Economic Crisis, Manorialism, and Demographic Response: Southern Sweden in the Preindustrial Period

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Published in:
Demographic Responses to Economic and Environmental Crises

2010

Demographic Responses to Economic and Environmental Crises

Edited by

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Proceedings of the IUSSP Seminar

May 21-23, 2009, Reitaku University

Kashiwa, Japan, 2010

Reitaku University

Reitaku University

Hikarigaoka 2-1-1, Kashiwa, Chiba 277-8686 Japan

Preface

This volume is the proceedings of the IUSSP (International Union for the Scientific Study of Population) seminar on "Demographic Responses to Sudden Economic and Environmental Change." The seminar took place in Kashiwa, Chiba, Japan, May 21-23, 2009. The fourteen papers presented at the seminar are included in this volume. The seminar was followed by a public symposium "Lessons from the Past: Climate, Disease, and Famine" in which five participants of the seminar presented and discussed issues related to the seminar to an audience that included 245 scholars, students and members of the public. Two additional papers presented at the symposium are also included in this volume.

The seminar was organized by the IUSSP Scientific Panel on Historical Demography and hosted by Reitaku University. The seminar received support from Reitaku University and was held in cooperation with the Centre for Economic Demography, Lund University and the Population Association of Japan. The public symposium was organized as part of a series of events to commemorate the 50th anniversary of Reitaku University.

The topic of the seminar was timely not only in the academic sense, but also in a practical sense, with the simultaneous worldwide outbreak of H1N1 flu. The local organizer had to prepare for various scenarios according to instructions given by the prefectural education commission that changed almost every other week. In early May, Japan went to the highest alert level and required screening of all airline passengers from abroad upon arrival. Some travelers suspected of being infected were quarantined for more than a week. The prefectural education commission even announced that all schools in the six neighboring cities would be shut down if even one infectious case was found among students, teachers or anyone else connected to the schools. In mid-May, after an infectious case was found domestically among someone who had not been abroad and had not been exposed to any visitors from abroad, the government drastically reduced the screening procedures at all airports.

This exemplified how people as well as government react to an outbreak of a disease, and therefore was an interesting and educational experience. Luckily, no participants were quarantined on their arrival and the seminar and symposium were held as originally planned. Since one of the topics covered in the symposium was the Spanish Flu in 1918-20, the symposium attracted greater interest from the public.

We are grateful to Reitaku University for hosting and sponsoring the IUSSP seminar, and for publishing this volume. We thank Professor Osamu Nakayama, the president of Reitaku University, Mr. Mototaka Hiroike, the board director of the Hiroike Institute of Education, and many staff members of Reitaku University as well as those at the Population and Family History Project at Reitaku for their support. We also thank Ms. Tomomi Hasegawa for helping with the copy-editing of this volume.

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Introduction

The focus of the papers in this volume is the effects on the demographic behavior of individuals and families of various crises that threatened most people in the past and many people even today. Such crises may be social, political, or economic in origin, stemming for example from financial shocks, harvest failure, violent food price fluctuations, regime change, or war. Alternatively they may be associated with natural disasters, stemming from earthquakes, unusually hot or cold summers, and droughts. Responses differ because while some changes were both rare and severe and therefore almost impossible to prepare for, others were milder and frequent enough to plan for.

Analyses of variations of demographic outcomes have basically followed two paths. The first one takes a time series model approach, analyzing causes of demographic variation over a certain period of time. In this approach linear or non-linear responses to such external factors as real wages, food prices, temperature, etc are analyzed. The focus is thus on testing *hypotheses* about determinants of demographic outcomes. The other path takes an entirely different approach, focussing on one or a few demographic crises, and in this way takes an *exploratory* approach (see Walter and Schofield 1989 or Bengtsson and Reher 1998 for an overview).

The influence of various forms of economic and environment change on demographic behavior is already well-documented in contemporary and historical empirical studies that apply a time series approach. For example, based on numerous studies of aggregated data from preindustrial populations, we know that economic fluctuations, as reflected in short-term changes in food prices, influenced demographic behavior, particularly fertility, but also mortality and migration (Galloway 1988; Lee 1981, 1990; for an overview see Bengtsson and Reher 1998). Contemporary financial crises, economic uncertainty, climatic fluctuations, and natural disasters all influence social and demographic outcomes, though response patterns are diverse, varying by time and place (Henry et al. 2004; Pörtner 2008; Thomas and Frankenberg 2006). The long term demographic effects of such crises, whether historical or modern, are in most cases limited since various population mechanisms make up for the initial losses rather quickly. Prominent exceptions included the Black Death, which erupted repeatedly and took centuries to overcome. However, even if most crises had only transitory effects, these effects can be severe.

Response patterns that appear quite modest from a comparison of aggregated data may conceal great diversity within a society and a severe response in a subset of the population. For example, evidence suggests that even while the magnitude of mortality responses to economic conditions in different populations appeared similar, underlying patterns of responses by socioeconomic status, household composition, and individual context were diverse. While some groups were not affected at all, others suffered a lot (Bengtsson, Campbell, Lee et al. 2004; Bengtsson and Saito 2000).

The diversity of responses reflects the multiplicity of options available to households and individuals. The precise configuration of available options depends not only on economic structure and social and cultural context, but also on household and individual factors. Some options are explicitly demographic, including delaying or foregoing marriage or childbearing. Some options were not specifically demographic, but affected demographic outcomes indirectly. Reductions in consumption, for example, may increase mortality risks. Short-term migration could reduce fertility by increasing spousal separation. Reduced savings, meanwhile, might have implications years later, by causing a delay in marriage, or reducing living standards during retirement.

Advances in data and methods allow for more detailed examination and comparison of demographic responses to economic and environmental pressure. Application of combined event history and time series techniques to longitudinal, individual and household level data allows for differentiation of demographic responses to changing economic conditions by individual socio-economic and demographic characteristics (Bengtsson 1993; see also Lee 1993), as well as by household characteristics (Bengtsson, Campbell, Lee et al. 2004). Such analyses show that patterns of demographic responses by socio-economic status, household composition, and individual characteristics to economic fluctuations were diverse (Allen, Bengtsson, and Dribe 2005; Bengtsson, Campbell, Lee et al. 2004; Bengtsson and Saito 2000; Tsuya, Wang, Alter, Lee et al 2010).

While this approach has been pursued most extensively for historical populations, especially by participants in the Eurasia Project on Population and Family History (Bengtsson, Campbell and Lee et al 2004; Tsuya, Wang, Alter, Lee et al 2010), it is amenable to application in a number of other recently constructed historical datasets based on household registers, family reconstitutions, genealogies, and other sources (e.g.

Engelen and Wolf 2005; Chuang et al. 2006), as well as contemporary datasets generated by panel surveys and administrative registration systems.

One problem with the time series approach, whether applied to macro or micro data, has been that it has not provided answers about whether demographic crises fundamentally differ from less pronounced demographic fluctuations in terms of root causes. While the time series model approach had been adapted for use for analyses of extreme environmental situations by accounting for non-linear effects, it has not been used to study whether extreme demographic crises are genuinely distinct from typical patterns of annual variation, or just “more of the same.”

The papers in this volume used both the explorative and the explanatory approaches in analyses of demographic variations during years of crises. Many of the studies applied new methods to novel historical and contemporary datasets with individual level information and thereby yielded new insights into the processes by which economic and environmental pressure translate into changes in demographic behavior. Several studies dealt explicitly with the question whether extreme demographic crises are genuinely distinct from typical patterns of annual variation. Taken together they dealt with a variety of crises of external origin across a wide range of time—the seventeenth century to the present—and space—including Europe, Asia, the United States and Africa. Studies looked at the external changes stemming from natural as well as political and economic origins. Crises included economic stress, political turmoil, harvest failure, famine, disease outbreak, earthquake, drought, and climate change.

The first six papers examined demographic responses to sudden changes in preindustrial period. By combining life-event and time-series techniques to analyze individual and household level data, these studies explored in detail processes by which economic and environmental pressure translate into changes in demographic behavior. Bengtsson and Broström (Chapter 1) analyzed mortality crises in a rural area in southern Sweden between 1766 and 1870 using a new approach to find out whether the causality during years of mortality crises differs from other years. They found that it differed in a number of ways, most notably with respect to effects of food prices. While high food prices almost always caused problems for the lower social strata, crises years were much different. Dribe, Olsson, and Svensson (Chapter 2) looked at the impact of regional economic fluctuations on demographic behavior for about 400 parishes in the province of Scania in southern Sweden. They demonstrated that manorial parishes exhibited a much smaller response to economic fluctuations than parishes dominated by freeholders, and argued that the manors helped insure against risk, which benefitted inhabitants by smoothing their consumption.

Two papers on Italy took a similar approach but compared multiple demographic responses—mortality, fertility, and nuptiality—by socioeconomic background in different regions. Breschi, Fornasin, Gonano, Manfredini, and Seghieri (Chapter 3) examined demographic responses to both short-term economic and epidemic stress in a Tuscan community 1819-1859 that had an economy largely based on sharecropping. The demography of the poorest classes emerged as being especially sensitive to the epidemiological environment and, to a lesser extent, short-term economic crises. Cholera, in particular, altered the entire demographic system of the poorest social groups by increasing mortality at all ages as well as household out-migration, and depressing fertility. Another paper by Breschi with co-authors (Chapter 4) applied the same approach to the region of Friuli in North-East Italy. Contrasting two populations, a mountain community and a parish of the plain, they found that in the mountain community, short-term economic stress affected mainly nuptiality and fertility, while in the plain, bad economic conditions influenced mortality. They suggested that the complex interaction between social and economic factors that existed in different areas of Italy were the basis of the differences in demographic responses.

In the Asian context, Tsuya and Kurosu (Chapter 5) examined demographic responses of men and women in preindustrial rural Japan to routine economic stress in normal years and to the two greatest famines in the early modern period, the Tenmei famine in the 1780s and the Tenpo famine in the 1830s. Modeling death and out-migration as competing risks, they found men were more likely to suffer death not only in the periods of the great famines but also in the years of less serious local economic downturns. But they were less likely to suffer death and to leave the village if they were in a wealthy household. Women responded to economic stress only when it was severe and widespread, for example during the times of the two massive famines. Campbell and Lee (Chapter 6) also examined the demographic impact of climatic fluctuations in northeast China in 1749-1909, distinguishing three periods during which there were cool summers of unusual frequency or intensity: 1782-1789, 1813-1815, and 1831-1841.

The results demonstrated that extended periods of adverse weather were associated with dramatic fluctuations not just in mortality, but also in fertility. The nature of demographic responses appears to have varied. They discussed a mixture of the expected and unexpected patterns of responses revealed by disaggregation by gender, age, socioeconomic status and other individual and family characteristics.

The next two papers discussed responses to external shocks of political origin in the twentieth century. Cai and Wang (Chapter 7) dealt with the demographic consequences of the Great Leap Forward famine, focusing on the mechanisms of fertility reduction. Their analysis revealed that, contrary to the popular periodization that the famine was a three year ordeal (1959-1961), 1959 was the single year that made the most difference. Their results further reinforce the view that the famine was caused mostly if not entirely by political miscalculations and mistakes of enormous historical proportions, rather than only poor harvests in 1959 to 1961. Even under the socialist system that was in place at the time of the famine, the effects of the famine varied by socioeconomic status: Urban Chinese as well as individuals of higher occupational status, such as professionals and officials, fared consistently better than others. Schoumaker, Vause, and Mangalu (Chapter 8), using recent retrospective data and event history models, demonstrated that international migration and political crises are closely related in DR Congo. They argued that international migration from DR Congo since the mid-1970s had been clearly influenced by political troubles and, to a lesser extent, by economic crises. Periods of political instability and wars have contributed to significantly higher risks of migration, especially to Europe and North America, but also to other places in Africa.

The next two papers discussed the influence of major earthquakes in Taiwan. Liu (Chapter 9) investigated measures of reconstruction after two major earthquakes undertaken by both the government and nongovernmental groups. The two major earthquakes, the 1935 Hsinchu-Taichung Earthquake and the 1999 Chichi (Jiji) Earthquake, were compared in terms of their demographic responses as indicated by the crude death rate, in and out-migration rates, and widowhood rates. Lo (Chapter 10) studied the impact of the 1999 earthquake on residents in Taichung and Nantou Counties in Taiwan to see whether or not property damage and the loss of family members had an effect on fertility, mortality, marriage and divorce. Other things being equal, those who experienced death of family members were more likely to have new children and subject to a higher probability of death than those who did not.

The impact of natural disasters on more widely defined demographic responses including land use and care for the aged were examined in the next two papers. Leonard, Gutmann, Deane, and Sylvester (Chapter 11) examined changes in the use of household labor on farms experiencing drought by applying multi-level growth models to data from over 25 townships in Kansas between 1875 and 1930. The land-use/labor relationship was unaffected by drought. However, drought did slow the process of farm building through cash cropping and farm expansion. Herrmann, Robine, and Michel (Chapter 12) focused on the aftermath of European heat wave during August 2003 which brought about 40,000 additional deaths. They assessed possible changes in individual and family broad demographic behaviors after the 2003 European heat wave regarding the oldest old, as well as public health and migration policies related to their care.

Two papers examined the effectiveness of measures against smallpox in historical Japanese populations. Murayama and Higashi (Chapter 13) examined the implications of differences in measures taken against the spread of smallpox by two neighboring villages of the Southwestern tip of Japan in 18 and 19th centuries. The two villages provide examples of successful and unsuccessful measures to limit the impact of smallpox. Comparison between the two villages suggests that isolating patients and quarantining their household members was an effective way of limiting the spread of smallpox. Kawaguchi (Chapter 14) discussed the role of the introduction of vaccination into villages in the outskirts of Tokyo around 1850 in reductions in childhood deaths attributable to smallpox. By analyzing quantitative data from temple death registers and qualitative data from diaries and paintings, he demonstrated how people responded to smallpox before and after the introduction of vaccination.

The last two papers are from the open symposium that focused on the Japanese past. Saito (Chapter 15) set out a new, revised chronology of famines from the eighth to the nineteenth century and found that there was virtually no correlation between the frequencies of famines and the alternating phases of cooling and warming over the so-called Medieval Warm Period and the Little Ice Age that followed. As a corollary, a major reduction in the frequency occurred half a century earlier than the start of

Tokugawa rule. Hayami (Chapter 16) re-estimated the number of death during the Spanish Influenza in 1918-1920 in the home land of Japan as well as its colonies in southern Sakhalin, Korea, and Taiwan at the time. He proposed a method to estimate "excess deaths" due to influenza from the number of deaths by respiratory diseases. The new estimates are much larger than earlier ones that were widely accepted. Moreover, the impact was much larger in the colonies of Imperial Japan than on the Japanese mainland.

In conclusion, this seminar successfully integrated multiple demographic outcomes of diverse exogenous impacts across time and space, offering novel insights to demographic responses to economic and environmental crises. A range of new themes emerged from the papers: First, the demographic impacts of sudden changes varied according to the type and extent of the external shocks. The diversity of responses reflected the multiplicity of options available to households and individuals. Second, individuals responded in different ways according to their age, gender, family context, and socioeconomic status. Who was protected during mortality crisis or economic stress very much depended on political, social and familial organization of the study population that experienced the shock. Third, however, there seems to be a nearly universal tendency for higher socioeconomic status at the household or individual level to help insulate individuals from various risks. Forth, individual responses during mortality crises such as famine and pandemic differed from responses to routine economic fluctuations. Fifth, the demographic response mirrored the effectiveness of political measures taken in response to urgent situations. Finally, the seminar also generated ideas for new comparative studies of demographic impacts, for example, of extended periods of adverse weather and poor harvest in the northern hemisphere in 1780s when Laki volcano erupted in Iceland, disrupting weather in the northern hemisphere for several years.

The contemporary and practical implications of the papers in the volume are clear. While the long-term population impacts of most crises are quite modest, the immediate consequences are sometimes severe. Certain groups of people or individuals, depending on the social and familial context, are much more vulnerable to sudden change and the accompanying stress than others. Moreover, the effects of natural disasters and epidemics, which appear to be beyond the control of human beings, are in fact conditioned by policy measures and social context. The human consequences of natural disasters, climatic fluctuations, and epidemics, in that sense, reflect interactions between exogenous changes in conditions and sociopolitical context.

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Mortality Crises in Rural Southern Sweden 1766–1860

Tommy Bengtsson and Göran Broström

Abstract

In this paper mortality crises in a rural area in southern Sweden are analysed by using a new approach. We start off with a combined life-event and time-series analysis approach in which the influences of food prices, agricultural production and air temperature on mortality by age, sex and socio-economic status is analyzed, much in line with our previous work. Special attention is given to years when food prices were particularly high, production particularly low and climate particularly unfavourable. We then identify years with mortality crises defined as two succeeding years with at least 25 percent more deaths than normal (often much more). This takes place five times between 1766 and 1860, which is the period we analyse. We analyse whether the causal factors for these crises differ from other years of excess mortality, or if it is just a matter of "more of the same". The data for five rural parishes in southern Sweden analyzed comes from the Scanian Demographic Database. Food prices are local, temperature data stems from a nearby town, and production refers to Scania, the southernmost county of Sweden where all five parishes are located. We find that the mortality crises differ from other years with respect to its causal mechanisms, in particular with respect to effects of food prices.

Introduction

Analyses of excess mortality basically follow two traditions: studies of mortality crises and studies of annual variation in mortality (for a comprehensive overview, see Walter and Schofield 1989; see also Bengtsson 2004a). While the mortality crises approach samples on the outcome variable, mortality studies of mortality variation sample on causal factors. While the former approach pays focus to one specific crisis, or a few cases of such, the latter covers a rather long time period with fluctuations in for example food prices, temperature, and so on.

Numerous studies, based on annual aggregated data from preindustrial populations, show that fluctuations in food prices affect demographic outcomes, particularly fertility, but also mortality and migration (Bengtsson 1993a; Galloway 1988; Lee 1981). The results refer not only to preindustrial Europe but also to other parts of the world, as well as for later periods (Lee 1990; for an overview, see Bengtsson and Reher 1998). Most of these studies are based on total number of events for the entire population of a certain area, often a country. From an analysis of age-specific mortality for Sweden, we know, however, that it was in particular children in ages five years and above and adults that were vulnerable to short-term economic stress (Bengtsson and Ohlsson 1985, 317). The mortality among infants seems to follow its own rhythm (Bengtsson and Ohlsson 1985, 317; Utterström 1957). Not only fluctuations in food prices influence demographic events; cold winters and warm summers affect demographic outcomes too (Lee 1981; Richards 1984; Tromp 1963). Most studies are based on estimations of distributed lag models with up to five years delay (for other methods, see Bengtsson and Broström 1997). Special attention has, however, been taken to the demographic response to extraordinary situations by analyzing thresholds and runs (for example, see Lee 1981). Response patterns of aggregated data may, however, conceal great intra-societal diversity in patterns of demographic responses, not only regarding age, as demonstrated by Bengtsson and Ohlsson (1985), but also with respect to other factors, such as socio-economic status and sex.

Advances in data and methods allow for more detailed examination and comparison of demographic responses to economic and environmental pressure. Application of combined event-history and time-series techniques to longitudinal, individual- and household-level data allow for identifying demographic responses to changing economic conditions by individual socio-economic and demographic characteristics (Bengtsson 1993b) as well as by household characteristics (Bengtsson, Campbell, Lee et al. 2004). Such analyses show that patterns of demographic responses by socio-economic status, household composition, and individual characteristics to economic fluctuations were diverse (Allen, Bengtsson, and Dribe 2005; Bengtsson, Campbell, Lee et al. 2004; Bengtsson and Saito 2000). This approach also allows for analyses of extreme environmental situations by investigating thresholds (Bengtsson 2000). Still, it has not previously been used to study whether mortality crises are particular in terms of their causes or just “more of the same”.

The new approach differs from previous developments of combined time-series and life-event techniques in that we pay special attention to the outcome variable, that is, mortality, by pre-defining years of mortality crises. One might then argue that we are creating bias by violating the principle of non-selection on the outcome variable. That is, however, not the case as we are not analysing just the years of mortality crises, but all years.

The first step is then to identify years of mortality crises. Various methods have been suggested (for example, see Dupâquier 1989). Here we have simply selected pairs of succeeding years in which the number of deaths was at least 25 percent above the average in the years following a previous crises, and most often much more. This occurs five times in the period 1766 to 1860 in the five rural parishes in Scania included in this study, as shown in Figure 1, namely in 1772/3, 1785/6, 1831/2, 1846/7, and 1852/3. In detecting the first crises we used data back to 1750. The main questions are whether these mortality crises are an outcome of particularly high food prices or of other factors, such as famines and extreme weather situations. To what extent did children and adults, or both the landed and the landless groups suffer from elevated mortality? Do these years fundamentally differ from other years of high mortality or is it a matter of “more of the same”?

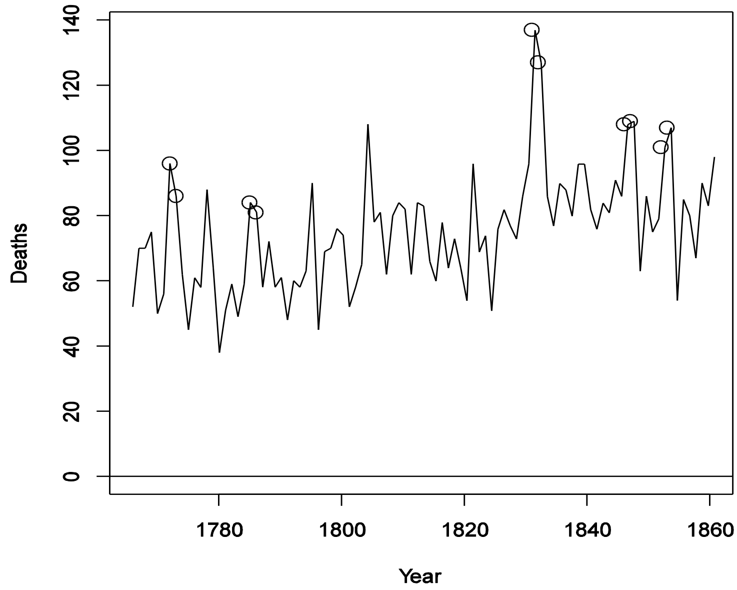

Figure 1. Total number of deaths by year in five parishes, 1766-1860.

Note: Circled years are pairs of successive years having very high mortality.

Data and Context

Longitudinal demographic data on individuals and household socio-economic data have been combined with community data on food prices, agricultural production and temperature. The individual-level data comes from the Scanian Demographic Database, which covers nine rural parishes and one town situated in Scania in the southernmost part of Sweden. Five of the rural parishes are included in this study: Hög, Kävlinge, Halmstad, Sireköpinge, and Kågeröd. The material for two of the parishes dates back to 1646 and for the others to the 1680s. While the publicly available records end in 1895, we end in 1860 when industrial activities evolved in this part of the country. Our interest in socio-economic position further limits our dataset since the data for the 18th century shows some gaps, which is why we choose 1766 as the starting year.

The parish register material is of high quality and shows no gaps for births, deaths, or marriages. Migration records are less plentiful, but a continuous series exists from the latter part of the eighteenth century. Information concerning farm size and property rights, in addition to various kinds of information from poll-tax records, land registers, and household examination records, are linked to family reconstitutions based on the parish records of marriages, births, and deaths. Taken together, we have very rich information on the household size and structure as well as socio-economic conditions. In addition, we have good information on food prices, production, and temperature. Data on food prices is available for the local area and refers to the fall. We are using the price of rye, since this was the most common grain in this part of the country. Data on temperature comes from Lund, apart from 1821 to 1833, for which we have used data for Copenhagen instead. Finally, the data on agricultural production stems from an investigation of agricultural output from a number of farms in different parts of Scania, with concentration on the southern and western parts (Olsson and Svensson 2008).

The sampled parishes are compact in their geographical location, showing the variations that could occur in peasant society with regard to size, topography, and socioeconomic conditions, and they offer good source material. Life expectancy at birth follows the same development as the entire country, but is about one year higher (Bengtsson and Dribe 1997; Bengtsson 2004b). The entire area was open farmland, except for northern Halmstad and parts of Kågeröd, which were more wooded. Halmstad, Sireköpinge, and Kågeröd were predominantly noble parishes, while freehold and crown land dominated in Kävlinge and Hög. The parishes each had between 400 and 1,700 inhabitants in the latter half of the nineteenth century. The agricultural sector in Sweden, and Scania, became increasingly commercialized during the early nineteenth century. New crops and techniques were introduced. Enclosure reforms and other reforms in the agricultural sector influenced population growth, particularly in Sireköpinge, which experienced fast population growth. In Kävlinge, the establishment of several factories and railroad communications led to rapid expansion from the 1870s onwards.

Land was the most important source of wealth in these societies. The social structure of the agricultural sector is often difficult to analyze since differences in wealth between various categories of farmers and occupations are unclear and subject to change with the passage of time. Data from land registers on different types of tenure must be combined with information from poll-tax records concerning farm size in order to arrive at a better understanding of each household’s access to land. We differentiate between two social groups: those with land enough to feed a family and those who needed to work for someone else to be able to support a family. The dividing line is set to 1/16 *mantal* based on well-founded arguments from numerous studies in this field of research, stating that peasants with smaller farms were not self-supporting (for an overview, see Bengtsson 2004b; Bengtsson and Dribe 2005).

We also take into account whether the parish of residence is the same as the parish of birth. If not, it means that a person has in-migrated into the parish, probably having smaller networks in terms of, for example, kin, neighbours, and so on.

The nineteenth century was also a period of considerable social change in the countryside. It has been described as a period of proletarization and pauperization. The share of landless increased (Carlsson 1968). Downward mobility was significant since many children of farmers were unable to obtain a farm themselves. This was true both for Sweden in general and for the area we study (Lundh 1998). Not only did the share of the lower strata increase but their economic situation worsened as well. They became, for example, more vulnerable to short-term economic stress than before, as shown by their mortality and fertility responses to food prices (Bengtsson 2000, 2004b; Bengtsson and Dribe 2005). What actions were then taken to reduce the negative impact of high food prices?

The Swedish poor relief system involved the state, the county administration, the local community and church, the employer and the family (Skoglund 1992; Åmark 1915). As stated by laws from the 1760s, local communities were obliged to take care of very poor people that were permanently sick or handicapped, or elderly without relatives or former employers to take care of them. On average, only a small fraction (2.1 percent), of the population received parish relief as shown by a public investigation in 1829 (Skoglund 1992); the figure for Malmöhus County, in which the five parishes in this study are located, was even lower (1.4 percent).

The Swedish poor relief system in the beginning of the nineteenth century was obviously not designed to take care of large groups of people in temporary need during years of high food prices. Furthermore, the granary system, which was abolished in 1823, was intended to provide loans to producers, not consumers (Olofsson 1996, 26). Social tensions grew and efforts were made by the state to create work in years of bad harvests. Finally, a new poor law system was introduced in 1847 (Skoglund 1992; Banggaard 2002) after which individuals and families could receive some temporary assistance. Before that time, while the poor temporarily might be granted a tax exemption, they were not given any direct support (for more details on the area we study, see Banggaard 2002; Bengtsson 2004b).

Thus families in the area we study had to rely on themselves when conditions deteriorated. While farmers with land were able to get loans, the situation for the landless was worse. Migration was not really an option to them, since conditions were similar throughout this part of the country (Dribe 2000). Instead they tried to avoid pregnancies (Bengtsson and Dribe 2006).

Famines, Weather, and Mortality Crises

Scania has been known as the granary of Sweden ever since the province was acquired from Denmark in 1658. Food prices often peaked, as shown in Figure 2, sometimes due to bad harvests in other parts of Sweden, like in 1797, sometimes due to demand from abroad, and sometimes due to bad local harvests. From the *harvest evaluations*, which are based on official inspections of the fields prior to the harvests, we know that Scania experienced famines in 1771 and 1783 with dramatically increasing prices as a consequence (Weibull 1923, 115).

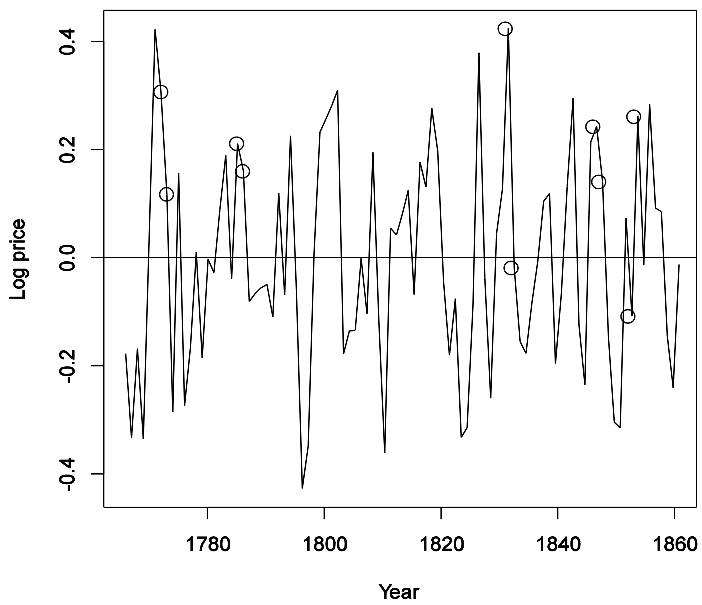

Figure 2. Yearly local food prices, 1766-1860 (logged, detrended prices of rye).

Note: Circled years are pairs of successive years having very high mortality.

While the harvests in the part of Scania we analyze here were below average in 1811, 1826, 1837, 1841, 1842, and 1853, these years should not be defined as weak years, even less as years of crisis (Sommarin 1917, Vol 1, 208-11). Thus the last famine in our area was in 1783. This makes the situation quite different from the rest of Sweden where four famines during the course of the nineteenth century occurred, namely in 1812, 1816, 1826, and 1841 (Sommarin 1917, Vol 1, 208-11).

The picture drawn from the harvest evaluations is quite consistent with new estimates of grain production, shown in Figure 3. The new estimates are based on a sample of farms throughout Scania and show that production increased from around 1790 and onward; even the worst years of the nineteenth century were well above good years of the eighteenth century (Olsson and Svensson 2008). This, however, does not mean that food production was stable. On the contrary, it varied a lot, which is evident from Figure 3. The fact that food prices did not only respond to local supply and demand means that the correlation with production is rather weak (the correlation coefficient of detrended series is 0.6).

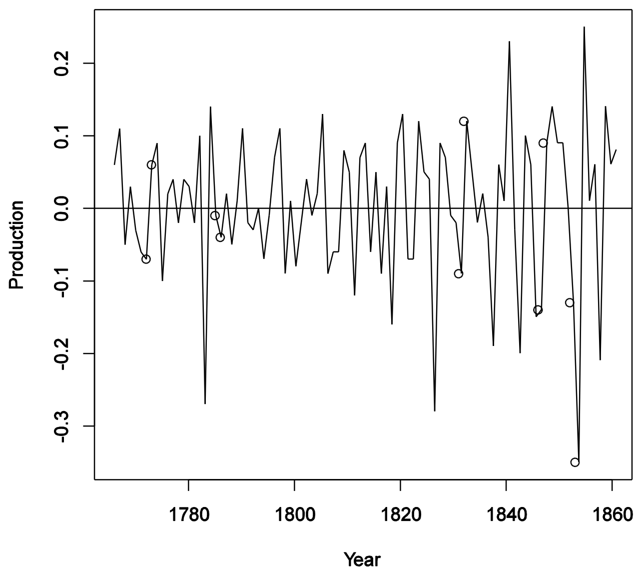

Figure 3. Production by year in Scania, 1766-1860 (logged and detrended).

Note: Circled years are pairs of successive years having very high mortality.

Information on temperature stems from daily observations in the city of Lund located 10-25 kilometres from the five parishes we analyze, with the exception of the years 1821-1833, for which we use data for Copenhagen. Winters are on average mild and summers not very hot, as shown in Figure 4. Still, the winters of 1785, 1789, 1799, 1800, 1809, and 1845, were very cold with monthly averages of 5 degrees centigrade below zero, occasionally 10 degrees below zero. Cold winters were not only hard for humans as people risked running out of stored firewood, but also for the cattle. In hard winters, as food became more and more scarce, the farmers were left with no other option than to feed them on grain, forcing poor people to bake *barkbröd* (bark bread) as was the case in 1727 (Weibull 1923, 115).

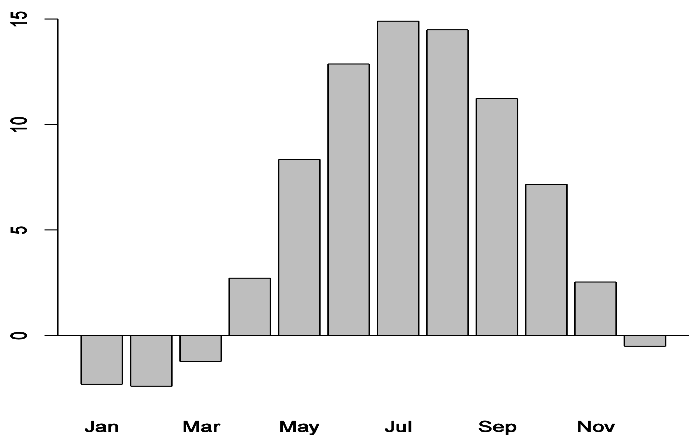

Figure 4. Monthly averages in temperature (centigrade) in Lund, 1766-1860.

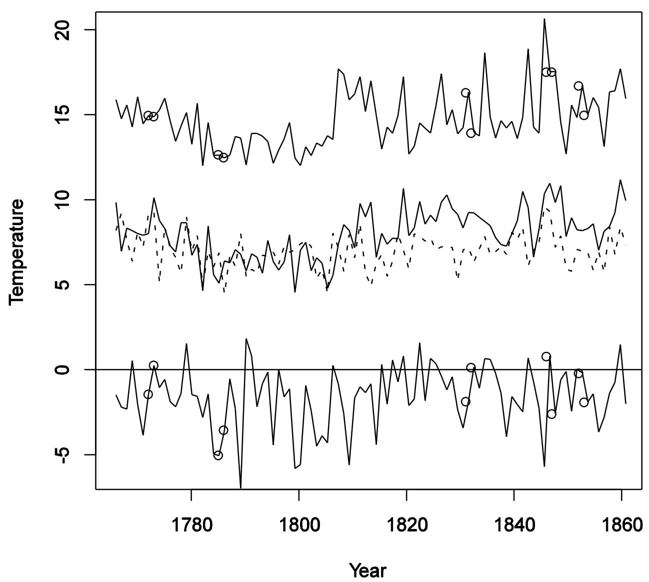

Figure 5. Monthly averages in temperature (centigrade) in Lund, 1766–1860.

Note: From top to bottom: summer (July and August), spring (solid line, April, May, and June), fall (dashed line, September, October, and November), and winter (January, February, March, and December previous year). Circled years are pairs of successive years having very high mortality.

Turning to the mortality crises—the years of 1772/3, 1785/6, 1831/2, 1846/7, and 1852/3—what are their characteristics in terms of age-specific mortality, patterns of causes of death, famines, food prices, temperatures, tax exemption, and so on? While the infant mortality during the five crises was only 23 percent above the average, the mortality in ages 1-15 year was 73 percent, in ages 25-55 years 78 percent and in ages 55+ years 99 percent above the average. It shows, again, that infant mortality followed its own rhythm. Years of high infant mortality were instead years of whooping cough and, in particular, smallpox mortality (Bengtsson and Lindström 2003). Although some overlap with mortality in other are-groups did occur, like in 1772/3, 1831/2 and 1852/, infant mortality often differed not only with respect to its annual changes but also causes of death. While peaks in infant mortality was typically due to outbreaks in smallpox and whopping cough, mortality crises among children and adults were primarily due to various fevers, typhus, pneumonia, malaria (1831/2), scarletina (1852/3) and others, several of which have a fatal outcome only for weak persons (Rotberg and Rabb 1985).

Food prices are higher than during surrounding years in all years with mortality crises, except for 1832 and 1852, but very high prices are also found in numerous years with no crisis (Figure 2). Production is generally low in years of mortality crises but low in many other years as well (Figure 3). One famine occurred in 1771, the year before one of the mortality peaks (1772/3), and again in 1783, two years before another mortality peak (1785/86). Since the famine in 1783 was the last one in Scania, the mortality crises of the nineteenth century have no relation to famines. Winters were sometimes colder during a mortality crisis, sometimes not, and quite cold in many other years as well, like in the beginning of the nineteenth century with no excess mortality as a consequence (Figure 5). Thus, the economic and climatic conditions during the five mortality crises varied and no common pattern is easily identified, and conditions in other years were sometimes equally bad without causing the mortality to peak. Succeeding years of high prices, bad harvests and harsh winters were rare and not systematically related to the mortality crises.

We now turn to a systematic analysis of the impact of economic and climatic factors on mortality, excluding infants as their mortality followed a different pattern. Thus we analyze the mortality among children ages 1 to 15 years, all presently or previously married persons at the age of 25 to 55 years, and 55 or above, between 1766 and 1860, paying special attention to mortality crises. The reason for choosing persons who are or have been married is to control for presence in the parish. Unmarried adults, though they are rather few, move a lot and are difficult to follow before the time that they marry. Most children below age 15 years, on the other hand, live with their parents (Dribe 2000).

A *proportional hazards model* (Cox 1972) is used for the mortality analyses. We assume that the relative effect on mortality of any covariate is constant over age. The model allows time-varying covariates. It is very important to check the underlying assumptions behind this model, especially the proportionality assumption. We have therefore routinely tested all models for deviations from the proportionality assumption. The test we have used is based on the correlation between log(t) and the Schoenfeld residuals for each covariate. A high correlation indicates that the corresponding coefficient varies with time; in other words, that the hazards are not proportional (for details, see Therneau and Grambsch 2000, 127-52). We found no sign of non-proportionality, neither on any of the covariates, nor globally. The statistical analyses are performed in the R statistical computing environment (R Development Core Team 2009), especially with the aid of the package eha (Broström 2009). Test of non-linearity for the time-varying community variables (food prices, temperature, and production) was done by categorizing, coding them as orthogonal polynomials and including them in the models.

Results

Table 1 shows the effects of food prices, summer and winter temperatures, and agricultural production on mortality in ages 1 to 15 years controlling for year at birth (to pick up a linear trend), sex, parish of residence and whether the person is born in the parish of residence or not. We also control for socio-economic status, whether their parents belong to the landed group or not. The period is 1766 to 1860 and the parishes are Hög, Kävlinge, Halmstad, Sireköpinge, and Kågeröd. The number of deaths in age-group 1 to 15 years is 1,258. Model 1 is a basic model with no interactions. Model 2 is a reduced form of Model 1 in which time-varying covariates that are not significant at 5 percent level are left out in order to improve the efficiency. In Model 3 we have categorized the food prices to find out whether there are threshold effects or not. Finally, in Model 4 we are testing whether the effect of food prices during the mortality crises years differs from other years by making an interaction between food prices and an indicator of crises years. Tables 2 and 3 show the same set of models for ever-married persons in ages 25-55 years and in ages 55-100 years.

Table 1. Mortality in ages 1-15 years (Number of deaths 1,258).

		Model 1		**Model 2**		**Model 3**		**Model 4**	
Covariate	Mean	Rel. risk	Wald p	Rel. risk	Wald p	Rel. risk	Wald p	Rel. risk	Wald p
birthdate	1811.935	0.994	0.000	0.994	0.000	0.994	0.000	0.994	0.000
sex									
male	0.508	1(ref)		1(ref)		1(ref)		1(ref)	
female	0.492	1.021	0.711	1.021	0.713	1.020	0.721	1.022	0.705
parish									
Hög	0.112	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Kävlinge	0.128	1.300	0.021	1.299	0.021	1.299	0.021	1.310	0.018
Sireköpinge	0.185	0.993	0.947	0.992	0.943	0.995	0.961	0.996	0.971
Halmstad	0.199	0.973	0.801	0.973	0.803	0.971	0.786	0.987	0.902
Kågeröd	0.376	0.440	0.000	0.440	0.000	0.435	0.000	0.450	0.000
birthparish									
same as living	0.706	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
other	0.294	3.458	0.000	3.459	0.000	3.490	0.000	3.388	0.000
ses									
landless	0.603	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
landed	0.397	0.989	0.849	0.989	0.849	0.991	0.838	0.983	0.769
food prices	0.000	1.504	0.018	1.614	0.001			1.024	0.887
temperature									
winter	–1.537	0.994	0.729						
summer	14.791	0.995	0.780						
production	–0.001	0.797	0.461						
food prices									
very low	0.197					1 (ref)			
low	0.201					1.252	0.017		
normal	0.212					1.438	0.000		
high	0.193					0.992	0.939		
very high	0.197					1.498	0.000		
crises year								1.498	0.000
food prices* crises year								2.386	0.051
Overall p			0.000		0.000		0.000		0.000

Table 2. Mortality for ever-married in ages 25-55 years (Number of deaths 1,023).

		Model 1		Model 2		Model 3		Model 4	
Covariate	Mean	Rel. risk	Wald p	Rel. risk	Wald p	Rel. risk	Wald p	Rel. risk	Wald p
birthdate	1780.925	0.996	0.004	0.997	0.010	0.997	0.008	0.997	0.006
sex									
male	0.482	1(ref)		1(ref)		1(ref)		1(ref)	
female	0.518	1.039	0.540	1.039	0.537	1.040	0.536	1.042	0.515
parish									
Hög	0.108	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Kävlinge	0.128	1.333	0.036	1.332	0.037	1.332	0.037	1.342	0.032
Sireköpinge	0.177	1.347	0.022	1.347	0.022	1.347	0.022	1.345	0.022
Halmstad	0.191	1.280	0.058	1.279	0.058	1.279	0.058	1.290	0.050
Kågeröd	0.396	1.318	0.021	1.318	0.021	1.319	0.021	1.318	0.021
birthparish									
same as living	0.418	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
other	0.582	1.432	0.000	1.434	0.000	1.434	0.000	1.422	0.000
ses									
landless	0.635	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
landed	0.365	0.981	0.776	0.981	0.777	0.981	0.782	1.034	0.703
food prices	0.000	1.414	0.068	1.514	0.010			1.140	0.854
temperature									
winter	–1.545	0.952	0.004	0.956	0.008	0.954	0.006	0.947	0.002
summer	14.799	1.028	0.166						
production	–0.001	0.868	0.679						
food prices									
very low	0.198					1 (ref)			
low	0.199					1.106	0.320		
normal	0.213					1.005	0.961		
high	0.191					1.077	0.473		
very high	0.200					1.199	0.068		
crises year								1.427	0.005
food prices* crises year								2.252	0.120
Overall p			0.000		0.000		0.000		0.000

Table 3. Mortality for ever-married in ages 55-100 years (Number of deaths 1,814).

		Model 1		Model 2		Model 3		Model 4	
Covariate	Mean	Rel. risk	Wald p	Rel. risk	Wald p	Rel. risk	Wald p	Rel. risk	Wald p
birthdate	1756.425	0.998	0.032	0.998	0.046	0.998	0.053	0.998	0.047
sex									
male	0.514	1(ref)		1(ref)		1(ref)		1(ref)	
female	0.486	1.062	0.205	1.061	0.206	1.062	0.206	1.061	0.209
parish									
Hög	0.104	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Kävlinge	0.112	0.951	0.640	0.950	0.637	0.950	0.632	0.958	0.692
Sireköpinge	0.162	1.001	0.989	1.002	0.987	1.000	0.996	1.003	0.975
Halmstad	0.170	1.004	0.963	1.004	0.963	1.005	0.962	1.001	0.989
Kågeröd	0.452	1.233	0.012	1.233	0.012	1.233	0.012	1.226	0.015
birthparish									
same as living	0.386	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
other	0.614	1.045	0.390	1.045	0.384	1.045	0.385	1.041	0.431
ses									
landless	0.829	1 (ref)		1 (ref)		1 (ref)		1 (ref)	
landed	0.171	0.993	0.924	0.993	0.920	0.993	0.926	0.982	0.800
food prices	0.000	1.500	0.005	1.501	0.005			1.127	0.446
temperature									
winter	–1.495	0.954	0.000	0.955	0.000	0.955	0.001	0.946	0.000
summer	14.824	1.012	0.417						
production	–0.001	1.846	0.017	1.763	0.024	1.713	0.032	1.767	0.026
food prices									
very low	0.197					1 (ref)			
low	0.201					0.941	0.432		
normal	0.212					1.015	0.846		
high	0.193					1.098	0.224		
very high	0.197					1.178	0.049		
crises year								1.178	0.114
food prices* crises year								2.589	0.023
Overall p			0.000		0.000		0.000		0.000

The parameter estimates for the fixed covariates, and for socio-economic status of parents as well, are as expected for age-group 1-15 years (Table 1, Model 1). While the sex difference in mortality is negligible, socio-economic differences is larger but still not significant. Being born one year later lowers mortality with 0.6 percent, while having in-migrated is very negative with mortality 3.5 times higher given everything else equal. In addition, considerable differences between the parishes of residence exist. These results are much the same as in other studies; no or minor differences between sex and socio-economic status but substantial regional differences (see Bengtsson and Dribe 2008).

The effect of food prices is strong and as expected; the higher the price relative to surrounding years, the higher the mortality in the year to come. But we find no effects of production and temperature, which is why we reduce the model to only include food prices (Table 1, Model 2). From our previous analyses of mortality, fertility, and migration, we know that the group of landless suffered from high food prices in the first half of the nineteenth century, less so in the periods before and after that (Bengtsson 2004b; Bengtsson and Dribe 2005; Dribe 2000). Here, when studying the period 1766 to 1860, we find no evidence of any difference between the two socio-economic groups (interaction not significant, tables not shown here).

To find out whether the effect of food prices is linear or not, we have categorized the detrended logged food prices into five groups. We find a slightly peculiar pattern of non-linearity (Table 1, Model 3), with low, normal and very high food prices being significantly different from very low food prices. A formal test confirms non-linearity (results not shown here).

The next question is whether mortality crises years are different from other bad years or just exhibit "more of the same" with regard to number of deaths. To test whether the effect of food prices during the mortality crises years differs from other years, we have made an interaction between food prices and an indicator of crises years. The result is that food price effects during mortality crises differ substantially from other years in all age groups (Table 1, Model 4). While the effect of one unit change in food prices (277 percent) is very modest in non-crises years and not significant, a one unit change in the crises years more than triples the mortality risk. Transforming the results to more "normal" food price changes, say a 50 percent increase, shows that mortality increases by 1 percent in a non-crises year and by 44 percent in a crises year. Thus, the mechanisms in play during these crises are very different from other years. This is also shown by the fact that the crises years have an effect of their own. We have also estimated models with interactions between mortality years and winter temperature and production, but found no effects (not shown here). Thus the effects of winter temperature and production on children are not different during years of mortality crises comparative to other years, but only the effects of food prices.

We then repeat the same exercise for ever-married persons in ages 25 to 55 years (Table 2). The total number of deaths in this age-group is 1,023. While the effects of sex, residence, and birth year is similar to what we found for children, the effects of being an in-migrant or not is smaller but still significant. Furthermore, we find that not only food prices but also air temperature during the winter (December to March) matters (Table 2, Model 1). The effect of cold winters is not only statistically significant but also strong. One degree lower winter temperature drives up mortality by 5 percent. We find no threshold effects of food prices for this age group (Table 2, Model 3). The effect of food prices follows the same pattern as for children (Table 2, Model 4). A 50 percent increase in food prices makes mortality go up by 5 percent in a non-crises year and by 47 percent in a crises year.

We now turn to ages 55 to 100 years, for which there are 1,814 deaths. While effects of sex and parish of residence are similar to those for children and adults, the mortality decline is slower (Table 3, Model 1). A major difference is that the effect of being an in-migrant has vanished among the elderly, which may be a result of improvements in integration into the parish and larger social networks by age.

Like children and adults in working ages, the elderly are vulnerable to food prices changes, more so to very high food prices (Table 3, Model 3). The threshold effect for the elderly seems, however, to be somewhat smaller than for children—only very high food prices differ from very low food prices—and a formal test shows that the effect of food prices is not linear (not shown here). Testing for food price effects during mortality crises years, yields almost identical results as for children and working adults (Table 3, Model 4). A 50 percent increase in food prices makes mortality increase by 5 percent in a non-crises year and by 54 percent in a crises year.

The elderly also show vulnerability to harsh winters, the size of effects being about the same as for working adults. Mortality among the elderly also differs in that it is affected by variations in production, and here we find evidence for non-linearity. The effect is, however, in the opposite direction of the one assumed. From estimations for smaller age-groups, we have found that production affects mortality in the "wrong direction" from around age 50 years onwards (not shown here). Presently, we have no viable explanation for this result.

Summary and Discussion

Excess mortality in years of mortality crises, here defined as two succeeding years of high mortality, does not have the u-shaped curve typical to age-specific mortality. While infant mortality increased to 23 percent above the average, mortality in ages 1 to 15 years rose by 73 percent, in ages 25-55 years by 78 percent and in ages 55 to 100 years by 99 percent. Causes of deaths show a very different pattern too, not only relative to average years but also by age. While infants suffer from small-pox and whooping cough, as in other years of outbreaks in these diseases, most death in other ages are due to fevers, typhus, pneumonia, malaria, scarletina etc. As shown elsewhere, infants show an entirely different pattern with small impact of external factors, such as food prices and temperature, and are left out of the analyses here.

We find strong evidence for the fact that food prices have a much stronger effect on mortality during years of mortality crises—succeeding years of unusually high mortality—than during other years, for which the effect is close to zero. This is a consistent pattern in all remaining age groups. For the mortality of adults and elderly, we also find strong effects of harsh winters with a range in the crises years much like in other years. Thus the mortality crises years differ not with respect to temperature but only with respect to food prices, and from the data we have on causes of death, we know that several of the diseases that have a fatal outcome for weak persons flourished during these years.

In future research, we plan to move in three directions to better understand the underlying mechanisms for why the effects of food prices are so different in years of mortality crises compared to all other years. First, we plan to develop the models to explain why food prices in some years have such devastating effects. Such models will include more details on occupation and access to land, as well as on household structure and location of residence. It will also include interaction between prices, production and temperature. Furthermore, we will make comparisons between crises years, the way we have defined it, with other years of high mortality and not only with all other years as in this article. Second, we plan to adopt a different approach by focusing on within-family differences. Third, we will take a nested case-control sampling and matching approach in order to handle confounding.

Acknowledgments

We kindly acknowledge the use of data from two different databases. The demographic and economic individual-level data as well as the data on food prices and temperature comes from the Scanian Demographic Database, which is a collaborative project between the Regional Archives in Lund and the Centre for Economic Demography at Lund University. The production data comes from the Historical Database of Scanian Agriculture, Department of Economic History at Lund University. Tommy Bengtsson is grateful for financial support from the Linnaeus Centre for Economic Demography, Lund University as well as from the Swedish Research Council. Göran Broström thanks for financial support from the Ageing and Living Conditions research environment, Umeå University, as well as from the Bank of Sweden Tercentenary Foundation.

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Economic Crisis, Manorialism, and Demographic Response: Southern Sweden in the Preindustrial Period

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Abstract

Previous research has consistently found demographic responses to grain price fluctuations in preindustrial Europe, both at macro and micro level. Grain prices serve as a summary measure of the workings of the preindustrial economy, reflecting not only local harvest conditions but trade patterns and market integration. All over preindustrial Europe the manorial estate was an important institution in the rural economy. It offered opportunities to insure tenants against extreme events such as harvest failures, impossible to achieve for independent peasants in a society without well-functioning markets for capital or insurance, and in the absence of state subsidies. In this paper we look at the impact of regional economic fluctuations on demographic behavior and study whether the presence of estates lowered the demographic impact of economic crises on the population. We will do this by utilizing a newly developed database on agrarian output together with county-level grain price data and parish level information on vital events and land tenure for about 400 parishes in the province of Scania in southern Sweden. The results show a clear response in births and deaths in ages 1-25 to fluctuations in grain prices and output levels. Manorial parishes show a considerably lower response in the year of the economic change, but the same response as in other parishes in the year after. This indicates that the manors, at least partially, functioned as insurers against risk, which had beneficial effects of its inhabitants by smoothing consumption.

Introduction

Previous research has consistently found demographic responses to grain price fluctuations in preindustrial Europe, both at the aggregate level (Galloway 1988; Lee 1990; Bengtsson and Reher 1998) and at the individual level (Bengtsson et al. 2004; Allen, Bengtsson and Dribe 2005; Bengtsson and Dribe 2010). Individuals in preindustrial society could not insulate themselves from these short-term economic fluctuations by migrating or by deliberately adjusting fertility, which lead to increases in mortality. Grain prices serve as a summary measure of the workings of the preindustrial economy, reflecting not only local harvest conditions but trade patterns and market integration as well. In most of the research in this area, however, grain price variations have been interpreted as variations in grain production. In reality, grain prices entail much more information than the local harvest outcome, which makes it important to study not only demographic responses to prices but also to fluctuations in output.

The strong demographic response to economic stress has also been interpreted as an important dimension of the standard of living of people in the past. Being unable to deal with economic uncertainties to avoid premature death clearly indicates a low standard of living (Bengtsson 2004; Allen, Bengtsson and Dribe 2005), and hence being able to hedge against the risks of economic crisis would be considered a major improvement in the standard of living, regardless of the average level of income, life expectancy, etc.

The older research in this field usually was done at aggregate level, often using data at the country level, although more disaggregated data (e.g. province or county) have frequently been used as well. More recently micro-level research has also appeared, which has enabled studies of the differential response by socioeconomic status, household context, etc. (e.g. Bengtsson et al. 2004, Tsuya et al. 2010). This line of research has shown that the mortality and fertility response was much more prominent among lower socioeconomic strata, further stressing the importance of the demographic response to economic stress as a crucial living standards indicator.

All over preindustrial Europe the manorial estate was an important institution in the rural economy. Especially in Marxist scholarship most attention has been directed towards the exploitative character of the estates, and the relation between the tenants and the landlord (e.g. Brenner 1985; Dobb 1963; Hilton 1976; see also Hatcher and Bailey 2001). One hypothesis, however, going back at least to the early writings of new economic history, is that the relation between tenant and landlord was contractual, where the tenant worked for the landlord in exchange for various forms of protection (e.g. North and Thomas 1971). It could be protection against war, violence or legal protection more generally, but it could also be protection against severe economic crisis. Because of its mere size, the estate offered opportunities to insure tenants against extreme events, such as harvest failures, impossible to achieve for independent peasants in a society without well-functioning markets for capital or insurance, and in the absence of state level subsidies.

If the estates in preindustrial society were able to insure its inhabitants against the apparent risks of economic downturns in agricultural production, they would have contributed in a major way to a better standard of living for tenants and other people living and working on the estates. One way of investigating the extent to which this was the case is to look at the demographic response to short-term economic fluctuations and compare the response in manorial parishes to the response in other parishes.

In this paper we do this by looking at the impact of economic stress on demographic outcomes (births and deaths in ages 1-25) in the province of Scania in southern Sweden in the period 1749-1859, and study whether the presence of estates lowered the demographic impact of economic stress on the population. The demographic response is measured at the parish level using two different measures of economic stress at higher level of aggregation: short-term fluctuations in rye prices at the county level and in grain output at the provincial level. Price data comes from the Market Price Scales, published by Lennart Jörberg (1972), while the output data comes from a newly developed database on agrarian production in preindustrial Scania (Olsson and Svensson 2009). The economic information is used together with parish level information on vital events (births and deaths) and land tenure. Data for about 400 parishes is included in the analysis.

The next section provides a background discussion on the demographic response to economic stress in preindustrial society, and on the characteristics of the manorial economy. Then follows an account of the study area, data and methods used, a presentation of the empirical results and a concluding discussion.

Demographic Response to Short-Term Economic Stress

By now there is a long list of studies showing a clear demographic response—in mortality, fertility and nuptiality—to short-term fluctuations in food prices, or sometimes real wages, in preindustrial society (e.g. Lee 1981, 1990; Weir 1984; Bengtsson and Ohlsson 1985; Eckstein, Schultz and Wolpin 1985; Galloway 1985, 1988). While the initial focus of research clearly was on northwestern Europe (mainly England, Sweden and France) subsequent research has basically confirmed the existence of a demographic response to short-term economic fluctuations for other parts of the preindustrial world as well (see Bengtsson and Reher 1998; Hammel and Galloway 2000; Feeney and Kiyoshi 1990).

The fertility response was usually much stronger than the mortality response (Galloway 1988). It was a direct effect and not explained by a price effect working through nuptiality (Carlsson 1970; Bengtsson 1993). At least partly the fertility response to economic stress seems to have been intentional as families deliberately postponed childbirth in times of economic hardship (Bengtsson and Dribe 2006, 2010; Dribe and Scalone 2009).

The mortality response was strongest among children (over the age of 1) and adults in working ages, while it was weaker among infants and elderly (Bengtsson and Ohlsson 1985; Bengtsson 1999; Bengtsson et al. 2004). The fact that infant mortality to a large extent followed its own cycles is also quite well established (see e.g. Utterström 1957, 207-208; Bengtsson 1999; Oris, Derosas and Breschi 2004), and is explained by the fact that most infants were breast-fed. For elderly, on the other hand, the weaker response to economic stress compared to working age adults, could have been a result of an already low consumption, which made it difficult to further lower in times of economic hardship. The fact that their work load was also lower than for people in working ages might also have contributed to this.

While most research in this area has been based on aggregated data (at country, or sometimes regional, level) more recently there has also emerged studies using micro-level data, following individuals over time and studying the response of aggregated price or real wage data on the individual risks of mortality or fertility (e.g. Bengtsson et al. 2004; Allen, Bengtsson and Dribe 2005; Tsuya et al. 2010). These studies have been able to show considerable differentials in the demographic response to economic stress by gender, socioeconomic status and household context. Generally speaking, and quite as expected, the individuals or groups with less resources showed the strongest demographic response to economic stress, and this seems to have been true for both fertility and mortality. In southern Sweden, for example, the non-landed groups, who were dependent on working for others to cover their subsistence needs, were much more vulnerable to economic stress as shown by their stronger, and much more consistent, response to grain price fluctuations (Bengtsson 2004; Bengtsson and Dribe 2005, 2006). Migration does not seem to have been an effective way to deal with economic stress in this area, most likely because of the lack of an urban sector close enough where the labor market could absorb masses of people fleeing from the countryside (Dribe 2003). The landless and semi-landless families in this area appear to have deliberately postponed child birth in times of hardship (Bengtsson and Dribe 2006), but these efforts were clearly not enough, as shown by the profound mortality response to economic stress in all age groups; somewhat weaker among infants and elderly than among children and adults in working ages (Campbell, Lee and Bengtsson 2004, 69).

