Time Effects and Socioeconomic Inequalities in Mortality:

an Age-Period-Cohort Analysis of the Last 200 Years in Southern Sweden

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Abstract

It is well established that higher socioeconomic status is associated with better health and lower mortality. Nevertheless, empirical results for historical periods are mixed and the understanding behind mortality patterns remain scarce. Most studies use a period perspective neglecting potential cohort effects in explaining socioeconomic differences. The aim of this paper is to study socioeconomic differences in adult mortality and analyze the effects of age, period, and cohort separately. I use longitudinal micro-level register data from both historical and contemporary sources linked together about southern Sweden. While the historical source of information is the Scanian Economic Demographic Database, data from 1969 onwards are taken from Swedish population registers. Both sources provide socioeconomic and demographic variables at the individual level. Preliminary results highlight the importance of cohort effects over period and age effects, and highlight a reverse socioeconomic gradient for cohorts in the second part of the nineteenth century. Differences in behavior or lifestyle factors between social classes could explain such pattern.

Introduction

The impact of socioeconomic status (SES) on health and mortality is long established. It has been increasingly studied from different perspectives and it is now recognized that there is a link between socioeconomic status and health, and that there are more or less wide inequalities both between and within countries based on social determinants (Marmot, 2005). Different components have been identified as indicators for an individual's socioeconomic status and differences in health are found regardless of whether socioeconomic status is measured with education, income, occupation, or social class (Cutler, Deaton, & Lleras-Muney, 2006; Cutler, Lleras-Muney, & Vogl, 2008; Elo, 2009).   The evidence from the recent past seems to indicate a divergence of socioeconomic inequalities on health and mortality (Hederos Eriksson, Jäntti, Lindahl, & Torssander, 2014), however, when going further back in time the trend in the SES differentials remains unclear.

Most of the studies investigating the relation between SES and health indicators are limited to a period perspective and consequently possible cohort effects are not considered. This means that when evaluating the development over time of SES inequalities, the focus is only on those changes and events that affected all individuals regardless of their age (e.g. wars, famines, epidemics). Nevertheless, there is growing evidence highlighting the significance that cohort effects have when studying health and mortality (Fogel, 2003).

The aim of this paper is to analyze how age, period, and cohort effects distinctively influenced adult mortality in the south of Sweden and how such effects vary by socioeconomic status. While there are several studies analyzing contemporary data, age-period-cohort (APC) models have not been applied to historical sources. By dividing the effects of time in its three components, APC analysis allows to have a more detailed perspective and ultimately a better understanding of how mortality have differed by socioeconomic status. The area under study is not representative for entire Sweden, but it is comparable in terms of living and working conditions to most communities of the analyzed period. More importantly, variations in composition of the population within the community reflect variations in other similar communities, which allows us to study SES differentials without introducing bias from geographical heterogeneity.

Background

There are several mechanisms behind the relationship between socioeconomic status and health and mortality. The common explanations that are found in the literature are related to medical care, resources, behavior, social structure, stress, and early-life conditions. One of the possible reasons could be that people with higher income have better access to health care (Adler & Stewart, 2010). However, one of the drawbacks of this theory is that socioeconomic inequalities in health are also seen in countries in which access to medical care is universal and affordable (Van Doorslaer et al., 2000). A second explanation could be related to resources. Here the idea is that a higher income favors access to goods and services non-related to medical care, such as better diet or better housing, that ultimately lead to an improved health (Cutler, Glaeser, & Shapiro, 2003). Furthermore, behavioral differences could play an important role. This is sometimes referred to as lifestyle factors. In this case a higher status might induce healthier behavior and decrease, for instance, smoking or drinking. Regular exercise, eating habits, and use of preventive care are also correlated with measures of socioeconomic status (Adler et al., 1994; Goldman & Smith, 2002). However, the socioeconomic gradient in health is still present even after controlling for lifestyle factors (Marmot, 1994). Social structure and stress could also influence the health disparities that we see. Marmot (2005) refers to these characteristics as psychosocial factors. His approach points out that individual experiences, emotions, and social environment can have an impact on health. In this framework, occupation and work environment are at the center in affecting the physical and mental well-being through, for example, higher or lower levels of stress that eventually will lead to different health outcomes. Finally, social circumstances in the fetal stage and during infancy play a crucial role in the development of health in early life. Eventually, this relation is behind the formation of physical and mental health that will emerge later in life (Marmot, 2005).

When focusing on the last decades, results about the widening inequalities in life expectancy by educational groups are consistent across different studies and, while conclusions for the causal effect of income on health are mixed, it seems that overall inequalities in life expectancy are increasing (Hederos Eriksson et al., 2014). From an historical perspective, however, there is still a debate about when such differences emerged. For the period before the 1960s there are several leading theories distinguishing decades of constant, convergent, or divergent inequalities. On one hand Antonovsky (1967) was among the firsts in proposing a

theory claiming that mortality differentials had not been constant throughout the history. More specifically he suggested that different periods registered different levels of inequalities: while before 1650 mortality inequalities were inexistent they have been widening between 1650 and around the turn of the century. This second phase was characterized by a middle- and upper class with a life expectancy increasing at a rapid rate contrasted to the lowest strata of the population which experienced a much slower pace of growth if not a decline in certain periods. However, in the third stage, 1850-1930, the trend changed and class differences started to diminish reaching an even narrower differential in the decades between 1930 and 1967. Eventually, Antonovsky argues that even if with time the class gradient has become less and less clear, differences among classes remain between the lowest classes and the highest; he also argues that mortality differentials and the overall mortality rate are strictly related: when very high or very low mortality rates are registered, mortality inequalities tend to narrow down (when humans have little power in controlling the threat of death or when the progress in dealing with it have made great achievements), whereas when moderate progress is in place mortality differentials should be expected (Antonovsky, 1967).

