to the solidarity created within marginalized migrant communities. Thus, it also seems appropriate to include this variable in a convergence equation as a conditional variable.
- ***Economic Development:*** As there are no data on average income at the local community level available for the starting period, we use two proxies to measure the economic development in a community: labor force participation rates and commuters. Depending on the estimation, we use the overall or gender-specific participation rate as explanatory variable. In the case of commuters, we calculated the ratio of in-commuters (who live outside and commute into the community) and the community population. The higher this ratio, the higher the economic level, as more jobs are available in those communities.
- ***Attractiveness of the region:*** To control for the long-term attractiveness of a region, we included the population growth between the census in 1971 and 1981 into our regressions.
- ***Genetic structure of the population:*** The genetic characteristics of individuals are one important input in the health status production function from an individual point of view. If aggregates of individuals (f. e. regions) are compared, the genetic structure is either seen as homogenous or controlled for by proxies such as ethnic criteria or the population origin. We control for the genetic structure of the local communities in the following way. Barrai et al. (2000) offer data on the genetic structure of the Austrian population based on a surname analysis (see also

Voracek/Sonneck (2007) for an application of this methods to explain differences in suicide rates in Austria on a district level). For societies with patrilinear surnames the surname can be considered as a single gene with a multitude of neutral alleles which are transmitted as in unisexual haploid species. Surnames can be considered as close substitute for Y-chromosome markers and haplotypes. Barrai et al. (2000) used information of about 4 million telephone users to calculate the surname frequency distribution for the 120 largest Austrian towns. Statistical classification of surname occurrence and frequency patterns yielded five major regions reflecting the genetic structure of the population. We assigned the Austrian communities to these five genetic regions on the level of districts. Region I includes the southern parts of the province of Salzburg, the eastern parts of Tyrol, southern parts of Lower Austria, Styria and the northwestern parts of Carinthia. Region II includes Upper Austria and the northern parts of Salzburg. Region III includes the north and eastern parts of Lower Austria, Vienna and Burgenland. Region IV includes the central and western parts of Tyrol and Vorarlberg. Region V includes the central and eastern parts of Carinthia. Within the regression this information is used as dummy information, region III (the north and east of Lower Austria, Vienna and Burgenland) is the reference region.

The following section presents important descriptive statistics of the included variables and the empirical results of our examination of convergence of the health status across regions.

## 3 Main Results

### 3.1 Descriptive Statistics

Summary statistics both of our dependent as well as explanatory variables for the first period (1969-84) and the population census in 1971 are reported in *Table 1*. Means and standard deviations are weighted by community size. Male mortality is considerably higher (1392.273) than female mortality (855.070). On the contrary, the growth rates of male and female mortality differ only slightly. However, as the growth rates are measured in percentage points, male mortality is nevertheless decreasing more quickly in absolute terms, which can also be seen by means of the negative growth rate for the gender mortality gap (-5.282%). The average share of foreigners amounts to 2.8%, the labor participation rates exhibits a value of 41.74%. The in-commuter ratio is quite high, amounting to 9.85%.

Table 1: Summary statistics (community level)

Variable	Mean	Std. Dev.	Min.	Max.
SMR, overall	1069.264	159.124	533.007	2693.433
SMR, growth rate	-32.594	8.321	-74.739	82.573
Male SMR	1392.273	192.674	501.927	2875.495
Male SMR, growth rate	-32.276	8.697	-76.765	189.509
Female SMR	855.070	157.059	402.022	2508.721
Female SMR, growth rate	-33.335	10.619	-92.913	80.362
Gender Mortality Gap	537.203	146.849	-1023.080	1814.17
Gender Mortality Gap, growth rate*	-5.828	1069.361	-98.530	84084.672
Education, average	1.509	0.246	1.020	2.290
Social attachments	0.494	0.901	-1.217	3.415
Foreigners, share	2.828	2.566	0.000	33.202
Labor participation rate	41.740	3.280	26.700	62.300
Commuter ratio	9.850	9.910	0.000	138.001
Population Growth (1971-81)	0.852	10.241	-26.047	116.223

*Notes:* Means and standard deviations are weighted by population. All reported values correspond to the first period (1969-1984), while the socioeconomic variables are taken from the census 1971. Growth rates report the percentage change from period one (1969-84) to period two (1988-2004).

