The democratization of longevity: How the poor became old. Paris, 1880-1914.

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"Mais comme il y a deux sortes de richesse, la richesse qui ne produit rien, et la richesse qui produit, que l'industrie sait partager pour l'accroître, j'ai été curieux de savoir si elles ont une influence également heureuse sur la durée de vie."

Louis-René Villermé, « De la mortalité dans les divers quartiers de la ville de Paris », *Annales d'hygiène publique et de médecine légale*, 1830

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Abstract
In the first decades of the 19th century, industrialized countries experienced both a decline in urban mortality and the reversal of the rural-urban mortality differentials, once vastly favorable to rural areas. This process can be linked with two broad phenomena: a rise in income and improved public goods. Here we focus on income and take advantage of the unusual quantity, quality, and variety of statistics computed by the statistical department of the Paris municipality under the lead of Louis-Adolphe and Jacques Bertillon. For the three decades preceding WWI, we have collected and standardized mortality data at the neighborhood (*quartier and arrondissement*) level. Therefore we have longitudinal data on mortality at a very small scale during the key period of the health transition. Life expectancy in Paris is not very different from the rest of the country –around 50 years at 5 years old– but the difference between the two extremes of the distribution is over 10 years in life expectancy. To explain such huge mortality differential between neighborhood, we add to this dataset various information on income and wealth from fiscal records, especially both the average rents and its distribution within neighborhoods. We document that the disparities in mortality between neighborhoods are strongly related to a variety of income indicators. Over time, mortality fell because of income increases rather than because of a change of the mortality income relationship.

Keywords: differential mortality, wealth, urbanisation, Paris

JEL codes: N33, N34

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Introduction

In the last third decades of the nineteenth century, Parisians had a life expectancy at age five that was 4 or 5 years shorter than the rest of France. The gap did not begin to narrow until the middle of the century and it did not close until the 1930s. In the 1890s, there were huge differences within Paris: the denizens of those neighborhoods where life was long could expect to live an additional 14 years above what those in the worst neighborhoods could expect (a difference that was almost twice as large as that between the best and worst departments within France). Those differences based on residence are also observable in difference in age a death between the bottom and the top part of the wealth distribution. In nineteenth century Paris life was both brutally short and massively unequal, yet each year the ci ty attracted hordes of migrants and, over the century after 1850, completely overhauled its sanitary infrastructure. While differences remain based on wealth, or neighborhood, their relative importance has massively diminished, increased longevity, it seems, has been one of the more widely distributed benefits of long term economic growth.

This synopsis of the Paris experience poses two questions, one about the sources of differential mortality, the other about how it changes over time. For the period before WWII scholars have identified two opposed forces that drove life expectancy; first, the negative impact of having an ever increasing proportion of the population living in crowded and adverse urban environments; second, increases in income and knowledge that in the long run offset the negative effects of urban living. In their pure form income and knowledge are quite distinct. Higher income allowed individuals to purchase goods and services that prolonged life (e.g. better nutrition, clothing, and housing) that they consumed privately. Save for possible epidemiological effects, the better housing of one family has little effect on the life expectancy of another. At the other extreme we can place pure knowledge effects (like home cleanliness or boiling milk), once the survival value of such techniques are known they can be adopted by everyone because their costs are low. Of course there is a range of other changes that lie in between: they are expensive, but they have economies of scale and but their benefits are greatest if they are adopted by the whole of a given population: public goods and infrastructure.

Paris turns out to be a very good laboratory to study differential mortality because the municipal statistical office was dominated by individuals who were obsessed with collecting and publishing detailed demographic data. Beyond the contrast between Paris and France that we can estimate for two centuries, we can track the evolution of mortality on a smaller scale (in each of Paris's 20 districts (*arrondissement*)) from 1880 to 1945 and, between 1880 and 1913, for each of the 80 neighborhoods (*quartier*) of the city. Their purpose in producing these disaggregated reports was to spur public action to reduce both mortality and morbidity in the city. Yet during this period (unlike the interwar period) their efforts did not lead to major changes in policy. Additionally the treasury collected (even though it did not publish) information on direct taxation for the same 80 neighborhoods, which were also the units for the census of housings. Finally individual data sets on wealth at death enable us to produce estimates of average wealth levels for the same neighborhoods. As we will show there is extraordinary stability in the ranking of these neighborhoods in terms of their real estate stock, their average wealth levels and in their relative life expectancy.

This paper aims at documenting the long term evolution of life expectancy in Paris and that it's extraordinarily marked by spatial variations. It is not great surprise that the poorest neighborhoods were also the deadliest, but the extent of this type of differential mortality is striking. Second, convergence to the low mortality regime was slow and although it did reduce the variation in life expectancy within Paris it did not eliminate it. To begin, however, we must return to Paris as a laboratory.

