Changes in Inequality in Mortality: New Evidence for Spain

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Abstract: We analyze the evolution of inequality in mortality in Spain during 1990-2014. We focus on age-specific mortality and consider inequality across narrowly defined geographical areas, ranked by average socioeconomic status. We find substantial decreases in mortality over the past 25 years for all age groups, which were particularly pronounced for men, resulting in a sizeable reduction in the gender gap in mortality. Inequality in mortality also decreased during this period, including during the recent recession, so that by the 2010's mortality presents a flat socioeconomic gradient for most age groups. Compared to the US and Canada, decreases in mortality have been larger in Spain, and inequality is the lowest of the three countries. We find essentially no change in inequality among the elderly, in contrast to the increase found in the US.

Keywords: Mortality, inequality, health.
JEL codes: J11, I14.

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1. Introduction

We analyze the evolution of inequality in mortality in Spain during 1990-2014. We focus on age-specific mortality, and consider inequality across narrowly defined geographical areas, ranked by different proxies of average socioeconomic status. This approach allows us to explore changes in inequality for all age groups, including children, compared to previous approaches using socioeconomic measures at the individual level, such as education or occupation.

Our results show substantial decreases in mortality over the past 25 years for all age groups, which were particularly pronounced for men, resulting in a sizeable reduction in the gender gap in mortality. Inequality in mortality across Spanish localities also decreased over this period, including during the recent recession, so that by the 2010's mortality presents a flat socioeconomic gradient for most age groups. During the same period, income inequality was also decreasing, albeit with short setbacks, such as after the 2008 crisis (Ferrer-i-Carbonell et al. 2013). Compared to the US and Canada, decreases in mortality were larger in Spain, and inequality is the lowest of the three countries by 2010. We find essentially no change in inequality among the elderly, in contrast to the increase found in the US (Currie & Schwandt 2016a).

Recent research found increases in mortality rates among (older) adults of lower socio-economic status (SES) in the United States (Case & Deaton 2015, 2017). This increase was driven by drug overdoses, suicides, and alcohol-related liver mortality, and some have suggested it might be related to economic factors (Case & Deaton 2017, Ruhm 2018), leading to it being labelled "deaths of despair". These findings raised concerns about increasing inequality in life expectancy (Chetty et al. 2016, Cutler et al. 2011, National Academies of Sciences Engineering and Medicine 2015).

Recent work on the US (Currie & Schwandt 2016a, 2016b) revisits these concerns, highlighting the relevance of studying trends in inequality separately for younger and older ages. Their analysis is based on comparing the evolution of age-specific mortality rates during the period 1990-2010, across groups of counties ranked by poverty rates. This approach reveals that, while for older groups (particularly for women), decreases in mortality have been larger in better-off areas, inequality has in fact decreased substantially among children and youth. Thus, the documented increases in inequality in mortality are concentrated in the group of older women, with inequality actually decreasing at younger ages. These results suggest that inequality in life expectancy may in fact be expected to fall in the long term for the younger cohorts.

Two recent studies comparing trends in the US with other countries reinforce the idea that increases in income inequality need not necessarily lead to increases in inequality in mortality, and stress the role of public policy and public health insurance in mediating this relationship. Parallel analyses of inequality in mortality in Canada (Baker et al. 2017) and France (Currie et al. 2018) find substantial decreases in mortality and low levels of inequality in these countries from 1990 to 2010, particularly in France and among younger cohorts, despite increases in income inequality during this period.

We replicate the exercise in Currie & Schwandt (2016b) using data for a Southern European country (Spain), with municipalities as the geographical unit of interest. We find no change in inequality at older ages, and a decline at younger ages, with flat slopes by the 2010's (we only find a slight increase in inequality among men in their 40's). Again, our results point towards falling inequality in life expectancy in the future, as the younger cohorts age.

In the case of Spain, a number of studies have documented the extent of inequality in health and mortality rates, but these have been mainly limited to specific regions, namely Madrid, Barcelona and the Basque Country, where availability of better data allows for analysis of mortality inequality at the individual level (Borrell et al. 1999, 2008, Martínez et al. 2009, Regidor et al. 2003). These three regions have been the only representation of Spain in international studies comparing socioeconomic inequalities in mortality across European countries. Those studies found that both Spain and Italy (represented by the city of Turin) have lower inequality than their northern neighbors (Huisman et al. 2005, Kulhánová et al. 2014, Mackenbach et al. 2008). These smaller socioeconomic differences arise from lower inequality in cardiovascular disease among men, and in cancer among women, together with lower inequality in smoking and sedentary lifestyle, due to the less healthy behaviors of higher educated individuals (Kulhánová et al. 2014).

At the national level, most studies for Spain have focused on mortality rates among the working age population (Clemente et al. 2016, Reques et al. 2014), or have aggregated mortality rates of all ages (Benach et al. 2001). This latter study analyzes differences across small areas (based on municipalities) ranked by a deprivation index which combines information on education, labor and living conditions. Their results show a significant socioeconomic gradient in mortality for the leading causes of death for men and women in the period 1987-1995.

Regidor et al. (2014) analyze the evolution of inequality in mortality rates at the province level, ranking provinces by income, in a period when income inequality across provinces declined in Spain (from 1970 to 2010). They consider both infant mortality and premature mortality, defined as mortality among the population younger than 75. They find decreasing inequality in infant mortality, such the correlation between income and infant mortality ceased being significant by 1995. On the other hand, inequality in premature mortality increased, especially among women.

We contribute to the international literature by providing evidence on changes in inequality in mortality by age and gender for a European country (Spain). The only similar analysis for Europe is a recent working paper analyzing French data (Currie at al. 2018), where their level of analysis is the *département* (there are 96 of them in France). Such an aggregate level of analysis, however, may miss a lot of within-unit inequality, as we show when comparing our results by province to those by municipality, and this may obscure some of the recent trends. As for the previous literature analyzing trends in mortality with Spanish data, we are the first study to cover the whole Spanish geography in an analysis of inequality in mortality by age group, including all ages.

The remainder of the paper is organized as follows. We describe our data sources and the methodology in Section 2. Section 3 describes our main results for changes in inequality in mortality by sex and age. Then we discuss our findings in relation with the recent literature for other countries and provide some additional analysis on the main causes of death in Section 4, and Section 5 concludes.

2. Data and methodology

2.1. Data

We use three main sources of data: death certificate data, the decennial Census, and the local population registry.

In order to construct (five-year) mortality rates, we use death counts by municipality, gender and age group for the different years, obtained from the National Statistical Institute (INE) death certificate microdata, from 1990 to 2014. We also use the restricted version of the death certificate data, which contains information on the cause of death. We assign individuals to their municipality of residence. These data only allow one to identify municipalities with at least 10,000 inhabitants; for the smaller ones, only the province is available.

For the denominator of the mortality rates we need population counts by municipality, gender, and age group, for years 1990, 1995, 2000, 2005, and 2010 (the initial year for each five-year interval). Both the Census and the local population registry provide this information, but they cover different periods. The Census is available for 1991, 2001 and 2011, while the population registry data are available annually from 1996 onwards. We use the population registry for all years starting in 1996, and supplement it with Census data for population counts in 1991. When we explore finer age groups for the younger ages, we use the Census data for 2011, since it allows for a more disaggregated analysis.

Finally, in order to rank municipalities by (proxies of) average socioeconomic status, we use the Census data of 1991, 2001 and 2011 to obtain municipality characteristics. In particular, we construct high school dropout rates (proportion of the population aged 19 and older that does not have a high school diploma), employment rates (proportion of the population 16 to 65 that is employed), and unemployment rates (proportion of unemployed among the active population) for each year. We approximate these measures for the intermediate years (1995 and 2005) using linear interpolation. Similar to the death certificate data, the Census only identifies municipalities of more than 20,000 inhabitants, while we only know the province of the smaller ones.

We check that our socioeconomic proxies are correlated with per capita income at the municipality level (which we cannot use directly since data on income by municipality is only available for recent years). To that end, we use estimates of median income by municipality constructed by FEDEA from tax records for the year 2006 (see section 2.2).[1]

2.2. Methodology

We first analyze the evolution of age-specific mortality by sex at the national level. Next, in order to study the evolution of inequality in mortality, we follow the methodology of Currie & Schwandt (2016a and 2016b) and construct 5-year mortality rates by sex, age group, and 5-year period at the municipality level.[2] We then rank municipalities according to our different socioeconomic proxies, with lower rank always indicating better outcomes, and group municipalities into bins, each accounting for approximately 5% of the total Spanish population in that year. This allows us to compare the average mortality rate for a given sex and age group in a given period, for the 5% of the population living in municipalities with the lowest dropout rate (or highest employment, or lowest unemployment rates) with the 5% of the

[1] Data available at http://www.fedea.net/renta/renta.html.