The strong dependency of demographic outcomes on economic conditions was a salient feature of preindustrial society and could be linked more generally with the Malthusian situation before the onset of modern economic growth (e.g. Wrigley and Schofield 1981). Even though the standard of living in Europe was not completely stagnant for the whole preindustrial period, it seems quite clear that the improvement for ordinary people was modest before industrialization, and this situation seems to have been similar in different parts of the world, with the possible exception of the most developed parts of northwestern Europe, such as southern England and the Netherlands, where an improvement, at least relatively speaking, in real wages of laborers can be noticed in the early modern period preceding the Industrial Revolution (see e.g. Broadberry and Gupta 2006; Clark 2007; Parthasarathi 2001; Pomeranz 2000; Allen 2009; de Vries and van der Woude 1997; van Zanden and van Riel 2004).

Indeed, the vulnerability to economic stress has been seen as a crucial indicator of the standard of living in preindustrial society (Bengtsson 2004, Allen, Bengtsson, and Dribe 2005). The mere fact that mortality depended on economic fluctuations, and especially the fact that mortality of children and people of working ages rose profoundly in times of economic distress, can be seen as an indication that at least parts of society enjoyed a low standard of living. The fact that the demographic response to economic fluctuations generally disappeared as the preindustrial society was transformed into an industrial society following the agrarian and industrial revolutions of the eighteenth and nineteenth centuries, is also consistent with this interpretation of the demographic response to economic stress being a fundamental indicator of (low) standard of living. Thus, being able to avoid the adverse impact of economic stress should be viewed as being connected to a higher standard of living, even though it might not imply that the average income level was higher.

Indicators of Economic Stress

Both food production and food prices affected short-term economic conditions in preindustrial society; exactly how depended on whether prices were exogenously determined or not (see, e.g. Dribe 2000). If prices merely reflected the local harvest, prices and output would measure the same thing. However, if prices did not completely follow harvests, because of price regulations, trade or other factors influencing prices, changes in output and prices would affect living conditions separately as well as jointly (Hiltpold 1989).

In most preindustrial societies land was the main asset and output from the land determined the prosperity, and thus the possibility of survival, of rural people. Low agricultural output implied less food in the local economy, especially for the landless groups since the landholding peasants would meet their consumption needs first, before supplying food to the market. Even if the local economy was open, and thus exposed to trade, a harvest failure most often struck a larger geographical entity than the local community, which created a food shortage at the regional level. Since import of food from more remote areas was more expensive and in some cases, as in Scania, trade organization in food was organized predominantly for exports and not for imports, short-term food shortages would be hard to cover. Moreover, bad harvests meant less working opportunities for the laborers, and hence lower income, which negatively affected the possibilities of buying food for this group, even if prices were not higher than normal. So, low production in itself, irrespective of price level, might hit poorer segments of the population hard. For landholding peasants, lower production meant less food to eat or at least less food to sell. However, if low production coincided with high prices, either through the economy being closed (no-trade) or by accident (with exogenous prices), the loss in production might be less than the increase in income obtained from higher prices (Abel 1980). During severe failures, though, even this group would probably be harmed (Dribe 2000, 169).

Exogenous prices might influence living conditions regardless of output level. High prices meant not only that poorer segments of the population had difficulties of reaching subsistence, due to falling real wages, but also that surplus-producers sought to sell their products on markets offering these high prices. So, irrespective of the level of the local harvest, peasants would try to sell their products where they could get the best price. Only if transport costs were high enough to eliminate the possible profit from selling on high price markets, peasants would sell their products on the local market for potentially lower prices. In reality, prices were to a high extent exogenously determined (i.e. by other factors than the local harvest yield) as shown by the high degree of market integration not only in Sweden but in the whole of northwestern Europe (Dribe 2000, Ch. 7; Persson 1999). However, when looking at higher levels of aggregation prices and output will naturally show a higher degree of correlation. Nonetheless, prices at county level reflected conditions far beyond the regional grain output.

In essence, both in years with high prices and when production failed the lower stratum of the population faced difficult living conditions, either through a general lack of food or through not being able to afford buying food. For landholders the effects of harvest failures would probably negatively affect living conditions while high prices would be beneficial if production was normal or higher.

Dealing with Economic Stress

There were different ways to avoid the negative impact of fluctuations in grain prices or agricultural output. One was the opportunity to save in good times, in order to have assets or stored grain to use in times of scarcity. The fact that landless groups seem to have been more severely affected by economic fluctuations than the landed groups could probably be explained by the lack of these kinds of resources among the poorer segments of the population.

Another way of dealing with stress would be to borrow capital on the market or, to insure against risk by buying various kinds of insurance policies. This is one way of dealing with risk used frequently in modern societies. To be effective it assumed the existence of well-functioning markets for capital and insurance, which we know did not characterize most preindustrial rural economies, even though the local economies entailed substantial financial interaction between individuals and families (e.g. Hoffman 1996, 69-80; Rosenthal 1994; Svensson 2006). Moreover, even in cases where there were markets for capital, some kind of collateral was usually required, which made it impossible for the non-landed, lower status, groups to make use of this opportunity. One could also expect that it was most difficult to get credit when it was needed the most, i.e. in times of crisis when those who had savings often needed them for their own survival. Yet another way of dealing with economic stress is through governmental transfers. Again, this is a common way to deal with uncertainties in contemporary societies (social insurance, unemployment benefits, aid to farmers, etc.), but something very rare in preindustrial societies. Although there were poor relief systems working in many places, they were usually designed to help only the very poor and destitute, and could not provide relief to large groups of people in times of economic crisis (see the discussion in Bengtsson 2004).

In the absence of own savings or stored grain, insurance policies, easy accessible credits through the market, or a well-developed welfare state, the opportunities to deal with stress for people of low economic status were quite small, as is also shown by their strong response to economic stress. There is one institution, however, which might, at least to some extent, have performed these functions, namely the preindustrial manor. Already Marx wrote about: "…all the guarantees of existence afforded by the old feudal arrangements" (Marx 1867, 705). The appearances of such "guarantees of existence" were later formulated in contractual terms by North and Thomas, who characterized the serfdom of the manorial system in Western Europe as "…a contractual arrangement where labor services were exchanged for the public good of protection and justice" (North and Thomas 1971, 778).

This contractual approach to serfdom has, however, been criticized for not taking into account the element of enforcement inherent in the system. A contract must not only be a mutual agreement, it must also be voluntarily accepted by the parties involved. Nonetheless, in contrast to Western European early medieval serfdom, early modern seignorialism in Eastern and Northern Europe never could be justified by the absence of juridical protection from kings and states.

The landlords basically offered land in exchange for labor services. It has been argued that in return for high fixed rents the landlord also provided insurance in times of need turning the manor "into a unit of insurance as well as exploitation" (Fenoaltea 1976, 133). Consequently, since the tenants paid for their insurance with surplus rents they were not better off as compared to freeholders (see also Bloch 1966, 77-83).

However, for this to hold true in respect to short-term economic crises, the freeholders must have had the possibility of putting aside means during good years to cover future bad years. Moreover, there are examples of landlords providing also for the landless part of the population, either directly or indirectly through the tenants (Plakans 1975, 639). This means that in order for a comparable situation to exist for freeholders the same links must have existed between landholding peasants and landless people. Following the arguments above on the negative impact of short term economic stress on landless groups, this seems not to have been the case.

The Swedish manorial system was founded on mutual agreements between landlords and peasants, and serfdom and moving restrictions were non-existing, except in a few special cases (Lundh and Olsson 2008; Olsson 2003). Hereditary tenancies, like in some parts of east and central Europe, were never offered in Sweden, but land transfers to tenants' sons and daughters were nonetheless a common feature at the estates (Dribe, Olsson and Svensson 2009). Although seldom formalized in contractual terms, the landlords could offer some social protection as well. In manorial parishes the same retirement systems were practiced as in parishes dominated by freeholders, in spite of the fact that the retiring tenants had no legal claims on such subsidies (Lundh and Olsson 2002). In the seventeenth century some noble landlords additionally founded hospitals, which was a poorhouse with some basic nursing facilities (Jeppsson 2001). Similar arrangements, often more unconditional for the seignors the more dependent their peasants were, existed in east and central Europe (Blum 1978, 91-92).

There are also some evidence that the lord of the manor could help out in events of harvest failures, e.g. by lending grains or by postponing land rents (e.g. Dyer 2005, 174; Fenoaltea 1976, 133). Outstanding debts from tenants can occasionally be identified in manorial accounts, and in preserved letters between bailiffs and landowners the welfare of the tenants could be discussed and elaborated in cases of harvest failures. This was not only the case in medieval England but from qualitative sources we can exemplify how the manorial system could act as an insurance institution also in eighteenth and nineteenth century Sweden. Bjersgård was a normal mid-sized Scanian estate. Around 1800 about 200 hectoliters of seed were annually sown on the demesne fields and the number of tenant farmers was about 85, most of them living in the same parish as the manor. Their principal land rent was defined as whole or half corvée (*hoveri*) and 89 percent of the estate income came from demesne production, the rest from tenant dues in money or products (Olsson 2002, 122-131). The owner of the estate, Axel Erik Gyllenstierna, was the governor of the adjacent county of Halland, and did not live on the manor 1794-1810. During these years the estate bailiff, Christian Tullstedt, wrote reports every month, asking his master for permission to take actions and measures of different kinds. A frequent topic was the welfare of the tenants, which in times of hardship could conflict with the owner's interest of profit from the estate. In December 1794 bailiff Tullstedt wrote to Gyllenstierna:

> …I cannot leave any forecast on future grain sales. The needs of the peasants are at the moment impossible to estimate, but I can with certainty assure that they will be bigger than before, because most of them will run

> out of grain by Easter, and some even before that. It is highly necessary that His Lordship leaves the grain where it is, except for the wheat, so the peasants can be saved for the future, because I fear that no grain will be here to get during the next year (Olsson 2002, 128).

In this case the estate supported the tenants by holding back external grain sales and instead preserving it for their needs. The same was the case after the harvest failures of 1798 and 1806. The latter year the bailiff wrote to his master that he will "…charge the tenant farmers and crofters 10 *riksdaler* per barrel rye, but 12 *riksdaler* from strangers" (Olsson 2002, 129). Thus, another way of supporting the tenants in times of hardship was to subsidize their grain prices.

So, even if the initial contractual relations of the Middle Ages concerning legal protection and protection against war and violence definitely became obsolete long before the eighteenth century, insurance against economic crisis could have been an importance aspect of the manorial institution. By selling or lending grain to its needy inhabitants the estate could act as an insurance institution against extreme events. This kind of arrangement was harder to implement among independent peasants. Needless to say, such an insurance function by the manors would have had a great impact on the living standards of its inhabitants.

In the analysis below we study the extent to which the manors performed this kind of insurance function, by looking at the demographic response in more than 400 geographic units (parishes, or groups of parishes), classified according to their degree of manorialism. If the manors insured their inhabitants against economic hardship we expect parishes dominated by manors to show less demographic response to economic stress more generally, and to economic crises in particular.

Study Area

Two hundred years ago the region of Scania, the southernmost province of Sweden, had about 250,000 inhabitants of which less than ten percent lived in towns. Agriculture was the dominant occupation and the backbone of the agriculturalists was landholding peasants. Generally, Scania can be said to have contained all sorts of different peasant ecotypes. There were tenants under the nobility forming crowded villages on the plains surrounding a manor as well as small scale freeholders in wooded areas. However, the reverse existed as well.

As for property rights, about half of Scanian land was owned by the nobility and the other half was owned either by the Crown or by owner-occupiers (freeholders). The freeholders owned their land and paid taxes to the Crown. They had representatives in the Diet of the Four Estates (a kind of pre-democratic parliament) and from the late seventeenth century onwards their property rights were strengthened, gradually giving the peasants the right to divide farms, to sell them on the land market and to break up from the village organization. The Crown leased most of its land to tenants, whose legal and economic status were very much like that of freeholders, and most of them had bought their farmsteads by the mid-nineteenth century, turning them into freeholds. The manorial parishes very typically organized in a classic mode: A manor house surrounded by demesnes; one or more dependent peasant villages with their arable and pasture land; forests and outlands regulated by the estate authorities; corvée as the villagers' predominant land rent and hardly any taxes to the Crown, or, on the whole, other forms of interference.

The nineteenth century saw a development full of contradictions. At the same time as Scania experienced a late wave of manorialism, with multiplied corvée dues and a massive closing down of tenant farms to increase manorial demesne farming (Olsson 2006), the freeholders in adjacent villages were fully emancipated. They initiated enclosures, developed their farming techniques and became more and more commercialized in the course of a strong agrarian upswing (Svensson 2006). So, while tenants under the nobility faced increasing rents, freeholders met almost fixed taxes over time and even though there was a general increase in farm output over the period, it was significantly stronger on freehold farms (Olsson and Svensson 2009). In both types of areas the social differentiation increased during this period. While the number of landless people in freehold parishes increased due to a larger demand for labor, this process was supplemented in the manorial parishes by the process of including farms into the demesne and thereby turning landholding tenants into landless laborers. From Table 1 it is clear that the share of landholding peasants declined over time, a general development in Sweden, in both types of parishes. What the table conceals is that in the freehold/Crown parishes some of the landholding peasants did not have farms large enough to support a family. These peasants had to work for others to cover their subsistence needs. Therefore, generally speaking, there does not seem to have been any large differences between manorial areas and freehold areas in terms of proletarianization.

Table 1. Percentage of landholding peasants of total heads of households in manorial and freehold/Crown parishes 1751-1840.

	Manorial parishes	Freehold/Crown parishes
1751	62	64
1775	52	56
1800	45	49
1840	37	49

Source: The Tabular Commission, The Demographic Database, Umeå University.
Note: The sample consists of 20 parishes where more than 80 per cent of the land was noble land, and 16 parishes where more than 80 per cent of the land was freehold or Crown land.

While Scania as a whole was a grain-surplus region providing food for other areas of Sweden, the geographical conditions differed over the Scanian countryside. Following earlier ethnological and geographical classifications it can be divided into three types of areas (e.g. Campbell 1928; see also Bohman 2009). The plain district was situated mainly along the coasts in the south and west but stretched into the middle of the region on some places. The soil was predominantly clay or clay based sand and it was the most fertile soil in Sweden. This allowed for relatively large villages with a denser population directing their production towards grain. However, also animals were needed since ploughing this soil demanded a large number of draught animals. The northern and central part of the region was a forest district displaying a more differentiated production including timber and tar but also grain and animals. Besides smaller villages there were frequent isolated single farms in the landscape. In between these two distinctly different parts of Scania, an intermediate brushwood district formed the transformation of the landscape from plains to forest. In this third part, animal breeding constituted one important preoccupation but also here grain was produced to a large extent. In the two latter districts soil conditions differed a lot but in general it was lighter soils than in the plains with smaller pieces of arable land located in between grazing areas and forests. Although many manors were situated where the plains gradually transformed to brushwood and forest districts, in all three districts as well freeholder and crown tenants as manorial estates with subordinate tenants were situated.

Data and Methods

We look at the demographic response at parish level. In total we have 31,051 observations for 459 geographical units consisting of a single parish or a pair of two parishes (*pastorat*). The data comes from the Tabular Commission, a predecessor to Statistics Sweden who started to gather nation-wide data in 1749. Vital events were recorded annually (unfortunately not by social group), while the populations at risk (divided by age, sex, etc) were usually recorded every three to five years. Here we only use the vital events.. The problem is that the geographic units reported change over time, which makes it a time-consuming task to construct coherent geographical units over time (see, e.g. Claësson 2009). However, by controlling for time period (10-year dummies) and county in the analysis the time trends in number of vital events, and basic inter-county differences in parish sizes, should not affect the basic patterns in the relationship between short-term economic fluctuations and demographic outcomes.

We look at annual number of births and deaths of children (age 1-9) and young adults (15-24). As was previously discussed, the demographic response is usually strongest for children over the age of 1 and for adults in working ages, which implies that if there is no clear pattern in these age groups, it is quite unlikely that we would find such a pattern for older age groups. Table 2 shows that there are an average of about 27 births, 3.3 child deaths and 0.8 young adult deaths across all observations.

We include two different measures of the economic conditions facing people in this region: rye prices at county level and output estimates of grain production for the province of Scania as a whole. This is done since prices were set exogenously of the local harvest in this region (Dribe 2000, 164) and following the reasoning earlier on separate effects of output and price shocks.

Table 2. Descriptive statistics.

Dependent variables:				
	Mean	St. Dev.		N
Births	27.1	0.104		841482
Deaths 1-9	3.3	0.021		102468
Deaths 15-24	0.8	0.007		24841
Explanatory variables:	%			
Degree of manorialism				
High	18.4			
Medium	45.3			
Low	36.2			
Period				
1749-1759	8.0			
1760-1769	7.6			
1770-1779	7.8			
1780-1789	8.3			
1790-1799	8.7			
1800-1809	9.5			
1810-1819	9.9			
1820-1829	10.1			
1830-1839	10.3			
1840-1849	10.0			
1850-1859	10.0			
County				
Kristianstad	37.8			
Malmöhus	62.2			
Type of area				
Plain	39.1			
Intermediate	43.2			
Forest	17.7			
Economic variables:		Percentage in groups:		
	Mean	Low	Normal	High
Rye price residuals	-0.004	9.6	78.7	11.7
Grain output residuals	0.001	13.1	77.5	9.4
Observations	31051			
Geographical units	459			

Sources: The Tabular Commission, The Demographic Database, Umeå University, Jörberg 1972; Olsson and Svensson 2009; Gillberg 1765, 1767, digitized by Lars Persson, Department of Social and Economic Geography, Lund University.

The output series come from the Historical Database of Scanian Agriculture (HDSA) and were derived from tithe payments to the local clergy. The tithes in this region were divided into three distinct parts: to the Crown, to the church, and to the local clergy. By government regulations in the 1680s the two former were set to a fixed annual amount, which remained unaltered for over 200 years. In some cases the tithes to the local clergy was also fixed after agreements with the parishioners, but in many cases this part remained a flexible annual production tax, until the 1860s. The clergymen kept accounts on each farmer’s annual tithe payments. These payments, besides some minor dues and boon days, consisted of every thirtieth sheave of the harvest and every tenth living animal born. Measured in production values animal breeding constituted about ten percent of the average farm output, and will not be further elaborated in this study. The crop output was dominated by barley and rye, and to a lesser extent oats and wheat. Additionally, farmers often grew some peas and beans on their fields, and occasionally buckwheat in districts with sandy soils. In the early nineteenth century potatoes moved out from the kitchen gardens into the arable and became an important crop in most districts.

The series displayed in Figure 1 was estimated from these flexible tithe payments in 34 parishes with a total of about 2,200 farm units. The sample reflects existing differences in property rights and geographical conditions of eighteenth and nineteenth century rural Scania. The individual farm production series are of different length, between 20 and 130 years, and on average 450 farms are present each year. The absolute levels of output differ between the parishes. To create the aggregated series, we first estimated the annual averages for each parish. Then a conversion figure for each parish was created, by comparing the mean values of the first five years it appeared in the database, with the current mean values. The individual farm series was smoothed with their respective parish's conversion figure, and finally an annual mean value was calculated from the whole sample.[1] Output is estimated as total production (in hectoliter) per average farm in the sample in 1770, using the measurement of farm size in the poll-tax registers (*mantal*). The high reliability of the output estimates is shown by their congruence with contemporary qualitative harvest reports, their high correlations with each other, and their negative correlations with regional grain prices.[2]

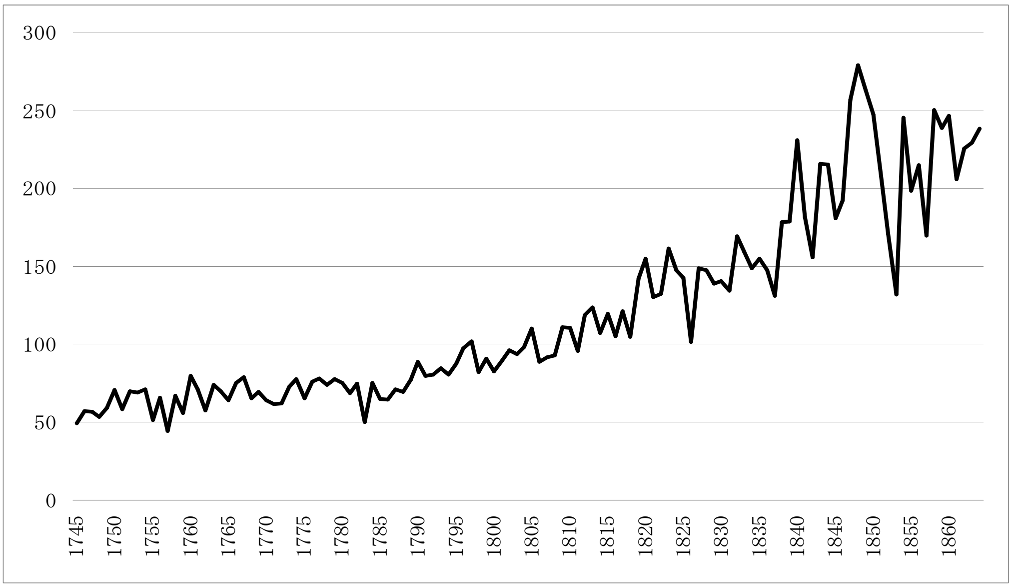

Figure 1. Grain output (hectoliter/average 1770 farm) in Scania, 1745-1864.

Source: Olsson and Svensson 2009.

[1] For further information on the methods of constructing the output estimates in the HDSA, see Olsson and Svensson (2009).

[2] On village level the mean correlation coefficient for 293 pair wise estimations is 0.54, with distances up to 100 kilometers in between, and their correlations with regional grain prices are typically -0.5, in both cases after trend elimination through first differences.

Data on the price of rye, which was the dominating bread grain in this period, is available from the Market Price Scales and was published by Lennart Jörberg in his price history of Sweden (Jörberg 1972). The Market Price Scales were administrative prices used to value the various payments made in kind. The rules governing the manner in which these prices were established varied somewhat over time, but generally speaking they were based on market prices gathered at lower levels, such as towns, judicial districts (*fögderi*) or parishes in the county. The procedure to weigh these prices into the Scales also changed over time; sometimes being the results of negotiations between various representatives, sometimes being simple averages (see Jörberg 1972I, 8-18). Despite the administrative character of the prices Jörberg argued that they reflected the true market prices in a satisfactory way, and that they hence were an invaluable source for a study of Swedish price history (Jörberg 1972 I, Ch. 3). We use rye prices for the two counties in Scania—Malmöhus and Kristianstad—and have recalculated the published figures into a single unit: *kronor*/hectoliter (see Figure 2). It is quite clear that the developments of the prices in the two counties are highly similar both in terms of trends and fluctuations.

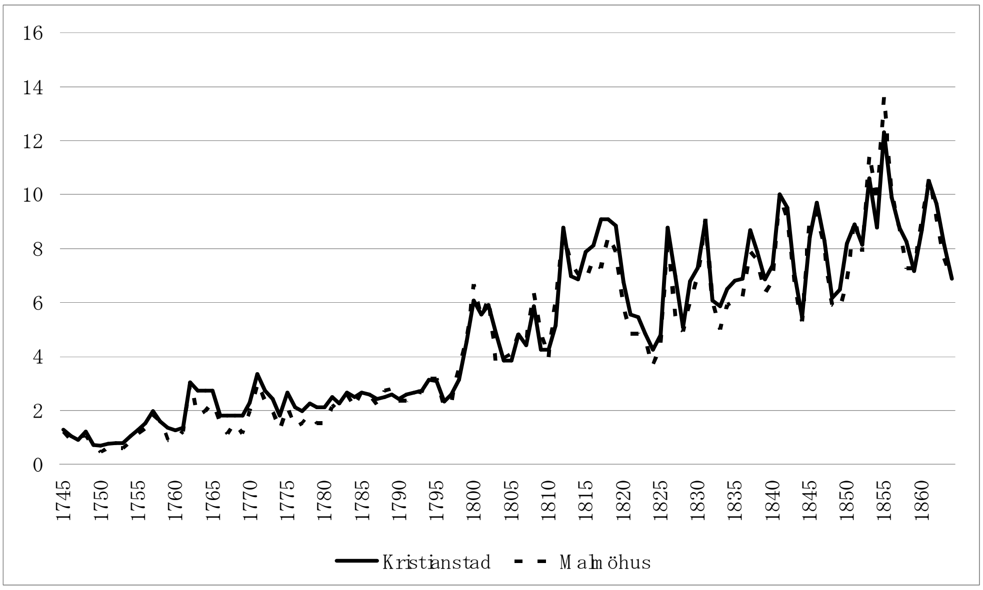

Figure 2. Rye prices (*kronor*/hectoliter) in the Scanian counties, 1745-1864.
Source: Jörberg 1972, own calculations.

Figures 1 and 2 clearly show the strong upward trend in both prices and grain output. To measure the short-term fluctuations we de-trended the logarithms of the series using the Hodrick-Prescott filter with a smoothing parameter of 6.25, which is suitable for annual data (Hodrick and Prescott 1997). In contrast to first differences, which measure the change between two consecutive years, our de-trended values measure the degree of departure in the series from a smoothed trend. Thus, while a change from low to medium would equal a change from medium to high using first differences, our residuals measure the conditions in the year under consideration in relation to normal years in the period. The de-trended values used in the analysis are shown in Figures 3-5, and even though there is some increase in the variance over time in the output series they can be considered quite stationary. In contrast to long-term trends, short-term variations differ between the price series and the output series. To check for possible threshold effects in the response we also categorize price and output residuals. We use absolute values of more than 0.12 for output and 0.20 for grain price as high/low deviations from normal. This corresponds to a 13 percent higher/lower output than normal and a 22 percent deviation in the rye price level. Over the entire period about 12-13 percent of the years were characterized by high prices/low output (see Table 2), and these are the years which we consider as crisis years.

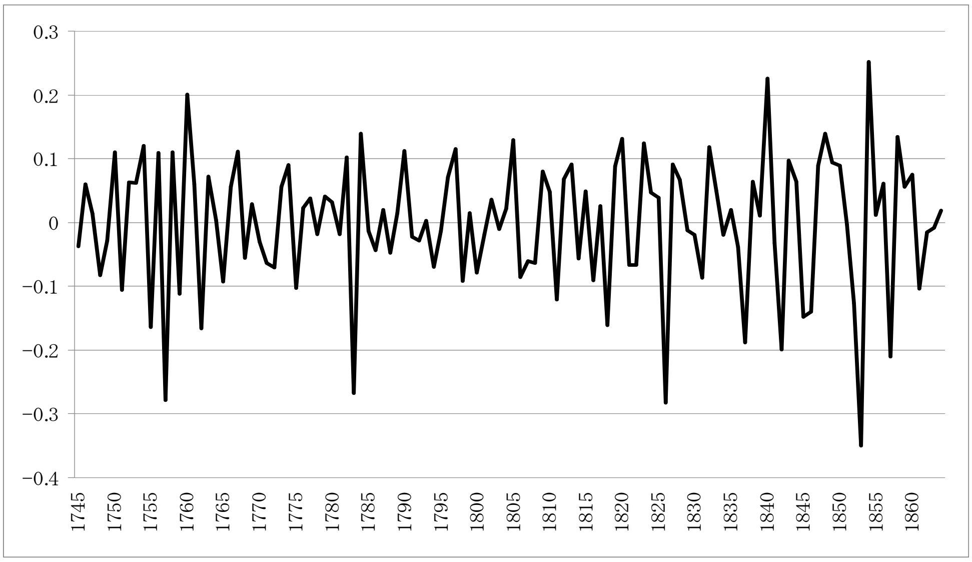

Figure 3. De-trended log grain output in Scania, 1745-1864.

Source: See Figure 1.

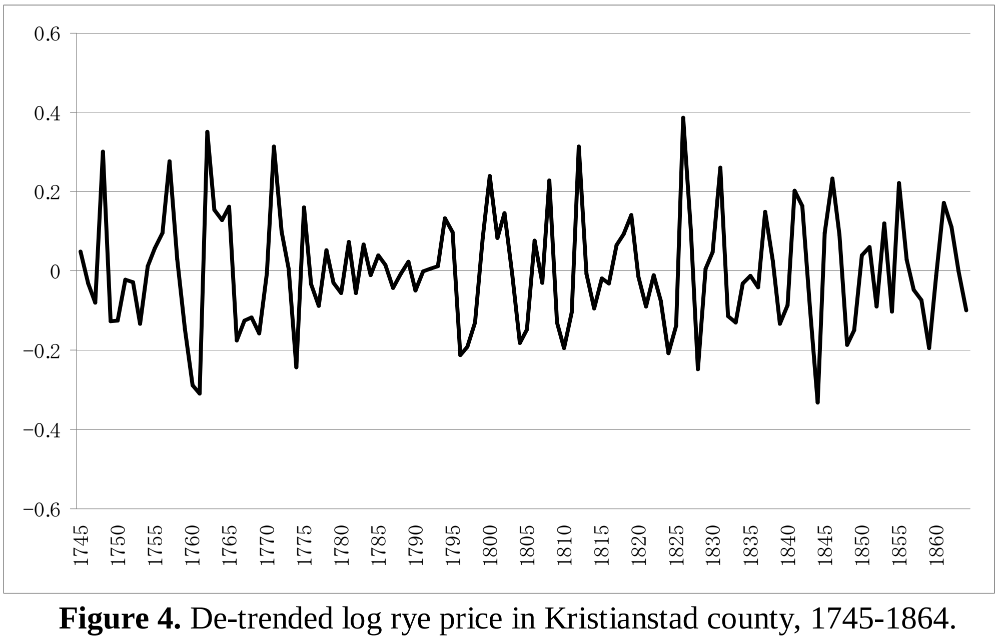

Figure 4. De-trended log rye price in Kristianstad county, 1745-1864.

Source: See Figure 2.

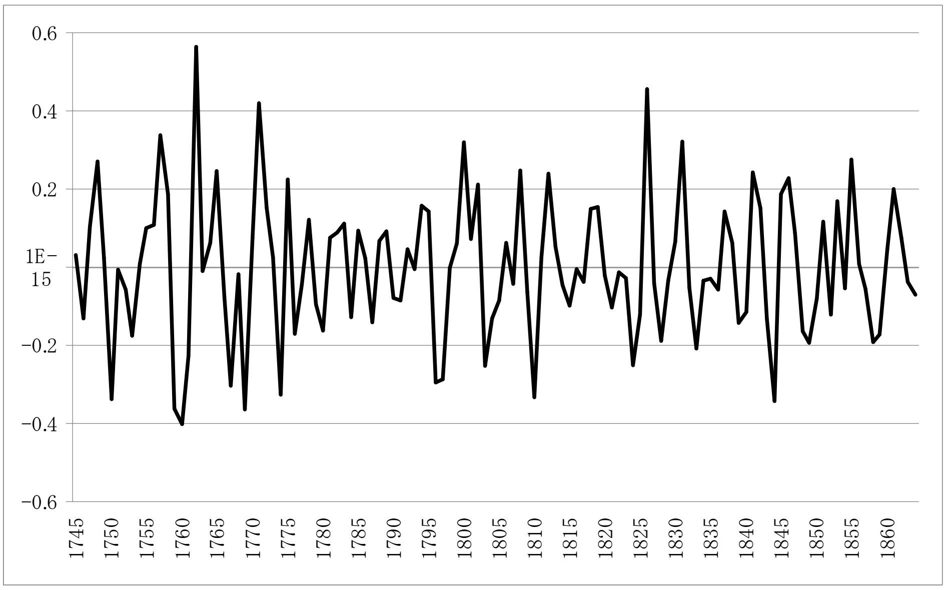

Figure 5. De-trended log rye price in Malmöhus county, 1745-1864.
Source: See Figure 2.

We analyze the demographic response to economic stress by estimating a series of pooled OLS models where the number of births, child deaths (1-9), and young adult deaths (15-24) are the dependent variables. We also estimated random effects panel regression models to account for the panel structure of the data (31,051 observations for 459 geographical units), but since the Hausman test indicated that the crucial assumption of independence between the random effects and the regressors could not be upheld we chose to report the OLS estimates. The two sets of estimates were also highly similar yielding the same substantive results. The standard errors are robust to the clustering of observation at the parish level, and thus allows for within-cluster correlation of errors (see Baum 2006, 138-139).

We control for period by including a set of 10-year period categorical variables. In this way the increasing number of vital events stemming simply from population increase over time is controlled for when estimating the price and output effects. We also control for county and type of district. The district classification—plain district, forest district and intermediate brushwood district—is based on traditional settled country characteristics (Campbell 1928) with some modifications.[3]

Our main variable, in addition to rye price and grain output, is the degree of manorialism. From data on the distribution of land ownership by parish[4] we categorized

[3] The deviation from Campbell's classical grouping concerns the so called Romele Ridge Forest district, which already in the early eighteenth century to a great extent was deforested. Besides, many of its forest areas were located in parishes that were partly plain lands at origin. The district as a whole is here classified as intermediate.

[4] Derived from Gillberg 1765 and 1767. Manorial demesnes and rectories are excluded from the estimates. We are greatful to Lars Persson, Department of Social and Economic Geography, Lund University, for helping us with his digitalized excerpts from Gillberg on distribution of land ownership.

the variable into “high” (80 percent or more of the land in the parish belonged to dominant manors), “low” (80 percent or more of the land in the parish was freehold land or crown land), or “medium” (all other parishes). In order to test the hypothesis about the manors having an insurance function we estimate interaction models where the degree of manorialism is interacted with the economic variables to see if the demographic response differ in a significant way between the different parishes.

Results

Before studying the potential insurance effect of manorialism in times of short-term economic stress, we must start by substantiate the existence of a demographic response to changes in prices and output. Table 3 reports the estimates of basic models including all the control variables as well as prices and output. The regression coefficients have been re-calculated to elasticities indicating the percent change in the dependent variables of a one percent change in the explanatory variables (a categorical variable represents a 100 percent change). Looking first at births (Panel A), there is evidently a clear response to both prices and output. The effects in the current year are very small, while the effects with a one year lag are more sizable. This is also what could be expected because of the waiting time between conception and birth. Previous studies have indicated a quite rapid fertility response, but not before the final part of the year of the price change (Bengtsson and Dribe 2006). The price elasticity of lagged prices is 0.144 which implies that prices 10 percent higher than normal were associated with a roughly 1.5 percent decline in births. Thus, the magnitude of the response is by no means huge, and for grain production it is even less.

For child deaths the pattern is similar, with a statistically significant response already of current prices, but a stronger response with a one year lag (Panel B). According to the estimates, years when prices were 10 percent above normal were associated with slightly less than 3 percent more deaths in the following year, while years with an output 10 percent below normal were associated with about 6 percent more deaths. This shows that economic stress clearly affected families in Scania by increasing the risks of child deaths, which has also been shown previously both at aggregate and at micro level (Bengtsson 1984; Bengtsson and Dribe 2005).

Also when looking at deaths of young adults in ages 15-24 (Panel C), we find a statistically significant response to both rye prices and grain output. As with births and child deaths, the response is stronger with a one year lag, but is visible and statistically significant also in the current year. Prices 10 percent above normal are associated with a 1.2 percent increase in the number of deaths in the current year and a 1.5 percent increase the year after. The corresponding figures for output are 2.6 percent more deaths in the current year and about 4 percent in the year after.

These results clearly establish the existence of a demographic response to prices and output, which was also what could be expected from previous research. It shows that the rather approximate method of using number of events rather than demographic rates seem to work sufficiently well to reproduce expected results.

Table 3. Regression estimates (elasticities) of demographic response to short-term economic fluctuations, 1749-1859.

A. Births

	Price				Output			
	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|
Price/output (t)	-0.052	0.000	-0.041	0.000	-0.024	0.082	-0.001	0.945
Price/output (t-1)	---	---	-0.144	0.000	---	---	0.082	0.000
Period								
1749-1759	ref		ref		ref		ref	
1760-1769	0.020	0.010	0.009	0.276	0.023	0.004	0.021	0.008
1770-1779	0.027	0.015	0.022	0.043	0.025	0.024	0.025	0.026
1780-1789	0.020	0.124	0.014	0.283	0.019	0.144	0.019	0.144
1790-1799	0.091	0.000	0.082	0.000	0.093	0.000	0.091	0.000
1800-1809	0.113	0.000	0.113	0.000	0.111	0.000	0.111	0.000
1810-1819	0.269	0.000	0.261	0.000	0.268	0.000	0.267	0.000
1820-1829	0.459	0.000	0.452	0.000	0.461	0.000	0.458	0.000
1830-1839	0.507	0.000	0.504	0.000	0.506	0.000	0.506	0.000
1840-1849	0.650	0.000	0.645	0.000	0.651	0.000	0.648	0.000
1850-1859	0.738	0.000	0.731	0.000	0.738	0.000	0.737	0.000
County								
Kristianstad	ref		ref		ref		ref	
Malmöhus	-0.184	0.002	-0.184	0.001	-0.184	0.002	-0.184	0.002
Type of area								
Plain	ref		ref		ref		ref	
Intermediate	0.339	0.000	0.339	0.000	0.339	0.000	0.339	0.000
Forest	0.389	0.000	0.389	0.000	0.389	0.000	0.389	0.000
Degree of manorialism								
High	0.016	0.814	0.016	0.813	0.016	0.815	0.016	0.815
Medium	ref		ref		ref		ref	
Low	0.017	0.786	0.017	0.784	0.017	0.786	0.017	0.786
Observations	31051		31051		31051		31051	
R^2	0.250		0.251		0.250		0.250	
F	44.6	0.000	45.1	0.000	43.9	0.000	42.0	0.000

B. Deaths, ages 1-9

	Price				Output			
	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|
Price/output (t)	0.168	0.000	0.147	0.000	-0.351	0.000	-0.521	0.000
Price/output (t-1)	---	---	0.286	0.000	---	---	-0.612	0.000
Period								
1749-1759	ref		ref		ref		ref	
1760-1769	-0.224	0.000	-0.201	0.000	-0.218	0.000	-0.204	0.000
1770-1779	-0.124	0.000	-0.114	0.000	-0.114	0.000	-0.112	0.000
1780-1789	-0.178	0.000	-0.166	0.000	-0.173	0.000	-0.173	0.000
1790-1799	-0.147	0.000	-0.128	0.000	-0.143	0.000	-0.130	0.000
1800-1809	-0.116	0.000	-0.117	0.000	-0.107	0.001	-0.109	0.001
1810-1819	-0.059	0.062	-0.045	0.160	-0.053	0.093	-0.053	0.097
1820-1829	0.133	0.000	0.148	0.000	0.136	0.000	0.154	0.000
1830-1839	0.221	0.000	0.226	0.000	0.224	0.000	0.222	0.000
1840-1849	0.172	0.000	0.182	0.000	0.184	0.000	0.199	0.000
1850-1859	0.580	0.000	0.593	0.000	0.581	0.000	0.583	0.000
County								
Kristianstad	ref		ref		ref		ref	
Malmöhus	-0.210	0.001	-0.210	0.001	-0.211	0.001	-0.211	0.001
Type of area								
Plain	ref		ref		ref		ref	
Intermediate	0.247	0.000	0.247	0.000	0.247	0.000	0.247	0.000
Forest	0.113	0.241	0.113	0.242	0.114	0.241	0.114	0.240
Degree of manorialism								
High	0.042	0.587	0.042	0.588	0.042	0.586	0.042	0.585
Medium	ref		ref		ref		ref	
Low	0.013	0.846	0.013	0.849	0.013	0.845	0.013	0.846
Observations	31051		31051		31051		31051	
R^2	0.061		0.062		0.061		0.064	
F	27.9	0.000	27.5	0.000	27.3	0.000	27.5	0.000

C. Deaths, ages 15-24

	Price				Output			
	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|
Price/output (t)	0.129	0.001	0.118	0.002	-0.149	0.014	-0.261	0.000
Price/output (t-1)	---	---	0.148	0.000	---	---	-0.404	0.000
Period								
1749-1759	ref		ref		ref		ref	
1760-1769	-0.107	0.001	-0.096	0.005	-0.107	0.001	-0.098	0.003
1770-1779	0.147	0.000	0.152	0.000	0.154	0.000	0.155	0.000
1780-1789	0.054	0.138	0.060	0.099	0.057	0.116	0.057	0.115
1790-1799	0.004	0.916	0.013	0.693	0.004	0.905	0.012	0.710
1800-1809	0.315	0.000	0.314	0.000	0.321	0.000	0.319	0.000
1810-1819	0.301	0.000	0.308	0.000	0.305	0.000	0.305	0.000
1820-1829	0.323	0.000	0.331	0.000	0.323	0.000	0.335	0.000
1830-1839	0.468	0.000	0.471	0.000	0.470	0.000	0.469	0.000
1840-1849	0.645	0.000	0.651	0.000	0.650	0.000	0.661	0.000
1850-1859	0.611	0.000	0.618	0.000	0.612	0.000	0.613	0.000
County								
Kristianstad	ref		ref		ref		ref	
Malmöhus	-0.200	0.003	-0.200	0.003	-0.200	0.003	-0.200	0.003
Type of area								
Plain	ref		ref		ref		ref	
Intermediate	0.339	0.000	0.339	0.000	0.339	0.000	0.339	0.000
Forest	0.361	0.000	0.360	0.000	0.361	0.000	0.361	0.000
Degree of manorialism								
High	0.016	0.823	0.015	0.824	0.016	0.823	0.016	0.822
Medium	ref		ref		ref		ref	
Low	0.040	0.569	0.040	0.570	0.040	0.569	0.040	0.569
Observations	31051		31051		31051		31051	
R^2	0.052		0.052		0.052		0.053	
F	23.3	0.000	22.0	0.000	23.3	0.000	22.1	0.000

Note: Elasticities express percent change in Y of a one percent change in X (categorical variables represent a 100% change in X). Elasticities are calculated at means of variables. Based on OLS estimates with standard errors adjusted for clustered observations (by parish).

Sources: See Table 2.

The main issue in this paper, however, is the possible role of manors in dealing with economic stress. To get at this we estimate a series of interaction models where the degree of manorialism (measured as a categorical variable) is interacted with rye prices and grain output, controlling for the same variables as before. Table 4 shows the elasticities of the main effects and the interaction effects. For births (Panel A) none of the interaction effects are statistically significant. However, looking at the interaction effects of high degree of manorialism reveals that they are opposite to the main effects indicating a weaker response in the manorial parishes.

For child deaths (Panel B) the interaction effects of high degree of manorialism are statistically significant for current rye prices, and again they go in the opposite direction from the main effects. The magnitude of the effects show that almost the entire mortality response of current prices is removed in the manorial parishes, pointing to a strong insurance effect of the manors. In the year after, however, there are no signs of any interaction between the degree of manorialism and rye prices. Evidently this protective effect of manorialism was only short-term as shown by the absence of any interaction effect of lagged prices. For production the interaction effects are not statistically significant, but the pattern is similar to the one for prices, even though the beneficial effects of manors seem lower than for prices. Again, there is no visible effect of manorialism in the second year. Turning to deaths of young adults in Panel C, there is much less of a consistent pattern. Here the only indication of an interaction effects is for lagged prices, but not for lagged output. There is no interaction effect for current prices, while the pattern for current output is the same as for child deaths, but not statistically significant.

Table 4. Price and output effects on demographic outcomes by degree of manorialism, 1749-1859. Regression estimates from interaction models.

A. Births

	Price				Output			
	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|
Price/output (t)	-0.064	0.000	-0.053	0.000	-0.028	0.147	-0.008	0.688
*Interaction Price/output (t)*Manor:*								
High	0.024	0.250	0.023	0.279	0.025	0.513	0.029	0.477
Low	0.019	0.275	0.018	0.311	0.000	0.990	0.005	0.878
Price/output (t-1)	---	---	-0.149	0.000	---	---	0.074	0.000
*Interaction Price/output (t-1)*Manor:*								
High	---	---	0.003	0.903	---	---	0.011	0.783
Low	---	---	0.011	0.615	---	---	0.016	0.601
Observations	31051		31051		31051		31051	
R^2	0.250		0.251		0.250		0.250	
F	40.5	0.000	37.8	0.000	39.6	0.000	34.7	0.000

B. Deaths, ages 1-9

	Price				Output			
	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|
Price/output (t)	0.222	0.000	0.198	0.000	-0.403	0.000	-0.557	0.000
Interaction								
*Price/output (t)*Manor:*								
High	-0.197	0.030	-0.195	0.031	0.216	0.180	0.175	0.314
Low	-0.039	0.591	-0.033	0.649	0.036	0.776	0.012	0.929
Price/output (t-1)	---	---	0.307	0.000	---	---	-0.557	0.000
Interaction								
*Price/output (t-1)*Manor:*								
High	---	---	0.006	0.943	---	---	-0.116	0.457
Low	---	---	-0.063	0.377	---	---	-0.093	0.447
Observations	31051		31051		31051		31051	
R^2	0.061		0.063		0.061		0.064	
F	25.1	0.000	22.5	0.000	24.6	0.000	22.7	0.000

C. Deaths, ages 15-24

	Price				Output			
	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|
Price/output (t)	0.107	0.049	0.093	0.085	-0.145	0.104	-0.241	0.010
Interaction								
*Price/output (t)*Manor:*								
High	-0.011	0.921	0.005	0.963	0.195	0.257	0.169	0.371
Low	0.067	0.462	0.068	0.448	-0.106	0.420	-0.137	0.338
Price/output (t-1)	---	---	0.187	0.004	---	---	-0.347	0.003
Interaction								
*Price/output (t-1)*Manor:*								
High	---	---	-0.175	0.090	---	---	-0.074	0.714
Low	---	---	-0.009	0.925	---	---	-0.118	0.506
Observations	31051		31051		31051		31051	
R^2	0.052		0.052		0.052		0.053	
F	20.8	0.000	18.0	0.000	20.9	0.000	18.4	0.000

Sources and Note: See Table 2. Models also control for all the variables in the basic model (Table 3).

Up to now we have been looking at effects of economic variables in continuous form. To assess the possibility that the demographic responses are not linear we estimate models with economic variables categorized into “high”, “normal” and “low” as described above. For births in Panel A (Table 5), there does not seem to be any real non-linearities in the price response, as shown by the positive (statistically significant) elasticity of “low” prices, and the negative elasticity of the same magnitude of “high” prices. The picture is basically the same for current prices and lagged prices. These results are in line with results at the micro level, where the fertility response to rye prices showed a similar linear pattern (Bengtsson and Dribe 2006). For grain output, on the other hand, there appears to be clear threshold effects in that there are only effects of “low” output, while the effects of “high” production is negligible, and not statistically significant.

Table 5. Effects of categorized prices and output on demographic outcomes, 1749-1859.

A. Births

	Model without lags				Model with lags			
	Price		Output		Price		Output	
	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|
Price/Output (t)								
Low	0.023	0.000	0.012	0.005	0.014	0.024	0.010	0.024
Normal	ref		ref		ref		ref	
High	-0.019	0.000	0.001	0.808	-0.033	0.000	0.004	0.490
Price/Output (t-1)								
Low	---	---	---	---	0.043	0.000	-0.026	0.000
Normal	---	---	---	---	ref		ref	
High	---	---	---	---	-0.068	0.000	-0.005	0.391
Observations	31051		31051		31051		31051	
R^2	0.250		0.250		0.251		0.250	
F	42.7	0.000	41.5	0.000	40.6	0.000	38.3	0.000

B. Deaths 1-9

	Model without lags				Model with lags			
	Price		Output		Price		Output	
	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|
Price/Output (t)								
Low	-0.022	0.154	0.172	0.000	-0.001	0.927	0.203	0.000
Normal	ref		ref		ref		ref	
High	0.034	0.033	-0.024	0.202	0.070	0.000	-0.024	0.213
Price/Output (t-1)					ref			
Low	---	---	---	---	-0.010	0.588	0.229	0.000
Normal	---	---	---	---	ref			
High	---	---	---	---	0.165	0.000	0.136	0.000
Observations	31051		31051		31051		31051	
R^2	0.060		0.063		0.062		0.067	
F	25.9	0.000	26.1	0.000	24.3	0.000	27.7	0.000

C. Deaths 15-24

	Model without lags				Model with lags			
	Price		Output		Price		Output	
	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|
Price/Output (t)								
Low	-0.035	0.102	0.048	0.028	-0.024	0.264	0.063	0.004
Normal	ref		ref		ref		ref	
High	0.037	0.108	-0.063	0.014	0.058	0.017	-0.078	0.003
Price/Output (t-1)								
Low	---	---	---	---	0.061	0.013	0.173	0.000
Normal	---	---	---	---	ref		ref	
High	---	---	---	---	0.095	0.000	0.035	0.238
Observations	31051		31051		31051		31051	
R^2	0.052		0.052		0.053		0.054	
F	21.8	0.000	21.9	0.000	19.7	0.000	20.7	0.000

Sources and Note: See Table 4.

For child deaths (Panel B) there are more indications of a non-linear response also to prices, although the effects of "Low" prices are negative, but not statistically significant. The effects of high prices/low production are much stronger than the effects of low prices/high production, which clearly supports the idea that the mortality response mainly resulted from times of crisis. The magnitudes of the crisis effects are also larger than what was implied by the linear effects in Table 3, further indicating the threshold effects in the mortality response. For young-adult deaths the pattern is less clear cut and there is no strong support for non-linearities in the response.

Finally, we look at the effects of crisis years ("high" prices and "low" production) on the demographic outcomes by the degree of manorialism to see if the previous pattern of a weaker effect of economic stress in manorial parishes still holds (see Table 6). Generally speaking the picture is the same as previously. There is a crisis response for both births and deaths, and the interaction between high degree of manorialism and crisis run in the opposite direction from the base effect indicating a weaker, or sometimes negligible, response in parishes dominated by manors. The pattern is clearer in the case of production for births, but for prices in the case of child deaths. As before, the protective effect of manorialism is only visible in the year of the crises, but not in the year after. This points to the conclusion that even though living on manorial land might have improved one's condition in times of crisis, the effect was mainly short-term, and in the year immediately following the crisis one suffered as much as people outside the manorial system. This is not to say the beneficial effect of living in manorial parishes was negligible. According to the estimates they avoided an increase in the number of child deaths by about 8 percent in years of crisis (measured by prices), but then suffered most of the 20 percent more deaths in the year following the crises (the interaction effect of -7 percent is not statistically significant).

Table 6. Effects of crises (high prices/low output) on demographic outcomes by degree of manorialism, 1749-1859. Regression estimates from interaction models.

A. Births

	Model without lags				Model with lags			
	Price		Output		Price		Output	
	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|
Crisis (t)	-0.026	0.001	0.022	0.056	-0.041	0.000	0.020	0.083
*Interaction Manor * crisis (t):*								
High	0.012	0.323	-0.041	0.105	0.010	0.409	-0.041	0.103
Low	0.006	0.631	-0.007	0.759	0.005	0.707	-0.006	0.776
Crisis (t-1)	---	---	---	---	-0.074	0.000	-0.013	0.226
*Interaction Manor * crisis (t-1):*								
High	---	---	---	---	-0.001	0.944	-0.031	0.228
Low	---	---	---	---	-0.004	0.815	-0.019	0.309
Observations	31051		31051		31051		31051	
R^2	0.250		0.250		0.251		0.250	
F	40.250	0.000	39.380	0.000	37.240	0.000	34.380	0.000

B. Deaths 1-9

	Model without lags				Model with lags			
	Price		Output		Price		Output	
	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|
Crisis (t)	0.045	0.069	0.195	0.000	0.083	0.002	0.211	0.000
*Interaction Manor * crisis (t):*								
High	-0.075	0.090	-0.058	0.390	-0.084	0.069	-0.056	0.398
Low	0.018	0.619	-0.024	0.643	0.010	0.784	-0.024	0.637
Crisis (t-1)	---	---	---	---	0.203	0.000	0.201	0.000
*Interaction Manor * crisis (t-1):*								
High	---	---	---	---	-0.076	0.106	0.041	0.499
Low	---	---	---	---	-0.060	0.128	-0.015	0.728
Observations	31051		31051		31051		31051	
R^2	0.062		0.063		0.063		0.066	
F	24.4	0.000	25.2	0.000	22.2	0.000	24.0	0.000

C. Deaths 15-24

	Model without lags				Model with lags			
	Price		Output		Price		Output	
	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|	Elasticity	P>|t|
Crisis (t)	0.031	0.355	0.089	0.008	0.054	0.117	0.102	0.002
*Interaction Manor * crisis (t):*								
High	0.013	0.835	-0.146	0.014	-0.006	0.923	-0.145	0.015
Low	0.022	0.671	-0.013	0.802	0.017	0.743	-0.014	0.785
Crisis (t-1)	---	---	---	---	0.128	0.002	0.154	0.000
*Interaction Manor * crisis (t-1):*								
High	---	---	---	---	-0.138	0.027	-0.008	0.897
Low	---	---	---	---	-0.036	0.518	0.018	0.747
Observations	31051		31051		31051		31051	
R^2	0.052		0.052		0.052		0.054	
F	20.6	0.000	20.8	0.000	17.9	0.000	18.3	0.000

Sources and Note: See Table 4.

Conclusion

In this paper we have studied the possible role of the manorial system—an important institution in the local rural economy of many parts of Europe in the preindustrial period—in insuring the parishioners, thereby facilitating the dealing with risk and lower their vulnerability to economic stress. Most preindustrial populations seem to have been highly sensitive to economic fluctuations, stemming from variations in agricultural output or grain prices, and rural Scania was no exception. We found a clear demographic response—in births, child deaths and young adult deaths—to short-term fluctuations in grain output and rye prices. Generally speaking, years of economic crisis, when prices rose with about 20 percent or more and output levels were about 15 percent or more below normal, led to a decline in births by 3 percent already in the year of the crisis, and about 7 percent in the year after. For child deaths the corresponding effects were about 7 percent, and 16 percent, respectively, and for young adult deaths 6 percent and 10-15 percent (Table 5). Thus, even though these effects might not appear to be at a disastrous level they are still noticeable and important.

In theory there are different ways of dealing with this kind of economic stress. One way is to live off personal savings or stored food, a second way is to borrow capital from various kinds of credit institutions, and a third way is to insure against risk through some kind of insurance policy. There is also the possibility that national, regional or local authorities provide assistance to the needy in times of crisis and in this way makes sure that they are not too severely affected by the distress. It is quite clear that in preindustrial society neither of these options worked in a satisfactory way. The amount of stored grain was too low to really make a difference in times of scarcity, and the public systems, such as poor relief, were not designed to take care of large numbers of people facing economic difficulties in times of crisis, but rather to help a limited number of poor and destitute. Similarly, capital and insurance markets were not developed enough to lower vulnerability to economic stress to those mostly affected, i.e. landless laborers. The only local institution with the potential of acting to lower the impact of economic stress in the population was the manorial estate. At least in the area under study many manors were big enough to be able to act as lenders of food, or to help by subsidizing food to people in need.

The question posed in this study was whether, or not, the manorial system actually performed this role and, the extent to which it had a real impact of the demographic response to economic stress. We approached the issue by looking at the parish-level demographic response to short-term fluctuation in grain output and rye prices, and specifically to see if the response differed between parishes dominated by manors and other parishes. Using both prices and output have provided us with the opportunity of testing two ways of measuring short-term economic stress. As argued above, these indicators do differ, but sometimes coincide, in an economy with exogenously set prices and the results show that both types of crises affected the well-being of the rural population. However, looking at the effects themselves the impact of the two types of crises did not differ much.

The results gave quite strong support to the idea that the manorial system actually had a kind of insurance effect, lowering the impact of economic stress. In the years of crisis the entire demographic response to short term economic stress was avoided, when we looked at child deaths, and also for births and deaths in young adult ages we found a similar pattern. This implies that the manorial lords not only helped their tenants by allowing arrears or subsidizing their food purchases, but that they also directly or indirectly helped the landless groups of the parish population. One interpretation would be that a contractual fulfillment from the landlords' side towards the tenants and crofters therefore was supplemented by a paternalistic behavior towards the whole of the population living in the manorial parishes. In the year following the crisis, however, we found no protective effect of living in a manorial parish, compared to living in other parishes. This shows that it was only in the short-term that estates could really make a difference for the standard of living of the inhabitants by reducing their vulnerability to economic stress. The higher rents and lower production output on tenant farms, as compared to on freehold farms, was thus only compensated by insurance from the landlord in the short run. In a way this shows the apparent imperfections in the institutional structure of preindustrial rural societies, which made the population highly vulnerable to economic stress. At the same time it provides valuable insights into the workings of the manorial economy in the late preindustrial period.

Acknowledgement

Financial support from the Linnaeus Centre for Economic Demography financed by the Swedish Research Council and Lund University is gratefully acknowledged, and so is the financial support from the Swedish Research Council to the project "Economic Development and Social Dynamics. Swedish Agricultural Transformation in European Perspective". A previous version of this paper was presented at the CNRS/EHESS workshop "A Critical Re-examination of Demographic and Economic Crises in Western Europe from the Middle Ages to the Early Twentieth Century", Treviso, Italy, June 2009, and at the World Economic History Congress, Utrecht, August 2009. We are grateful to participants at these meetings for comments and suggestions, and to Lars Persson at the Department of Social and Economic Geography, Lund University, for sharing his data on land tenure with us.

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Demographic Responses to Short-Term Economic Stress in a 19th-Century Tuscan Sharecropping Population

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Abstract

Tuscany is the Italian region whose demographic history has been largely investigated. In our study on the relationship between mortality and economic fluctuations in 43 rural areas of the Grand Duchy of Tuscany in the first half of the 19th century, some sharecropping communities revealed an unexpected weakness, with adults and children showing higher mortality when grain prices increased. Here, we move from an aggregate to an individual point of view. In particular, we will check demographic responses, mortality in particular, to short-term economic stress. The analysis concerns the community of Casalguidi, a large village in-between the cities of Pistoia and Florence. As in many other areas of Tuscany, the rural economy of Casalguidi was characterized by the presence of the two categories of sharecroppers and day laborers, which were antithetic in many respects, along with a non-indifferent presence of artisans and shopkeepers. The main point is that, thanks to a careful nominative linkage between different sources, we were able to reconstruct the life-histories of the dwellers of Casalguidi in the period 1765-1884, a pre-transitional period only slightly touched in its late phase by the first signs of demographic transition.

