Paths to the city and roads to death

Mortality and migration in East Belgium during the industrial revolution

MICHEL ORIS
Professor, Department of Economic History,
University of Geneva
GEORGE ALTER
Professor, Population Institute for Research and Training (PIRT),
Indiana University

INTRODUCTION

For a long time, population historians have believed that urban populations in the Middle Ages and the Early Modern Period were not able to grow without migration from rural areas (De Vries, 1984, ch. 9). In a famous contribution, Sharlin (1978) emphasized the importance of differential mortality of natives and immigrants in this urban demographic dynamic. However, this question has been neglected by researchers working on the nineteenth century, while it is during that period that rural worlds became more urban and industrial (see Williamson, 1988 for a nice exception). In France (Pitié, 1979, esp. 25-29), in England (Lawton, 1989, 8-9) as well as in Belgium (Van Molle, 1983), several authors have studied the immediate perceptions of such major changes. Urbanization, especially the industrial type, has been seen as a monster, a chaotic explosion of mines, a mass of factories and miserable houses constructed without order and caution, a cradle of new epidemics like cholera, and a society where promiscuity endangers sexual morality as well as private hygiene (Moch, 1992, 143). Moreover, the chaos of the *tentacle* towns (*"les villes tentaculaires"* of the Belgian poet Verhaeren) consumed a rural world depicted in soft colors, as the refuge of naivety, virtues, morality, health, and so on. Naturally, the migrant was typically pictured as a rustic, morally and physically destroyed by the perversity of the urban environment (Pinol, 1991, 55-60). As the Belgian socialist leader Emile Vandervelde wrote in 1903, the migrant was *"hypnotized by the city lights like the sea bird after sunset flying bewildered under the beam of the lighthouse"*.[1]

[1] Vandervelde, 1903, 18-19, cited from the English translation of Leslie Page Moch, 1992, 143. Moch makes an excellent point in *"Crime and illegitimacy: the marginal migrant"* (pp. 143-147).

One or two centuries later, historians remain largely imprisoned by these qualitative visions, which the intellectual elite of this time shared (Lis and Hélin, 1991, 297). However, scientific investigations see beyond such stereotypes. Michael Anderson played a pioneering role in 1985, when he emphasized the large proportion of immigrants recruited in adjacent areas. These people were already familiar with their place of destination. They had accurate information on housing and professional opportunities, the same cultural background, and usually little risk of being segregated.[2] Since most migratory movements in nineteenth-century East Belgium, have indeed been short-distance (Oris, 1999), these remarks are one of our foundations for the construction of a new differential demography of immigrants and natives. The underlying observation is quite basic: during their paroxysmal phase of growth, the proportion of immigrants in industrial towns almost always exceeded 50 per cent, reaching even more than 70 per cent in extreme cases. When newcomers are the majority, the problem of integration has to be considered in completely new terms (Oris, 1995, 291-295). Two further studies showed that immigrants to the coal towns were the first to abandon the malthusian pattern of late marriage, and they may also have pioneered the fertility decline (Oris, 1996 and 1999).

With these ideas in mind, we offer an interpretation of the migration-mortality complex in the nineteenth century at the time that the population was escaping from the grip of hunger and recurrent famines. The geographical setting is the province of Liège in East Belgium, located in the French part of the Kingdom and bordering the Netherlands and Germany. This region was the first one on the European continent to follow the British example and enter the industrial revolution. We will use results from several case studies, based on both aggregate statistics and cross-sectional analyses of nominal data. In addition, we present some original multivariate longitudinal analyses from Belgian population registers, which are famous for their precise recording of migratory movements (see Alter, 1987, ch. 1; Neven, 2000a, ch. 1). In the first two sections, we use graphs to summarize the histories of migration and mortality in nineteenth-century East Belgium. These syntheses lead to two conclusions. First, the 'migration revolution' was much more complex than a simple rural exodus.

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2. In another perspective, Leslie Moch (1992, 143) pointed to research on *"the systems of chain migration that protected migrants from anomic behaviour and that operated to protect even the poor from dislocation"*. Here we will not deal with this issue, which we have treated in other papers (Oris, 1999; Alter et al., forthcoming). We found some evidence of protection of widows and orphans by family networks in industrial towns, but of course only when such a network existed. Generally, chain or network migration does not seem to have been dominant in the process of formation of the new industrial populations in nineteenth century East Belgium.

Second, they show that an impressive 'epidemiological depression' in the industrial neighborhoods substantially widened the gap in mortality between town and countryside, precisely at the time when massive flows linked the two worlds.

Section 3 evaluates the relationships between mortality and migration by using mortality tables and a logit regression on time series. It challenges prevailing views by showing clear evidence of an under-mortality of migrants above the age of 5 in industrial towns. Moreover, as a new illustration of Alan Sharlin intuition, this differential demography explains most of the peculiarities of mortality in urban-industrial populations (as described by Haines, 1991; Oris, 1998; Neven, 2000b).

Sections 4 and 5 use case studies to explore one of these peculiarities, the surprising evidence of relatively low mortality among working adults. A rural case study is based on an Ardennes village, Sart-lez-Spa, while an urban one focuses on Tilleur, an industrial coal and iron suburb of Liège. We focus first on the hypothesis of migrant selection as an explanation of their ability to cope with morbidity and mortality in growing cities. However, analyses show clearly that adult in-migrants did not form a homogeneous population. Even though it is extremely difficult to evaluate the effect of time since arrival in the city (epidemiological shock or accommodation with the new epidemiological environment), we see that segregation by origin and by socio-professional status interacted among married working adults, and that the family status and household economy determined the survival chances of young single men.

The differences between individual and family experiences of integration in the new industrial towns appear again when we examine the mortality risks of infants and children in section 6. Indeed, another peculiarity of the urban-industrial mortality pattern is that children paid a much higher price than adults for the industrial revolution and explosive urbanization. Those born in migrant families were clearly more at risk. A multivariate analysis stresses cultural differences as well as hygienic, housing and epidemiological conditions, and it emphasizes the difficulties of entering a new society and a challenging environment.

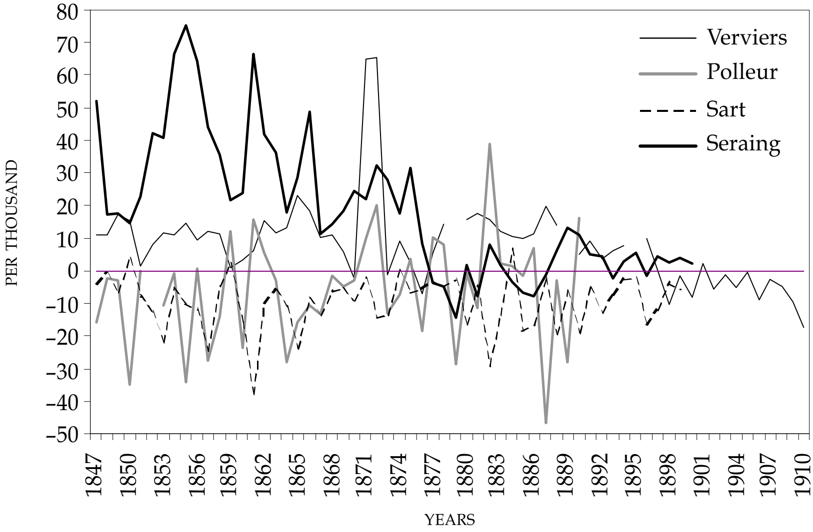
1. MIGRATION IN TOWN AND COUNTRYSIDE: DIFFERENTIAL CONJUNCTURES

The geographical distribution of the population in Wallonia was completely modified by the industrial revolution. Around 1800, Liège had 50,000 inhabitants, the urban and industrial region of Verviers had 19,000 and the 'Charleroi Country' had approximately 22,000. In the middle of the nineteenth century, the three factory regions centered on these cities had respectively 127,000, 35,000 and 62,000 people. At the beginning of the twentieth century, they had reached 422,000, 90,000 and 200,000 inhabitants. The Liège and Verviers basins are located in East Belgium, primarily in the province of Liège, where 25 per cent of the population lived in towns around 1800. One century later, townsmen were 60 per cent (De Laet, 1992, 427; Oris, 1990, 90; Morsa, 1987, 75 and 90; Desama, 1985, 58; Hasquin, 1971, 270). It seems obvious that massive migratory flows must explain these deep changes which affected not only the geography, but also the economy, society, and civilization. Reality, however, is a bit more complex.

Figure 1 compares trends in net migration in different settings between 1847 and 1910. Polleur and Sart are rural districts in the northeast of the Ardennes, a few kilometers from Verviers. This was one of the poorest rural areas of Belgium. During the nineteenth century it experienced the destruction of proto-industrial spinning after 1825, the sale and division of common lands after 1847, and the progressive substitution of cultivation by forests (see Hoyois, 1981; Alter and Oris, 2000, 303-304). Structural changes and a positive balance of births and deaths produced continuous pressure for out-migration. Polleur lost 0.59 per cent of its population each year between 1847 and 1890, and Sart lost almost one per cent of its inhabitants annually between 1847 and 1899 (average rate is –0.97 per thousand). Recently, Muriel Neven (2000a, 155) has observed a similar demographic pressure in the adjacent rural region, the Land of Herve.

A perfect contrast can be found in Verviers, a textile city located just between the Ardennes and the Land of Herve, which was the pioneer of the industrial revolution in continental Europe from 1799 to 1810. Net in-migration permitted its population to increase by one per cent each year between 1847 and 1870 (an average rate of 10.5 per thousand). This was not excessive if we compare it with Seraing, where the famous John Cockerill founded a modern iron industry in 1817. Yearly gains from migration reached 3.37 per cent between 1847 and 1875, although the trend was clearly decreasing. The difference in the intensity of migration between the wool city, Verviers, and the coal and iron city, Seraing, was a clear consequence of industrial structure. In the former, the concentration of workers in factories completely modified the geographical

FIGURE 1: MIGRATORY BALANCE IN FOUR LOCALITIES OF EAST BELGIUM, 1847-1910



distribution of activity in woolen textiles. However, the number of workers stayed the same between 1806 and 1846 with mechanization being the source of increases in production and productivity (Lebrun et al., 1979). Iron work, on the other hand, has been strongly linked with the exploitation of coal fields since the 1820s. Steam power permitted a decisive extension of the mines, but the basic work remained manual and required thousands of new workers. Coal and iron basins have consequently experienced a dramatic demographic expansion.