\*In the case of this variable, we excluded observations with negative values in one of the two periods. Thus, the reported values include only 2324 (out of 2381) communities.

Figure 1 shows scatter plots of the mortality levels (and the corresponding gender gap) and the corresponding growth rate of the variable from period one to two. At first sight, each of the four figures shows a negative relationship (as shown by reference to the regression line), which indicates absolute convergence of mortality from period one to two. However, in the following section we examine the convergence of the health status (mortality) in detail.

### 3.2 Results on Convergence/Divergence

We start with the examination of the patterns of cross-regional dispersion or inequality by calculating the weighted standard deviations, the coefficient of variation and the Theil-index of inequality for each variable (overall mortality, mortality by gender and the resulting gender gap) and the two periods. The values of these indicators are reported in Table 2. For each variable, the first column reports the weighted standard deviation ( $\sigma$ ), the second column the coefficient of variation (CV) and finally, the Theil-index of inequality (L). For all four variables, the weighted standard deviation shows an increase in equality, as the value decreases from period one to two. However, the picture seems less clear when correcting for the (falling) mean in the distribution. Both the coefficient of variation and the Theil-index of inequality (L) do hardly change, and in some cases (male

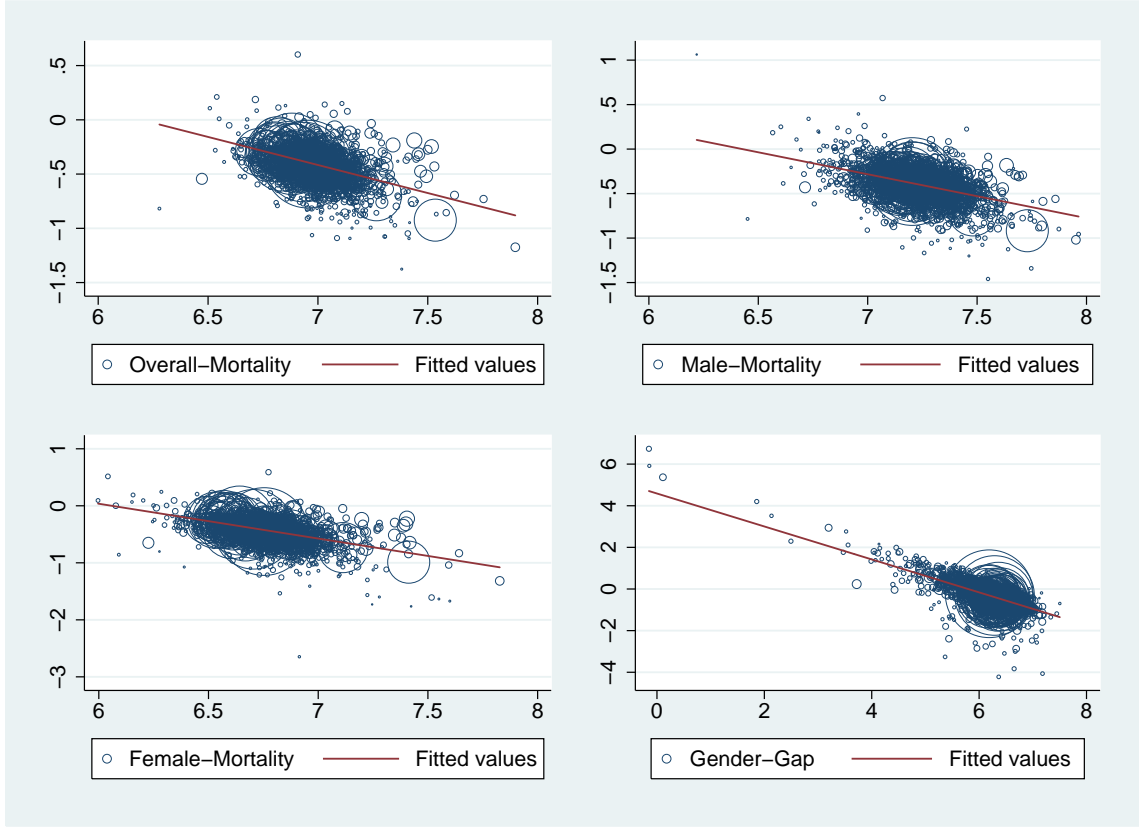


Figure 1: Scatter plots for the level of each variable in period one (abscissa in logs) and the corresponding percentage change (ordinate in log-differences) from period one to two. The magnitude of the circle shows the size of the community (population).

mortality, overall mortality) even increase from period one to two. Despite of these mixed results for sigma-convergence, it is also important to analyse absolute and conditional beta-convergence, as it is based on a different methodological framework of examining convergence.

Since the standardized mortality has a lower limit on the feasible magnitude of its decrease, it is a reasonable explanatory variable in an estimated convergence equation. Moreover, in the case of conditional beta-convergence, we include the above explained variables in our estimations. Weighted OLS estimation results are shown in *Table 3*, where the first column for each variable reports absolute beta-convergence, as specified in equation (4), and the second column shows the results for conditional beta-convergence, as constructed in equation (5).