An alternative view has been proposed by Link and Phelan (1995) in their "Fundamental causes of disease" theory suggesting that differences in mortality among social classes have always existed and stayed approximately constant over time. They point out the importance of contextualizing risk factors and understanding of the process that leads to exposure and the "fundamental factors that put people at risk of risks." Furthermore, they claim that risk factors mediating the association between SES and disease have changed with time – some have been eradicated while some other emerged – nevertheless the effect of SES on disease has endured because a deeper sociological process is at work and hence SES is a fundamental cause of disease. The reason for this persistence, Link and Phelan argue, is due to the fact that fundamental social causes regulates access to resources (e.g. knowledge, money, power) needed to avoid a disease or reduce the consequences. Moreover, these fundamental causes endure because of change over time: new risks and diseases, and new knowledge about treatment emerge and independently from the disease, those with higher social and economic resources will be less affected. In other words if diseases and knowledge were static, the association between SES and disease would decrease as social risk factors would be blocked.

Recently, Clouston et al. (2016) presented an updated version of the fundamental cause theory. Their idea is that even if overall mortality is declining, there are new diseases emerging

and dominating the trend and that mortality differentials from all diseases go through the same four phases. A first phase in which diseases cannot be prevented because there is no knowledge on possible treatments and therefore socioeconomic differences in mortality are small and can, sometime, be reversed, is followed by a second phase in which new knowledge on how to prevent or cure diseases emerges, higher status groups acquire first this information, and social differences start increasing. In the third stage, awareness about how to manage diseases is spread to a larger portion of the population and also low status group health starts improving. At this point, the rate at which mortality declines for lower SES groups is faster than those at higher levels with a resulting decline in inequalities (a similar point is made by (Cutler et al., 2006)). Finally, the impact of mortality reducing innovation reaches the maximum and no improvement can be made. While sometimes the disease is eliminated throughout the whole population, in other cases differences between higher and lower SES groups persist due to differences in behavior or access to resources. Eventually, the point that Clouston and colleagues want to make is that the process just described is cyclical and is observed for every disease through time. As a consequence, socioeconomic differences in overall mortality will always be present. The changing set of diseases affecting the population as time goes by is a concept that can be linked to the epidemiological transition theory proposed by Omran (1971) which describes the major shift of causes of death in three phases, from highly virulent infectious disease to man-made degenerative diseases with a phase in the middle of receding pandemics in which life expectancy start increasing and the epidemic peaks are less frequent.

Alternatively, Smith (1983) argues that about two centuries ago there was no socioeconomic gradient and that it is possible that the gradient was even reversed, while, in the last 150 years there has been a divergence in inequalities. The theory behind this argument wants that while in the past communicable diseases were the main cause of death and were affecting higher and lower classes in the same way. Similarly, for Sweden, Bengtsson and Dribe (2011) found that there was no clear socioeconomic gradient in mortality until the second half of 1900.

All the studies mentioned above, however, look at the relation between socioeconomic status indicators and mortality only from a period perspective. As a consequence, relatively little is known about the difference among age, period, and cohort components affecting such trends. Cohort effects derive from groups of individuals experiencing the same event in the same time unit (e.g. birth cohorts). It is frequently assumed that rates of mortality changes over

time are equal across birth cohorts and that such changes depend on different period-specific conditions and events that are independent of the birth year, such as health care improvements and technological innovations (Yang, 2008). Considering cohort contributions might lead to different results and interpretations. While focusing on period effects greatly simplify estimating procedures, it is inconsistent with the growing literature supporting the significance of birth cohorts effects and support the claim that it might be misleading to neglect them (Fogel, 2003). Master et al. (2012) show that mortality reduction in the United States by sex and race were wholly driven by changes in cohort mortality and that cohorts effects are leading to widening differences in all-cause, heart disease and lung cancer mortality risk between educational groups. Master et al. (2013) and Robinson et al. (2013) argue for the importance of considering cohort effects when studying mortality due to obesity and conclude that studies neglecting the effect of cohorts are likely to underestimate the impact of obesity. Yang and Lee (2009) found that differences by sex and race in psychological and self-assessed health are "cohort-related phenomena".

The importance of distinguishing the effects of age, period, and cohort is given by the different nature of the relationship that these time components have with the outcome of interest. Age effects are internal to the individual and they reflect the biological and social processes of aging (Yang & Land, 2013). Period effects arise from events and changes happening as time passes by that affect individuals of all ages, for example: wars, famine, policy changes. Finally, cohort effects derive from differences between groups of people who go through a common initial event (e.g. birth) in the same time unit (e.g. year). Cohort effects arise from a variety of time related changes. Firstly, cohort effects follow the similar experience that birth cohorts have in going through historical and social event at the same age, thus indicating the intersection of individual level characteristics and macrosocial influences; secondly, birth cohorts continuously change the composition of the population thus reflecting social change (Ryder, 1965). In addition, cohort effects highlight the impact of early life conditions, with respect to current conditions, on later life outcomes. Several theories relate to this point: the fetal origin hypothesis (Barker, 1998), the cohort morbidity phenotype hypothesis (Finch & Crimmins, 2004), the theory of techno physio evolution (Fogel & Costa, 1997). Hence a cohort effects can be seen as "a period effect that is differentially experienced through age-specific exposure or susceptibility to that event" and it can have both short and long term consequences (Keyes, Utz, Robinson, & Li, 2010). As a whole, APC analysis allows to describe the complex

social, historical and environmental factors that simultaneously impact individuals and populations (Yang & Land, 2013).

Data and context

This paper analyses data from the Scanian Economic Demographic Database (SEDD) (T. Bengtsson, Dribe, Quaranta, & Svensson, 2017) that contains individual-level longitudinal information about subjects living in five parishes and a port town in Scania (the southernmost region in Sweden). Individuals are followed form 1813 until 2015 for the five parishes and from 1947 until 2015 for the port town Landskrona. Before 1969 data relies on information taken from parish registers that were continuously updated and that have been complemented with birth and death registers. Starting from 1969 up to 2015, Swedish administrative population registers covering the whole country from Statistics Sweden and the National Board of Health and Welfare are used as data source. In and out migration from the study area is recorded during the whole observation period.