Net migration into Verviers reached 6.5 per cent in 1871-1872 during two exciting years at the top of a Kondratieff cycle, just before an over-production crisis. The outflows of 1873-1876 were a direct consequence, probably due to rejection of the most recent immigrants. However, if the migratory response to the crisis was brutal, it was also limited. From 1878 until 1888, Verviers gained 1.4 per cent of inhabitants annually. This evolution was unique if we compare it to the Liège basin. During the 1873-1893 depression in this region, net migration fell in industrial suburbs like Seraing, while it increased in older cities with rich charitable institutions that traditionally offered a refuge (Oris, 1993, 195-197; see also Lis and Soly, 1977, 462). The pattern in Verviers was symptomatic of the double nature of this textile city, which was industrial and traditional at the same time.

Migration to the textile city declined after 1890 and became negative in 1898. A pioneer in the industrial revolution, Verviers was also the first to experience industrial decline. In its 'mono-industrial' region, migration responded directly. Seraing and the Liège basin benefited from the steel Kondratieff until 1913, but net migration remained low or null.

The history of net migratory flows contrasts with the growing intensity that figure 2 demonstrates for Verviers. Until 1860 there was no real difference in the intensity of mobility (crude rates of entries and exits) between town and country, and these rates remained stable or slowly increased in Polleur and Sart (average rate respectively 68.8 and 64 per thousand). In Verviers, however, transience or turbulence exploded from an average annual rate of 72.6 per thousand between 1847 and 1860 to more than 200 per thousand at the beginning of the twentieth century! This evolution has also been observed in other cities of the Liège region (Hélin, 1990, 628-629; Oris, 1993, 197-199). Since the 1870 a very efficient and affordable system of daily train and tram connections was increasingly used by the working population to commute between home and factory (Leboutte et al., 1998, 42). Throughout this period, 'real' migration (domicile change) increased continuously. A clear revolution was developing among urban populations with the development of new uses of space and housing (Oris, 1993).

Transience is typical of the urban world (Langewiesche and Lenger, 1987, 89-91; Hélin 1990, 628; Moch 1992, 142-143). Turnover is often higher in new settlements, and it is closely linked to working conditions and working discipline. First, high turnover was possible because the pioneer enterprises created before 1850 were rapidly encompassed by the large agglomerations or industrial basins discussed above, where workers could move from place to place. In 1856, around 18 per cent of the immigrants in Seraing were born in the Liège urban and industrial region, which had 131,886 inhabitants. In 1900, approximately 40 per cent of the inhabitants came from a basin of 375,252 persons (see figure 4).

Secondly, Tugault (1973, 167) has demonstrated a link between hard, repetitive jobs and the intensity of turnover, and Leboutte (1988; 1995) found similar historical evidence among the coal miners of the Liège basin. Business leaders protested regularly throughout the nineteenth century against the 'excessive' turnover of their workforce. Typically, they strengthened the work discipline by accentuating the decomposition of the production process and the repetitive character of the job, which permitted efficient work with continuous changes among workers (see Clark, 1984; Oris 1995). The original cause of the turnover was thus reinforced, and turbulence itself increased. This process of constant mutual reinforcement continued until the depression between the two World Wars (Owen, 1992).

FIGURE 2: URBAN AND RURAL MIGRATION INTENSITY, 1847-1910

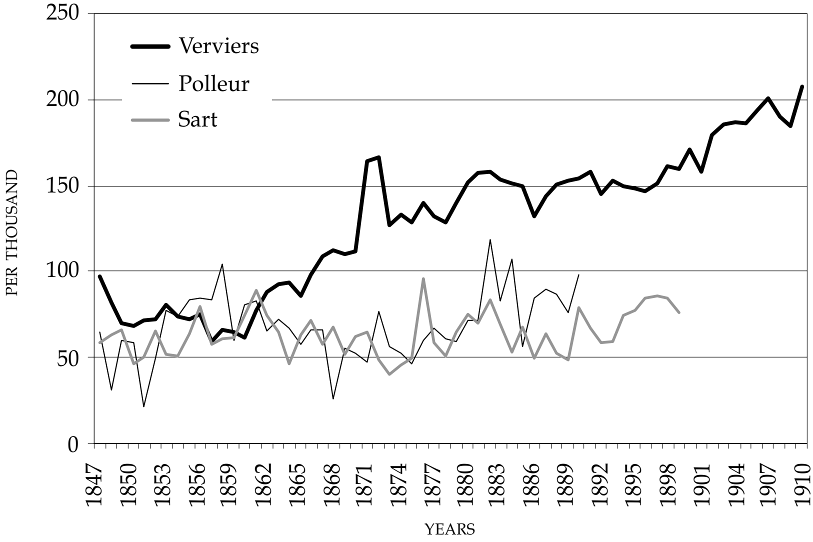
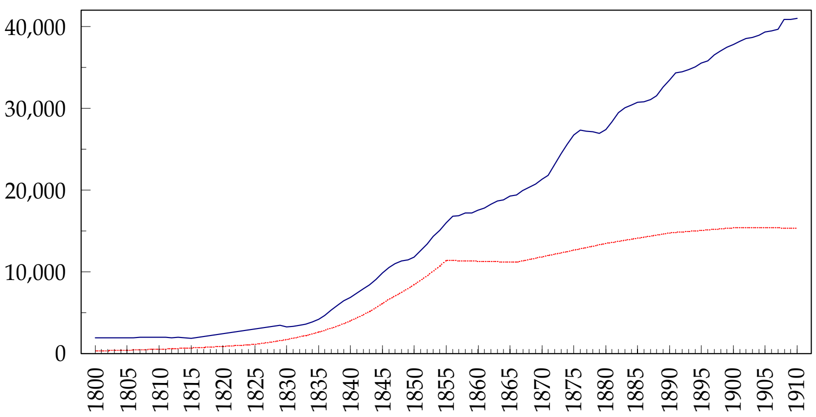
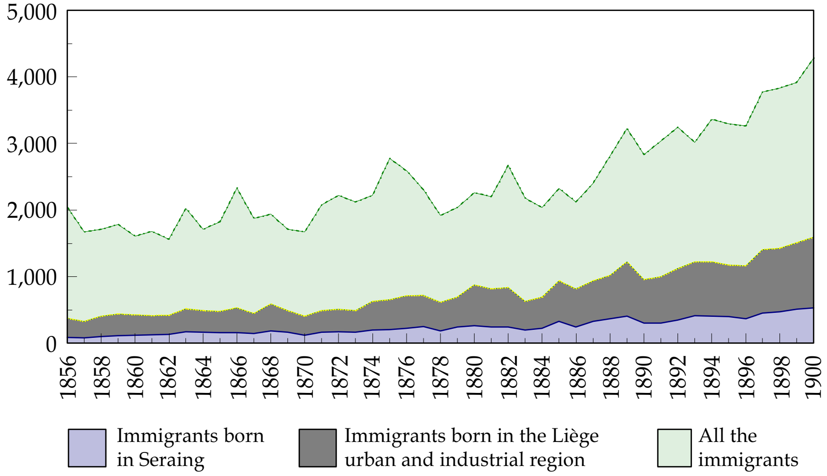


FIGURE 3: POPULATION GROWTH AND IMMIGRATION PRESENCE IN SERAING, 1800-1910



These changes in the migration patterns, characterized by increasing mobility within the industrial and urban regions, rapidly affected the demographic and social structures of the industrial populations. Figure 3 presents the movement of the whole population and of the non-native population in Seraing between 1800 and 1910. There is a clear distinction between the 'foundation phase', a time of paroxysmal growth, and the 'maturation phase'. During the first period, migration played a decisive role; in 1856, almost 68 per cent of the inhabitants of Seraing were not born in the municipality! However, in 1910, natives comprised 62.5 per cent of the population. This reversal is explained in two ways. First, the influx of adults in the reproductive age groups, induced by the massive migrations, increased overall fertility and the birth rate (demonstrations in Desama, 1985, 92-93; Eggerickx and Poulain, 1995, 275-280; Oris, 1996, 171-179). The second explanation is a normal component of turnover: return-migration. In figure 4, we see that the proportion of in-migrants born in Seraing grew from 5-6 per cent to 20 per cent among those arriving between 1856 and 1900, while the number of entries doubled. Since this estimate considers only persons born in the industrial town, it obviously underestimates return-migration.

FIGURE 4: MOVEMENT OF IMMIGRATION IN SERAING BY BIRTHPLACE OF THE IMMIGRANT, 1856-1900



Nevertheless, this evolution shows again that in the maturation phase, the nature of migration flowing to industrial cities changed: growing mobility had less and less effect on the social, economic and cultural composition of the urban-industrial population. A native proletariat arose from the offspring of the migrants who settled in the new towns. In another contribution, one of us has examined the evolution in the proportion of natives in 50 Walloon municipalities,[3] thanks to the Belgian decennial population censuses published between 1846 and 1910. The pattern in figure 3 was important in 20 localities situated in the heart of the Walloon industrial basins. These 20 municipalities contained 43,829 inhabitants around 1806, 107,311 in 1846, and 269,697 in 1910 (Oris, 1995, 292). As the heart of the industrial revolution, they also became the fortress of the socialist movement which appeared during the maturation phase. Moreover, we have observed that the decrease in the proportion of immigrants was particularly precocious in two regions: the Borinage coal fields in the province of Hainaut and the wool agglomeration of the Vesdre valley including Verviers. The two extreme dissident movements within the Belgian Workers Party were born in the Borinage (republican and communist movements) and in the Vesdre valley, whose deputies voted for Bakounine against Marx after the 'Commune de Paris'. During a short period in the 1870s, Verviers became the world capital of the anarchist movement (Puissant, 1982; Moulaert, 1996).

Of course, we do not want to over-interpret these facts, which might be merely coincidental. However, the transition between the foundation and maturation phases is a good general framework for studying differences between natives and immigrants in industrial cities, including differential mortality (see below). In effect, the problem of integration changes completely. In the first phase, rural immigrants arrived in rural districts that became industrial towns, in which immigrants rapidly became more numerous than natives. Speaking of integration makes little sense. In the second phase, the proletariat and its components defined their own culture, rules, and way of life specific to the black country or the textile districts. Newcomers faced a more traditional process of assimilation into an established community.

3. These are all places with a density above 500 inhabitants per square kilometre in 1846.

2. MORTALITY BETWEEN EPIDEMIOLOGICAL DEPRESSION AND EPIDEMIOLOGICAL TRANSITION

The nineteenth-century mortality conjuncture is embedded in a long-term downward trend since 1700-1750 (Bruneel et al., 1987, 298). The years 1798-1847 form a period of transition to low death rates and modern population growth in East Belgium. War had little influence after the Napoleonic regime, and fatal subsistence crises ended after crises in 1798, 1811-1812 and 1816-1817. Even the potato disease in 1847 had no clear effect on the mortality in the region (Alter and Oris, 2000, 305). However, a genuine epidemiological depression delayed progress.