[2] Currie & Schwandt (2016a and 2016b) run their analysis at the county level and construct 3-year mortality rates.

population living in municipalities with the highest dropout rate (or lowest employment, or highest unemployment rates), and see how this comparison evolves over time.

For each of the periods 1990-94, 1995-99, 2000-04, 2005-09, and 2010-14, we construct mortality rates for each gender and age group at the national (municipality) level by adding up all deaths for that sex and age group that took place in Spain (or in that municipality) during each period, and dividing over the population of that sex and age group in Spain (or in the municipality) in the starting year of the period.[3] For instance, the 5-year mortality rate for females aged 0-4 in a given municipality in 2010-2014 would be the sum of all deaths for females younger than 5 that took place in that municipality between January 1st, 2010 and December 31st, 2014, divided by the number of girls younger than 5 that lived in that municipality in 2010.

As explained in section 2.1, the data only allow us to identify deaths in municipalities of at least 10,000 inhabitants, and to obtain municipality characteristics for municipalities with at least 20,000 inhabitants. In order not to limit our analysis to the larger municipalities, we include information from the smaller (unidentified) municipalities by creating, for each province, two "fake" municipalities: one representing average values across all municipalities with less than 10,000 inhabitants, and another one representing all municipalities with between 10,001 and 20,000 inhabitants. As a result of these restrictions, the total number of municipalities we can observe in our data ranges from 380 in 1990 to 489 in 2010.

We use several different variables to proxy socioeconomic status (SES) at the municipality level. We construct high school dropout, employment, and unemployment rates,

[3] Due to limitations in data availability, for the first two periods we have to use as denominator for the mortality rates the population in years 1991 and 1996, respectively.

as described in section 2.1. Figure A1 shows that these three variables are strongly correlated with income at the municipality level in 2006, when income data are available. We show the correlation between median per capita income in each municipality and our three proxies. Median income shows a strong negative correlation with high school dropout rates (-0.74) and unemployment rates (-0.52), and a positive one with local employment rates (0.47), all of them significant at the 99% confidence level. Our main results rank municipalities by high school dropout rates, but in the Appendix we also report results using employment and unemployment rates.

We first order municipalities from higher to lower socioeconomic rank, and then group municipalities into "bins" using ventiles of the distribution of the socioeconomic variable, such that each bin contains approximately 5% of the total Spanish population. As argued by Currie & Schwandt (2016b), the advantage of this procedure over using municipalities directly is that we avoid selection problems that could arise from shrinking or growing municipalities. Given the skewness in the distribution of population size across municipalities, we make some adjustments to achieve similar-sized bins. In particular, we split the two largest municipalities (Madrid and Barcelona) into five, each with 1/5 of the population of the original municipality and identical values for mortality and the ranking variables. This process is done separately for each year of analysis. Figure A2 in the appendix shows the resulting population per bin for the different years and ranking variables. The variation across bins is relatively small and is not systematically related to the ranking variable.

We also replicate our main analysis using data at the province level, in order to compare the results at different levels of granularity. There are 50 provinces in Spain, plus two additional autonomous cities. We thus aggregate mortality rates and socioeconomic status proxies at the province level. We then follow the same procedure as with municipalities, ranking provinces by socioeconomic status and grouping them into bins of approximately 5% of the total Spanish population in each year.

There is large variation in socioeconomic status across bins in all periods, as shown in figure A3 in the appendix. High school dropout rates range from 40% to 80% in 1990, and from 15% to 45% in 2010. This figure also shows that, while in 2010 there was a strong correlation between both employment rates and dropout rates, these relationships were much weaker in the 1990s. This highlights the importance of checking the robustness of our results to using different indicators of SES.

Regarding changes in socioeconomic inequality over time, Figure A4 shows the evolution of the 90^{th} to 10^{th} percentile ratio for each of our three socioeconomic proxies. Inequality in high school dropout rates increased steadily since 1990, as educational attainment increased more rapidly in better-off areas. Inequality in employment rates resembles more closely the evolution of income inequality documented by Ferrer-i-Carbonell et al. (2013), as it decreased from 1990 to 2005, and then increasing with the crisis, without reaching the 1990 levels. Dispersion in unemployment rates, in turn, was highest in 2000-04 (a period of low unemployment levels, see Figure A3), falling after 2004.

3. Main results

3.1. National-level results

Before exploring changes in inequality using the geographical variation, Figure 1 shows 5-year national mortality rates by age group and sex, from 1990-94 to 2010-14. There are three main takeaways. First, during the 25-year period under analysis, there are important declines in mortality in all age groups (illustrated by the negative slopes), including young adults and children. Second, mortality rates are lower for women than men, in all periods and age groups (although the difference is smaller among children 0-4). Third, the declines over time are more pronounced for men. In all but the oldest age groups, the mortality rate falls by more than half for men between the early 1990's and the early 2010's. The negative slope is much less pronounced for women (except for children 0-4), so that the gender gap in mortality falls significantly over the period. In the early 1990's, the mortality rate for men 20-49 was about 12 per 1,000, compared with 4 for women. By the 2010's, the corresponding numbers were 5 and 3.

The 1990's, as well as the 2010's, were periods of high unemployment and low growth, compared with the 2000's (at least up to 2008). In spite of the changing economic conditions, the declines in mortality seem to follow an approximately linear trend, with no apparent deceleration during the recent recession.

3.2. Results by socioeconomic rank

We next present the results for mortality rates by socioeconomic status (SES), measured at the municipality level (Figures 2 and 3). As detailed in Section 2.2, we rank municipalities by proxies of per capita income, and group them in 20 bins that include approximately 5% of total population each. Bins are ordered from higher to lower SES. The slopes of the lines measure the degree of inequality in each 5-year period. Positive slopes indicate that richer municipalities have lower mortality rates.

The results for the same four age groups as in the previous section are displayed in Figure 2. The top dots (and lines) describe the degree of inequality in mortality in 1990-94. The lines are essentially flat for women 5-19 and 20-49 (see Appendix Table A1), indicating that mortality rates were similar in poorer and richer areas. The slopes are positive for older ages (50+) and men aged 5-19, i.e. mortality rates were lower in richer areas. Mortality rates were in fact higher in richer areas among children 0-4, as well as for men 20-49. We explore the sources of this pattern in section 4.

The bottom triangles (and corresponding lines) illustrate the degree of inequality in mortality for the different age groups in 2010-14. The slopes are essentially flat for both men and women in all age groups below 50, indicating that by the early 2010's mortality rates are very similar in poorer and richer areas. Therefore, inequality decreased among both children and (young) adults. The slopes are however significantly positive and large in magnitude for older men and women (see Appendix Table A1). Inequality in mortality did not decline among the older age group.

Since the 50+ age group is very broad and there could be changes in age composition across geographical areas, Figure 3 disaggregates this group into four finer ones (Appendix Tables 2-3 provide more detail on the numbers behind the graph). The slopes in 2010-14 are now essentially flat for women 50-69, while they remain positive for all groups of men, and women 70 and older. Figure 3 also disaggregates children younger than 5 into those younger than 1, with higher mortality rates, and those between 1 and 5. Both groups present flat gradients by 2010, and we can see that the negative gradients observed by 1990 were more pronounced among females aged 1-4.

In Figure A5 in the Appendix we replicate the analysis for the four bigger age groups using measures of mortality and socioeconomic status at the province level (instead of municipality). The qualitative conclusions remain, as we see virtually no inequality among younger groups by 2010-14, and a positive gradient among older men and women. However, the analysis at this level hides some of the variation in inequality over time, as we do not find the significant changes in the slopes from 1990 to 2010 for the younger groups that we do observe in the analysis at the municipal level.

The results reported in this section are robust to using alternative measures of socio-economic rank. Appendix Figure 6 replicates Figure 3 using employment rates as an alternative socioeconomic proxy[4]. The conclusions are similar: we see decreases in inequality among the young, a small increase in inequality for men in their 40's, and parallel trends for the older groups.