The historical and contemporary sources of information have been linked together allowing to follow multiple generations over two hundred years. Furthermore, the linkage permits to follow individuals who were ever present in the area under study but who were living in other regions after 1969. In addition to the individuals themselves, it was also possible to follow people related to them (spouses, parents, grandparents, children and siblings) all over Sweden. Whilst the main analysis will be on the five parishes, the variation in the sample allows for some sensitivity analyses that are discussed below. The sample studied in this paper is not representative for the entire country, however it reflects a situation comparable to rural and semi-urban areas of the same period (Dribe et. al., 2015). The dataset provides detailed information about socioeconomic indicators and demographic events. The advantage of having such detailed data source is that when aggregating the information in 10-year age-period groups, I am able to precisely calculate the number of cases and the time at risk for each socioeconomic category.

Socioeconomic status is measured, initially, through occupation which is recoded from HISCLASS to manual (HISCLASS 6 to 12) and non-manual (HISCLASS 1 to 5) (Van Leeuwen & Maas, 2011). For the period between 1813 and 1969 and from 2001 to 2015 information about occupation is updated annually, while for the period between 1969 and 2001,

occupational status is taken from the 1970, 1975, 1980, 1985, and 1990 census. A "life-time occupation" is measured taking the highest occupation achieved before the age of 55. The reason for this condition is that when people retire they might not have a registered occupation anymore or it might be distorted. Subjects indicated as servants with no occupation recorded, were put in the manual group.

	1816 1825	1826 1835	1836 1845	1846 1855	1856 1865	1866 1875	1876 1885	1886 1895	1896 1905	1906 1915	1916 1925	1926 1935	1936 1945	1946 1955	1956 1965	1966 1975	1976 1985	1986 1995	1996 2005	2006 2015
Non-manual	6,33	6,38	4,65	5,28	7,43	7,51	6,58	9,37	15,02	15,73	18,30	16,70	19,17	16,87	20,70	23,51	31,17	33,60	36,89	40,29
Manual	82,78	82,08	85,59	86,83	84,58	82,85	82,78	76,89	66,19	68,58	70,72	68,18	69,80	69,97	68,43	64,47	55,83	51,93	49,15	41,60

Table 1: occupational categories distribution by period (percentage) in the five parishes

Table 1 shows, for each period group, the share of non-manual and manual occupations. There is a substantial increase in the non-manual group reflecting the structural changes happening in the analyzed period. Up to the 1870s, before industrialization, only 6-7% of the population had a non-manual occupation; afterwards, as development was taking place, the share increased up to around 20% in the 1960s and to 40% in the last decade.

I further explore the socioeconomic impact in mortality by studying differences across income groups. The dataset provides information about individual annual income from 1903 onwards. Information about income is taken from tax declarations and it is important to clarify some important features relative to this source. Firstly, particularly in the past, there were threshold below which people did not have to report their income. To these individuals I assigned an income of zero. Secondly, sources of income differ between the historical and the contemporary period (before and after 1969). In the first part, income includes labour, capital, and self-employment income as well as a taxable amount calculated on the wealth (estates). After 1969, income refers to labor income including self-employment and welfare benefits related to the working history of the individual such as pension and unemployment allowance. Thirdly, throughout the period there are differences between men and women dictated by how income was supposed to be reported and tax to be paid. For married women, until 1947, incomes from husband and wife were added together and taxes were paid on the joint income. Afterwards, up until 1953, incomes of husband and wife were reported separately but taxes were still payed together. In the following period until nowadays, both income and taxes of a married couple are reported and payed separately (T. Bengtsson, Dribe, & Helgertz, 2017).

		30-39	40-49	50-59	60-69	70-79	80-89	Deaths	Person-years
1846	1855	7,30						22	3013,62
1856	1865	5,52	5,79					53	9459,39
1866	1875	5,91	10,09	14,24				125	13835,27
1876	1885	4,92	11,69	17,27	32,65			224	17028,69
1886	1895	3,89	5,76	17,14	32,55	54,74		295	19840,37
1896	1905	4,61	7,58	14,75	24,58	76,52	176,94	436	23551,15
1906	1915	4,02	5,00	9,00	22,52	67,21	168,74	427	27573,83
1916	1925	4,36	4,76	8,52	23,38	58,46	155,50	453	29675,84
1926	1935	4,11	4,70	8,92	20,85	52,60	133,55	492	32028,10
1936	1945	1,89	3,55	8,79	18,46	49,98	133,47	530	36199,56
1946	1955	1,24	2,46	7,68	15,09	47,63	99,51	474	36031,70
1956	1965	1,83	2,07	5,32	16,32	40,56	85,53	494	38814,83
1966	1975	1,38	2,56	5,88	14,40	42,30	93,96	594	43268,54
1976	1985	0,92	1,73	7,17	15,21	38,84	96,99	666	45534,72
1986	1995	1,17	1,76	5,26	14,82	37,99	92,55	839	51992,01
1996	2005	0,85	1,53	4,93	12,02	34,87	85,69	877	57620,92
2006	2015	0,76	1,17	4,21	9,02	26,30	78,40	945	70820,81
Deaths		381	491	876	1450	2349	2399	7946	
Person-years		138889,20	134957,10	112563,90	88326,33	56505,96	25046,89		556289,38

Table 2: mortality rate per 1000 for each age-period group. Total number of person-years and total number of deaths per period groups and per age groups

For each 10 years period groups and sex, I calculated income quartiles. Similarly to occupation grouping, individuals are assigned with the highest income category they achieved throughout their life. As dependent variable, I consider all-cause adult mortality for ages between 30 and 90, for cohorts between 1816 and 1975, and for the period 1846-2015. Table 2 reports the mortality rate for each age-period cell, the total exposure, and total number of deaths for each age group and each period group.

The analyses have been conducted separately for men and women. For married women, individual occupational status and income level might not indicate their real social position. Therefore I also run the analysis considering "family occupation" and "family income" which indicate the occupation with the highest status within the couple and the aggregated income of the couple.