Introduction

Within Italy, by far the most studied population history is that of the Tuscan area.[1] It is possible to outline the population evolution as well as peopling of the area starting from as far back as the 10th century, as well as underlying demographic mechanisms from the end of the 16th century. Moreover, the availability of data on long-term series of real wages and grain prices has granted the opportunity to examine the relationship between Tuscan population dynamics and living standards.[2] In particular, it has been noted that nineteenth-century Tuscany appears to match the Malthusian scheme (Breschi and Malanima 2002). In phases of demographic recession—as in during the years of the plague and the 17th century—the population's decline is an element of price reductions and real-wage increases, both sustained by increases in labor demand. In pre-transitional societies, the balancing mechanism between population and resources occurred through the dramatic check of mortality, and in particular epidemic mortality. With the gradual

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[1] There is a vast literature on the Tuscan population. See, among others, Bandettini 1960 and 1961; Breschi 1990; Breschi and Malanima 2002; Del Panta 1974, 1976, 1978; Del Panta, Livi Bacci, Pinto, and Sonnino 1986; Parenti 1937.

[2] Real wage series for Tuscany are among the best in Europe. The complete series of grain prices for Tuscany was calculated by P. Malanima and is available at www.issm.cnr.it and www.iisg.nl. See also Malanima 2002, Appendices IV.

disappearance of such epidemics and subsistence mortality crises, population growth grew increasingly less erratic, particularly regarding the continuous modulations of the fertility-nuptiality pairing. As for resources, the increasing population pressure meant that the reclamation of large marshy areas became urgent during this period, and led many people to work harder and longer, for relatively little increase in productivity.

Many further studies investigate the connection between short-term stress of an epidemiological or economic nature and demographic behavior. Time-series analysis is again the standard methodology applied in these cases. In this paper, we focus on this same issue but choose to use a different approach. For the first time in Italy, we make use of individual, micro-level data to investigate the relationship between certain key demographic forms of behaviormortality, fertility, nuptiality and household mobility and short-term economic and epidemic stress. The study concerns a Tuscan community—the parish of Casalguidi, from 1819 to 1859—whose economy was largely based on sharecropping. The complexity and informative richness of our database allows us to classify and stratify the entire population both according to occupation and wealth. We are therefore presented with the opportunity to examine how stress conditions affected individuals depending on their sex, age, household structure, occupation and wealth status, and additionally, which "defense" mechanisms were adopted to limit or prevent the effects of negative conjunctures.

This paper is divided into four sections. The first addresses a review of the literature on the most important results regarding the relationship between demographic and economic variables in Tuscany. The second and third outline the characteristics of the dataset used in this paper and the main features of Casalguidi and its economic structure, respectively. Finally, the last section is devoted to the presentation and interpretation of results in light of an apparent paradox: Tuscany's richest area, whose prosperous and harmonious landscape was universally admired, results as also being the most fragile and sensitive to short-term variations of the economic cycle.

1. A Fragile Population: Subsistence Crises and Mortality in Tuscany

Over the last fewdecades, a vast amount of literature has been dedicated to the analysis of the relationship between demographic time-series of births, deaths and marriages on the one hand, and economic time-series, mostly concerning grain prices on the other.[3] Besides certain variants relative to the lag and intensity of demographic reactions,[4] these studies confirm that strong price increases were usually followed by relevant rises in mortality. Subsistence crises can also be seen to have had consequences on other demographic events: a drop in marriages and conceptions, as well as a marked increase in the mobility of poor and indigent people. In the case of Tuscany, quantitative findings are in line with the picture outlined above. The consequences of subsistence crises, often amplified by the spread of infectious diseases, were tragic and profound during the

[3] There is such a vast amount of literature on Italy alone that here we limit our citations to those studies that make use of econometric techniques.

[4] It is worth noting that mountain populations were usually less affected by short-term crises (Breschi, Fornasin, and Gonano 2002, 2005; Fornasin 2005).

16th and the 17th centuries, especially in the cities (Livi Bacci 1987, 85-95). Significant consequences were still present in the 18th and 19th century and even in the early 20th century (Breschi and Gonano 2000). For example, between 1879 and 1934, a 100 percent rise in grain prices resulted in a 48 percent increase in deaths, reduced to 22 percent after accounting for periods of epidemic in the model. These repercussions proved to be particularly accentuated among the young (5-19 years) and adult population (20-60), signaling the relative fragility of these two particular age groups. A deterioration of the economic situation was enough to expose even the typically more robust sector of the population to a rapid worsening of living standards. In fact, for the most part, increases in deaths can be seen to have occurred in the same years that grain prices rose, namely between 1823 and 1878. This result is consistent with the long-term trend of real wages, which reached extremely low levels throughout the 19th century (Malanima 2002; Breschi and Malanima 2002). People tried to face these hard times by increasing both their activity rate—women and children were also involved in agricultural work—and labor time—everyone had to work longer hours (Mori 1986; Scardozzi 2001; Malanima 2002). In conclusion, the living conditions of the Tuscan population showed no sign of improvement in the 19th century, notwithstanding significant dietary changes due to the diffusion of the consumption of corn and potatoes.

The precarious life conditions of the Tuscan population can also be seen to have affected the average height of conscripts born during the 19th century. Empirical findings seem to suggest a decreasing trend of stature from the birth-cohort of 1840 to those born at the close of the century (Boattini and Pettener 2008; Arcaleni 2006; A'Hearn, Peracchi, and Vecchi 2009).

The same situation is reflected by the absence of any significant improvements in the survival of young people and adults (Breschi 1990). The probabilities of death for the female population of reproductive age (15-40), calculated for the years between 1808 and 1882, are steady and close to those of the South model levels 6-7 in Coale and Demeny's life tables (where e_0 = 32.5-35 years). Starting from 1880-82, there are signs of a gradual improvement in the survival of men aged between 30-50, with mortality probabilities approaching level 10 of the South model in Coale and Demeny's life tables (e_0 around 40 years). The slight gain in life expectancy at birth detectable at the end of the 18th and during the 19th century can be largely attributed to a reduction in infant mortality (Breschi 1988; Breschi and Fornasin 2007).

In conclusion, notwithstanding the fact that epidemics became increasingly less frequent, much evidence suggests that during the 19th century the Tuscan population remained "fragile" and vulnerable to short-term cycles of events. Econometric analyses appear to suggest that grain price increases triggered serious demographic effects. Voluntary demographic reactions were especially stimulated throughout the 19th century (Breschi and Gonano 2000; Fornasin, Gonano, and Seghieri 2002),[5] given that husbands and wives had the possibility of choosing whether or not to have a child and families of

[5] In this century, demographic responses to price fluctuations were normally more marked for marriages and less so for mortality (Fornasin, Gonano, and Seghieri 2002).

betrothed couples could decide to postpone marriage. These responses occurred not only in particularly hard times characterized by strong crises, but also in presence of moderately negative economic cycles. It is symptomatic that the Tuscan population was wary and perspicacious, but it was also a sign that living standards were as precarious as to induce people to remain ever prudent.

One of our previous works (Breschi, Fornasin, and Gonano 2005), also using time-series data, examines the causal relationship between economic fluctuations and mortality in various age-groups of 43 rural and 8 urban areas of Tuscany in the period from 1823 to 1854. Significant effects can be seen both in the cities and the countryside, especially, as mentioned previously, in childhood and adulthood. However, it is possible to distinguish two distinct patterns of mortality response within these rural territories. In the immediate surrounding areas following the course of the River Arno, the richest and most densely populated zone of Tuscany, the increase in child and adult mortality is significant and almost immediate, and particularly marked in traditional sharecropping community areas, where the land was intensively cultivated to produce grains, oil and wine. Conversely, in the south of the region, where the territory was less densely populated, much poorer and characterized by large-scale farms and land generally "fit for seed," the increase in child and adult mortality results as being markedly weaker and often not as immediate. Interestingly, this finding contrasts with the bucolic and classic image of Tuscany, handed down to us by numerous Italian and foreign travelers. Those chroniclers emphasize the presence of two different Tuscanies: one to the North, the area known as the "Tuscany of the river," rich and tended like a garden; and the other to the South, encompassing the desolated and unhealthy area of Maremma, void of trees and men, bordering the Siena territories to the east.[6]

More wealth was undoubtedly generated, at least on a macro-economic level, in the "Tuscany of the river" area, but econometric analyses appears to suggest that this same rich and harmonious area also hosted the most vulnerable and fragile portion of the population.

2. The Microcosm of Casalguidi: A Study with Individual Data

For the community of Casalguidi, situated in the richest part of Tuscany, we have the rare opportunity to examine the relationship between economic fluctuations and demographic reactions at an individual and family unit level. A meticulous work of data linkage between parish birth, marriage and death registers, has enabled a reconstruction of the life-histories of its inhabitants for the period between 1819 and 1859. This information has been supplemented and integrated with information drawn from the *Status Animarum*, census-like parish registers recorded annually by priests that specify the name, surname, age, sex, marital status and relationship with the household head of all those living under the same roof, including servants and, at times, absent family members. It has also been possible to exploit a civil source regarding the same

[6] The volume by Carlo Pazzagli (1992) offers a clear presentation of the characteristics of these two macro-areas of the region.

community, namely the annual lists of family taxes. This register gathers information on each household head assessed as non-indigent and therefore taxable according to wealth, recording their name, surname, profession and tax level. In this way, we are able not only to obtain a reliable picture of Casalguidi's socioeconomic structure, but also have a clear picture of the economic level of each household and its members. This is possible through a nominative linkage between information drawn from the Tax Register and the data already reconstructed at the individual and family level drawn from parish registers. Although the tax system did undergo changes during the period under analysis, it is possible to identify three different household tax categories: high/medium (the wealthiest), low (the poor), and those exempt (the poorest and most indigent). This latter category includes all those household heads who feature in the *Status Animarum* but are absent in the Tax register, which listed taxed families alone. Being compiled yearly, tax share records provide extremely detailed and indispensable information for the assessment of household socioeconomic status and its variation over time. Likewise, we are also presented with the opportunity to study, at the individual and household level, the demographic consequences of grain price fluctuations. Making use of Event History techniques (Bengtsson 1993), we formed eight models in relation to various demographic events and different age groups. The first five models concern mortality, namely that of infant (0 years), early child (1 year), child (2-18 years), adult (19-54) and old-age (55+), with the other three regarding the effects of price fluctuations on nuptiality, fertility and household mobility. However, we consider it useful at this point to provide the reader with a description of Casalguidi's population and society, before entering a more detailed discussion of these findings.

3. The Microcosm of Casalguidi: Economy and Social Structure

The vast territory of the parish of S. Pietro in Casalguidi is largely situated between the slopes of Montalbano and the Ombrone River plain, bordering the municipality of Pistoia, a mere 8 km to the north. This region's most densely populated area was the strip of land on the plain used to cultivate grains and other cereals (the population's most important food resource), whereas its less densely populated hilly areas were characterized by vineyards and olive-groves. The village of Casale served as the centre of the community, inhabited by farm laborers, artisans, shopkeepers and a small but significant number of wealthy families (doctors, chemists, lawyers, etc.).

During the eighteenth century, Casalguidi was, like a large part of "Tuscany of the river" area, already characterized by a territorial structure referred to as "urbanized countryside," definable as a rural area disseminated by farms, isolated farmhouses, numerous country roads and well-cultivated estates and land. This landscape's other significant component was its network of small villages and rural communities which connected the countryside to the towns. In this microcosm, the village of Casale, situated at the crossroad connecting Pistoia to the Arno valley, served as the gathering point for products directly connected to the city market. This network of villages expanded greatly during the 17^{th} and 18^{th} century when population increased at a greater rate in rural communities than in cities (Del Panta 1978, 1982). Chroniclers note that this growth was due to the increase in landless laborers, a less stable social group compared to sharecroppers, thereby perceived as a potential social threat. Demographic analyses of the 1841 census confirm not only the demographic relevance of landless farm laborers in many "Tuscany of the river" areas, but also the most important features of this social category, such as household structure and age at marriage (Barbagli 1984, 1990; Corsini 1988; Della Pina 1990, 1993; Doveri 1990, 2000; Torti 1981, 1982).

The picture outlined above finds quantitative support in the figures of Tables 1-2. Casalguidi, with an average of around 2,400 inhabitants between 1819 and 1859, can be identified as the most populous parish of the Pistoia region, sustained by a significant growth rate of 5.8 percent.

For a rural community, the socioeconomic structure proves to be quite variegated. About 2/3 of inhabitants were more or less directly employed in farm labor, although some forms of proto-industry, such as silk weaving and embroidery, were also present and taking root in the region. Despite this apparent uniformity, the various agricultural categories were marked by considerable differences in demographic behavior, migratory attitude, family formation systems, household structure, mortality and fertility levels, and socioeconomic status.

Table 1. Households by head's profession and tax class (%); tax register, Casalguidi 1819-59.

Profession	High Tax	Medium Tax	Low Tax	No Indication	Total %	Total N
Day laborers	1.1	16.4	82.1	0.4	100.0	3,358
Sharecroppers & other farmers	1.7	14.9	83.2	0.2	100.0	6,138
Artisans & other non-agricultural activities	2.5	18.8	78.5	0.2	100.0	1,761
Nobles, landowners & middle-class	55.7	28.0	15.8	0.5	100.0	326
Total %	3.3	16.2	80.3	0.2	100.0	11,583
Total n.	382	1876	9302	23	11583	

Table 2. Households by head's profession and tax class (%); tax & parish registers, Casalguidi 1819-59.

Profession	High Tax	Medium Tax	Low Tax	Tax Exempt	Total %	Total N
Day laborers	0.9	11.6	58.6	28.9	100.0	4,723
Sharecroppers & other farmers	1.3	10.7	59.3	28.8	100.0	8,621
Artisans & other non-agricultural activities	1.9	13.6	56.9	27.6	100.0	2,432
Nobles, landowners & middle-class	47.4	23.9	13.5	15.1	100.0	384
No Profession	0.3	4.2	13.0	82.4	100.0	2,393
Total %	2.1	10.7	51.9	35.3	100.0	18,557
Total n	386	1993	9625	6549	18557	

In particular, day laborers on the one hand, and sharecroppers on the other, represented the traditional dichotomy of the Tuscan countryside.[7] Whereas sharecroppers tended to marry quite late in life, follow a patrilocal system of living arrangements after marriage, and live in large and complex households, day laborers on the other hand, tended to marry earlier, have a neo-local family structure and live in simple family groups, formed by a sole biological nucleus. Furthermore, day laborers had a lower fertility level and slightly higher mortality compared to sharecroppers. These differences in marriage pattern and family structure and size of these two groups are attributable to the different nature of their ties with the land (Poni 1982; Doveri 2000). Sharecroppers notably lived on the same farm they cultivated for an absent landowner, under a contract that tied the entire family group to the landowner and foresaw the equal division of the crop between the two parties. Each year this contract was up for renewal, with the capacity of the sharecropping household to ensure an adequate crop for the landowner as one of the key contractual points (Giorgetti 1974; Pazzagli 1973). Thus, one of the sharecroppers' main concerns was to preserve an adequate work force within the household and as a result no member was allowed to work outside the farm and specific forms of demographic behavior, such as higher fertility, expulsion of less productive members, and a patrilocal arrangement for men after marriage, were adopted.

Conversely, day laborers had no such tie with the land since rather than having fixed accommodation on the farm, they continuously moved around from place to place in search of temporary agricultural work. When the demand for agricultural labor fell, day laborers were able to find employment in artisan activities, such that the two groups were easily interchangeable in that they shared similar nuptiality patterns and family formation systems, characterized primarily by mobility and neo-locality. For day laborers, the family work force was not the central factor for finding or maintaining a job, and large households were unsuitable for the frequent movements of this social category and unsustainable for the resources available to them. As a consequence, both the male and female members of these nuclear households left their native family upon marriage. Recent studies consider farm laborer families as the chief actors in the spread of proto-industrial activities in North Tuscany during the 18th century.

Although it is widely held that sharecroppers were in a better economic condition than day laborers, Tables 1-2 tell a different story. A classification of households according to their head's profession and tax level, reveals no difference in wealth between day laborers, other farmers, and even artisans (Table 1). All these social groups result as having between 79 and 83 percent of households falling into the low tax band,

[7] The demographic dichotomy between day laborers and sharecroppers in the population of Casalguidi has been largely proven and highlighted in a number of our previous works. See, for example, Breschi, Manfredini, and Pozzi 2004; Manfredini 2003b; Manfredini and Breschi 2008a, 2008b.

indicative of an overall low economic status.[8]

Conversely, the higher professions and occupations can be seen to be well differentiated in terms of wealth, with 77 percent of households paying the largest taxes. The “No Indication” column refers to households whose tax status was either missing or impossible to deduce from the source, or who were exempt from paying taxes, as, for example, in the case of widowhood.

Since tax registers exclude exempt households, we made an attempt to recover information on these household heads’ professions from parish registers, to determine whether or not the majority belonged to the day laborer group (Table 2). We were able to reconfirm the picture described above: there appears to be no difference between these day laborers and farmers in terms of household wealth, with only around 12 percent of families living in good economic conditions with about 29 percent of exemptions due to manifest poverty. In general terms, the number of indigent and disadvantaged households was extremely high, at over 85 percent, denoting a situation of diffuse poverty.

Although much is now known about Casalguidi, there is a lack of data available on the food consumption of resident families. Nothing is known about the quantity of food directly produced and consumed, or how much was bartered for in exchange for farm labor and/or other activities. Thus, for Casalguidi we are constrained once again to use grain price as an indirect proxy of food availability. This obviously oversimplifies the real situation, especially for rural communities who were obliged to purchase food on the open market much less than urban populations (Livi Bacci 1987).

This paper makes use of the series of grain prices reconstructed by Bandettini (1957), calculated on the basis of the Florence market. While the market prices of Pistoia are consistent with these, despite being systematically 8 percent higher (Figure 1), the decision to use the Florentine series is due to the fact that this data is more complete.[9] The price series consists of the mean annual figures of wheat prices, which is coherent choice with the structure of our demographic database, founded on annual population records.[10]

Lastly, it is important to underline the strong association between price increases and the spread of cholera that hit the whole of Tuscany in the biennium 1854-55. In Casalguidi, this epidemic caused numerous deaths between July and October, and the month of August alone witnessed as many deaths as normally counted in 6-7 months.

[8] It is important to underline that among agricultural workers the only clear distinction from the information available is between day labourers and farmers. This latter term is a generic classification including sharecroppers, tenants, smallholders and other professional figures who had fixed employment and/or abode on an estate.

[9] Data on grain prices for Pistoia was drawn from *Comunità civica di Pistoia*, “Registri dei prezzi delle grasce” and “Prezzi delle grasce,” Pistoia State Archive.

[10] In the following hazard models, we used Hedrick-Prescott filter to even out grain price series and remove the trend.

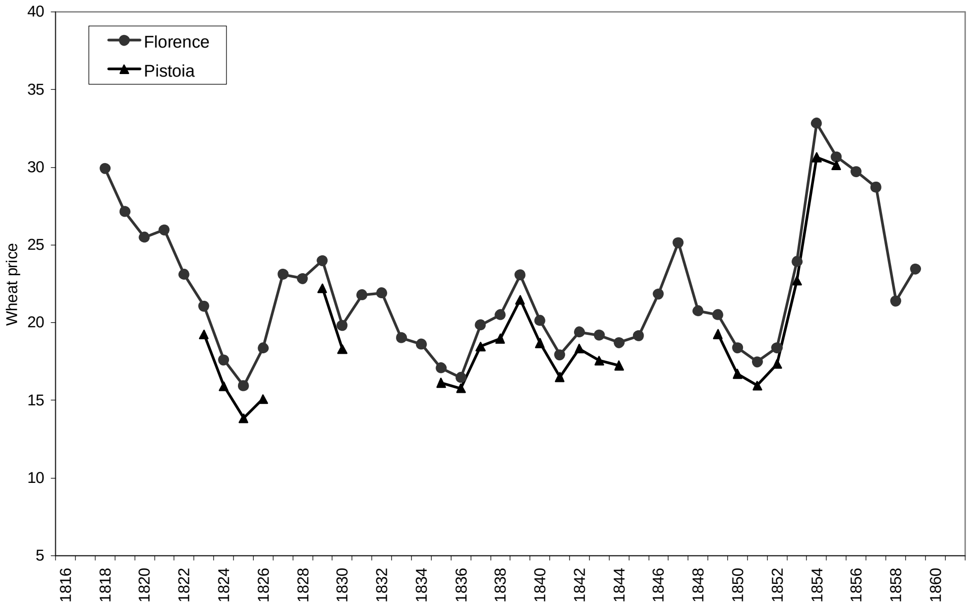

Figure 1. Wheat price in the market of Florence and Pistoia, 1817-1859.

4. Results and Discussion

Tables 3-4 reveal the effects of three variables, or rather the different possible forms of stress that risk prompting various demographic events, namely, wealth at the household level, grain price at the macro-economic level, and the epidemiological level. These models also take into account the household head's profession, home ownership, and age of all individuals. A brief examination of the possible interactions between these variables is given below.

The first observation to be made is the absolute and generalized influence of household wealth status on demographic events, including mortality (for all age brackets except infant), fertility, nuptiality and household emigration. Clearly, belonging to the wealthiest socioeconomic category meant being less likely to die, less likely to emigrate as a whole family group, marry, yet more likely to have children with respect to the poorest group of untaxed households and individuals. While this general pattern holds equally true for males and females, we can note that for all the age brackets in the mortality analysis (with the exception of old-age), the SES differential appears to be more pronounced among men than women. The low-tax category demonstrates a significantly reduced risk of certain specific events with respect to tax-exempt households, falling between the richest and poorest groups in childhood, adult and old-age mortality, as well as in household out-migration. This obviously reflects a difference in living standards, the quantity and quality of available resources and the role of marriage. Although this result was expected, the extent and universality of the effects of household wealth status on the demographic process would actually suggest the existence of two distinctly separate demographic systems in the rural community of mid-nineteenth century Tuscany; one for the wealthiest people and the other for the poorest (Fauve-Chamoux 1993).

Table 3. Effects of price and cholera epidemic on mortality, Casalguidi 1819-59.

	Infant Mortality (0 years)						**Early childhood Mortality (1 years).**						**Childhood Mortality (2-18 years).**					
	M		**F**		**ALL**		**M**		**F**		**ALL**		**M**		**F**		**ALL**	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Untaxed	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1
Low-tax group	1.035	1.021	1.162	1.157	1.135	1.122	1.088	1.062	1.025	1.024	1.061	1.050	**0.401**	**0.370**	0.732	0.689	**0.558**	**0.536**
High-tax group	0.902	0.908	0.886	0.891	0.972	0.980	**0.545**	**0.557**	**0.409**	**0.409**	**0.478**	**0.482**	**0.320**	**0.347**	**0.279**	**0.284**	**0.307**	**0.320**
Logged price at time t	1.952	1.869	0.496	0.483	0.951	0.900	1.316	1.237	1.350	1.345	1.345	1.299	1.334	1.063	1.290	1.010	1.308	1.030
Logged price at time t-1	0.983	0.768	0.784	0.706	1.027	0.807	1.668	0.905	1.227	1.192	1.438	1.056	1.951	0.545	**5.731**	1.821	**3.590**	1.082
Cholera		1.603		1.455		**1.781**		**2.790**		1.065		**1.774**		**4.557**		**3.594**		**3.996**
Person-months	19,914		19,813		39,727		12,016		11,190		23,206		17,244		16,846		34,090	
Deaths	353		336		689		181		185		366		160		206		366	

	Adult Mortality (19-54 years).						**Old-age Mortality (55+ years)**						**Overall Mortality (2+ years)**					
	M		**F**		**ALL**		**M**		**F**		**ALL**		**M**		**F**		**ALL**	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Untaxed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Low-tax group	**0.577**	**0.561**	**0.457**	**0.450**	**0.518**	**0.504**	**0.369**	**0.354**	0.692	0.664	**0.505**	**0.509**	**0.450**	**0.451**	**0.685**	**0.661**	**0.558**	**0.539**
High-tax group	**0.466**	**0.473**	**0.279**	**0.300**	**0.367**	**0.381**	**0.379**	**0.386**	**0.662**	**0.670**	**0.502**	**0.485**	**0.437**	**0.436**	**0.478**	**0.496**	**0.464**	**0.480**
Logged price at time t	**8.522**	**8.017**	**5.484**	**4.881**	**6.672**	**6.091**	0.783	0.683	1.411	1.267	1.030	0.915	**1.890**	1.660	**2.416**	**2.064**	**2.171**	**1.883**
Logged price at time t-1	1.090	0.602	0.647	**0.203**	0.826	**0.334**	1.295	0.706	1.945	1.052	1.577	0.860	1.309	0.623	1.698	0.640	1.479	0.626
Cholera		**2.139**		**4.346**		**3.160**		**3.094**		**2.416**		**2.692**		**2.950**		**4.463**		**3.203**
Person-months	23,086		23,195		46,281		6,003		5,954		11,957		46,333		45,995		92,328	
Deaths	225		265		490		319		268		587		704		739		1443	

Notes: The models control also for age, household head's profession, and property of house. In bold, coefficients significant at p<0.05.

Table 4. Effects of price and cholera epidemic on marriage, fertility and household mobility, Casalguidi 1819-59.

	Marriage (never-married people, 15-49 years)					
	M		F		ALL	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Untaxed	1	1	1	1	1	1
Low-tax group	1.109	1.11	0.981	0.972	0.999	0.991
High-tax group	**0.775**	**0.775**	0.874	0.892	**0.763**	**0.769**
Logged price at time t	0.533	0.534	0.649	**0.473**	**0.58**	**0.493**
Logged price at time t-1	1.509	1.509	0.833	0.814	1.105	1.089
Cholera		0.995		1.54		1.257
Person-years	13,051		10,769		23,820	
Marriages	530		662		1,192	

Fertility (married women, 15-49 years)	F	
	Model 1	Model 2
Untaxed	1	1
Low-tax group	0.999	0.991
High-tax group	**1.288**	**1.259**
Logged price at time t	0.927	1.098
Logged price at time t-1	0.938	0.848
Cholera		**0.787**
Person-years	6,148	
Births	2,091	

Household mobility (emigration)	ALL	
	Model 1	Model 2
Untaxed	1	1
Low-tax group	**0.667**	**0.661**
High-tax group	**0.399**	**0.408**
Logged price at time t	**1.778**	1.115
Logged price at time t-1	0.922	0.884
Cholera		**1.648**
Household years	17,618	
Out-migrations	590	

Notes: The models control also for age, household head's profession, and the property of house. In bold, coefficients are significant at p<0.05.

The effects of short-term economic stress prove to be less common but likewise important in this context. Firstly, regarding the time-lag aspect included in our analysis, these findings support the idea that the effects of short-term economic stress, namely at time *t*, were almost immediate on demographic events. Besides the obvious influence of grain prices, at *t-1*, on fertility, which naturally has an immediate effect on conceptions, the only significant impact of prices which lagged by 1 year is limited to child and adult mortality, although with signs of an opposite tendency limited to women. For children, the positive relationship between mortality at *t-1* and price increase is linked to the cholera epidemic of 1855. Once a dichotomous variable aimed at capturing the effects of this epidemic event is included in the model, the size of the grain price coefficient at *t-1* shows a noticeable drop leaving no real statistical significance. As for adults, the correlation between grain price at time *t-1* and mortality is vice versa negative and unaffected by the introduction of the covariate concerning cholera. It is worth noting that this effect particularly concerns women once the effects of cholera have been accounted for. One might argue that the drop in fertility during the cholera epidemic would also reduce the number of births in the following year, a decrease further accentuated by the drop in marriages due to grain price increase at time *t*. Hence, it is likely that female mortality associated with delivery and childbearing results as reduced by the limited number of births following periods of crisis.

We can note that at time *t*, grain price effects influence mortality, nuptiality and household emigration. While the absence of any significant effect of grain prices on infant mortality was expected, its extent on that of adults aged between 19-54 is somewhat surprising, even if this outcome is consistent with results of econometric analyses on time series. Our findings reveal a 12-18 percent rise in mortality in response to a 10 percent price increase. It also appears that those age brackets with a normally higher risk of death in regular periods—such as infants and the elderly—suffered less from price increases on the Florence market than the categories of active and working adults.

With regards to nuptiality and emigration, findings are consistent with previous expectations. The economic burden that first marriages put on families made them less likely to be celebrated in hard times, naturally both for males and females, and hence normally postponed to more propitious times. Out-migrations of entire households were usually associated to the circulation of day laborers, who moved around on a seasonal basis in search of work, as well as the possible expulsion of sharecroppers from farms. However, the positive relationship between price increases and out-migration is simply the consequence of the exaggerated price of grains during the cholera epidemic of 1854-55. After having accounted for cholera, this association becomes insignificant and the exp-coefficient is largely reduced. Therefore, the reason behind the rise in household out-migration risk was the increased circulation of individuals and households that usually occurred during epidemics rather than the grain price itself (Manfredini 2003a). Sharecropping contracts terminated and were up for renewal in November, and it is likely that landlords decided to expel those sharecropping families whose size had been dramatically reduced by cholera during the previous summer.

There is a close association, therefore, between the cholera epidemic and grain prices in mid-nineteenth century Tuscany. As shown in Figure 1, grain prices on both the Florence and Pistoia markets peaked in the biennium 1854-55, precisely when cholera hit Tuscany hard, reaching an increase of 40 and 50 percent respectively over the mean for the period. This epidemiological stress obviously affected mortality intensity, but it also had negative repercussions on fertility and household mobility, stimulating an increase in household out-migration. Indeed, all demographic events were concerned but marriage. All classes saw a significant rise in mortality risk, although less marked, as typical of cholera epidemics, in the early years of life. As expected, fertility also resulted as being affected, with a significant 22 percent drop of childbirth among married woman. As already mentioned, the circulation and emigration of entire households also results as being influenced by the 1854-55 epidemic, and, finally, no changes were made to marriage plans. In our case study, economic reasons appear to be much more important than epidemiological ones in determining marriage behavior and weddings. This can be said to be quite surprisingly since much previous data has confirmed the existence of a negative relationship between marriage and mortality crisis. However, the reason for our findings could lie in the different seasonality patterns of cholera and marriages. In Casalguidi, most marriages were celebrated at the beginning of the year (January and February), in October and, especially, in November. Very few weddings were recorded in July and August, the very two months when the epidemic provoked the most deaths in the village. Thus, we can note both that the earlier seasonal peak of marriages would not have been affected by cholera, as well as that the later one would have been, to some extent, reinforced by remarriages and summer marriages that had been postponed.

Our final step was to investigate the extent of the relationship between short-term crises and SES. For each event and age-bracket of mortality, we used Model 2, with no differentiation by sex, as a base to form separate models for the untaxed and low-tax group on the one hand, and the high-tax group on the other. The results (Table 5) prove that wealthy families reacted very differently compared to poor and untaxed ones. Or better, they appear to have no reaction at all except for an increase in the risk of mortality associated to the cholera epidemic for young children and teenagers (2-18 years) and the elderly (55+). The demography of the poorest classes emerges as being greatly affected by epidemiological and, to a less extent, economic short-term crises. Cholera, in particular, altered the entire demographic system of the poorest social groups by increasing mortality at all ages as well as household out-migration, and depressing fertility. Grain price resulted as being conversely effective in influencing adult mortality and nuptiality.

Table 5. Summary of price & epidemic effects by demographic event and SES (All individuals).

	Untaxed + low-tax group			High-tax group		
	Price t	Price t-1	Cholera	Price t	Price t-1	Cholera
Mortality						
0	No	No	+	No	No	No
1	No	No	+	No	No	No
2-18	No	No	+	No	No	+
19-54	+	—	+	No	No	No
55+	No	No	+	No	No	+
Fertility	No	No	—	No	No	No
Nuptiality	—	No	No	No	No	No
Household emigration	No	No	+	No	No	No

Table 6. Summary of price & epidemic effects by demographic event and rural occupation (All individuals).

	Day laborers			Sharecroppers & tenants		
	Price t	Price t-1	Cholera	Price t	Price t-1	Cholera
Overall mortality	+	No	+	No	—	+
Fertility	No	No	No	No	No	—
Nuptiality	—	No	+	No	No	No
Household emigration	+	No	No	No	No	+

The picture was even more complicated when tried to gain more insight into the large and predominant world of the very poorest classes (Table 6). We ran various models of adult mortality by household head's occupation with the purpose of determining the effects of prices on both those who relied on the market for the purchase of food and those who lived off their farm's produce. The question was not of being landless or not, but that of form of land tenure. In fact, the landless categories of sharecroppers and tenants were part of the latter group, whilst day laborers and rural wage earners formed the former one. The results demonstrate that the landless day laborers were undoubtedly the most fragile sector of the population. Day laborers suffered a 26 percent mortality increase in response to a 10 percent price increase, whereas this was true for only 7 percent of sharecroppers and tenants. Hence, it was poverty and the impossibility of direct access to land produce that determined a high risk of mortality in the presence of short-term economic stress. Clearly, the worsening of life conditions caused by rapid price increases had dramatic consequences on their survival. In most cases, they were in difficulty in even covering household expenses and therefore unable to cope with the minimum negative economic conjuncture. Conversely, sharecroppers, tenants and smallholders appear to be more capable of facing hard times induced by negative, economic, short-term cycles. Given the wide variety of Tuscan farm produce, these categories had little difficulty in finding what they needed, namely food and raw materials, such as textile fibers and wood, used to construct objects of everyday use. Indeed, one of the main characteristics of sharecropping was its high degree of auto-consumption.

On the other hand, it was virtually impossible for sharecropper or indeed wealthy families to avoid the effects of epidemics, so much so that cholera can be seen to have had an great impact on all Casalguidi's social categories. Indeed, sharecropping households, due to their larger size and high housing density were extremely likely to be affected by infectious diseases such as cholera.

In conclusion, although the measuring of demographic effects from short-economic stress by SES proves to be extremely complex, the rich dataset we have been able to reconstruct for this Tuscan rural community has allowed us to assess the socioeconomic and professional status of individuals and families in great detail. Many social and economic aspects, such as occupation, wealth, and home ownership, were used to highlight demographic differentials by SES. This occasion to identify the day laborer category as the "poorest poor" and most fragile in absolute would seem to partly explain the paradox of the "Tuscany of the river" area, which while being the richest and most populated zone proves also to be the most sensitive to short-term economic stress and cycles. It is these day laborers and rural wage earners that became ever more present in rural Tuscany of 19th century[11] and considered by contemporaries as the main source of moral and social disorder.

[11] In the countryside around Pisa, the 1841 Grand Duchy census counted over one third of day laborers in the general category of rural workers (Doveri 1990).

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Demographic Responses to Short-Term Economic Stress in North East Italy: Friuli, 18th-19th Century

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Abstract

Friuli is a region of Northeastern Italy characterized by profound geographic and climatic differences. The role of agriculture was strictly connected with the geographic characteristics, getting more and more important going from north to south. In the plain, mixed agriculture was common, based partly on the binomium wheat-maize, partly on the cultivation of mulberry and vine. On the other hand, in the mountains the most common activity was cattle-breeding, while corn production was rather poor. Environmental context, forms of land tenure, types of cultivation, dependence or independence from the market of primary goods were all key factors in determining the complex relationship between population and resources. As we have demonstrated in a previous work, the most fragile populations in years of crisis were those with high levels of maize production and also consumption. Mountain populations were conversely the less affected in terms of mortality. A strong preventive check operated to limit access to marriage, which in turn brought to a drastic drop of births, therefore re-balancing the relationship between population and resources. This paper aims at analyzing the interdependence between economic crisis and demographic behaviors in Friuli. Our approach is here based on individual-level data. We have reconstructed the life-histories of the inhabitants of two communities of Friuli—one belonging to a maize-production area, the other situated on the mountains—for the period 1834-1900. We have therefore the opportunity to study much more in depth the consequences of economic crises on individuals and families. In this work we use two new historical time series: weekly series of price of indispensable goods, and daily series of meteorological data.

1. Introduction

The aim of this work is to analyze the interdependence between economic crises and demographic behaviors in Friuli, in North-East Italy. This analysis is based on aggregate time series of corn prices and demographic data regarding two distinct regional areas; one in the mountains and the other on the plain. In further detail, particular consideration is given to the population of the mountain community of Treppo Carnico, and that of the parish community of Sant'Odorico on the plain. We examine the demographic reactions for these two populations, so different in their geographic localization, economic structure, social composition, consumption pattern and relationship with grain markets, when faced with rises in corn prices. A key characteristic of this work is that the reactions observed for these two populations refer to the "same" corn and "same" price, namely that of the grain market of Udine, the most important town in Friuli (Fornasin 2000, 2001).

The paper is structured as follows. Section 2 describes the sources used and organization of data, whereas section 3 gives details of the two populations involved in the analysis; section 4 presents the results on the relationship between short-economic stress and demographic variables in the plain and mountain regions of Friuli between 1700 and 1880 by means of macro-level data; and section 5 approaches the same issue with micro-level data using specific information on the two populations of Treppo Carnico and Sant'Odorico for the period 1834-68.

2. Sources

Individual-level and time-series analysis were obviously conducted by means of different statistical techniques. Grain prices were used as a proxy of food availability although we can note that this assumption does not always hold true, especially during the second half of the 19th century, when the increasing integration of world grain markets broke the previously strict connection between crop amount and grain price on the local-scale (O'Rourke and Williamson 2002). This process is quite evident in Friuli, where we can observe a constant fall in grain price along with a remarkable reduction in its variability. On the other hand, it must be said that market prices are to a certain extent independent from consumption dynamics since there was a high degree of auto-consumption in most rural areas, although it holds true that certain sectors of the population still depended on the market to purchase food. These consumers' choices were driven and determined by the balance between price and income. However, data on real wages are extremely rare and limited to other areas of Italy (Zamagni 1984; Federico 1986; Fenoaltea 2002).

In this paper, we made use of corn prices of the city market of Udine. This is a complete and detailed collection, well-known among economic historians within the field (Braudel and Spooner 1975) and the object of recent studies (Gonano 1998; Fornasin 2000). The price series of grains and vegetables spans from 1586 to 1806, when the Napoleonic troops arrived in Friuli, for the second time. We can observe that political events did not have a large effect on the collection of grain prices, even during the passage from the Austrian to the Italian Kingdom. However, in order to use all these series, which were originally expressed in different currencies, it was necessary to convert them into Italian Lire. The price was then referred to one hectoliter.

Our decision to use data on corn is because corn flour cooked with water was the most highly consumed food by the poorest social strata of Northern Italy during the 18th and 19th centuries. The spread of pellagra, starting from the mid-19th century, is one of the most evident consequences of this dietary habit (Livi Bacci 1986).

As for macro-level analyses, we used records of baptisms, marriages, and burials in two parish groups, the first, as already mentioned, situated in the Alpine area, and the second on the plain. Our sample is formed by seventeen mountain parishes, with a total of around 18,000 inhabitants, and sixteen on the plain, with a population of approximately 17,000. The detail of the localization of the various parishes is reported in Map 1, referring to 1790.

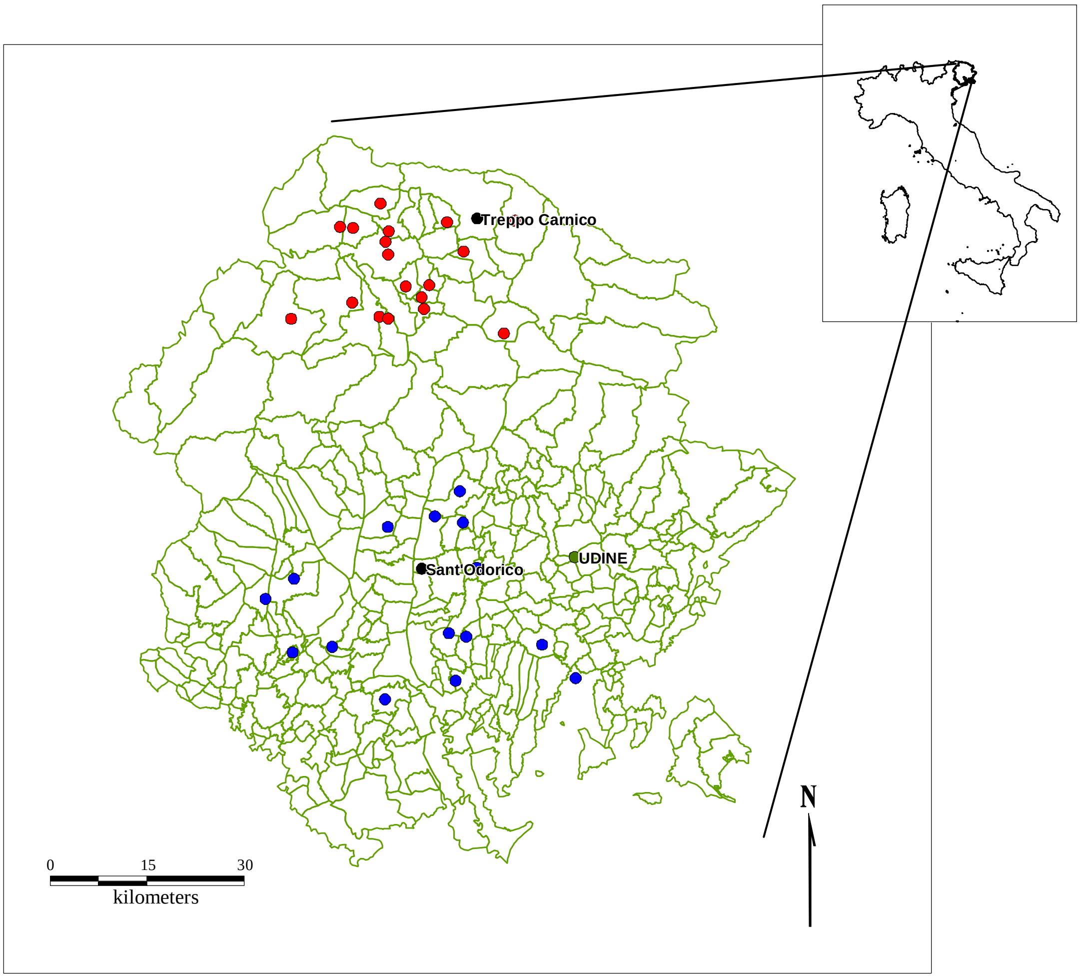

Figure 1. Friuli 1790.

The basic statistical model used for examining the short and medium term relationship between economic and demographic time series is based on a distributed lag model, with price as the independent variable and the number of deaths, births and marriages as those dependent.[1] This regression model features lagged independent variables plus an autoregressive error component. In particular, we include prices for lags from 0 to 2 in the regression of deaths and lagged values from 0 to 2 of prices and deaths in the regressions of births and marriages.

For the purposes of carrying out micro-level data analyses we utilized the population registers of Treppo Carnico and Sant'Odorico. For both, we used two population registers; the first covering the period from 1834 to 1850; and the second, replacing the first, which starts in 1851 and continues to the end of 1868, roughly two

[1] The same model was applied in Breschi, Fornasin and Gonano (2002) where the estimation techniques used are reported in detail. In particular, to obtain detrended values for all the series used we applied the Hodrick-Prescott filter -a standard method for removing trend movements in the business cycle literature (Ravn Uhlig 2002). A general consideration of the distributed lag model and its application as well as the relationships between different demographic variables can be found in Lee (1981); however, a good review of the literature can also be found in Bengtsson and Reher (1998).

years after the transfer of control over Friuli to the Kingdom of Italy. These registers contain information on all households, specifying the name and surname of all members along with dates of significant life events: births, deaths, marriages and changes in residence. Nominative data recorded in the population registers was supplemented with information taken from parish registers, serving mostly to correct for the underreporting of newborn deaths. To analyze how demographic factors responded to price fluctuations at an individual level, we adopt the combined life-event and time-series approach introduced in Bengtsson (1993).

3. The Regional Area and the Two Populations Studied

As already mentioned, we used data from two different areas of Friuli to analyze demographic responses to price dynamics. Our choice of rationale was based on the need to find and draw a comparison between two areas that had different functional relationships with the market and distinctive food consumption patterns.

Grain production on the large plain of South Friuli well exceeded local demand, and therefore it supplied other areas in need. Throughout the 18th century, these grain surpluses arrived at the market of Udine (Fornasin 2000), which remained the main point of commercial trade of food-stuffs well into the following century.

Auto-consumption was widespread on the plain, frequently based on grains, with a tendency towards corn from the beginning of the 18th century (Bianco 1994; Morassi 1997, 2002). Smallholders and landless farmers formed the largest part of the rural population, wealthy farming households were a minority and the "bourgeoisies" component was even smaller. Noble landowners only resided in their country houses for certain periods of the year. Given this situation, the demand for cereals on the city market was obviously quite low.

In the mountain area, on the other hand, grain production was insufficient, meeting demand for a mere two to three months of the year, which is why this region relied on supplies from the city market. The diet of the mountain inhabitants was reasonably varied thanks to a more diversified agricultural production than that on the plain and the presence of a large livestock population that sustained dairy production (Fornasin 2005, 2008).

Of the two individual villages examined in this paper, Treppo Carnico, located in Carnia, a mountainous region of North East Italy, had a yearly average of around 1,100 inhabitants and 230 households. From a demographic point of view, Treppo Carnico displays lower levels of both mortality and fertility, with a life expectancy at birth of 39 years, and a TFR of 4.8 children per woman (Breschi, Gonano and Lorenzini 1999). Carnia was therefore characterized by a low-pressure demographic regime, whose preventive checks were late first marriages (estimated 31.4 years for men, 28.7 for women) and remarkably high levels of life-long celibacy (14.4% for men, 16.7% for women).

The economy of Treppo Carnico was based on a sustained seasonal emigration of adult males. The mid-nineteenth century was a period of great change for the activities associated to these emigration flows. Until the mid 18th century, these emigrants had been mainly peddlers and artisans, but the second half of the 19th century saw these categories progressively substituted by masons. In the period of transition between the two professional models—i.e. the period under study here—farm activities gained more importance in the seasonal emigration of men although their role remained minor in the local economy (Fornasin 1998). Marriage certificates, military records and population registers provide evidence of a great variety of professions, many of which were connected with trading activities, handicraft and/or the building industry.

The second village, Sant'Odorico, located in the central plains of Friuli, had a yearly average of around 430 inhabitants and 100 households. From a demographic point of view, Sant'Odorico displays higher levels of both mortality and fertility, with a life expectancy at birth of 34 years and a TFR of 5.2 children per woman. The plain of Friuli was therefore characterized by a relatively high-pressure demographic regime, with an average age of 29.6 years for men and 26.5 for women at first marriage and life-long celibacy for both sexes ranging between 10-12%.

The economy of Sant'Odorico was characterized by mixed agricultural production, based partly on cereal farming and partly on viticulture, and was to some extent orientated toward the market. The overwhelming majority of the population was employed in rural activities. The level of schooling for men was similar to that of Treppo Carnico, whereas for women it was somewhat lower.

Regarding the economy, the Austrian Cadastre of 1851 provides data on land property for both populations; information that can be taken as a proxy of the socioeconomic status of families within the two communities (Tab. 1). Here, we focus on the cadastral revenue values, which can be assumed as indicating the wealth status of the entire community. On average, this was around 7 lire per head for the inhabitants of Treppo Carnico and 16 for those of Sant'Odorico.

Table 1. Cadastral revenue in Treppo Carnico and Sant'Odorico in 1851.

	Treppo Carnico		Sant'Odorico	
	Italian lire	%	Italian lire	%
Private plots	5771.95	73.2	6894.04	98.3
Communal lands	2115.23	26.8	118.31	1.7
Total	7887.18	100.0	7012.35	100.0

Source: Austrian Cadastre 1851.

It is worth noting that in Treppo Carnico, but not in Sant'Odorico, collective land tenure was still of great economic relevance (Barbacetto 2000). In Treppo Carnico, the cadastre revenue for public goods was higher than that corresponding to private owners, which we consider a crucial element in understanding the wealth distribution within this community. Families of original descent, who were also the least well-off, had non-irrelevant revenues at their disposal. Therefore, the large size of collective land worked as a mechanism of wealth redistribution in greatly reducing economic inequalities within the local population. The Gini concentration coefficient computed taking redistribution of collective land into account is higher in Treppo Carnico than in Sant'Odorico (0.64 and 0.47 respectively), revealing that wealth was more equally distributed in the former than the latter. In addition, we should consider that the most important economic activity in Treppo Carnico was emigration, not agriculture.

4. Macro Level Analysis

In order to assess the relationship between corn price and demographic variables, we carried out a first application of the distributed lag model based on aggregate annual data for the period 1700-1880. Estimated coefficients are reported in Table 2.

Table 2. Distributed lag model for births, marriages and deaths 1700-1880.

	F	Adj. R^2	Lag 0	signif.	Lag 1	signif.	Lag 2	signif.	Total Lag	signif.
Deaths										
Mountain	6.36	0.08	0.153	***	0.962	*	0.085	*	1.200	***
Plain	13.62	0.17	0.237	**	0.089	**	0.044		0.370	***
Marriages										
Mountain	7.35	0.18	-0.190	***	-0.146	***	-0.079	**	-0.415	***
Plain	2.60	0.05	-0.059		-0.006		-0.061		-0.126	*
Births										
Mountain	23.36	0.43	-0.025		-0.263	***	0.051	**	-0.237	***
Plain	7.68	0.18	-0.052	**	-0.067	***	0.013		-0.106	***

Note: Significance level *** 1%, ** 5%, * 10%.

A first glance of the main results allows us to confirm their consistency with data in previous literature on the relationship between economic and demographic variables. Once again, a close connection between short-term economic stress and demographic events is evident. The estimated coefficients are in line with those observed in a previous study on the same region (Breschi, Fornasin, and Gonano 2002). The slight differences detected are likely due to the time periods examined by the two distinct studies being different.

A comparison between the demographic responses to short-term economic fluctuations in the mountain and plain regions reveals, at times, very different effects. The demographic responses to price increases are similar for both populations regarding number of deaths, which rose in response to price increases, although this effect can be observed as greater on the plain than in the mountains.

A more marked geographical difference emerges regarding the relationship between price and number of marriages. In this case, the response to price increases is insignificant for the population on the plain, whereas for that of the mountain the estimated coefficients are all significant, with a discernable drop in the number of marriages, at least during the eighteenth century.

As for number of births, we can observe an inverse relationship with price, especially occurring with a time lag 1. In other words, when corn prices increase we observe a considerable decrease in the number of conceptions. This effect is more intense and also longer lasting in the mountain area than on the plain. We can conclude that the effects of short-term economic stress relate particularly to births and marriages in the mountain area, and deaths on the plain.

Table 2 considers the relationship between price and demographic responses throughout the entire period (about one and a half centuries) in order to study structural changes. However, this produces an oversimplification and does not allow for taking certain important changes that intervened in Friulan society and economy into account, such as a rising level of corn consumption, modifications in the features of mountain emigration and its related intensity, the increased facility of goods displacement and basic changes in medical care, all of which notably occurred after the fall of the Venice Republic. We accordingly subdivided the time period of analysis into three sub-periods (of 60 observations each) and re-estimated the distributed lag model for each of the periods and dependent variables: births, marriages, and deaths. The results are reported in Tables 3-5.

Table 3. Distributed lag model for deaths.

	F	Adj. R^2	Lag 0	signif.	Lag 1	signif.	Lag 2	signif.	Total Lag	signif.
Deaths *1700-1759*										
Mountain	1.54	0.03	0.232	**	0.014		0.070		0.316	*
Plain	3.03	0.09	0.212	**	0.047		0.052		0.311	*
Deaths *1760-1819*										
Mountain	6.42	0.22	0.149	**	0.153	**	0.143	*	0.445	***
Plain	8.99	0.29	0.295	***	0.122	*	0.044		0.461	***
Deaths *1820-1879*										
Mountain	0.95	-0.05	0.043		0.030		0.007		0.080	
Plain	1.01	0.00	0.125		0.055		0.051		0.231	

Note: Significance level *** 1%, ** 5%, * 10%.

Table 4. Distributed lag model for marriages.

	F	Adj. R^2	Lag 0	signif.	Lag 1	signif.	Lag 2	signif.	Total Lag	signif.
Marriages *1700-1759*										
Mountain	2.13	0.10	-0.169	**	-0.159	*	-0.019		-0.347	***
Plain	3.13	0.26	-0.171	**	0.175	**	-0.272	***	-0.268	***
Marriages *1760-1819*										
Mountain	4.02	0.24	-0.191	***	-0.135	**	-0.105		-0.431	***
Plain	3.05	0.17	-0.060		-0.033		0.026		-0.067	
Marriages *1820-1879*										
Mountain	1.22	0.02	-0.128		-0.113		-0.107		-0.348	
Plain	1.09	0.01	0.038		-0.010		0.007		-0.035	

Note: Significance level *** 1%, ** 5%, * 10%.

Table 5. Distributed lag model for births.

	F	Adj. R^2	Lag 0	signif.	Lag 1	signif.	Lag 2	signif.	Total Lag	signif.
Births *1700-1759*										
Mountain	7.43	0.40	-0.012		-0.261	***	0.066		-0.207	***
Plain	4.27	0.25	-0.046		-0.141	***	0.054		-0.133	*
Births *1760-1819*										
Mountain	15.65	0.60	-0.050		-0.328	***	0.148	***	-0.230	***
Plain	4.53	0.26	-0.052		-0.015		-0.015		-0.082	*
Births *1820-1879*										
Mountain	3.06	0.17	0.000		-0.115	***	-0.033		-0.148	
Plain	4.85	0.28	-0.036		-0.054	*	0.010		-0.080	

Note: Significance level *** 1%, ** 5%, * 10%.

When examining the results reported in Tables 3-5, we limit our focus to the most marked differences in the general framework discussed above compared to the model applied to the entire period of 1700-1880. In terms of the price-deaths relationship, it is evident that during the first period the effects of price increases are significant only among the mountain population, whereas in the second, the number of deaths rise for both regional areas. This is probably owing to the fact that these years (1760-1820) saw the most positive deviations of price. Some of these peaks are due to the incidence of bad harvests in the second half of the eighteen century, with others in the Napoleonic period, although the major peak occurred during the severe famine of 1816-17. However, the relationship between high prices and mortality is no longer observable in the third time-span. This disappearance may be attributable to improved general economic conditions and/or living standards, which would have protected the population from the scarcest of harvests (Bengtsson and Dribe 2005).

As regards marriages, the effects of high prices are particularly evident during the first time period, when a statistically significant relationship is evident in both the mountain and plain areas. It is also possible to recognize a characteristic pattern to this influence: high prices inhibit weddings in the same crisis year, followed by a “recovery” phase of likely postponed marriages. At lag 2, and here the causal relationship is more difficult to identify, the number of marriages reduces even further. The marriage response is still present in the second period, but significant only in the mountain area. However, contrary to the previous time-span, the effects of high prices are particularly intense and statistically significant from lag 0 to lag 1. It is possible that during those years marriage behavior in the mountain population was influenced by the French and Austrian domination which introduced new rules about compulsory conscription. We are unable to determine to what extent marriage increases could be interpreted as a means to escape army recruitment, but anyhow, this relationship totally disappears in the following period, even in the mountain area, likely due to significant changes in migration flows. At the beginning of the nineteenth century emigration experienced a certain stagnation, followed by a number of decades when its economic structure underwent radical change. Initially, emigrants were involved in activities connected to trade and craft, whereas they turned to professions related to construction from the second half of the nineteenth century. This change can be seen to have had an impact on marriages from different points of view. First and foremost, the seasonal pattern of marriages changed drastically, with artisans and merchants getting married in the summer and masons and kiln workers in the winter. In addition, after the 1830's, price rises were much less intense than those previously recorded. And finally, one can argue that the population was relatively more protected during short-term economic crises, as already noted for the relationship between price and mortality.

Likewise, for births, the relationship is stronger in the eighteenth than in the nineteenth century, essentially following the general pattern outlined above. However, while the birth response to price increases is consistently apparent in the mountains, this is not so on the plain, where we see a negative affect on births in the first period, a lack of influence in the second, and again a negative relationship in the third (at a 10% significance level).

How can we interpret this relationship? Are we dealing with a fall in fertility or, conversely, a conscious behavior? While it is possible that both factors exerted their influence to some extent, we are more inclined to support the thesis of conscious behavior. Although some studies conducted on populations in developing countries conclude that worsening food conditions do affect women's reproductive capacities (Panter-Brick 1996), it is difficult to capture this issue using our models. During periods of high grain prices, we can observe an increase in all prices, not only those related to production, and it would be otherwise impossible to explain the more stable fertility levels in the countryside. Upon consideration, we tend to support the idea that, even in the past, people chose to behave in such a way as to limit the number of births (Livi Bacci 1978; Merzario 1992). In our case study, we can identify an indirect check for this behavior in the data on baptisms recorded in the mountain villages. One of the demographic characteristics of Friuli's mountain population was the occurrence of seasonal migration, which obliged migrants to be absent from their villages for most of the year. Since they returned home mainly during the summer months of July and August, it goes without saying that this was also the period when the greatest number of conceptions occurred (Fornasin 1998, 19-27). In order to check for a conscious response in fertility in times of grain shortage, we can make a comparison between the data on the seasonality of conceptions in years of high prices with the analogous curve referring to conceptions in the 18th century.

As demonstrated in Figure 2, conceptions in the mountain area vary greatly during "bad" years, with a particular decline in the month of August. With this effect notably absent on the plain, where migration was not widespread, it is reasonable to suppose that, since July and August were straight after the wheat harvest and immediately prior to that of corn, many of the returned men would decide whether or not to depart on the basis of current and forecast prices.

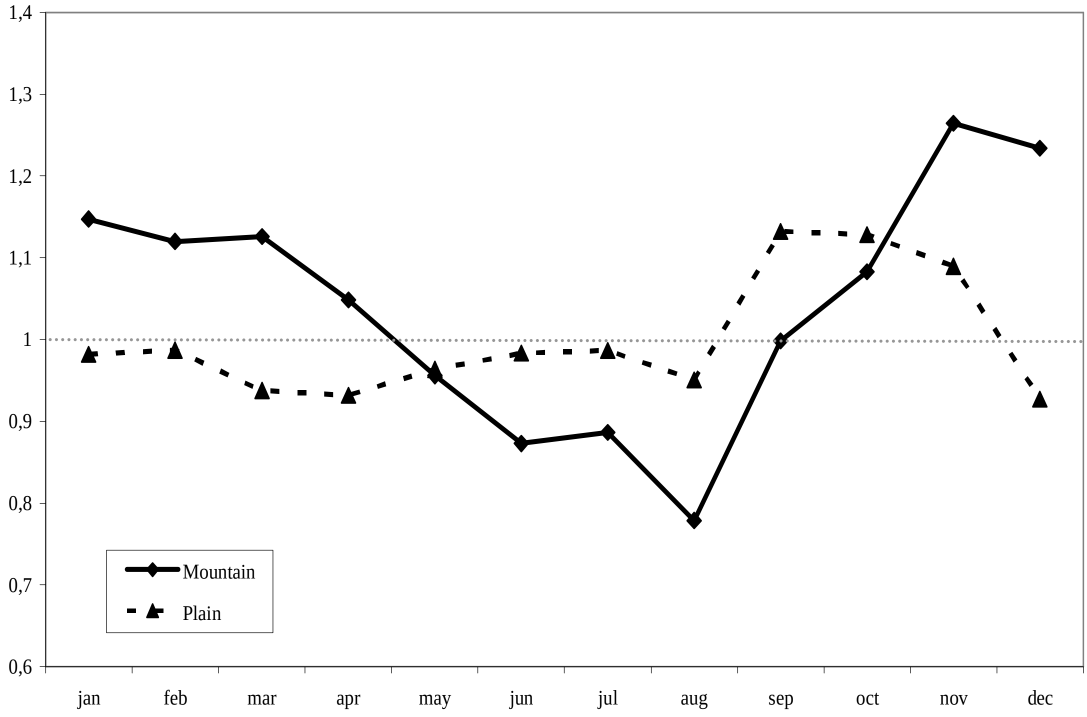

Figure 2. Seasonality of conceptions in years of crisis (1=18th century).