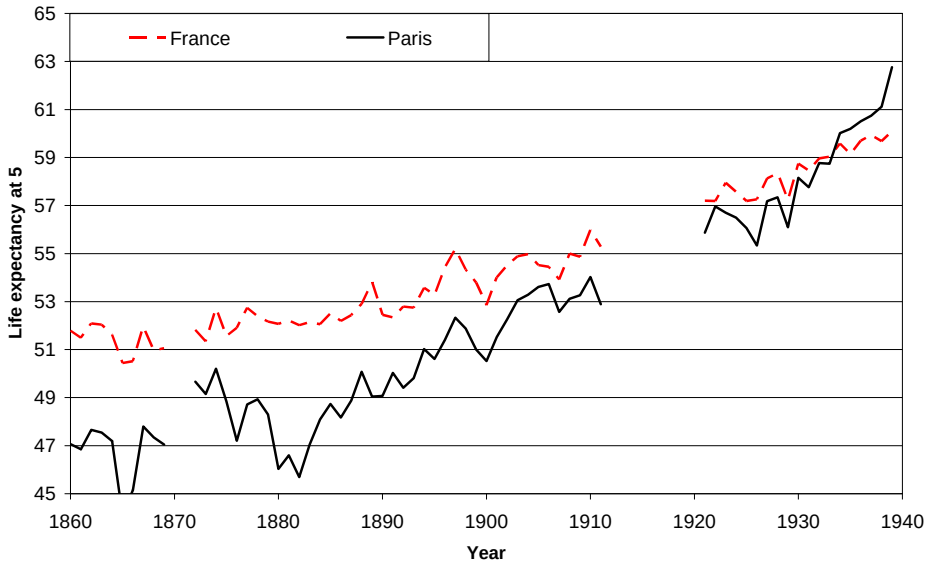
I. Paris as a laboratory

Paris has many advantages for studying differential mortality; the most straightforward of these is that the variance within Paris in incomes, wealth, and life expectancy were extremely large. There are some serious complications, however, the most obvious of these being that the individuals who were living in Paris at a point in time were not a randomly drawn sample. Thus the choice of focusing on one large city rather than France as a whole as would be more conventional needs some defense.

France as a whole would be an attractive laboratory for studying differential mortality because among the countries on both sides of the North Atlantic France is the one with lowest levels of migration (either inward or outward). Hence if one were to estimate differential mortality rates in a cross-section, one would not need to worry about the extent to which the individuals observed were selected, something that comes up if one deals with other location that have high rate of emigration or immigration. However, scholars have long established that mortality rates varied by location (e.g urban vs rural) and we know that location was correlated with income. Hence in cross section it is difficult to separate income effects from other effects. Using time to help sort out these correlations reintroduces the thorny problem of endogeneity because even if French people did not often fall victim to the siren calls of North America they moved around within their country quite a bit, and in particular cities were growing steadily since the beginning of the nineteenth century and the largest ones (Paris among them) fastest of them all (Guérin-Pace, 1993).

Rather than deal with France as a whole we focus on Paris. Paris is obviously interesting in and of itself, but it presents a remarkable contrast with the country as a whole. In 1880 Parisians could expect to live four years less (or nearly 10%) less than French people as a whole (figure 1). Over the next three and a half decades, life expectancy in France increases by four years but that of Paris by nearly seven years leading to a convergence that would turn into Paris' advantage in the interwar period. Thus the patterns of spatial differential demography went through a great reversal. Yet at the same time the pattern of spatial differential demography changed very little before World War 1.

Figure 1. Life expectancy at age 5, Paris and France, 1860-1939.



To understand the increase of life expectancy in Paris we must confront two different selection effects, first, selection of migrants from France into Paris and, second, the sorting of Parisians into neighborhoods. Because changes in the mortality of Parisians could thus be simply attributed to changes in rates of migration and migrants' characteristics. Yet in prior work we

established that migrants from the countryside to cities were positively selected (i.e. had lower mortality than those who stayed behind at comparable ages shortly after migrations), but their mortality converged to that of individuals who were born and resided in cities after a decade of residence (Kesztenbaum and Rosenthal, 2011). Our analysis will take advantage of these results by examining difference in mortality rates by age where older groups will not be so sensitive to migration rates. The second selection effect, residential sorting, complicates the analysis; indeed, there could be two reasons for a neighborhood to have high life expectancy. It could simply be that everyone there has high income and high income buys a longer life span. For other reasons high income individuals may want to live near each other which lead to lower mortality even if the neighborhood itself has no attributes that affect life expectancy. At the other extreme one could imagine that income is irrelevant in itself but that some neighborhoods have attributes that make them healthier places to live. Households with high income might well seek to live in such better neighborhoods and thus bid up the rental price of housing.

As noted above and as we discuss below the difference between the worst and best decile of neighborhoods is nearly 15 years in life expectancy, which is enormous. Furthermore, this difference is relatively stable over time and is measured after the city had provided broad access to clean water: building could connect to the water system to provide running water to each dwelling, a faucet at every floor or simply one on the ground floor, and there were also local fountains (Bocquet, Chatzis et al., 2008). It was in fact the other side of the water question: waste water disposal that was going to occupy Parisians and mobilize investment in the half century following 1880. To the extent the diffusion process favored rich neighborhoods over poor ones and thus actually further the spatial inequality within the city.