The 1800 was a period of great development for the Scanian region, first with agricultural transformations (Tommy Bengtsson & Dribe, 2010) and then, in the last decades of the century, with a rapid industrialization that continued in the first part of the 1900. Among the five parishes (Hög, Kävlinge, Halmstad, Sireköpinge, and Kågeröd) Kävlinge experienced a more rapid development following the construction of a railway station in the second half of

the 1880s which also helped the development of several industrial areas such as mills, leather industry, and food industry (Tommy Bengtsson & Dribe, 2011). While in the first part (preindustrial period) adult mortality transition had not yet started, in the second half of the 1800, together with industrialization, there was a decreasing adult mortality.

The first half of the twentieth century was a period in which the region continued to experience industrialization and urbanization and in which welfare institutions (e.g. pension system, housing allowances) were founded and started growing. Economic growth and development continued in the second half of 1900 together with further development of the welfare state which advanced in providing services from childhood to old age (T. Bengtsson et al., 2017).

Method

The individual level data described above, have been collapsed into 10 years age-period-cohort groups. While there are 6 age groups ranging from 30-39 to 80-89, there are 17 period groups and 17 cohort groups. I model the mortality rate using the Hierarchical Age Period Cohort (HAPC) model proposed by Yang and Land (2006, 2008). It consists in a multilevel mixed modelling in which age effects are nested in cross-classified period and cohort effects (age effects are nested within period and within cohort groups; periods are *not* nested within cohorts and vice versa).

The specification of the model is as follows:

Level-1 model $$\log D_{apc} = r_{pc} + \Sigma_l \, \alpha_l A_{apcl} + \log Y_{apc}$$

Level-2 model $$r_{pc} = \alpha_0 + \pi_{0p} + \chi_{0c}$$

Combined model $$\log D_{apc} = \alpha_0 + \Sigma_l \, \alpha_l A_{apcl} + \log Y_{apc} + \pi_{0p} + \chi_{0c}$$

With $a = 1,..,6$ age groups; $p = 1,...,17$ period groups; $c = 1,...,17$ cohort groups.

D_{apc} is the number of deaths in the age-period-cohort group, A_{apcl} is a set of dummies denoting the age groups with fixed effects α_l, and Y_{apc} is the time at risk in each age-period-

cohort group. r_{pc} is the random intercept and it indicates the logarithm of the mortality rate in the reference age group (80-89) in period p and cohort c. Such random intercept is broken down in three parts in the level-2 model. α_0 is the average log mortality rate of the reference age group over all periods and all cohorts, π_{op} is the average period effect over all cohorts, and χ_{oc} is the average cohorts effect over all periods. By combining the two models (level-1 and level-2) it is possible to estimate the log mortality rate for each age-period-cohort group with the assumption that it follows a Poisson distribution. Such model overcomes the identification problem because the effects of age, period, and cohort are not assumed to be linear and additive (Yang & Land, 2013). In addition, there is not a perfect linear dependency of age, period, and cohort because, by having individual level data I know precisely who died and when. This means that two persons of the same age in the same period can belong to two different cohorts (Robertson & Boyle, 1986).

Results

Figure 1 shows results from the HAPC model for men. Results are reported as deaths per 100.000 person-years. For the first two age groups (30-39 and 40-49) the manual category shows a higher mortality than the non-manual. However, this age effect is not statistically significant. The period effect is stable and negligible throughout the analyzed time span: there are no significant differences between the two occupational categories in any of the analyzed period groups. Occupation-specific log mortality rates by cohort groups (reported on the left hand side of Figure 1), on the other hand, show a clear decline in mortality for both categories, particularly for cohorts from the end of the nineteenth century onwards. Furthermore, it is possible to see distinct occupational differences in mortality. Cohorts effects in the second part of 1800 show a clear and significant (at 90% level) lower mortality for the manual group. The non-manual category catches up in the first decades of the twentieth century and seems to decrease with a faster pace in the last decades, however the difference is not statistically significant due to large standard errors.

Figure 2 reports the APC effects for women. The estimated log mortality rate increases with age, and there is a marked age effect in the difference between manual and non-manual, which, in this case, is significant at a 90% level for the youngest age group. Similarly to the trend for men, the estimated log mortality rate decreases with cohorts, and remains stable through period groups. For the youngest cohort groups, mortality for the non-manual category

appear to decrease more steeply than the manual one, however, none of these two trends show significant occupational differences.
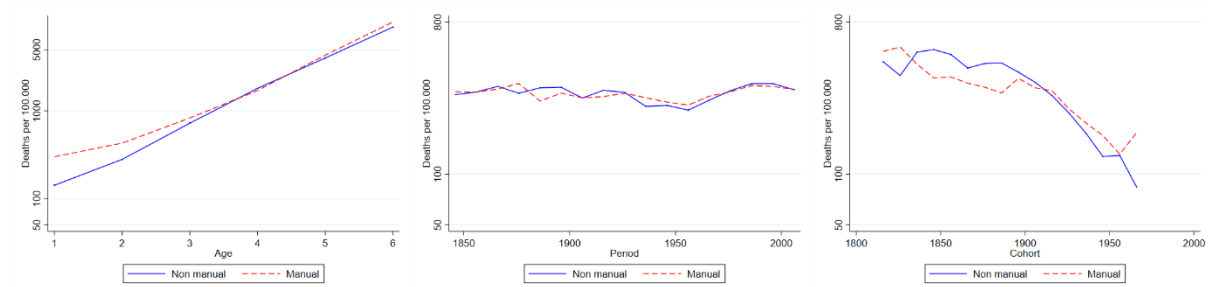