The beginning of this depression differed from place to place, depending upon the timing of the industrial revolution and urbanization. The first evidence is found in Verviers, where the typhoid fever of 1818-1820 can be seen as the first disease of this new phase. This outbreak raised the crude death rate above 50 deaths per thousand inhabitants during three years. The widespread diffusion of cholera in 1832-1834, which returned in 1848-1849 and in 1866, was a clear indicator of the new demographic regime. These epidemics were the tip of an iceberg, the base of which was intestinal diseases. The other main sources of everyday mortality as well as episodes of high mortality were childhood diseases: smallpox, measles, scarlet fever, etc.[4]

Such a mortality and morbidity landscape is atypical in the nineteenth century European context, and peculiar to new industrial towns (Perrenoud and Bourdelais, 1998). Often established in the countryside, these new cities struggled to keep up with their population growth throughout the nineteenth century. Their growth was so sudden and so rapid that urban infrastructure usually arrived after the city was built. The installation of a waste system or water supply was especially difficult and expensive in the existing, fragile urban framework. However, these poor, working-class municipalities had few financial resources and many needs: not only for the public health, but also for basic education, commercial development, and so on. Case studies of Dison, the main suburb of Verviers, and of Seraing show that after 1850 local administrators did their best to transform *"their urban villages in real cities"*, but it was a long and hard job that is still unfinished today (Potelle, 1987; Oris, 1995). Of course, housing conditions were also very bad and landed intense

[4] The identification of crises, the sensitivity of mortality, and causes of death are topics developed in Neven 1997; see also Capron 1998, 50-54 and Oris 1998.

speculation. De Saint-Moulin (1969) has shown that the coal towns were often located in rural areas where space was available. The building sector responded rapidly, and workers were able to become homeowners even before the appearance of public assistance in 1887-1891. However, the quality of this housing was often poor, basic hygiene often absent, and crowding the norm (see Oris, 1998, 299-305 for a synthesis).

To establish the reality and impact of the epidemiological depression, table 1 presents the evolution of life expectancy at birth and the average duration of life after the fifth birthday in eight different localities in East Belgium. While the information for the village of Sart comes from a continuous observation of deaths and ages during periods of at least 10 years, other measures are constructed from cross-sectional tables based on the ratio of deaths counted at one, two or three years, and the population at the census taken between. By chance, several crises were located around or even during the year of the census, especially the cholera epidemic of 1866. This accentuates the drop in life expectancy between 1846 and 1880 that we observe in three areas: Olne in the Vesdre valley; Dalhem in the Land of Herve but close to the industrial Meuse valley; and in the Basse-Meuse, a less developed part of the Liège industrial basin. These areas began with expectations of life at birth similar to the more isolated Ardennes village of Sart, but life expectancy declined after 1846. Because childhood diseases returned around 1880 and even around 1890, Dalhem and the Basse-Meuse recovered late and incompletely. The epidemiological depression of the second third of the nineteenth century is also obvious in Huy, a traditional center of artisanal production.[5] It also appeared in more severe form in the industrial neighbourhoods like Dison and Seraing, which had to pay the price of unregulated urbanization.

Table 1 shows also that urbanization, especially industrial urbanization, had a disproportionate impact on infant mortality: there is a less important difference in expectations of life at age 5 among the different settings. Figure 5 demonstrates the importance of childhood mortality in the new towns (Belgian data from Masuy-Stroobant, 1983, 437 and 447). However, data from the rural Ardennes village of Sart indicates an infant mortality rate of 159 per thousand. This rate was higher than the rate of 130 infant deaths per thousand births in the province of Luxembourg, which covers the largest part of the Belgian Ardennes (Eggerickx, 1993, 210). At the opposite ecological extreme

5. Mortality tables in Huy are also cross-sectional because the population is estimated from census data, but deaths are observed in a sample of one in ten deaths during the entire period.

TABLE 1 EXPECTATION OF LIFE AT BIRTH AND AT AGE 5, EAST BELGIUM, 1820-1890

Years	*Sart*	*Olne*	*Dalhem*	*Basse-Meuse*	*Huy*	*Limbourg*	*Dison*	*Seraing*
			Expectation of life at birth					
1820	–	–	–	48	36	–	–	–
1830	43	–	–	42	38	–	–	–
1846	–	43	44	41	38	40	35	34
1856	45	–	37	32	37	–	–	26
1866	49	37	34	35	35	–	23	35
1880	53	47	35	40	41	–	–	40
1890	58	–	41	43	44	–	–	45
			Expectation of life at age 5					
1820	–	–	–	–	50	–	–	–
1830	49	–	–	–	47	–	–	–
1846	–	52	54	51	47	50	48	47
1856	50	–	50	45	50	–	–	42
1866	53	49	54	49	47	–	38	51
1880	58	56	55	51	51	–	–	50
1890	59	–	56	56	54	–	–	54

Sources: Capron 1998; Leboutte, 1975 and 1988; Marechal 1987; Oris 1998; Potelle 1987.

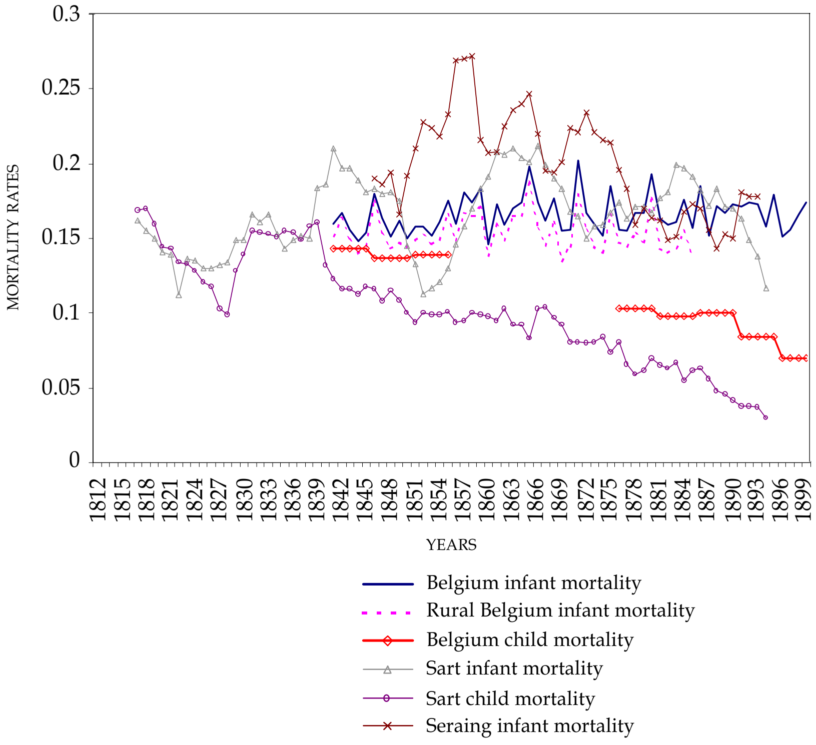
was Seraing in the Meuse valley, which grew from 2,000 to 40,000 inhabitants between 1800 and 1900. Between 1846 and 1873 the infant mortality rates in Seraing were continually above 200 per thousand. Rural chances of death between ages 1 and 5 ($_4q_1$) were also half the level in Seraing.[6]

Seraing suffered a clear epidemiological depression in the second third of the nineteenth century, but also made important progress in reducing infant mortality at least 25 years before Belgium or Sart. Eggerickx and Poulain (1992, 10) have made a similar observation for the Hainaut industrial town of Châtelet and Neven (2000b, 307) for Tilleur, which neighbours Seraing. Infant mortality also declined earlier and faster in the urban parts of Germany (Vögele, 1994) and the United States (Haines, 1991, 180-181). The chronology of childhood mortality decline is more coherent. The movement started after 1840 in Sart and probably after 1860 in Seraing and the rest of Belgium. The decisive decline

6. Values of $_4q_1$ in Seraing are 0.213 in 1846, 0.301 in 1856, 0.211 in 1866, 0.136 in 1880, 0.97 in 1890.

of mortality began after the severe smallpox epidemic of 1870-1872, and mortality statistics clearly distinguish this period from the modernization phase (±1800-1830) and the epidemiological depression (±1830-1873) (Neven, 1997).

FIGURE 5: INFANT AND CHILD MORTALITY IN SART, SERAING AND BELGIUM, 1812-1899



3. MORTALITY AND IMMIGRATION: FIRST QUESTIONS, FIRST LINKS

Of course, we can assume that the strongest links between migration and mortality existed during the epidemiological depression. First, we consider a causal chain — industrialisation-migration-urbanisation-mortality — that we test in indirect and simple ways. Table 2 presents the results of logit regression models showing the effects of in-migration on death rates in three different cities: the textile centre of Verviers, the coal and iron centre of Seraing, and Huy, a traditional urban center with around 10,000 inhabitants.

The variables used in the equations are:

Year	calendar year (1839-95 for Sart and Verviers, 1846-95 for Seraing and Huy;
Price trend	9-year moving average of Michotte (1937) price series;
Price difference	annual difference from 9-year moving average of Michotte price series;[7]
Net migration lagged	net migration rate in the preceding year (calculated as the change in population net of natural increase);
In-migration lagged	in-migration rate of the preceding year;
Out-migration lagged	out-migration rate of the preceding year.

Models were estimated using a grouped data logit regression procedure, which takes into account the differences in numbers of deaths and population at risk in different years.

The models all find that migration into a commune reduced the death rate in the following year. In each case the estimated coefficient of the lagged net migration rate is negative, which indicates that positive net migration reduced the death rate. The size of these effects is indicated by the 'relative risk' in the second panel of table 2. These relative risks show the proportional changes in the death rate caused by a one unit change in the independent variable. In this case, a one unit change would mean a migration rate of 1.0 or one migrant for every person at the beginning of the previous year. The relative risks associated with the net migration rate are all very large, and they suggest that migrants had extremely low mortality. This difference is too large to be explained entirely by migrants' young ages.

7. We did this exercise four years ago. Since then, we have collected more recent series of prices, some at the regional level. But the results discussed here are not modified by this improvement of the data.