4. Discussion: International comparison and main causes of death

4.1. International comparison

Compared to the findings for the US by Currie & Schwandt (2016a, 2016b), our results suggest that mortality rates were lower in Spain than in the US in 1990 for all age groups, except for children younger than 5 and for the elderly. In terms of the evolution over time, decreases in mortality were larger in Spain for children, adult women, and the elderly. The results for Spain are similar to those found for France (Currie et al. 2018) in that adult women experienced substantial decreases in mortality in both countries, in contrast to the little

[4] Results using unemployment rate as socioeconomic proxy are similar and available upon request.

improvement seen in the poorer areas of the US and Canada (Baker et al. 2017). For adult men, declines have been smaller in the poorest places in Spain when compared to the poorest places in the US, but higher in the richest areas. As a result, by the 2010's Spain still has lower mortality rates than the US, and comparable to those in Canada and France for most age groups.

Although inequality in mortality was lower in Spain than in the US in 1990, Spain also had larger declines in inequality for young children and for adult women. Inequality in mortality among adult women in fact increased both in the US and Canada, due to the stagnation of mortality in the poorest places. Decreases in inequality were also greater in Spain than in France, where inequality changed little in either age group and remained at low levels throughout the period (Currie et al. 2018). The lack of change in inequality reported in France could be partly due to the high level of aggregation of the data. The comparison of our analyses at the municipality and province level show that the higher level of aggregation obscures some of the changes in inequality among children.

On the other hand, declines in inequality were greater in the US for children older than 5 and for men until age 49. For older men there was not much change in inequality in either country. As a consequence of these developments, in 2010 Spain presents overall low levels of inequality, comparable to those of France and lower than those in the US and Canada. This finding is consistent with previous literature that, although based only on data from three regions in Spain, found inequality in mortality to be lower in Spain compared to other European countries (Huisman et al. 2005, Kulhánová et al. 2014, Mackenbach et al. 2008).

4.2. Analysis by cause of death

In this section we turn to the analysis of mortality by cause of death to further investigate the patterns in overall mortality. We first explore the main drivers of the large declines in mortality documented for all ages at the national level, and then discuss the sources of the socioeconomic inequalities identified for certain groups.

National level

Figure 4 shows the evolution of mortality rates from the two main causes of death in each age group. Among children younger than 5, complications arising in the perinatal period were and remain the leading cause of death, particularly in the first year of life. Mortality from this cause has decreased notably for both boys and girls during this period, but not as much as mortality from congenital malformations, the second cause of death, which fell to one third of its 1990 level for girls and even more so for boys[5].

For older children (ages 5-19), external injuries (mostly from car accidents) were the main cause of death in the 1990’s, but have decreased sharply over time, particularly for boys, and account for roughly the same number of deaths as cancer by 2010. Mortality from cancer, the second cause of death in this group, remained stable over the period and at low levels, comparable to those in the US and Canada in 2011 (Baker et al. 2017).

Among adults younger than 50, cancer remains the first cause of death among women, and showed only moderate improvement over the last two decades. Among men, on the other hand, external injuries (again, derived chiefly from traffic accidents) accounted for the most

[5] Congenital malformations were the cause of death behind the negative gradient observed in 1990-94 among females aged 1-4, but present a flat gradient by the 2010’s.

deaths in this age group in the 1990's, but have been reduced by more than 60%, although they are still the leading cause of death together with cancer.

Finally, for older ages, there were large decreases in mortality from diseases of the circulatory system, both for men and women. Mortality from cancer has changed little for either sex, but is twice as large for males than for females, becoming the leading cause of death among men older than 50 by the 2010's.[6]

Our analysis highlights three main drivers of the large overall decreases in mortality: perinatal and congenital-related diseases among young children, traffic accidents among children and young adults, and circulatory diseases among the elderly. Declines in mortality from ***perinatal and congenital-related conditions*** are likely to be the result of advances in screening, delivery attendance, and perinatal care (Alonso et al. 2006, Zeitlin et al. 2016). These declines have been larger in Spain than those observed in US or Canada, where mortality from congenital anomalies also decreased substantially, but where deaths from perinatal factors actually increased (Baker et al. 2017).

Traffic accidents and their associated fatalities were higher in Spain than in other Western European countries in the early 1990's, particularly among youth, but have decreased strongly since then due to improvements in safety technologies and regulation (Redondo Calderón et al. 2000, Villalbí & Pérez 2006). As a result, in the most recent period of analysis mortality from external injuries is lower in Spain than in the US and Canada, both for children and for younger adults (Baker et al., 2017).

[6] If we look at finer age groups, we can see that cancer is the first cause of death for all men older than 50, except for ages older than 80, where circulatory-related diseases are more important.

Lastly, mortality from ***circulatory conditions*** (cardio and cerebrovascular disease) decreased at a faster pace in Spain compared to the OECD average (OECD, 2015), partly due to better initial treatment, and partly due to decreases in risk factors like high cholesterol or high blood pressure (Flores-Mateo et al. 2011). By the 2010's, mortality from these causes was lower in Spain than that in the US, and similar to that of Canada for women, but lower for men (Baker et al. 2017).

Results by SES rank

We next turn to the discussion of the causes of death behind some of the patterns observed in the analysis of inequality in mortality. Our analysis revealed that mortality was higher in richer areas in the 1990's among men aged 20 to 49 (see Figure 2). This surprising pattern turns out to be driven by AIDS mortality. Although AIDS accounted for fewer deaths than traffic accidents or cancer, it presented a marked negative gradient, as shown in Figure 5. In 1990, the 5-year mortality rate in the highest-educated group of municipalities was almost 3, while it was only 0.4 in the lowest-educated group. After 1995, mortality from AIDS fell vastly in richer areas, and by 2000 it presented a completely flat gradient and low levels.

HIV infection spread rapidly in Spain during the 1980s, mostly among intravenous drug users, and linked to the "heroin boom" of this decade (Valdes 2013). Although this epidemic affected both rural and urban areas, it was particularly problematic in poor neighborhoods within cities which had overall high education levels, explaining the observed negative gradient (Gamella 1997). AIDS mortality reached its peak in Spain in 1994, with higher levels than in other European countries, and then fell from 1995 on thanks to combination therapy and prevention and awareness campaigns (Valdes 2013).

Our analysis by socioeconomic rank also showed that inequality increased for men in their 40's (and in their 50's, to a lesser extent) because mortality fell more in richer areas (see Figure 3). This larger decline in higher-educated municipalities was due to larger decreases in VIH mortality, as just discussed, and also in cancer mortality. Figure 6 shows the evolution of mortality rates from cancer for men aged 40 to 59 by high school dropout rank. While cancer presented a flat gradient in the 1990's, improvements over this period where larger in more educated areas. This widening inequality was mostly driven by lung cancer, the most common type of cancer for this group, and resembles the pattern observed in smoking cessation among men during the 1990's, with higher educated men being more likely to quit smoking than lower educated ones (Fernandez et al. 2001).

Figure 7 examines the evolution of inequality in mortality from "deaths of despair", which received much recent attention in the US (Case & Deaton 2015, Ruhm 2018). We look at mortality from suicides, drug or alcohol poisoning, and alcoholic liver diseases and cirrhosis, for men in their 40's. Suicides and poisonings have both increased over this period, but without much change in inequality. Suicides present a marked positive gradient, with mortality rates in low SES areas being around 60% higher than in high SES ones. Poisonings, in turn, do not differ much along the socioeconomic spectrum. On the other hand, mortality from alcoholic liver diseases and cirrhosis has decreased in the last two decades, but this decrease has been much more pronounced in high SES areas, leading to emerging inequality from this cause. Overall, the increase in mortality from suicides and poisonings among middle-aged men resembles the trend observed in the US and Canada (Baker et al. 2017). However, the magnitude of the increase has been smaller in Spain, so that none of these "despair" causes affect significantly the general patterns in mortality. This is also in contrast to the developments observed in France where, despite the decreases in mortality from all these three causes, “deaths of despair” are still the leading cause of death among young male adults, and suicide rates are on average still higher than in the US (Currie et al. 2018).

5. Conclusions

We analyze the evolution of inequality in age-specific mortality across Spanish municipalities, ranked by socioeconomic status, from 1990 to 2014.. We document substantial decreases in mortality over the past 25 years for all age groups, which were particularly marked for males, resulting in a sizeable reduction in the gender gap in mortality. In general, inequality in mortality decreased over the period, including during the recent crisis, so that by the 2010’s mortality presents a flat socioeconomic gradient for most age groups. Compared to the US and Canada, decreases in mortality have been larger in Spain, and inequality is the lowest of the three countries. We find essentially no change in inequality among the elderly, in contrast to the increase found in the US.