For all observed variables, we find highly significant coefficients for absolute and conditional beta-convergence from period one to two. Interestingly, while the male coefficient is smaller than the female in the absolute convergence specification, it exceeds the female

Table 2: Empirical Results -  $\sigma$ -Convergence

Method	$\sigma$		CV		L	
Period	1	2	1	2	1	2
<b>SMR Males</b>	192.6739	128.5883	0.1384	0.1377	0.0087	0.0103
<b>SMR Females</b>	157.0589	91.9134	0.1837	0.1631	0.0139	0.0134
<b>SMR Overall</b>	159.1242	98.1804	0.1488	0.1371	0.0096	0.0099
<b>Gender Gap</b>	146.8487	97.1865	0.2734	0.2626	—	—

Notes:  $\sigma$  reports weighted standard deviations, whereas CV corresponds to the *coefficient of variation* and L reports the *Theil-index of inequality*, respectively. In the case of CV, weighted standard deviations were used. L could not be calculated in the case of the gender mortality gap due to negative values of this variable in 57 cases, where no natural logarithm could be calculated.

coefficient when controlling for other factors.<sup>8</sup> Similarly, in communities which exhibit a high gender mortality gap in the first period, the decrease in this variable is much higher as compared to regions where the gender mortality gap was already smaller in the first period. As expected, a higher educational level, stronger social attachments and a higher share of foreigners accelerate the decrease in mortality both for males and females. The same applies to the labor participation rate, although it appears insignificant in the estimation for female mortality. The commuter ratio (and thus, a higher economic development) exercises a positive influence on the growth rate, and thus, seems to slow down the improvement in terms of mortality and life expectancy, respectively. On the contrary, the attractiveness of a community (as measured by the population change from 1971 to 1981) does not influence the growth rates significantly.

The results for our dummy variables for the genetic structure seem to be particularly interesting. For the change in the SMR for the whole population all genetic regions show a significant negative coefficient compared to the reference region (Northern and Eastern Lower Austria, Vienna, Burgenland) of similar size. As the region including Vienna served as base category, our results could be reversed by taking a different region as base category. Thus, as the magnitude of the coefficients across regions feature similar values in *Table 3*, just the region of Vienna (and the surroundings as explained above) show significant coefficients in this slightly changed specification (not shown).

<sup>8</sup>As mentioned before, the percentage convergence can be calculated by  $-\ln(1 + \beta)/T$ .