These results support the analysis of the city of Verviers by Claude Desama (1985), who examined the relationships between demographic trends and structures during the industrial revolution. He noted that immigration reduced mortality in the short-term because it increased the proportion of adults with low mortality risks. In the medium-term, however, as these adults increased the population in the reproductive ages and had children, the resulting higher birth rate implied higher mortality because of the importance of urban infant and child mortality. Moreover, child mortality was especially sensitive to urban ecology and housing conditions, which deteriorated in the face of massive immigration. Thus, the immediate and delayed effects were completely different!

TABLE 2 LOGIT REGRESSION MODELS OF MORTALITY BY YEAR IN FOUR BELGIAN LOCALITIES, 1839-1895

Independent variable	*Sart*	*Verviers*	*Sercaing*[a]	*Huy*[b]
Estimated coefficient:				
Year	–0.005 *	–0.012 *	–0.009 *	–0.003 *
Price trend	0.005 *	0.008 *	0.013 *	0.005 *
Price difference	0.009 *	0.000	–0.014 *	0.000
Net migration lagged	–2.188 *	–1.047 *	–3.825 *	–1.922 *
Constant	4.855 *	17.920 *	11.635 *	1.224
Relative risk [exp(coefficient)]				
Year	0.995	0.988	0.991	0.997
Price trend	1.005	1.008	1.013	1.005
Price difference	1.009	1.000	0.986	1.000
Net migration lagged	0.112	0.351	0.022	0.146

* statistically significant ($p < .05$)
a 1846-95: 1877 and 1878 omitted
b 1846-95

The logit regression models suggest that in-migrants had lower mortality than urban natives. This contradicts the very traditional black and white picture of the poor migrant from the countryside described in the introduction. Table 3 confirms that the survival chances of natives were worse than those of non-natives. Estimates based on vital statistics and censuses show a 5-6 year difference in life expectancy at age 5 in the textile suburb of Dison around 1846 and 1866. In Limbourg, another textile city, expectation of life at age 5 between 1847 and 1866 was 47.9 for the natives and 51.2 for the immigrants. The difference is smaller but the industrial character of Limbourg at this time was much less pronounced than in Dison. In a traditional city like Huy, the difference between natives and non-natives was also low and the former were sometimes in the best position.

TABLE 3 EXPECTATION OF LIFE AT AGE 5 AMONG NATIVES AND NON-NATIVES IN SERAING, DISON AND HUY, 1846-1890

Localities	*Origin*	*1846*	*1856*	*1866*	*1880*	*1890*
Seraing	Natives	39	39	51	48	55
	Immigrants	52	43	50	49	53
Huy	Natives	47	52	47	52	55
	Immigrants	49	48	49	50	52
Dison	Natives	44	–	36	–	–
	Immigrants	49	–	30	–	–

It is in the largest industrial centre that migrant under-mortality was the most important: around 1846, the expectations of life at age 5 of Seraing natives and immigrants were 39 and 52, respectively. However, the difference rapidly decreased and became very small after 1866. Natives were at a disadvantage around 1846, because their age-specific rates were higher than migrants above age 15. Analyses by Capron (1998, 60) and Potelle (1987, 103-105), on Limbourg and Dison, respectively, also locate native over-mortality in the ages between 20 and 55. In Seraing, both sub-populations shared equal risks in the age groups 5-14. Around 1856, this equality extended to the 15-39 groups, and then in 1866 to the people aged 40-64. After 1866, the death rates of old immigrants (65 and above) were higher than those of natives. However, old natives were few in number. Taking this into account, we can say that the age-specific mortality patterns of natives and immigrants after the age of 5 were becoming quite similar from 1866 to 1890 (table 4).

We can understand this evolution if we remember the distinction presented in section 1 between a foundation phase and a maturation phase of the industrial populations, with a transition after 1856 in the case of Seraing. During the second period, we see that short-distance migration inside the Liège industrial agglomeration increased. Consequently, migrants and natives presented more and more the same economic, social and cultural types. The evolution of life expectancy and age-specific mortality suggest that they also became more similar in their biological characteristics and their ability to cope with urban growth.

A few case studies from elsewhere complement the Belgian data. In Le Creusot, an important French iron city, Patrice Bourdelais and Michel Demonet (1996, 187-188, 203) observed *"the lower mortality among young male immigrants*

TABLE 4 AGE-SPECIFIC RATES OF MORTALITY BY ORIGIN IN SERAING, 1846-1890

	1846	*1856*	*1866*	*1880*	*1890*
Immigrants					
0-4	0.061	0.109	0.058	0.057	0.037
5-9	0.018	0.019	0.010	0.005	0.004
10-14	0.005	0.011	0.009	0.005	0.001
15-19	0.008	0.015	0.009	0.008	0.006
20-24	0.008	0.013	0.009	0.011	0.006
25-29	0.006	0.014	0.009	0.012	0.005
30-34	0.005	0.012	0.008	0.008	0.011
35-39	0.010	0.013	0.008	0.014	0.008
40-44	0.007	0.011	0.017	0.013	0.016
45-49	0.011	0.019	0.018	0.019	0.016
50-54	0.005	0.027	0.018	0.027	0.022
55-59	0.023	0.028	0.025	0.030	0.028
60-64	0.034	0.038	0.037	0.049	0.049
65-69	0.030	0.096	0.037	0.059	0.067
70 et +	0.096	0.125	0.149	0.141	0.133
Population	4251	7584	10444	12774	14273
Deaths	61	172	176	266	272
Natives					
0-4	0.120	0.178	0.116	0.076	0.062
5-9	0.015	0.025	0.008	0.005	0.005
10-14	0.007	0.006	0.009	0.003	0.003
15-19	0.016	0.009	0.007	0.008	0.003
20-24	0.014	0.017	0.008	0.010	0.005
25-29	0.012	0.010	0.007	0.009	0.007
30-34	0.029	0.018	0.008	0.015	0.007
35-39	0.038	0.017	0.005	0.010	0.008
40-44	0.033	0.029	0.019	0.013	0.013
45-49	0.024	0.038	0.032	0.011	0.015
50-54	0.027	0.045	0.014	0.030	0.024
55-59	0.034	0.015	0.013	0.053	0.013
60-64	0.081	0.111	0.071	0.068	0.035
65-69	0.056	0.114	0.060	0.106	0.045
70 et +	0.145	0.172	0.125	0.143	0.176
Population	3593	4799	8021	12994	18017
Deaths	161	319	326	353	328

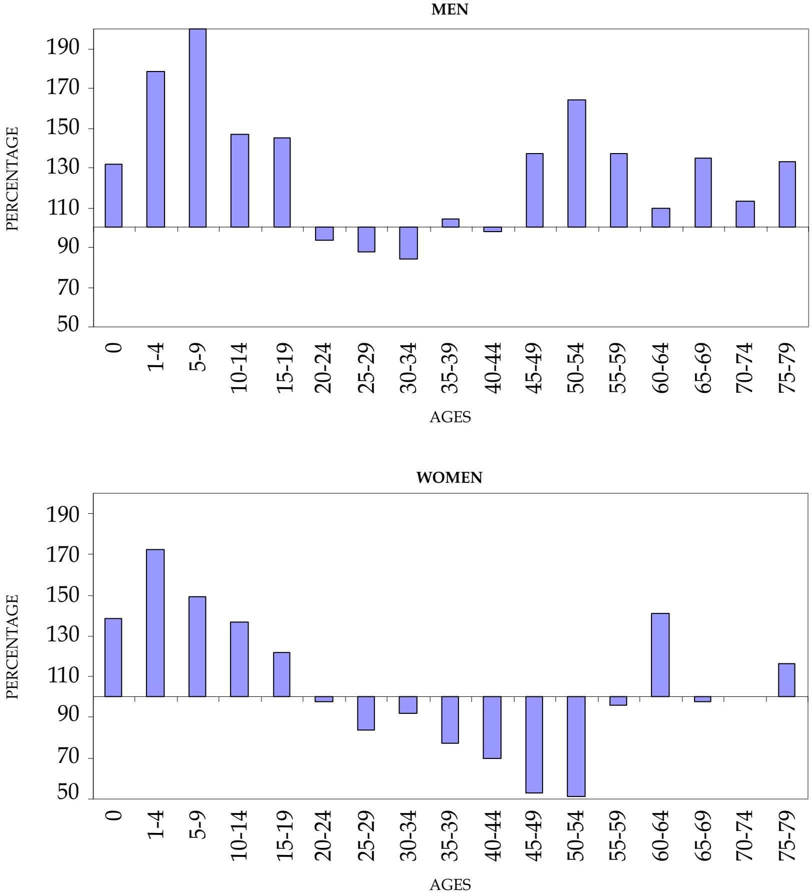
in Le Creusot during the period which marked the greatest cramming and promiscuity". The study of Bremen by Robert Lee and Peter Marschalk (1995, 44-47) is especially interesting, because they established that the life expectancy of immigrants was lower than that of natives and was rising in 1905 after the port city benefited from late industrialization. As in the early Belgian data, differences were most important between ages 15 and 30, somewhat less but in the same direction between 30 and 55, and greater for male than female immigrants. Developments in Bremen confirm what table 3 already suggested; namely that the under-mortality of migrants is an industrial characteristic and not an urban one.[8]

The relatively low mortality of migrants not only contradicts, or at least weakens, several stereotypes, it is also key to understanding the pattern of mortality in industrial cities. Continuing the example of Seraing, figure 6 presents age-specific death rates by sex in 1845-1857, and it shows death rates for Seraing expressed as percentages of the values in all of Belgium (see André and Pereira-Roque, 1974, 89, for Belgian data). It is becoming standard to observe that child mortality is a better indicator of living standards than infant mortality. While ${}_1q_0$ was 32-39 per cent higher in Seraing than in Belgium, the differential reached 72-79 per cent between ages 1 and 5! It remained above 22 per cent until age 19. However from the ages of 20 to 44, citizens of Seraing benefited from a clear under-mortality for both sexes (see Oris, 1998, 293, for the detailed analysis; also confirmed by Neven 2000b, especially 307-309). These results have been quite surprising for us because social historians have usually described the hard and dangerous working conditions, the long days in the factories, the intensity of manual activities, the frequent accidents. However, Bourdelais and Demonet (1996, 189-199) have also observed a clear adult under-mortality in Le Creusot in comparison with France.

Case studies demonstrate that industry used and attracted a special population, a selection of strong people who were more resilient in the industrial environment. However, again, we must distinguish between the immediate and the deferred (generational) effects. Figure 6 also shows that while the women of Seraing remained in a better position than Belgian females even after the end of their fertile life, men above the age of 45 clearly suffered from excess mortality. This reflects the low female employment in this city, and it confirms contemporary physicians, who observed that 45-50 was the age at which workers paid the price of excessive physical exertion beginning at too tender an age. But this deferred effect is not at the heart of our interests (see Oris, 1998, 296-298, and Neven, 2000b, 318-321 for a discussion on this issue). The central issue for our purposes involves the role of selection.