5. Micro Level Analysis

As we have seen, the results from analyses on aggregated data at the macro-level are consistent with data in literature on the same area. However, the macro-level does not allow for entering into the details of underlying demographic mechanisms.[2]

Results of the analysis carried out at the micro-level are reported in Table 6. In terms of deaths, these results are generally akin to those obtained using aggregated data (Table 3), with no response in mortality to price increases across all ages at time t and t-1. However, if we subdivide this analysis by age group, we witness, for Sant'Odorico only, a higher mortality rate for 19-55 year olds (the working population) one year after price increases. This is consistent with the outcome of a previous study carried out on nineteenth century Tuscany (Breschi, Fornasin, and Gonano 2005), though with a different lag.

[2] For the individual analysis we use data collected for solar-year. Respect to the data collected for crop-year, these usually reduced the emphasis of reactions but not the sign (Breschi, Fornasin, and Gonano 2002, 61).

Table 6. Effects of price on mortality, nuptiality, and fertility.
Treppo Carnico and Sant'Odorico 1834-1868.

Mortality		Treppo Carnico		Sant'Odorico	
		Logged price at time		Logged price at time	
	Age	t	t-1	t	t-1
	0	0.237	0.183	0.316	-0.924
	1	-0.723	0.406	-0.379	0.284
	2-18	0.570	0.369	1.288	-1.702
	19-54	0.453	0.334	0.671	**1.314**
	55+	0.017	0.340	-1.022	-0.260
	Overall 2+	0.266	0.245	-0.036	0.121
Nuptiality		**Treppo Carnico**		**Sant'Odorico**	
		Logged price at time		Logged price at time	
		t	t-1	t	t-1
	M	0.471	-0.078	-0.191	0.316
	F	**0.986**	-0.683	0.259	0.209
	All	**0.745**	-0.374	0.078	0.241
Fertility		**Treppo Carnico**		**Sant'Odorico**	
		Logged price at time		Logged price at time	
		t	t-1	t	t-1
		-0.112	**-0.534**	-0.517	-0.129

Note: Bold = Significance level 5%.

Considering nuptiality, the results for Sant'Odorico (Table 6) are consistent with macro-level data relative to the plain (Table 4). Vice versa, price has a strong influence in Treppo Carnico, in contrast to results obtained for the nineteenth century, although this pattern is in line with what emerges from the periods 1700-1760 and 1760-1820.

Previously, we interpreted fluctuations in the price-marriage relationship partly in terms of changes in the structure of migration flows. However, we should stress that the migration pattern of Treppo Carnico presents some specificities. The process of adaptation and change of migration flows in this community was slower and more delayed in comparison to the majority of villages in the same area, which may have led the population to maintain behaviors typical of eighteenth century Friuli mountain areas even into the nineteenth century. Since estimated models refer exclusively to first marriages, and we observe an increase in marriage among women only, we are led to believe that these "extra" marriages were actually between women who had never been married and widowers, although we are not currently able to prove this interpretation. However, this reasoning is not without logic. Although marriages between never-married women and widowers were undoubtedly more frequent than those between never-married men and widows, one should not conclude that widowers were likely to marry since it is more plausible that a young woman was more attracted to a young and unmarried man rather than an older and widowed one.[3] We also know that traditional societies usually opposed marriages between couples of marked age difference,

[3] For Italy, see Breschi, Fornasin, Manfredini, and Zacchigna 2009.

especially if one of the parties, usually the groom, had already been married. It is probable that during unfavorable economic times, it was easier for a young woman and her family to face and overcome the social barriers associated to this kind of marriage.

Lastly, the results emerging from an examination of the relationship between high price and birth rates are consistent with those estimated at the macro-level (Table 5). Indeed, for Treppo Carnico there is a significant and meaningful reduction in births in the year following price increases, which, as noted in the former case-study, can be attributed to connections between migration and demographic variables.

In conclusion, the main results from micro-level data are similar to those estimated from models applied to aggregated data, and can be summarized as follows: Short-term economic stress primarily affected marriages and births in the mountain area, and, conversely, deaths on the plain. These are long-term relationships that may have their grounds in the complex interaction between social and economic factors that existed in different areas of Friuli.

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To Die or to Leave: Demographic Responses to Famines in Rural Northeastern Japan, 1716-1870

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Abstract

This study examines demographic responses of men and women aged 10 to 74 to the two great famines (Tenmei in the 1780s and Tenpo in the 1830s) in rural northeastern Japan. Using the local population registers of two agrarian villages in 1716-1870, we examine in the multivariate context the effects of famines on mortality and out-migration, treating them as simultaneous competing risks that individual men and women in the two villages faced, using the multinomial logit model. The results show that the likelihoods of both dying and leaving rose significantly for both sexes during the acute and large-scale economic and environmental upheaval caused by the Tenmei and Tenpo famines. Less severe local economic downturn also affected men, but not women, making them more susceptible to die and less likely to leave the villages.

Introduction

This study examines the demographic responses of individual men and women in preindustrial rural Japan to two of the greatest famines in the early modern period, the Tenmei famine in the 1780s and the Tenpo famine in the 1830s. Using the local population registers called "*ninbetsu-aratame-cho*" of two northeastern farming communities from 1716-1870, we analyze in the multivariate context how residents of these preindustrial Japanese villages responded to the acute economic and environmental stress caused by large-scale famines, juxtaposing two types of demographic outcome—mortality and out-migration—as competing risks.

In preindustrial rural communities, people's livelihood was strongly influenced, much more so than today, by agricultural output. In preindustrial Japanese villages in which agricultural technologies were under-developed and not mechanized (Sato 1990; Smith 1959, 87-107), individuals and households were often affected seriously by downturns in local and regional agricultural production. Because the northeastern region was the northernmost boundary of rice cultivation in Tokugawa Japan (1603-1868), residents of northeastern villages at that time were able to grow only a single crop per year. These circumstances often put villagers at the mercy of fluctuations in harvest, driving their living standards near or below subsistence levels when famines hit their community.

Our previous studies found that when the local economic conditions deteriorated because of harvest failures and famines, mortality of men and women in our two study villages rose, although the likelihood of death differed, often significantly, by sex and life stage (Tsuya and Kurosu 2000a, 2004a). When these natural calamities made local economic conditions grave, however, people were unlikely to stay put and wait to die. Rather, those who were able and well enough likely left the community. Despite the commonly held notion of 'peasants tied to their land' during the Tokugawa period, residents in preindustrial Japanese agrarian communities indeed migrated frequently, influenced by environmental, socioeconomic, and household circumstances (Hayami 1973, 1978; Kurosu 2004; Nagata 2001; Takahashi 2000). Our previous studies found that the likelihood of absconding (leaving the community of legal domicile without notifying local authorities) increased significantly at the times of crop failures in our two study villages (Tsuya 2000; Tsuya and Kurosu 2005).

This study seeks to elucidate the mechanisms of demographic responses of individual men and women to acute economic and environmental upheaval caused by large-scale famines, modeling death and out-migration as competing risks, while simultaneously accounting for annual local economic fluctuations, household context, and individual demographic characteristics. In the next section we provide an overview of major famines in Tokugawa Japan. We also explain the settings of this study and changes in their population sizes, as well as temporal changes in regional economic conditions. We then explain the data, the variables, and the multivariate model used by this study. Next, we examine in the multivariate context the effects of famines on demographic outcome, as measured by mortality and out-migration, treating them as simultaneous competing risks that individual men and women in the two agrarian villages faced, using the multinomial logit model. The paper concludes with summary of findings and discussion of their implications.

Because Tokugawa Japan was a society with enormous local differences in demographic patterns and economic development, evidence from a study based on two northeastern villages is clearly not sufficient to provide a general picture of the demographic responses to famines in preindustrial Japanese agrarian communities. Nevertheless, examining in the multivariate context different types of demographic responses to widespread and acute crop failures, we seek to shed light on the nature of the effects of large-scale economic and environmental stress on the demographic behaviors of individual men and women in the Japanese past.

Backgrounds

(1) Famines in Tokugawa Japan

Japan experienced a number of famines in the 18th and 19th centuries. It is difficult, however, to clearly differentiate ‘famines’ from ordinary crop failures, or to identify the exact years of these famines and crop failures. For example, Saito (2002) reports that according to one source (Ogashima 1894) there were 28 famines in the Tokugawa period (1603-1868), and according to another (R. Saito 1966) there were 61 famines from 1600 to 1900. Nonetheless, the large-scale famines in the imperial eras of Kyoho in the 1730s, Tenmei in the 1780s, and Tenpo in 1830s are widely and commonly recognized as the three major famines in Tokugawa Japan.[1]

According to historical studies, the scale and regional patterns of these three major famines seem to vary, however.[2] Among them, the Tenmei famine, that devastated northeastern and eastern Japan from 1783-1788, was by far the most serious famine recorded in early modern Japan (Hayami 1982; Narimatsu 1985, 199-200). The onset of the famine was triggered by the eruption of Mt. Asama in July 1783 which caused extensive damages to crops on the east as well as in the southern part of northeastern Japan, piling up volcanic ashes and causing avalanches of volcanic rocks over agricultural land (Hayami 2008).[3] The eruption was then followed by the prolonged cold weather, resulting in massive crop failures that lasted until 1788.

The Tenpo famine swept through Japan in 1836-1838 (Hayami 1982). The population of northeastern Japan had been on the gradual rise starting from the turn of the 19th century, but the Tenpo famine halted this upward trend temporarily until the population resumed an upturn in the 1840s. According to Hayami (2008), the famine was also accompanied by an epidemic, resulting in the serious crisis mortality in 1837-1838.

While the Tenmei and Tenpo famines caused widespread devastations on the northeast (and the east), the effects of Kyoho famine seem to have been more limited, affecting mostly southwestern Japan and lasting for only about one year during 1732-1733 (Hayami 2008; Kikuchi 1995, 12). In this study, we therefore focus on the Tenmei and Tenpo famines (1783-1787 and 1836-1838, respectively) as they are thought to have caused acute and large-scale economic and environmental stress in the northeastern region.[4] Historical records document the depth of suffering among peasants as well as various remedial attempts by the government of the Nihonmatsu domain, in which our study villages were located, during these two famines (Kikuchi 1995; Narimatsu 2004). As desperate as the policy efforts of the domain government might have been, and as

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[1] The definitions of the precise years (dates) of these famines vary among historians who studied famines in Tokugawa Japan (e.g., Hamano 2001; Jannetta 1992; Kikuchi 1995; Nihonmatsu-shi 1982, 974-979; Saito 2002). This study uses the years most commonly suggested by historical evidence as affecting northeastern Japan.

[2] Crop failures on the northeast were caused mostly by very cold summers and lack of daylights, while harvest damages on the southwest tended to be caused by droughts, storms, and floods, as well as abnormal increases of noxious insects (Kikuchi 1995).

[3] The eruption of Mt. Asama coincided with the eruption of volcanic mountains in Iceland. As a result, the northern hemisphere in general suffered lack of daylight and cold weather for several years afterwards (Hayami 2008).

[4] The Nihonmatsu domain in which the two study villages were located was also affected negatively by a smaller but nevertheless serious famine (known as the Horeki famine) in 1755 (Hayami 2001, 47-49). Since its scale is much smaller than those of the Tenmei and Tenpo famines and it only lasted for less than one year, this study does not treat it as a major famine. However, as shown below, we account for the demographic effects of this Horeki famine and other local economic fluctuations by including annual rice prices in the local market of Aizu.

hard as individual men and women might have tried to cope with the situation, however, these calamities devastated the communities, households, and individual lives, resulting in high casualties.

(2) Trends of regional economic changes

Periodization of history is always somewhat arbitrary. However, looking at temporal changes in local development, economic policy contexts, and environmental conditions in the Nihonmatsu domain and the northeastern region as a whole, we can discern, to some extent, the trends of socioeconomic changes during the 154-year period (1716-1870) analyzed by this study.

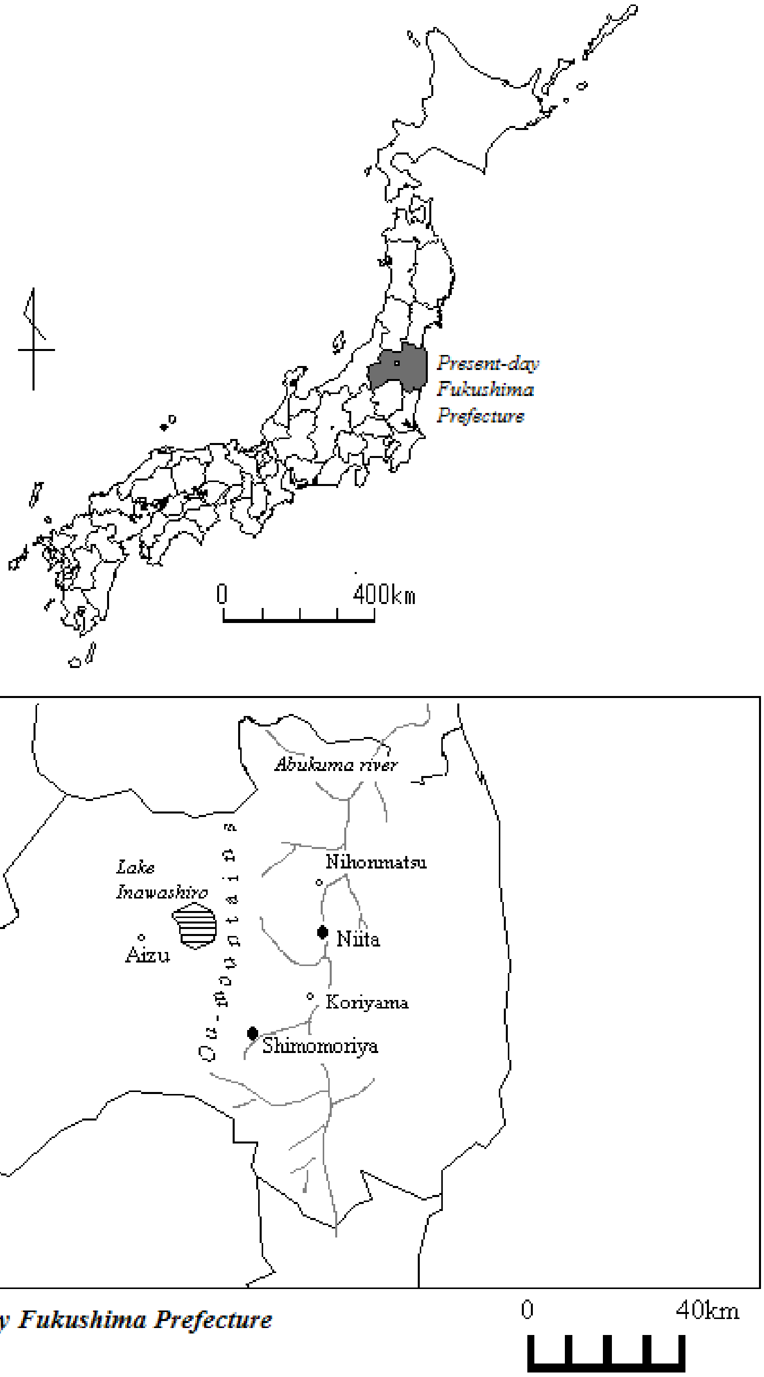
As discussed in the previous subsection, living standards in the two villages under study, as well as on the northeast as a whole, were affected inversely by frequent crop failures with the damages caused by Tenmei and Tenpo famines being especially severe. Despite the outbreak of these large-scale famines that caused temporary devastations, however, evidence suggests that, based on average real wages in agrarian communities, living standards in rural Japan seem to have been on the gradual rise in the 18th century and in the early part of 19th century. According to Saito (1998, 25-31), the average real wages of agricultural day-laborers in villages in eastern and central Japan increased throughout the 18th century until they started to decline in the 1820s. Hayami and Kito (2004) also showed that the real wages of servants in farming households in the central region rose in the 18th century.

The commercialization of agriculture based on family farming also began on a full scale in the 1750s (Hayami 1985, 91-92). Due to the continuing agricultural commercialization and also because of the intensified need to increase rice production after the Tenmei famine in the 1780s, the Nihonmatsu domain government reversed its economic policy at around the end of the eighteenth century. Once having discouraged the development of proto-industries, it began to encourage locally specialized production of cash crops such as mulberry and lacquer trees (Nagata, Kurosu, and Hayami 1998). This resulted in proto-industrialization of farming villages in the domain, as seen in the growth of silk textiles and lacquer industries. After the Tenpo famine in the 1830s, the rigid social structure and hierarchy of Tokugawa Japan that had been sustained for almost two and half centuries became increasingly slack, leading to the period called '*bakumatsu*,' the last years of the Tokugawa regime.

(3) The setting and local population changes

The main sources of empirical data used in this study are the local population registers in Shimomoriya and Niita, two farming villages in the present-day Fukushima prefecture in northeastern Japan (see Map 1). During the Tokugawa period, both villages belonged to the Nihonmatsu domain that governed the central part of the prefecture. Located at the foot of the Abukuma mountain range, Shimomoriya was susceptible to cold summers and poor harvests resulting from chilly gusts off the mountains (Narimatsu 1985, 1-3).

Because the village was located in a hilly area with severe winter weather, most of its agricultural land was not fertile and unfit to grow cash crops such as mulberry trees.[5]



Map 1. Northeastern Japan and the villages of Shimomoriya and Niita.

[5] Sericulture became popular in the region in the 18th century, and mulberry leaves were major cash crops. Existing historical records show that several neighbouring villages that were located in a plain had much higher proportions of fields used for growing mulberry trees (Narimatsu 1985, 53-54).

Located in a plain between the capital town of Nihonmatsu and the market town of Koriyama, two major population centers in the domain at that time, Niita enjoyed a better climate for agriculture (Narimatsu 1992, 4-6). Although situated north to Shimomoriya, Niita had more fertile agricultural land fit to be cultivated as rice paddies and mulberry fields.[6] Nonetheless, lying on the banks of the Gohyaku River, the village was vulnerable to frequent floods. Although somewhat different in their geographical conditions, both villages were almost entirely agricultural (consisted almost entirely by farmers and peasants) and depended mostly on rice agriculture, supplemented by a number of dry crops (Nagata, Kurosu and Hayami 1998; Narimatsu 1985, 152-180, 1992: 6).

According to the local population register, Shimomoriya was a relatively small village with the population of 1716 being 419. As shown in Figure 1, the village population was relatively stable in the first 35 years for which the records are available until it started to decline at around the time of Horeki famine in the mid-1750s. Devastated by the great Tenmei famine in the 1780s, the village population further declined to 286 in 1786—a decline of 32 percent in the 70 years from 1716. Though the population was restored somewhat during the 1790s-1820s, it again took a dramatic downturn during the Tenpo famine in the late 1830s, marking a lowest figure of 238 in 1840. Although the population recovered gradually afterwards to 328 in 1869, it did not recover the 1716 level.

Niita was a bigger village with the population of 538 in 1720. The village population was also stable, like the case of Shimomoriya, for the first 50 years until it began to decline in 1770. Owing mainly to the Tenmei famine in the mid-1780s and a long spell of bad weather preceding it (Koriyama-shi 1981a, 340-341, 1981b, 176-180), Niita's population decreased from 530 in 1770 to 430 in 1786—a decline of 19 percent in mere 15 years. After fluctuating at the level of around 420 to 450 from 1786 to 1800, the population decreased again in the early 1800s. Reaching the all-time low of 367 in 1820, the village population started a gradual upturn afterwards. The population size of Niita was not as seriously affected as Shimomoriya by the Tenpo famine, recovering, and even surpassing, the 1720 level by the late 1860s.

[6] According to a survey by the domain government in 1828 on the use of agricultural land, around 30 percent of the dry field in Niita was cultivated as mulberry field, whereas only 5 to 10 percent of the dry field in Shimomoriya was used to grow mulberry trees (Nihonmatsu-shi 1982, 581).

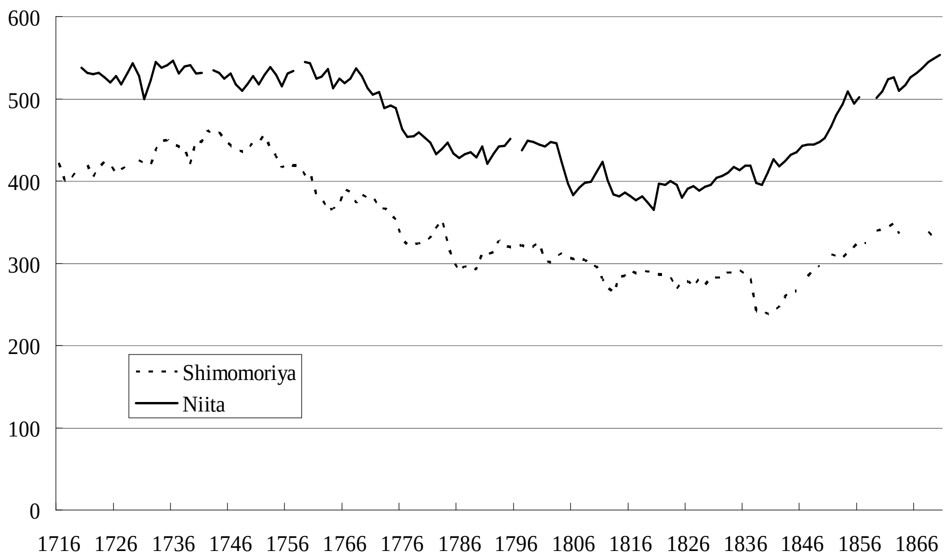


Figure 1. Population size of the villages of Shimomoriya and Niita, 1716-1870.

This difference in the population trend during and after the Tenpo famine in the 1830s may have been due at least in part to differences between the two villages in their capabilities in storing extra rice for crises. Because the economic, demographic, and political damages caused by the Tenmei famine in the 1780s were so severe, the Nihonmatsu domain government began, after the famine, a program encouraging each locality to store rice for emergency use (Narimatsu 1985, 52-53). Consequently, when the Tenpo famine hit the region in the 1830s, many municipalities in the domain, including Niita, are thought to have not been affected as seriously as they had been during the previous massive famine. Presumably because such extra rice was unavailable for storage given its poor agricultural land, Shimomoriya may have been devastated again by the Tenpo famine (Tsuya and Kurosu 2000a).

In summary, except for the first few decades of the records in which population size was stable, and for the last few decades in which it showed an upturn, the population size in the two villages was in overall decline. Especially large net population losses occurred at the times of the Tenmei famine in the 1780s and the Tenpo famine in the 1830s. Hence, although evidence is by no means definitive, these findings seem to imply that the village populations were affected seriously by these widespread famines.

Data and Measures

(1) Data

This study draws the data from the local population registers called '*ninbetsu-aratame-*

cho' (NAC) in the northeastern Japanese villages of Shimomoriya and Niita.[7] In both communities, the NAC was enumerated annually at the beginning of the third lunar month. Surviving NAC registers in Shimomoriya cover the 154 years from 1716 to 1869 with only nine intermittent years missing (1720, 1729, 1846, 1850, 1858, and 1864-67). In Niita, the surviving NAC registers cover the 151-year period from 1720 to 1870, during which there are only five years missing (1742, 1758, 1796, and 1857-58). Thus, in the two villages there exist virtually undisrupted records spanning the latter half of the Tokugawa regime. Because the format and contents of the NAC registers of the two villages are almost identical, this study pools the records from them together.

In addition to the continuity of the existing records, the NAC registers in the two study villages have other advantages as demographic records. First, the registers were compiled using the principle of current domicile; thus, the NAC data are all '*de facto*.'[8] Registers compiled this way give far more exact demographic information than those based on the principle of legal residence although the latter '*de jure*' principle seems to have been much more widely used (Cornell and Hayami 1986).

Second, in the NAC registers of the two villages, the dates (month and year) of births and deaths were annotated as far as these events occurred during the period of observation. The dates of occurrence of these events were not usually given in local population registers in Tokugawa Japan (Saito 1997; Smith 1977, 19), and this provides another evidence for the high quality of the population registers in Shimomoriya and Niita.

One exception is for infants who died before the first registration after birth. Not all births and infant deaths were recorded in local population registers of pre-industrial Japanese communities, as was the case elsewhere in preindustrial East Asia. Only those who survived from birth to the subsequent registration were entered into the registers. Consequently, many infants who died before the first registration after birth were excluded and never came under observation. The under registration of infant deaths is the most serious shortcoming of our data source, although this would not seriously affect the results of our analysis because it focuses on men and women aged 10-74.

Third, exits from the registers due to unknown reasons are extremely rare in the population registers of the two villages. Such 'mysterious disappearances' consisted merely 19 (0.6 percent) of all exits during the 154 years covered by Shimomoriya's

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[7] The population registers in Shimomoriya and Niita, like all other localities in the Nihonmatsu domain, were *ninbetsu-aratame-cho* (NAC), rather than *shumon-aratame-cho* (SAC). Though similar in terms of information collected by these two types of registers, SAC was carried out, in its original purpose, to hunt hidden Christians whereas NAC was primarily for population registration and investigation (Narimatsu 1985, 11-14, 1992, 10-12).

[8] The size of '*de jure*' population can also be computed for both villages because records were kept as far as one's permanent (legal) domicile was in the villages. However, for persons whose legal domicile was in the village but who were not present (residing) there, information on individual circumstances including demographic events occurred while away from the villages are generally unavailable.

NAC, and only 13 (0.3 percent) of all exits during the 151 years recorded by Niita's register were such cases.[9] Thus, we can determine, in most cases, the timing of entrance to the 'universe' of observation (due to birth or in-migration) as well as the timing of death and other exits, although the two villages experienced considerable in- and out-migration during the 154-year period under study (Narimatsu 1985, 101-120, 1992, 32-38; Tsuya 2000; Tsuya and Kurosu 2005).

The original annual NAC records (which were organized into one sheet per year for each household) were first linked into time-series data sheets called 'basic data sheets' (BDS) for all households. The BDS were then entered into a machine-readable form, from which a relational database was created (for specifics, see Hayami 1979; Ono 1993; Tsuya 2007). Using this database that contains all information available in the NAC, it is possible not only to derive for each individual (and for each household) indices of past, present, and future demographic and life course events, but also to link all individuals (present in the village) to the records of other household members. From the relational database, we then constructed a rectangular file for our empirical analyses, using a person (man/woman) year recorded in the NAC register as the unit of observation.

Although it is possible to compute chronological age for residents whose birth dates were recorded in the NAC registers, a majority of individuals appeared in the registers were either present at the beginning of the records or migrated into the village some time after their birth. Moreover, NAC information used to construct the covariates of our analyses is organized in terms of the timing of NAC registration. Hence, for the purposes of our analysis, it is necessary and appropriate to use as the measure of individual age the variable indicating the number of NAC registrations each individual went through after birth until his/her exit from the universe of observation through death or emigration. Therefore, in this study, the word 'age' refers to the age measured in terms of the timing of the NAC registration.[10]

(2) Methods

This study conducts a multinomial logit analysis of the effects of the Tenmei and Tenpo famines on the probability of dying or out-migration among individual men and women aged 10-74 in Shimomoriya and Niita from 1716-1870. The multinomial logistic regression model (also called the polytomous logit model) is a generalization of the

[9] Eighteen out of the 19 disappearances from Shimomoriya's NAC and seven out of the 13 disappearances from Niita's registers occurred during 1851-1870, the last two decades of the Tokugawa regime. For details, see Narimatsu (1985, 54-56, 1992, 32-38).

[10] In addition to chronological age (i.e., age according to Gregorian calendar) and NAC age, there is also the traditional Japanese method of counting age. As in the rest of East Asia, it regards a child as age 1 at birth and adds an additional year on each New Year's Day thereafter. Consequently, if counted by the traditional Japanese method, most newborns, if they survived, appear in population registers at the age of 2 *sai* although in extreme cases they could be on the second day of life. If population registration was conducted on each New Year's Day (which was rarely the case), traditional Japanese age (in *sai*) minus one is equivalent to NAC age.

binary logistic regression model. While the dependent variable of the binary logit model is dichotomous, the response variable of the multinomial logit model has three or more mutually exclusive and exhaustive categories.[11]

Simultaneously treating death and out-migration as competing risks, our multinomial logit model relates the probability of dying in or moving out of the study villages in next one year among resident men and women aged 10-74 to the two great famines in the Tenmei and Tenpo era, while controlling for annual changes in local economic conditions and their household context including landholding, coresident kin, and relationship to household head at the beginning of the interval. The model also controls for current age, time period, and village of residence. Because the likelihood of migration on their own is very low among individuals below age 10, our analysis excludes those under age 10. To avoid the estimation bias caused by increasingly selective populations who survived to very old age, we also restrict the analysis to individuals under age 75.

Because the data for our analysis are constructed with a person year as the unit of observation, individuals are likely to contribute more than one observation. This built-in interdependence can affect the standard errors in multivariate analyses.[12] To take into account the effects of intercorrelation among observations obtained from same individuals, we estimate the multinomial logistic regression with robust standard errors based on Huber's formula (Huber 1967).[13]

(3) Dependent variable

The dependent variable of our analysis is a tri-categorical variable indicating whether a resident of Shimomoriya and Niita died, or left, or were alive and stayed in the village during next one year. Out of the 6,257 individuals (3,155 males and 3,102 females) who appeared in the population registers of the two study villages, there are 2,840 (1,478 male and 1,362 female) deaths recorded.

In our analysis, out-migration is defined as the observed movement of any resident out of the community of legal domicile to other communities.[14] The NAC registers in Shimomoriya and Niita annotated in detail information on people's movements across

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[11] For specifics of the multinomial logit model, see Amemiya (1981), Maddala (1983), Retherford and Choe (1993, 151-165), and Theil (1969).

[12] According to Guilkey and Murphy (1993), when records are repeated over five times, the problem of intercorrelation among observations becomes serious and affects the estimation results.

[13] The formula was independently discovered by White (1980) and is also known in the econometrics literature as White's method.

[14] When migration consisted of more than one individual (i.e., migrants did not move alone), we counted the event pertaining to each individual as one. For example, when a household of three members moved out of the village, we counted three events; and all three were used in the analysis. This multiple counting of events in the case of migration of a whole (or part of) household would not seriously affect the results of our analysis because a large majority (90 percent) of out-migration was by a lone individual.

the village boundaries, including the name of destining village and the name of the household head of destination for out-migrants and those of origin for in-migrants.[15] Based on this information, we can differentiate the out-migration of individuals whose legal domicile was in one of the two study villages, from the migration of persons whose legal domiciles were elsewhere. To 6,224 legal residents (3,138 male and 3,086 female residents) who appeared in the population registers of the two villages, 2,729 out-migrations (1,598 male and 1,131 female) were recorded.

Our analysis is restricted to men and women aged 10-74 and also to the years for which an immediately succeeding register is available. The specific numbers by sex of person years, deaths, and out-migration included in the analysis are as follows:

Sex	Persons years at age 10-74	Deaths at age 10-74	Out-migration of those age 10-74
Male	41,325	686	2,005
Female	38,994	698	1,453
Both sexes	80,319	1,384	3,458

From the trends of death and out-migration rates per 1,000 persons aged 10-74 by sex and time period shown in Table 1, we do not see clear signs at the aggregate level of increases in the rates of mortality and out-migration at the decades of the Tenmei and Tenpo famines, although the death rates are somewhat higher for both men and women during the 1780s, the decade covering the Tenmei famine. The rates of out-migration were also highest for both sexes during the decade of the Tenmei famine and those preceding it.

Looking at the trends of the annual fluctuations in the rates of death and out-migration per 1000 persons aged 10-74 shown in Figure 2, we can see the highest spikes in the death rate for the years of the Tenmei and Tenpo famines, although increases are not limited to the years of these massive famines. The out-migration rate also shows the highest spikes in the years of these two large-scale famines, and also in those of the Kyoho famine in the 1730s. Thus, although evidence is not conclusive, nor consistent, we can see the possible mortality and out-migration effects of these major famines on persons aged 10-74 in our study villages.

[15] The NAC registers of the two villages also provide the information on reasons for migration. Based on this information, out-migration of legal residents can be differentiated into various types of movements. Among those, service (*hoko*) is by far the most common reason for male out-migration constituting 65 percent, followed by absconding (*kakeochi*, i.e., leaving the village of legal domicile without notifying the local authority) constituting 17 percent, and marriage or adoption constituting 10 percent (Tsuya 2000; Tsuya and Kurosu 2006). As for out-migration of female legal residents, their reasons were mostly marriage or adoption (45%) or service (35%), with absconding being the third-largest category (13%).

Table 1. Rates of death and out-migration per 1,000 persons aged 10-74 by sex and time period: Shimomoriya and Niita, 1716-1870.

Time period	Male		Female	
	Death	Out-migration	Death	Out-migration
1716-1729	15	73	18	28
1730-1739	18	68	22	33
1740-1749	17	46	17	39
1750-1759	14	51	18	37
1760-1769	11	61	17	39
1770-1779	18	65	15	57
1780-1789	23	64	22	54
1790-1799	10	45	12	38
1800-1809	19	52	19	29
1810-1819	19	50	23	34
1820-1829	20	38	20	35
1830-1839	22	34	18	36
1840-1849	14	20	12	27
1850-1859	13	17	17	19
1860-1870	23	16	18	24
1716-1759	16	55	19	37
1769-1799	15	59	17	47
1800-1839	20	43	20	33
1840-1870	15	18	16	22
1716-1870	17	49	18	36

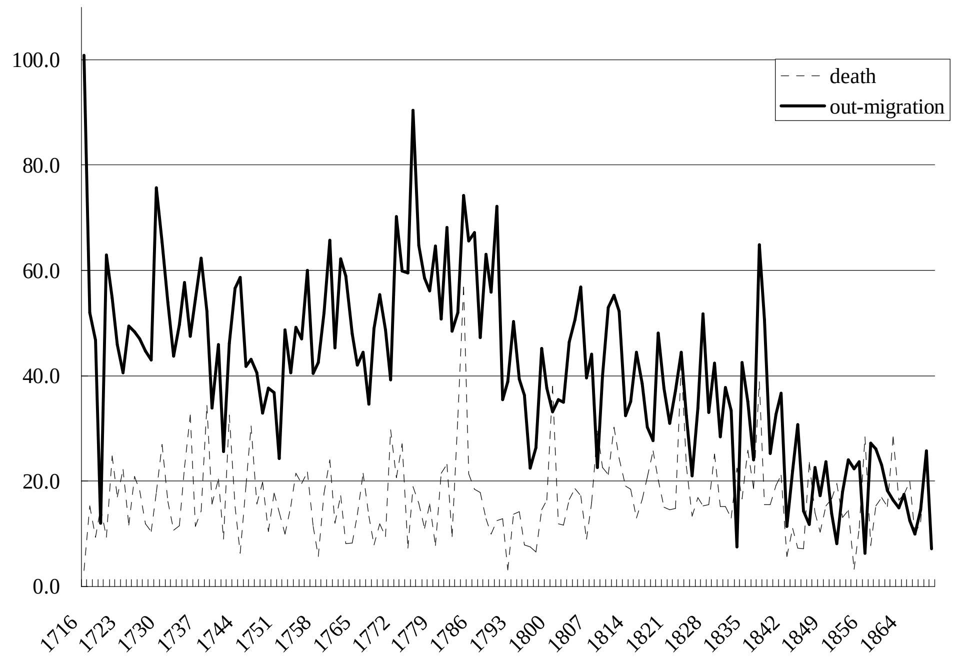

Figure 2. Rates of death and out-migration per 1,000 persons aged 10-74 in Shimomoriya and Niita, 1716-1870.

(4) Independent and control variables

The independent variable of our analysis is the Tenmei and Tenpo famines, two great famines that devastated northeastern Japan in the mid-1780s and the late 1830s. The variable is dichotomous, indicating the years of these two famines, 1783-1787 and 1836-1838, respectively. It seeks to measure the effect of acute and large-scale economic and environmental upheaval caused by these famines.

Our analysis also accounts, net of the effects of the two large-scale famines, for the effects of annual fluctuations in local economic conditions, as measured by logged raw rice price in the local market of Aizu.[16] In our earlier study of mortality in the two study villages (Tsuya and Kurosu 2000a), we examined the effects of different rice price series—prices in Aizu as well as in the central market of Osaka—using different specifications: raw prices, detrended prices based on moving averages, and prices detrended using the Hodrick–Prescott filter.[17] We found that fluctuations in agricultural output were best measured by raw prices, rather than detrended prices. Included in the model together with the dichotomous variables indicating the years of Tenmei and Tenpo famines, this variable measures the effects of local economic downturns and upturns in the years other than those of these massive famines.

We also account for the effects of household context, measured at two levels: aggregate characteristics such as household landholding, and individual features such as coresident kin and relationship to household head. In preindustrial Japanese agrarian settings in which intensive family farming was prevalent (Tsuya and Kurosu 2005, 2006), people's livelihoods were often determined by socioeconomic status of the household to which they belonged, and their demographic behaviors were affected, often strongly, by the amount of economic resources available in the household. In preindustrial rural communities in which households were the primary unit of production as well as that of consumption, individual demographic responses also differed according to wealth of the household. Furthermore, given the rigid hierarchies within household in northeastern Tokugawa agrarian communities (Aruga 1943; Nakane 1967; Naito 1973; Takei 1971; Tsuya and Kurosu 2004a), the position of each individual within the household also affected his/her well-being and life opportunities.

Household landholding recorded in the population registers (*mochidaka* in *koku*) indicates the productive capacity (expected yield) of the land owned by each household.[18] This variable is thought to measure the amount of household income and economic resources available, although it may also serve as a proxy of the wealth and socioeconomic status of household (Tsuya and Kurosu 2004a). Our multivariate analysis

[16] We also tested the effects of local rice prices time lagged by 1 to 3 years, and found that the effects became weaker and often insignificant. We therefore decided to use current price.

[17] For details on various rice price series in early modern Japan, see Iwahashi (1981), and for the relationship between local rice markets and the Osaka central market in Tokugawa Japan, see Miyamoto (1988, 386-430).

[18] One *koku* equals approximately five bushels.

estimates the effects of landholding as a continuous variable.

In order to account for the differential effects of the two major famines by household socioeconomic status and size of coresident kin, we also tested an interaction of the two large-scale famine years to each of these covariates, and found a significant interaction between household landholding and the famine years for demographic outcome of males. We therefore estimate the model including this interaction for males.

Our model also estimates the effects of various coresident kin. Our earlier studies found that the likelihood of survival was affected, often strongly, by the number and relationships of kin who were living with them (Tsuya and Kurosu 2004a; Tsuya and Nystedt 2004; Tsuya and Kurosu 2006). The total number of coresident kin is a continuous variable that indicates the number of household members who have kinship ties to the household head.[19]

We also estimate the effects of different types of kin members within household, by differentiating them in terms of their relationships to the index person—parents, siblings, and children—because the presence of certain kin members could have important implications. The presence of parents or parents-in-law in household is included because our previous study found that childhood mortality was affected by coresident parents and siblings (Tsuya and Kurosu 2004a), and also because old-age mortality was influenced strongly by coresidence with children (Tsuya and Nystedt 2004). The variable indexing the effects of coresident parents has four categories: both parents present, only father present, only mother present, and no parents present. Using no parents present as the reference (omitted) category, we construct three dummy variables. The effects of coresident siblings are measured by four continuous variables indicating the numbers of older brothers, older sisters, younger brothers, and younger sisters living with the index person at the beginning of the interval.[20] The effects of coresident children are estimated by two continuous variables indicating the number of sons and daughters of the index person living in the household.

Our model takes into account the effects of relationship of an index individual within household. A person's position within the household was supposed to be an important determinant of his/her social standing and life chances, and it was especially the case in the patrilineal stem family systems prevalent in northeastern Tokugawa Japan (Aruga 1943; Nakane 1967; Otake 1982; Takei 1971; Naito 1973). Household relationships have six categories: head of household (reference), spouse of head, stem kin of head, spouse of stem kin of the head, non-stem kin of the head, and non-kin or servant.

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[19] We use the number of coresident kin, rather than the total household size. Our earlier study of mortality in these two villages found that total household size was highly multicolinear to landholding (Tsuya, Kurosu and Nakazato 1997). Theoretically, it is also more appropriate to control for the size of coresident kin, rather than total household size, as non-kin and servants are thought to have had much less access, if any, to income and wealth of their household of residence.

[20] Siblings here include not only biological and adopted siblings of the index individual, but also his/her siblings in-law.

In addition, our model also controls for current age and village of residence of the index individual, as well as time periods. Current age is a covariate the effect of which needs to be controlled, because the likelihoods of death and migration vary greatly by age. This variable is continuous and, to account for the possible curvilinearity of its effect, we also include the square of current age. Because the data from two different villages are pooled in our analysis, a dichotomous variable is also included to control for possible village differences.

Finally, the model takes into account the effects of different time periods within the 154 years (1716-1870) under consideration. As explained in the previous section, there were considerable period differences during the 18th and 19th centuries in local development, policy context, and environmental conditions in the Nihonmatsu domain and the northeastern region as a whole. To avoid slicing the data too thin, we divide the 154-year period into four subperiods: before 1760, 1760-1799, 1800-1839, and 1840-1870. Using the earliest subperiod (1716-1759) as the reference category, we construct three dummy variables. Table 2 presents the descriptive statistics (means and standard deviations) of these covariates used in the multivariate analysis, separately for men and women.

Results of the Multinomial Logit Analysis

In this section, we examine the effects of the Tenmei and Tenpo famines on the probabilities among men and women aged 10-74 of dying in or moving out of the villages of Shimomoriya and Niita, using the multinomial logit model. Positing these two types of demographic behaviors as competing risks, we estimate the demographic responses of acute economic and environmental upheaval caused by the two massive famines, controlling for annual variations in local economic conditions, household socioeconomic status, and coresident kin. Tables 3 and 4 present the estimated coefficients of the covariates of the multinomial logit analysis of the probabilities of dying and out-migration in the next year for men and women, respectively.

Table 2. Descriptive statistics of the covariates used in the multinomial logit analysis of the probabilities of dying and out-migrating in the next year: Males and females age 10-74 in Shimomoriya and Niita, 1716-1870.

	Male		Female	
	Mean	S.D.	Mean	S.D.
Economic stress				
Tenmei & Tenpo famines	0.057	0.231	0.060	0.237
Log of local rice price	-0.210	0.292	-0.209	0.291
Socioeconomic status				
Household landholding (in *koku*)	12.137	8.635	12.311	8.204
Coresident kin				
Number of kin	4.910	1.986	5.046	1.907
Presence of parents (ref: no parent):				
Both parents	0.309	0.462	0.283	0.451
Father only	0.071	0.257	0.066	0.248
Mother only	0.118	0.323	0.112	0.316
Number of siblings:				
Older brothers	0.096	0.313	0.087	0.300
Older sisters	0.079	0.289	0.074	0.278
Younger brothers	0.167	0.428	0.155	0.418
Younger brothers	0.153	0.410	0.135	0.396
Number of children:				
Sons	0.536	0.721	0.638	0.737
Daughters	0.472	0.679	0.567	0.698
Household relationship (ref: head)				
Spouse of head	0.006	0.079	0.419	0.493
Stem kin	0.370	0.483	0.359	0.480
Spouse of stem kin	0.044	0.206	0.102	0.302
Non-stem kin	0.033	0.179	0.028	0.166
Nonkin/servant	0.088	0.283	0.059	0.235
Unknown	0.001	0.032	0.003	0.053
Current age	37.659	17.879	37.185	17.715
Current age squared	1737.83	1453.98	1696.59	1430.07
Time period (ref: 1716-1759)				
1760-1799	0.327	0.469	0.331	0.470
1800-1839	0.266	0.442	0.280	0.449
1840-1870	0.124	0.330	0.132	0.338
Village (Shimomoriya=1)	0.417	0.493	0.441	0.497

Notes: The unit of data is person-year.

We can see from the top panels of Tables 3 and 4 that, during the Tenmei and Tenpo famines, both men and women were significantly more likely to either die or leave, relative to staying alive in the village. Between the two types of demographic responses considered here, men were more likely to die than emigrate at the times of these great famines, while there is no significant difference between the likelihoods of these two demographic responses among women. These results suggest that the demographic responses to the acute economic and environmental stress caused by these large-scale famines were in general similar between the sexes in the northeastern Japanese farming villages under study. During the two massive famines, both men and women suffered a significantly higher likelihood of death, and they were also more likely to leave the village probably because the likelihood of absconding (illegal disappearance of legal residents from the village) rose at the time of these famines (Tsuya 2000; Tsuya and Kurosu 2006).

On the other hand, the responses to variations in local economic conditions in the years other than those of the Tenmei and Tenpo famines are very different between the sexes. Even after the effects of the two great famines are controlled for, men were still more likely to die, but much less likely to move out of the village. Put differently, even at the time of a less serious economic downturn, men were still more likely to suffer death and, if they survived, were more likely to stay in the village. In clear contrast, once the effects of the two great famines are controlled for, women were not affected significantly by annual variations in local economic conditions.

Household socioeconomic status was strongly and negatively associated with the likelihoods of death and out-migration among men, as household wealth as measured by landholding significantly reduced the probabilities of their dying and leaving. Furthermore, the negative effects of household socioeconomic status became even stronger at the time of the Tenmei and Tenpo famines. As indicated by the size of the (negative) coefficient of the interaction between landholding and the famines, the enhancing effect of household resources and wealth is especially strong for men's survival. Put differently, men in wealthier household were more likely to be alive and stay in the village compared to their less well-to-do counterparts, and such a tendency became even more salient during the time of the two large-scale famines. This implies that household resources and wealth enhanced men's health and enabled them to stay in their village, and that such protective effects of household socioeconomic status became stronger during the times of economic and ecological upheaval. On the other hand, household socioeconomic status did not affect the likelihood of death among women, but it significantly reduced the likelihood of their out-migration, relative to staying alive in the village (see the second panel of Table 4). In other words, women were more likely to stay in the village, rather than leaving it, at the time of local economic downturns in the years other than those of the two massive famines.

Table 3. Estimated coefficients of the covariates of the multinomial logit analysis of the probabilities of dying and out-migrating in the next year: Males age 10-74 in Shimomoriya and Niita, 1716-1870.

	Model 1			*Model 2*		
	Dying vs. (Staying)	Emigrating vs. (Staying)	Emigrating vs. (Dying)	Dying vs. (Staying)	Emigrating vs. (Staying)	Emigrating vs. (Dying)
Economic stress						
Tenmei & Tenpo famines	0.979**	0.355#	-0.624*	0.979**	0.341#	-0.638*
Log of local rice price	0.304*	-0.390**	-0.694**	0.306*	-0.382**	-0.688**
Socioeconomic status						
Household landholding	-0.015*	-0.011**	0.004	-0.013*	-0.015**	-0.002
Landholding x famines	-0.034*	-0.008**	0.030	-0.039*	-0.007	0.032
Coresident kin						
Number of kin	-0.030	-0.158**	-0.127**	--	--	--
Presence of parents:						
Both parents	--	--	--	-0.322*	-0.730**	-0.408*
Father only	--	--	--	-0.178	-0.343**	-0.164
Mother only	--	--	--	-0.139	-0.154	-0.015
Number of siblings:						
Older brothers	--	--	--	0.325	-0.011	-0.336
Older sisters	--	--	--	0.053	0.050	-0.003
Younger brothers	--	--	--	0.058	-0.112	-0.169
Younger brothers	--	--	--	0.032	-0.331**	-0.363*
Number of children:						
Sons	--	--	--	-0.089	-0.531**	-0.442**
Daughters	--	--	--	-0.127#	-0.354**	-0.228*
Household relationship						
Spouse of head	-0.173	0.894**	1.067	-0.207	0.792**	0.999
Stem kin	0.210*	0.259**	0.049	0.212*	0.277**	0.065
Spouse of stem kin	0.087	0.907**	0.820**	0.129	0.911**	0.781*
Non-stem kin	0.650**	1.021**	0.370	0.410#	0.627**	0.216
Nonkin/servant	-0.177	2.187**	2.363**	-0.423#	1.290**	1.713**
Unknown	0.860	2.142**	1.287	0.725	1.569**	0.844
Current age	-0.024#	0.101**	0.125**	-0.010	0.125**	0.135**
Current age squared	0.001**	-0.001**	-0.002**	0.001**	-0.002**	-0.002**
Time period						
1760-1799	-0.128	0.002	0.130	-0.134	-0.003	0.130
1800-1839	0.253*	-0.185*	-0.438**	0.243*	-0.179*	-0.422**
1840-1870	0.239#	-0.968**	-1.207**	0.226	-0.972**	-1.199**
Village (Shimomoriya=1)	0.039	-0.140*	-0.179#	0.035	-0.143*	-0.178#
Constant	-4.689**	-3.953**	0.736*	-4.880**	-4.255**	0.625
Person-years at risk	41,298			41,298		
Number of individuals	2,566			2,566		
Log-likelihood	-10217.62			-10121.44		
Wald chi2 (d.f.)	1774.73 (34)			1890.63 (50)		
Probability > chi2	0.0000			0.0000		

Note: Category in parentheses is the reference category.
** Significant at 1 percent. * Significant at 5 percent. # Significant at 10 percent.

Table 4. Estimated coefficients of the covariates of the multinomial logit analysis of the probabilities of dying and out-migrating in the next year: Females age 10-74 in Shimomoriya and Niita, 1716-1870.

	Model 1			*Model 2*		
	Dying vs. (Staying)	Emigrating vs. (Staying)	Emigrating vs. (Dying)	Dying vs. (Staying)	Emigrating vs. (Staying)	Emigrating vs. (Dying)
Economic stress						
Tenmei & Tenpo famines	0.566**	0.311*	-0.255	0.561**	0.274*	-0.287
Log of local rice price	-0.149	-0.164	-0.015	-0.158	-0.167	-0.010
Socioeconomic status						
Household landholding	0.0003	-0.009*	-0.009	0.002	-0.011**	-0.013#
Coresident kin						
Number of kin	-0.009	-0.117**	-0.108**	--	--	--
Presence of parents:						
Both parents	--	--	--	-0.397*	-0.844**	-0.447*
Father only	--	--	--	-0.155	-0.551**	-0.396
Mother only	--	--	--	-0.616**	-0.355**	0.261
Number of siblings:						
Older brothers	--	--	--	0.104	0.439**	0.335
Older sisters	--	--	--	-0.036	-0.116	-0.080
Younger brothers	--	--	--	0.065	0.296**	0.231#
Younger brothers	--	--	--	0.079	0.013	-0.067
Number of children:						
Sons	--	--	--	-0.096	-0.763**	-0.667**
Daughters	--	--	--	0.013	-0.601**	-0.614**
Household relationship						
Spouse of head	-0.065	-0.734**	-0.679**	-0.041	-0.433*	-0.392
Stem kin	-0.284	0.008	0.292	-0.274	0.130	0.403
Spouse of stem kin	0.346	-0.262	-0.608#	0.395	-0.094	-0.488
Non-stem kin	0.488	0.710**	0.222	0.430	0.325	-0.105
Nonkin/servant	-0.358	1.704**	2.062**	-0.566#	0.898**	1.464**
Unknown	-0.919	0.654	1.574	-0.951	0.359	1.310
Current age	-0.046**	0.030**	0.076**	-0.047**	0.087**	0.134**
Current age squared	0.001**	-0.001**	-0.002**	0.010**	-0.002**	-0.003**
Time period						
1760-1799	-0.229*	0.174*	0.402**	-0.226*	0.137#	0.363**
1800-1839	-0.008	-0.205*	-0.196	-0.002	-0.223*	-0.221
1840-1870	0.024	-0.601**	-0.624**	0.024	-0.662**	-0.686**
Village (Shimomoriya=1)	0.062	-0.299*	-0.361**	0.078	-0.280*	-0.357**
Constant	-4.192**	-2.235**	1.957**	-3.960**	-3.015**	0.944*
Person-years at risk	38,897			38,897		
Number of individuals	2,559			2,559		
Log-likelihood	-8718.21			-8552.31		
Wald chi2 (d.f.)	1542.41 (32)			1593.18 (48)		
Probability > chi2	0.0000			0.0000		

Note: Category in parentheses is the reference category.
** Significant at 1 percent. * Significant at 5 percent. # Significant at 10 percent.

Turning to the effects of coresident kin, we can see from Model 1 of Tables 3 and 4 that, for men and women alike, the more coresident kin they have, the less likely they were to leave the village, while the number of coresident kin did not affect the likelihood of death for both sexes. As to why the size of coresident kin significantly reduced the likelihood of leaving the village, we can see from Model 2 of these tables that having sons and daughters greatly reduced the likelihood of out-migration. The more children men and women had, it was more likely for them to stay in the village. Presence of parents or parents-in-law in the household also lowered the probability of leaving the village for both sexes.

Compared to coresident children and parents/parents-in-law, the effects of coresiding siblings are somewhat more limited and less consistent. As shown in Model 2 of Table 3, the number of younger brothers is significantly and negatively associated with the probability of men's leaving the village. This suggests that men who were eldest (or elder) sons were more likely to stay in the village, and that such a tendency became stronger as men had more younger brothers. On the other hand, coresident brothers—either older or younger—strongly increased the likelihood of women's leaving the village (see Model 2 of Table 4). The presence of male siblings propelled women to leave the village probably because, under the predominance of virilocal marriages in the two villages, women whose male sibling was often an heir or the head of household were more likely to marry out of the community (Tsuya and Kurosu 2000b).

Household relationships strongly influenced the likelihood of men's leaving the village. Compared to men who were the heads of household, men who were stem kin (sons and grandsons) of head were more likely to die or to leave the village. Furthermore, the farther away men were from the main (stem) line of the family, the higher was their likelihood of leaving, relative to staying in the village. The probability to leave the village was the lowest among men who were household heads, with stem kin of head being the second lowest, spouses of stem kin (sons-in-law) of head being the third, non-stem kin (nephews and uncles) of head being the fourth, and non-kin or servants being the most likely to leave.[21] Spouse of stem kin (sons-in-law of head) and non-kin/servants were also more likely to leave, relative to dying in the village. Without kinship ties to the head, they appear to have been freer to leave especially when a crunch time came.

Although not as consistent and strong as was the case for men, household relationship also affected women's likelihood of out-migration. Compared to women who were household head, women who were spouse of head were more likely to stay in the village, rather than leaving or dying. Put differently, because women in these villages were likely to assume household headship only when there were no suitable male was available to head the household and also because female-headed households tended to be poor (Tsuya and Kurosu 2004b), female heads were more likely to emigrate or to die,

[21] We do not discuss men who were spouse of head because such men were extremely rare. As shown in Table 2, men spent on average merely 0.6 percent of their years at age 10-74 as spouse of head.

rather than to stay alive in the village, compared to women whose husband was household head. Similar to men, women who were non-kin or servants were also much more likely to leave the village, rather than to stay or die in the village. This again implies that it was easier for women without kinship ties to the head to leave the community, instead of remaining and dying there.

Turning to the relationship between age and demographic responses, both men and women show similar age patterns. As expected, the probability of dying (relative to either staying or leaving) by age is J-shaped, while the age-specific probability of out-migration (relative to staying or dying) is reverse J-shaped.

We can also see some temporal differences in the likelihood of out-migration for both sexes. Compared to the earliest subperiod of 1716-1759, the likelihood of leaving (relative to staying or dying) was significantly higher for women during the subperiod of 1760-1799, whereas the likelihood of out-migration became increasingly lower for both sexes in the 19th century. The increasing probability of female out-migration during 1760-1799 was due primarily to dramatic increases in the probability of absconding at the time of acute and prolonged devastation caused by the Tenmei famine in the 1780s (Tsuya and Kurosu 2000a, 2005). On the other hand, the increasingly lower likelihood of out-migration in the 19th century was due primarily to large decreases in service (*hoko*) migration and also, for women, to decreases in marriage-related out-migration (Tsuya and Kurosu 2006). Service out-migration (and out-migration in general) began to decline precipitously after around 1790 and continued declining until the end of the period under study (Tsuya 2000). This decline in out-migration coincides with the reversal of the domain government's policies from discouraging to encouraging proto-industrial development (Koriyama-shi 1981b, 79-81; Nagata, Kurosu and Hayami 1998). This in turn suggests that local proto-industrialization reduced the likelihood of out-migration by making it increasingly unnecessary for villagers to engage in long-term and long-distance labor contract that kept them away from their home village (Nagata 2001).

Conclusions and Discussion

Our multivariate analysis of the demographic responses of men and women in two northeastern Japanese villages showed that the likelihoods of dying and leaving rose significantly for both sexes during the acute and large-scale economic and environmental upheaval caused by the Tenmei and Tenpo famines. Less severe local economic downturn also affected men, making them more susceptible to die and less likely to leave the village. Net of the two great famines, however, local economic variations did not affect the probabilities of dying and leaving among women.

Comparing the two sexes in their demographic responses to two types of economic stress—the acute and large-scale famines and local economic downturns in the non-famine years—men were, relative to being alive and staying in the village, more likely to suffer death not only in the years of the great famines but also in those of less serious local economic downturns. This suggests that adult and elderly men in the two northeastern Japanese farming villages under study were vulnerable to economic stress regardless of its scale and intensity. Further, men were more likely to leave the village during the two great famines, but much more likely to stay there in the years of less severe local economic hardships. This is due largely to the fact that absconding increased precipitously during the Tenmei and Tenpo famines, while service out-migration decreased significantly at the time of local economic hardships (Tsuya 2000; Tsuya and Kurosu 2005, 2006). Service (*hoko*) being by far the most common reason for male out-migration in the two villages, and the destination of service migration being mostly a locality within the domain (Narimatsu 1985, 103-104), local economic downturn would have hurt the domain or regional labor market, reducing employment opportunities outside the village.