Table 3: Empirical Results - Absolute and Relative  $\beta$ -Convergence

Dependent variable Method	Change SMR		Change SMR Males		Change SMR Females		Change Gender Gap	
	Absolute $\beta$	Relative $\beta$	Absolute $\beta$	Relative $\beta$	Absolute $\beta$	Relative $\beta$	Absolute $\beta$	Relative $\beta$
$\beta$ -Coefficient	-0.517*** (0.016)	-0.553*** (0.017)	-0.493*** (0.018)	-0.617*** (0.019)	-0.610*** (0.017)	-0.591*** (0.017)	-0.792*** (0.018)	-0.871*** (0.018)
Education, average		-0.245*** (0.018)		-0.256*** (0.016)		-0.230*** (0.028)		-0.682*** (0.049)
Social attachments		-0.066*** (0.006)		-0.064*** (0.006)		-0.066*** (0.007)		-0.156*** (0.015)
Foreigners, share		-0.004*** (0.001)		-0.006*** (0.001)		-0.004*** (0.001)		-0.010*** (0.003)
Participation rate, share		-0.002*** (0.001)		-0.008*** (0.001)		-0.001 (0.001)		-0.009*** (0.002)
Commuters		0.002*** (0.000)		0.002*** (0.000)		0.001*** (0.000)		0.005*** (0.001)
Attractiveness		0.000 (0.000)		-0.000 (0.000)		0.000 (0.000)		-0.002*** (0.001)
Genetic 1		-0.035*** (0.006)		-0.020*** (0.007)		-0.044*** (0.008)		0.015 (0.017)
Genetic 2		-0.030*** (0.006)		-0.016** (0.007)		-0.040*** (0.008)		0.037** (0.017)
Genetic 3		-0.032*** (0.010)		0.004 (0.010)		-0.058*** (0.013)		0.108*** (0.026)
Genetic 4		-0.037*** (0.010)		-0.020* (0.011)		-0.048*** (0.013)		0.013 (0.027)
Constant	3.204*** (0.114)	3.973*** (0.132)	3.169*** (0.130)	4.960*** (0.178)	3.696*** (0.115)	3.949*** (0.125)	4.588*** (0.110)	6.548*** (0.182)
N	2381.000	2381.000	2381.000	2381.000	2381.000	2381.000	2324.000	2324.000
$R^2$	0.297	0.395	0.239	0.347	0.350	0.424	0.467	0.532

*Notes:* The first value reports regression coefficients, standard errors are reported in parentheses. \*, \*\*, \*\*\* denote 10%, 5% and 1% significance levels. Regressions are weighted by community size (population). For the variables „*Education, average*“ and „*Participation rate, share*“ gender-specific values were used for gender-specific mortality convergence. *Attractiveness* of a region is measured by the population change from the census 1971 to the census 1981. The four categories for genetic structures are dummy variables following the study by Barrai et al. (2000), where the region III (North and East of Lower Austria, Vienna, Burgenland) is the reference region.