8. Alter et al. (1999) discusses this scattered evidence in depth.

FIGURE 6: AGE SPECIFIC RISKS OF MORTALITY BY SEX IN SERAING (1845-1857) AND COMPARISON WITH BELGIUM (=100)



Source: Oris, 1998, 293.

4. SELECTION? MORTALITY AND MIGRATION OF SINGLE ADULTS FROM A RURAL PERSPECTIVE

Our evidence from the Ardennes village of Sart adds a useful rural perspective on the interaction between mortality and migration. Like many rural areas in Belgium and Europe, Sart experienced both population growth and decline during the nineteenth century. In some places the population was released from rural areas by the consolidation of farms into larger units and the decline in proto-industrial production, resulting in rapid depopulation. (This was the experience of the nineteenth century Pays de Herve described by Neven, 2000a.) In the Ardennes, however, attempts to apply more modern agricultural techniques failed until the middle of the century. Even after that, Sart remained a village of small farmers heavily dependent on forestry. The population of Sart grew from 1,910 people in 1815 to 2,521 in 1855, but the gradual decline in mortality reversed the direction of migration. By the middle of the century Sart was experiencing net out-migration, decreasing to a population of 2,150 by 1895 (Alter and Oris, 2000, 303-304).

The population registers of Sart allow us to observe the relationship between mortality and migration at both the aggregate and individual levels. Table 5 shows components of population changes in Sart by decade from 1815 to 1895. In the decade following 1815, Sart experienced rapid growth, with both positive natural increase and net in-migration. But after 1825 more people were leaving than arriving, which is directly linked to the mechanization and concentration of the spinning industry in Verviers (Patriarca, 1986; Neven, 2000a,

TABLE 5 COMPONENTS OF POPULATION CHANGE IN SART, 1815-1895

Period beginning	*Population on January 1*	*Changes in following period:*				
		Net change	*Births*	*Deaths*	*Natural increase*	*Net migration*
1815	1910	380	707	505	202	178
1825	2290	170	720	539	181	–11
1835	2460	22	697	538	159	–137
1845	2482	39	664	505	159	–120
1855	2521	–237	672	549	123	–360
1865	2284	–66	637	515	122	–188
1875	2218	58	668	416	252	–194
1885	2276	–126	671	419	252	–378
1895	2150					

Source: Population registers of Sart.

ch. 2). Out-migration was particularly heavy during the 1850s, 1860s, and 1880s. Population decline at the end of the century occurred in spite of a larger excess of births over deaths.

In table 6, we present a model of migration at the individual level. The data used in this table come from the population registers of Sart, which kept a continuous record of its population from 1812 to 1899. Individuals were recorded by household, and notations were made for births, deaths, marriages, and migration. New registers were opened in 1847, 1867, 1881, and 1891 following censuses. The data has been corrected to include all births and deaths, but we know from linking individuals across registers that migration is under-reported, especially before 1846.[9] However, we have no reason to believe that this under-registration will have a systematic relationship to the explanatory variables used in this analysis. The Cox 'partial likelihood' method – already presented in Jan Van Bavel's contribution to this special issue – was used to estimate the effects of individual and household characteristics on the probability of migration in nineteenth-century Sart. To focus on the group most likely to migrate, the analysis is limited to unmarried persons ages 15 to 29 who were directly related to the head of household, which translates into an exclusion of servants and domestics. The column labeled 'relative risk' presents the exponentiated value of the coefficients estimated in the model, which can be interpreted as odds-ratios. For example, the relative risk of 1.03 associated with age means that each additional year of age increases the likelihood of migration by 3 per cent.

Overall, the results in table 6 show the importance of family composition in the migration decision. Persons living with older brothers or sisters were less likely to migrate, while those living with younger siblings were more likely to leave. Those who were not living with a parent were more than twice as likely to leave as those who lived with at least one parent. We also find that young women were about 5 per cent more likely to out-migrate than young men. The higher out-migration rates for women probably reflect two factors. First, while there were few employment opportunities for single women in Sart after the disappearance of the proto-industrial spinning, there was a high demand for female labor as domestic servants and operatives in the textile mills of nearby Verviers. Second, newly-weds usually settled in the community of the groom, so young women who married men from neighboring communes were likely to out-migrate at the time of their marriage.

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9. We have used a randomization procedure to identify periods of risk for persons who disappeared without a trace, but we do not assign migration events to these people.

TABLE 6 PROPORTIONAL HAZARDS MODEL OF PROBABILITY OF MIGRATING, UNMARRIED PERSONS 15-29 BORN IN SART, 1812-1899

Covariate	*Estimated coefficient*	*Relative risk*	*Mean of covariate*
Age	0.03 ***	1.03	19.09
Number of deaths in household in preceding two years	–0.19 ***	0.82	1.07
Older brother	–0.12 *	0.89	0.46
Younger brother	0.06	1.06	0.62
Older sister	–0.37 ***	0.69	0.43
Younger sister	0.10	1.11	0.59
Parents not in household	0.88 ***	2.40	0.07
Female	0.05	1.06	0.45
Number of events	877		
–2 Log likelihood	16096.04		
Chi^2	188.28		
Degrees of freedom	8		

* significant at .10
*** significant at .01
Source: Population registers of Sart.

The results in table 6 also show a strong relationship between migration and mortality within households. Unmarried persons living in households that had experienced more deaths in the last two years were less likely to out-migrate. Each additional death reduced the likelihood of migration by about 18 per cent. Together with the results for siblings, this suggests that migration decisions were affected by family needs. On one hand, siblings tended to wait in line for their chance to marry or migrate. The presence of older siblings in the household probably indicates that the household was able to use more labor. On the other hand, departure could be delayed when the household needed their labor, either because of a recent death or because parents had no younger children to rely upon.

We have explored these family determinants more extensively in another study (Alter and Oris, 1999). For the present research, the most important result is certainly the association between migration and recent mortality within households. Indeed, such an association implies that young single migrants were disproportionately recruited among households with fewer deaths. Does this mean that migrants came from healthier environments? Quite probably yes. Historians as well as demographers working on developing countries pay increasing attention to the clustering of mortality in certain families, the concentration of deaths in some families while others are spared. In the specific case of Sart-lez-Spa, we have recently established that *"the healthiest 25 per cent of the population was at least 37 per cent less likely to die than the average family, and the least healthy 25 per cent was 28 per cent more likely to die than average"*, which means a differential of 65 per cent between the extreme quartiles (Alter, Oris and Broström, 2001, 19). So, we can say that our results indeed suggest that those who migrated were healthier than those who did not. If health early in life is correlated with later mortality, as some have argued (Fogel et al., 1986; Floud, 1991, 151), migrants would have been drawn disproportionately from those with the most favorable early experiences. This may be one explanation for the lower mortality of migrants in destinations such as Seraing. Needless to say, Sart is just one case, and we must be cautious. Nevertheless, as far as we know it is the first time that the selection of out-migrants in their rural place of origin has been demonstrated.

Ironically, migrants were almost certain to increase their risk of death by leaving Sart for one of the industrial centers of Eastern Belgium. Mortality rates for 20-year olds in the textile suburb of Dison or the heavy industrial center of Seraing were 25, 50, or even 100 per cent higher than those in Sart. So, although migrants had more favorable mortality experiences than either their neighbors in Sart or natives of the industrial towns to which they moved, they were moving to a much less healthy environment. Over the course of the century, therefore, much of the benefit from the falling mortality rates in places like Sart was lost as migrants left for overcrowded, unsanitary urban places.

5. FROM SELECTION TO HETEROGENEITY: MORTALITY AND MIGRATION OF ADULTS FROM AN URBAN PERSPECTIVE

Tilleur was a small municipality of about 4.3 square km., located between the industrial centre of Seraing and the city of Liège, home of one of Europe's richest coal-fields. The industrial revolution started with the establishment of coal-mines in 1828 and 1830 by two capitalist companies using modern machines. After Belgian independence in 1830, one of these companies, the *Société de Sclessin*, wanted to construct a new outlet for its production to compensate for the loss of the Dutch market. With the technical help of the famous John Cockerill and the financial help of the very important *Société Générale* bank, they added coke blast furnaces, then a steel mill, and foundries to their coal-mines (see Soete and Caulier-Mathy contributions in Van der Herten et al., 1995). From the mid-1830s until 1850-1860, Tilleur belonged to a group of four adjacent localities (with Seraing, Ougrée and Grivegnée) which form the strongest center of iron production in continental Europe and the heart of the Belgian industrial revolution.

TABLE 7 COMPONENTS OF POPULATION CHANGE IN TILLEUR, 1830-1880

Period beginning	Population on January 1	Changes in following period: Net change	Births	Deaths	Natural increase	Net migration
1830	611	773				
1846	1384	862	757	550	207	655
1856	2246	806	1184	891	293	513
1866	3052	1259	2357	1300	1057	202
1880	4311					

Source: Population registers of Tilleur.

In 1807, Tilleur had only 520 inhabitants working in agriculture and open-air mines. In 1831, the population hardly exceeded 600 persons. But in 1846, the *Sclessin Society* already employed 838 workers, and 1,875 in 1869. Clearly, the arrival of modern industry destabilized this village as it exploded to reach 6,500 inhabitants in 1900. The rest of the story is quite typical of industrial urbanization. At the census of 1807, 85 per cent of Tilleur's citizens were natives of the locality. In 1847, this proportion dropped to 42 per cent, in 1856 to barely 33 per cent, then it grew to 43 per cent in 1880. In table 7, we see how, after 1856 and especially after 1866, the natural excess of births over deaths took over from net migration as the motor of demographic growth. This is the transition between the explosive foundation phase and the maturation phase that we discussed in section 1. In the case of Tilleur, we have been able to show how the first phase generated the second one, because the massive flows of in-migrants radically changed the marriage market (the sex ratio grew from 93 men for 100 women to 119 between 1830 and 1866) inducing intense and precocious female nuptiality and high birth rates. Between 1857 and 1880, 86 per cent of the births in Tilleur came from in-migrant mothers (Oris, 1996). The evolution of mortality was no less typical, with the distinct mark of the epidemiological depression (see section 2). Cholera epidemics in 1849, 1855, and 1866 each killed 6 per cent of inhabitants in a few months, while smallpox raged in 1871 and childhood diseases spread in 1857. Life expectancy fluctuated around 30 years between 1847 and 1873. (See Neven, 2000b for a detailed presentation.)