In contrast, women responded to economic stress only when it was really acute and widespread like in the times of the two massive famines. During these famines, they were more likely to die due to the crisis, and also to leave the village primarily because absconding increased especially dramatically (Tsuya and Kurosu 2005, 2006). However, women’s likelihoods of death and out-migration were largely unaffected by less severe local economic downturns. This in turn implies that women tended to be more robust and resilient than men were. Under the predominance of patriarchal family system in northeastern Tokugawa Japan (Aruga 1943; Nakane 1967; Naito 1973; Otake 1982; Takei 1971), the status of women in the two study villages was in general very low, and women did not enjoy as much power within their household as their male counterparts. This relative but nevertheless constant deprivation may in turn have made women much less susceptible to local economic fluctuations.

Household socioeconomic status as measured by landholding also affected the patterns of demographic responses of both sexes. Men in wealthy household were less likely to suffer death and less likely to leave the village, compared to men in poor household. And such a tendency became more salient at the time of the two great famines during the Tenmei and Tenpo periods. As mentioned above, under the predominance of patrilineal and patriarchal stem family system in northeastern Tokugawa Japan, adult men tended to have a greater access to and control over household wealth and resources than their female counterparts (Kodama 1957: 155-160; Tsuya and Choe 1991). The result of our analysis implies that men in wealthy household are likely to have benefitted from resources and wealth generated by the land owned by their household in reducing their health risks.

Men in wealthy household were also more likely to stay in the village primarily because the likelihoods of absconding and engaging in service (*hoko*) outside the village were significantly lower among men living in well-to-do household (Tsuya 2000; Tsuya and Kurosu 2006), compared to men living in poor household. Similar to men, women in wealthy household were also more likely to stay in the village, primarily because women in household with more income and resources were less likely to abscond and also less likely to marry out of the village (Tsuya 2000; Tsuya and Kurosu 2006). We interpret these results to imply that the lack of household resources and wealth often forced men and women in these preindustrial northeastern Japanese villages to abandon their communities in crisis times, and also propelled them to leave for the purposes of employment or marriage.

Our multivariate analyses also revealed that the number of kin household members decreased the likelihood of leaving the village for both men and women. This was due primarily to that a large number of coresident kin often meant the presence of both parents/parents-in-law and a larger number of offspring in household. Having the older and younger generations living with them, both men and women in these preindustrial Japanese communities were clearly more likely to continue to live in their village possibly because their parents and their children would have needed as well as provided care and support. This in turn implies the importance of intergenerational ties in countering health risks and also in binding men and women to their communities.

Household relationships also influenced mortality and emigration, especially those of men. The farther away from the main (stem) line of the family, the more likely men were to leave the village, rather than staying there. Women who were nonkin or servant were also more likely to leave, rather than stay in the village. These results suggest that those with little or no kinship ties did not have a compelling reason or a strong incentive to stay in the village especially in bad times, reaffirming the importance of kinship in the lives of peasant men and women in preindustrial northeastern Japan.

From the perspective of preindustrial rural Japan, this study on two farming villages in the northeastern region offers new insights on the factors and patterns of demographic responses to large-scale famines. The mechanisms through which famines and other economic downturns influenced demographic behaviors of individual men and women in preindustrial agrarian communities are complex, dynamic, and situational. Our study hopefully provides some clues to untangle the complexity. Clearly, more studies are needed to fully account for the nature of the dynamism between economic and environmental stress and demographic outcome in the past.

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Demographic Impacts of Climatic Fluctuations in Northeast China, 1749-1909*

Cameron Campbell and James Lee

Abstract

We examine the demographic impacts of climatic fluctuations in northeast China in the late eighteenth century and the nineteenth century. Specifically, we focus on the consequences of extended periods of unusually cool summers, which in northeast China tended to be associated with poor grain harvests. During the period covered by the northeast Chinese population register data that we analyze, 1749-1909, there are three periods during which there were cool summers of unusual frequency or intensity: 1782-1789, 1813-1815, and 1831-1841. These periods coincided with major disruptions elsewhere in Asia that were climate-related. In Japan, the Tenmei famine took place in 1783-1786, and the Tenpo famine took place in 1833-1838. The Indonesian volcano Tambora erupted in April of 1815, and had adverse effects on climate around the world. We show that the period that coincided with the Tenmei famine in Japan was characterized by a massive mortality crisis, another that took place between 1810 and 1817 was characterized by a substantial reduction in fertility, and another that coincided roughly but not exactly with the Tenpo famine in the 1830s did not exhibit a pronounced mortality or fertility response. Patterns of responses revealed by our disaggregation by gender, age, socioeconomic status and other characteristics are a mixture of the expected and unexpected. Low-status individuals generally fared especially poorly, but there were cases where nominally high-status individuals also fared especially poorly.

Introduction

We examine the demographic impact of climatic fluctuations in northeast China in the late eighteenth century and the nineteenth century. Specifically, we focus on the consequences for mortality and fertility of three prolonged periods of unusually cool summers. During the period covered by the northeast Chinese population register data that we analyze, 1749-1909, there are three periods during which there were cool summers of unusual frequency or intensity: 1782-1789, 1813-1815, and 1831-1841 (Lee and Campbell 1997, 33-34; Wang 1988). At least in the region we study, fragmentary evidence suggests that the period around 1813-1815 was also characterized by heavy rains and flooding. In northeast China, cool summers tended to be associated with poor harvests because of a shortened growing season and the possibility of adverse conditions even during the summer (Feng, Li, and Li 1985). In Liaoning, all three of these periods were characterized by grain price increases of an intensity and duration suggestive of poor harvests (Lee and Campbell 1997, 33-34).

* This research was supported by NICHD 1R01HD045695-A2 (Lee PI), “Demographic Responses to Community and Family Context.”

The aim of this paper is to show that in historical China, the demographic response to major and sustained exogenous shocks was not restricted to increased mortality, but could also include reduced fertility. As discussed below, previous examinations of the role of demographic crises in historical Chinese population dynamics have mostly assumed that dramatic reductions in population size associated with major exogenous shocks such as prolonged wars and repeated poor harvests resulting from climatic shocks were attributable to increases in mortality (Chu and Lee 1994; Ho 1959; Zhang et al. 2006). This assumption has usually been implicit rather than explicit, and reflects the reliance of such studies on changes in population size for evidence of demographic crises. In these and other studies, little consideration has been given to the mechanisms underlying sudden or secular reductions in population size, in particular, the possibility that they were also the result of substantial reductions in fertility and increases in early infant and early child mortality, not solely the result of massive increases in mortality at later ages attributable to starvation or epidemics. We are agnostic as to whether reductions in fertility or increases in infant and early child mortality reflected deliberate behavior on the part of couples, or was the byproduct of other behaviors taken in response to adverse conditions.

To demonstrate that the demographic response to major and sustained exogenous shocks could include reductions in fertility as well as increases in mortality, we examine the mortality and fertility impacts of these three periods of cool summers. We begin with background. We introduce the region in northeast China that we study, focusing on its climate and the three periods of cool summers, and then contextualize this study by clarifying its relationship to previous studies of mortality and fertility fluctuations in Liaoning and their relationship to economic conditions, and previous studies of the influence of climate on demographic outcomes. In the second part of the paper, we introduce the data and methods used in the analysis. Finally, in the third part of the paper, we present results. We review trends and fluctuations in mortality and fertility to show that the first of the three periods of cool summers, 1782-9, was characterized by elevated mortality, and that the second and third periods were characterized by substantially reduced fertility. We then compare patterns of mortality by age and sex for 1780-3, 1783-6, and 1786-9 to identify the specific years in which the mortality response to climatic fluctuation was most severe, and which age and sex groups were most affected. Finally, we present results from discrete-time event-history analysis that differentiate fertility and mortality responses in the three periods by age, sex, and socioeconomic status.

Background

Our data cover a region in Liaoning province in northeast China, in the region sometimes referred to as Manchuria. Liaoning has a temperate, continental monsoon climate. Rain falls primarily in the summer. There is relatively little precipitation during the rest of the year. Winters are cold, with temperatures well below freezing, and the summers are hot. The area of Liaoning covered by our data has a short growing season, with about 180 frost-free days per year. The association of cool summers with poor harvests Liaoning suggested in Feng, Li, and Li (1985) does appear to differ from the association between low winter temperatures and poor harvests typically observed in historical northern Europe (Galloway 1986, 8-9). We speculate that the association between cool summers and poor harvests reflects especially late spring frosts or early autumn frosts that damaged crops, or unusually heavy precipitation, not direct effects of a slightly lower average daily temperature.

Two of the periods of cold summers coincided with major economic and demographic disruptions elsewhere in East Asia that appear to have been climate-related. In Japan, the Tenmei famine took place in 1783-1786, and the Tenpo famine took place in 1833-1838. These were among the most serious famines of the Tokugawa era. In both cases, the effects were most severe in northern Japan. Both famines appear to have been associated with cool weather and excessive rain that led to especially poor rice harvests. Eventually, comparison of results between Liaoning and Japan on mortality and fertility differentials in responses to these events will illuminate how social and family organization mediated their impact on individuals, just as comparisons of patterns of responses to grain price fluctuations have illuminated how households and communities managed milder forms of economic stress (Bengtsson, Campbell, Lee et al. 2004; Tsuya et al. 2010).

The first two periods also coincided with major events much further afield that had powerful effects on climate and by extension demographic behavior and the economy. In 1783, the Laki volcano erupted in Iceland, disrupting weather in the northern hemisphere for several years. England experienced substantially elevated mortality in 1783 and 1784 that has been linked to the Laki eruption (Witham and Oppenheimer 2005). In 1784, the winter in North America was the longest and coldest on record. In Japan, Asama also erupted in 1783, but its effects are likely to have been more local, and less likely to have affected climate in northeast China. In 1815, the Tambora volcano erupted in Indonesia, disrupting weather worldwide (Oppenheimer 2003). For example, in 1816, the northeast United States, maritime Canada, and Europe experienced unusually cold weather, and the year became known as the “Year Without A Summer.” In Europe and North America, crops failed and livestock died, leading to what Post (1977) referred to as “the last great subsistence crisis in the western World.”

This study extends upon earlier examinations of the demographic impact of periods of cold summers in Liaoning that found that the second and third were associated with elevated mortality and/or depressed fertility (Lee and Campbell 1997). This study makes use of a much expanded dataset that covers a much larger swath of the province, representing a much wider variety of ecological and economic contexts. The dataset in the original study only covered a small collection of communities just to the north of what is now Shenyang. The larger dataset in this study increases confidence that observed phenomena are regional, not idiosyncratic local variations peculiar to a small cluster of communities. The dataset used in this study is also large enough to follow Bengtsson, Campbell, Lee et al. (2004) and Tsuya et al. (2010) and differentiate mortality and fertility responses to periods of cold summers by socioeconomic status, household context and other individual characteristics. Finally, the larger dataset allows for a detailed examination of the period 1782-1789. In the earlier study, there was too little data from that period to compare its mortality and fertility patterns to early or later periods.

Previous studies of demographic responses to variations in economic conditions mostly used grain price series as indices of harvests and by extension weather conditions. Early studies examined the influence of grain price variations on crude rates of birth, death, and marriage (Galloway 1988; Wrigley and Schofield 1981). More recent studies examine patterns of variations by age, sex, socioeconomic status and family context in the demographic responses to variations in grain prices (Bengtsson, Campbell, Lee et al. 2004; Campbell and Lee 1996, 2000, 2004; Tsuya et al. 2010). Grain prices reflected local harvests and in these studies were intended as an index of food consumption. Higher prices tended to reflect poorer harvests. Subsistence farmers had less to eat, and families with non-agricultural incomes who bought their food faced higher prices in the market. The implicit assumption in such studies was that the response of demographic rates to changes in grain prices was linear, so that for example, a ten increase in prices had twice the effect of a five increase in prices.

By focusing on the demographic impact of extended periods of extreme weather, this study complements others that examine the impact of price fluctuations. Grain prices may not have been a perfect indicator of harvest outcomes or the weather conditions that helped determine them. In Liaoning and elsewhere, grain prices may also have reflected economic conditions unrelated to local harvests, for example, changes in the supply or demand of grain elsewhere, state intervention in markets, or fiscal phenomena such as inflation or deflation. According to Figure 1, which presents annual sorghum prices in Liaoning, the three periods of cold summers that are the focus of this study were indeed characterized by grain prices increases large enough to be suggestive of extremely poor harvests. However, price increases are also apparent in years that were not identified as period of cold summers, especially later in the nineteenth century. If elevated prices in these other periods reflected factors other than harvest outcomes, periods of cold summers may have been more likely to be periods of hardship than periods of high grain prices.

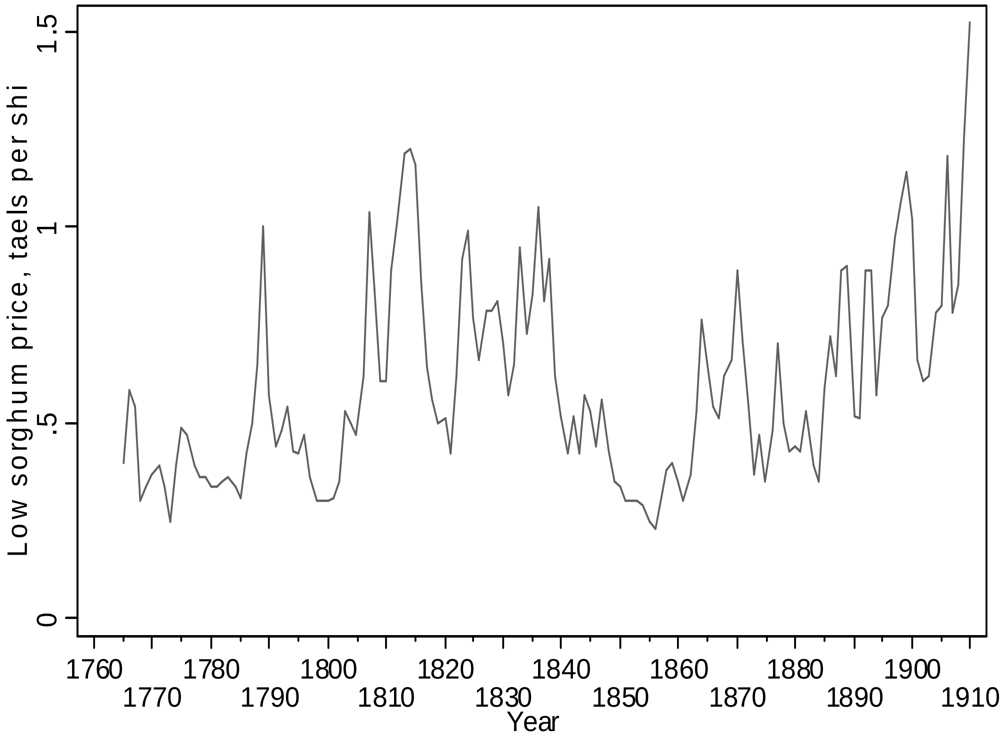


Figure 1. Annual low sorghum prices, Liaoning, 1765-1912.

This study advances upon earlier studies that examine the effects of climate on population because of its focus on the effects of multiple years of bad weather. Previous studies have tended to focus on the very long term or the very short term by looking at relationships over centuries or single years. An early study that directly addressed the role of climate in population dynamics, Galloway (1986), focused on the implications of secular changes in climate for trends in population size. He was interested primarily in the influence of centuries-long periods of warming or cooling on total population size. A similar study focused specifically on China over the last millennium argues that climatic variation was a more important determinant of population trends over the long term than dynastic cycles, Malthusian processes, and other mechanisms (Lee, Fok, and Zhang 2008). Another study, Galloway (1994), applies distributed-lag models time series to demographic rates, temperature, and grain prices in Europe. The focus in that study is whether unusually high or low temperatures in specific seasons are associated with elevated mortality in the same year. It did not allow for the possibility explicitly considered here that while a historical population might have been able to ride out a single bad harvest, a succession of bad harvests might have had catastrophic results.

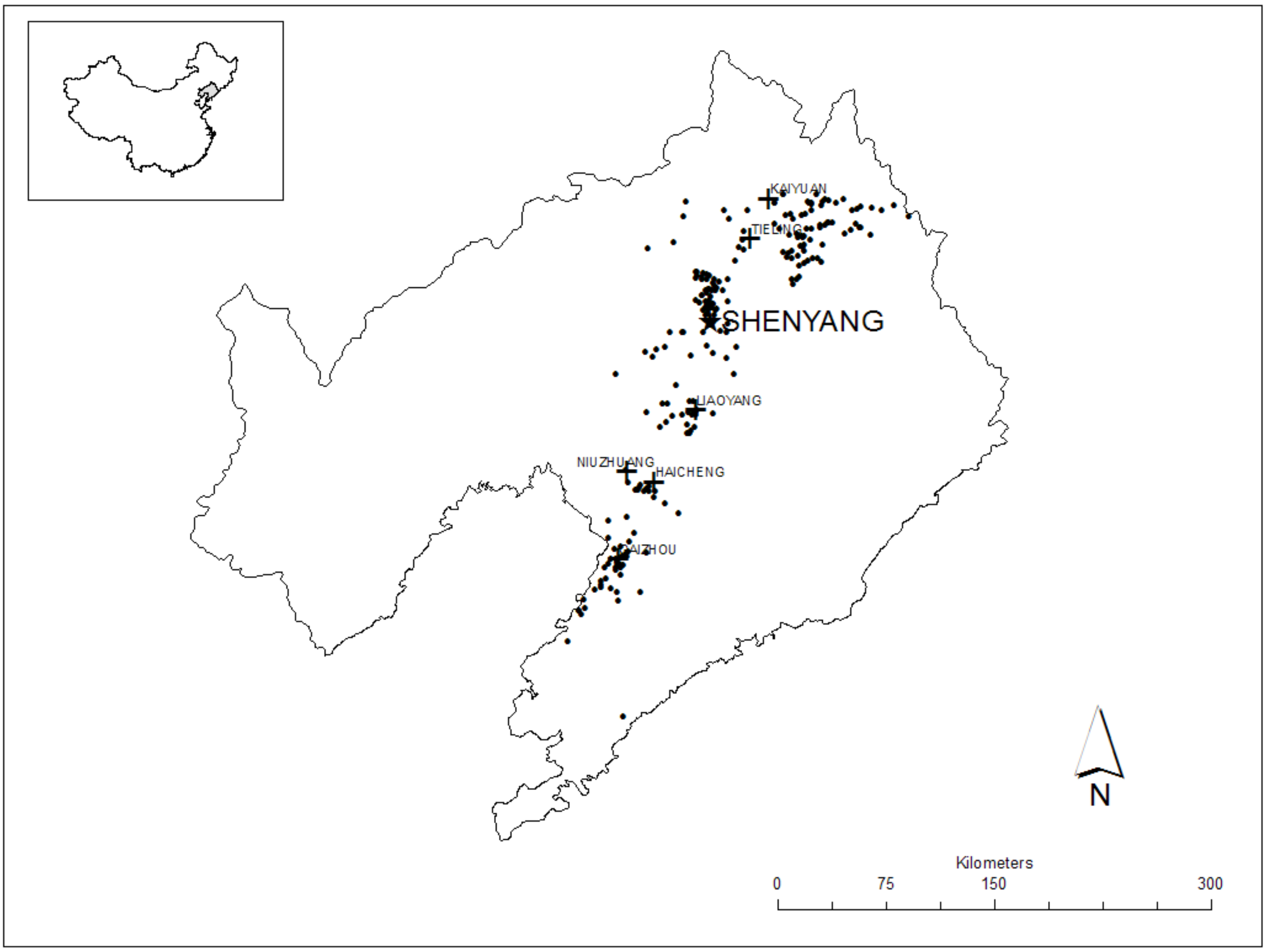
This study contributes to the literature on demographic crises in past times by differentiating fertility and mortality responses to the periods of cold summers by family context and socioeconomic status. The large existing literature on demographic crises before the twentieth century, especially famines and epidemics, relies heavily on aggregated data on total numbers of births and deaths, and on written accounts by contemporaries about harvest failures, famines, and other disasters (Walter, Schofield, and Appleby 1991). Only a few studies of famines, epidemics, and other demographic crises have disaggregated mortality or fertility responses by age or sex (Dyson and Ó Gráda 2002). As a result, most assessments of the long-term consequences of demographic crises before the twentieth century assume patterns of effects by age and sex based on data from famines and other crises in developing countries during the twentieth century (Watkins and Menken 1985; Menken and Campbell 1992).

Data

The data we analyze consists of triennial household register data for 1749 to 1909 for more than 600 villages in Liaoning province in northeast China. The database comprises 1.4 million observations of one-quarter million people who lived in 28 administrative populations between 1749 and 1909. We have been able to produce such historical data because of the internal consistency of the core household register data, their availability through the Genealogical Society of Utah and the Liaoning Provincial Archives, and the sustained efforts of teams of colleagues and data entry personnel in the People's Republic of China. We have already described the origins of the registers as well as our procedures for data entry, cleaning and linkage in Lee and Campbell (1997, 223-237).

The features of the registers relevant for studying demographic and social outcomes have been described in published investigations of mortality differentials (Campbell and Lee 1996, 2000, 2002b, 2004), transmission of household headship (Lee and Campbell 1998), migration (Campbell and Lee 2001), ethnic identity (Campbell, Lee, and Elliott 2002), social mobility (Campbell and Lee 2003b), the influence of secular economic change on demographic behavior (Lee and Campbell 2005), and kinship organization (Campbell and Lee 2002a). The description of the data here is based in large part on the discussions of the data in these publications, Lee and Campbell (1997), and Campbell and Lee (2002a).

The geographic and economic contexts of these populations varied. As Map 1 shows, more than 600 Liaoning villages are arranged in four distinct regions spread over an area of 40,000 square kilometers, larger than the province of Taiwan. These regions include a commercialized coastal area around Gaizhou, a farming region around Haizhou and Liaoyang that we identify as Liaoning South Central, an administrative center on the Liaodong Plain around the city of Shenyang that we refer to as Liaoning Central, and a remote agricultural area in the hills and mountain ranges in the northeast that we refer to as Liaoning Northeast. The institutions, regions and communities covered in the data are diverse enough that even if the population is not representative of China or even Liaoning in a formal statistical sense, results are likely to be relevant for understanding family and social organization in other parts of China.



Map 1. Liaoning communities covered by the household register data, 1749-1909.

The Liaoning household registers provide far more comprehensive and accurate demographic and sociological data than other household registers and lineage genealogies available for China before the twentieth century (Harrell 1987, Jiang 1993, Skinner 1986, Telford 1990). This is because the Northeast, which was the Qing homeland, was under special state jurisdiction, distinct from the provincial administration elsewhere. Regimentation of the population actually began as early as 1625, when the Manchus made Shenyang their capital and incorporated the surrounding communities into the Eight Banners (Ding 1992; Ding et al. 2004; Elliott 2001). By 1752, with the establishment of the General Office of the Three Banner Commandry, the population was also registered in remarkable precision and detail, and migration was strictly controlled, not just between Northeast China and China Proper, but between communities within Northeast China as well. Government control over the population was tighter than in almost any other part of China (Tong and Guan 1994, 1999). Movement within the region was annotated in the registers, and individuals who departed the area without permission were actually identified in the registers as 'escapees' (taoding).

The Qing state implemented a system of internal cross-checks to ensure the consistency and accuracy of the registers. First, they assigned every person in the banner population to a residential household (*linghu*) and registered him or her on a household certificate (*menpai*). Then they organized households into groups (*zu*), and compiled annually updated genealogies (*zupu*). Finally, every three years they compared these genealogies and household certificates with the previous household register to compile a new register. They deleted and added people who had exited or entered in the previous three years and updated the ages, relationships, and official positions of those people who remained as well as any changes in their given names. Each register, in other words, completely superseded its predecessor.

The result was a source that closely resembled a triennial census in terms of format and organization. Entries in each register were grouped first by village, then by household group (*zu*) and then by household. Individuals in a household were listed one to a column in order of their relationship to the head, with his children and grandchildren listed first, followed by siblings and their descendants, and uncles, aunts, and cousins. Wives are always listed immediately after their husbands, unless a widowed mother-in-law supersedes them. For each person in a household, the registers recorded relationship to household head; name(s) and name changes; adult occupation, if any; age; animal birth year; lunar birth month, birth day, and birth hour; marriage, death, or emigration, if any during the intercensal period; physical disabilities, if any and if the person is an adult male; name of their household group head; banner affiliation; and village of residence.

The registers also record official positions held by adult males. We have identified four broad categories of official position: banner, civil service, examination, and honorary. These constituted the local elite. The first three categories were formal governmental offices and included a salary and other perquisites. They predominantly comprise lower-level occupations such as soldier, scribe, or artisan. Positions also included some high administrative offices that entailed not only a salary, but substantial power as well. Positions and titles in the fourth category, honorary, were typically purchased, and indicate substantial personal resources or access to such resources through the family. For the purposes of this analysis, we do not distinguish among the various categories of position. While the positions varied in terms of the incomes they implied, the incomes associated with even the most humble of positions were substantial by the standards of the area.

The registers distinguish disabled adult males, classified as *feiding* or *chenfei*, from other adult males (Lee and Campbell 1997). Campbell and Lee (2003a) assess the quality of the disability data and examine causes and consequences of being recorded as detailed in detail. Classification as disabled could occur for any one of a number of reasons and until 1786, the registers generally specified a specific disease or condition for each disabled male. Reflecting the prevalence of tuberculosis in the eighteenth and nineteenth centuries, respiratory diseases, especially consumption (*laozheng*), were by far the most common, affecting more than 5 percent of adult males and 25 percent of all the disabled. Eye diseases were second most common, affecting more than 3 percent of adult males and 15 percent of the disabled, followed by such neurological disorders as retardation, insanity, dementia, and epilepsy which affected and afflicted 2 percent of adult males and 10 percent of the disabled.

In contrast with most historical censuses, the triennial registers allow for linkage of the records of an individual across time. Households and their members appeared in almost the same order in each register, even if they moved to another village. Linkage from one register to the next is straightforward: as our coders transcribe each new register, for each individual they list the record number of his or her entry in the previous register. Since the coders transcribe each new register by copying over the file for the preceding register and then editing it, this is straightforward. From the linked records for each individual, we reconstruct life histories. By comparing observations for the same individual in successive registers, we can construct outcome measures indicating whether particular events or transitions took place in the time between two successive registers.

These registers have a number of features that distinguish them as a source for historical demography. The population is closed, in the sense that the registers followed families that moved from one village to another within the region. Entries into and exits from the region were rare, and when they did occur, their timing was recorded or can be inferred (Lee and Campbell 1997, 223-237; Lee and Wang 1999, 149-153). In contrast with historical Chinese demographic sources such as genealogies that only record adult males, the Liaoning registers record most boys and some girls from childhood, as well as all women from the time of their marriage. Unlike genealogies, they also provide detail on village and household residence. In contrast with parish registers, an important source for European historical demography, they allow for precise measurement of the population at risk of experiencing most demographic events and social outcomes.

The most serious limitations of the registers relevant to this analysis are the frequent omission of boys who died in infancy or early childhood, and the omission of most daughters. As a result, we cannot reliably estimate infant or early childhood mortality for boys or girls. While we can produce reliable estimates of mortality in later childhood and early adolescence for boys, we cannot do so for girls. Our analysis of fertility, meanwhile, is based on boys who survived long enough to be included in the registers. Apparent fertility differentials may also reflect differentials in infant and child survival. When we produce estimates of the Total Fertility Rate, we first calculate a TFR based on the recorded boys, multiply by 1.5 on the assumption that one-third of boys died without ever being recorded, and then multiply by (100+105)/105 to include an estimate of the number of girls who were born.

Methods

To examine differences in the mortality impact of the periods of cold summers, we estimate discrete-time event-history models. Following the approach in previous studies of mortality with these data, we estimate logistic regressions in which the dependent variable is an indicator of whether an individual died in the next three years or not (Campbell and Lee 1996, 2000, 2002b, 2004, 2009). Models include controls for age and year, in the form of a fourth-order polynomial for age and a third-order polynomial for year. Models also included variables of substantive interest described below, and interactions between these variables and whether the record is for 1783-1786. We focus on the differential mortality impacts of the period 1783-1786 because our descriptive results demonstrate unambiguously that this was a period of extraordinarily high mortality. Differentiating mortality patterns for this period identifies the population subgroups that were most adversely affected by this catastrophe. Descriptive results indicate that mortality effects of the other two periods of cold summers were limited.

The analysis of male mortality used all the observations for which the immediately succeeding register or the one after that was also available. In the situations where the immediately succeeding register was not available but the one that followed was available and the male was recorded there, either as still alive or as having died in the time since the missing register, an observation was created to serve as a filler record to indicate whether the male died in the period between the missing register and the one following. If the male was not present in the later register, they were assumed to have died in the time between the first register and the missing register, and the outcome variable in the first register set accordingly. For female mortality, analysis was based on records of live married and widowed women for whom the immediately succeeding register was available. In cases where an intervening register was missing, it was not possible to create and insert a record because women who disappeared between the first register and the missing register might have remarried and left the household, not died.

For fertility, we estimate a Poisson regression on annualized data in which the outcome is a count of the number of births attributed to a married woman in a year. We focus on the periods 1782-1789, 1810-1817, and 1837-1841. In each of these three cases, we estimate a model that includes controls for age and year, right-hand side variables of substantive interest, and interactions between these variables and an indicator of whether the observation falls into one of these periods. The annualized data for the fertility analysis were created from the original triennial register data by creating additional records in the registers for the years between registers. In these records, women were aged forward, and other information copied forward from their most recent register entry. Through record linkage of children to their parents, counts of the numbers of births attributed to them in each year were constructed. We restrict analysis to the annualized records of women in the years where there was at least one observation of the woman in the original registers 5 to 9 years later, by which time any child they bore would have had a chance to be registered.

In differentiating the demographic impact of climatic fluctuations, we focus on the role of socioeconomic characteristics. Specifically, we measure socioeconomic status with three dichotomous indicator variables: official position, disability, and diminutive name. For adult males, the variables reflect their own status. For women, they reflect husband's status. For boys, the variables reflect father's status. For boys, we also include an indicator of whether or not they were recorded with a diminutive name. Disability status was a measure of socioeconomic status in the sense that in a preindustrial society like the one studied, most of the conditions associated with being listed as disabled implied impaired capacity for contributing agricultural labor to the household. We use diminutive names as an indicator of status because prior exploratory analysis has revealed that boys and adult males recorded with such names appeared to have less favorable socioeconomic outcomes. While diminutive names may not have been as precise a marker for socioeconomic status as official position, many more men were recorded with such names than were listed as having an official position.

For boys, we also examine how the presence or absence of parents conditioned the mortality impact of the cold summers between 1783 and 1786. We include dummies for whether or not their father and mother were alive, along with interactions with the indicator for 1783-1786. Based on previous findings that the absence of a parent, especially a mother, increases child mortality in the short-term and even the long term (Campbell and Lee 2002b, 2009), we expect boys who lost a parent to have suffered disproportionately when times were bad.

For fertility, we also examine how a married woman's childbearing history conditioned the response during the periods of cold summers. Specifically, we contrast the changes in fertility during periods of cold summers according whether women had no registered male births, one, two, or three or more. This comparison will yield insight into whether fertility responses reflected deliberate behavior that was conditioned by the number of boys that had already been born. To the extent that fertility responses to periods of poor weather reflected deliberate postponement of births, we expect a stronger effect for later births than for earlier births, on the assumption that couples without any sons may have been less willing to postpone than couples with sons.

Results

Descriptive

According to Figure 2, period life expectancy at age 1 *sui* ranged between 30 and 40 years in the middle of the eighteenth century, plummeted to around 15 years for males and 20 years for females between 1783 and 1786, then exhibited a slow upward tendency through the nineteenth century into the beginning of the twentieth century. According to Figures 3 through 5, which summarize trends in the probability of surviving from age 1 *sui* to age 15 *sui*, the probability of surviving from age 16 *sui* to 55 *sui*, and life expectancy at age 56 *sui*, mortality rose at all ages in the years between 1783 and 1786. According to Figure 3, only one-quarter of males aged 1 *sui* would survive to age 15 *sui* if they experienced the mortality of the period 1783 to 1786 through childhood and early adolescence. In other time periods, anywhere between two-thirds and four-fifths of men would be expected to survive. According to Figure 4, only about one-tenth of males aged 16 *sui* would survive to age 55 *sui* if they experienced the mortality of the period 1783 to 1786 all the way through adulthood.

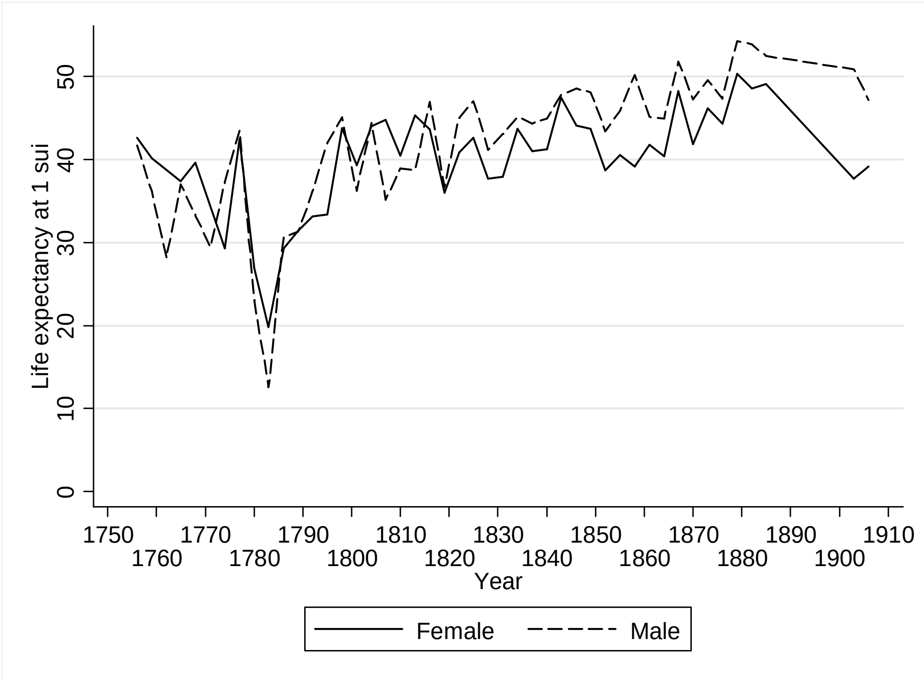


Figure 2. Life expectancy at age 1 *sui* by year, Liaoning, 1749-1909.

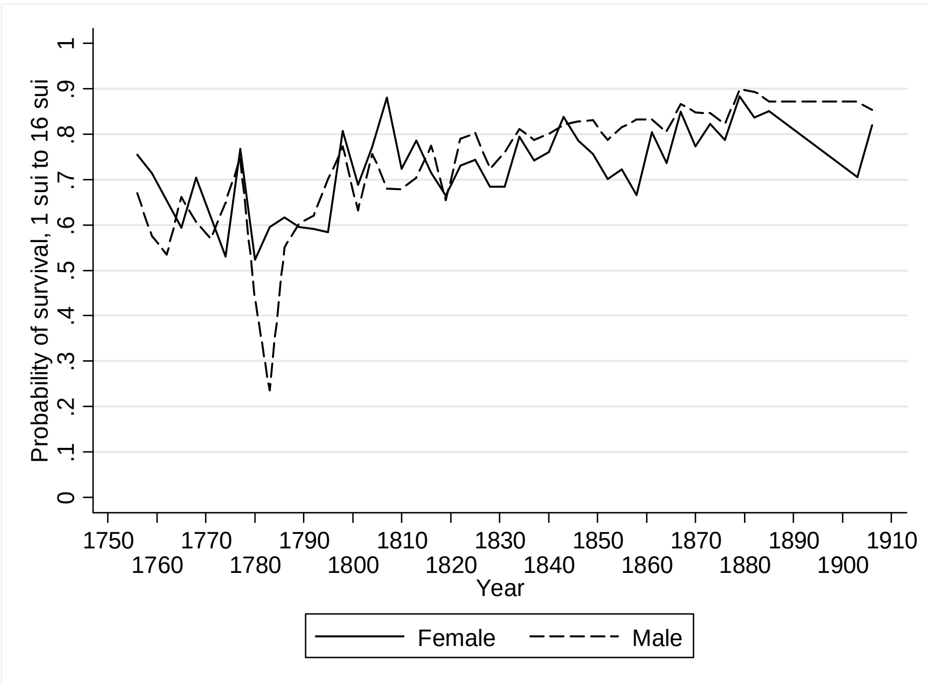


Figure 3. Probability of surviving from age 1 *sui* to age 16 *sui* by year, 1749-1909.

Figure 4. Probability of surviving from age 16 *sui* to 56 *sui* by year, 1749-1909.

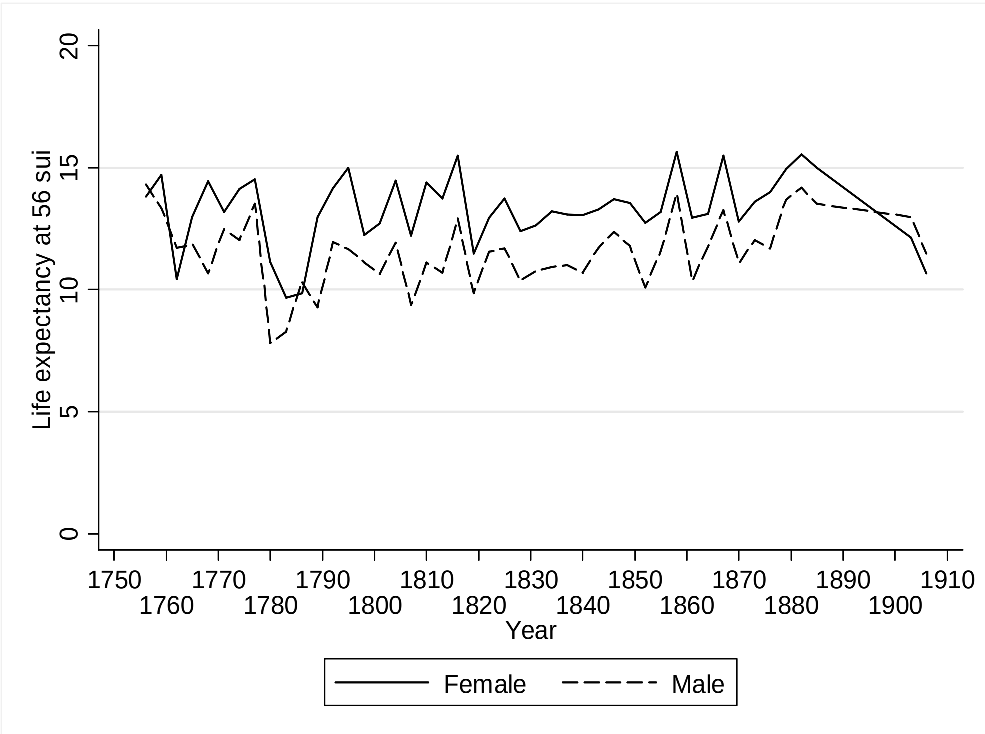


Figure 5. Life expectancy at 56 *sui* by year, 1749-1909.

Mortality crisis is apparent only in the first period of cold summers, 1782 to 1789. Table 1 confirms the impression from the reviews of Figures 2 through 5 that mortality change in the latter two periods was negligible. According to the odds ratios from a logistic regression that included polynomials to control for age and date and indicator variables for periods characterized by cold summers, mortality between 1810 and 1819 was slightly below trend. Mortality between 1837 and 1843 was only slightly above trend. Accordingly, subsequent examination of differentials in the mortality response to cold summers is focuses on the period from 1780 to 1789, especially between 1783 and 1786.

Table 1. Mortality variation in three periods of cold summers, Liaoning, 1749-1909.

Variable	Odds Ratio	p-value
Time Period (Ref: Remaining years 1749-1909)		
1783-1786	2.87	0.00
1810-1819	0.83	0.00
1837-1843	1.07	0.00
N	1162706	

Notes: Models also included a fourth-order polynomial to control for age and a third-order polynomial to control for year. Observations included males age 1-75 *sui* and ever-married females aged 16-75 *sui*.

Male child and early adolescent mortality and adult female mortality increased most dramatically in the period between 1783 and 1786. Figures 6 and 7 present the ratios of age-specific mortality rates for 1780 to 1783, 1783 to 1786, and 1786 to 1789 to rates in the baseline years 1749 to 1780 and 1789 to 1804. Table 2 details the age and sex pattern of mortality increase between 1783 and 1786 by presenting age- and sex-specific odds ratios for mortality in that period, relative to time trend as represented in a polynomial. According to these figures, male mortality in childhood and adolescence, and female mortality in early adulthood, increased fivefold or sixfold in 1783 to 1786 compared to the years earlier and later. Increases at other ages were substantial as well. Above age 55, mortality increases were limited, in keeping with the results on life expectancy at age 56 *sui* in Figure 5.

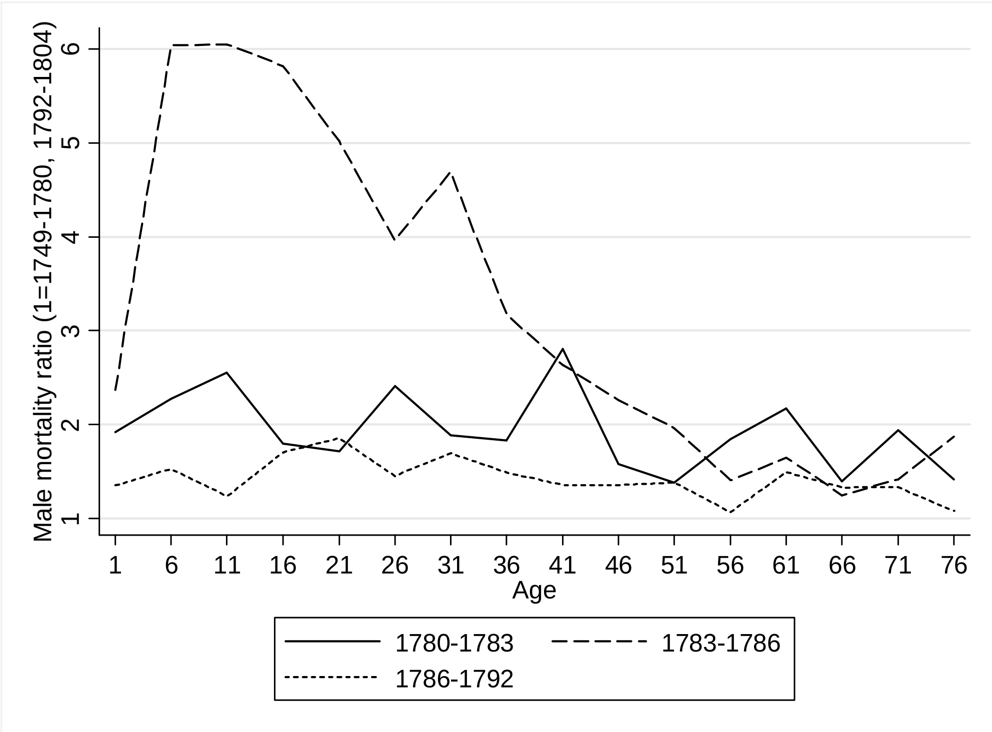


Figure 6. Male age-specific patterns of mortality increase, 1780-1792 compared to 1749-1780, 1792-1804.

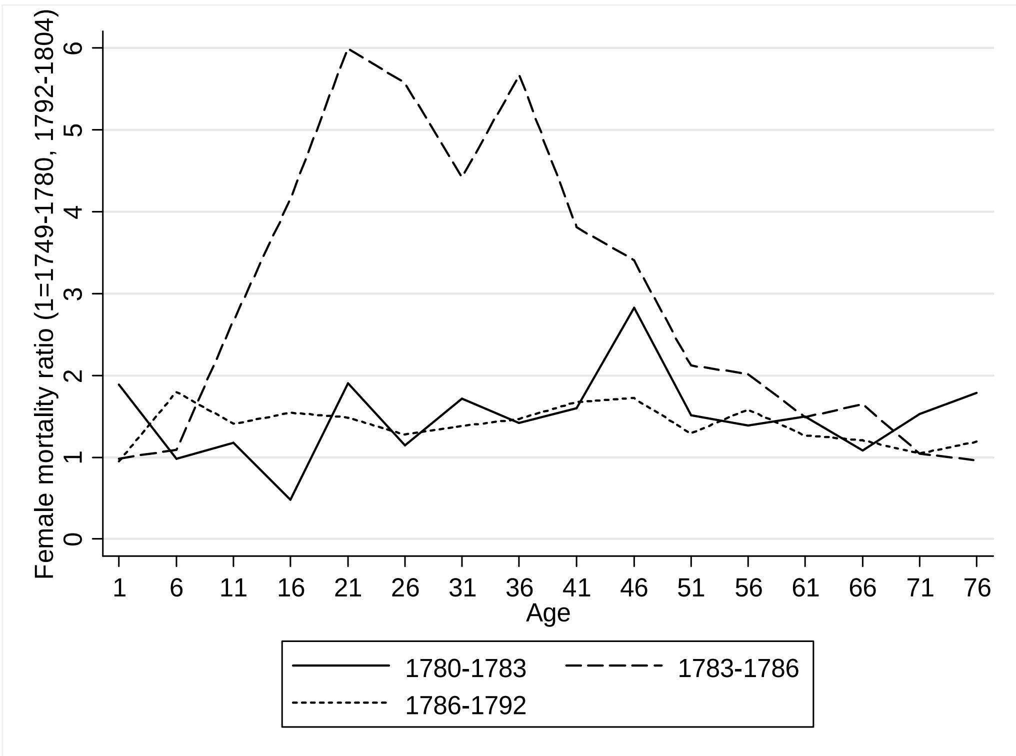


Figure 7. Female age-specific patterns of mortality increase, 1780-1792 compared to 1749-1780, 1792-1804.

Table 2. Age- and sex- specific mortality increases in the odds of dying, Liaoning, 1783-1786.

	Odds Ratio (Relative to same age/sex combination, 1749-1909)
Males	
1-5 *sui*	3.59
6-15 *sui*	8.78
16-35 *sui*	4.38
36-55 *sui*	2.00
56-75 *sui*	1.31
Married and Widowed Females	
16-35 *sui*	4.65
36-55 *sui*	2.78
56-75 *sui*	1.28
N	792460

Notes: Based on results from a logistic regression of the chances of dying for men ages 1-75 *sui* and married and widowed women ages 16-75 *sui* in north and central Liaoning, 1749-1909. Odds ratios presented in table were computed by multiplying the odds ratio for the specified age/sex group by the main effect of 1783-1786, which referred to males age 56-75 *sui*. Controls included a fourth-order polynomial for age and a third-order polynomial for year.

Fertility reductions were apparent around the time of the periods of cold summers, but they did not line up precisely. Figure 8 presents annual estimates of the Total Marital Fertility Rate, the number of births a women would have if she married at age 16 *sui* and remained married until she was age 50. Fertility was mildly depressed from 1786 to 1790, severely depressed for the seven years from 1810 to 1817, and mildly depressed again from 1837 to 1841. The tendency for fertility to be depressed around the time of recorded cold summers, but not exactly in those years, raise the possibility that cold summers were just one feature of the poor weather that affected demographic behavior, and that neighboring years in which the summers were not cold were nevertheless adverse for other reasons, and that in some years of cold summers were counterbalanced by other, more favorable features of the weather. On the assumption that the specific years of low fertility were the ones in which conditions for childbearing were most adverse, we focus on differential fertility changes in those years, even if they do not line up precisely with the years of cold summers.

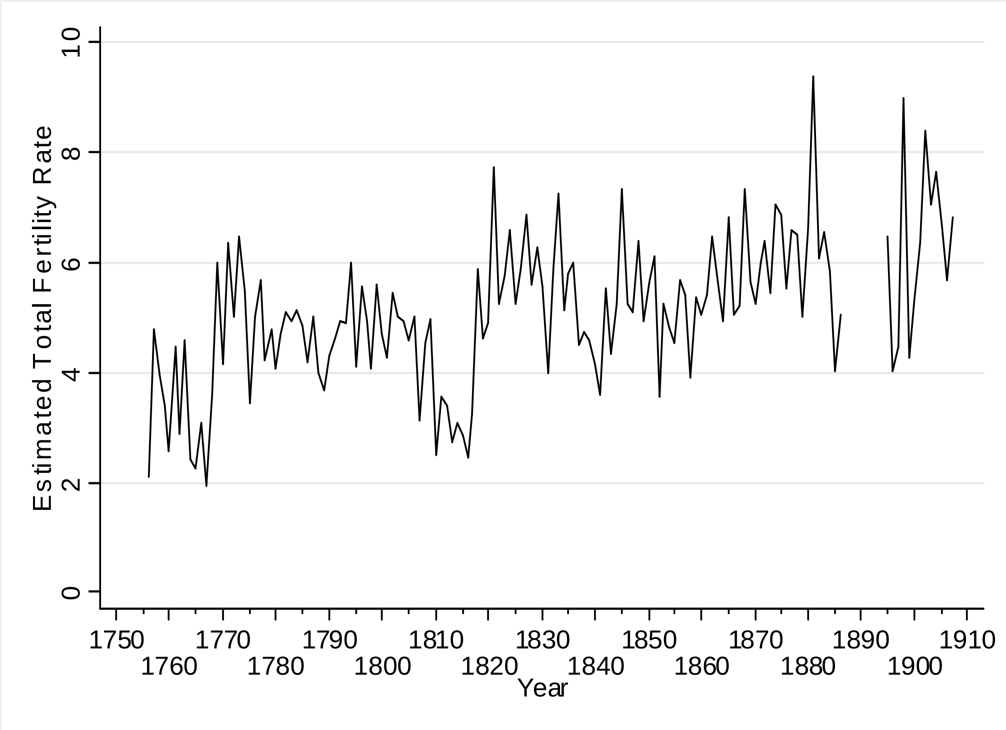


Figure 8. Estimated Total Marital Fertility Rate by year, 1749-1909.

Differential Responses

Patterns of change in child mortality in the period between 1783 and 1786 are mostly as would be expected if the mortality increases were most pronounced among the least advantaged, with the prominent exception of the mortality response of the sons of officials. Table 3 presents results from an analysis of child mortality in which an indicator for period 1783 to 1786 is interacted with indicators of social and family circumstances. Boys who had lost their mothers appear to have been especially vulnerable between 1783 and 1786, but the effect is not statistically significant. Child mortality rose much more in northern Liaoning, a hilly, forested and remote area, than in central Liaoning, the agricultural area around what is now Shenyang. Boys who had a diminutive name were affected much more than boys who did not have one. Unexpectedly, however, boys who were the sons of men who held official position experienced greater mortality increases during this period than boys whose fathers did not hold position.

Table 3. Differential mortality change in 1783-1786, children 1-15 *sui*, Liaoning 1749-1909.

	Odds Ratio	p-value
1783-1786	1.49	0.06
Age 1-5 *sui* (Ref: 6-15 *sui*)	1.02	0.75
Northern Liaoning (Ref: Central)	0.95	0.10
Father Alive	1.02	0.71
Mother Alive	0.91	0.05
Father Disabled	1.00	0.95
Father has Official Position	1.21	0.00
Father has Diminutive Name	1.01	0.91
Diminutive Name	0.96	0.18
1783-1786*		
Age 1-5 *sui* (Ref: 6-15 *sui*)	0.31	0.00
Northern Liaoning (Ref: Central)	1.88	0.00
Father Alive	1.20	0.47
Mother Alive	1.50	0.12
Father Disabled	12.54	0.00
Father has Official Position	2.23	0.02
Father has Diminutive Name	1.35	0.18
Diminutive Name	1.67	0.00
N	129456	

Notes: Based on data for north and central Liaoning. Controls included a fourth-order polynomial for age and a third-order polynomial for year. To save space, the results for these controls are not included here.

Among adults, the pattern is similar. Once again, increases in mortality are most pronounced for groups that would be expected to be the least advantaged, except that men who were officials experienced a more substantial increase than other men. Table 4 presents the results from logistic regressions of adult male and female mortality. Northern Liaoning, which because of its hilliness and relative inaccessibility is even now is the least well-off of the regions of Liaoning covered by the data, experienced the most substantial increase in mortality. Men who were disabled, and the women who were married to them, experienced a larger mortality increase than other men and women. Men and women who were childless experienced a much larger mortality increase than other men and women. However, once again, official position has an unexpected effect: men who held official position experienced a more substantial mortality increase than other men. Their wives, however, did not experience a disadvantage.

Table 4. Differential mortality change in 1783-1786, adults 16-55 *sui*, Liaoning 1749-1909.

	Males		Females	
	Odds Ratio	p-value	Odds Ratio	p-value
1783-1786	0.96	0.81	1.18	0.34
Age 36-55 (Ref: 16-35 *sui*)	1.06	0.30	1.10	0.06
Northern Liaoning (Ref: Central)	0.95	0.01	1.07	0.00
Disabled	1.07	0.02	1.01	0.75
Official Position	1.16	0.00	0.94	0.19
Diminutive Name	1.10	0.00	1.05	0.22
Widowed	1.23	0.00	1.34	0.00
Never-Married	1.18	0.00		
Childless	1.02	0.39	1.44	0.00
1783-1786*				
Age 36-55 (Ref: 16-35 *sui*)	0.48	0.00	0.78	0.05
Northern Liaoning (Ref: Central)	4.17	0.00	2.81	0.00
Disabled	2.56	0.00	5.57	0.00
Official Position	2.16	0.01	1.31	0.42
Diminutive Name	0.90	0.41	1.12	0.43
Widowed	1.00	0.99	0.30	0.05
Never-Married	0.94	0.68		
Childless	1.81	0.00	2.53	0.00
N	308028		227955	

Notes: Based on data for north and central Liaoning. Controls included a fourth-order polynomial for age and a third-order polynomial for year. For females, variables for disabled, position, etc. refer to husband's status. To save space, the results for these controls are not included here.

In old age, the same pattern was apparent. Table 5 presents results from logistic regressions of male and female mortality in old age. Interactions with the indicator for years between 1783 and 1786 reveal that childless men and women experienced much larger increases in mortality than other men and women. Results for adults and the elderly on the effects of the presence of children are consistent with previous findings that adults, especially women, had lower mortality overall if they had surviving children (Campbell and Lee 1996, 2002b, 2004.) The results here suggest that during an extraordinary crisis, adults with children were also better insulated than those without. The insulating effect of the presence of children is much clearer here than in the study of differences in mortality responses to grain prices in Campbell and Lee (2004). Women married to men who in old age still retained a diminutive name also experienced larger mortality increases than other women. Men who retained an undignified diminutive name in old age are likely to have been unusual, almost certainly of low socioeconomic status, thus this result is not unexpected. However, privilege in the form of an official position once again had an adverse effect: women married to officials experienced larger mortality increases than other women.

Table 5. Differential mortality change in 1783-1786, adults 56-75 *sui*, Liaoning 1749-1909.

	Males		Females	
Variable	Odds Ratio	p-value	Odds Ratio	p-value
1783-1786	0.89	0.56	0.98	0.95
Northern Liaoning (Ref: Central)	1.06	0.02	1.03	0.26
Disabled	0.98	0.34	1.04	0.17
Official Position	1.21	0.00	0.89	0.02
Diminutive Name	0.98	0.60	0.91	0.19
Widowed	1.19	0.00	1.18	0.00
Never-Married	0.92	0.08		
Childless	1.00	0.88	1.03	0.42
1783-1786*				
Northern Liaoning (Ref: Central)	0.86	0.61	0.91	0.82
Disabled	1.39	0.10	1.29	0.30
Official Position	1.26	0.56	3.14	0.01
Diminutive Name	1.03	0.91	1.86	0.08
Widowed	0.82	0.31	0.85	0.54
Never-Married	1.48	0.21		
Childless	1.74	0.01	3.02	0.00
N	61744		56304	

Notes: Based on data for north and central Liaoning. Controls included a fourth-order polynomial for age and a third-order polynomial for year. For females, variables for disabled, position, etc. refer to husband's status. To save space, the results for these controls are not included here.

Reductions in fertility were most pronounced in the second of the three periods, and differentials in response most apparent for that period as well. According to Table 6, which measures fertility reductions in the three periods in a model that includes polynomials to control for age and year as well as other control variables, fertility was only about 10 to 12 percent below trend in 1786 to 1790 and 1837 to 1841, but more than 40 percent below trend between 1810 and 1817. According to the logistic regression results in Table 7, reductions between 1810 and 1817 were most pronounced in north Liaoning and south Liaoning, and less pronounced in central and south central Liaoning. They were most pronounced for women married to men who held diminutive names, and least pronounced for women married to men who held official position. Intriguingly, reductions were most apparent among women who had not yet recorded a male birth, and less pronounced among women who already had sons.

Table 6. Fertility in Liaoning, based on boys born to married women ages 16-50 *sui*, Liaoning, 1749-1909.

	Incidence Rate Ratio	p-value
Period (Ref: 1749-1909)		
1786-1790	0.89	0.05
1810-1817	0.57	0.00
1837-1841	0.80	0.00
Location (Reference: North Liaoning)		
Central	1.06	0.00
South Central	1.04	0.00
South Central	1.02	0.29
Husband's Characteristics		
Official Position	1.22	0.00
Disabled	0.91	0.00
Diminutive Name	0.90	0.00
Number of Boys Already Born (Ref: 0)		
1	0.80	0.00
2	0.91	0.00
3+	1.04	0.17
N (person-years)	1011981	

Notes: Controls included fourth-order polynomials for age and year. To save space, the results for these controls are not included here.

Table 7. Differential fertility change during extended periods of cold summers, Liaoning, 1749-1909.

Variable	1786-1790 Incidence Rate Ratio	1786-1790 p-value	1810-1817 Incidence Rate Ratio	1810-1817 p-value	1837-1841 Incidence Rate Ratio	1837-1841 p-value
Period	1.00	0.98	0.49	0.00	0.78	0.00
Location *(Reference: North Liaoning)*						
Central	1.06	0.00	1.05	0.00	1.05	0.00
South Central	1.04	0.00	1.04	0.00	1.04	0.00
South	1.02	0.28	1.02	0.29	1.00	0.96
Husband's Characteristics						
Official Position	1.21	0.00	1.20	0.00	1.21	0.00
Disabled	0.91	0.00	0.92	0.00	0.90	0.00
Diminutive Name	0.90	0.00	0.90	0.00	0.90	0.00
Boys Already Born (*Reference: 0*)						
1	0.80	0.00	0.79	0.00	0.80	0.00
2	0.91	0.00	0.90	0.00	0.91	0.00
3+	1.04	0.14	1.02	0.37	1.04	0.12
Period *						
Location (*Reference: North Liaoning*)						
Central	0.95	0.51	1.43	0.00	1.07	0.26
South Central	0.85	0.15	1.21	0.00	1.11	0.10
South	0.90	0.41	0.90	0.31	1.45	0.00
Husband's Characteristics						
Official Position	1.22	0.05	1.28	0.04	1.11	0.39
Disabled	0.92	0.61	0.97	0.60	1.02	0.78
Diminutive Name	0.96	0.67	0.82	0.02	0.85	0.06
Boys Already Born (*Reference: 0*)						
1	0.97	0.72	1.07	0.24	0.95	0.34
2	0.55	0.01	1.35	0.00	0.99	0.88
3+	0.91	0.77	1.32	0.05	0.97	0.82

Notes: Controls included fourth-order polynomials for age and year.