### 3.3 Robustness checks and discussion

To substantiate our empirical results we proceed in the following way. (i) We ran robustness tests in several directions and discuss their results below. (ii) We refer to the potential limits of our study and discuss possibilities for improvement. We start with the robustness checks. Regarding the significant influence of the genetic structure, we tried a specification where we included eight dummy variables for the nine federal states (*Bundesländer*) in Austria. While we concluded from our regressions above that the remaining regions (other than Vienna, Burgenland and Lower Austria) experience a higher decrease in mortality from period one to two due to the specific genetic structure, this effect could also be due to other unobserved regional characteristics. Not surprisingly, the effects appear mostly insignificant when including eight dummy variables for the nine federal states in Austria in our conditional beta-convergence estimations (not shown). However, this is not really surprising considering that we distinguished five different genetic regions (including four dummies), while the state effects include eight regional dummy variables. Thus, although it is not appropriate to conclude that the genetic structures play a major role in our analysis, it would nevertheless be one plausible explanation for the observed regional effects. To test for this hypothesis of the well-recognized pattern of „convergence clubs“ (as described above), we also ran separate regressions for each of the five genetic regions. Interestingly, when testing for absolute beta-convergence, there is a considerable difference between the coefficients (not shown). More precisely, the growth rate of mortality depends more strongly on the initial value in region III, which was our basement category in the estimations above. Thus, while it seems that mortality decreases at a lower pace in this region (as the dummies for other regions show significantly negative coefficients), we also find a stronger relationship between the initial mortality rate and subsequent growth rates. This applies to overall mortality as well as mortality by gender, while the differences between regions in terms of the gender mortality gap are less strongly pronounced. Moreover, the differences between other regions are also of considerable magnitude, albeit less distinctive. Clearly, this result speaks in favour of the above mentioned convergence clubs hypothesis. However, a detailed analysis of the differences between those regions would go beyond the scope of this paper. Despite of these differences, the robustness of our results presented in the preceding section is confirmed, as we find significant beta-convergence in each region and dependent variable.

The well-known „regression to the mean“ phenomenon is also a widely discussed issue in the literature, as it might be the reason for considerable bias in regressions of absolute and conditional beta-convergence as presented above. More precisely, the concept refers to the fact that individuals which give rise to extreme values upon first sampling typically produce less extreme values upon a repeated sampling in the presence of stochastic relationships

and measurement error (which might be the case in our study due to small communities, and thus, random variation). This could lead to significant beta-coefficients even in the absence of beta-convergence. Thus, the methodology of 'Barro regressions' (as applied in the last section) was strongly criticized by Friedman (1992) and Quah (1993), who emphasize that this method is subject to Galton's fallacy. We control for this problems in several ways. (i) We apply weighted regressions according to the population size of the communities. (ii) We observe long term mortality and eliminate short time effects, which might be influenced by the stochastic component. (iii) Finally, we also ran regressions excluding smaller communities with less than 500 inhabitants to account for this random variation (not shown). Once again, the results only changed slightly, confirming significant beta-convergence between communities in Austria.

Boyle and McCarthy (1997) propose an alternative strategy to test for beta-convergence, which is sometimes also referred to as gamma-convergence. They argue that sigma- and beta-convergence measure two different dimensions of convergence. While the former measures convergence by simply tracking the intertemporal change in the coefficient of variation, the latter is concerned with the intra-distributional mobility over time, specifically the picking up of the poorer performing units in the starting period. In our case this means to look at the change in the ranking of communities with respect to mortality. The measure focuses on the evolution of the ordinal ranking over a particular time interval. In their paper, they suggest a slightly adapted Kendall's index of rank concordance (Siegel 1956) to measure beta-convergence. In a binary version, we focus on the concordance between the ranks in year  $t$  and year 0. This rank concordance index is calculated by:

$$RC = \frac{Variance(AR(Y)_{it} + AR(Y)_{i0})}{Variance(2 * AR(Y)_{i0})} \quad (7)$$

where  $AR(Y)_{it}$  is the actual rank of community  $i$ 's mortality rate in year  $t$  (period 2), and  $AR(Y)_{i0}$  the rank of community  $i$ 's mortality rate in year 0 (period one). The value of this index ranges from zero to unity, where the denominator is the maximum sum of ranks which would be obtained if there were no change in rankings over time. The closer the index is to zero the greater the extent of mobility within the distribution (Boyle/McCarthy 1997, p. 259). The values for this *rank concordance index* are reported in *Table 4*.

Table 4: Empirical Results - Rank Concordance Index

Variable	SMR Males	SMR Females	SMR Overall	Gender Gap
RC	0.7336	0.5916	0.6450	0.6989

*Notes:* The *Rank Concordance Index* (following Boyle/McCarthy 1997) was calculated by using population-weighted variances as described in equation (7).