As noted in the introduction we can carry out this analysis at three level aggregation: the city, its 20 arrondissement, and its 80 neighborhoods from 1880 to 1913. We can extend the analysis forward to 1940 if we accept to limit ourselves to arrondissement level data and backwards to 1820 if we accept to limit ourselves to the city level. We can do so because the statistical department of the Paris municipality under the lead of Louis-Adolphe and Jacques Bertillon produce a regular flow of statistics about mortality. Jacques Bertillon himself was concerned with reducing the impact of communicable diseases in the city and with establishing the causes behind the dramatic differences in life expectancy. In fact, Paris was the birth place of studies of the relationship between mortality and wealth, with the work of Louis-René Villermé at the beginning of the 19th century (Villermé, 1823; Villermé, 1830). Indeed, Villermé was certainly one the first – if not the first – to explore the link between affluence and life expectancy, breaking a long established belief of equality in front of death (Villermé, 1828; Lécuyer and Brian, 2000). Once that belief has been successfully challenged, scholars take granted that inequality in wealth – or, for that matter, in income, social status, and so on – produces inequality in health.

From that point on, many studies and works explored the income gradient in mortality and its evolution over time –not to mention a wide range of works that focalize on this gradient nowadays (Williams, 1990; Hummers, Rogers et al., 1998; Cambois, Robine et al., 2001). Some look at this relationship from a macro perspective in order to explain what was soon labeled "the mortality transition" (Kingsley, 1956; Preston, 1975; McKeown, 1976), others – probably most of them in fact – look at specific time and place. Both macro and micro level studies, however, try to get insights into the mechanisms that produce a socio-economic gradient, whether it is nutrition (Harris, 2004), better housing, better hygiene, or better access to medical resources, among others. They try also to establish what may be called the historical origins of health inequality, opposing those who think that the social gradient has always existed and stay more or less the same to those who think of a divergence-convergence pattern with the gradient rising – for instance during the industrial revolution – and then declining (Haines and Ferrie, 2011). According to the first hypothesis, the mechanisms that relies a fundamental cause (wealth) and mortality may change over time (for instance lack of sanitation and bad housing in the 19th

century, smoking and bad habits in the 20th century) but the association stays the same and is reproduced at each period. The second hypotheses postulates that mortality inequalities were small before the industrial revolution as both income inequalities and medical knowledge were limited. Then it rises with income inequalities and access to better quality medicine for the wealthiest before diminishing again as public infrastructure were developed on a large scale, therefore beneficiating disproportionately to the poorest part of the society.

Indeed, scholars have come to establish two facts at the same time: the income gradient in mortality did not necessarily appear with the industrial revolution and it did not disappear with the large-scale development of public goods. Both findings were puzzling. This leads to rich and insightful debates but also tends to somehow reduce the importance of socio-economic gradient in mortality. Environmental effects were put forward: first with a simple rural-urban opposition, hence the "urban disamenity" effect (Szreter and Mooney, 1998; Woods, 2003; Cain and Hong, 2009), second in relation with a more detailed account of living conditions (Brown, 1989; Cain and Rotella, 2001; Ferrie and Troesken, 2008). As a result, most studies conclude to a much weaker link between mortality and wealth that was assumed before, in favor of a strong environmental effect on mortality. In fact, more recent works are challenging the very existence of any causal relationship between income and mortality (Bengtsson and van Poppel, 2011).

So a general pattern is emerging on the long run: in the distant past, around before the 19th century, mortality, and health, was not supposed to be linked to income. In the catholic West, for instance, the moment of death depends on the deity and not on merely material matters such as wealth or even living conditions. Then, for two centuries, it was taken for granted that income was one of the major determinants of mortality inequalities, if not the major one, even though its causes were still unknown in precise details. And, again, for the late twenty or thirty years, the relative importance of affluence for determining health and mortality has receded among social sciences scholars, almost to the point of disappearing. To be more precise, the gradient is still there, but environment is now the leading explanation. Hence, the same pattern reproduces back and forth over time with a transition from no effect of wealth on mortality to a strong effect to no effect again. Then the question is how to escape from that linear health-wealth nexus?

First, it should be acknowledged that scholars are, directly or not, influenced by the general context. The perception of mortality inequalities is by itself an important social fact that may not be dismissed as a simple measurement error. For instance, it has consequences on sanitary policies. Hence the case of Paris: we do have such a good observatory of mortality because social scientists, politics, urban planners, etc. were all concerned by the dramatic differences in mortality they observed. In fact, it was considered, up to the 1960's, that the massive influx of immigrants had badly damaged Paris, some say it was a sick city (Chevalier, 1958). This idea has since been challenged (Ratcliffe and Piette, 2007).

Second, it should be acknowledge that there is no such thing as an unambiguous link between affluence (be it wealth or income or social status) and life expectancy. Public goods such as sanitation or water improvement do improve life expectancy. But the wealthiest enjoy them differently; for instance, they often benefit from them first. In that case, it is somehow contradictory to explore socioeconomic inequalities in death as if there was a one side relationship between the two. It is better to admit that this relationship must be put in a broader context. Recent papers have succeeded in putting the health-wealth nexus in historical perspective but this is merely a start. This historical context must be detailed: how institutions evolve as a response to high mortality differentials, how individual react to them, etc. This is the aim of this paper. But to start we need to compute standard indicators of mortality in order to compare neighborhoods and years.

II From the data to life expectancy

This article relies centrally upon data published by the statistical office of the city of Paris from 1880 to 1913 that provide a variety of relevant information at level of 'quartier'; each arrondissement included four such neighborhoods. Before 1880 and after 1913 the same data are available for city wide aggregates or at the arrondissement level. The city level data are useful only in so far as they allow us to situate the capital in the French context. The arrondissement data are crucial because they will allow us to study how life expectancy inequalities of the late 19th century evolve during the interwar period.