Conclusion

The results here demonstrate that extended periods of adverse weather were associated with dramatic fluctuations not just mortality, but fertility. The nature of demographic responses appears to have varied. We examined changes in demographic behavior in three different periods characterized by cold summers, indicative of conditions associated with poor harvests, and found that one that coincided with the Tenmei famine in Japan was characterized by a mortality crisis, another that took place between 1810 and 1817 was characterized by a massive reduction in fertility, and another that coincided roughly but not exactly with the Tenpo famine in the 1830s did not exhibit a pronounced mortality or fertility response.

Patterns of responses revealed by our disaggregation by gender, age, socioeconomic status and other characteristics were a mixture of the expected and unexpected. For the mortality crisis between 1783 and 1786, lower-status individuals such as the childless generally fared worse. However, individuals related to men who held official position, including their sons and their wives, and in adulthood, the officials themselves, also fared worse. At present we cannot explain this apparent disadvantage except to note that it appears to be another example of the relative complexity of the relationships between socioeconomic status and mortality in historical China. Whereas in almost all contemporary societies, socioeconomic status and mortality are inversely associated, previous studies of mortality in Liaoning, including Campbell and Lee (1996; 2006) and Lee and Campbell (1997) all reported that high-status males, including household heads, eldest sons, and men with position, experienced elevated mortality.

For the fertility trough between 1810 and 1817, patterns of differential responses were largely as expected, except that couples with more children appear to have changed their reproduction less than children with fewer children. This may reflect selectivity in the sense that couples with more children may have been better off, and thus more resistant to the adverse conditions that affected others. Again, in light of the magnitude of the climate shocks that triggered these fertility responses, we remain agnostic as to whether the responses reflected deliberate behavior, or were involuntary. While a role for deliberate limitation of fertility in historical Chinese population dynamics has been suggested (Lee and Wang 1999; Wang, Campbell, and Lee 2010), the magnitude of the shocks considered here were large enough to allow for involuntary responses, including reduced fecundity induced by malnutrition, spousal separation associated with short-term migration, and other mechanisms. Moreover, given the under-registration of deaths in infancy and early childhood, what we refer to as fertility reductions in this study may also have reflected increases in infant and early childhood mortality that reduced the numbers of children surviving long to be registered. Such mortality increases would need to have been truly massive to account for the extraordinary reduction in fertility apparent in the data between 1810 and 1817.

To our knowledge, this is the first study of a demographic disruption in China before the twentieth century to distinguish between mortality and fertility responses. Prior discussions of the role demographic crises in Chinese population dynamics before the twentieth century examine relationships of total population size to the frequency of famines, epidemics, and wars recorded in historical sources (Chu and Lee 1994; Ho 1959; Zhang et al. 2006; Zhao and Xie 1988). In our view, the longstanding reliance on changes in population size to infer demographic impacts of climatic and other disruption has been accompanied by an unspoken and largely untested assumption that reductions in population size were mostly due to increases in mortality, not reductions in fertility. The results here show that reductions in fertility, or increases in infant and child mortality indistinguishable in the data from reductions in fertility, may have been an important part of the demographic response to large exogenous shocks in historical China. Additional historical climate time series have recently become available, including estimates specifically for north China and possibly northeast China and Korea, and we look forward to replicating this analysis with these newly available time series.

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Reproductive Consequences of China's Great Leap Forward Famine

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Abstract

The Great Leap Forward Famine of China is the costliest famine ever in human history in terms of human lives lost. In this paper, we reexamine the demographic consequences of the Great Leap Forward Famine, focusing on the mechanisms of reproductive (fertility) loss, namely the *sequencing*, *responses,* and *social differentiation*. Our analysis reveals that, contrary to the popular periodization that the famine was a three-year ordeal, between 1959 and 1961, all demographic evidence reported in this paper point to 1959 as the single year that made the most difference. The Chinese population responded to this enormous famine following stages and employing multiple means; and even under a socialist system at the time of the famine, the famine affected population of different social status clearly differently, highlighting the importance of social entitlement, which was only magnified during the time of economic and social calamity. Our work, while offering a number of new facts and new conclusions, is a beginning of more in-depth analysis and understanding of the Great Leap Forward Famine.

Introduction

The Great Leap Forward Famine of China is the costliest famine ever in human history in terms of human lives lost. Political blunders during the Great Leap Forward movement that collectivized hundreds of millions of Chinese farmers resulted in commonly cited 30 million premature deaths and another 30 million lost or postponed births between 1959 and 1961 (Ashton et al. 1984; Coale 1984; Kane 1988; Peng 1987; Yang 1996). According to official statistics, crude death rate more than doubling from 10.8 per thousand in 1957 to 25.3 per thousand in 1960, and birth rate plummeted from the high of 34 per thousand in pre-famine 1957 to 18 per thousand in 1961, nearly halved, before rebounding to 43.4 in post-famine 1963. The average number of birth per woman, measured by the total fertility rate (TFR), dropped from 6.41 in 1957 to 3.29 in 1961, before rebounding to 7.5 in 1964 (Coale and Chen 1987). Together, China experienced its first net population decline in decades, with a natural growth rate of -4.57 per thousand recorded for 1960. Such huge demographic losses and swings not only wrought havoc and generated profound reverberations for the Chinese people and society, felt up to this date, they also provide a rare opportunity to understand how human populations react and adapt to such calamities, and how social organizations helped to protect some while punishing others.

Nearly half century after the famine and numerous studies of its impact on people's lives, many questions remain. Whereas the magnitude of both mortality and fertility impacts of the famine have been examined and documented, there is still a wide disagreement about the demographic impact of the famine. For instance, the estimate of premature deaths ranges from as low as 10-20 million to as high as 40-50 million. Moreover, it is not clear in what sequence the famine affected people's lives, and how people responded to the famine. For instance, while the famine is generally regarded as lasted between 1959 and 1961 as the drastic fertility reduction has been widely noticed in these 3 years, we know little about the kinds of reproductive responses or mechanisms through which fertility reduction took place. Last but certainly not the least, there has been little research on the kinds of social entitlements by populations of different social status and economic resources as shown in the differential impacts of the famine.

In this paper, we reexamine the demographic consequences of the Great Leap Forward Famine, focusing on the mechanisms of reproductive (fertility) loss. We have two broad questions in mind: through what mechanisms did reproductive loss occur or how did the population cope, and how were population of different social strata affected differently by the famine? Answering the first question allows us to better understand how human populations react to famines by resorting to different mechanisms at their disposal, while answering the second helps us to gain an appreciation of the sociological underpinnings of human societies in times of serious crises, namely how power and status in a society affected the chances of reproduction of population occupying different positions. In the following, we will first provide some general background of the famine, followed by three sections that examine the reproductive responses to the famine, which we call *sequencing*, *responses*, and *social differentiation*.

To detect the various forms of reproductive responses to the Great Leap Forward Famine, we use data from two sources. The first are the recent Chinese censuses. Based on population age structure data we are able to discern both the magnitude and the timing of population loss, due to both elevated mortality and reduced fertility. The second data source is China's National Survey of Fertility and Contraception, known as the Two-Per-Thousand Survey, conducted in 1988. The largest fertility survey ever for any population, this survey employed a stratified, systematic, clustered, non-proportional probability sampling design, with an aim to ensure representativeness at the national as well as the Chinese provincial level. The primary respondents were ever-married women between ages 15 and 57 in 1988. The sample contains nearly half million of ever-married women with 1.5 million pregnancies. The centerpiece of the survey is the reproductive history of each woman interviewed. The pregnancy history is integrated with contraceptive and birth histories. Such a survey design, with redundant questions in different sections and successive questions of pregnancy, birth and contraceptive use, help to reduce problems caused by fading memory or recall bias, which represents the most common and serious problem in using retrospective surveys to study reproductive loss. The survey also collected information on each household member's socioeconomic characteristics (e.g. education, occupation, and household registration status), which enable us to study social risk factors of reproductive loss, be it postponement of marriage, birth, or increased intrauterine mortality. Information on reproductive history includes age at menarche and menopause, age at first marriage, and history of pregnancy and contraceptive use. For each pregnancy, order, time when pregnancy ended, and pregnancy outcome were recorded. The outcome of each pregnancy is coded into one of five mutually exclusive categories: live birth (male or female), miscarriage (before the seventh month), stillbirth, induced abortion, and currently pregnant.

We need to note at the outset two data limitations with the 1988 survey for the purpose of our study. First, as the survey was carried out in 1988 and the oldest women for whom pregnancy history was collected were 57 years old at the time of the survey. At the start of the famine, 1958, they were only 27 years old. What this means is that our data do not include women who were older than 27 at the start of the famine, and therefore miss a large portion of women of reproductive age. Given that marriage took place early and childbearing also started relatively early at that time, however, we are still able to examine reproductive impact of the famine for women during the beginning as well as the peak years of reproduction. What we miss is the impact of the famine on women's reproduction in relative advanced ages (30 and above), especially if famine also terminated their reproduction prematurely. For this reason, we focus in this study mostly on the onset of reproduction. The second data limitation that has implication for our study is that the data only included survivors of the famine. This limitation could be consequential for our study, if those who died as a result of the famine had a reproductive profile significantly different from those who survived. Such a scenario is possible, given that those who were affected the most by mortality were also affected most severely in reproduction. Our results in other words may be an understatement of the famine impact on reproduction. Given we know famine mortality concentrated mostly on children and elderly, and given most of our work below focuses on the pattern not the magnitude of famine impact, however, we believe that the biases resulted from this source of data limitation not to be serious.

Background: The Great Leap Forward

The Great Leap Forward Famine, as suggested by its name, traces its roots clearly to the enormous human blunders associated with the Great Leap Forward movement in China's socialist history, under a highly centralized and non-democratic political system. Though commonly regarded as a famine that lasted between 1959 and 1961 (e.g. Kane 1988), the Great Leap Forward, which led to the subsequent famine, began as early as the fall of 1957, at the Third Plenum of the Eighth Central Committee of the Chinese Communist Party. Emboldened by the success of economic recovery in the early years of the People's Republic and the implementation of the First Five-Year Plan (1953-1957) that formalized China's planned economic system, Mao and some of his communist colleagues felt China was ready for an accelerated growth and further consolidation of political power. Shortly after the meeting, China's supreme leader Mao Zedong announced in Moscow, during his first and the only visit abroad, that China would overtake the Great Britain in steelmaking in 15 years, a goal to demonstrate the superiority of the Chinese socialist system. Within a short time period, Chinese peasants were organized into the People's Communes. By the end of 1957, 93.7% of all peasant households had been organized into full collectivized agricultural producer's cooperatives, with an average size of 157 households, by November 1, 1958, 99.1% of peasant households had been "built" into 26,500 People's Communes, with the average size of over 5,000 households (Yang 1996, 23, 36). In the winter of 1957-58, more than 100 million peasants were mobilized to build large-scale water conservation projects. Only a year after his ambitious announcement in Moscow, Mao advanced the timetable for China to catch up with the Great Britain in steel output from 15 years to only one year, and entertained the idea of catching up with the United States in only 20 to 30 years.

Agricultural collectivization and forced industrialization especially steelmaking in 1958 resulted in enormous interruptions in the economy and in peoples' lives, and laid the foundation for the further and worse crisis. Steelmaking took farmers from the countryside to the cities, and from the field to their backyards. Forced industrialization resulted in a short urbanization boom, with urban population increasing by 30 percent in only three years, from 99.49 million in 1957 to 130.73 million in 1960 (Peng 1987, 655). Blind pursuit of output goals led to fake statistics and wasted labor and resources. Of the steel produced in 1958, it was later realized over 30 percent was simply useless. Reported grain output shot up meteorically following the wishes of the planners, by as much as over 100 percent in one year, from 185 million metric tons in 1957, to as high as 500 million tons, before settling down to 375 million tons. It was not until after 1980, following Mao's death and the repudiation of the Great Leap Forward movement, that the official number for grain output in 1958 was adjusted downwards to 200 million tons (Ashton et al. 1984, 626).

Such false output statistics not only fueled enthusiasm for even more unrealistic goals, but also made the Chinese population ill prepared for a crisis that was soon to worsen. Collectivization and over-reporting of production quotas led to two developments in rural China: over-procurement in 1958 and 1959 that squeezed whatever grain left in the local (households and villages) hands (Bernstein 1984; Zhou 2003) and made farmers more vulnerable in the subsequent year, and eating in commune mess halls that led to great waste in food consumption. The share of grain output that went to state procurement rose from 24.6 percent in 1957 to 29.4 percent in 1958, 39.7 percent in 1959, and 35.6 percent in 1960, before dropping to 27.4 percent in 1961 (Riskin 1987, 137). Share of the rural population eating in commune mess hall reached 72.6 percent by the end of 1959 (Yang 1996, 56), and the share was as high as over 90 percent in several provinces that later experienced the worst demographic consequences (Kung and Lin 2003). In eight provinces, the share went up further between December 1959 and February 1960 (Yang 1996, 72). By mid 1960, 99 percent of peasants in Henan and 94 percent in Guizhou, two of the hardest hit provinces, were still eating in communal mess halls (Peng 1987, 664). One estimate put the waste due to collective consumption at up to 8.75 percent of annual grain output in 1958 (cited in Peng 1987, 664).

In part attributing to the poor weather conditions but in no doubt also due to the massive rural reorganization in 1958, poor harvest was reported for spring 1959, then for the whole year and two subsequent years. Grain output in 1959, according to official Chinese statistics later released, dropped from 200 million tons in 1958 to 170 million in 1959, further to 144 million in 1960 and 148 million tons in 1961, before rising to 160 million tons in 1962 (cited in Ashton et al. 1984, 626). Per capita daily food energy intake dropped from the pre-famine 1957 level of 2,167 Kcal to the low of 1,534.8 in 1960, 1650.5 in 1961, a level below famine laden countries such as Chad, Ethiopia, Uganda, and Afghanistan in 1980 (Ashton et al. 1984, 623). Moreover, in hard hit areas, grain output reduction was far worse than the national average, reaching as severe as more than 40 percent in one year (Peng 1987, 651). The blatant human errors contributing to the famine are further seen in Mao's silencing of opposition voice in July 1959, with the firing of Defense Minister Peng Dehuai, in the leadership's decision to continue and in fact to increase grain export in the first two years of the famine, and in its refusal to receive any foreign food aid until 1961.

Sequencing in Demographic Responses

Famine affects a population through multiple ways. First and the most often mentioned is starvation or various degrees of malnutrition. Food shortage, depending on its severity, could result in a variety of demographic consequences, from changes in diet composition such as prolonged breastfeeding for infants, reduced libido and lower frequency of sexual intercourse among adults, delayed return to menstruation, and increased incidences of miscarriage and stillbirths (Bongaarts and Cain 1982; Hugo 1984). Second, times of extreme economic difficulties also generate mental stress and fear, which could lead to depressed sexual desire and lower chances of conception. Elevated stress level can also contribute to increased level of miscarriages (Cai and Wang 2005). Third, famines also dry up household savings quickly. Combined with economic and social uncertainties, marriages are likely to be postponed. Fourth, to look for more secured food supply and better economic opportunities, people are also more likely to migrate away from areas that suffer more serious famines. Increased migration leads to delayed marriages and to increased incidences of spousal separation, both could have an impact on reproduction.

The effects of famine are clearly visible in China's population age structure. In Figure 1, we present population cohort size observed in the 1990 census by month of birth (gray diamond points/line), along with a year-based average (black square points/line), for those born between January 1955 and January 1965. The dating of the Great Leap Forward Famine to 1959-1961 is largely based on the year-based picture that there were heavy population losses three years in a row. However, these monthly surviving birth cohorts reveal a rather different picture of the sequences and consequences of the famine: there are two dips in population size related to the Great Leap Forward Famine. Prior to January of 1959, the average of cohort size in China swung around 1.5 million per month. The first dip came in January 1959, when the monthly cohort size dropped to only about 1 million, and this low lasted for about 8 months, till August 1959. Surviving birth cohort size between September 1959 and July 1960 then hovered around 1.25 million, lower than the pre-famine level of 1.5 million, but higher than the level observed in the previous 8 months. The second dip started from

August of 1960, and lasted for a whole year till September 1961. Starting from October 1961, the population clearly was on a steady recovery. By February1962, the monthly cohort size returned to the pre-famine level of 1.5 million. The recovery included the full year of 1962 and followed by a historical peak in the 1963.

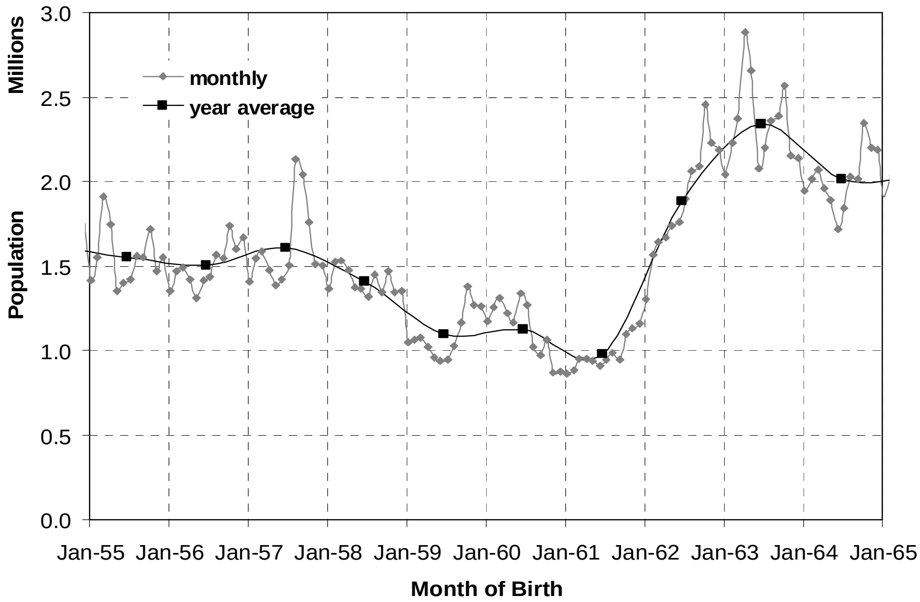

Figure 1. Demographic impact of the great leap forward famine: Monthly birth cohort size reported in the 1990 census.

Data Source: 1990 census, combined 2 percent micro sample.

The population age structure observed in the 1990 census is a result of the combining forces of passive responses and active adaptations faced with the calamity, both short term and long term. It is especially puzzling and interesting to understand the two dips in Figure 1: what are the underlying forces during the famine that display in such a desynchronized fashion? Had there been two different waves of famines or it is mainly a result of different demographic responses? Demographic responses to famines follow a sequence, with mortality being likely the most immediate one (Bongaarts and Cain 1982). Famine-resulted starvation however does not kill population of all ages indiscriminately. Rather, children and elderly are more likely to die than young adults. Estimates by Ashton et al. (1984) suggest that during the Chinese Great Leap Forward Famine, mortality especially male mortality for those aged 40 and above elevated especially significantly. Following an immediate mortality response, fertility decline begins. The impacts of famine on fertility also unfold through multiple mechanisms, and followed a sequence.

Infant and Child Mortality

Infant and child mortality increased sharply during the famine years. In Figure 2 we show mortality rates for the first three years of life for reported live births by their birth year. Such numbers, based on incomplete retrospective pregnancy histories of women alive in 1988, may well underestimate the true level of infant and child mortality at the time, but the clear rise is unlikely to be due to problems associated with either the sample selection or recall biases. The highest lines on these figures are reconstructed infant mortality rate. Two observations can be made about infant survival during the famine years. First, births in 1958 and 1959 experienced a clear and pronounced rise in mortality, when compared with those born in 1957 and 1960. What this suggests is that infant mortality was the worst in 1959 and 1960 (roughly a year following the births), but by 1961, before the famine officially ended, infant survival returned to a normal (pre-famine) level. Such an independent source of infant mortality, based on retrospective pregnancy history survey not the census, provides a strong clue for the first dip in surviving birth cohorts observed in Figure 1, namely that the first dip was the result of an immediate response to famine in the form of infant mortality. Second, for early childhood survival, between ages 1 and 2, an increase in mortality is observed for birth cohorts of 1957 and 1958, suggesting famine impact in 1959 and in 1960. Similarly, for child survival between ages 2 and 3, an increase in mortality is observed for birth cohorts 1956 and 1957, suggesting famine impacts in 1959 and 1960. Similar conclusions can be reached from a period perspective. For example, the infant mortality of 1959 is about 20% higher than that of 1958. The upward increase in infant mortality was more pronounced for female births (an increase of 24.9 percent in mortality) than it was for males (a 16.9 percent rise).

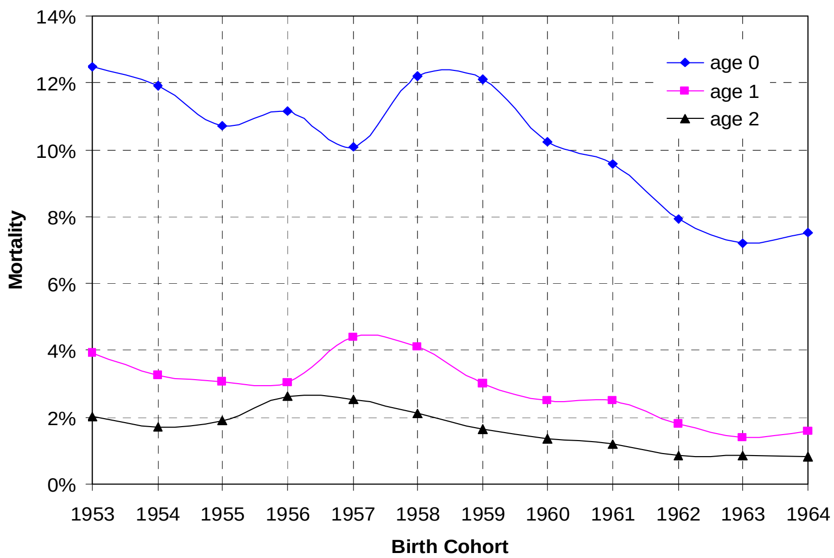

Figure 2. Infant and child mortality by birth cohort 1953-1964.
Data Source: 1988 Fertility Survey.

Marriage

Among reproductive responses to the famine, there were also different forms and a sequence. The first reproductive response is to postpone marriage. Total first marriage rate, which was on the decline in the early 1950s in China as the result of a gradual increase in the age at first marriage, dropped suddenly and substantially in 1959, from the level of around 0.9 in 1958 to around 0.7 in 1959 (Figure 3). This sudden drop in total first marriage rate reflects the strong response to the famine, in the form of postponed marriages of a large scale. By 1960, the total first marriage rate returned to the level of 1958 but a full compensation was not seen until 1962, when a sharp rebound in total first marriage rate pushed the level to close to 1.2. The sharp drop in total first marriage rate in 1959 and the sharp rebound in 1962 suggest that the famine began to affect marital behavior as early as in late 1958 and life returned to normalcy by the most part in 1961, as marriages often require some lead time to plan. In rural China, where marriages concentrate in the months following the fall harvest, a sharpest drop was seen in 1959 not only of the total number of marriages but also a sharp reduction in marriages during those months, further confirming the poor harvest and interruptions in life in that year.

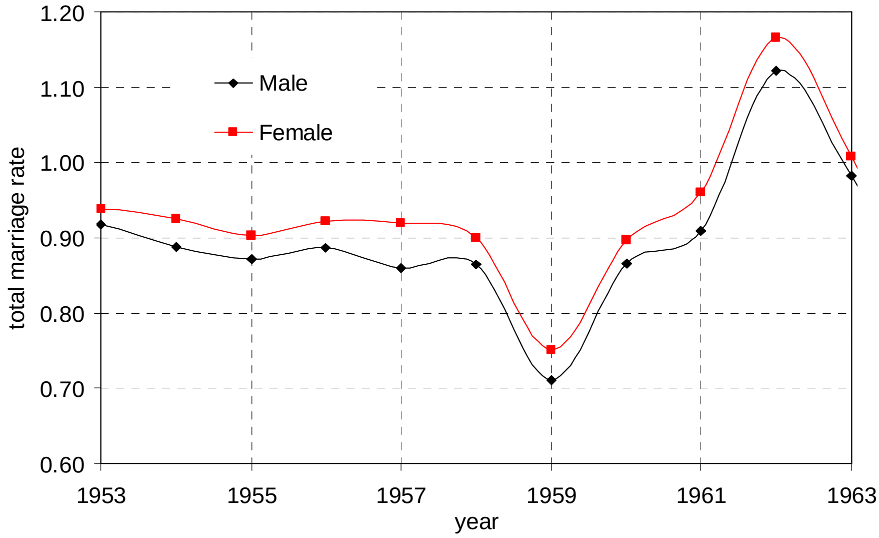

Figure 3. Total first-marriage rate by sex, China 1953-1963.
Data Source: 1988 Fertility Survey.

Fertility

In contrast to infant mortality and marriage, both of which responded to the impact of the famine immediately and concentrated in 1959, the full impact of the famine on reproduction unfolded in stages and with some time lag. Using the common measure of fertility, the total fertility rate, as the benchmark, the decline began in 1959, with a drop from 5.97 in 1958 to 4.23, but the bottom of the fertility free fall was not seen until two years later, in 1961. The total fertility rate dropped to 3.99 in 1960, and to 3.28 in 1961 (numbers from Coale and Chen 1987). As we shall show in the following, such a slower unfolding of fertility response to famine in comparison to infant and child mortality and marriage was an outcome of multiple factors and mechanisms. A portion of the fertility reduction was simply a corresponding change to sharply reduced first marriages, but there were also more reproductive responses as a direct result of the famine.

Passive and Proactive Reproductive Responses

In addition to its indirect effect through marriage, a famine affects reproduction through a number of other mechanisms and at two stages. The first stage a famine affects reproduction is conception. Sharply reduced food intake and increased mental stress could lead to lower probability of conception. The mechanism affecting the probability of conception could be passive, such as reduced libido or an interruption of the menstrual cycle, or proactive, such as the deliberate lengthening of breastfeeding period, which helps infant and child survival but delays the return of menstrual cycle and therefore reduces the likelihood of conception. Once conceived, a fetus may still face multiple outcomes, and this is the second stage by which a famine affects reproduction. A fetus could end up as a live birth, or suffer from miscarriage or stillbirth, which are passive outcomes. At the same time, a fetus could also be aborted voluntarily, which constitutes a proactive behavior. In our previous work (Wang 1995; Cai and Wang 2005), we documented the rise in induced abortion and in miscarriage and stillbirths. In the following we examine and provide evidence of other components of reproductive responses.

The heavy footprints of the famine effect on reproduction can be first seen in the mean age of menarche (Figure 4). The mean age at menarche, which was on its way to a secular decline between women born in 1930 and 1935, who on average reached the age of menarche in the late 1940s and early 1950s, changed course during the famine years. For women born between 1940 and 1950, roughly ten birth cohorts, mean age at menarche increased in comparison to those born before them. The impact of the famine was both immediate and prolonged. It was immediate as the peak of the mean age is seen for those born around 1945, who reached their menarche age around the peak of the famine, 1959. It was also delayed or prolonged, as it was not until for the birth cohort of 1953, who reached their menarche age in the late 1960s that the downward trend became evident again. In other words, not only were women who were about to reach their age at menarche affected by the famine, so were those in their pre-puberty ages. Nutritional deficiency associated with the famine resulted in delayed age at menarche for young girls who lived through the famine as well.

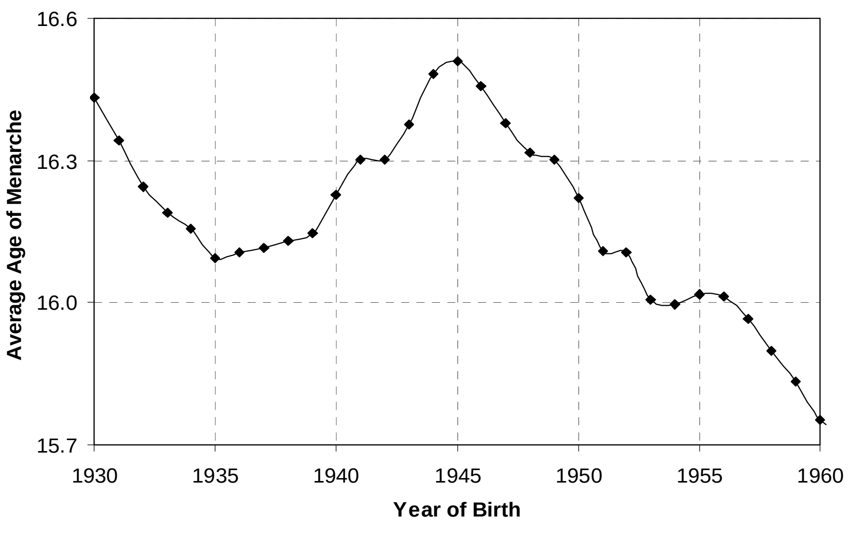

Figure 4. Average age at menarche by birth cohort 1930-1960.
Data Source: 1988 Fertility Survey.

In addition to postponement in marriage, reproduction within marriage was also postponed. One indictor of this postponement is the lengthening of the interval between marriage and first birth. Again, similar to the interrupted trend of declining age at menarche, the trend of shortening birth interval was also reversed. As shown in Figure 5, in which we provide mean length of first birth interval for four provincial units, first birth intervals became longer as a result of the famine in both urban (Beijing and Shanghai) and largely rural (Anhui and Sichuan) settings. In Beijing and Shanghai, prolonged first birth intervals are observed for marriage cohorts of 1958, 1959, and 1960. In Anhui, it was for marriage cohorts of 1957 to 1960, and for Sichuan, 1958 to 1960. In contrast to the urban settings, the mean length of the first birth interval was not only longer in rural areas but also increased more noticeably (an increase from 40 to 48 month). Most of this response can be attributed to passive forces caused by the famine.

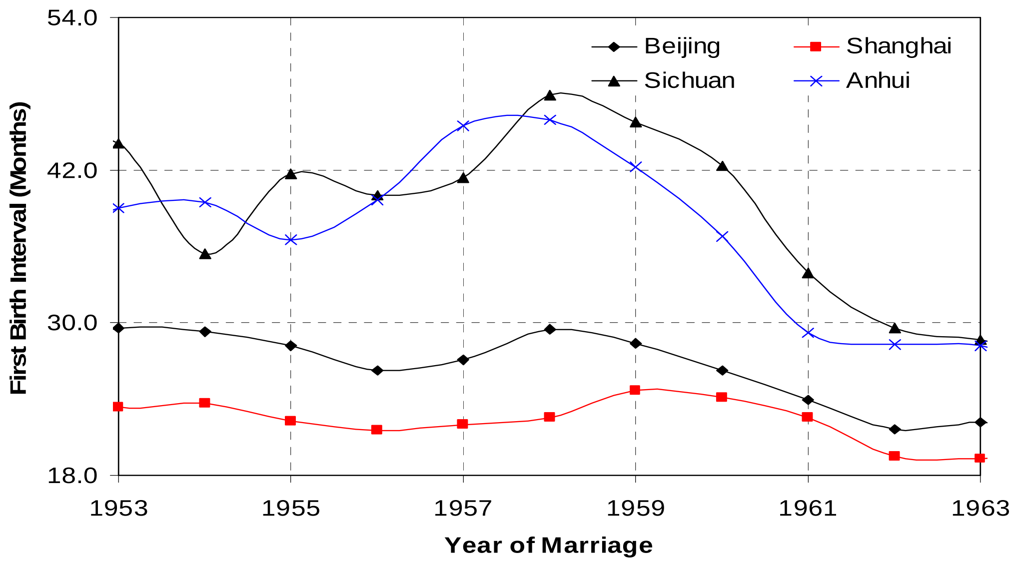

Figure 5. Average length of first birth interval by year of marriage in 4 provinces.
Data Source: 1988 Fertility Survey.

Beyond the first birth, both passive and proactive forces were at work to affect reproductive outcomes. In Figure 6, we show evidence of both forces. First, as shown by the lower line on this figure, at the time of the famine, fecundity was reduced as suggested by the increase in postpartum non-menstrual period. This increase is most substantial following births in 1957 to 1959, corresponding to the period of 1959 to 1961 (assuming an average of 18 month breastfeeding period plus about 3 month beyond the end of the breastfeeding period). Second, and as shown by the top line in this figure, at least part of the suppressed fecundity could be due to deliberate actions, which is shown by the clear increase in breastfeeding period. The average period of breastfeeding increased by about 10 percent. Increased breastfeeding is likely a strategy used by women to protect the survival chances of their infants, but it also contributed to the delayed return of fecundity.

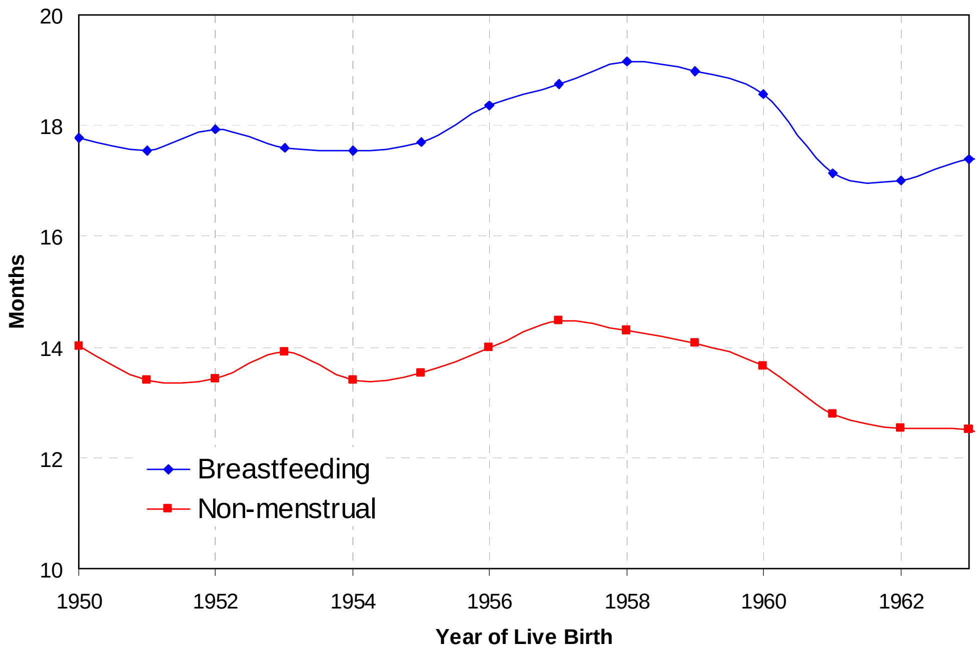

Figure 6. Average lengths of breastfeeding and non-menstrual following a live birth.
Data Source: 1988 Fertility Survey.

Behavioral Adaptation and Social Entitlements

In any society, not all members suffer from an acute crisis by the same extent, nor do they all respond to a crisis with the same strategies. Differences in economic, social, and political power create different social entitlements (Sen 1981). Individuals and families with different entitlements could also resort to different strategies in times of economic and social crisis. In the case of reproduction, some stopped, some continued, while others postponed. Why the differences? Who used what strategies and why? From our previous work we already learned that induced abortion was used more in cities and miscarriage and stillbirths were at a higher occurrence levels in the countryside and among women who had lower level of educational attainment. With information for individual as well as household socioeconomic characteristics, we examine in this section the socially differential response to famine. Specifically we examine the second stage of famine related impact on reproduction within marriage, namely pregnancy outcomes. Once a fetus is conceived, there are multiple possible outcomes, some passive and others involving more active choices. We differentiate pregnancy outcomes in the following categories: live birth, still birth, miscarriage (spontaneous abortion), and induced abortion.

The statistical model we use in this analysis is multinomial regression, in which the likelihood of multiple pregnancy outcomes are contrasted, as a function of the pregnant woman's personal biological as well as social and her contextual background. Our data are limited in the sense that a woman's social characteristics, such as her educational attainment and occupation, were her characteristics at the time of the survey, not at the time of the famine. So is her residential classification, whether living in a city or in the countryside. Given that education prior to the 1980s was almost always completed prior to marriage and childbearing, and given the low level of residential mobility and the high degree of correlation in one's occupational ranking in life prior to the recent reforms, however, the limitation in our data should not cause serious biases in our results. Our analytical model is expressed as the following:

$$\Pr(Y_i = k) = \frac{e^{\sum_{j=0}^{p} x_{ij}\beta_{jk}}}{\sum_{m=1}^{r} e^{\sum_{j=0}^{p} x_{ij}\beta_{jm}}} = \frac{e^{X\beta(k)}}{\sum_{m=1}^{r} e^{X\beta(m)}}$$

$$\frac{\Pr(Y_i = k)}{\Pr(Y_i = 1)} = e^{X\beta(k)}$$

Here $\Pr(Y_i=k)$ is the probability of a pregnancy ending up in live birth, miscarriage, abortion, or stillbirth. $\frac{\Pr(Y_i = k)}{\Pr(Y_i = 1)} = e^{X\beta(k)}$ is the relative risk (probability) of a pregnancy ending up in miscarriage, abortion, or stillbirth, as compared to being a live birth. We control for biological characteristics such as mother's age, birth order, and previous history of miscarriage, stillbirth and abortion. Year is used to compare with the pre-famine benchmark of 1957, to detect the effect and timing of famine. In Table 1 we present the results of our analyses.

Table 1. Likelihood of pregnancy outcomes an infant death, China, famine years.

Variable	Multinomial (N=123,069) Miscarriage	Abortion	Stillbirth	Binomial (N=115,754) Infant Mortality
Year (Ref.=1957)				
1958	1.22 **	1.15	1.06	1.31 ***
1959	1.56 ***	1.53 **	1.03	1.32 ***
1960	1.53 ***	1.58 **	1.27 *	1.06
1961	1.73 ***	1.84 ***	1.06	0.96
1962	1.09	1.42 *	0.85	0.74 ***
Mother's Age (Ref.=21-30)				
age1620	1.36 ***	1.11	1.06	1.48 ***
age3135	0.70 *	0.99	0.87	0.66 ***
Pregnancy Order (Ref.=1)				
porder2	1.03	6.09 ***	0.75 ***	1.20 ***
porder3	1.11	13.58 ***	0.75 **	1.31 ***
porder4	1.31 ***	26.10 ***	0.79 *	1.69 ***
porder5	1.74 ***	36.27 ***	0.75 *	1.94 ***
porder6	1.60 ***	54.54 ***	0.95	2.60 ***
No of previous miscarriage (Ref.=No)				
1 Miscarriage	3.73 ***	0.69 *	1.01	0.78 ***
2 Miscarriage	5.29 ***	0.31 *	0.55	0.78
3 Miscarriage	6.87 ***	0.00 ***	0.55	0.54
4 Miscarriage	9.54 ***	0.00 ***	0.00 ***	1.32
5 Miscarriage	54.80 **	0.00	0.00	0.00 ***
Stillbirth History (Yes vs. No)	0.91	4.75 ***	1.33	0.48
Abortion History (Yes vs. No)	1.69 ***	0.66	8.70 ***	0.86
Hukou (Ref.=City)				
Town	1.05	0.53 ***	1.36 **	1.67 ***
Rural	1.00	0.33 ***	1.58 ***	2.09 ***
Mother's Education (Ref.=Illiterate)				
College and higher	2.00 ***	8.84 ***	0.78	0.54
Senior high school	1.65 **	6.50 ***	1.25	0.54 ***
Junior high school	1.26 *	4.39 ***	0.96	0.73 ***
Primary School	1.15 **	2.12 ***	0.95	0.84 ***
Mother's Occupation (Ref.=Peasant)				
Peasant-worker	1.17	2.89 **	0.76	0.66 ***
Worker	1.11	2.92 ***	0.98	0.68 ***
Service/commerce	1.05	3.23 ***	0.47 **	0.75
Cadre/professional	0.96	3.59 ***	0.43 **	0.67
Other	0.89 *	2.25 ***	0.80 **	0.66 ***
Intercept	0.02 ***	0.00 ***	0.01 ***	0.06 ***

Note: ***<.000; **<.01; *<.05

Miscarriage started to increase as early as in 1958. Controlling for a woman's biological and other characteristics, in 1958 the relative risk ratio for a pregnancy to end in miscarriage as opposed to live birth increased by nearly 22 percent. Elevated risks of miscarriage remained high for four years, until 1961, when it was over 70 percent above the level in 1957. Among the social background characteristics, higher level of education is shown to have a higher likelihood of miscarriage. This effect, we believe, is most likely due to better recalls among women with higher level of educational attainment rather than their higher level of miscarriage, as miscarriage is a passive response to the famine crisis unlikely to be caused by personal volition.

In contrast to miscarriage, which is a passive response, induced abortion is a proactive strategy to regulate reproduction. As early as in 1959, induced abortion began to increase substantially. Compared with 1957, the likelihood of a pregnancy ended in induced abortion rose by over 50 percent. Elevated level of induced abortion continued throughout the famine years. Such a proactive strategy in reproductive response, however, was not available for all people in China at the time of the famine. Induced abortion was legalized in the early 1950s and became gradually available, first in the cities as carrying out safe induced abortions required hospital facilities, which were generally lacking in the Chinese countryside at that time (Wang 1995). As shown by the results in Table 1, indeed in residential areas classified as towns and rural areas, the likelihood of induced abortion was only half of that in the cities (the reference group). Moreover, the fact that induced abortion was used actively as a means to control reproduction can be seen in the linear relationship between abortion versus live birth and pregnancy order: the likelihood of abortion increases drastically among higher order pregnancies. Here, unlike the pattern shown for miscarriage, women with higher level of education were much more likely to resort to abortion. Compared with women whose occupation was farmers and controlling for all other factors, officials and professionals were also the ones who had a much higher likelihood of having an induced abortion during the years included in this analysis, between 1957 and 1962.

Stillbirths, which occur near the end of the pregnancy period, also increased in association with the famine. But unlike miscarriages and induced abortions, which started to increase as soon as the famine set in, in only one year, 1960, was there an elevated level of stillbirths, when the level increased by 27 percent. Such a concentrated elevation of stillbirth risk again suggests that the famine struck the population most severely in 1959, as most stillbirths that occurred in 1960 were pregnancies conceived many months earlier, many in this case in 1959. In addition, unlike miscarriage, which is mostly passive, and abortion, which is proactive but does not suggest clearly whether it was a price to pay or a social entitlement to claim, occurrences of stillbirths reveal to some extent the differential social entitlement bestowed upon population of different social strata. As shown by the results of our analyses, there are some clear signs of social entitlement associated with the risks of having a pregnancy ending up in a stillbirth. In comparison to cities, women lived in towns and rural areas had an elevated risk of stillbirth about 40 to 50 percent higher. Such an elevated stillbirth risk could be due to the inferior prenatal care available to rural women, and due to the lack of adequate medical care facilities at the time of delivery, which could make a difference between a live birth and a stillbirth. In addition to this categorical difference in the likelihood of stillbirth between urban and rural residents, a woman’s personal social characteristics, as shown by occupational status, also made a difference. Urban service workers and white collar professionals had a much lower risk of having stillbirths in comparison to ordinary farmers and workers.

Patterns of infant mortality, shown in the last column of Table 1, confirm both the timing of the famine impact and the socially differentiated famine impact. In comparison to the level in 1957, infant mortality rose for two years, in 1958 and 1959, before reaching the pre-famine level and followed by a decline. Similarly, compared with residents in cities, those in towns and rural areas suffered a much higher level of infant mortality, and those with higher educational attainment and non-farming occupations had substantially lower infant mortality level. Given the more educated and non-farming individuals mostly also lived in cities, their advantage in infant survival during the famine years multiplied.

Conclusion

China's Great Leap Forward Famine, while known to be the worst in history in terms of human lives lost, leaves many questions unanswered. In this paper, by examining demographic especially reproductive responses to the famine, we are able to reveal a number of facts that hopefully can reshape our understanding of the famine, of how famines affects reproduction, and how the impact of famine highlights social entitlements and social stratification.

First, contrary to the popular periodization that the famine was a three-year ordeal, between 1959 and 1961, all demographic evidence reported in this paper point to 1959 as the single year that made the most difference. This is the year when infant and child mortality increased most pronouncedly, when the prevalence of marriage suddenly dropped, when chances of conception declined, and when miscarriages and abortions increased. Whereas a number of demographic indicators, such as the risk of stillbirth and the overall fertility level, did not reach their full extent following the famine until a year (in the case of stillbirth) or two (in the case of overall fertility) later, these observed maximum impacts of the famine are mostly delayed effects of the adversity in 1959.

Second and related, both the timing of the famine and related demographic consequences further reinforce the view that the famine was caused mostly if not entirely by political miscalculations and mistakes of enormous historical proportions, rather than only poor harvests in 1959 to 1961, as still preferred by the official Chinese framing that calls it a natural disaster of three years, and believed by many. Whereas officially reported grain output and per capita food availability remained low in both 1960 and 1961, demographic responses to the famine documented in this paper show that as early as in 1960, normalcy already began to return. At the same time, signs of stress such as increased miscarriages and infant deaths began to be seen as early as in 1958, further pointing to the roles of misdirected policies rather than poor harvests in affecting people's lives.

Third, and as postulated in the famine literature and shown in the cases of other famines, the Chinese population also responded to this enormous famine following stages and employing multiple means. Faced with the massive famine, the first demographic responses were increased infant and child mortality, followed by increased length of breastfeeding, later return of menstrual cycle, increased miscarriages and abortions, and increased incidences of stillbirths. Marriage delays also led to further fertility reduction, with a time lag of two to three years in this case.

Fourth and lastly, even under a socialist system at the time of the famine, the famine affected population of different social status clearly differently, highlighting the importance of social entitlement, which was only magnified during the time of economic and social calamity. As a group, urban Chinese not only had more means to deal with the famine, such as resorting to induced abortion rather than infant and child deaths, they also suffered much less in terms of having a pregnancy ended up as a stillbirth or to have a birth die in infancy. Moreover, individuals of higher occupational status, such as professionals and officials, fared consistently better than others.

Our work, while offering a number of new facts and new conclusions, is nevertheless a beginning of more in-depth analysis and understanding of the Chinese Great Leap Forward Famine. Our next steps of work would involve better use of data and to extend our understanding of the famine beyond the short term consequences. The annual patterns we present in this paper can and should be examined with the use of monthly information that we have in our data sources. Given the discrepancy between calendar year and seasonality of agricultural production, using monthly rather than yearly data allows us to further locating the timing and the unfolding of the famine and its consequences. Similarly, while our current work has focused on the short term consequences of the famine, the effects of the famine last far longer than the years immediately following the famine itself. Without also examining the long term consequences of this massive famine, our understanding can only be incomplete and partial.

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Political Turmoil, Economic Crises, and International Migration in DR Congo: Evidence from Event-History Data (1975-2007)

Bruno Schoumaker, Sophie Vause, and José Mangalu

Abstract

The aim of this study is to document the impact of political and economic crises in DR Congo on international migration using a recent longitudinal survey on international migration conducted in Kinshasa. The data was collected in Kinshasa (DR Congo) in August-September 2007 as part of a research project called "Crisis and international migration in DR Congo". The survey was conducted among a representative sample of 945 households in Kinshasa, the capital city of DR Congo. This paper is organized around three objectives. The first objective is to measure the impact of economic and political crises on the risks of international migration, using event history analyses. The second objective is to evaluate separately the impact of crises on migration to African countries and to developed countries (mainly Europe and North America). Our results show notably that political crises have a strong impact on migration to developed and developing countries in similar ways. The third objective of this study is to evaluate if sudden economic and political changes influence different people in different ways. We show that migration is less sensitive to crises among the better educated than among the less educated.

1. Background and Objectives

Since its independence in 1960, DR Congo has been hardly hit by economic and political crises. The deteriorating economic context and the wars that have affected the country over the last decades epitomize the tragic and complex situations faced by many African countries. Over the last four decades (and especially since the 1980s), migration flows from DR Congo to Europe (measured with immigration statistics and asylum claims) have also increased significantly (Migration Policy Institute 2007) and are widely thought to be reflecting the deteriorating economic and political situation in the country.[1] Large numbers of Congolese refugees in neighboring countries (more than 250,000 according to the UNHCR 2007) also illustrate the impact of political instability in DR Congo on international migration.

Although these data suggest a link between deteriorating political and economic conditions and international migration, the impact of crises on international migration in DR Congo has received very little attention in the scientific literature. One reason may be that this impact seems obvious. Yet, research in other contexts (mainly in Latin America) has shown that the influence of political and economic crises on migration may be complex, and that crises do not necessarily increase international migration.

[1] The topic is little discussed in the scientific literature, but commonly debated on 'forums' or in the press.

Previous research also suggest that economic or political crises may influence migration to different destinations in different ways (Massey and Capoferro 2006; Jokisch and Pribilsky 2002). Crises can also influence the composition of the flows of migrants or, said differently, can have different effects on different categories of people (Massey and Capoferro 2006; Jones 1989).

The lack of studies on this topic also reflects the lack of appropriate data. Data on migration flows to African countries are very limited (not to say inexistent). Data on ‘stocks’ of refugees (UNHCR 2007), and on the variations in stocks of refugees (Moore and Shellman 2004) provide useful information to analyze trends in migrations. However, they do not include ‘classical’ migrants, and are affected by measurement errors. Moreover no information on the characteristics of refugees is available. In Western countries, existing data on Congolese migration mainly include data on flows of Congolese immigrants and asylum seekers. While these data are also very useful, they have several drawbacks to analyze the impact of crises on migration from DR Congo (and from developing countries more generally). First, the analyses are conditioned by the availability of data in the destination countries, and such data are not readily available in many countries.[2] Lack of data on undocumented migrants is another limitation of the available aggregate data. In addition, the immigration dates recorded in the statistics may not correspond to the dates of departure of the countries of origin, and are not necessarily appropriate to analyze the relationship between crises and migration.[3] Finally, aggregate data on migration flows do not allow analyzing differential migratory responses according to individual characteristics, such as education.

The aim of this study is to document the impact of political and economic crises in DR Congo on international migration, using a recent longitudinal survey on international migration conducted in Kinshasa (MAFE-Congo). These data, collected from households in the origin areas, allow more detailed analyses than the aggregate data presented above.

This paper is organized around three objectives:

(1) The first objective is to measure the impact of economic and political crises on the risks of international migration. Even though the impacts of economic and political changes are not easily disentangled in migration analysis (Morrison 1993), we take into account both political and economic macro-level variables to distinguish their effects on migration.

(2) The second objective is to test if political and economic crises have had similar effects on migrations to African countries and to Western countries (Europe and North America). Existing data make it difficult to estimate if some destinations are preferred in times of crisis. While aggregate data on immigration and asylum claims in European countries suggest that European countries are particularly attractive in times

[2] And when they are available, they are not necessarily comparable across countries.

[3] For instance, some migrants (notably irregular migrants) can take several months or years to reach their ‘final destination’.

of crises, such conclusions do not take into account the fact that migration to other destinations may also increase.

(3) The third objective of this study is to evaluate if economic and political changes influence different people in different ways. More specifically, we test the hypothesis that migration is less selective according to education in times of economic and political troubles or, said differently, that the impact of crises is stronger on the less educated than on the more educated people.

This study uses two complementary types of data: individual data on migration collected from households in Kinshasa, and macro-level variables to measure political and economic conditions (see details in data section). Event history models are used to reconstruct migration trends, and to test the impact of crises on migration.

2. The Political and Economic Context in DR Congo

The Democratic Republic of Congo is one of the largest countries in Sub-Saharan Africa. It is the second largest Sub-Saharan African country in term of area (after Sudan), and with a population estimated at 59 millions in 2005 (United Nations 2009),[4] DR Congo is also the third most populated country in Sub-Saharan African (after Nigeria and Ethiopia), and the largest country in francophone Africa. DR Congo is also currently one of the poorest countries in the World. According to the Human Development Index (UNDP 2009), DR Congo ranked 177 out of 179 countries in 2008, and poverty is a mass phenomenon in DR Congo.

Since the country gained independence in 1960, Congo has experienced a series of economic downturns and of episodes of political instability. Overall, six broad periods can be distinguished in the country's political and economic history. The period from 1960 to 1965 (First republic) started with independence from Belgium and ended with the seizing of power by Joseph Mobutu (Stengers 1989; Ndaywel 1998; Bamba 2003). That period was a time of political instability, in which several parties struggled for power, most of which were constituted on regional or tribal grounds. From the economic point of view, the period was characterized by a stagnating economy, high inflation, and a deterioration of external balance (Peemans 1997; RDC and UNDP 2000). However, the repercussions of the economic troubles on the population are thought to have been limited at that time, notably because infrastructure and social systems were still operating (Ndaywel 1998).

The Mobutu regime started at the end of 1965, and opened a new period in Congo's political and economic history. The Second Republic lasted from 1965 to 1997, and was characterized by a strongly centralized regime and dictatorship. At first the political situation was fairly stable, but it seriously deteriorated until the end of the Mobutu regime in 1997. The country's economy improved at the beginning of the Second Republic, but it started deteriorating in the mid 1970s. Between 1965 and 1974, the average GDP growth rate was around 7% per year (Nzisabira 1997; RDC and PNUD 2000). The high prices on the world copper market, the increase of foreign direct

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[4] It doubled between 1985 and 2005, and increased fivefold since 1960.

investments, and the growing internal market all contributed to the positive economic performances (Peemans 1997; Nzisabira 1997). However, government spending and debts also increased during that period, notably to fund projects of dubious profitability (Peemans 1997; Nzisabira 1997; RDC and PNUD 2000).

From 1975 to 1982, the economic situation deteriorated. The 1973 oil crisis, along with the collapse of the price of copper (1974) and of other commodities, and bad economic policy (notably the process of zaïrianisation of the economy which started in 1973), ruined the benefits of the preceding period (Peemans 1997; Nzisabira 1997). Foreign investments decreased, public expenditures increased, and the country accumulated a large foreign debt, in unfavourable conditions (RDC and PNUD 2000). From 1975 to 1978, the GDP dropped by 3.5 percent annually. That period was also characterized by political turmoil. Opponents to the regime started wars to try gain control of the country, notably in 1977 (80 day war) and in 1978 (Shaba War). The support of Western countries was decisive to control the rebellions (Peemans 1997; Ndaywel 1998).

The period from 1983 to 1989 started with economic reforms, and with a slight increase of the GDP, along with the start of a structural adjustment program with the World Bank and the IMF (Nzisabira 1997; RDC et PNUD 2000). In 1986, the country broke off with Bretton Woods institutions, and the GDP growth rate plunged (Nzisabira 1997). Inflation increased (from 65% in 1986 to 75% in 1987), and the devaluation of the currency accelerated (Peemans 1997). At the end of the period, the growth rate was negative (-1.3 % in 1989). The end of this period coincided with the end of the cold war and serious changes in the political situation in DR Congo.

The period from 1990 to 1999 is one of the darkest periods in Congo's recent political and economic history. The combined pressure of the internal opposition and of the international community forced the President Mobutu (in April 1990) to announce the democratization of the regime. However, the process was lagging and remained unfinished: in May 1997, a rebellion led by Laurent-Désiré Kabila (AFDL), seized power (the first Congo War in 1996-1997) and ended the 32 years of Mobutu's regime. The second Congo War started in 1998, and formally ended in 2003. That decade was also characterized by a rapid deterioration of the economic situation. The GDP growth rate, which was already negative at the beginning of the period, decreased from -6.6% in 1990 to -14% in 1999. Congo's economy was also struck by hyperinflation, and the country's public debt also soared. During that period, the purchasing power of the Congolese population declined drastically.

Since the year 2000, and especially since 2003, the economic context and living conditions of the population have slightly improved. In 2002, the country experienced positive GDP growth rates for the first time since 1995, and the growth rate was above 1% for the first time since 1986. The improvement in the economic situation is explained by the post-war reunification of the country, by the resumption of international development aid, the control of public finances, and a massive injection of foreign currency by the IMF in Congo's economy as part of the Poverty Reduction and Growth Facility (PRGF). However, the living conditions of the Congolese population remain extremely difficult.

The political situation has also changed since the year 2000. In early 2001, Laurent-Désiré Kabila was assassinated and his son, Joseph Kabila, became President of the DR Congo. In 2002, the second Congo War officially ended, and a transition government was installed in 2003 and formally ended the war. In 2006, elections were organized and Joseph Kabila was elected President. Despite the end of the war, Eastern Congo has continued to be regularly prone to violence. In 2009, Laurent Nkunda (chief of rebels in Northern Kivu) was arrested, heralding an improvement of the political situation in Eastern Congo.

As shown by this summary, Congo's history has been characterized by large economic and political changes. It is also clear that, in DR Congo as elsewhere, economic and political troubles are closely intertwined (Akokpari 1999; Smith 1992). As a result, it may not be easy to disentangle their effects on migration.

3. Congolese Migration over the Last Decades

Congolese migration is relatively little studied. In Western countries, Congolese migration has mainly been studied using immigration statistics and statistics on asylum seekers. In African countries, data sources are even scarcer, and quantitative research on Congolese migration to other African countries are not readily available, apart from some research on migration to South Africa (Steinberg 2005). Despite the lack of data and studies, it is possible to draw a general picture of Congolese migration.

Congolese migrations within Africa are to a large extent directed to neighbouring countries. Angola and Congo Brazzaville are major destinations for migrants originating from Western Congo (where Kinshasa is located), while Zambia is a common destination among migrants living in the region of Lubumbashi, in Katanga. Congolese migrations to neighbouring countries also include movements of refugees, which have been quite large since Congo's independence. In 2007, according to the UNHCR (2007), more than 250 000 Congolese refugees were living in neighbouring countries, most of them in Tanzania, Zambia, Rwanda and Uganda. Since the 1990s, South Africa has also become a major destination for Congolese migrants (Steinberg 2005). According to estimates in the early 2000s, more than 20 000 Congolese were registered as refugees in South Africa (Steinberg 2005), and many more were living without refugee status.