The rank concordance measure also confirms beta-convergence in mortality rates between communities in Austria, while the convergence seems to be stronger among females as compared to males.<sup>9</sup> As noted by Boyle and McCarthy (1997), the simple measure says nothing about the dynamics of evolving mortality distributions. An in-depth analysis of the changes in the distribution, however, would be particularly interesting in our context, because it could reveal helpful information to test for the persistence of relative mortality advantages/disadvantages. Thus, *Table 5* shows the rank changes in overall mortality from period one to two.

Table 5: Empirical Results - Rank Changes (Overall Mortality)

Percentile	10	20	30	40	50	60	70	80	90	100	Total
10	79	45	20	22	13	22	7	8	9	13	238
	33.19	18.91	8.40	9.24	5.46	9.24	2.94	3.36	3.78	5.44	10.00
20	43	39	30	29	26	11	14	16	14	16	238
	18.07	16.39	12.61	12.18	10.92	4.62	5.88	6.72	5.88	6.69	10.00
30	31	43	31	30	21	19	21	17	16	9	238
	13.03	18.07	13.03	12.61	8.82	7.98	8.82	7.14	6.72	3.77	10.00
40	33	27	30	25	23	27	18	22	27	6	238
	13.87	11.34	12.61	10.50	9.66	11.34	7.56	9.24	11.34	2.51	10.00
50	16	21	31	34	30	30	20	19	22	15	238
	6.72	8.82	13.03	14.29	12.61	12.61	8.40	7.98	9.24	6.28	10.00
60	11	20	26	31	32	24	32	21	25	16	238
	4.62	8.40	10.92	13.03	13.45	10.08	13.45	8.82	10.50	6.69	10.00
70	9	14	19	27	29	28	42	29	23	18	238
	3.78	5.88	7.98	11.34	12.18	11.76	17.65	12.18	9.66	7.53	10.00
80	4	13	20	16	24	36	30	45	25	25	238
	1.68	5.46	8.40	6.72	10.08	15.13	12.61	18.91	10.50	10.46	10.00
90	7	8	22	17	24	24	36	28	32	40	238
	2.94	3.36	9.24	7.14	10.08	10.08	15.13	11.76	13.45	16.74	10.00
100	5	8	9	7	16	17	18	33	45	81	239
	2.10	3.36	3.78	2.94	6.72	7.14	7.56	13.87	18.91	33.89	10.04
Total	238	238	238	238	238	238	238	238	238	239	2,381
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

*Notes:* The mortality deciles of the first period (1969-1984) are reported in rows, where the deciles of the second period (1988-2004) are reported in columns. The first value reports absolute values, the second percentages (on the basis of 238 communities per decile).

For calculating this cross table, we divided our sample in period one into ten deciles of 238 communities each (and 239 in the last decile, as we have a total of 2381 communities). The first decile (as reported as „10“) refers to the decile with the highest mortality in period one. The columns show the deciles of mortality rates in period two. Thus, the table shows the change in rankings depending on the original decile of the community, giving further insights into rank changes besides the aggregated measure of the Rank Concordance Index.

<sup>9</sup>As the statistic is distributed as chi-squared ( $\chi^2 = 2(N-1)RC$ , where N is the number of communities and RC is the calculated Kendall rank concordance measure with N-1 degrees of freedom) and we test the null hypothesis of no association between ranks of different years, the null can easily be rejected in all four cases.

We are able to see, for instance, that 33.19% (or 79 out of 238 communities) which have been in the first decile in period one also remained there in period two. On the contrary, 13 communities (5.44%) changed from the first to the last decile (and thus, from the highest mortality decile to the lowest level of mortality). In the case of no change in rankings, the diagonal would show values of 100% each, as no community would change the decile from period one to two. In a nutshell, it is easy to see that there were major rank changes from period one to two, leading to our highly significant *rank concordance* measure presented above.