Compared to previous literature on inequality in mortality in Spain, which used mainly socioeconomic measures at the individual level, such as education or occupation, the analysis of inequality across small geographical areas allows us to explore changes in inequality for the whole of Spain separately for different age groups, including children. This approach provides relevant insights: like Currie & Schwandt (2016b, 2016a) in the US, we see larger decreases in inequality among younger cohorts, which may be anticipating lower inequality in life expectancy in the future.

The low levels of inequality observed across municipalities by 2010 do not imply that inequality does not exist between individuals within municipalities. For instance, a recent study for the region of Catalonia using individual data found substantial socioeconomic inequalities in health care utilization even among young children in 2015 (Observatori del Sistema de Salut de Catalunya, 2017).

In conclusion, we show that the decreases in mortality experienced during the last twenty-five years in Spain were accompanied by reductions in inequality among younger cohorts, and no change among the older ones, in spite of the increase in income inequality that followed the recent economic crisis. These findings support the idea that increases in income inequality do not necessarily translate, at least in the short run, into more inequality in mortality, in the context of a country with public health insurance and a European welfare system.

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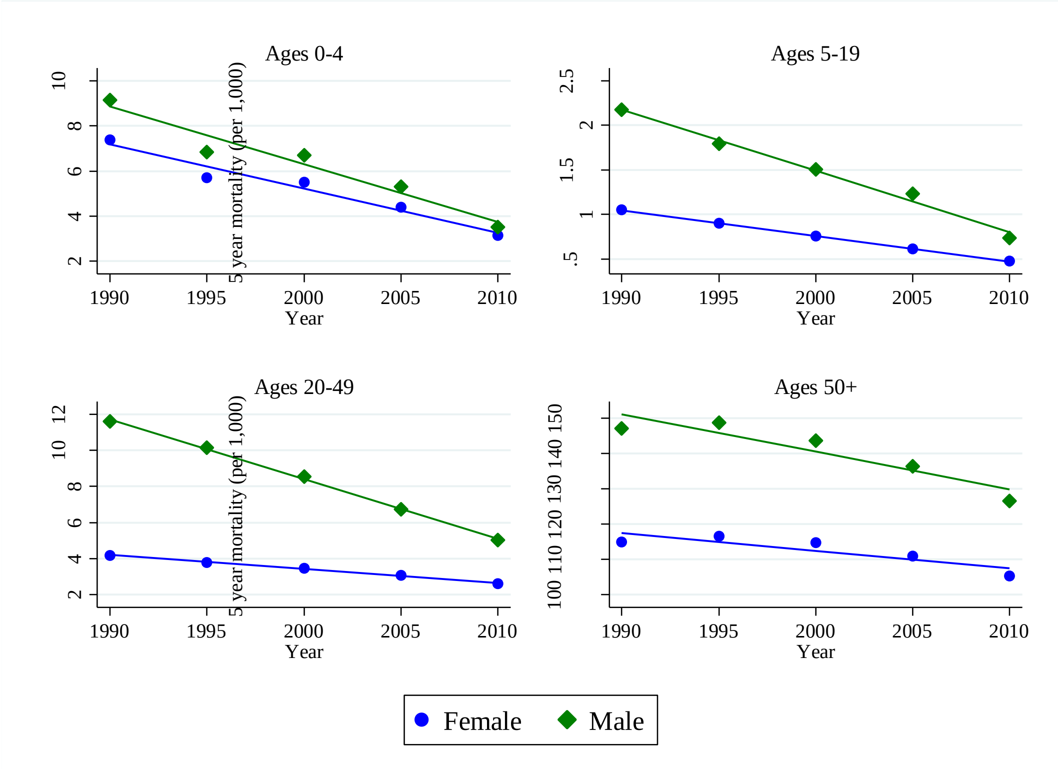
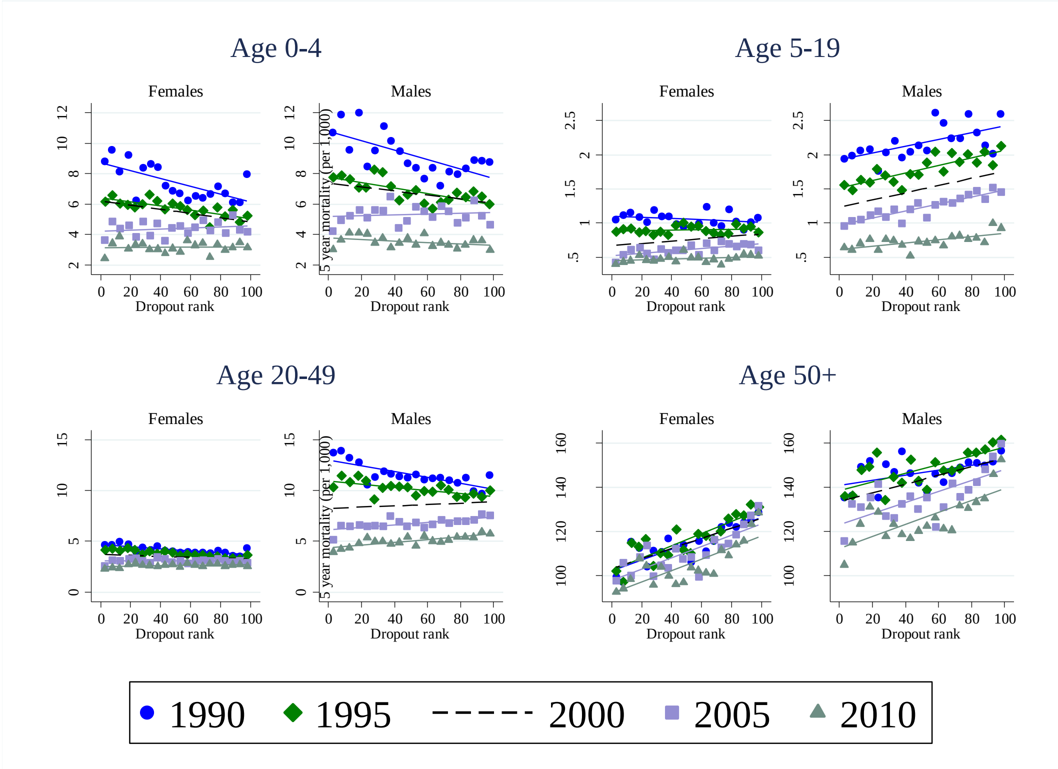
Figure 1: Evolution of national mortality rates by gender and age group



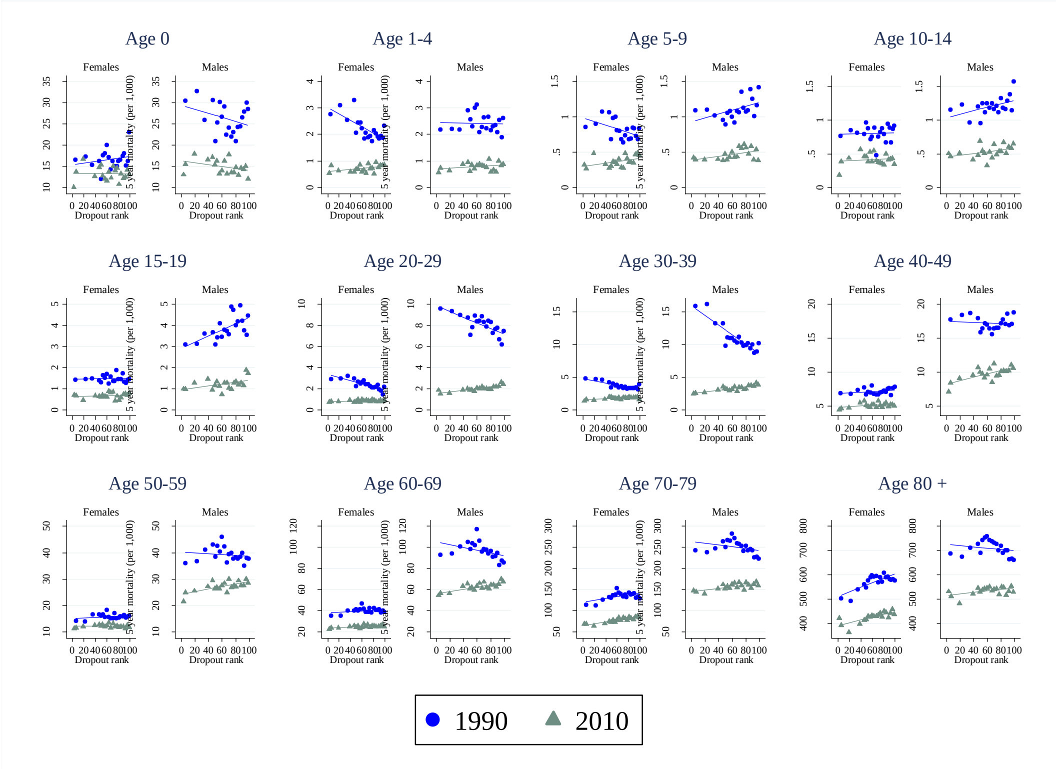
Notes: This figure plots the evolution of 5-year mortality rates for each gender and age group at the national level from 1990-94 to 2010-14.