Figure 1: Occupational differences in estimated mortality rate by age, period, and cohort for men aged 30 to 89.
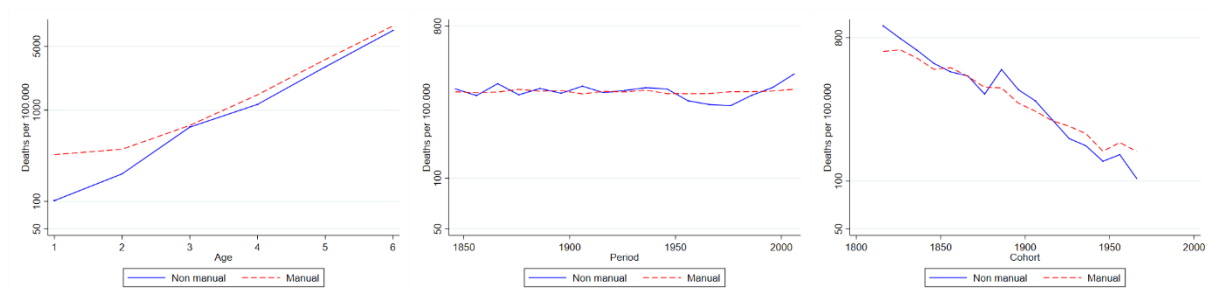

Figure 2: Occupation differences in estimated mortality rate by age, period, and cohort for women aged 30 - 89.

Results for the analysis using individual income as indicator of men's socioeconomic status are reported in Figure 3. Income specific log mortality rate by cohort groups shows, also in this case, the largest decrease, in particular for cohort from the beginning of the twentieth century. Similarly to the case for occupational differences, cohort effects are again showing a lower mortality level for the lowest income quartile with respect to the highest (statistically significant at 90% level) for cohorts in the second part of the 1800 with the exception of the 1876-1885 birth years group. Interestingly, income differences in mortality for cohorts from the turn of the century until mid-1900 are more marked than occupation disparities and the highest individual income quartile group has a significant (at 90% level) lower mortality than the lowest quartile. When looking at the relation between different income levels and mortality, age effects are relevant as well. As the graph on the left hand side of Figure 3 shows, there is a significant age effect below 60 years old which fades out in older ages. Even though there is a more evident difference between the income than between occupation categories, period effects are still not statistically significant.

Figure 4 displays results for women. While there are no period and cohort differences between the two groups, there is a slightly higher age effect for the lowest income group. Nevertheless, none of the three effects is statistically significant.
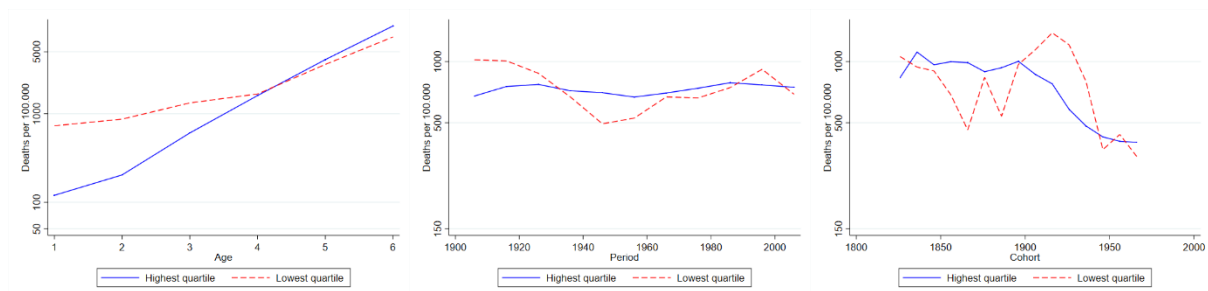

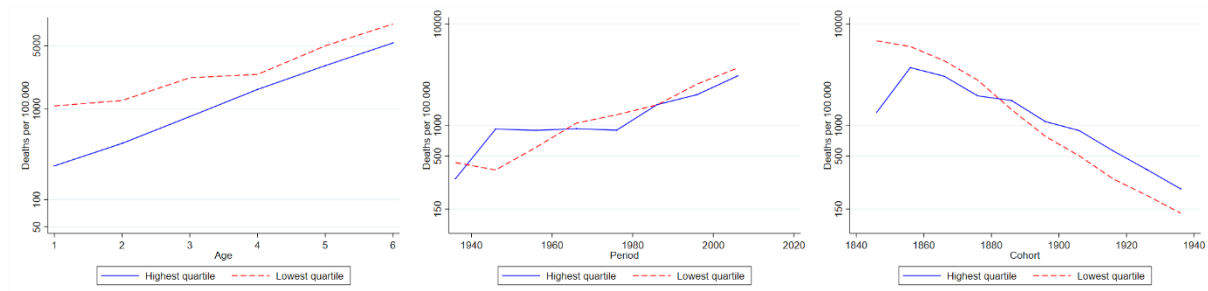*Figure 3: Income differences in estimated mortality rate by age, period, and cohort for men aged 30 to 89.*

Figure 4: Income differences in estimated mortality rate by age, period, and cohort for women aged 30 to 89

The significance of age effects in the younger age groups and their subsequent disappearing suggests that age as an equalizer influence (Beckett, 2000) in which differences between occupation and income categories tend to be smaller and smaller as individuals get older. Consequently, such results would suggest that there is not a cumulative advantage for the higher socioeconomic status groups for which we should see a diverging pattern in the outcome as age increases.

Furthermore, these results point towards a reverse gradient in mortality for birth cohorts in the second half of the nineteenth century. Reverse gradient that turns around into a lower mortality level for the higher socioeconomic categories for twentieth century cohorts. The results indicates a similar pattern both by looking at occupation or income differences.

These trends are consistent with other studies about SES and mortality patterns in Sweden. Dribe and Eriksson (2017) analyzed the Swedish censuses at the end on the nineteenth century and at the beginning of the twentieth century and found a reverse gradient in life expectancy at 60 years old in which farmers have a higher life expectancy than blue collar

workers (skilled, lower skilled, and unskilled manual workers) and white-collar workers have the lowest life expectancy. Similar results have also been found for the Umeå region, in the north of Sweden, by Edvinsson and Broström (2017); they find that the elite group had a higher mortality than the middle and working classes in the 1800.

One possible explanation is that this differential could be explained by life-style factors; smoking in particular. For cohorts in the second part of the nineteenth century smoking was much more common among higher social classes whereas people in the lower social strata were using *snus* (snuff, wet tobacco put under the lip).