Starting in 1817 the city began to publish death by age totals for each gender by five year age intervals. Then in 1880 the *Annuaire statistique de la ville de Paris* reports death totals for each gender broken down into six age categories for each neighborhood. The statistical office also published a series of detailed abstracts for the city drawn from the national censuses from 1882 forward that give us the age distribution of the living for the same localities[1]. Taking these two data together allows us to compute life expectancy at the *quartier* level.

Indeed, the ideal construct to measure differential mortality is in fact life expectancy by class or place of residence. One might want to compute life expectancy at birth. For Paris, at least, this would, however, present insurmountable problems because of underestimation of both deaths and population. On the one hand, there was a massive recourse to wet nurses who live a distance from the capital until very late in the century. Such wet nursing was associated with very severe mortality, but the deaths were not recorded in the capital, thus any computation of life expectancy in early years would suffer from massive undercounting. On the other hand, still birth registration remains a problem until late with some newborn being reported as still birth even though they may have lived for a very short moment after birth, and vice versa.

Thus we prefer life expectancy at age 5, and for comparability with the estate tax data (that are censored to age 20 or higher) we also compute life expectancy at 20. Even then both because the age categories reports at the *quartier* level are not stable over time and do not necessarily accord between the *Annuaires* and the Censuses, we must make corrections. We proceed in three steps.

First, we adjust both mortality and population reports in order to obtain the number of deaths and the number of living for the same six age intervals: before one year old; between one and four years old; between five and nineteen years old; between twenty and thirty-nine years old; between forty and fifty-nine years old; over sixty years old. In all cases, we have very detailed report at Paris level (every five year reports) so we take advantage of them to correct the report at the *quartier* level. Take for instance the death reports before 1893: instead of reporting death for 5-19; 20-39 and 40-59, they use the age intervals 5-14; 15-34; 35-59. So we estimate, from data pertained to Paris as a whole, the share of deceased aged 15-19 among those aged 15-34. We apply this share to the groups defined at the *quartier* level and we get, for each *quartier*, the number of death between 15 and 19 years old. We add this number to the total number of deaths in the age group 5-14 and retrench it from the number of deaths in the age group 15-34. We proceed in the same way for the age groups 15-34 and 35-59.

Second, we estimate inter-census population for every year. The standard way to do so is to evaluate the change in population between census year by combining the effect of aging and net migration. If the population were closed, then a cohort based analysis will do (a new cohort is born each year, all other cohorts get one year and decline due to mortality). If the population is open and migration rates just depend on age then one has to add that factor back in. In other words two elements influence the growth rate of the population between censuses: death and

[1] Since the French Revolution, censuses were performed every five years; they have been kept in the archives from 1831 on in most cases. Here we use data on censuses from 1881, 1886, 1891 and so on.

migrations within each age group. When the first are the most important one can follow the evolution of each five year cohort from one census to the next. Then, the number of individuals of age (a) in year t depends on the number of individuals of age (a-5) in year (t-5) and one must then simply allocate the variation between the two values to the intervening years. However, when migration is significant, then the size of the age group (a) in year t depends less on the size of the age group (a-5) at (t-5) than on migration. For Paris where migrations were very large, we estimate the size of an age group between census years from the variation between census years at age (a). In other words the size of the population of age a in year t is an interpolation of the size of that group in the two adjoining censuses.

Third, we compute a life table for each year and neighborhood: to do so we calculate mortality rate (m) for each age group by dividing the number of death in the age group by the number of individuals living in that age group for each year and neighborhood. We can then produce death probabilities (q) where $q=n*m/(1+(n-a)*m)$ where n is the length of the age group and a is the time lived by deaths within this age group. This last value is taken from Keyfitz and Fliegler (1968:491) for individuals older than 5 and Coale et Demeny (1983) for ages 0-5 (but we focus here on life expectancy after 5 years old). Once death probabilities computed, we can immediately calculate mortality tables and life expectancy at each age (Preston, Heuveline et al., 2001: 42-50).

The assumptions we make in these computations do affect the results. In particular the time living by the deaths of the oldest group comes out at just under eight years which is perhaps a bit more optimistic than it should. More importantly it would be realistic to think that this number is likely to have varied across neighborhood: it seems sensible to assume that mortality is more severe in the poorest part of the city than in the richest parts. In this case the mortality differential would be even larger since mortality in the poorer neighborhood is underestimated. Yet it seem logical, at least to start, to make the same assumptions for all the neighborhoods so as not to produced differential mortality by construction. Overall, we have chosen to make the simplest assumptions to avoid biasing our results. The same goes for the way we calculate inter-census population: it is probably not true that migration affects all ages and neighborhoods in the same way. It is more likely that migration is more intense in the poor neighborhood –this would increase the population of rich neighborhoods and thus reduce their mortality.