Figure 2: Age-specific mortality rates by high school dropout rank



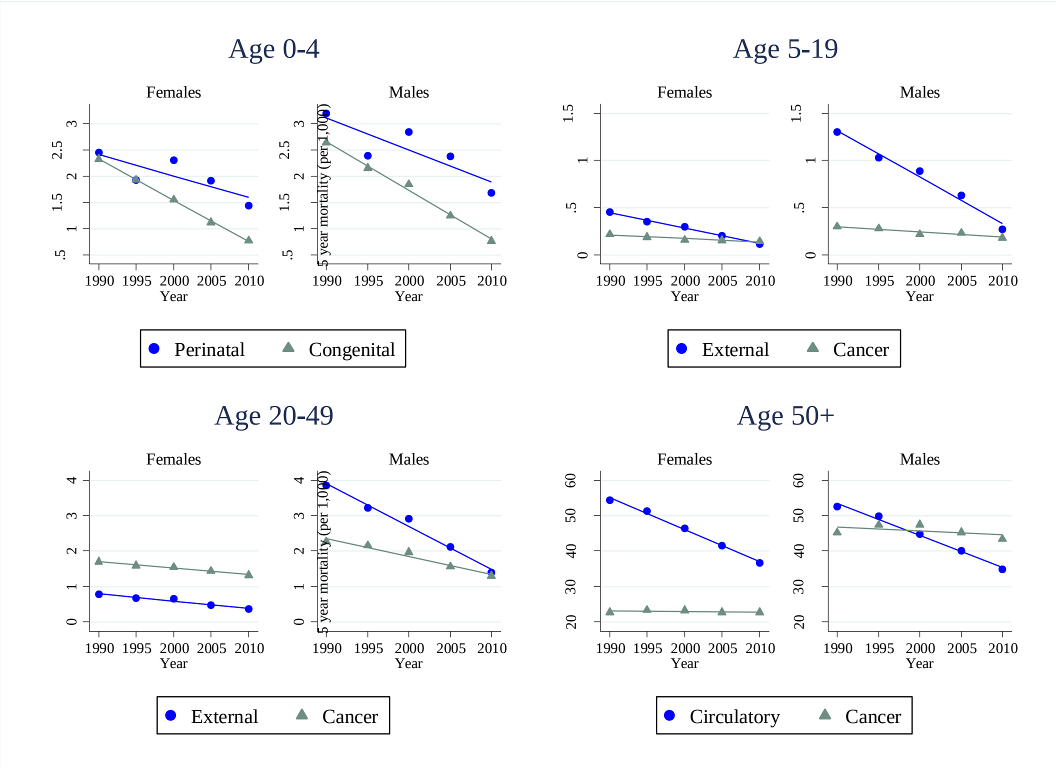
Notes: This figure shows the evolution of 5-year mortality rates for each gender and age group by socioeconomic level, proxied by high school dropout rates. Each dot ("bin") represents average values for groups of municipalities accounting for approximately 5% of the total Spanish population in that given year. Bins are ordered from low to high dropout rates in each period, so that a positive slope implies lower mortality in higher educated areas. Different colors of lines and dots are for different groups of 5 years.

Figure 3: Age-specific mortality rates by high school dropout rank, finer age groups



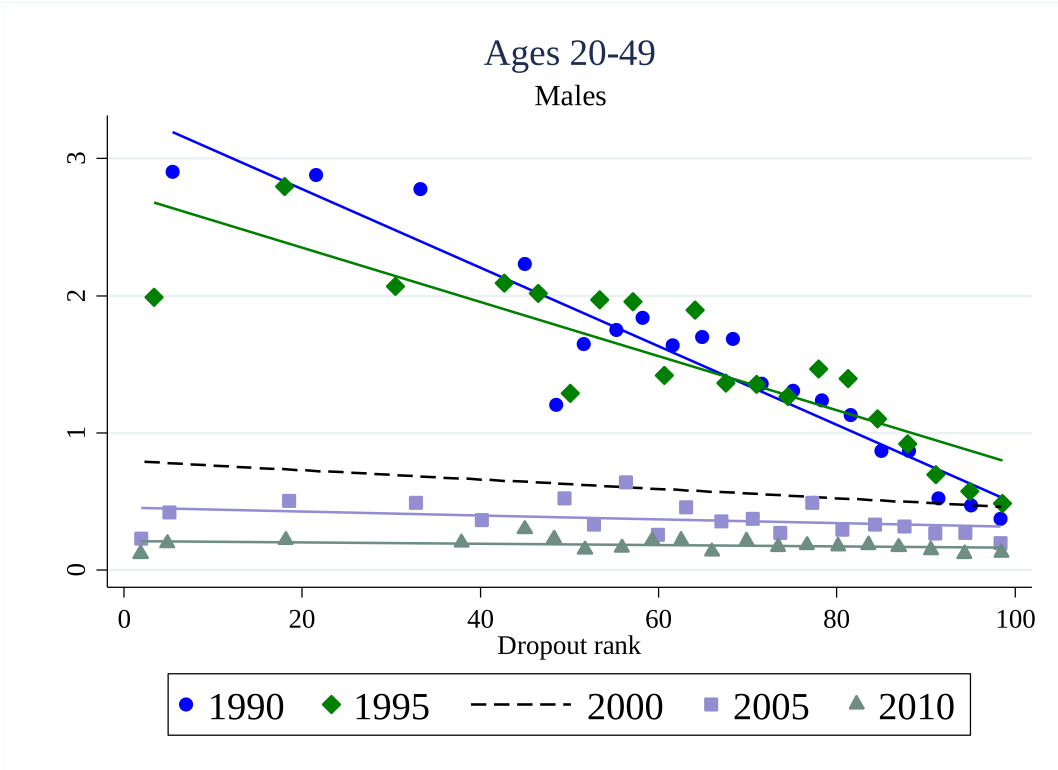
Notes: This figure shows the evolution of 5-year mortality rates for each gender and finer age group by socioeconomic level, proxied by high school dropout rates. Each dot ("bin") represents average values for groups of municipalities accounting for approximately 5% of the total Spanish population in that given year. Bins are ordered from low to high dropout rates in each period, so that a positive slope implies lower mortality in higher educated areas. Blue circles and lines represent values in 1990-94, while green triangles and lines represent values in 2010-14.