Figure 5: On the left, household expenditure in tobacco as a percentage of total household expenditure
On the right, consumption of tobacco in kg per capita 1856-1951. Source: Historisk Statistik för Sverige (1950)

Partial evidence is given in Figure 5: the graph on the left reports the household expenditure in tobacco per social class. It is evident that since the early 1900 the highest social class was spending considerably more than the lowest one. It is also evident how the pattern changed with time with a sharp decline for the highest class reaching consistently lower level of expenditure than the lowest one. Moreover, the chart on the right in Figure 5 and Figure 6 give an idea of the development, in the period under consideration, of the consumption and production of (smoking) tobacco.
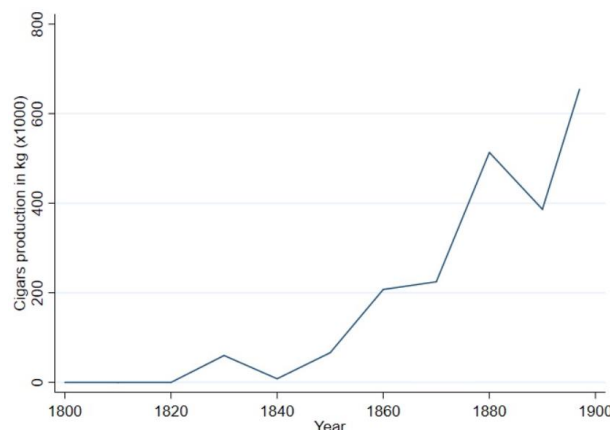
Figure 6: Swedish production of cigars in 1000 kg in the 19th century.
Source: (Munthe, Hellner, & Vasseur, 1940)

In the earlier period, infectious diseases were one of the most common cause of death and were affecting in a similar way both social strata. As time went by, deaths caused by infectious diseases steadily declined and other causes (e.g. cardiovascular diseases) came to dominate mortality rates. This is also clear from census data for 1960 where men in non-manual occupations had higher mortality from heart disease than manual workers, while there were no similar difference for women in the two groups (Vågerö & Norell, 1989).

The dataset contains information about cause of death for approximately 80% of the events. The different causes have been standardized in nine categories (airborne infection diseases, food-borne and waterborne infectious diseases, other infectious diseases, cardiovascular diseases and diabetes, accidents, crimes, etc., weakness due to old age, cancer, other specified non-infectious diseases, not specified) (Tommy Bengtsson & Lindström, 2000). This allow us to plot the mortality rate for the two occupational groups by cause of death in order to have a preliminary descriptive evidence for the proposed hypothesis. Figure 7 shows cause-specific mortality rates for men aged 30 to 90 and for cohorts between 1785 and 1885. Differently from infectious diseases (in which there are no clear differences between the two groups), the mortality rate for cardiovascular diseases, diabetes, and cancer is clearly higher for the non-manual occupation category.

A second possible explanation is that for cohorts after 1835 the non-manual group was more concentrated in urban areas where mortality became higher, particularly in the industrialization period. I consider as urban areas the parish of Kävlinge which, as mentioned earlier, experienced some industrialization at the end of the nineteenth century, and the port town of

Landskrona. Figure 7 shows the share for the two occupation groups living in urban areas. The non-manual group has a consistently higher share of people living in urban areas than the manual workers.
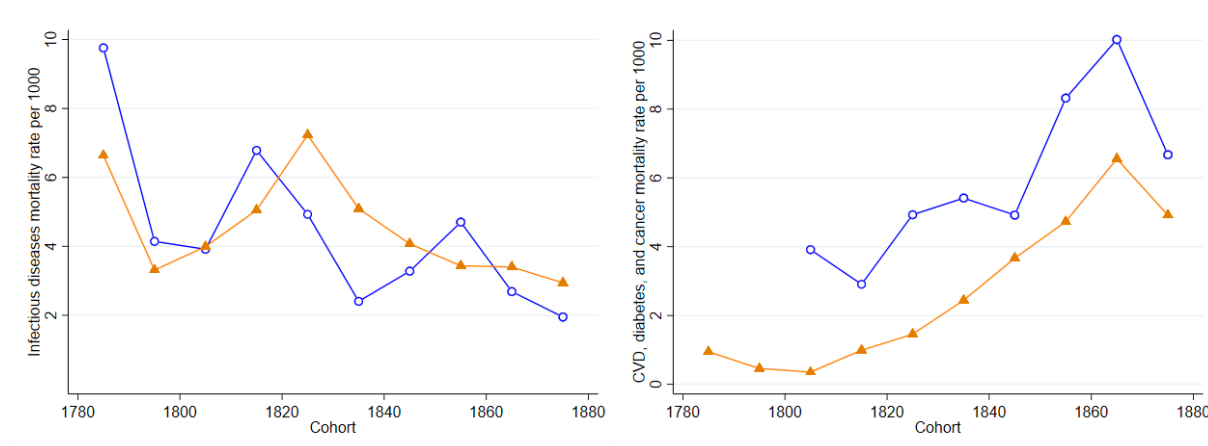

Figure 7: Mortality rate by cause of death and occupational status; non-manual group in blue (circle)