In the end, our computations probably understate mortality differences across neighborhoods; on the other hand the methods we use probably have little influence on our findings. After all the life expectancies we compute for the census years (when we have the exact population) are very similar to those for inter-census years. Varying the average life span per interval or the maximal age in the life table has some impact on life expectancy but very little on the between neighborhoods differences in Paris

Beyond these published data we have access to a series of cross section drawn from estate tax records that provide wealth, gender, and age for the entire population of decedents roughly once every five years from 1807 to 1937. To match the life expectancy by neighborhood one would want to have life expectancy by wealth fractile. We cannot, however compute such measures. Indeed we do not have an age distribution for the living that are in a given wealth fractile. In particular at the top end of the wealth distribution, one has to worry about endogeneity. Indeed we need to purge from the empirical age-wealth at death relationship the part that runs from age to wealth. To be sure it is likely that wealth helps prolong life (thus distribution of ages for the top fractile is likely to be to the left of the age distribution of lower fractiles), that is the phenomenon we would like to capture. It is also true that at high levels of wealth, the older an individual lives, the larger the estate that person will leave behind, first because of unrealized capital gains and because the likelihood that he or she will inherit from collateral lines increases with age. Because of the latter channel we cannot compute life

expectancy by wealth fractile without some joint distribution of wealth and age among the living. Thus here we will simply present age at death by fractile.

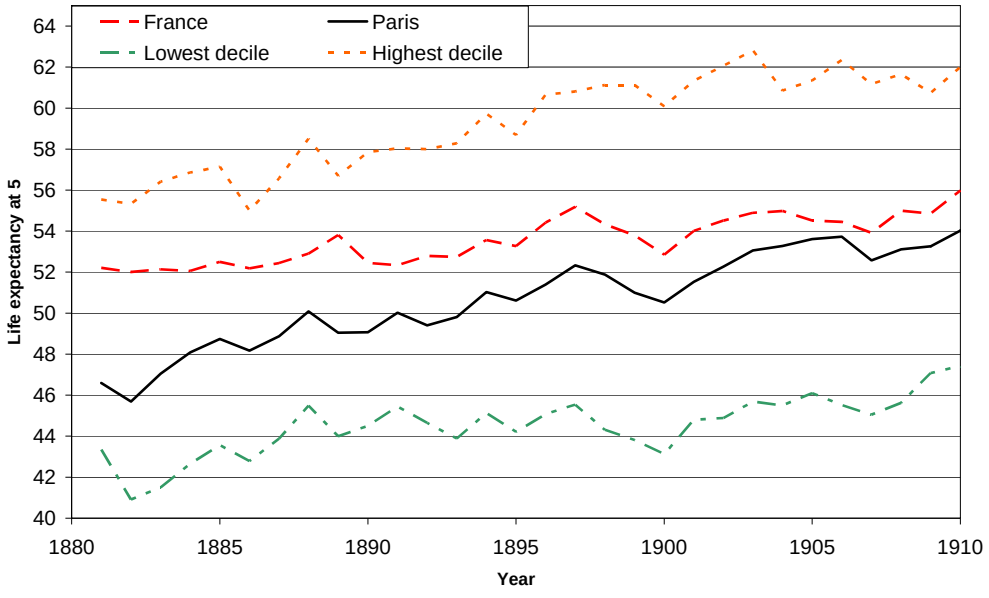
Finally there exist four real estate censuses (1876, 1890. 1900, and 1910) that provide number of housing units as well breakdowns of these units by their fiscal assessment. The data are reported by household (*ménage*) and break down rents into up to nearly two dozen categories including one that are below the threshold at which one would be liable for the *taxe mobilière* (a direct tax assessed on the basis of occupation and of the rental value of the household's dwelling). The largest category in 1890 included those 521 dwellings assessed at more than 16,000 francs in rent. We define three categories of households, the poor are those who pay less than 300 francs a year in rent, then comes the middle class which pays between 300 and 1000 francs (per capital income in the 1880s for France), the rich pay more than a 1000 francs.

The halcyon days of the statistical office ended abruptly in 1913. Afterwards, and despite a massive increase in the city involvement in sanitation and other life preserving activities, its expenditures on publishing the life outcomes of its inhabitants declined massively. After WWI the demographic data are only given by arrondissement, and there were no real estate censuses published. Now we focus on the period for which the more detailed data are available: 1880-1913.

III. Inequalities in time and space

Figure 2 below presents mortality patterns across neigborhoods within Paris compared with the average life expectancy for Paris (the black line) and for France (in red). The figure also shows the life expectancy for the best eight (in orange) and worst eight neighborhood (in green) in Paris. In this scale the difference between the average life expectancy in Paris and France do not seem so large any more. In fact the worst neighborhoods in Paris have a life expectancy that is always about eight year less than the average in the city and 10 to 12 years relative to France. The twentieth arrondissement life expectancy increase barely matched that of France and its relative gap did not change. At the other end of the spectrum, in the early 1880s the best neighborhoods in Paris had seven year advantage over the rest of the city and a four year advantage over the rest of France. Over the next three decades life expectancy rose quickly and neared 64 years; over that time these neighborhoods saw their differences with all other benchmarks increase. Economic growth, it seems, did not translate into a reduction of life expectancy inequality.