Figure 4: Evolution of main causes of mortality



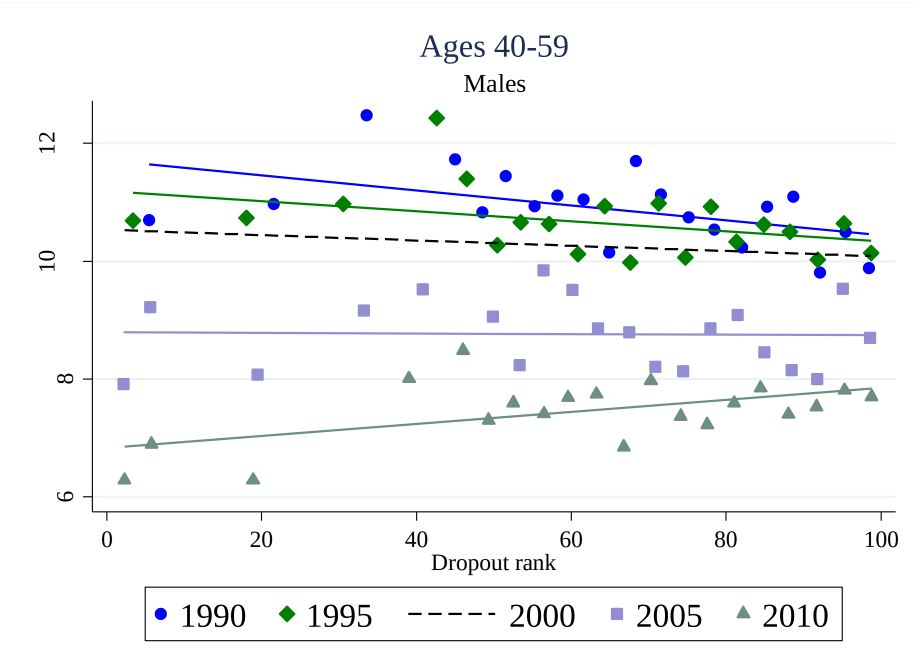
Notes: This figure shows the evolution of 5-year mortality rates from the two main causes of death for each gender and age group from 1990-94 to 2010-14 at the national level.

Figure 5: Evolution of AIDS mortality for males aged 20-49



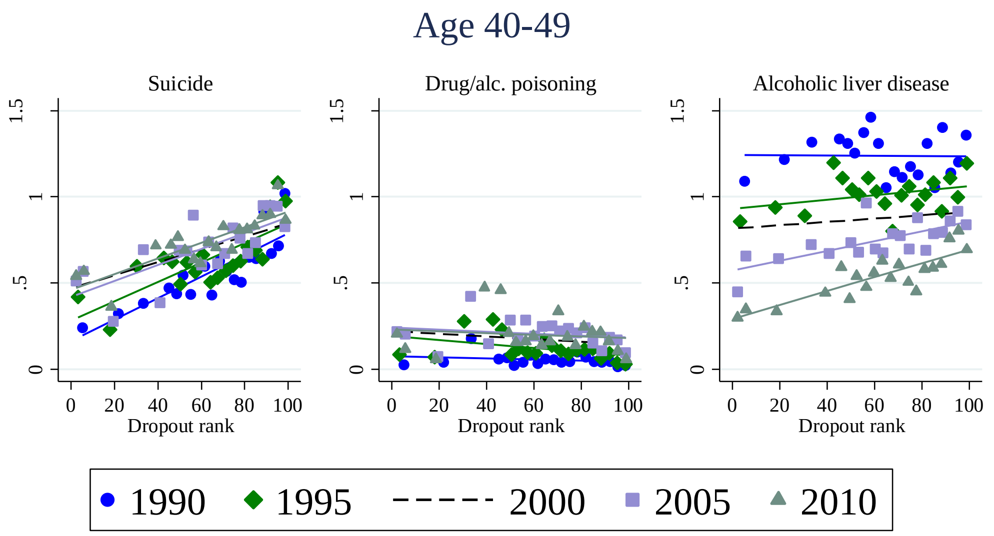
Notes: This figure shows the evolution of 5-year mortality rates from AIDS and HIV by socioeconomic level, proxied by high school dropout rates, for males aged 20 to 49. Each dot ("bin") represents average values for groups of municipalities accounting for approximately 5% of the total Spanish population in that given year. Bins are ordered from low to high dropout rates in each period, so that a positive slope implies lower mortality in higher educated areas. Different colors of dots and lines are for different groups of 5 years.

Figure 6: Evolution of cancer mortality for males aged 40-59



Notes: This figure shows the evolution of 5-year mortality rates from cancer by socioeconomic level, proxied by high school dropout rates, for males aged 40 to 59. Each dot ("bin") represents average values for groups of municipalities accounting for approximately 5% of the total Spanish population in that given year. Bins are ordered from low to high dropout rates in each period, so that a positive slope implies lower mortality in higher educated areas. Different colors of dots and lines are for different groups of 5 years.

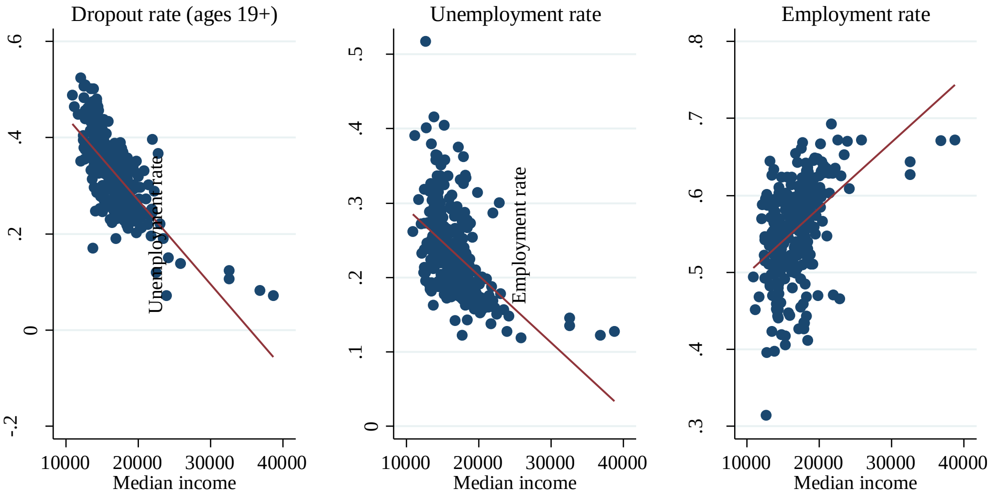
Figure 7: Evolution of mortality from "deaths of despair" for males aged 40-49



Notes: This figure shows the evolution of 5-year mortality rates from three types of "deaths of despair" by socioeconomic level, proxied by high school dropout rates, for males aged 40 to 49. The left panel represents mortality from suicides; the center panel shows mortality from alcohol or drug poisoning, and the right one shows mortality from alcoholic liver diseases and cirrhosis. Each dot ("bin") represents average values for groups of municipalities accounting for approximately 5% of the total Spanish population in that given year. Bins are ordered from low to high dropout rates in each period, so that a positive slope implies lower mortality in higher educated areas. Different colors of dots and lines are for different groups of 5 years.

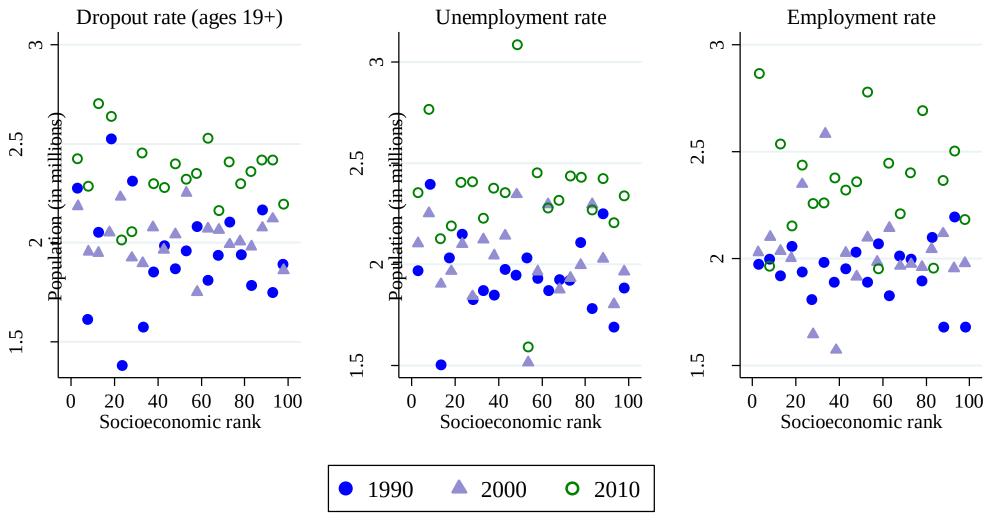
Appendix

Figure A1: Relationship between median income and socioeconomic indicators in 2006