Figure 8 displays the mortality rate in urban and rural areas. The mortality rate in urban areas for cohorts after 1830 is well above the mortality rate in the rural parishes which is steadily declining throughout time. Moreover, it shows a steep increase for cohorts in the second half of the century. This could be an indication that for the cohorts for which I observe the reverse SES gradient in mortality there was a urban penalty for the non-manual category.
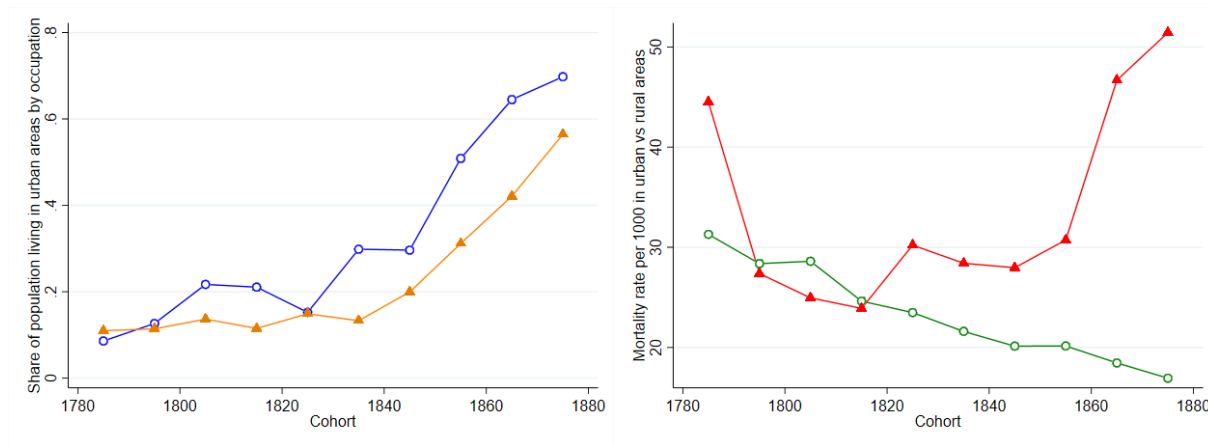
Figure 7 (on the left): Share of people living in urban areas by occupation ages 30-90. Non-manual occupation group in blue (circle), manual in orange (triangles)
Figure 8 (on the right): Mortality rate in rural vs urban areas ages 30-90. Rural areas in green (circle), urban in red (triangles)

Conclusions and limitations

There is extensive evidence that different measures of socioeconomic status are associated with health and mortality. When it comes to historical patterns, the literature offers different theories and the available evidence would indicate that, across different geographical context, there was no clear socioeconomic gradient in mortality (see Bengtsson & Van Poppel, 2011). For southern Sweden, previous evidence suggests that mortality differentials do not appear before 1950. However these studies only consider period effects on mortality. It has been shown that disentangling the three time components, age, period, and cohort, allows to have new, different insights on the relation. This paper analyzed data about the Swedish southernmost region and showed that period effects have been quite small and similar across socioeconomic status measured with occupation and income. Cohort effects, instead, appear to have an important role and display a reverse gradient for cohorts in the second part of the nineteenth century. This diverging pattern in such period could be explained by life-style factors, especially class differences on smoking prevalence. While the descriptive graphical evidence showed above does not provide conclusive information about the mechanisms behind the observed mortality patterns or about whether such hypothesis is correct or not, it gives an initial input for further research.

One important limitation of this study is that it considers only one method to disentangle APC effects. While the HAPC method has been previously implemented providing reliable results (Masters et al. 2012) there is still an ongoing discussion about the validity and interpretability of these outcomes (Bell & Jones, 2018). Hence, while this works highlights that APC is an interesting tool to find patterns over a long period of time, more research is needed to confirm the presented findings.

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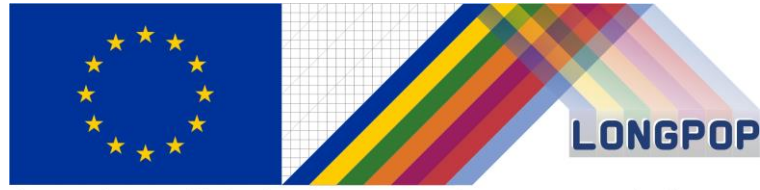
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Sensitivity analyses

Age, period, and cohort effects for *men*; manual vs non-manual occupations using *family* occupation: similar results when using family occupation or individual occupation.
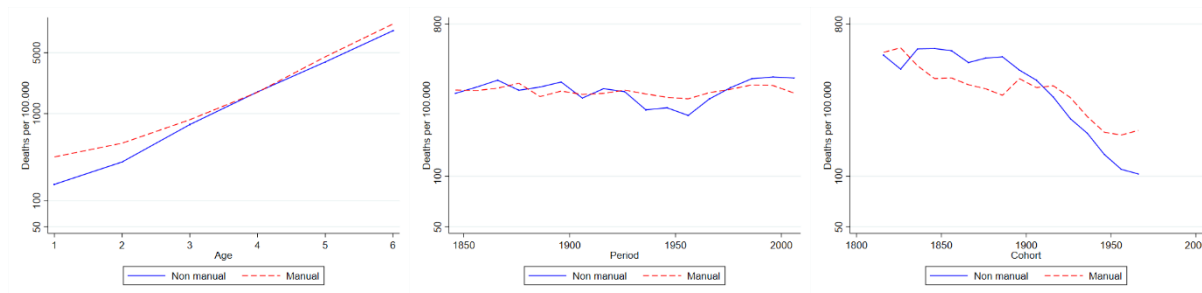