Another common criticism about the Barro-approach is that the growth regressions assume an implicit condition of homogeneity, or in other words, that all the communities/regions are restricted to have the same rate of convergence represented by the beta-coefficient. Thus, the process of formation of convergence clubs cannot be captured by using simple Barro regressions, as we only estimate a single  $\beta$  for all communities in the sample. This problem as well as the criticism related to Galton's fallacy can partly be handled by applying quantile regressions, because they allow for heterogeneity in the coefficients of the regression. Thus, the phenomenon of „convergence clubs in mortality“ could also be revealed by such a methodology. Results for quantile regressions for absolute beta-convergence are reported in *Table 6*.

Table 6: Empirical Results - Quantile Regressions for Absolute  $\beta$ -Convergence

Dep. Var. Quantile	SMR Overall		SMR Males		SMR Females		Gender Gap	
	0.25	0.75	0.25	0.75	0.25	0.75	0.25	0.75
$\beta$ -Coefficient	-0.668*** (0.076)	-0.456*** (0.049)	-0.539*** (0.051)	-0.334*** (0.045)	-0.689*** (0.044)	-0.555*** (0.029)	-0.660*** (0.037)	-0.832*** (0.019)
Constant	4.194*** (0.531)	2.840*** (0.343)	3.442*** (0.369)	2.078*** (0.328)	4.153*** (0.295)	3.397*** (0.201)	3.644*** (0.229)	4.966*** (0.114)
N	2381	2381	2381	2381	2381	2381	2324	2324

*Notes:* The first value reports regression coefficients, standard errors are reported in parentheses. \*, \*\*, \*\*\* denote 10%, 5% and 1% significance levels. Regressions are weighted by community size (population).

In a nutshell, we estimate quantile regressions for different segments of conditional distribution of the relative decrease in mortality, similarly to the analysis of Ram (2006, p. 523). As shown in *Table 6*, the beta-coefficient is higher in the lower quartile (0.25) as compared to the upper quartile (0.75). This pattern is not only observed for overall mortality, but also for gender-specific mortality. Thus, the relationship between the initial level and the growth rate in mortality is stronger in the lower quartile of the conditional distribution, which would once again confirm the existence of convergence clubs. This result does not change when including other explanatory variables by estimating quantile regressions of

conditional beta-convergence (not shown, available on request by the authors). Despite this evidence of convergence clubs, we nevertheless are able to conclude that we observe absolute as well as conditional beta-convergence in all our quantile regressions, albeit the speed of convergence differs significantly between different quantiles in the distribution.

Overall our checks allow the conclusion, that the results are quite robust and the methodology used is appropriate to cope with several problems. This leads over to a discussion of additional issues (problems) involved in our research question, the data set and the research strategy. Our indicator for convergence of the health status is overall mortality of the total population measured by age standardized mortality rates. It is needless to say that this only covers one important dimension of the health status. No information on life expectancy and quality related aspects of health is currently available at the level of local communities in Austria. For specific health policy conclusions, however, overall mortality of the total population might mask important structural information of two kinds: (i) the mortality caused by different disease groups, (ii) the mortality ratios of different age groups. There exists a lot of anecdotic evidence in Austria that differences in the mortality between regions might be caused by different nutritional attitudes. Data on this issue are available and it is up to future research to study the convergence/divergence of disease specific mortality rates. As Illsey/Le Grand (1993) point out in their study of long term inequalities between British regions the use of standardized mortality rates might obscure differences in the convergence rates of age specific death rates between regions. A look at mortality rates divided by age groups might also improve the insights into the health production function which forms the basis for conditional convergence. Unfortunately, there is no possibility to get reliable information on age specific mortality rates on the local community level. The only promising strategy to cope with this problem is to take data from larger regional units, f. e. the districts level.