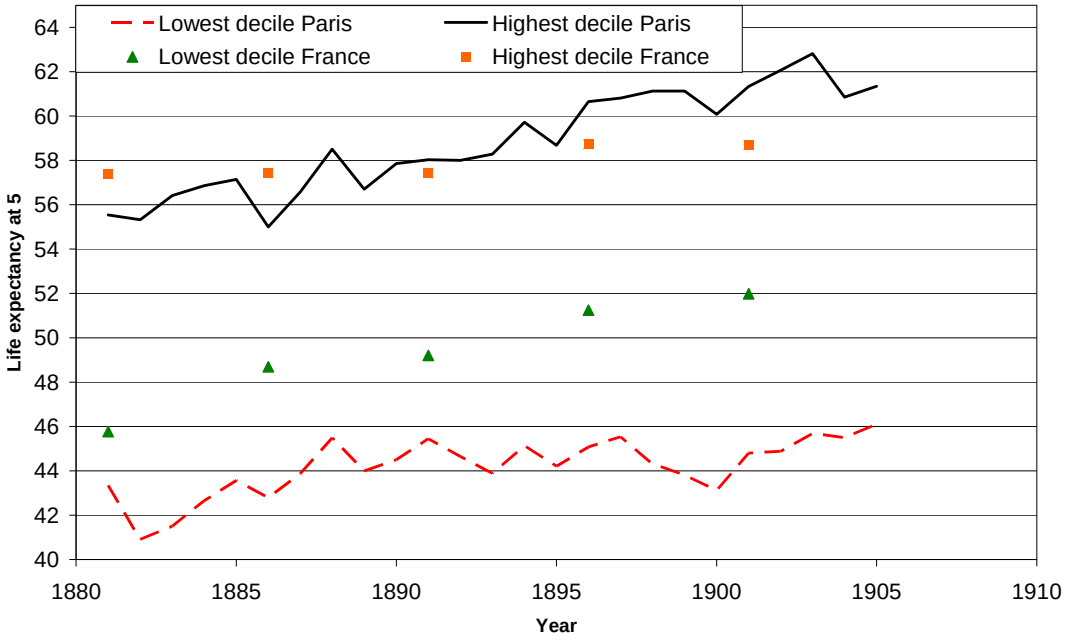
Figure 2. Life expectancy at age 5 within Paris, compared to France



The inequality in life expectancy within Paris is particularly striking because it in fact much larger than the difference observed across departments.[2] As Figure 3 shows, the gap between the nine departments with the highest and lowest life expectancy was about 12 years in the 1880s; by 1910 it had shrunk to seven. Most of the gain came from the worst departments who experienced large (6 years) gains in life expectancy while the best departments only eked out a gain of about 1 year. The pattern of rough stability at the top and big gains at the bottom is the reverse of Paris, where the bottom managed at best a three year gain in life expectancy when the top gained six. As a result the worst departments, which started out with higher life expectancy than the worst neighborhoods in Paris pulled away with a difference that jumped from about two years to almost seven. At the top the neighborhoods with the lowest mortality experienced enough gains that they become the healthiest areas of France.

This is not simply an effect of picking tiny populations with unusual life circumstances. Even as early as the 1870s the rich neighborhoods had, each, populations of about 20,000 and the largest of the poor neighborhoods had a population above 35,000. The primary reason for these differences comes from deep difference in the material circumstances of the residences of these neighborhoods.

Figure 3. Life expectancy at age 5 within Paris and within France



IV Mortality and wealth

Looking at 1876, the city's inequality becomes instantly obvious. The number of rich was less than 10%, and the poor made up 68% of households. These different classes lived in different places. Twelve neighborhoods (principally in the eastern edge of the city) had more than 90% of their households paying less than 300 francs in rent, and in these neighborhoods less than 0.7% of households were rich. In contrast in five neighborhoods more than 40% of households could be classified as rich (all in the northeast), and in most of those the share poor was less than half that of the city. Average rents reflect these contrasts and had been noted at the time. Rents in the Champs Elysées neighborhood averaged 3400 francs while, while in the Charone neighborhoods they were 179, in our twelve reference neighborhoods rents average 186 francs while in the five rich ones it was 2204. This better than ten to one difference in rents in part reflects the massive differences in the size of apartments (the census provides the

[2] Life expectancy by départements are taken from (Bonneuil, 1997).

distribution of apartments by number of rooms) in amenities like running water, toilets within the apartment rather than in the hallway or on the ground floor, in air quality (prevailing winds being from the west, the east end of Paris was more polluted than the west) but it is also clear that there were location rents, indeed the high rent districts are clustered around the financial center (the Bourse) and its political counterpart (the Elysée).