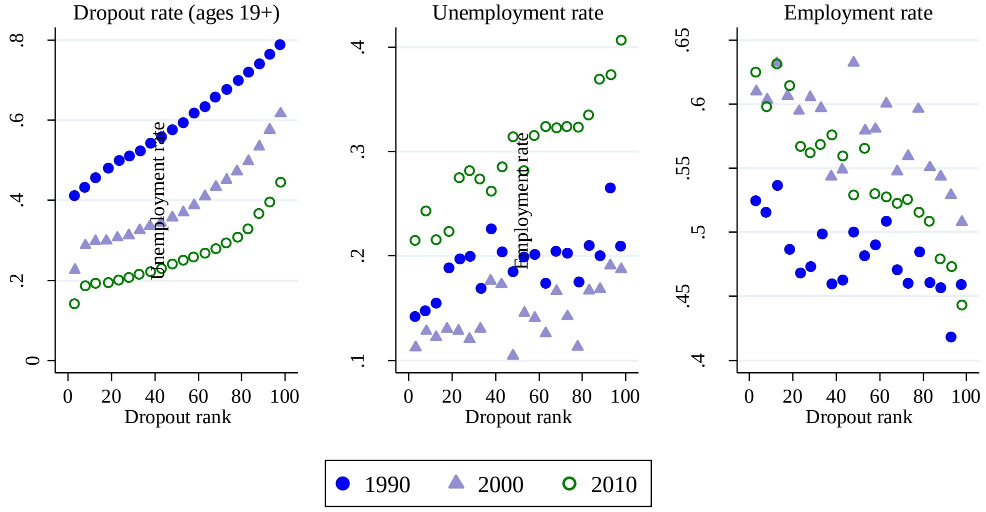
Notes: This figure shows the relationship of high school dropout rates (left), unemployment rates (center) and employment rates (right) with median income per tax payer by municipality in 2006. Source: FEDEA for income data, and 2001 and 2011 Census for socioeconomic status proxies (2006 values are linear interpolations of these two years).

Figure A2: Population by bin, for the different socioeconomic ranking variables



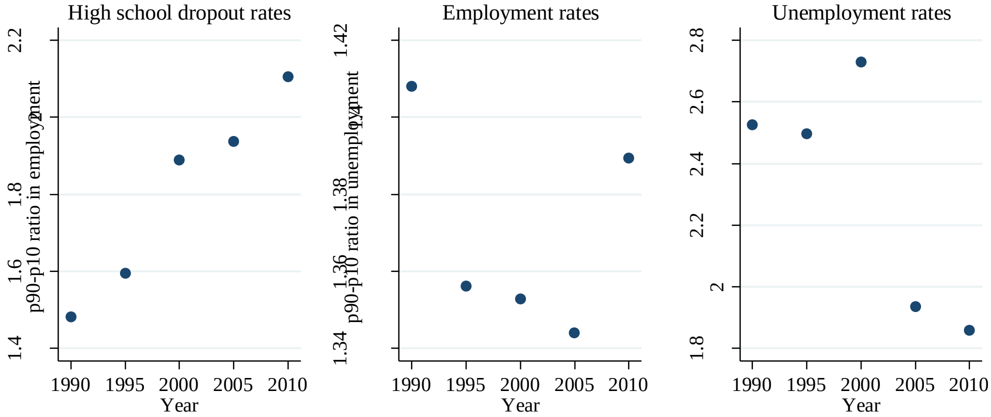
Notes: This figure shows the population included in each bin (in millions), with bins ordered by different proxies of socioeconomic rank: high school dropout rates (left), unemployment rates (center), and employment rates (right). Each dot ("bin") represents values for groups of municipalities accounting for approximately 5% of the total Spanish population in that given year. Bins are ordered from higher to lower socioeconomic status for all variables. Different colors of dots and lines are for different groups of 5 years.

Figure A3: Bin characteristics, ranked by high school dropout rates



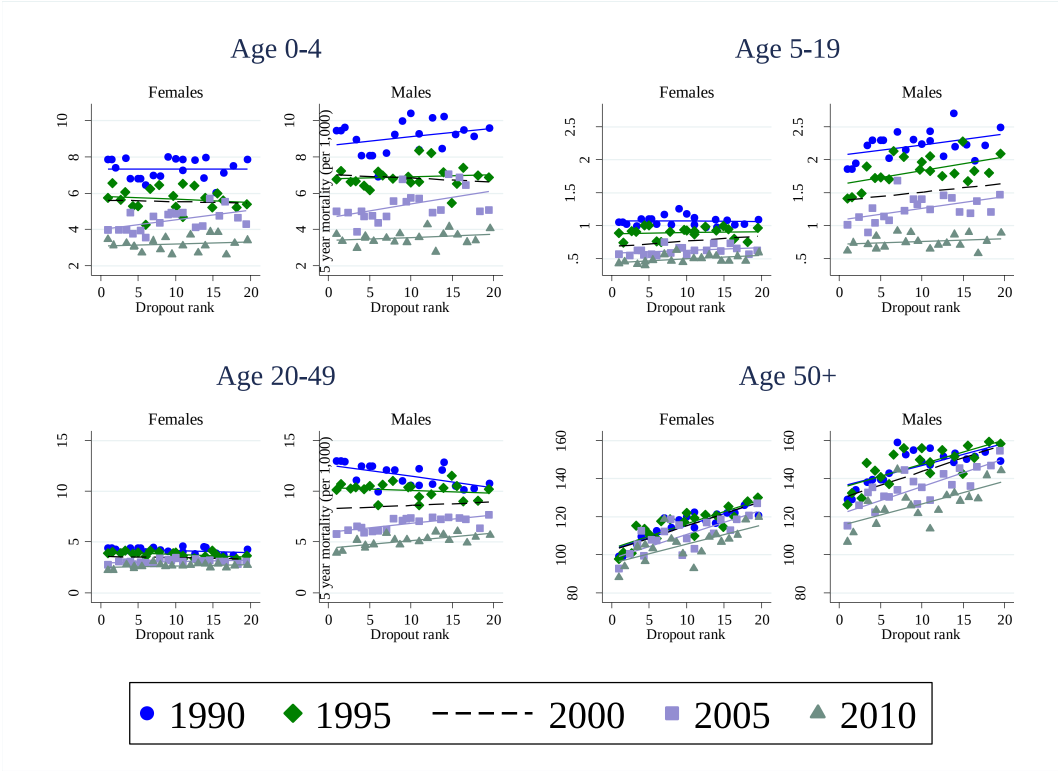
Notes: This figure shows average high school dropout rates (left), unemployment rates (center), and employment rates (left) by bin, with bins ordered by high school dropout rates (from low to high rates). Each dot ("bin") represents values for groups of municipalities accounting for approximately 5% of the total Spanish population in that given year. Blue colors are for 1990, lilac triangles for 2000, and green hollow circles for 2010.

Figure A4: Evolution of inequality in SES proxies



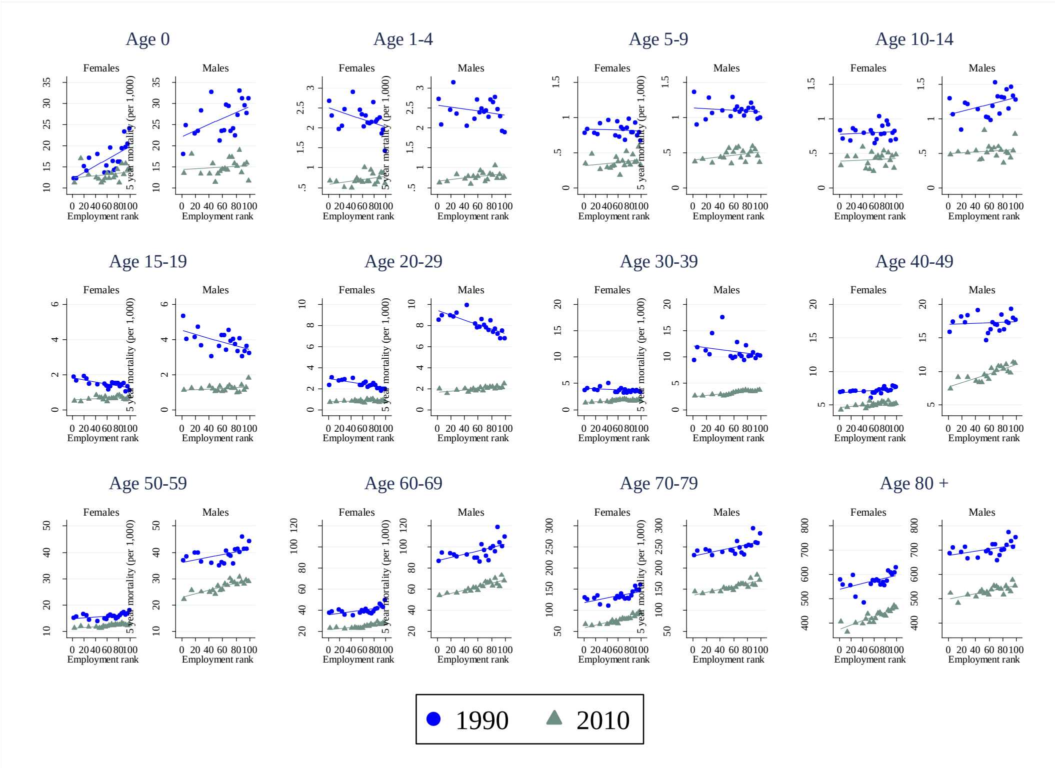
Notes: This figure shows the evolution of inequality in high school dropout rates (left), employment rates (center), and unemployment rates (right) from 1990 to 2010, as measured by the ratio of the 90th to the 10th percentile of the distribution of each variable.