Age, period, and cohort effects for *women*; manual vs non-manual occupations using *family* occupation: similar results when using family occupation or individual occupation.
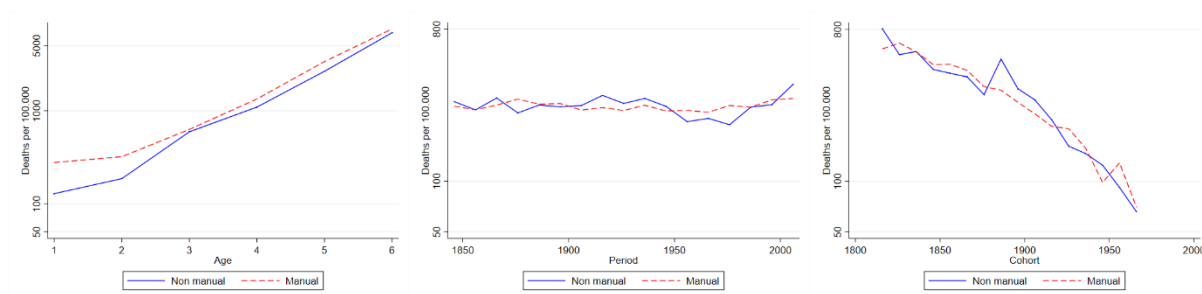
Age, period, and cohort effects for *men*; lowest vs highest income quartile using *family* income: results show a similar pattern when using family income or individual occupation.
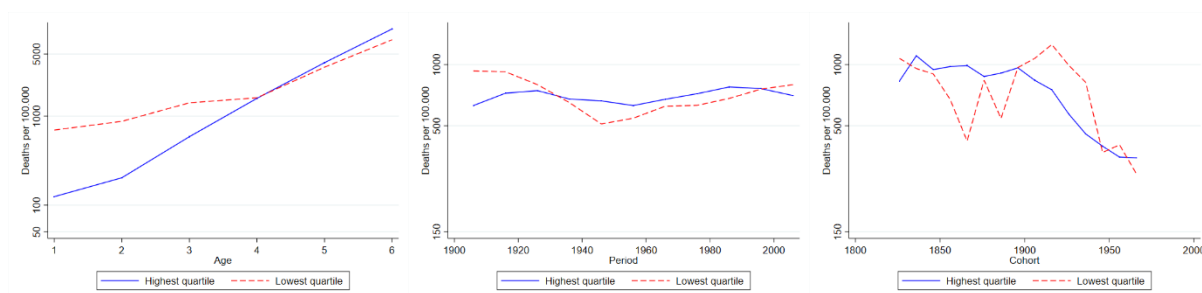
Age, period, and cohort effects for *women*; lowest vs highest income quartile using *family* income: results show a different pattern than by using individual income for women. Interestingly, the three effects are similar to those obtained for men by using individual income.
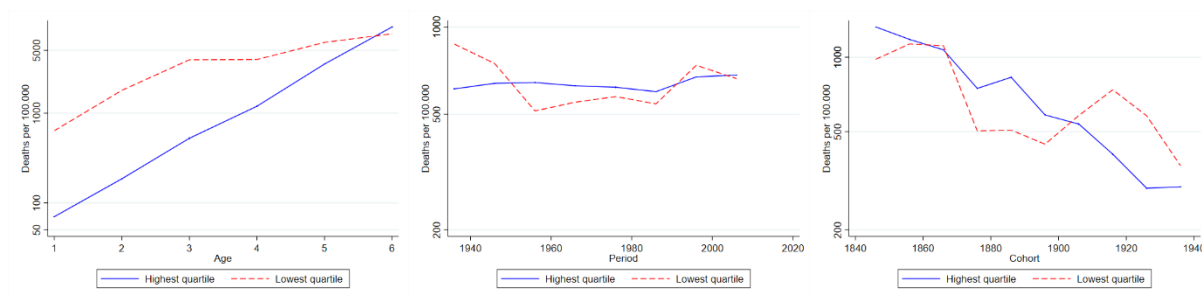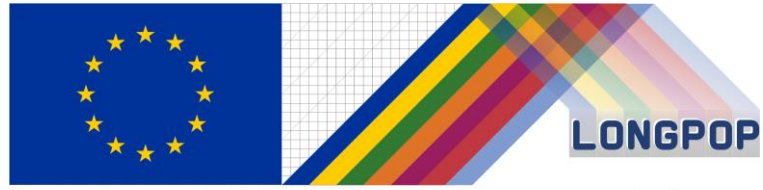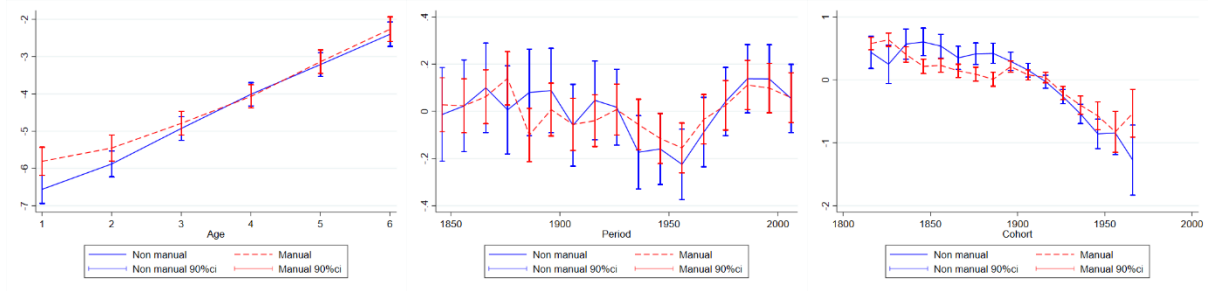
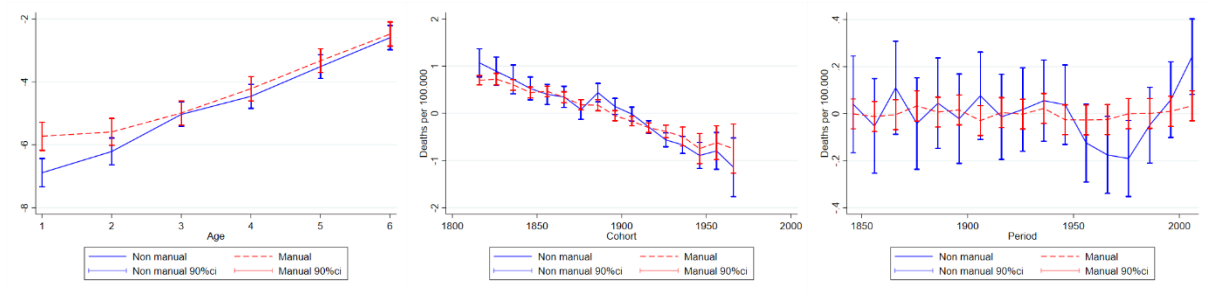**Appendix: Graphs with confidence intervals for significant results**

Age, period, and cohort effects with 90% confidence intervals for men; manual vs non-manual occupations

Age, period, and cohort effects with 90% confidence intervals for women; manual vs non-manual occupations

Period and cohort effects with 90% confidence intervals for men; lowest vs highest income quartile using individual income