The relatively modest size of Tilleur permitted us to carry out a complete adjustment for the under-registration of births and deaths in the population registers. Linkage of the nominal records allowed us to identify under-registration due to migration, which was rather low at less than 10 per cent. This long and tedious process reconstructed the life histories of all inhabitants from 1846 to 1880. The resulting database consists of 101,416 person-years, 2,620 deaths and 14,265 in-migrations for 17,135 individuals (for more details on the database, see Neven 2000b, 298-300). Tilleur is also an interesting case because the locality received distinct groups of migrants: people from other parts of the Liège industrial basin, from rural regions of the French speaking part of Belgium, from the Flemish speaking region, and from foreign countries (see Oris, 1996, table 1 for statistics). Moreover, an analysis of marriage has clearly shown that these sub-populations had distinct patterns, and that the last two groups were segregated by the first two (Oris, 2000).

Table 8 extends the analysis on Sart, again using Cox proportional hazard models to study the mortality risks of adults in Tilleur. We ran separate models on four groups, single men, single women, ever-married men and ever-married women, to compare the effect of region of origin, as defined by the place of birth. The first part of the table is a very parsimonious model, with origin, a dummy variable for the period (before or after 1874, to take into account the beginning of the mortality decline), and another dummy variable describing relationship to the household head for single persons (son or daughter of the head, or anything else). In the second part of the table, we include the social status (of the household head for the married adult women, of the individual for the other categories). In the event-history analyses the effect of one explanatory variable takes into account the effects of other variables present in the model. This means that if we observe higher mortality for Flemish natives while social-professional position is also specified, this over-mortality cannot be attributed to the concentration of Flemish immigrants in the low social statuses of coal miners and day laborers. With multivariate analysis, we have a way to deal with the ambiguous causalities created by the segregation on the labor market.

The simple models of mortality among ever-married adults of both sexes confirm the discrimination against Flemish natives and foreigners. They incurred 35 to 87 per cent higher risks of dying than the reference category, people born in the urban and industrial region of Liège (including the natives of Tilleur). In the more complete model, we see that a part of these influences is captured by the socio-professional structure, but it is a general effect since no specific category stands out. The only exception is among the ever-married women who had a 53 per cent higher probability of death than the wives of coal miners when the household head was unemployed. This situation usually involves households headed by a widow or a man with disabilities.

TABLE 8 HAZARD PROBABILITIES OF THE RISK OF DYING AMONG THE ADULTS, TILLEUR, 1847-1880

Explanatory variables	*Single men 15-49*		*Single women 15-49*		*Married men 20-54*		*Married women 20-54*	
	Relative risks	*p>z*	*Relative risks*	*p>z*	*Relative risks*	*p>z*	*Relative risks*	*p>z*
				Model 1				
Region of origin								
Urban & Industrial	1.000		1.000		1.000		1.000	
Rural	1.324	0.246	0.752	0.416	1.228	0.258	1.128	0.515
Flemish	1.054	0.823	0.740	0.492	**1.375**	0.066	**1.587**	0.006
Foreign	0.951	0.874	1.264	0.527	**1.869**	0.001	1.348	0.118
Unknown	–	–	–	–	1.832	0.243	0.536	0.535
Relationship to household head								
Son/daughter	**1.843**	0.003	**2.142**	0.015	–	–	–	–
Other	1.000		1.000		–	–	–	–
Periods								
1847-1873	1.000		1.000		1.000		1.000	
1874-1880	0.837	0.464	0.993	0.981	0.813	0.193	**0.666**	0.022
N. deaths	131		73		268		239	
Person-years	39380		19959		43149		44173	
Chi2	14.66		10.53		13.37		14.54	
Prob>chi2	0.023		0.104		0.020		0.013	
				Model 2				
Socio-professional status								
No activity	1.202	0.584	1.158	0.578	0.429	0.101	**1.529**	0.081
Daily laborer	1.521	0.160	1.000		1.031	0.856	1.180	0.387
Coal miner	1.000		–	–				
Iron worker	0.964	0.930	–	–	0.874	0.535	0.789	0.339
Petty bourgeoisie	1.508	0.298	0.402	0.373	0.894	0.625	0.827	0.461
Region of origin								
Urban & Industrial	1.000		1.000		1.000		1.000	
Rural	1.258	0.350	0.763	0.442	1.197	0.327	1.100	0.609
Flemish	1.002	0.994	0.755	0.522	1.276	0.197	**1.378**	0.077
Foreign	1.033	0.922	1.301	0.483	**1.797**	0.006	1.258	0.275
Unknown	–	–	–	–	1.816	0.252	0.499	0.491
Relationship to household head								
Son/daughter	**1.933**	0.002	**2.018**	0.029	–	–	–	–
Other	1.000		1.000		–	–	–	–
Periods								
1847-1873	1.000		1.000		1.000		1.000	
1874-1880	0.863	0.562	0.945	0.856	0.832	0.248	**0.648**	0.015
N. deaths	131		73		268		239	
Person-years	39380		19959		43149		44173	
Chi2	18.46		15.73		17.87		23.19	
Prob>chi2	0.048		0.107		0.037		0.006	

In bold: significant at .10 level

Although mortality differed by origin and socio-professional position among ever-married adults, young, never-married persons above the age of 15 were untouched. Their relative risks of death were never significantly affected by region of birth or activity. In other analyses utilizing indicators of crowding or communal variables, like retail prices or wages, we have been surprised by the incredible resistance of this group, whose mortality did not seem to respond to any structural or conjunctural pressures (Alter, Neven, Oris, forthcoming). Our interpretation was that married persons tried to place roots in the industrial town and were exposed on a long term basis to its horrible ecological, hygienic, epidemiological and working conditions. In contrast, young single adults were mainly migrants moving alone or in small groups and making short stays. They suffered the worst conditions, living as lodgers in small, crowded houses. They could cope with these terrible circumstances, precisely because they did not stay for a long time and because they were probably a select and unusually healthy group. This is perfectly consistent with the analysis of Sart data carried out in the preceding section.

To examine these hypotheses and to highlight questions about epidemiological shock versus accommodation, we identified five groups: (1) born in the urban and industrial region of Liège (including the natives of Tilleur), (2) born elsewhere and present in Tilleur for less than one year, (3) present for at least one year and less than 5, (4) present for 5 years or more, and (5) truncated observations, e.g. an immigrant first observed in the census of 1846 whose length of stay is unknown. The first group was the reference category. Then, we tested several models, simple or complex, without or with interactions, and obtained only confusing results! It would be interesting to discover the reasons for this failure. The problem may be that we implicitly considered Tilleur as a kind of island by considering only length of stay in the commune. However, this small town is located between two 'monsters', Seraing and Liège, in a large industrial agglomeration. In the Belgian population registers, we have not only the place of birth but also the place of origin, commune of residence just before arrival in Tilleur. These records show that 70 per cent of the foreigners, 66 per cent of the Flemish natives, and even 62 per cent of the people born in the Walloon countryside, had not arrived directly. Many came from the Seraing basin (Seraing, Ougrée, Jemeppe, Flémalle) and from the rest of the Liège agglomeration. This means that they already had some familiarity with the urban-industrial world that we cannot measure in the Tilleur data.

A partial way to bypass this problem is to examine differences by family composition in table 8. Among unmarried adolescents and adults, those living with their parents were twice as likely to die. Those living with parents represented 51.2 per cent of the person-years observed between 1847 and 1880 in Tilleur among single adult males, and 68 per cent among females. Those without parents were more numerous than the person-years suggest, because they were usually migrants staying for a short time, contributing to the notorious transiency that characterized the industrial town. These migrants were responsible for this surprising under-mortality of the working adults in the heart of the industrial revolution . As we noted above, their selection on the basis of health as well as their duration of exposure to urban hazards could explain this pattern. We must note an alternative explanation, however. It is also possible that when they fell ill and had no kin in the industrial town, they returned to the parental home where they eventually died. Indeed, in parliamentary debates about Belgian poor relief some representatives pointed out that local charity offices in the countryside unfairly bore heavy expenses for the care of migrants whose health had deteriorated in towns (Neven, 2000a, 553).

The other part of the story is that the selective effect of migration did not protect children who came with their parents and siblings or were born in the industrial town. Analyses run elsewhere (Neven, 2000b; Alter, Neven, Oris, forthcoming; Oris et al., 1999) show that the effects of mortality on the household economy could be very dangerous for them. The death of a parent, especially the male household head, and the burdens of younger siblings, especially when the father's income declined at older ages, substantially increased the risks of dying for adolescents and young adults. Stereotypes from the industrial revolution of children who precociously entered the workforce and sacrificed themselves for their needy families are confirmed in the nineteenth century experience of Tilleur.

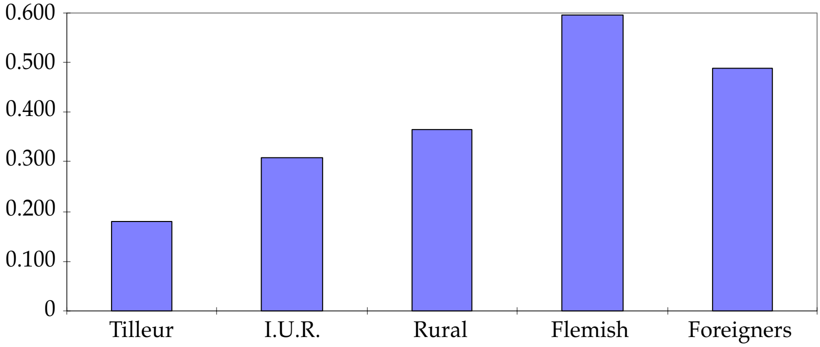
Thus, we arrive at an important distinction. On one side, we have highly mobile, single migrants passing through the industrial world, who were at the heart of this peculiar pattern of lower than expected adult mortality in the urban-industrial environment. On the other side, we have families trying to establish roots, live, and survive in harsh ecological conditions, who formed a miserable proletariat with a precarious household economy. Such a distinction is still rough, but it constitutes a good starting point for further investigations.