Figure A5: Age-specific mortality rates by high school dropout rank at the province level



Notes: This figure shows the evolution of 5-year mortality rates for each gender and age group by socioeconomic level, proxied by high school dropout rates, constructed from province-level data. Each dot ("bin") represents values for groups of provinces accounting for approximately 5% of the total Spanish population in that given year. Bins are ordered from low to high dropout rates in each period, so that a positive slope implies lower mortality in higher educated areas. Different colors of lines and dots are for different groups of 5 years.

Figure A6: Age-specific mortality rates by employment rate rank, finer age groups



Notes: This figure shows the evolution of 5-year mortality rates for each gender and finer age group by socioeconomic level, proxied by employment rates. Each dot ("bin") represents average values for groups of municipalities accounting for approximately 5% of the total Spanish population in that given year. Bins are ordered from high to low employment rates in each period, so that a positive slope implies lower mortality in areas with more employment. Blue circles and lines represent values in 1990-94, while green triangles and lines represent values in 2010-14.

Table A1: Age-specific mortality in most and least educated municipalities

	Lowest dropout		Highest dropout		Slope of regression line		
	1990	2010	1990	2010	1990	2010	p-value difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Males							
0-4	10.678	3.013	8.782	2.983	-0.031***	-0.005	0.001
	(2.211)	(1.241)	(2.112)	(1.045)			
5-19	1.939	0.639	2.594	0.929	0.005***	0.002***	0.107
	(0.259)	(0.344)	(0.533)	(0.297)			
20-49	13.755	3.939	11.492	5.754	-0.029***	0.014***	0.000
	(2.092)	(1.114)	(2.356)	(0.414)			
50 +	135.303	104.986	156.483	152.430	0.112**	0.271***	0.036
	(7.518)	(23.471)	(12.110)	(8.220)			
Females							
0-4	8.809	2.425	7.961	3.156	-0.026***	0.000	0.001
	(1.125)	(1.359)	(1.813)	(0.956)			
5-19	1.052	0.399	1.083	0.519	-0.001	0.001*	0.017
	(0.163)	(0.358)	(0.274)	(0.240)			
20-49	4.670	2.295	4.311	2.544	-0.010***	0.002	0.000
	(0.427)	(0.657)	(0.694)	(0.265)			
50 +	99.432	92.697	128.769	128.565	0.241***	0.259***	0.766
	(16.052)	(17.290)	(8.279)	(8.443)			

Notes: Columns (1)-(4) report the means (and standard deviation in parentheses) of 5-year mortality rates for each gender and age group in 1990 and 2010, in the bin of municipalities with lowest dropout and highest dropout, respectively. Columns (5) and (6) report the coefficient of the fitted regression line in each year (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$), and column (7) reports the p-value for the null hypothesis that the slopes are equal in both years.

Table A2: Age-specific mortality in most and least educated municipalities – males

	Lowest dropout		Highest dropout		Slope of regression line		
	1990	2010	1990	2010	1990	2010	p-value difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
< 1	30.444	12.999	28.523	11.969	-0.046	-0.022	0.471
	(8.812)	(5.847)	(10.079)	(5.366)			
1-4	2.184	0.563	2.616	0.872	-0.001	0.001	0.465
	(0.764)	(0.646)	(1.090)	(0.638)			
5-9	1.094	0.419	1.423	0.387	0.003*	0.001**	0.328
	(0.266)	(0.439)	(0.613)	(0.386)			
10-14	1.152	0.505	1.575	0.654	0.003*	0.001**	0.353
	(0.425)	(0.472)	(0.390)	(0.466)			
15-19	3.070	0.983	4.460	1.722	0.014***	0.004*	0.005
	(0.369)	(0.837)	(1.318)	(0.552)			
20-29	9.573	1.843	7.438	2.416	-0.027***	0.007***	0.000
	(0.933)	(0.739)	(1.370)	(0.680)			
30-39	15.859	2.436	10.198	3.848	-0.073***	0.014***	0.000
	(3.655)	(0.924)	(2.423)	(0.741)			
40-49	17.752	7.084	18.785	10.606	-0.005	0.024***	0.004
	(3.184)	(2.532)	(3.088)	(1.004)			
50-59	35.935	21.615	37.614	28.577	-0.014	0.049***	0.034
	(1.906)	(5.666)	(6.099)	(3.084)			
60-69	93.130	54.582	85.626	67.405	-0.132	0.109***	0.002
	(2.947)	(10.345)	(13.794)	(7.017)			
70-79	242.682	147.473	223.433	159.981	-0.204	0.197***	0.013
	(19.849)	(22.613)	(33.323)	(21.490)			
80+	687.527	532.249	661.232	531.320	-0.249	0.287	0.123
	(87.315)	(51.073)	(60.901)	(48.636)			

Notes: Columns (1)-(4) report the means (and standard deviation in parentheses) of 5-year mortality rates for males in each age group in 1990 and 2010, in the bin of municipalities with lowest dropout and highest dropout, respectively. Columns (5) and (6) report the coefficient of the fitted regression line in each year (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$), and column (7) reports the p-value for the null hypothesis that the slopes are equal in both years.

Table A3: Age-specific mortality in most and least educated municipalities – females

	Lowest dropout		Highest dropout		Slope of regression line		
	1990	2010	1990	2010	1990	2010	p-value difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
< 1	16.499	10.065	23.048	13.120	0.019	-0.002	0.420
	(4.125)	(5.724)	(10.866)	(5.112)			
1-4	2.757	0.531	2.326	0.862	-0.012***	0.002*	0.000
	(1.593)	(0.637)	(1.486)	(0.649)			
5-9	0.854	0.318	0.833	0.454	-0.003**	0.001*	0.001
	(0.410)	(0.552)	(0.287)	(0.386)			
10-14	0.762	0.188	0.917	0.350	0.000	0.000	0.870
	(0.318)	(0.291)	(0.269)	(0.389)			
15-19	1.398	0.685	1.434	0.779	0.000	0.001	0.602
	(0.240)	(0.784)	(0.448)	(0.485)			
20-29	2.903	0.706	2.132	0.903	-0.015***	0.001	0.000
	(0.322)	(0.446)	(0.573)	(0.396)			
30-39	4.731	1.315	3.916	1.526	-0.016***	0.004**	0.000
	(0.763)	(0.541)	(0.762)	(0.428)			
40-49	6.895	4.450	7.778	4.999	0.004	0.005*	0.889
	(0.754)	(1.557)	(0.940)	(0.698)			
50-59	14.131	11.449	16.092	11.802	0.010	0.002	0.392
	(1.160)	(2.288)	(1.687)	(2.054)			
60-69	35.404	22.787	39.077	25.102	0.035	0.026***	0.683
	(2.522)	(3.975)	(6.102)	(3.647)			
70-79	113.928	69.400	128.584	84.223	0.210**	0.208***	0.983
	(16.393)	(12.563)	(15.980)	(14.530)			
80+	503.170	422.416	578.290	437.979	0.941***	0.592***	0.176
	(87.116)	(40.291)	(42.852)	(35.610)			

Notes: Columns (1)-(4) report the means (and standard deviation in parentheses) of 5-year mortality rates for females in each age group in 1990 and 2010, in the bin of municipalities with lowest dropout and highest dropout, respectively. Columns (5) and (6) report the coefficient of the fitted regression line in each year (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$), and column (7) reports the p-value for the null hypothesis that the slopes are equal in both years.