Congolese migration to Western countries has also increased significantly over the last 30 years, according to migration statistics in selected European Countries. Congolese migration to Europe started in the early 1960s, after Congo gained its independence from Belgium. At that time, migration to Europe was primarily a migration of elites moving to Belgium for training (Kagne and Martiniello 2001). Over the past 30 years, the profiles of migrants and their destinations have progressively diversified. France has become an increasingly popular destination among Congolese and, more recently, the United Kingdom and Germany have attracted a sizeable share of the Congolese migrants in Europe. In the 1980s, economic migration gained momentum and, since the 1990s, asylum-seekers have been the bulk of Congolese migrants. Currently, the largest communities of Congolese migrants in Western countries live in France (approximately 90 000 Congolese migrants in the early 2000s, see Bazenguissa-

Ganga 2005) and in Belgium (approximately 50,000 Congolese migrants in 2007, Schoonvaere 2009). Other destinations such as Canada and the United States have become increasingly popular among Congolese migrants, but the number of Congolese migrants living in these countries remains much lower than in Europe.

Although data and research point to increasing numbers of Congolese migrants in African, European and North American countries, research on the timing of migrations is lacking. If one wants to link increasing migration with economic and political troubles, time series on migration are needed. In African countries, statistics on migration flows are lacking, and to our knowledge, no study has been done on Congolese migration trends to African countries. In Europe, immigration statistics and statistics on asylum seekers provide a more detailed picture of variations in Congolese migration over the last decades. The available data suggest that migration from DR Congo to Europe was especially intense during the periods of crisis in DR Congo since the early 1990s. For instance, statistics combining immigration flows and asylum seekers in Belgium (Figure 1) indicate that migration was particularly high in the early 1990s and at the end of the 1990s and early 2000s (Schoonvaere 2009). However, data on annual migration flows to Europe may be difficult to interpret for several reasons: lack of data on undocumented migrants, time lag between departure from Africa and arrival in Europe, lack of information on place of departure of migrants.

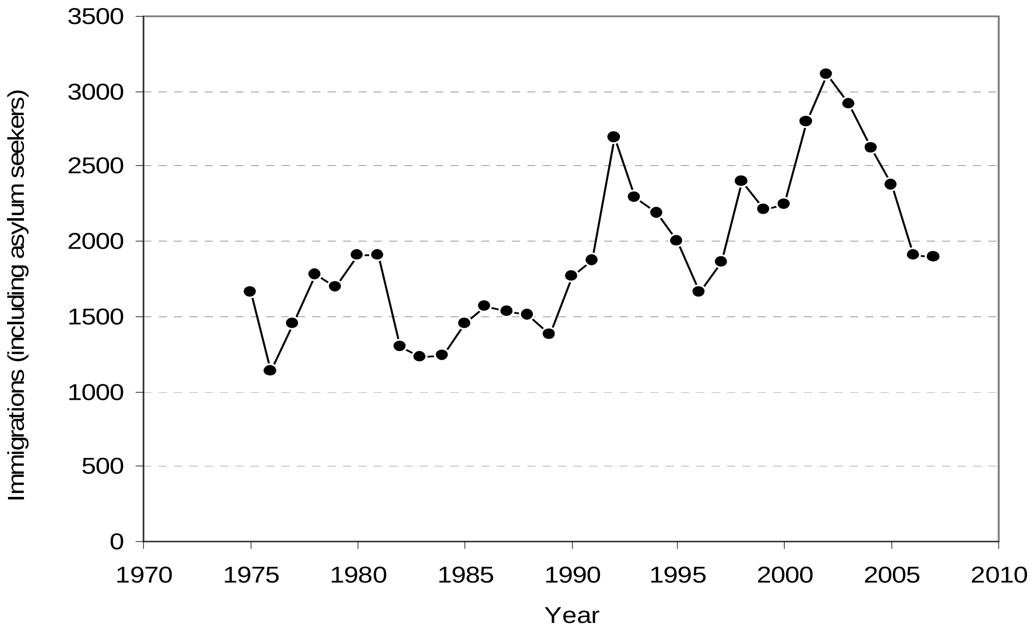

Figure 1. Number of entries of Congolese immigrants and asylum seekers in Belgium (1975-2007).

Source: Schoonvaere (2009)

4. Crises and Migrations: A Brief Review of the Literature

The impact of macro economic and political conditions on migration has, surprisingly, received relatively little attention in developing countries. Migrations have often been studied through the lens of individual determinants, especially with the neoclassical paradigm. The role of the larger economic context in which migration takes place is rarely take into account in empirical research on migration in developing countries. Yet, from a theoretical point of view, many authors recognize that macro-economic and political conditions are major driving factors in migration. For instance, in the African context, Adepoju (1994) mentions four types of macro conditions that can explain migration dynamics: the deterioration of economic conditions, changes in demographic population (which increase underemployment), political instability and cultural practices (traditional practices tend to push young people to leave the country). According to him, economic factors and political instability are the two most important factors to explain flows of migrants and refugees. Nevertheless, no empirical results are provided in his study.

Despite the lack of empirical research on the links between crises and migration, especially in Sub-Saharan Africa, some studies have been produced in a variety of contexts in present-day populations. Migratory responses to wars and political turmoil (including movements of refugees and asylum-seekers) have been documented in places like ex-Yugoslavia (Conti and Mamolo 2007), the Gulf Countries (Addleton 1991; Russell 1992), and Vietnam (Merli 1997). Moore and Shellman also used a global sample of countries over 40 years to measure the impact of violence (wars, dissident violence…) on forced migration, and concluded that "violent behavior has a substantially larger impact on forced migration than variables such as the type of political institution or the average size of the economy" (2004, 723). All in all, political turmoil generally has a positive impact on migration, although – as we shall see later – this general conclusion should be qualified.

Most of the empirical literature on the impact of economic crises on migration has been done on Latin American countries. A recent paper by Massey and Capoferro (2006) studied the impact of the deteriorating economic context on international migration in Peru in the 1980s and the 1990s. Using longitudinal data of the LAMP project (and event history models), they showed that the start of the structural adjustment programme, along with the deterioration of employment opportunities and wages, coincided with an increase in international migrations. They also showed a diversification of the destinations of migrations (with an increase of migration to European countries), as well as a decrease in the selectivity of migration. Their work indicates that, before the economic crisis, migration was more selective by level of education. Their explanation is that, in a 'reasonably functioning labor market', people are likely to move to maximize earnings, and will be positively selected with respect to education, as expected from the neoclassical theoretical perspective. On the other hand, in periods of economic downturns, people tend to flee deteriorating economic conditions rather than seek to maximize earnings abroad, and migration becomes less selective. This situation is more in line with the new economics of labor migration.

Work was also done in Ecuador on this topic (Jokisch and Pribilsky 2002), although the impacts of economic and political troubles on migration were not tested in statistical models. The authors consider that new Ecuadorian migrations are a response to economic and political crises. Before the 1990s, Ecuadorian international migrations were mainly directed to the United States. From the 1990s, Ecuador experienced a political and economic crisis, which coincided with stronger immigration policies in the US. The authors observe increasing migration flows in times of crisis, a change in destinations (more migrations to European countries like Spain, France, Italy), and a diversification of migrants profiles in terms of gender (feminization) and socio-economic status. Contrary to results found by Massey and Capoferro in Peru, Jokisch and Pribilsky (2002, 91) suggest that migration to the United States are mainly done by "poor *campesiños* from the countryside", while "migration to Spain is a phenomenon capturing the imagination of Ecuadorians of all classes". In short, migration is also less selective in times of crises, but in a different way from what is found in Peru.

Little research has looked simultaneously at the effects of economic and political troubles on migration. One of the early works on this topic was done by Stanley (1987), who studied international migration from Salvador to the United States in the early 1980s, and tried to distinguish the impact of political and economic factors. Using aggregate time series data on migration flows (US Immigration and Naturalization Service apprehension statistics) and indicators of economic and political troubles (political violence), Stanley (1987, 147) concluded that "fear of political violence is an important and probably the dominant motivation of Salvadorans who have migrated to the U.S. since the beginning of 1979". In contrast, economic factors were considered less important, although the author underlines that economic conditions interact with political turmoil in a number of ways, e.g. violence can "disrupt economic activities, thereby eliminating jobs and reducing pay levels" (Stanley 1987, 133). Also working on migration from Salvador to the United States, Jones (1989) reached different conclusions. According to him, bad economic conditions did influence migration to the United States. In contrast, a spatial analysis of regions of origin of migrants to the United States led him to conclude that "political violence has most affected the relatively poor Northern provinces, but a lack of money and knowledge makes flight to the United States out of the question" (Jones 1989, 194).

Research of relevance to our work has also been done on internal migration. For instance, Morrison (1993), and Morrison and May (1994) compare the impact of economic factors and violence on internal migration, and conclude that "even when political violence is explicitly introduced, the coefficients on purely economic variables continue to be strongly significant, and the elasticity of migration response with respect to economic variables is significantly larger than it is with respect to violence variables" (Morrison 1993, 828).

All in all, the existing research is scarce, and has led to mixed conclusions. The general idea is that deteriorating economic and political conditions tend to increase migration, although this should be qualified, notably because the impact can vary according to the destination of migration and according to the characteristics of individuals (e.g. education and gender). Research on the relative importance of political and economic crises has also provided mixed results. Finally, the impact of economic and political crises on African migration is almost totally absent from the literature.

In this paper, we treat the three following questions:

Question #1: ***Do economic and political troubles increase migration?*** Our hypothesis is that, as economic conditions deteriorate, people will move to neighboring countries or more distant countries to secure a job or better wages. We also expect migration to increase in times of political troubles. People may flee to neighboring countries during wars, although it might not be the most frequent type of moves from Kinshasa. Another reason why people moved during periods of political troubles may be due to the regime change, especially among people who used to be close to the Mobutu regime.

Question #2: ***Do the impacts of economic and political troubles on migration vary by destination?*** As discussed in the literature review, economic and political crises may have different impacts depending on the destination. We expect that the impact of deteriorating economic conditions will be larger on migration to Africa than on migration to Europe. Our hypothesis is that, as the economy deteriorates, financial resources to move to distant countries are less readily available. In contrast, people may be tempted to move to close countries with better economic prospects (e.g. South Africa). Although the impact of political crises on migration may also vary depending on the destination, the direction of the effect is not obvious. For instance, in Salvador, Jones (1989) found that political violence did not increase international migration from Salvador to the United States, but rather increased internal migration, while Stanley (1987) concludes the opposite.

Question #3: ***Is migration more or less selective according to education in times of crises?*** According to Massey and Capoferro (2006), migration is less selective in times of economic crises. Their argument can be summarized as follows: in periods of economic downturns (and probably in periods of political instability), people tend to flee deteriorating economic conditions rather than to maximize earnings abroad. As a result, the selectivity should be lower in periods of crisis than in periods of economic stability. In contrast, Jones' work on migration from Salvador to the United States (Jones 1989) has pointed out that the poorest people are not able to migrate to the United States to flee violence in periods of political crises. Migration may thus be more selective with respect to education in times of crises.

5. Data

This study relies on unique retrospective data collected in Kinshasa (DR Congo) in August-September 2007 as part of a research project called "Crisis and international migration in DR Congo". This project is a collaborative research project between the University of Kinshasa (DR Congo) and the University of Louvain (Belgium), and is part of an international research program on 'Migration between Africa and Europe' (MAFE[5]).

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[5] The survey used in this research was funded by the French government through the FSP program coordinated by the CEPED. The design of the survey and of the questionnaires was done in close collaboration with INED in France and IPDSR in Senegal. The MAFE program is now funded by the European Union, and involves three African countries (DR Congo, Senegal, and Ghana) and six European countries (France, Belgium, Italy, Spain, The Netherlands and United Kingdom).

The survey was conducted among a representative sample of 943 households in Kinshasa, the capital city of DR Congo.[6] Selected retrospective data were collected in the household survey, and full life histories were also collected from 992 adults in these households (males and females, return migrants and non-migrants) aged between 20 and 60. Only data from the household questionnaire are used in this paper.

In all the households, questions were asked to identify all the people who had lived in the household at some point in time and who had gone abroad for at least three months, whether they were still living abroad or had returned to DR Congo. In addition, brothers and sisters of the household head and of his/her spouse who had lived out of DR Congo were also identified through this questionnaire. Data on the migrations of these individuals (year of departure, destination country, year of return if the person returned, etc.) were collected. In addition, socio-demographic characteristics (age, gender, education, marital status and date of marriage, place of birth) were recorded for all the current members of the households as well as for the migrants. The availability of data for both migrants and non-migrants, as well as data on the timing of migration enables us to use event history models. In this research we use data on current members of household and past members of households (data on brothers and sisters are not used, unless they were part of the household at some point in time).

Macro-level data are used in this research to measure changes in economic and political conditions. Two types of data are used. Economic conditions are measured with the GDP growth rate. The GDP data were obtained from the World Development Indicators online data base (World Bank 2009). Political conditions are captured using an index of political troubles. The index is computed using the "Internal Wars and Failures of Governance, 1955-2007" data set prepared by the Political Instability Task Force (PITF) at the School of Public Policy (George Mason University).[7] The dataset includes four types of political instability events for all the years since 1955. These events include "ethnic wars, revolutionary wars, genocides and politicides, and adverse regime changes. Each annual record for each event includes three measures of magnitude and a composite magnitude score" (PITF 2009).[8] Our index of political troubles uses all four types of events, and is computed as a weighted average of the four composite magnitude scores, using principal components analysis. The first component, which explains 68% of the variance, is used as the index of political troubles. The value of this indicator is shown on Figure 2. In the event history models, the average of these indicators for the two preceding years (standardized) are used (see footnote 13).

These indicators suffer from some limitations. For example, the GDP growth rate is affected by measurement errors. Also, the GDP does not necessarily measure precisely the deterioration of the living conditions of the population. However, it is one

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[6] The sampling frame of the 2007 Demographic and Health Survey was used to select randomly 29 primary sampling units (neighbourhoods) in Kinshasa. Four streets were selected randomly in each neighbourhood, and 8 households were selected in each street. Overall, 943 households were successfully interviewed.

[7] The data sets are available online at http://globalpolicy.gmu.edu/pitf/pitfpset.htm.

[8] http://globalpolicy.gmu.edu/pitf/pitfpset.htm, consulted on May 11, 2009.

of the few indicators for which time series are available, and which reasonably describes economic conditions in the country. The index of political troubles also has some limitations. One of them is that all the conflicts are taken into account in the indicator even if they do not directly affect Kinshasa. Another potential limitation is that the quantitative indicator is computed using ordinal data. However, we believe this indicator provides a more detailed picture of the intensity of political troubles in the country than simple dichotomous indicators.

6. Methods

Event history models are used to reconstruct migration trends and to evaluate the impact of political and economic crises on migration since 1975 among people aged 15. Event history models are particularly well-suited to study the impact of sudden economic, political and environmental changes on migration (Henry, Schoumaker and Beauchemin 2004), as time-varying variables at micro and macro levels can be included in the models.

Piecewise exponential models are used (Allison 1995; Blossfeld et al. 2007). These models rely on the organization of the data file as a person-period file. Each line in the data file represents a period of time during which the explanatory variables (including age and year) are constant. The dependant variable (dummy variable) indicates if the event (international migration) takes place during the time interval corresponding to the line in the data file. The rate of migration is supposed constant within each time interval. Age (in single years) and years are included in the models as time varying variables, so that in practice migration rates are allowed to vary each year and at each age. The model is estimated with Poisson regression (Allison 1995; Blossfeld et al. 2007), and an offset is included in the models to control for the varying lengths of the periods (exposure).[9]

The population at risk of experiencing a migration includes all the people currently living in the households, and people who lived in the household in the past and who have migrated to another country for at least 3 months (whether they were still living abroad at the time of the survey or had returned to DR Congo). In this way, the risk set includes non-migrants, return migrants, as well as migrants still living abroad. Individuals are included in the data set from age 15 and from year 1975. For people older than 15 when entering the data set (1975), this corresponds to a situation of late entry (left truncation) (Allison 1995; Guo 1993). The analysis period starts in 1975 for two reasons. First, because of the retrospective nature of the migration data, sampling errors increase as one goes back in time, as the size of the sample gets smaller. Moreover, as explained in section 2, the economic and political situation was fairly stable until the mid 1970s. The analyses are also restricted to migration after age 15, as we are interested in autonomous migration.

[9] Complex sample design (stratification, multi-stage sampling, weighting) is taken into account in the analyses. Standard errors of coefficients are corrected for the clustering of observations in the same neighborhoods.

The reconstruction of migration trends is done using the piecewise exponential model with no explanatory variables, except age and year. A linear function of age and logarithm of age is included in the model, and time periods (years) are taken into account in the models in two separate ways. First, it is included as a series of dummy variables (non parametric approach), in order to measure annual variations in migration risks. Secondly, linear splines are fitted to identify breaking points in migration trends. The number and location of the knots (breaking points) are estimated using a stepwise forward method of selection (Marsh and Cormier 2001).[10] Results are presented in Section 7.1.2.

Piecewise exponential models are also used to test the impact of political and economic troubles on migration rates. Three series of models are estimated, that correspond to the 3 research questions.

The first series of models are fitted to measure the impact of political and economic troubles on migration rates (Question #1). The two indicators of political and economic troubles are first included separately in the models, and are then included jointly. Individual variables (age, marital status, education) are controlled in the models, as well as a variable measuring the migration trend.

The second series of models is similar to the first series, but distinguishes migration by broad destination (Europe and North America vs. Africa). These models are fitted to test the impact of economic and political troubles on migration by destination (Question #2). Separate analyses rely on recoding the dependant variable to take into account the migration of interest. For example, if one is interested in migrations to Europe and North America, the dependant variable is equal to 1 if a person migrates to Europe or North America, and zero otherwise.[11]

Finally, the third series of models explores the interactions between economic and political troubles and education. More specifically, the objective is to identify if migration is less or more selective with respect to education in times of crisis (Question #3). Said differently, these models aim at testing if crises impact different people in different ways. Models with interactions are estimated separately for migration to Western countries, African countries and all countries.

7. Results

We first present descriptive results, and next turn to the event history models corresponding to the three research questions.

7.1 Influence of Political and Economic Crises on Migration: Descriptive Analyses

7.1.1 Political and economic crises: 1975-2007

The two indices presented in section 5 are used to measure changes in economic and

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[10] Spline variables are included in the model using stepwise regression. The p-value for a variable to enter the model is set to 0.09 (Wald test), and the p-value for the variable to remain in the model is set to 0.10.

[11] Migration to the other region is considered as censored.

political conditions since 1975 in DR Congo (Figure 2). They illustrate the very changing political and economic conditions in DR Congo described in section 2. As shown by the GDP growth rate, economic conditions started deteriorating seriously at the end of the 1980s and remained very poor until the early 2000s. The situation was at its worst in the early 1990s, when the GDP was decreasing at a rate close to 10% per year. Since 2002, the country's economic situation has improved significantly but the situation remains fragile.

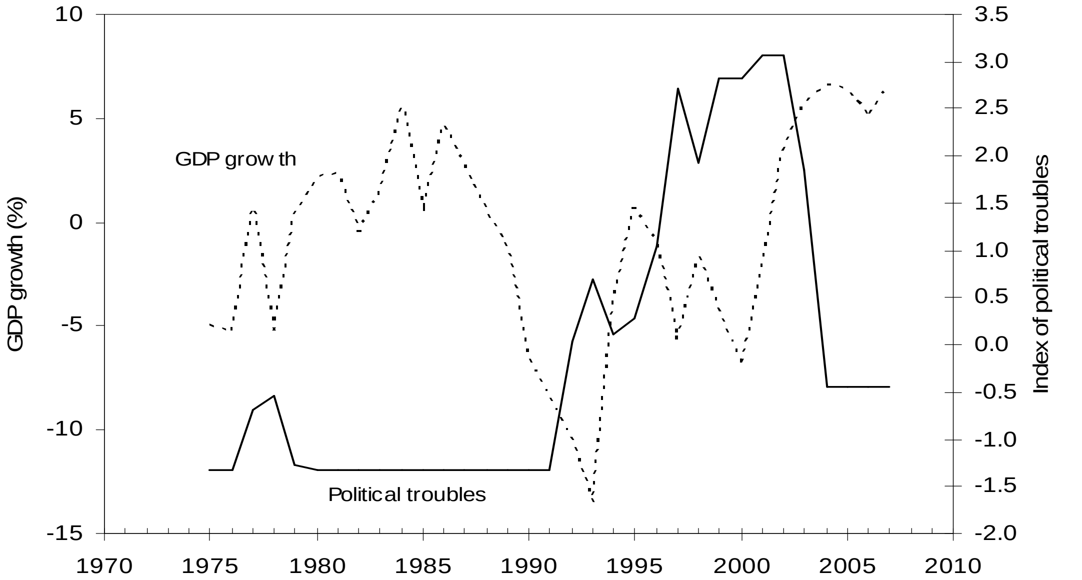

Figure 2. Indices of economic conditions (GDP growth) and political troubles, DR Congo, 1975-2007.

The index of political troubles summarizes the political history of DR Congo since the mid-1970s. The first hump corresponds to the 80-day war and the Shaba war in 1977 and 1978. The 1980s were fairly stable from a political point of view. The situation started deteriorating in the early 1990s with the regime crisis. The start of the war in 1996 and the regime change in 1997 (replacement of President Mobutu by President L. Kabila) correspond to periods of increasing political troubles. Between 1996 and 2002, corresponding to the periods of wars, the value of the index remains very high. The war officially ended in 2002, and the political situation improved significantly from 2003.

7.1.2 Reconstruction of migration trends: 1975-2007

Figure 3 shows annual migration rates[12] and linear splines fitted to the annual migration rates. The overall trend is clearly an upward trend: the rates of first migration at age 25

[12] The values of migration rates are computed at age 25 for the graphical presentation. Since the model relies on the assumption of the proportionality of effects of independent variables, the relative annual variations in migration rates do not depend on the age variable. As a result, the trend in migration rates for other ages is the same as the trend for age 25.

were less than 1% until the mid-1980s, they went as high as 3%, and decreased to less than 2% in 2007. Four knots, which correspond to breaking points in the migration trends, were located with the spline regressions: 1983, 1991, 1996, and 2001. Rates started to increase significantly around 1983; in the early 1990s, the trend stabilized. Of particular significance is the large increase in migration risks after 1996 (starting in 1997, the end of the Mobutu Regime), and the significant decrease after 2001, when economic and political conditions improved.

Figure 3. Rates of first international migration, Kinshasa (DR Congo), 1975-2007.

7.1.3 Comparisons of political and economic conditions and migration trends

The comparison of the indices of economic and political troubles[13] and migration rates (Figure 4a and Figure 4b) indicates overall a good consistency between migration trends and trends in economic and political conditions. The consistency is particularly striking for the index of political troubles: the large increase in international migration rates at the end of the 1990s corresponds with the intense political crisis. The correlation between migration rates and changing economic conditions is less striking; however, this figure shows that since the mid-1990s, periods of deteriorating economic conditions (grey curve going up) correspond to increasing migration rates, while periods of economic improvement are accompanied by decreasing migration rates.

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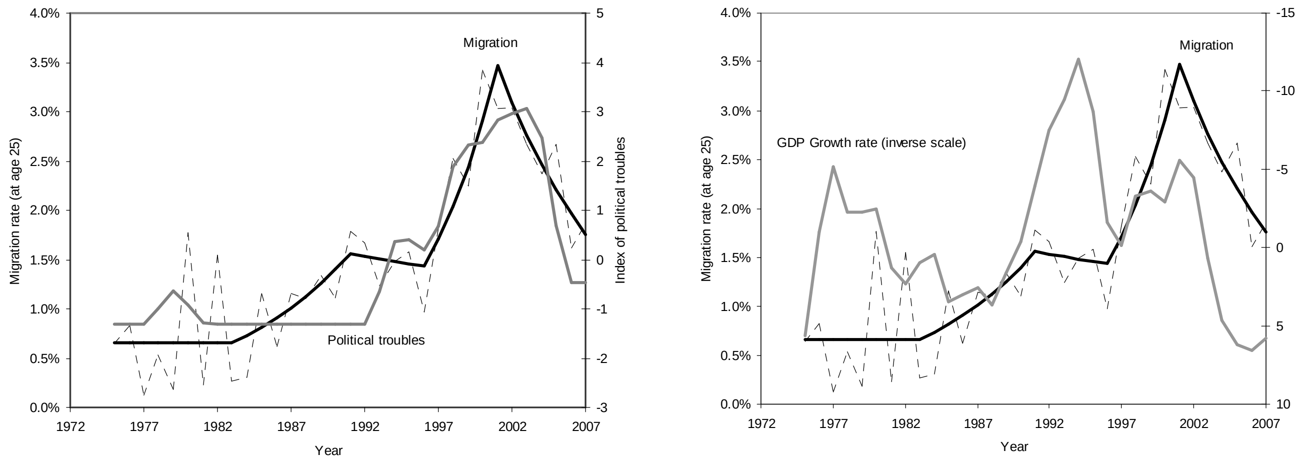
[13] The indices were computed as averages over the two preceding years. This is based on the idea that migrant respond with a time lag to deteriorating economic and political conditions. This time lag was chosen because it seems a reasonable time needed to realize the situation is deteriorating, and to organize the migration. Several lags were tested, and this approach turned out to be the most statistically significant.



(a) Index of political troubles

(b) GDP growth rate

Figure 4. Comparison of migration rates and (a) index of political troubles and (b) GDP growth rate, DR Congo, 1975-2007.

Note: Both indices are computed as the average of the original indices over the two preceding years (e.g. the index represented for the year 1995 is the average for the years 1993 and 1994).

7.2 Influence of Political and Economic Crises on Migration: Event history models

Although graphical analyses provide strong hints of a positive relationship between political and economic troubles and migration, they do not allow testing the statistical significance of these relationships, nor do they allow isolating the effects of economic and political conditions, or testing the differential impact of crises on different categories of people.

In the next section, event history models are used to measure the effect of political and economic conditions on international migration from Kinshasa. The models also include individual variables in the migration models, and are used to test interactions between crises and individual characteristics.

7.2.1 Question #1: Do economic and political troubles increase migration?

Models 1 to 3 measure the effects of economic and political troubles on migration. All the models include age, education, gender and marital status as individual control variables (age not shown). Year is also included as a control variable, to capture the trend in migration, regardless of the variations in political and economic conditions. In the first model, the index of political troubles is included as the only macro variable. GDP growth rate is included alone in the second model. The third model includes both variables together.

First, individual-level variables show expected results. Males are significantly more likely to migrate than females. People who have never been married are also twice as likely to migrate for the first time at each age as married people. Finally, education is strongly correlated to migration. People with secondary or higher education are more than twice as likely to migrate as their less educated counterparts. The variable ‘year’, which measures the trend in migration rates, is positive, but not significant in two of the three models.

Table 1. Event-history models of first international migration, Kinshasa (DR Congo), 1975-2007 (results expressed as rate ratios).

Variables	Categories	Models		
		1	2	3
Education	No / primary	1.00	1.00	1.00
	Secondary	2.16***	2.24***	2.23***
	Higher education	2.33***	2.50***	2.48***
Gender	Males	1.00	1.00	1.00
	Females	0.77**	0.78**	0.77**
Marital status	Ever married	1.00	1.00	1.00
	Never married	2.10***	2.06***	2.10***
Year (linear trend)		1.02 (ns)	1.05***	1.02 (ns)
GDP growth (a)			0.89***	0.97 (ns)
Political troubles (b)		1.27 ***		1.25***
Sample size		4485	4485	4485

Notes:
a) Average GDP growth rate over the two previous years (standardized variable)
b) Average index of political troubles over the two previous years (standardized variable)
Significance: *: p<0.10; **: p<0.05; ***: p<0.01; (ns) : not significant.

The first two models show that, when included separately in the models, economic and political troubles both significantly increase the risk of international migration, controlling for individual factors (Table 1). In the first model, an increase of one standard deviation in the index of political troubles is associated with an increase of migration rates of 27%. The second model shows that that an increase of one standard deviation of the GDP growth rate is associated with a decrease in migration rate of 11%. When both indicators are included in the same model (Model 3), the impact of economic conditions is almost completely offset and is not significant. The impact of politic troubles, on the other hand, is very strong and largely significant. This result suggests that migration is much more responsive to political troubles than to economic troubles.

7.2.2 Question #2: Do the impacts of economic and political troubles on migration vary by destination?

Separate analyses by destination show several important results (Table 2). First, as expected, education is a major determinant of migration to Europe and North America, but much less so for African migration. Rates of first migration to Europe and North America are more than ten times higher among people with higher education than among less educated people. Migrations to Africa are, on the other hand, more likely among people with secondary education. Interestingly, gender is a strong determinant of migration, but with opposite effects for migration to African and to Western countries. Migration rates to Europe and North America are more than 50% higher among females, while migrations to Africa are more frequent among males. For both destinations, single persons are, as expected, significantly more likely to migrate.

Table 2. Event-history models of first international migration by destination of migration, Kinshasa (DR Congo), 1975-2007 (results expressed as rate ratios).

Variables	**Categories**	**Destination**	
		Africa	Europe & N.A.
Education	No / primary	1.00	1.00
	Secondary	1.69**	4.98***
	Higher education	1.28 (ns)	11.62***
Gender	Males	1.00	1.00
	Females	0.57***	1.58***
Marital status	Ever married	1.00	1.00
	Never married	1.77***	2.41***
Year (linear trend)		1.07***	0.97**
GDP growth (a)		0.89***	1.03 (ns)
Political troubles (b)		1.13*	1.41***
Sample size		4485	4485

Notes:
a) Average GDP growth rate over the two previous years (standardized variable)
b) Average index of political troubles over the two previous years (standardized variable)
Significance: *: p<0.10; **: p<0.05; ***: p<0.01; (ns) : not significant.

Macro-level variables also show different effects by destination. Migrations to Europe and North America seem completely independent from economic conditions, and vary only according to changes in political conditions. An increase of one standard deviation is associated with a 41% increase of migration rate to Western countries. Interestingly, the overall trend measured by the variable 'year' is negative: in other words, after controlling for political troubles in DR Congo, there is a slight decrease of migration rates to Europe and North America. It suggests that improving political conditions in origin countries is a major lever in stabilizing migration flows to Europe and North America.

Migrations to Africa, on the other hand, depend on both economic and political conditions. Bothe indices have similar (and expected) effects on migration (the GDP growth rate is more significant): an increase of one standard deviation in political or economic troubles corresponds to an increase in the rate of migration of a little more than 10%. The model also shows that there is a residual positive trend in migration rates, after controlling for political and economic troubles. Said differently, migration to Africa has been increasing, regardless of political and economic troubles.

7.2.3 Question #3: Is migration less selective according to education in times of crises?

Previous models have shown that political and economic crises influence migration. Economic and political troubles both influence migration to Africa, while migration to Europe and North America is influenced only by political conditions in the departure country. These models have also shown that migration propensities depend on individual characteristics. As explained earlier, crises may influence different categories of people in different ways. For instance, as shown by Massey and Capoferro (2006) in Peru, migration tends to be less selective according to education in times of economic crises. The third hypothesis we test in this section is that the impacts of economic and political conditions on migration depend on the level of education of individuals.

Table 3 shows the results of three models that include the interactions between education and the two macro-level variables (for all destinations, Africa, Europe & North America). The interactions between education and political conditions show a clear pattern, consistent across destinations: deteriorating political conditions have a significantly stronger impact on people with no education or primary education than on their more educated counterparts. On the contrary, economic conditions do not interact with education. In other words, the impact of deteriorating or improving economic conditions does not vary significantly by level of education.

As shown in the first model (all destinations), the rate ratio for the impact of political troubles on the less educated is equal to 1.83: an increase of one standard deviation in the index of political troubles is associated with an 83% increase in the rate of first migration. In contrast, political troubles are not associated with a significant increase in migration among people with higher education (rate ratio equal to 1.17, not significant). A similar (but less pronounced) result is found for migration to Africa. On the other hand, the interaction between education and political troubles is very strong and highly significant for migration to Western countries. In periods of political troubles, rates of first migration increase more than threefold among the less educated, while they change more slightly among the more educated (rate ration equal to 1.30).

Table 3. Event-history models of first international migration by destination, including interactions between education and economic and political troubles, Kinshasa (DR Congo), 1975-2007 (rate ratios).

		Destination		
Variables	**Categories**	**All destinations**	**Africa**	**Europe & N.A.**
Education	No / primary	1.00	1.00	1.00
	Secondary	2.82***	2.07**	9.36***
	Higher education	3.21***	1.59**	23.47***
Gender	Males	1.00	1.00	1.00
	Females	0.78*	0.57***	1.57***
Marital status	Ever married	1.00	1.00	1.00
	Never married	2.05***	1.79***	2.45***
Year (linear trend)		1.02*	1.07***	0.97***
Interactions				
GDP growth (a) * Education	No /primary	1.09 (ns)	0.99 (ns)	1.05 (ns)
	Secondary	0.93 (ns)	0.85 (ns)	1.05 (ns)
	Higher education	1.03 (ns)	1.00 (ns)	1.00 (ns)
Political troubles (b) * Education	No /primary	1.83***	1.46 **	3.51***
	Secondary	1.24 (ns)	1.12 (ns)	1.47 (ns)
	Higher education	1.17 (ns)	1.00 (ns)	1.30 (ns)
Sample size		4485	4485	4485

Notes:
a) Average GDP growth over the two previous years (standardized variable)
b) Average index of political troubles over the two previous years (standardized variable)
Significance: *: p<0.10; **: p<0.05; ***: p<0.01; (ns): not significant.

Another way of interpreting this interaction is to look at the impact of education in period of political crises vs. periods of relative political stability. As shown on Figure 5, rates of migration are much higher in periods of intense political crises (corresponding to the average plus two standard deviations of the indicators) than in periods of political stability. This figure also clearly shows that the impact of crises is stronger among the less educated than among the more educated (measured by the ratio of the black bar to the grey bar). In other words, migration is much less selective according to education in periods of political troubles than in periods of political stability. However, as is also clear from this figure, the more educated are much more likely to migrate than their less educated counterparts, even in periods of political troubles.

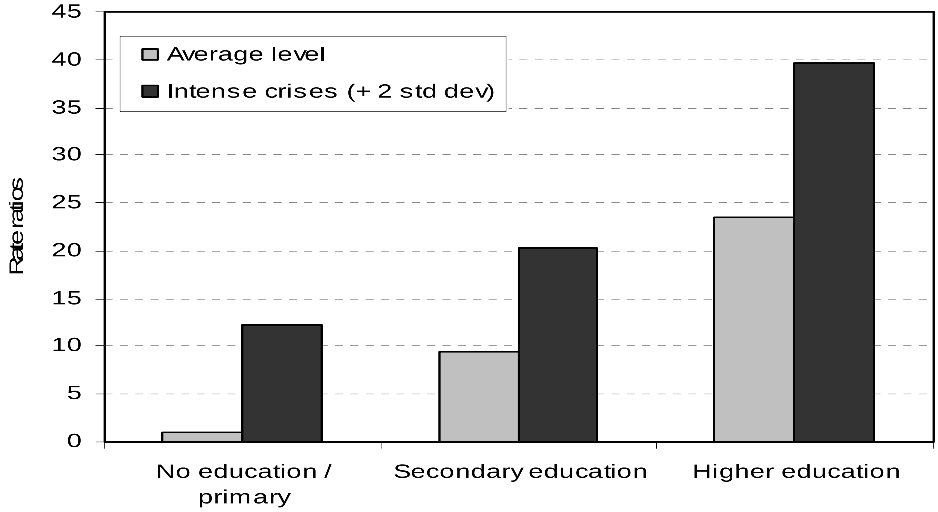


Figure 5 . Impact of economic and political troubles on migration to Western countries, by level of education.

8. Discussion and Conclusion

Using recent retrospective data and event history models, we have shown that international migration from DR Congo since the mid-1970s has been clearly influenced by political troubles and, to a lesser extent, by economic crises. Periods of political instability and wars have contributed to significantly higher risks of migration, especially to Europe and North America, but also to Africa. The graphical analyses and the robust results of event history models show clearly that international migration and political crises are closely related in DR Congo. This expected impact of political crises is in line with results in other parts of the world (Moore and Shellman 2004; Stanley 1987), and suggests that improving political conditions in departure countries contributes to stabilizing migration flows. The recent slowdown of migration from DR Congo (since 2002) illustrates this influence of the improvement of the political conditions in DR Congo on migration.

Economic troubles have also increased migration, but their effect is less clear-cut than the impact of political troubles. Results suggest that, when controlling for political conditions in the models, deteriorating economic conditions only increase migrations to Africa. In contrast, migrations to Europe seem largely unaffected by economic conditions, and have varied essentially with the political situation in DR Congo. One possible explanation is that, in periods of crises, the availability of resources to migrate to distant places may not be available. Although desires to move may increase, the financial resources may be lacking. This result should be qualified however. First, economic troubles and political troubles are not independent from each other. Models including only economic indicators show that economic troubles increase migration when all destinations are considered together (the coefficient is also positive for migration to Western countries, but not significant). In other words, migrations do increase in periods of economic crises, but the association between economic conditions and migration is very much reduced when political conditions are taken into account. Secondly, the simple indicator of economic troubles that was used (GDP growth) may also partly explain that the impact of economic conditions is not significant. More refined indicators might lead to stronger results.[14] However, at this stage, it seems reasonable to say that political conditions clearly have a strong impact on migrations, while the effects of economic conditions are less conclusive.

Models including interactions between individual education and political and economic troubles have also shown that educated and uneducated people respond in different ways to crises (Figure 4). A consistent result across all the models is that political crises have a significantly stronger impact on migration among the less educated than among the more educated, and the impact is much stronger on migration to Europe and North America than on migration to Africa. This means that, in times of political crises, migration to Western countries is much less selective by education than in periods of relative stability. A similar result was found by Massey and Capoferro (2006) in Peru, although their work dealt with economic crisis. This might be interpreted, as in Massey and Capoferro's study in Peru (2006), as the result of different migration strategies prevailing in periods political troubles compared to more stable periods. Another reason, specific to the Congolese context, is that bilateral cooperation seriously slowed down in periods of political troubles. As a result, a decrease in the number of scholarships granted to Congolese students may have had an offsetting effect among the better educated on the increasing desire to migrate in period of political troubles.

Further work is needed on several issues. The mechanisms by which political and economic crises influence migrations have not been dealt with in detail in this paper. The analysis of in-depth interviews conducted with Congolese migrants will provide further insight into the motivations of migrations in times of crisis. Retrospective quantitative data collected in Kinshasa among non migrants may also help understand the way crises influence migration. These data include information on migration attempts, which can be compared to data on effective migration (sued in this paper). Such data make it possible, for instance, to estimate if increasing migrations in times of crises reflect increasing desires to migrate (higher migration attempts), or a higher "success rate" of migration attempts (i.e. higher probability that an attempt is transformed into an effective migration). Using more refined indicators, especially of economic troubles, may also lead to a better understanding of the links between crises and migration.

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[14] Preliminary tests with another indicator, measuring change in GDP growth, rather than GDP growth, indicate that when growth rates are going down migration increase.

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Determinants of Reconstruction After Major Earthquakes in Taiwan

Ts'ui-jung Liu

Abstract

Taiwan is located on the Circum-Pacific seismic zone where earthquakes occurred frequently. Some of these earthquakes can be disastrous. For instance, the 1935 Hsinchu-Taichung Earthquake, which measured 7.1 on the Richter scale, caused 3,279 deaths and 61,682 houses damaged; the 1999 Chichi (Jiji) Earthquake (7.3 on the Richet scale) caused 2,505 deaths and 103,961 houses damaged. Moreover, strong earthquakes have also triggered dangerous landslides, which further aggravated victims' misery and complicated relief efforts. This study attempts to make a comparison of the above-mentioned two earthquakes by investigating measures of reconstruction undertaken by both the government and nongovernmental groups. Using general population trends of Taiwan as a background, the focus of this study will be on the resettlement of people in stricken areas, with special emphasis given to villages endangered by landslides triggered by earthquakes and occasional heavy rains.

1. Major Earthquake Disasters in Taiwan

Taiwan is located on the Circum-Pacific seismic zone, one of the three main seismic zones around the world. Before seismographic records were available, abundant historical records made it possible for seismologists to identify major earthquakes that occurred in Taiwan (Tsai Yi-ben 1978; Hsu Ming-tung 1983). During 1644-1896, nine earthquakes measuring above 7 on the Richter scale were identified: Taipei (1694/4/24-5/23), Chiayi-Tainan (1736/1/30), Chiayi (1792/8/9), Chiayi-Changhua (1815/10/13), Yilan (1816/9/21-10/20), Yilan (1833/12/13-30), Changhua (1848/12/3), Taipei-Keelung (1867/12/18), and Taiwan (1882/12/9-16). Based on seismographic records during 1898-1997, ten disastrous earthquakes have been identified as listed in Table 1 (Cheng Shih-nan et al. 1999).

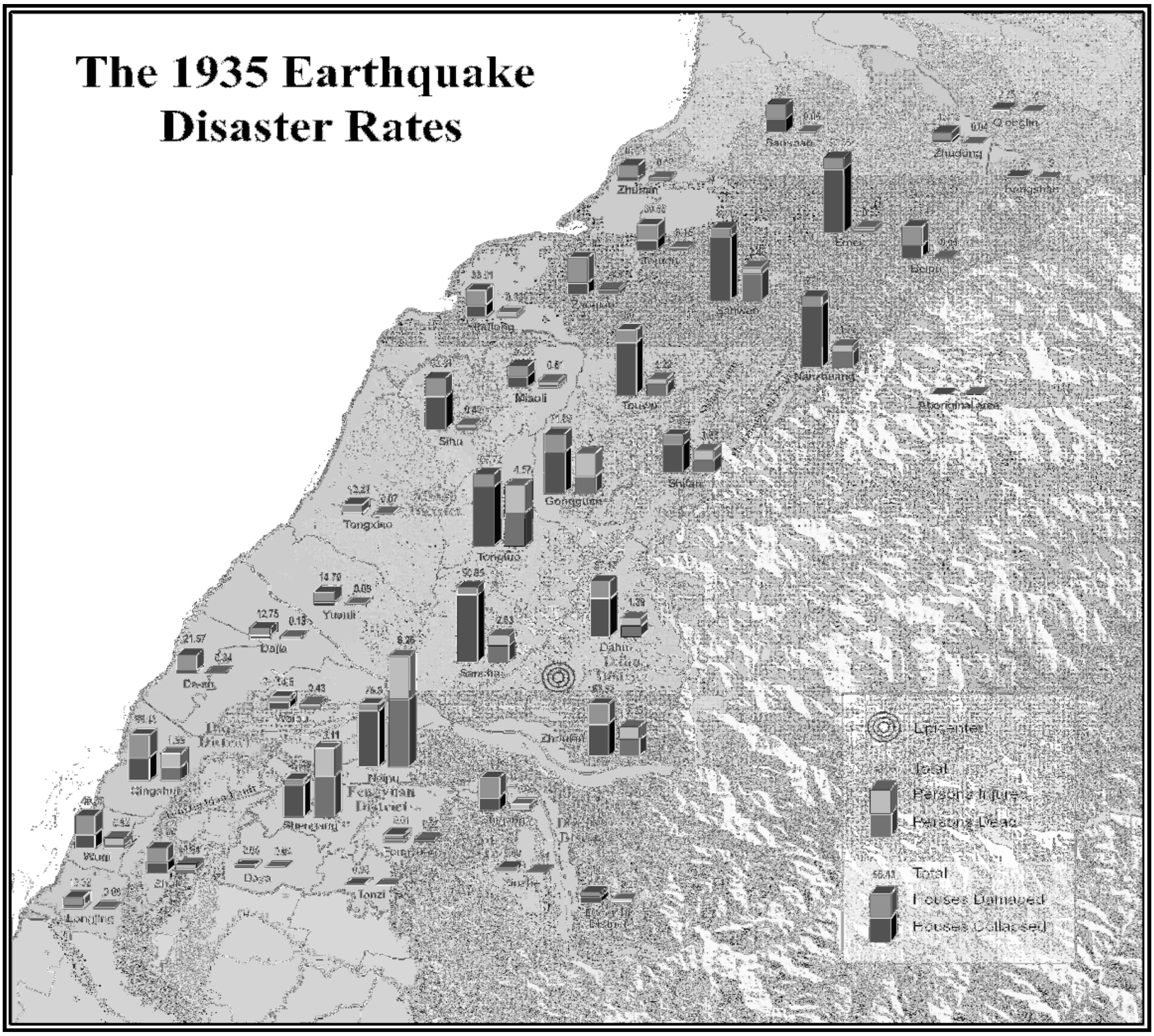
Of these ten major earthquakes, the 1935 Hsinchu-Taichung Earthquake, also known as the Tunzijiao Earthquake or the Guandaoshan Earthquake, was the most disastrous with 3,279 persons killed, 11,971 injured and 61,685 houses damaged. The stricken areas in Hsinchu Prefecture were located in today's Taoyuan County, Hsinchu City, Hsinchu County, and Miaoli County; those in Taichung Prefecture were in today's Taichung City, Taichung County, Changhua City and Changhua County.

Table 1. Ten disastrous earthquakes that struck Taiwan during 1898-1997.

Name of Earthquake	Time	Scale (M_L)	Focus (Km)	Persons Dead	Persons Injured	Houses Damaged*
Touliu	1904/11/06 04:25	6.1	7.0	145	157	3790
Meishan	1906/03/17 06:43	7.1	6.0	1,258	2,385	22,017
Nantou Sequence	1916/08/28 15:27	6.8	45.0	16	159	5,512
	1916/11/15 06:31	6.2	3.0	1	20	1,078
	1917/01/05 00:55	6.2	Very shallow	53	127	3085
	1917/01/07 02:08	5.5				
Hsinchu-Taichung	1935/04/21 06:02 Aftershocks	7.1	5.0	3,279 44	11,971 430	61,685 8,538
Chungpu	1941/12/17 03:19	7.1	12.0	361	729	78,783
Hsinhua	1946/12/05 06:47	6.1	5.0	74	474	1,971
Hua-Tung Longitudinal Valley Sequence	1951/10/22 05:34	7.3	4.0	68	856	2,382
	1951/10/22 11:29	7.1	1.0			
	1951/10/22 13:43	7.1	18.0			
	1951/11/25 02:47	6.1	16.0	17	326	1,616
	1951/11/25 02:50	7.3	36.0			
Hengchun	1959/08/15 16:57	7.1	20.0	17	68	3,720
Paiho	1964/01/18 20:04	6.3	18.0	106	650	39,671
Hualien	1986/11/15 05:20	6.8	15.0	15	62	267

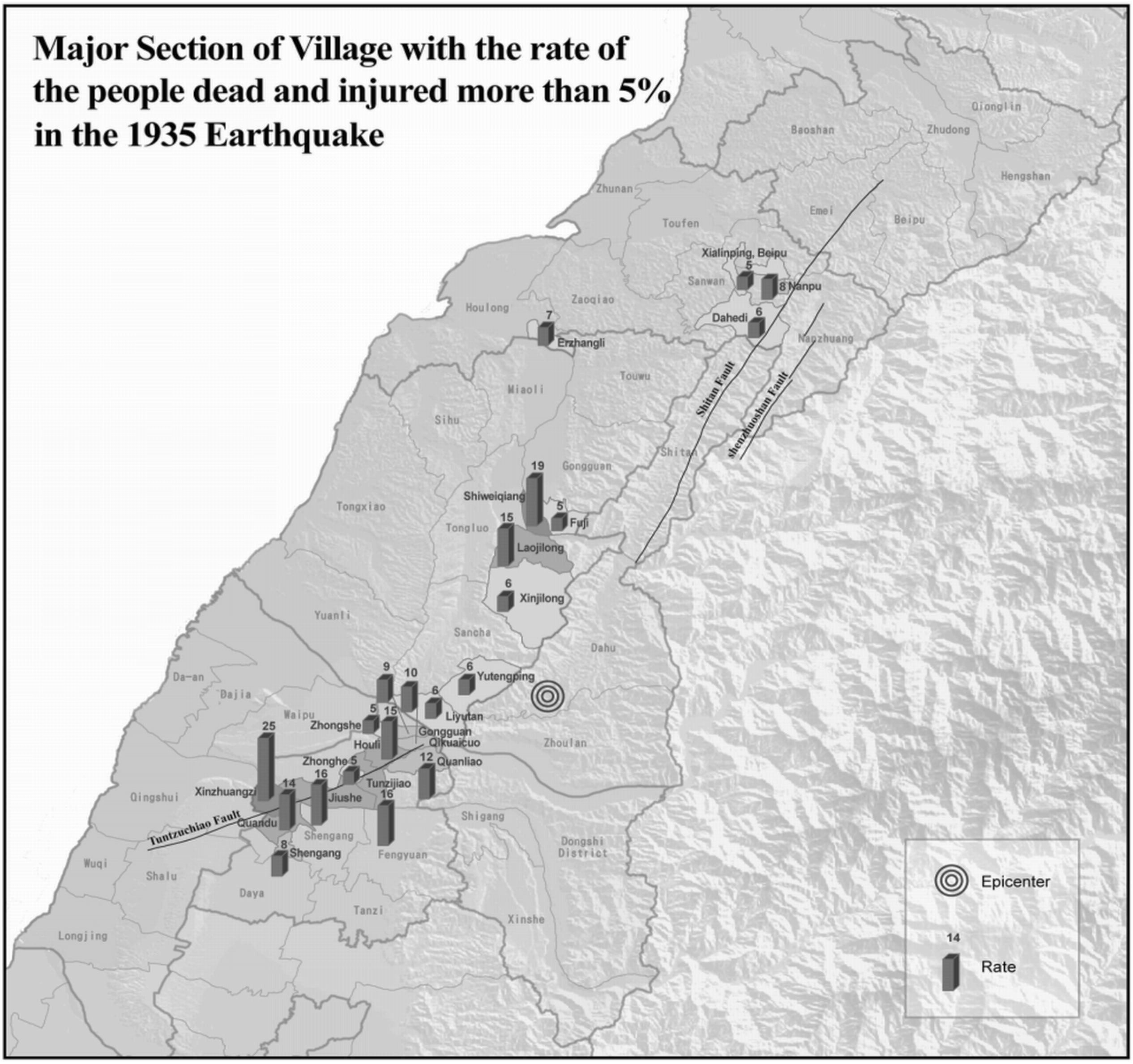
Note: * Including entirely and partially destroyed as well as major and minor damage.

The earthquake disaster records of the Taiwan Governor-General Office reveal that the most seriously stricken places were in today's Miaoli County and Taichung County; the former had 36.9% of all casualties and 49.8% of houses damaged, while the latter had 61.6% and 39.5% respectively (TGO 1936, 20-58). The rates of disaster were calculated according to the population and households at each Major Section of Village (*ōaza*, hereafter MSV) under each District (*gun*). Among the seven Districts, Fengyuan (in today's Taichung County) ranked on the top in terms of all casualties with 3.93% and Dahu (in today's Miaoli County) ranked on the top in terms of houses damaged with 61.17% (TGO 1936, 83-100) (See Map 1).



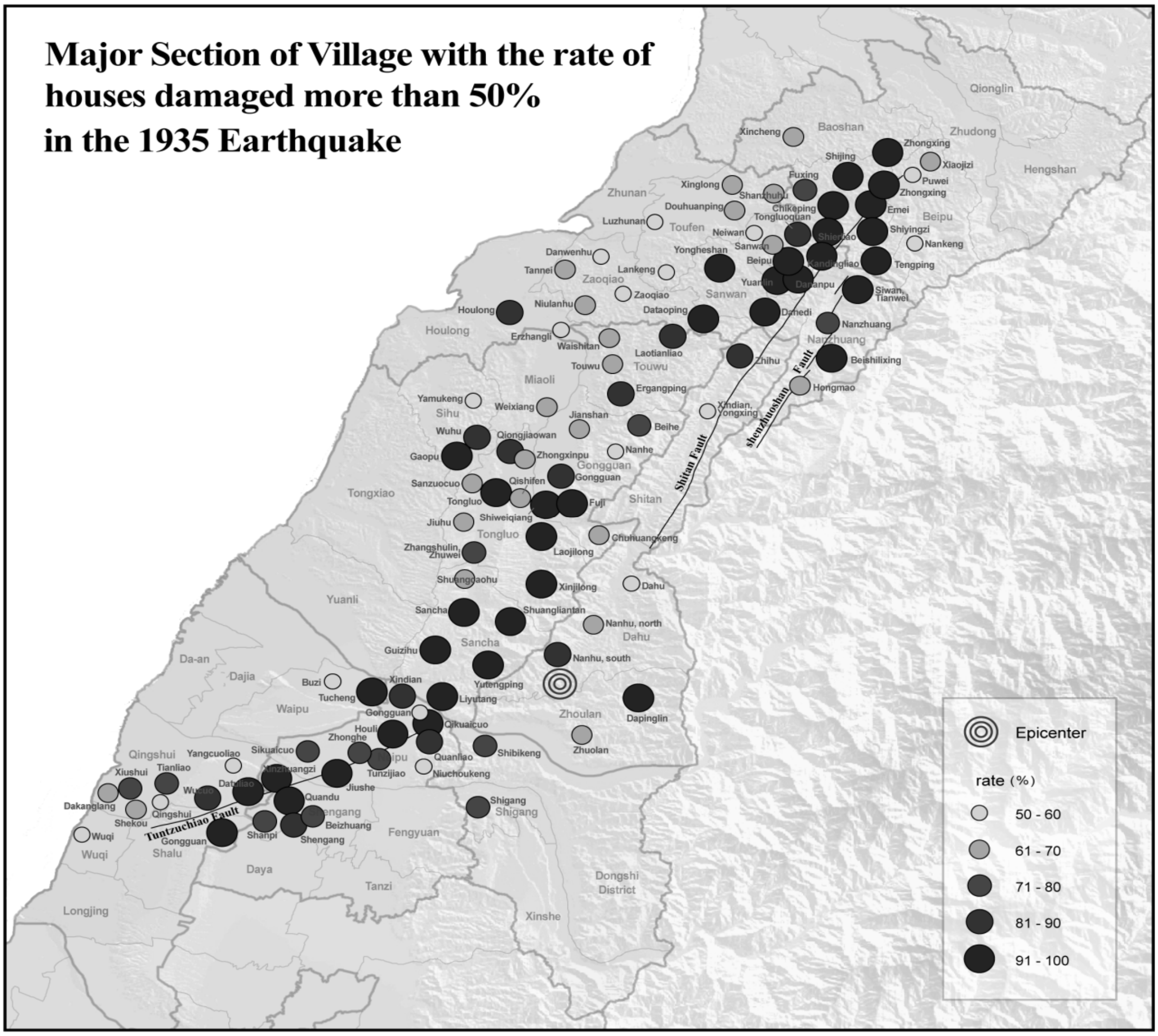
Map 1. The 1935 Earthquake disaster rates.

There were 22 MSV suffering more than 5% of the people dead and injured. These MSV made up 7% (22/314) of the total. Fengyuan District had 11 MSV, with Xinzhuangzi (25%), Tunzijiao (16%), Jiushe (16%), and Houli (15%) ranked on the top. Zhunan District had 5 and Miaoli District had 6 MSV; among them Shiweiqiang (19%) and Laojilong (15%) ranked on the top (See Map 2).



Map 2. MSV with more than 5% of the people dead and injured in 1935.

There were 157 MSV (50% of the total) that experienced more than 25% of houses damaged, with 19 of them having rates that reached 100%. Of these 19 MSV, 8 were in Zhunan, 5 in Miaoli, 4 in Zhudong (in today's Hsinchu County), and 1 each in Fengyuan and Dajia (in today's Taichung County) (See Map 3).



Map 3. MSV with more than 50% of the houses damaged in 1935.

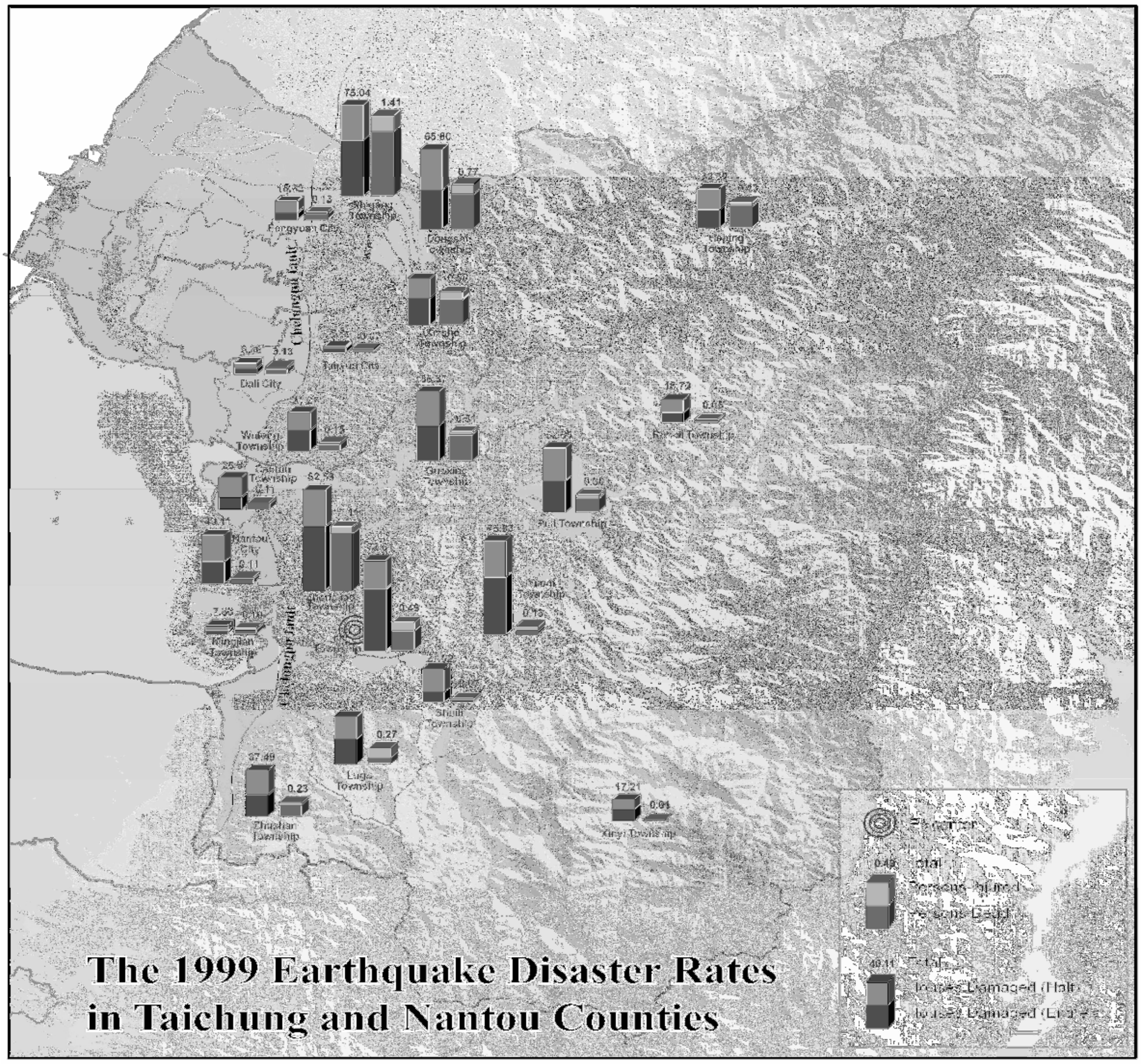
Among the most seriously stricken MSVs, Xinzhuangzi ranked on the top with 25% of the people dead and injured and 100% of houses damaged, while Tunzijiao, the village closest to the epicenter, had 16% and 76% respectively. However, in terms of sheer number, Tunzijiao recorded 641 casualties and 555 houses damaged, while Xinzhuangzi recorded 280 and 150 respectively.