This leads to the question of choice of the unit of observation and the level of data aggregation in general. Our study relies on units of observation and data aggregation defined by general administrative boundaries. We are aware that this might cause misleading information in several respects. From a descriptive point of view the results on convergence/divergence might be different depending on the definition of the observation unit. We decided to study the convergence/divergence of within country mortality at the lowest possible level. In future research we will complement this by studies of larger regional aggregates (f. e. districts). Similarly, our test for conditional convergence is also confronted with some methodological issues. In general, to be able to test for conditional convergence, a health production function is needed, which allows a test for unit specific steady states. There is a broad agreement in the relevant literature that an empirical specification of an aggregated health production function (f. e. at the local level) should use multilevel

information (Susser 1994, Diez Roux 2003) to get unbiased results and to identify the coefficients of the explanatory variables correctly, even if - as in our case - no conclusions are drawn for the individual level (ecological fallacy). One important aspect of this problem is once again the appropriate definition of the observation unit. This definition predecides how the aggregated and contextual information enters the conditional convergence regression. Eventually, this leads to the question about the relevant neighbourhood for the individual health status. Clearly, it seems logical that this might be different in urban areas compared to rural areas, that it depends on the individual mobility, etc. The literature on this issue (see f. e. Lebel et al. 2007, Pickett/Pearl 2000, Lupton 2003, Coombes 2000) agrees that administrative boundaries are not able to cope with the problem of neighbourhood in an appropriate way and favours a multi-perspective approach for defining neighbourhood units. On the other hand, previous attempts to implement such approaches (see Lebel et al. 2007) lead to the conclusion that this strategy is only possible for small scaled projects and not for country wide comparisons.

## 4 Conclusions

As stated above, the majority of research on the convergence of mortality has focused on between-country-convergence on a worldwide scale, neglecting the issue of considerable heterogeneity between countries. Particularly from a long-term perspective, within-country convergence of mortality has rarely been investigated by applying the methods well established in other scientific fields, especially in the economic growth literature. In this paper we aimed at reducing such a shortcoming by focusing on the examination of convergence of the health status within a rather homogenous country. More precisely, we used data from 2381 Austrian communities from 1969-2004 to test for various forms of beta- and sigma-convergence. As an indicator for the health status we used overall standardized mortality rates by considering four different dimensions, namely (i) the overall population, (ii) males, (iii) females, and (iv) the resulting gender mortality gap.

Regarding sigma-convergence, we find rather mixed results. While the weighted standard deviation shows an increase in equality for all four variables, the picture appears less clear when correcting for the decreasing mean in the distribution (coefficient of variation and Theil-index of inequality). On the contrary, we find highly significant coefficients for absolute and conditional beta-convergence between the periods. Interestingly, a higher educational level, stronger social attachments, a higher labor participation rate and a higher share of foreigners, as expected, accelerate the decrease in mortality both for males and females. On the contrary, the commuter ratio seems to slow down the improvement in terms of mortality. While these results are confirmed in several robustness tests, including

the exclusion of small communities (population less than 500) and the calculation of a rank concordance index as proposed by Boyle and McCarthy (1997), we also find evidence for the existence of convergence clubs. Both the significance of the dummy variables for genetic structures in our conditional beta-convergence estimation as well as the considerable difference of the beta-coefficients when running separate regressions for these regions can be interpreted as evidence for possible convergence clubs. In order to test for differences in the beta-coefficients within the distribution we also ran quantile regressions for the lower and upper quartile of the distribution. Once again, the impression of differences in the coefficients in different parts of the distribution was confirmed, albeit the conclusion of beta-convergence across communities is unaffected by this result. More precisely, we find significant convergence in all regions and in each quantile regression applied, although the speed of convergence seems to differ across regions - probably due to the well known phenomenon of convergence clubs. Nevertheless, the highly significant rank concordance index (and the corresponding cross table in rank changes) confirms highly significant beta-convergence in the observed time period.

While our data set considered data from Austria, a small and homogenous country, it would also be interesting to extend this line of research to other countries to test whether between-country convergence is also accompanied by within-country convergence in mortality and the health status, respectively. Moreover, it would also be interesting to test other measures of the health status in similar regressions. Given the huge contribution of gains in health to overall human well-being in the last decades, such studies are also highly rewarding from a welfare perspective.

## 5 References

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