6. WHEN CHILDREN PAID: DIFFERENTIAL MORTALITY AT YOUNG AGES IN AN INDUSTRIAL TOWN

The idea that families paid for economic growth and urbanization by furnishing the victims of the epidemiological depression is confirmed by the excess mortality among children, another peculiarity of the urban-industrial mortality pattern. In fact, this is the most important cause of low life expectancies in industrial areas (see section 3, as well as Oris, 1998, 289-294; Neven, 2000b, 307-309). To understand this pattern and to address the role of migration, we must again go beyond the use of simple, static information like the place of birth. Readers have certainly observed that in section 3 we used expectation of life at 5 and not at birth, while in sections 4 and 5 we focused on adults. Expectation of life is often estimated from cross-sectional tables, where the denominator is the population present during a census. In these cross-sectional surveys, non-natives less than 5 years old are very few, even in a big centre like Seraing. Mortality is very high at these young ages, and random variations due to small numbers make expectation of life at birth (e_0) much less accurate than expectation of life at age 5 (e_5). Moreover, when we can distinguish natives and immigrants only on the basis of their birthplace, the children of inmigrants are counted as natives in the computation of expectation of life at birth, which is not sociologically correct.

To complete our analysis, we return to the Tilleur database. Figure 7 is based on the population registers, in which the household and not the family is the basic unit. It shows mortality at ages 0-4 between 1857 and 1866 according to the regional or cultural origin of the household head.

FIGURE 7: RISK OF MORTALITY FOR THE AGE GROUP 0-4 ACCORDING TO THE CULTURAL ORIGIN OF THE HOUSEHOLD HEAD. TILLEUR, 1857-1866



Mortality differences among migrant communities were obviously large. The children of Flemish in-migrants were three times more likely to die than children of Tilleur natives. Perhaps for natives, the size of the population is a problem: 2,810 person-years but only 55 deaths. However, a clear contrast exists between Flemish and foreigners on one hand and Walloons on the other: Tilleur was a graveyard for children of the former. Following the mortality patterns observed between 1857 and 1866, the chances of dying before their fifth birthday were no less than 60 per cent in households headed by a Flemish migrant and about 50 per cent for foreigners compared to 37 per cent for migrants from the Walloon countryside and 31 per cent for natives of industrial and urban regions (I.U.R.).

Obviously, if selection on the basis of health and resistance played an important role in recruiting adult migrants, their children did not benefit from any genetic protection. Important differences appear to be linked to both adaptations to the bacterial and ecological environment, which was more familiar to people from the industrial and urban regions, and to culture. From this point of view, we should remember other differences between French (Walloon) and Flemish parts of the Kingdom in nineteenth century. In particular, breast-feeding and the duration of lactation differed between regions, and consequently both infant and maternal mortality were higher in Flanders, as was fertility (see among others, Masuy-Stroobant, 1983; Lesthaege, 1977). The quality of water and of food in general was particularly bad in places like Tilleur, and it was difficult to obtain fresh cow milk before Pasteurisation (Oris, 1998, 300). We suspect that weaning was a very dangerous moment, and that the shorter duration of breast-feeding among the Flemish and foreign families exposed babies to environment hazards, when they were younger and more frail.

Within the frame of the *EurAsian Project for the Comparative Study of Population and the Family*, a team of scholars has recently developed a methodology to test this sort of hypotheses (see Breschi et al., forthcoming). The main feature is a segmentation of the different stages of infant and child life (proposed originally by Breschi and Derosas, 2000, 220). In table 9, we examine mortality risks during the first 10 days of life, a period from 10 days to 6 months of life, 6 months to less than 1 year, and finally from 1 to less than 5 years. This implies that we work on small populations, but event-history methods are suited for that purpose (see Allison, 1984; Alter, 1998). Each estimated coefficient is associated with a probability of statistical significance (the p>z value), and since Cox regression is time transformation invariant, time at risk is of no significance. What matters are risk set sizes and the number of transitions (deaths) at each observed time point (age). The amount of information in the sample is approximately proportionate to the total number of observed deaths. In the present study, the concentration of so many deaths at young ages is suited to this approach.

By using a multivariate approach, we can see when social factors took the place of biological ones. A newborn has a very weak immune system, but active biological substances in the mother's milk are highly protective (Livi-Bacci, 1999, 179). Consequently, we expect that biological factors remained a primary determinant until weaning, the real transition between infancy and childhood. We expect mortality differentials by social status or region of origin as well as sensitivity to seasonality to appear in childhood (see Bengtsson, 1999). Indeed, the interpretation of seasonality is related to food quality (see Lee, 1988, 16, or Breschi and Livi-Bacci, 1994, among many others). In historical Europe infant mortality usually peaked during the winter months, except in the coldest areas where populations were accustomed to coping with the climate. In cold or temperate Northwest Europe, winter remained the most dangerous season until the fifth birthday, while in Mediterranean Europe mortality peaked during the summer after six months of life. The warm summers of the Mediterranean unleashed a multitude of infectious diseases of the digestive system, which were particularly dangerous to infants at the time of weaning (Caselli, 1991; Breschi et al., forthcoming).

In table 9, we see that the biological factor *par excellence*, sex, was very significant until 6 months of age. Girls were 56 per cent less likely to die during the first ten days of life, and their risks were still 28 per cent lower between 10 days and 6 months. At the very beginning of life, we observe an over-mortality large enough to be statistically significant among the babies of daily laborers and iron workers, when compared to the reference category, the children of coal miners. This must be related to practices affecting the delivery or the care of newborns, but we do not know precisely how. The influence of season was not significant, but the general pattern was clear and typical: summer was the best period to start life.

Immediately after the 10 first days of life, however, summer became the worst season, and remained the most dangerous. This could be due to water or food that was more frequently contaminated in the summer. But these were complementary to the mother's breast-feeding, not an alternative, because social differentials indicating weaning did not appear before the first birthday. If we look at the children of Flemish households in particular, their relative risks of mortality at 10-164 days or 6 months-1 year are only 2 to 8 per cent higher than the reference category. These deviations are not significant from a statistical point of view. Because of its horrible hygienic conditions and difficulties in constructing an efficient system of retail food supply, Tilleur, an industrial city in Northwest Europe, followed the Mediterranean pattern! But the heterogeneous population of the town seems to have been affected equally. Surprisingly, from the multivariate models we do not observe significant differences among groups in either the mortality of primary infancy (10 days-

TABLE 9 HAZARD PROBABILITIES OF RISKS OF DYING IN INFANCY AND CHILDHOOD, TILLEUR, 1846-1880

Explanatory variables	*0-9 days*		*10-164 days*		*6 months - < 1 year*		*1-4 years*	
	Relative risks	*p>z*	*Relative risks*	*p>z*	*Relative risks*	*p>z*	*Relative risks*	*p>z*
Sex								
Male	1.000		1.000		1.000		1.000	
Female	**0.443**	0.001	**0.723**	0.004	0.907	0.482	0.932	0.401
Socio-professional status								
No activity	0.799	0.774	0.856	0.530	0.917	0.789	1.145	0.476
Daily laborer	**1.949**	0.095	0.898	0.478	1.019	0.920	0.948	0.650
Coal miner	1.000		1.000		1.000		1.000	
Iron worker	**2.657**	0.017	0.786	0.174	0.710	0.142	**0.751**	0.043
Petty bourgeoisie	1.748	0.240	0.791	0.247	0.714	0.203	**0.525**	0.000
Region of origin								
Urban & industrial	1.000		1.000		1.000		**1.000**	
Rural	1.386	0.284	0.898	0.539	0.940	0.777	1.171	0.211
Flemish	0.804	0.591	1.076	0.644	1.017	0.934	**1.649**	0.000
Foreign	1.451	0.397	**0.695**	0.096	1.182	0.461	**1.284**	0.080
Unknown	0.000	–	1.851	0.138	0.511	0.504	1.569	0.241
Current season								
Summer	1.000		1.000		1.000		1.000	
Spring	1.657	0.157	**0.636**	0.003	**0.691**	0.062	**0.677**	0.001
Fall	1.157	0.712	**0.725**	0.036	**0.705**	0.073	**0.774**	0.026
Winter	1.712	0.132	**0.770**	0.079	0.857	0.412	0.833	0.114
Periods								
1847-1873	1.000		**1.000**		1.000		1.000	
1874-1880	0.685	0.186	0.913	0.459	**0.691**	0.029	**0.695**	0.000
N. deaths	221		343		209		575	
Person-years	97		1685		1734		8701	
Chi2	29.45		26.14		17.28		75.23	
Prob>chi2	0.0056		0.0163		0.1869		0.0000	

In bold: significant at .10 level

6 months), which is largely due to endogenous causes, or the mortality of the second stage of infancy (6 months-1 year), which is largely exogenous and was most responsive to improving environmental conditions (a decrease of 31 per cent from 1847-1873 to 1874-1880).

When we turn to mortality between 1 and 5 years, important differences emerge. Again, we find an interaction between social (socio-professional status) and cultural (region of origin) factors, even more clearly than among married adults: some activities of the household head were protective, some origins were negative. Compared to the children of coal miners, those of iron workers were one fourth less likely to die, and those of the petty bourgeoisie half less. On the other hand, children of foreigners were 28 per cent more at risk than the children of natives from Walloon urban and industrial areas, and children of Flemish migrants had a 65 per cent higher probability of dying between their first and fifth birthday. The appearance of these differentials did not affect the seasonal pattern, and in fact, the model without seasonality shows almost exactly the same results.

We cannot explain the excess mortality of children in Flemish households by referring to breast-feeding practices, because it begins after age one, when weaning was less likely to matter. Seasonal variations in food and water quality were obviously an important factor beginning after 10 days of life, but these effects were shared equally. The appearance of social and cultural differentials between ages 1 and 5 confirms the conclusion of Preston and Van de Walle in their classic 1978 study of mortality in nineteenth century French towns, i.e that mortality between 1 and 5 was a better indicator of living conditions, especially sanitary conditions, than infant mortality. With aggregate data, Eggerickx and Debuisson (1990) and Kearns (1993) have demonstrated that mortality between ages 1 and 5 had a much larger range of variation than infant mortality, which is also confirmed in our micro data on Tilleur and other researchers in the *EurAsian Project* (Breschi et al., forthcoming).

Our analysis has rejected one hypothesis and established a few facts, but we are always searching for explanations. Why were there so many deaths among Flemish children and to a lesser extent those of foreign households? Some years ago, one of us did an exercise on the use of the *own child method*. This approach tabulates the children alive at a census by age and by mother's age. Then, estimated survival rates are applied to retrospectively reconstruct fertility levels during the 10 or 12 preceding years (see Breschi and De Santis, 1995 for a comprehensive presentation). Since we can rely on population registers and not just the census, our role in this project was to see when the method failed and why. When we applied the method to Tilleur data (taking the census of December 31, 1866 as a starting point), an interesting discrepancy occurred between the estimates from cross-sectional data and the longitudinal histories directly observed in the population registers. While the results obtained with the own child method were generally good and close to the longitudinal results, the own child estimate of 14.8 children per woman for Flemish migrants was obviously excessive. This occurred because 40 per cent of the children in Flemish households were not born in Tilleur, and another 16 per cent were born in Tilleur but had experienced at least one migration between their birth and the census of 1866. Consequently, we applied the wrong survival rates to these children. The own child method assumed that they had experienced the high mortality prevalent in Tilleur during the epidemiological depression (remember figure 7), but many of them had spent the crucial first months or years of their lives in much more favorable environments.