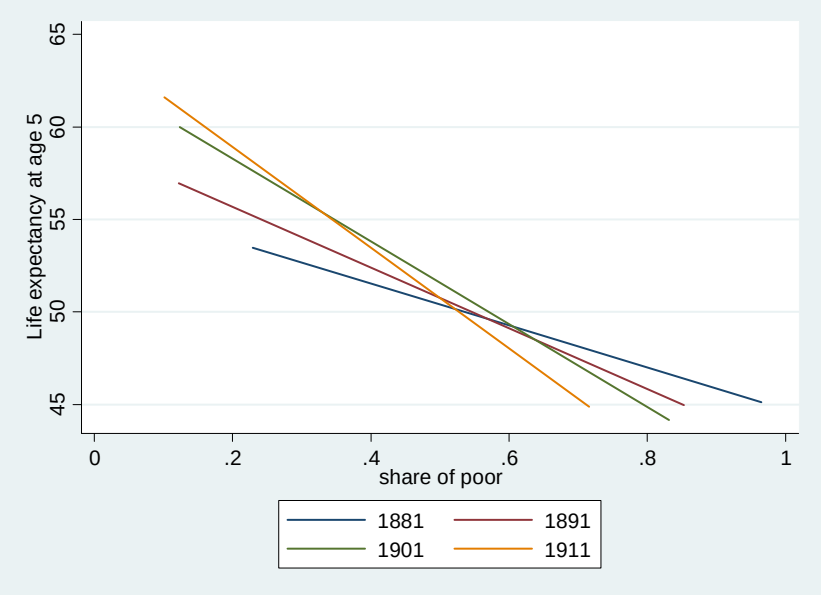
To evaluate the role of wealth or income we proceed in two steps. First we explore links between mortality and wealth within neighborhood. To do so we use a panel regression with four observation that link housing census with its nearest mortality year (1876 with 1880, 1890 with 1890 mortality and so on) Because we only have four housing surveys our panel has four cross sections for a total of 320 observations (Table 1). The advantage of this approach is that it allows us to include fixed effects that absorb any constant characteristics of the neighborhood (hence the estimates are based on the within neighborhood change over time). Those regressions show that increases in a neighborhood share of poor were strongly associated with mortality: an increase of one standard deviation of the share of poor reduces life expectancy in the neighborhood of three years (both share of poor and share of rich are standardized and thus the coefficients can be directly expressed as variations in life expectancy, the constant measuring the life expectancy at the average value of the share of poor). Increases in the share of rich were conversely good for life expectancy and the implied effect is actually slightly larger, with a one standard deviation change leading to more than four years of additional life expectancy. If we include both variables the effect of the share of rich declines dramatically and becomes statistically insignificant, but the coefficient on share poor is essentially unchanged.

Table 1: Mortality, the Rich and the Poor

Dependent variable is life expectancy at age 5			
Share of poor	-3.08***		-2.94***
(S.E.)	0.24		0.27
Share of rich		4.15***	0.706
(S.E.)		0.714	0.671
Constant	51.51	51.51	51.51
(S.E.)	0.130	0.157	0.157
R^2	0.59	0.53	
Fixed effects for Quartier	Yes	Yes	Yes
N	320	320	320

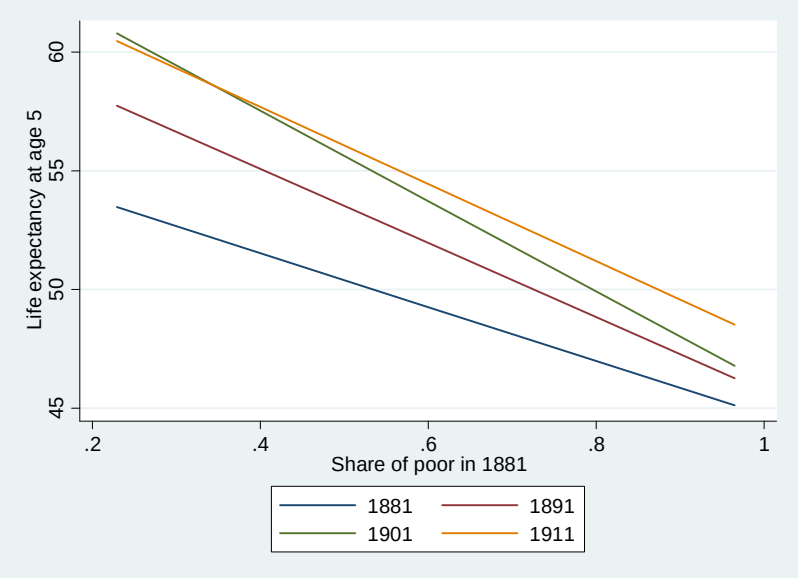
An alternative approach is to focus on the cross sectional variation and estimate the impact of the share of poor across neighborhoods at each census date. Figure 3 shows the fitted values for regressions we do not report. The first set for 1881 shows a negative association between life expectancy and the share of poor, then with each decade the relationship steepens, in part because of increased in life expectancy in richer (fewer poor) neighborhood and because the fraction of poor tended to decline over time even though their mortality patterns did not change much. The curve for 1911 is in fact the steepest, consistent with an increase in differential mortality as was suggested by figure 2.

Figure 4 Life expectancy and the share of poor households



To net out the effect of a decline in the share poor we re-ran the regression from Figure 3 but instead of using the contemporaneous survey, we used the only the first census as an explanatory variable. Again the 1881 predicted mortality ranges from 45 to 54, then 1891 show both an increase in life expectancy everywhere and a steeper slope suggesting that part of the increase in life expectancy in 1891 was associated with a decline in the share of poor. The 1901 data is even steeper suggesting that while things continued to improve in the richer neighborhoods, they had deteriorated in the poorer ones. 1911 is then flatter and higher with the richest neighborhoods (as defined in 1876) having gained almost 7 years in life span since 1881 while the poorest ones had a gain of about 3 years or less than half. The timing of both increases is very different though: the wealthiest neighborhoods gain a lot between 1881 and 1891 and again between 1891 and 1901 and then nothing up to 1911 whereas the poorest ones gain almost nothing before 1901 and then get better in the last period.

Figure 5 Life expectancy and the share of poor in 1876



V Individuals and neighborhoods

This analysis shows the huge differences in life expectancy between neighborhoods within Paris. It allows us to conclude that life in Paris was very unequal, differences between neighborhood being both strong (and stronger than in France as a whole, in fact probably stronger than anywhere else in France) and closely related to wealth. It also gives some clues about the evolution up until WWI which demonstrates an increase –and not a decrease– of mortality inequalities. It has one clear limitation however, which is that it does stay at the neighborhood level. This may be a problem because people move between neighborhoods and thus experience different mortality patterns (and people chose where to stay at least in part because of the living conditions in a given neighborhood). And at the same time it does not link directly the wealth of the individual with their mortality.

A way to overcome this limitation is to use individual data. We do have an exceptional dataset that gives wealth at death from (Piketty, Postel-Vinay et al., 2006; Piketty, Postel-Vinay et al., 2011). From these data, we have various information (including age, but also marital status), including a very precise account of their wealth, on all wealthy deceased in Paris every five years. A first piece of information they provide is how much wealthy individuals live in the same neighborhood(s). This is an important point because if wealthy people can be found all over Paris. In fact, the residential patterns of the wealthiest Parisians are very similar to the wealth pattern given by the tax record (Table 2). And it reveals concentration indeed with between a quarter and half of the wealthiest living in the 8 arrondissement only. More surprisingly, even among the wealthiest, concentration diminishes greatly according to wealth, as people less wealthy are forced to live in adjacent neighborhoods.

Table 2: Place of residence of wealthy individuals according to their asset (1872-1912)

	Wealth>4 million	4M> Wealth> 1 million	1million> wealth> 500K	500K > wealth> 250K	250K> wealth> 125K
N	97	850	1040	1455	2091
Richesse	8 702 609	2 562 100	698 441	350 078	178 848
	Fraction that reside in what arrondissement				
1	3.1	2.8	4.3	2.7	2.8
2	0.0	3.2	1.8	1.7	2.2
3	0.0	0.9	1.7	1.9	2.3
4	0.0	2.8	3.3	4.1	4.7
5	0.0	1.8	2.5	4.9	4.6
6	0.0	4.0	7.9	7.0	6.6
7	13.5	11.3	8.6	6.8	7.2
8	52.1	36.5	22.7	19.3	12.5
9	12.5	13.4	15.6	14.7	12.3
10	0.0	3.2	5.8	6.7	6.1
11	1.0	1.9	3.2	5.5	6.4
12	0.0	0.9	0.8	1.7	3.2
13	1.0	0.6	0.6	0.9	1.1
14	0.0	0.2	0.7	1.4	2.5
15	0.0	0.5	1.4	1.3	2.6
16	13.5	11.9	11.1	10.3	9.6
17	2.1	2.6	5.2	5.1	6.2
18	1.0	1.0	1.4	2.0	2.4
19	0.0	0.4	0.5	1.2	2.5
20	0.0	0.1	0.7	0.9	2.2

These data allow us to study mortality at the individual level. Unfortunately no source would give the same data for the living and, as a result, we have to stay with the information on deceased only. As we noted previously, we cannot compute life expectancy by wealth fractile without additional data, which we do not have. Thus here we will simply present age at death by fractile (Table 3). Again, it should be noted that this indicator is certainly biased because we observe wealth only at death; it nonetheless confirms the results we have seen in the previous section, age at death being inversely related to wealth. And again the effects are incredibly strong, with the differences in age at death between the wealthiest (the top 2% among the deceased of a given year) and the poorest (the 92% poorest among Parisians) being over 17 years old. And just as in the previous analysis, one striking feature is the stability of this pattern over time, the difference being roughly the same forty years later.

Table 3: Age at death according to wealth at death

	1872	1877	1882	1887	1902	1912
top 2%	65.0	66.2	66.1	67.3	67.3	68.4
next 4%	61.2	62.5	62.5	63.1	63.6	65.6
next 8%	56.4	57.1	55.3	58.0	58.0	58.3
Rest	48.0	49.8	47.9	49.6	52.0	52.9
Av age	49.5	51.2	49.5	51.2	53.2	54.2
Total deaths	24348	28777	36790	34410	36366	36681
N with age and wealth	15576	18597	24831	20860	26624	29323

Note: the estate tax sample are comprised of all the individuals who died in a given year (e.g. 1872) and filed a return within 30 months of January 1 of that year; not all individuals with tax data have an age, we accordingly trim the population of no wealth individuals by the same proportion

Concluding remarks

Why was it that Paris was so exceptional? It was, at the turn of the 20th century, one of the emblems of huge metropolis that were beginning to be build. Not so much by the number of inhabitants but by the huge accumulation of everything and, especially, capital and men. Paris was the largest and the richest place in France. In fact, in this period, more than a quarter of the total French wealth was concentrated in Paris (Piketty, Postel-Vinay et al., 2004). And the result was extremely brutal with strong and persistent mortality inequalities, the wealthiest living on average almost a quarter longer than the youngest (even when excluding infant mortality). This, combined with the scientific interests of the time, has a specific consequence in creating huge interests among social scientists for what was happening within the city, producing as a result an incredible and detailed amount of various demographic data.

In this paper, we take advantage of these data in order to build the first step towards exploring the health-wealth nexus and the urban mortality transition. We give a whole set of converging results –at the neighborhood or individual level, based on demographic or taxation data, and so on– that demonstrate the extension of mortality inequalities in Paris before WWI.

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