The distance between the own child estimate and the more accurate longitudinal method (14.8 vs. 9.7 children per woman) can be seen as a proof that Flemish children had much lower mortality before their arrival in Tilleur, where they confronted a real epidemiological shock. What was the nature of this shock? For the reasons explained above, it is difficult to delve further into this issue. Since migratory paths from the Flemish provinces to Tilleur often went through Liège, Seraing, and other places, we cannot use length of stay in Tilleur as an indicator of duration of exposure to urban-industrial epidemiological conditions. As for the adult in-migrants, our conclusions must be limited.

CONCLUSIONS

The relationships between migration and mortality form a pattern, which is itself inscribed in changing trends in mobility and epidemiological conditions. This paper was not intended to identify all these relationships, but we believe that some important results have emerged. In industrial towns, migration had a positive impact on mortality in the short-term, because many adult migrants were healthier than natives of the same age. But the impact of heavy migration on urban ecology and housing conditions produced a mortality increase that went beyond the effect of changing the age structure of the population. Within urban and industrial populations, migration was the primary cause of the particular mortality pattern of coal mining and factory towns. These places had both high infant and child mortality and relatively low adult mortality, in spite of the bad working and housing conditions.

The peculiarity, lower than expected adult mortality in industrial towns, was a special feature of these areas that we do not find in traditional cities. The evidence from Seraing suggests that the favorable position of adult migrants disappeared when industrial settlements became more mature, a phase characterized by lower proportions of non-natives and a rise in short-distance mobility. Urban and rural evidence from the multivariate analyses of individual longitudinal data shows that single adult migrants may have been protected by their high mobility. However, they also appear to be a select population, recruited disproportionately among healthier families. We have seen that they had quite different mortality than married adults, and they were even more different from their non-migrant peers. Young single adults of the same age who lived with their parents in the industrial towns were very responsive to fluctuations in the proletarian family economy.

Even when adult migrants had relatively favorable survival rates, the children of migrants were disproportionately affected by urban epidemiological conditions. Shortly after birth seasonal variations in mortality in nineteenth century Tilleur followed the Mediterranean pattern, a sign of extremely poor food and water quality, which affected even breast-fed babies. In the first days of life this penalty was imposed on the entire population. It is only after the first birthday that origin and social-professional status of parents interacted, producing large mortality differences within an apparently homogeneous proletarian population (Neven, 2000b). The causes of this differential remain unclear, but we found indirect evidence that familiarity with the epidemiological environment of the industrial world was the most important factor. For sons and daughters of Flemish migrants, the relationship between mortality and migration reflected the road taken by their parents, often involving several transitions between relatively benign rural areas and urban environments that were especially dangerous for children. This pattern was specific to the context of nineteenth-century East Belgium. During this time of industrial expansion and epidemiological depression, the mortality gap between countryside and towns had probably never been so large, and life expectancies were more than ten years higher in the rural world! (cfr. section 2 and Neven, 1997; 2000a).

Beyond these specific research questions, our results show the value of longitudinal data, in which the populations at risk can be defined with more precision. This is the best way to confirm, reject or sometimes re-specify the many stereotypes about migrants and the health of industrial populations. Taking into account the high risks faced by children under age 5 and by the adolescents living with their parents, we can conclude that the real challenge was not migrating to the boom towns at the heart of the industrial revolution, but raising a family in this new environment. Obviously, family history must become central to a new social history of the formation of the nineteenth-century working class.

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Wegen naar de stad en routes naar de dood: sterfte en migratie in het oosten van België tijdens de industriële revolutie

MICHEL ORIS
GEORGE ALTER

SAMENVATTING

De relaties tussen migratie en sterfte maken deel uit een ingewikkeld systeem dat evolueert naargelang de ecologische omstandigheden en de tendensen in mobiliteit. Ten eerste betekende de negentiende-eeuwse migratierevolutie veel meer dan een loutere plattelandsvlucht. Daarnaast groeide door een indrukwekkende epidemiologische depressie in de industriële voorbuurten het sterftecontrast tussen stad en platteland aanzienlijk, en dit op het ogenblik dat de grote instromen de twee werelden met elkaar in verbintenis brachten. De studie van de relaties tussen migratie en sterfte levert een aantal belangrijke resultaten. Op korte termijn had migratie voor de industriële steden een positieve impact aangezien veel volwassen migranten in betere gezondheid verkeerden dan stadsbewoners van dezelfde leeftijd. Niettegenstaande, op middellange termijn bracht de impact van massamigratie op de stedelijke ecologie en woonomstandigheden een sterftepiek teweeg, die verder ging dan een simpele wijziging van de leeftijdsstructuren. Migratie lag daarenboven aan de basis van het specifieke sterftepatroon van steenkool- en fabriekssteden. Dit patroon, dat we niet terugvinden in traditionele steden, onderscheidde zich door hoge zuigelingen- en kindersterfte, en een relatief lage volwassenensterfte, en dit ondanks de slechte werk- en woonomstandigheden.

Het voorbeeld van Seraing toont aan dat de gunstige positie van volwassen migranten tijdens de zogenaamde "maturisatiefase" van industriële steden verdween, een fase die zich karakteriseerde door lage proporties niet-autochtonen en een stijging van de korte termijnbewegingen. Niettegenstaande lijken deze migranten een geselecteerde bevolking, onevenwichtig gerekruteerd uit gezonde families.

Alhoewel volwassen migranten gunstige sterftekansen genoten, werden de kinderen van deze migranten meer getroffen door de stedelijke ecologie. De seizoenschommelingen van de zuigelingensterfte in Tilleur volgen een mediterraan patroon, en getuigen van uitzonderlijk arme voeding en slechte kwaliteit van het water. Tijdens de eerste levensjaren werd de ganse bevolking getroffen. Na het eerste levensjaar ging het socio-professioneel statuut van de ouders en hun afkomst een rol spelen, wat resulteerde in grote sterfteverschillen binnen een ogenschijnlijk homogeen proletariaat. De oorzaken van deze verschillen blijven tot op vandaag onbekend, maar een aantal

onrechtstreekse bewijzen suggereren dat de familiariteit met de epidemiologische omgeving van de industriële wereld de belangrijkste factor vormt.

Naast deze specifieke onderzoeksvragen tonen onze resultaten het belang van longitudinale gegevens aan; ze stimuleren om de risicobevolking met meer precisie te definiëren. Het is de beste manier om de vele stereotypen over de gezondheid van industriële populaties en over migranten te bevestigen, te verwerpen of te herspecifiëren. Gegeven de risico's voor jonge kinderen en inwonende adolescenten, kunnen we besluiten dat de grote uitdaging niet zozeer de migratie naar een industriële stad was, maar wel het stichten van een gezin in deze nieuwe omgeving. Inderdaad, gezinsgeschiedenis is essentieel voor een hernieuwde sociale geschiedenis van de negentiende-eeuwse arbeidersklasse.

Chemins vers la ville et routes vers la mort: mortalité et migration dans l'est de la Belgique pendant la révolution industrielle

MICHEL ORIS
GEORGE ALTER

RÉSUMÉ

Les relations entre migration et mortalité forment un système complexe, qui évolue en fonction des tendances de la mobilité et des conditions épidémiologiques. D'une part, la révolution migratoire fut bien plus qu'un simple exode rural. D'autre part, une dépression épidémiologique impressionnante dans les faubourgs industriels a substantiellement accru l'écart de mortalité entre ville et campagne, précisément au moment où des flux massifs relient les deux mondes. L'étude des relations entre migrations et mortalité fait ressortir une série de résultats importants. Dans les villes industrielles, la migration a un impact positif sur la mortalité à court terme, parce que beaucoup de migrants adultes sont en meilleure santé que les natifs du même âge. Toutefois, l'impact des migrations de masse sur l'écologie urbaine et les conditions de logement produisent à moyen terme une hausse de la mortalité, qui va au-delà d'une simple modification des structures de la population. En outre, la migration est à l'origine du patron particulier de la mortalité des villes charbonnières et manufacturières, qui se distinguent pas une mortalité infantile et enfantine élevée et une mortalité adulte relativement basse, en dépit des mauvaises conditions de travail et de logement. C'est une particularité assez inattendue des centres industriels, que l'on ne retrouve pas dans les villes traditionnelles.

L'exemple de Seraing tend à monter que la position favorable des migrants adultes disparaît lors de la "phase de maturation" des villes industrielles, phase qui se caractérise par des proportions plus basses de non-natifs et par une augmentation des mouvements de courte distance. Cependant, ces migrants apparaissent aussi comme une population sélectionnée, recrutée de façon disproportionnée parmi les familles saines, en bonne santé.

Toutefois, alors que les migrants adultes bénéficient de quotients de mortalité favorables, les enfants de migrants sont sur-affectés par les conditions épidémiologiques urbaines. Juste après la naissance, les variations saisonnières de la mortalité infantile à Tilleur au XIXe siècle suivent le patron méditerranéen, ce qui témoigne d'une nourriture extrêmement pauvre et de la mauvaise qualité de l'eau. Dans les premiers jours de vie, cette pénalité touche l'ensemble de la population. C'est seulement après un an que le statut socio-professionnel des parents et leur origine interviennent, produisant de larges différences de mortalité au sein d'une population prolétaire apparemment

homogène. Les causes de ces différences restent à ce jour inconnues, mais une série de preuves indirectes indiquent que la familiarité avec l'environnement épidémiologique du monde industriel était le facteur le plus important.

Au-delà de ces questions de recherche spécifiques, nos résultats montrent la valeur des données longitudinales, qui permettent de définir avec plus de précision la population à risque. C'est le meilleur chemin pour confirmer, rejeter ou parfois re-spécifier les nombreux stéréotypes sur les migrants et la santé des populations industrielles. Etant donné les risques encourus par les enfants de moins de cinq ans et par les adolescents vivant avec leurs parents, nous pouvons conclure que le réel challenge n'était pas de migrer vers les villes en pleine croissance au cœur de la révolution industrielle, mais bien de fonder une famille au sein de ce nouvel environnement. Manifestement, l'histoire de la famille est essentielle pour renouveler l'histoire sociale de la formation de la classe ouvrière au XIXe siècle.