The 1935 Earthquake did not cause any disasters in today's Nantou County, which belonged to Taichung Prefecture at that time. However, four earthquakes struck this area in 1916 and 1917, particularly two very shallow earthquakes occurred on 5 and 7 January 1917 in Puli had caused notable damage as shown in Table 1.

Another earthquake measuring 7.3 on the Richter scale occurred near the small town Chichi (Jiji) in Nantou County at 1:47 AM local time on 21 September 1999. It was known as the Chichi Earthquake or the 921 Earthquake. This was a shallow earthquake with the depth of focus measuring 8 kilometers. In total, it caused 2,505 persons to be dead or missing, 758 seriously injured, 50,644 houses destroyed, and 53,317 partially damaged. The stricken area covered 31 townships in 7 counties and 3 cities; of these, Nantou County and Taichung County were most seriously stricken (EYCR 2006, 4). In terms of people dead and injured, Nantou County's figures were 36.97% and 34.69%, and Taichung County's 47.87% and 52.87% of the total; in terms of houses destroyed and damaged, Nantou County counted for 54.26% and 53.81%, and Taichung County 36.21% and 34.53% of the total (calculated using the statistics in Hsieh Chih-cheng 2000, 2-5).

Based on Hsieh's figures and the 1998-99 average population and household data taken from statistical yearbooks, estimated disaster rates in Nantou County show that there were 0.17% of people dead, 0.05% seriously injured, 19.41% of houses destroyed, and 20.02% damaged. The 13 townships in the county all recorded disasters, with those ranking on the top including: Zhongliao, with 0.99% of people dead, 0.12% injured, 52.94% of houses destroyed and 29.65% damaged; Guoxing had 0.46%, 0.05%, 28.76% and 28.11% respectively; Jiji had 0.34%, 0.15%, 50.26% and 23.35% respectively; and Puli, where the largest numbers of calamities occurred, had 0.24%, 0.06%, 25.61% and 27.04% respectively. As for Yuchi, in terms of people dead and injured, it had 0.08% and 0.06 % respectively, but in terms of houses destroyed and damaged, it had 47.38% and 29.45% ranking just below Zhongliao.

In Taichung County, there were 0.08% of the people dead and 0.03% injured, with 4.93% of houses destroyed and 4.89% damaged. Of the 21 sub-divisions, only 9 recorded notable disasters; those ranking on the top included: Shigang, which had 1.12% of fatalities, 0.28% injuries, 45.95% of houses destroyed and 29.09% damaged; Dongshi had 0.61%, 0.17%, 31.96% and 33.84% respectively; and Xinshe had 0.43%, 0.14%, 21.97% and 16.23% respectively. It is notable that these three townships were under Dongshi District in 1935, and reported 0.3% of casualties and 19.5% of houses damaged in that earthquake (TGO 1936, 96-7) (See Map 4).



Map 4. The disaster rates in Taichung and Nantou counties in 1999.

In addition to dwellings and office buildings, 870 schools suffered damage, including 488 elementary, 168 junior high, 129 senior high and vocational, 4 special schools, and 81 colleges and universities. The loss of destroyed public works, such as electricity and communication facilities, railroads, roads, bridges, dikes, water supply and irrigation systems, could not be easily estimated. Several aftershocks measuring over 6 on the Richter scale accelerated the collapse of mountain slopes and triggered dangerous landslides, which added the misery of disaster victims (HRCT 2000, 303-96, 517-766; Hsieh Chih-cheng 2000,1, 208; EYCR 2006, 4-5).

2. General Demographic Trends in Taiwan

Did the earthquake disaster induce any demographic responses in Taiwan? In order to address this issue, general trends related to birth, death, marriage, old age, and migration are reviewed below based on available statistics (NTG, OCET, TCG).

Figure 1 illustrates population growth trends in Taiwan in terms of crude birth rates (CBR) and crude death rates (CDR).

During 1906-1960, the CBR in Taiwan was usually around or above 40‰, and once reached a peak of 49.9‰ in 1951. After the peak, the CBR started to decline, but it became lower than 20‰ only in 1984 and lower than 10‰ in 2002. As for the CDR, there were drastic fluctuations before 1920, but it declined from 33‰ in 1906 to 19.2‰ in 1930, then increased to slightly above 20‰ in 1934-1935, and from 1936 onwards became lower than 20‰. In the post World War II period, the CDR declined below 10‰ in 1952 and below 5‰ in 1970, but it rose again slightly above 5‰ in 1988 and above 6‰ in 2005. In terms of natural growth rate, despite occasional fluctuations, the difference between CBR and CDR held steady at above 20‰ until 1976 and declined to below 10‰ from 1994 onwards.

Comparing the CBR and CDR of Nantou County and Taichung County with those of Taiwan during 1966-2007, it is notable that the CBR of Nantou was lower than that of Taiwan during 1966-1978 and then became higher until 2005, while the CBR of Taichung was always higher than that of Taiwan. In contrast, the CDR of Nantou was always higher than that of Taiwan, while that of Taichung was more or less the same of Taiwan until 1987 and then became lower. It is also notable that the CDR reached a peak in 1999, with Nantou's rate (8.7‰) sticking out above those of Taiwan and Taichung (both 5.7‰).

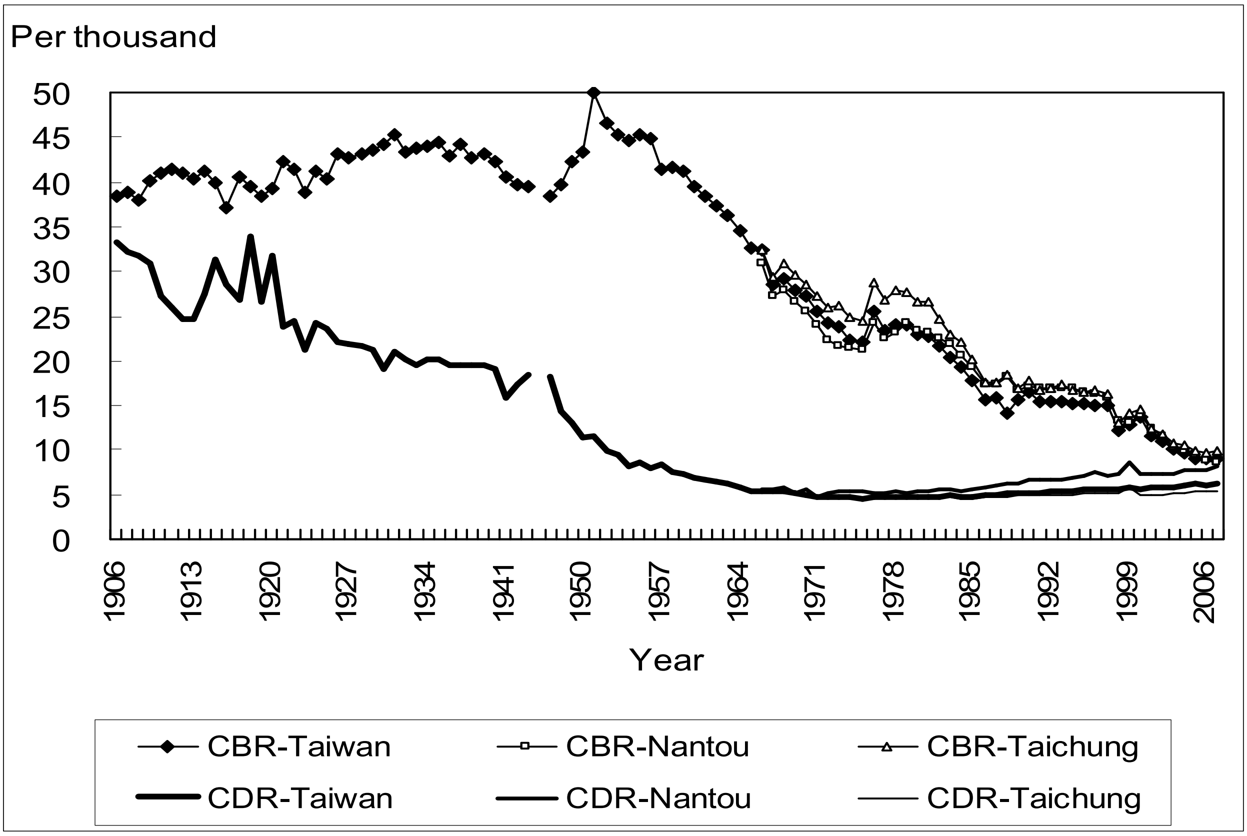


Figure 1. The CBR and CDR of Taiwan's population, 1906-2007 with comparisons to Nantou and Taichung counties, 1966-2007.

In respect to marriage, Figures 2 and 3 illustrate the rates of currently married, unmarried, widowed, and divorced people aged 15 and over. Figure 2 shows that the currently married rate in Taiwan increased from 57.3% in 1976 and peaked at 59.3% in 1989 before declining to 53.2% in 2007. In Taichung it was slightly higher than in Taiwan, reached a peak of 60.9% in 1989 before declining to 53.9% in 2007. In Nantou it became higher than in Taiwan in 1983, reached a peak of 61.7% in 1990 before declining to 54.2% in 2007. As for the unmarried rate, during 1976-2007, it declined from around 37% to 34% in Taiwan; it was slightly lower in Taichung until 1997, and then became slightly higher; in Nantou it became lower than in Taiwan in 1980, and became much lower after 1989 at around 31%.

Figure 3 indicates that during 1976-2007 the widowed rate was higher in Nantou than in Taiwan and Taichung. In Nantou the rate increased from 5.2% to 7.7%, in Taiwan from 4.5% to 5.8%, and in Taichung from 4.8% to 5.5%. As for the divorced rate, it increased constantly during 1976-2007, with a slightly higher rate in Taiwan than in Nantou and Taichung. The rate in Taiwan increased from 0.9% to 6.4%, in Nantou from 0.8% to 5.9%, and in Taichung from 0.6% to 5.3%.

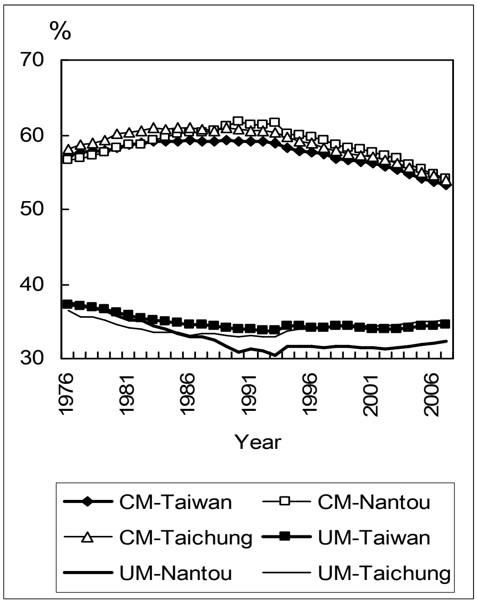


Figure 2. Rates of currently married and unmarried (15 years old and over).

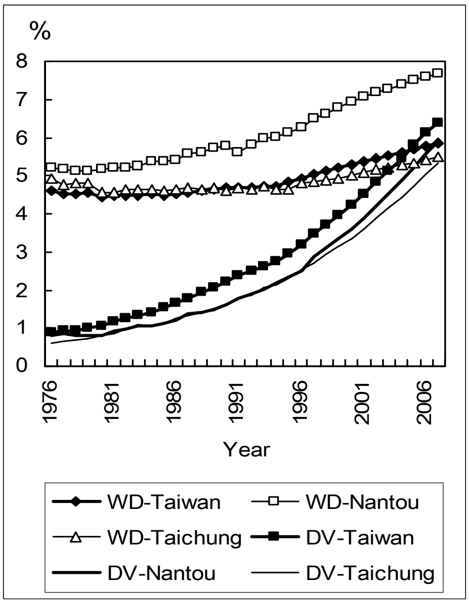


Figure 3. Rates of widowed and divorced (15 years old and over).

Figure 4 illustrates the old age rate (65 years and over) during 1976-2007. The rate in Nantou was the highest, increasing from 4.1% to 13.0%, as opposed to from 3.6% to 10.2% in Taiwan and from 3.7% to 8.5% in Taichung. The benchmark of 7% was reached in 1990 in Nantou, 1993 in Taiwan, and 1999 in Taichung.

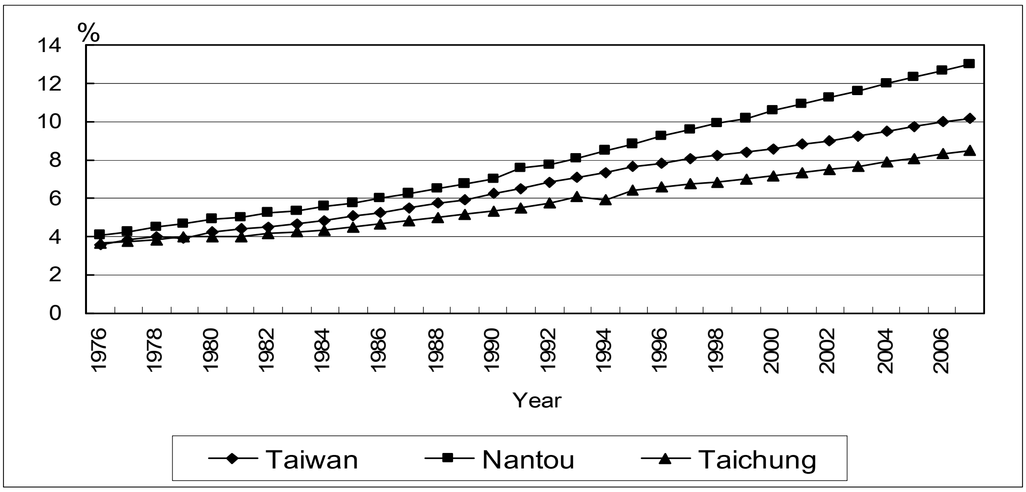


Figure 4. Old age rates in Taiwan, Nantou, and Taichung, 1976-2007.

Figures 5 and 6 illustrate the in-migration and out-migration rates in Nantou County and Taichung County during 1994-2007, and both reveal a declining trend.

It is notable that in Nantou County the out-migration rate was consistently higher that the in-migration rate, but the former increased in 1999-2000 and the latter decreased during 2000-2001. In Taichung County the in-migration rate was higher before 1999 but in contrast the out-migration rate became higher during 2000-2005.

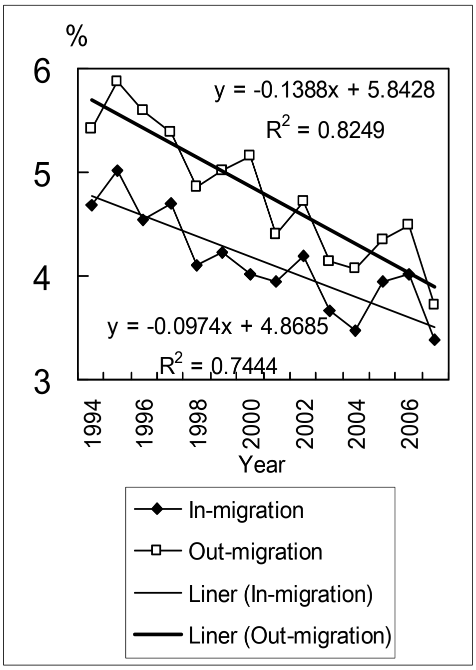


Figure 5. In- and out-migration rates in Nantou county, 1994-2007.

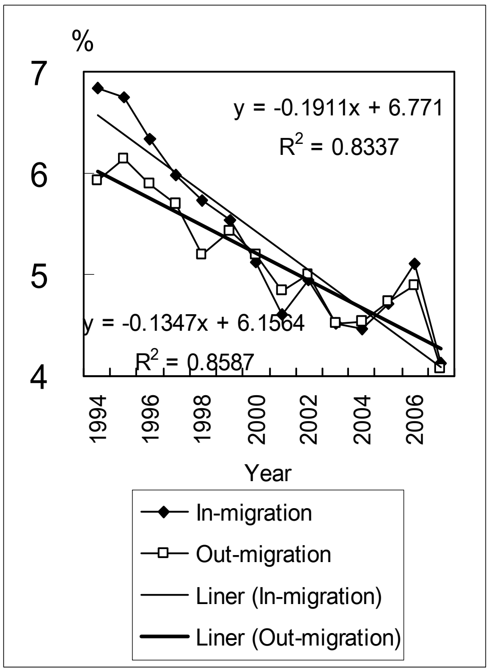


Figure 6. In- and out-migration rates in Taichung county, 1994-2007.

In sum, the demographic trends discussed above reveal that the 1935 Earthquake had an impact on the crude death rate. The 921 Earthquake had two forms of impacts: (1) The crude death rate in 1999 reached a peak, particularly in Nantou County and (2) In Nantou County, the out-migration rate increased during 1999-2000 and the in-migration rate decreased during 2000-2001; in Taichung County, the out-migration rate was higher than the in-migration rate during 2000-2005, in contrast to the previous trend. As for the consistent higher rates of widowed, old age, and out-migration in Nantou County during 1976-2007, they were apparently related more closely to long-term social, economic, and geographic conditions of the County.

It is notable that the *Taiwan Daily News* reported: several hundred people had emigrated by mid July 1935 from the earthquake affected areas to settle in Hualien, Yuli, and Fenglin on the East Coast (1935/7/21). An interview at Tunzijiao 60 years after the 1935 Earthquake revealed that in order to provide care for little children, it was not unusual for those who lost their spouses to remarry (Chen Mei-yi 2000).

3. Disaster Management after the 1935 and 1999 Earthquakes

Disaster management requires several phases of work: relief, rehabilitation, reconstruction and mitigation, with high levels of local participation proving most effective (Özerdem and Jacoby 2006,11-2). In below, the measures adopted after the 1935 and 1999 earthquakes will be presented in parallel as a means of comparison.

3.1 Government Responses

In 1935, after the earthquake occurred at 6:02 AM on April 21, a meeting was called at the Taiwan Governor-General Office at 3 PM to decide four principles of emergency rescue: (1) The Branch Office of Red Cross, the Health Department of Police Affairs Bureau, and all official hospitals should dispatch emergency rescue groups; (2) Local authorities should assume responsibility for handling donations and rescue materials; (3) A Rescue Fund should be set up at each prefecture for emergency rescue, and the money provided by the national treasury should be used expediently; and (4) The Director of the Domestic Affairs Bureau should visit the stricken area within 3 days to decide tax reductions for victims, and the Director of the Culture and Education Bureau should visit the stricken area on behalf of the Governor-General. The very next day, the Earthquake Rescue Office was set up under the Social Division of Culture and Education Bureau to handle donations, keep close contact with local authorities, decide rescue measures, and regulate supplies of rescue resources such as food, medicine, and construction materials (TGO 1936, 188-9, 193-6).

In 1999, after the earthquake occurred at 1:47 AM on 21 September, the Executive Yuan set up a Center for Managing the Major Earthquake at 2:30AM and announced 9 points of emergency management. At the same time, the Army was mobilized for emergency rescue. At 4:30 PM, a meeting at the Executive Yuan decided 15 points of emergency rescue. On September 23, a Center for Directing the Rescue was set up at Zhongxing Xincun in Nantou County. On September 25, the President announced 12 points of emergency order for carrying out rescue, rehabilitation, and reconstruction. On September 27, the Executive Yuan Committee for Reconstruction was established. On October 13, the Reconstruction Fund was set up for handling donations. On 3 February 2000, the Provisional Regulations for

Reconstruction after the 921 Earthquake were formally announced as bylaws for reconstruction. After the new government was inaugurated following the 2000 election, the Executive Yuan Committee for Reconstruction was reorganized and set up at Zhongxing Xincun on 1 June 2000. Local centers for disaster management were also set up in Taichung County and Nantou County (Wu Kun-mao 2004, 3-14, 49; EYCR 2006, 5, 22-32, 46-7).

3.2 Emergency Rescue and Medical Care

In 1935, personnel mobilized immediately for emergency rescue included police officers, police doctors, public health staffs, public doctors, local officials and staffs, youth corps, able-bodied corps, fire brigades, reservists, and social service groups. Each group took up different tasks. In addition, during April 21-27, the Army dispatched officers, while military hospitals in Taipei, Tainan, and Keelung sent military doctors to the most seriously stricken villages such as Tunzijiao, Xinzhuangzi, Gongguan, Dahu and Houli. During April 21-26, public hospitals in Taipei, Keelung, Yilan, Hsinchu, Taichung, Chiayi, Tainan, and Kaohsiung, the Branch Hospital of Red Cross and Patriotic Women's Society, and the Rehabilitation Hospital also sent rescue groups to stricken areas; some of these groups stayed until May 18 or June 29. Local official doctors and private doctors from many places also organized rescue groups and stationed at different localities. From April 21 to June 30, a total of 90,901 injured persons and 4,746 other patients received medical treatment. For children needing special care, five temporary nurseries were set up at Miaoli, Neipu, Shengang, Wuqi, and Shigang during the emergency rescue period (TGO 1936, 221-34, 264-9, 323-4).

In addition, several measures were taken to ensure public health in the stricken areas: (1) Supplying drinking water quickly at places where water supply systems or wells were damaged; (2) Keeping residential quarters clean; (3) Removing solid waste, as well as cleaning up waste water and sewage; (4) Cleaning up feces and urine; (5) Spreading disinfectant; (6) Eradicating mosquito, flies, and other harmful insects; (7) Paying special attention to toilets and drainages at shelters; and (8) Rigorously looking after the health conditions of people in stricken areas. In order to prevent outbreaks of infectious diseases, special attention was given to stop epidemic meningitis from prevailing again. Attention was also given to typhoid fever and other infectious diseases of the digestive organs. Local official doctors and private doctors were asked to report promptly any occurrence of infectious disease, and to investigate it carefully. Moreover, special attention was given to prevent malaria. Although epidemic meningitis did not occur, there were 55 cases of typhoid fever in Hsinchu Prefecture (22 in Zhudong, 5 in Zhunan, 27 in Miaoli, and 1 in Dahu) and 9 cases in Taichung Prefecture (1 in Dongshi and 8 in Fengyuan). There was also one case of dysentery in Dahu District. The number of people infected with malaria doubled in Hsinchu, although there was no increase in Taichung Prefecture (TGO 1936, 307-9).

Once all efforts were being devoted to emergency care of injured people, from the fifth day after the earthquake a medical group led by Yang Zhao-jia, a leader of local self-governing movement, started to do health examinations for people and to provide free medicine. Still, diseases made people miserable in some places. The principal of a school recalled that malaria prevailed in September-November, with

70% of residents at a village in Zhunan being infected. A school teacher at Neipu said that 10-15% of pupils were absent due to typhoid fever, malaria, and influenza. It is also notable that by mid-May more than 10 cases of mental disorder were found at Neipu and Shengang (Sen and Wu 1996, 114, 143, 152, 156-7).

In 1999, more than 400 medical personnel from 50 institutions were mobilized and sent to the stricken areas, while all seriously injured persons were delivered to major hospitals nearby within 12 hours after the earthquake. Within 40 hours, a medical station had been set up at each township. In addition, non-governmental and religious groups recruited more than 20,000 volunteers in just a few days to assist rescue operation. There were also 40 emergency rescue groups with 767 personnel, as well as 99 dogs and equipment dispatched from 19 countries and the United Nations (EYCR 2006, 51, 56, 127).

In order to prevent outbreaks of epidemics, the Centers for Disease Control formed a guiding group on 22 September, while monitoring groups were set up at each township on 28 September. By the end of November, at Ren-ai Township, Nantou County, it was found that cases of bacillary dysentery did not increase significantly compared to levels in previous years. Except for this, no other infectious diseases were found. To ensure a healthy environment, disinfectant was spread immediately and corpses taken care of. Solid waste was quickly removed and more than 3,000 mobile toilets were set up at various places. For protecting high-risk groups, a vaccination station was set up on October 1; people aged 65 and over received the influenza vaccine, while cooks at shelters received the hepatitis-A vaccine. There were also 6,000 doses of tetanus vaccine delivered to major hospitals. From September 22, psychological consulting services were provided at medical stations, funeral parlors, and shelters; a special 24-hour telephone line was also set up. Some medical schools sent psychiatrists to do surveys within one month after the earthquake, and found that those suffered from symptoms of post-traumatic stress disorder constituted 50-70% of 308 at Yuchi Township and 35.7% of 157 at Xinshe Township. It is also notable that by 19 February 2000, in Nantou County 32 persons had committed suicide (EYCR 2006, 56-61; Huang Hsiu-cheng 2005, 439; Chen Yi-shen 2000, xii).

3.3 Condolences

In 1935, the Emperor of Japan bestowed ¥50,000 each for the afflicted prefectures for condolences. In principle, ¥10 was given for each death, ¥6 for each serious injury, ¥1 for each light injury, ¥1.2 for each destroyed house, and ¥1 for each damaged house. The Emperor's donations were used mainly for memorial ceremonies, medical care, and construction materials. Moreover, Japanese imperial princes and noble families donated ¥1,500 for each of the two prefectures and the Emperor of Manchukuo bestowed ¥10,430 for each as well; these bestowals were used for the relief of poor people (TGO 1936, 291-6, 301, 318-22).

In 1999, the government provided NT$1 million for each fatality, NT$0.2 million for each serious injury and each destroyed house, and NT$0.1 million for each damaged house. Altogether, NT$18,116.7 million were used for these purposes

(EYCR 2006, 79). If the wholesale price of brown rice is taken to gauge material value, in 1935 ¥1 could buy 2.8 kg, while in 1999 NT$1 could buy 0.04 kg (Liu Ts'ui-jung 2001, 148; Council of Agriculture 2000, 132).

3.4 Relief and Rehabilitation

In 1935, local officials from the Division of General Affairs and the Division of Police Affairs supervised and carried out the relief work with the assistance of various local groups such as the heads of neighborhood systems (*hokō*), reservists, youth corps, able-bodied corps, and social-welfare groups (TGO 1936, 184).

In Hsinchu Prefecture, rationed goods included food, clothes, and construction materials. During the first five days, cooked rice was provided to all victims whose houses had been heavily damaged, but afterwards only to the poor people. Water supply systems were restored in three days after rush repairs. Rationed foods like rice, soy sauce, pickled radish, salt fish, and salt, were provided on the first two days to all victims, but from the third day on only to the poor until May 6, when rescue money was distributed. Later, the Taiwan Governor-General Office allocated donations for distribution to the poorest. For shelter, there were 17 public buildings not destroyed by the earthquake, 105 newly built emergency shelters, and 3,773 huts. Town and village authorities also proceeded to build 1,033 dwellings with loans of ¥103,300 provided by the national treasury. Moreover, 358 dwellings for the poor were built at 17 locations with donations of ¥50,000 allocated by the Taiwan Governor-General Office and ¥3,750 by the Prefecture Office (TGO 1936, 185-6, 309-10, 410-11).

In Taichung Prefecture, a sum of ¥183,522 was allocated from the Rescue Fund for distributing rationed foods and construction materials. The water supply problem was solved on April 25 after rush repairs. As Taichung City was nearby and resources were relatively abundant in the prefecture, relief work was carried out smoothly and quickly. Cooked rice was provided on April 21-22 at places needed, but in most cases rationed food was provided until early May. It is notable that a survey was conducted by members of social-welfare committees (*hōmen iin*) at many places to identify those really needing relief. As a result, from May 4 to June 3, rationed goods were given only to 1,057 poor households with 4,837 persons. During that period, more detailed surveys were done in order to decide how to distribute money from the Rescue Fund. As the weather was turning warmer, heavy clothes were not needed but shelters and huts were quickly constructed at safe places for rehabilitation; a survey in late April reported that 7,350 units were built at various districts. The victims were also encouraged to rebuild their own houses; those who paid less than ¥300 in household tax had priority for receiving loans. Shortages of building materials like zinc plates were quickly made up through a report to the Taiwan Governor-General Office, and supplies were hastily shipped from Japan. In total, town and village authorities built 1,949 dwelling houses with loans of ¥194,900 provided by the national treasury. Moreover, there were 333 dwellings for the poor built at 8 locations with donations allocated by the Taiwan Governor-General Office (TGO 1936, 186-8, 310-12, 411).

In 1999, materials such as food, bottled water, clothes, blankets, and tents were sent immediately by various non-governmental and religious groups for the relief effort. While supplies were rather abundant, regrettable problems of uneven distribution, inappropriate hoarding, and wastefulness occurred (EYCR 2006, 64).

For rehabilitation, a policy of three alternatives was adopted for victims to choose from: (1) To apply to live in temporary assembled houses for a certain period of time, (2) To purchase public housing at a 30% discount, and (3) To apply for a subsidy to rent a private house. For the first alternative, there were 5,854 temporary assembled houses built at 112 locations, of which 4,031 (68.9%) were at 81 locations in Nantou County, 1,481 (25.3%) at 23 locations in Taichung County and the rest in other counties. Of these 112 locations, 39 were built by the government, 56 by philanthropic groups, and 17 by private enterprises. In October-November 1999, the Japanese Government delivered 1,003 assembled houses once used after the 1995 Ōsaka-Kōbe Earthquake; these were reassembled at 10 locations in Nantou County, 2 in Taichung City, and one each at Taichung and Miaoli Counties. Two types of households were qualified to apply for living in the assembled houses: (1) Those whose houses had been damaged and (2) Minority households, such as low and medium income, handicapped, old people living alone, and single-parent families. The government provided them with subsidies for water and electricity fees, management fees, and land rent. The policy adopted was to rebuild damaged houses before demolishing assembled houses. In practice, the allotment started from October 1999 and extended until February 2006. By the end of June 2005, already demolished were 4,393 units (75%), but 807 households, of which 364 (45%) were at Puli, still awaited further arrangements. For ensuring the health of those living in assembled houses, physical examinations were conducted for 28,936 persons up to December 2002 (EYCR 2006, 64-74, 297-8).

For the second alternative, from 12 October 1999 to 4 February 2005 those who purchased public housing totaled 1,198 households; among them 628 (52.4%) were relocated in Taichung City and 111 (9.3%) in Nantou County. It is notable that 749 (62.5%) of these households completed purchases by 29 October 1999, and another 252 (21%) by 24 March 2000 (EYCR 2006, 75-8).

The third alternative was carried out over three years (1999/10-2002/10) in different practices. In the first year, each person from a household whose owned house had been damaged was qualified to receive NT$3,000; a total of 316,960 persons received this subsidy. In the second year, 6,307 households were qualified according to the following three categories: (1) Their owned house had been destroyed and they had received the first-year subsidy, (2) Their owned house had been partially damaged and subsequently demolished, so they rented a house with a contract, and (3) Low and medium income households with houses partially damaged. In the third year, the subsidy was only provided for 4,196 minority households to improve their housing conditions. Altogether, these housing subsidies totaled NT$12,168.48 million (EYCR 2006, 80-3, 271-4).

For assisting the unemployed, four measures were adopted: “giving relief by providing labor”, temporary work allowances, employment for reconstruction, and job training. Stations were set up at 25 townships for helping the unemployed to apply for a job. Up to 12 February 2001, there were 9,601 applicants and 3,666 (38.2%) of them got employed. Other results included: (1) From October 1999 to March 2000, the practice of “giving relief by providing labor” recruited 135,794 persons/days to clean up the stricken areas; (2) From February 2001 to January 2004, temporary work allowances were given to 13,157 persons; (3) By the end of March 2000, plans were drawn up at 33 townships to provide work for 135,794 persons; (4) From 2 October 2000 to 10 July 2001, reconstruction work employed 6,515 persons; (5) From 31 October 1999 to 31 December 2003, there were 831 job training classes and 8 special courses, which together benefited 30,533 persons; (6) From late 1999 to the end of 2002, job training for middle-aged people benefited 3,010 persons; and (7) In July-October 2003, 61 programs were approved for minority groups, with 417 persons being employed (EYCR 2006, 84-6, 301-11).

3.5 Reconstruction

In 1935, the Taiwan Governor-General Office organized a Committee for Reconstruction on April 29 to handle the task. The first meeting decided that the national treasury should provide loans at low interest rates for the following tasks:

(1) The reconstruction of public buildings; (2) The adjustment of prefectural finances; (3) The reconstruction of irrigation systems; (4) Urban planning for small towns and villages, and reconstruction of dwellings at these selected localities; and (5) The revival of the tea, straw hat, and silk manufacturing industries. Moreover, on May 31, a notification concerning dwellings was delivered by the Director-General to the two Prefects, and on July 1 the two prefectures announced their own regulations to stipulate standards for dwellings to be built with concrete in order to replace those mud brick houses destroyed by the earthquake (TGO 1936, 355-61, 395-407).

A few more words are needed for urban planning and reconstruction. Urban planning involved two types of locations: (1) Small towns that had more than 500 households, of which more than 50% of houses were in dangerous condition and (2) Small villages that had more than 100 households, of which more than 70% of the houses were entirely or partially damaged. There were 11 locations belonging to these categories in Hsinchu Prefecture and 7 in Taichung Prefecture. The urban planning program involved standards for streets, dwellings, sewage, green stretches, parks, and public squares. Total expenditures for urban planning amounted to ¥324,912 in Hsinchu and ¥422,453 in Taichung; both had 40% provided by the national treasury and the rest by the prefecture. As for reconstruction of dwellings, 5,543 (63.6% of the total households) were completed at the 11 locations in Hsinchu and 5,340 (75.7%) at the 7 locations in Taichung. Of these 18 locations, 6 had the rates of reconstruction reaching 100%, namely Tongluo (583 households), Nanzhuang (344), Gongguan (405), Tunzijiao (712), Shigang (476), and Shengang (330). The cost of house reconstruction totaled ¥2,851,600, of which 5% were subsidized by the national treasury and another 5% by the prefecture. The subsidies were provided over two years, 60% in 1935 and 40% in 1936. Of the total 10,883 households that needed reconstruction, 3,754 lacked the ability to borrow money and 2,628 (70%) of them were resettled at housing operated by towns and villages with loans of ¥262,800 provided by the national treasury. Apart from these 18 locations, there were 12,723 households (9,531 in Hsinchu and 3,192 in Taichung) that obtained a loan of ¥400 each for rebuilding their homes (TGO 1936, 392-4, 407-11).

In 1999, seven programs were initiated for reconstruction. Major results by the end of June 2005 are summarized below (Huang Hsiu-cheng 2005: 22-70; EYCR 2006, 342-434): (1) A total of 30,757 households completed rebuilding their own houses. (2) There were 139 partially damaged aggregated buildings, comprising 16,891 households, which completed repairs. As for the 162 destroyed aggregated buildings, 44 were rebuilt at their original locations, 5 at other places, 99 as part of the urban renovation program, and 14 still in negotiations for consensus among the households. (3) Old streets at three townships were renovated: Zhongliao had reconstructed 84.7% of the 157 households, Guoxing 83.5% of the 139 households, and Dongshi 97.4% of the 115 households. (4) For the development of new communities, two types of housing were built: one for sale and the other for rent or for helping minority households. Nantou County built 348 and 223 housing units of these two types, Taichung County built 184 and 198 respectively, and Yunlin County built 385 housing units for sale. (5) For rural settlements in Taichung, Nantou, Yunlin, and Chiayi Counties, a total of 1,133 houses were rebuilt, of which 1,068 (94.3%) were in Nantou. (6) For the 12 villages threatened by landslides, safety engineering was completed at 5 villages and thus villagers decided not to move. Otherwise, new communities were constructed for relocation. In Nantou County, Beimei New Community was constructed at Puli for accommodating 184 households and Qingfeng Community at Zhongliao for 20 households. In Taichung County, Sanchakeng Community was built at Liberty Village in Heping Township for 45 aboriginal households. (7) A total of 6 aboriginal villages needed relocation; 2 of them (including Sanchakeng) had completed moving, 3 were under construction, and 1 was in the process of acquiring available land. At another 16 aboriginal villages needing reconstruction, 663 (61.8%) of the 1,072 destroyed houses had been rebuilt and 846 (84.6%) of the 1,000 partially damaged houses had been repaired.

The above seven programs involved 32,735 households and they together applied for loans of NT$57,872.07 million. Of these, 30.7% of the households used 48.0% of loans to purchase houses, 32.6% of the households used 38.8% of loans to rebuilt houses, and 36.7% of the households used 13.2% of loans to repair houses.

A few more words are needed for the relocation of villages that were threatened by landslides. In addition to loans, the Qingfeng Community at Zhongliao was fortunate to receive an overseas donation of NT$10 million from Hong Kong which reduced the average burden of the 20 households to less than NT$1 million. The Community gratefully celebrated relocation on 7 February 2004 (*News Express*; EYCR 2006, 410). The story of moving from Wugong Village to the Beimei New Community at Puli did not have such a happy ending. The threat of landslides turned very urgent after heavy rains on 21 February 2000, and a local committee was formed to plan for relocation. After several meetings, a survey was completed on 15 March 2001, and 148 households expressed willingness to move with indications of sizes of houses they desired. On 25 April, a site of 3.4 hectares to be provided by the Taiwan Sugar Company was approved. On 9 July, the Nantou County Government assumed responsibility for construction, but the plan was delayed due to election of a new county magistrate. Finally, Beimei New Community was completed on 28 October 2004; however, many people who had originally planned to move had changed their minds. In fact, 84 of the 184 units were still vacant by March 2008 and by the end of June all were sold off at the same low price of NT$2.62-2.69 million a unit; most purchasers were not local people (Wei Yu-hui 2002, 70-6; EYCR 2006, 409; Huang Mei-ying 2008, 126-8; *National Property*).

As for the reconstruction of public works, programs included repairs and reconstruction of electrical systems, telecommunications, irrigation, water supply, railroads, roads and bridges, as well as gas and oil. The Construction and Planning Agency at the Ministry of Interior conducted a survey on seismic retrofits for all public buildings during 6-23 October 1999. By the end of 2004, reconstruction of 1,287 office buildings had been completed. Moreover, 185 schools were reconstructed by the central and local governments and 108 by non-governmental organizations. For historical buildings, the Council for Cultural Affairs cooperated with a group of architects from universities to do investigations and proposed that 228 of these buildings should be preserved, and a three-volume report was published in November 2000. As for engineering, two barrier lakes created by the earthquake were under control in due course, and eco-engineering was introduced to reconstruct works related to water and soil conservation (Lin Hui-cheng 2000; Chen Yi-shen 2001, 63-5; Huang Hsiu-cheng 2005, 590-6; EYCR 2006, 92-112, 186-222, 232-70).

3.6 Further Reconstruction

For further reconstruction, the Cultural and Education Bureau initiated a self-reliance program with an order issued on 17 May 1935. This order provided guidelines for the programs regarding community-wide regeneration movements, promotion of folkways, improvement of dwellings, economic revitalization movements, and cultivation of concepts and behavior for public health. Based on this order, the two prefectures also drew up their own guidelines (TGO 1936, 464-78).

After the 921 Earthquake, a four-year (2003-2006) program to revitalize the stricken areas was taken with emphases on: (1) Promoting the tourist industry through creating agricultural parks of tea, bamboo, flower, fruit wine, and holiday market; (2) Raising the competitive capabilities of local products and businesses; (3) Constructing a living environment in harmony with nature; and (4) Continuing to promote community empowerment, a program originated in 1994. The expenditures for this four-year program totaled NT$22,365 million (EYCR 2006, 435-71).

3.7 Government Budget and Private Donations

After the 1935 Earthquake, the expenditures of rescue and reconstruction totaled ¥15,798,645, of which 33.5% came from the national treasury, 4.1% from the prefecture, 7.4% from towns and villages, and 55.2% from other public sources. Uses included 5.5% for emergency rescue, 24.2% for rebuilding of railroad, telegraph and telephone systems, and 70.3% for reconstruction of houses, streets, irrigation systems, manufacturing, and self-reliance programs (TGO 1936, 531-2). In addition, private donations totaled ¥1,747,821 (including ¥14,396.4 of interest), of which 25% came from Taiwan; 70% from Japan, Sakhalin, Manchuria and Korea; and 5% from other areas around the world. Uses included 22% for emergency rescue, 5% for shelters, 19% for relief, 6% for condolences for casualties and 30% for houses damaged, 16% for recovery public facilities, and 2% for gifts to schools (TGO 1936, 335-9, 345).

In 1999-2001, the government allocated a sum of NT$212,359 million from the budget for reconstruction after the 921 Earthquake. By the end of June 2005, only 80.18% of this amount had been spent. This lag reflected problems of red tape in planning, poor communication between the central and local governments, inexperienced personnel, a lack of integration between the public and private sectors, and difficulties in obtaining suitable sites for constructing new communities (EYCR 2006, 139-44; also see Chen Yi-shen 2001, 38, 211-2; Wu Kun-mao 2004, 46).

In addition, private donations totaled NT$37,500 million according to statistics provided by the National Alliance for Post-Earthquake Reconstruction, a volunteer group for supervising the use of donations. Of these donations, 39.5% were handled by 215 non-governmental groups, 35.7% by the central government's Reconstruction Fund, and 22% by local governments. By June 2000, non-governmental groups used donations mainly for school reconstruction (61.74%), assembled houses (11.04%), condolences (5.52%), and medical care (5.35%), with 4.32% remaining unplanned. Local governments used donations mainly for condolences (27.48%), recovery engineering (23.55%), school reconstruction (12.87%), and social welfare (10.43%), with 0.59% remaining unplanned. The Reconstruction Fund used some donations for house reconstruction (17.12%), social welfare (11.63%), and condolences (8.51%), but left 60.56% unplanned by August 2000 (Hsieh Kuo-hsing 2001, 57-62).

4. Concluding Remarks

In retrospect, the reconstruction experiences after the 1935 and 1999 earthquakes showed similarities in three respects: (1) The government responded quickly and emergency rescue operations worked quite well in providing medical care, temporary shelter, and relief; (2) The government budget was the major source for reconstruction, but private donations were indispensable supplements; and (3) An emphasis was given to revitalizing stricken areas after early reconstruction.

Key differences can be found in means of command and control. In 1935, Taiwan was under Japanese colonial rule, with the Taiwan Governor-General Office playing the main leadership role but the actual work of rescue and reconstruction being carried out by local authorities with the assistance of various local groups operating under the colonial system. In 1999, Taiwan was a democracy. The Executive Yuan Reconstruction Committee played a key command role, but the reconstruction process was plagued by poor communication among different levels of the bureaucracy. Furthermore, in 1935 the efforts of a few private groups might symbolize a budding civil society (Sen and Wu 1996, 109, 131-3), while in 1999 the enthusiastic participation of a large number of non-governmental and religious organizations reflected a civil society that was becoming mature in postwar Taiwan (Hsieh and Feng 2000, 190).

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The Impact of the Chi-chi Earthquake on Demographic Changes: An Event History Analysis

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Abstract

The Chi-chi Earthquake, which registered 7.3 on the Richter scale, occurred on September 21, 1999 (921 earthqueke), with 2,494 people being confirmed either dead or missing. Within the stricken areas, Taichung and Nantou Counties were the hardest hit. This study attempts to investigate the impact of the 921 earthquake for residents in Taichung and Nantou Counties by separating the households into two groups, one where family members were lost in the disaster and one where they were not lost and then examining their differences with regard to the births and deaths and marriage and divorce of household members. The household registration records as well as the birth application forms, the death application forms, the marriage application forms and the divorce application forms were used; and the logistic regression models were employed. Of the four hypotheses tested, members from households with 921 earthquake-related deaths were more likely to have new children and subject to a higher probability of death. As to the hypotheses that members from households with 921 earthquake-related deaths were less likely to get divorced and less likely to get married were not supported by the data.

Introduction

The Chi-chi Earthquake, which registered 7.3 on the Richter scale, occurred at 1:47 am on September 21, 1999 in central Taiwan (it will be referred to as the 921 earthquake hereafter). This was the strongest earthquake in Taiwan in the past few decades, with 2,494 people being confirmed either dead or missing and more than 100,000 houses damaged or completely destroyed (Hsieh 2000). Within the stricken areas, Taichung and Nantou Counties were the hardest hit. Nearly eighty-five percent of those who died were residents of those two counties.

Past studies that investigated the impact of the earthquake on the victims primarily focused on issues to do with the psychological effects, such as posttraumatic stress disorder (PTSD) and depression (Bleich et al. 1997; Chou 2000; Goenjian et al. 1994; Kato et al. 1996; Kessler et al. 1995; Kuo et al. 2007; Ironson et al. 1997); emotional disturbance (Lima et al. 1989; Joseph et al. 1993); and resulting suicidal behavior (Chou et al. 2003; Krug et al. 1999; Simon and Savarino 2007; Shioiri et al. 1999; Yang et al. 2005; Zhang et al. 2004). Almost all the studies showed that natural disasters caused people who had experienced the catastrophe to suffer from posttraumatic stress disorder and depression, which in turn made those people more prone to committing suicide. Nevertheless, no study was able to tell us how long the psychological effects would last because the time frames of the studies were mainly from two to six months to a year after the disaster. Moreover, there was also no study that focused on the demographic changes taking place in the households affected by the disaster.

We can imagine that radical behavior such as committing suicide would fade away after a year or so, but the deep sorrow of losing loved ones would remain for quite some time. It is also known that such deep sorrow would influence people’s health and probably generate depression. However, in order to identify the probable length of the psychological effects after a disaster, one needs to have panel data, most preferably event history data. In addition, it is also believed that those who have lost close relatives understand the meaning of life better and appreciate their families more. Therefore, observing a person’s behavior in relation to his/her marriage, attitudes towards divorce and his/her intention to have children after encountering a sudden disaster will shed some light on the long-term impact of the disaster.

The reasons for the lack of studies measuring the duration of the psychological effects resulting from a disaster, particularly losing a loved one, and the lack of studies that examine the impact of such a disaster on demographic behavior include the unavailability of event history data, which are not only costly but also very time-consuming to collect. One way of solving this problem is to use administrative data.

Generally speaking, regardless of whether one is looking at a developed country or a developing country, the government will normally maintain a most up-to-date household registration record file; in addition, all of the demographic changes to do with the births and deaths, marriage and divorce of household members, as well as migration in and out of the household are kept on file. By using the household registration records and all of the records for the status changes, we can establish the event history data for the household members.

This study therefore attempts to investigate the impact of the 921 earthquake for residents in Taichung and Nantou Counties with regard to the births and deaths and marriage and divorce of household members by separating the households into two groups, one where family members were lost in the disaster and one where they were not lost nor property damage, and then examining their differences.

Data and Method

This study used the household registration records as well as the birth application forms, the death application forms, the marriage application forms and the divorce application forms maintained and updated by the Taiwan government, in order to analyze the differences between households that suffered from the 921 earthquake and households that did not, in terms of the demographic changes that took place among household members. The study group therefore consists of the households with members who died in the 921 earthquake while the control group comprises the households who lived in the same counties but who did not have any casualties or sustain any housing damage as a result of the disaster.

The content of the household registration record includes information about the household as well as its members. The former includes the household's identification number and address, while the latter includes each household member's name, his/her identification number, date of birth, sex, education level, marital status, relationship with the household head and the spouse's identification number. The contents of the birth application form include each new child's identification number, his/her date of birth, the mother's and father's identification numbers, birth weight, weeks of gestation, relationship with the household head, as well as the household identification number. The contents of the death application form include the dead person's identification number, his/her date of birth, marital status, his/her spouse's identification number, date of death, cause of death, place of death, as well as the household identification number. The contents of the marriage application form include the identification number of the person who got married, his/her pre-marital marital status, date of marriage, date of birth, education level, his/her spouse's identification number and the household identification number. The contents of the divorce application form contain the identification number of the person who got divorced, his/her date of divorce, date of marriage, date of birth, education level, his/her spouse's identification number and the household identification number.

Owing to the fact that what we would like to analyze is whether there were any differences in terms of the household member's decision to get married or to get a divorce, have children and the probability of being dead between those two types of households, what we begin with are thus the household registration records prior to the 921 earthquake and then follow them through. That is to say,

> Household members in the current household registration records = Household members in the household registration records prior to the 921 earthquake + new members through births – members who died + members who migrated in – members who migrated out + new members through marriage – loss of spouse through divorce.

All the additions and subtractions were performed according to the household identification number. In other words, the household identification number served as a key to merging the data files. The deaths resulting from the 921 earthquake were defined as those who appeared on the death application form during the period from September 21, 1999 to September 30, 1999 with the causes of death being earthquake, suffocation and exhaustion.

Four hypotheses were tested: members from households with deaths due to the 921 earthquake were less likely to get married if they were unmarried at the time of the incident; they were less likely to get divorced if married at that time; those married females of childbearing age were more likely to have new children; and all members were subject to a higher probability of death than members from households that were not affected by the 921 earthquake.

Four logit models were therefore estimated. The first was for those family members who were unmarried and got married; the second for those who were married and obtained a divorce; the third for those females who were married and of childbearing age who gave birth to a child; and the fourth for the probability of the death of any member. The dependent variables were dummy variables, with one standing for getting married in Model 1, another for getting a divorce in Model 2, one for having delivered a baby in Model 3, and the last for being dead in Model 4. The explanatory variables were age, sex, and educational attainment, while a dummy variable indicated whether the person under observation was from a family of which a member died as a result of the 921 earthquake. The household size was included in Model 1; whether there were any children at age 0-4, age 5-9 and age 10-14 were included in Model 2; whether there were any sons or daughters were included in Model 3; and the marital status was included in Model 4. All variables, such as age, education level and marital status referred to the situation that prevailed at the time the 921 earthquake struck. Samples were chosen for the overall period extended from October 1, 1999 to the end of 2008.

Results

Altogether, 1,491 people were identified as having died as a result of the 921 earthquake, coming from a total of 1,088 households. Table 1 displays the number of households classified by the household size prior to the 921 earthquake and the number of deaths for each household due to the earthquake. The greatest number of deaths within a single family was 6 persons and there were two households for which this tragedy became a reality. Among the 1,088 households in which members had died, one-quarter of them (264 households) were households in which all the members had been killed, leaving 824 households to make up our study group.

Table 2 displays the number of deaths by age and sex. More than one-third of the deaths were of household members aged 60 and older and 13.1% were those aged 75 and older. Those younger in age, aged 14 and under, accounted for 18.2% of the deaths.

Table 1. Number of households by number of deaths and household size prior to the 921 earthquake.

Household size prior to 921 earthquake	Number of deaths						
	1	2	3	4	5	6	Total
1	174	0	0	0	0	0	174
2	122	53	0	0	0	0	175
3	87	24	21	0	0	0	132
4	113	25	7	10	0	0	155
5	113	27	6	4	4	0	154
6	78	17	8	2	1	2	108
7	57	14	7	3	0	0	81
8	36	5	3	1	1	0	46
9	13	5	1	0	0	0	19
10	11	3	1	0	1	0	16
11+	15	6	5	0	2	0	28
Total	819	179	59	20	9	2	1,088

Table 2. Number of deaths by age and sex.

Age	Male		Female		Total	
	N	%	N	%	N	%
0-4	44	6.1	42	5.4	86	5.8
5-9	46	6.4	58	7.5	104	7.0
10-14	37	5.2	43	5.6	80	5.4
15-19	31	4.3	34	4.4	65	4.4
20-24	21	2.9	36	4.7	57	3.8
24-29	29	4.0	35	4.5	64	4.3
30-34	42	5.8	38	4.9	80	5.4
35-39	40	5.6	45	5.8	85	5.7
40-44	42	5.8	52	6.7	94	6.3
45-49	41	5.7	52	6.7	93	6.2
50-54	39	5.4	32	4.1	71	4.8
55-59	41	5.7	38	4.9	79	5.3
60-64	59	8.2	51	6.6	110	7.4
64-69	57	7.9	52	6.7	109	7.3
70-74	52	7.2	66	8.5	118	7.9
75+	97	13.5	99	12.8	196	13.1
Total	718	100.0	773	100.0	1,491	100.0

Table 3 exhibits the odds ratios for marriage and divorce. All the coefficients for the unmarried getting married were significantly different from zero except for the dummy for the 921 earthquake. When compared with those between the ages of 25 and 29 (the reference group), those with ages between 15 and 24 and between 30 and 34 had higher chance of getting married, while those older than 35 had less chance of getting married. Females were one-third less likely to get married than men, and the higher the education level as well as the bigger the household a person had, the higher the probability of him or her getting married. Other things being equal, those members from households in which there had been 921 earthquake-related deaths were no different from those who had not been affected by the 921 earthquake.

In referring to Table 3 again, we found that all the coefficients for those married getting divorced were significantly different from zero except for the dummy for the 921 earthquake and children' age between 5 and 9. When compared with those between the ages of 30 and 34 (the reference group), those were younger had higher while those were older had lower probability to get divorced; the odds ratio of ending up divorced decreased as the age increased. Females were one-third less likely to get divorced than men and the higher the education level a person had, the lower the probability that he or she would get divorced. Comparing with those without kids, those who had children between the ages of 0 and 4 were less likely to get divorced; while those who had children between the ages of 10 and 14 were more likely to get divorced. After controlling for age, sex and education level, members from the households with 921 earthquake-related deaths were no different from those who had not been affected by the 921 earthquake in terms of getting a divorce.

Table 3. Odds ratios for entering a marriage or getting a divorce.

Effect	Entering a Marriage		Getting a Divorce	
	OR	95% Confidence Intervals	OR	95% Confidence Intervals
Age 15-24	1.770 ***	1.731 - 1.811	4.016 ***	3.758 - 4.291
Age 25-29	R		1.604 ***	1.519 - 1.693
Age 30-34	1.313 ***	1.260 - 1.369	R	
Age 35-39	0.748 ***	0.699 - 0.801	0.651 ***	0.616 - 0.688
Age 40-44	0.388 ***	0.345 - 0.437	0.418 ***	0.392 - 0.446
Age 45-49	0.291 ***	0.242 - 0.351	0.236 ***	0.218 - 0.256
Age 50-54	0.252 ***	0.184 - 0.344	0.142 ***	0.127 - 0.159
Age 55up	0.392 ***	0.345 - 0.445	0.036 ***	0.032 - 0.041
female	0.611 ***	0.598 - 0.624	0.641 ***	0.618 - 0.664
Education Level (Years of Schooling)	1.069 ***	1.064 - 1.074	0.941 ***	0.934 - 0.947
921 Victims (1: yes; 0: no)	0.974	0.845 - 1.121	1.142	0.905 - 1.44
Household Size	1.008 ***	1.003 - 1.012	-	- -
Children's Age				
0-4	-	- -	0.895 ***	0.853 - 0.938
5-9	-	- -	1.033	0.983 - 1.084
10-14	-	- -	1.065 *	1.011 - 1.122

Notes: "R" indicates the reference group.
Significance: ***0.001 level; **0.01 level; *0.05 level.

Table 4 shows the odds ratios of those females who were married and of childbearing age that gave birth to a child. All the coefficients were significantly different from zero. The younger the woman was and the higher the education level she had, the higher was the probability that she would deliver a baby. Those women who came from households with children left after the disaster had lower chance of delivering a baby in a later period. After controlling for the age, education level and whether or not there were youngsters left in the household, it was found that the married females of childbearing age from households with 921 earthquake-related deaths had significantly higher probability than those who had not been affected by the earthquake in terms of having a baby.

Table 5 displays the odds ratios of death. All the coefficients were significantly different from zero. The higher the age a person had, the higher the probability of he or she being dead. Females were fifty-five percent less likely to be dead than men, and singles were 47% more likely to be dead than married ones. The higher the education level a person had, the lower was the probability of that person being dead. Other things being equal, those members from the households with 921 earthquake-related deaths had higher probability to be dead than those who had not been affected by the earthquake.

Table 4. Odds ratios for giving birth.

Effect	OR	95% Confidence Intervals
Age 15-24	2.194 ***	2.055 - 2.341
Age 25-29	R	
Age 30-34	0.302 ***	0.287 - 0.317
Age 35up	0.037 ***	0.035 - 0.041
Education level (Years of schooling)	1.183 ***	1.172 - 1.194
921 Victims (1: yes; 0:no)	1.432 *	1.085 - 1.89
Son	0.417 ***	0.395 - 0.439
Daughter	0.817 ***	0.775 - 0.862

Notes: Same as Table 3.

Table 5. Odds ratios for deaths.

Effect	OR	Confidence Intervals
Age 0-4	0.056 ***	0.044 - 0.07
Age 5-9	0.064 ***	0.047 - 0.087
Age 10-14	0.192 ***	0.161 - 0.228
Age 15-24	0.428 ***	0.389 - 0.471
Age 25-29	R	
Age 35-44	2.077 ***	1.93 - 2.234
Age 45-54	3.732 ***	3.469 - 4.014
Age 55-64	7.836 ***	7.279 - 8.436
Age 65-74	20.475 ***	19.066 - 21.988
Age75 & up	64.805 ***	60.004 - 69.99
Female	0.449 ***	0.435 - 0.463
Education level (Years of schooling)	0.931 ***	0.927 - 0.935
921 Victims (1: yes; 0: no)	1.255 **	1.056 - 1.491
Single (1: yes; 0: no)	1.473 ***	1.425 - 1.524

Notes: Same as Table 3.

Discussion

The ever increasing numbers of natural disasters all over the world have made the study of their avoidance, loss reduction and impact analyses increasingly important issues. Past studies that investigated the impact of earthquakes on the victims (referred to as those who lost co-resident family members, were injured, or experienced property loss) focused primarily on the psychological effects and suicidal behavior. The results indicated that posttraumatic stress disorder and depression were the risk factors in suicidal thinking (Krug 1999) and that the psychological effects were more marked among females, those younger in age and those with low socioeconomic status (Kiliç et al. 2003; Kuo et al. 2007; Salcioglu, Basoglu, and Livanou 2003; Chen et al. 2001; Seplaki et al. 2006; Sharan et al. 1996). Being single was also one of the risk factors that resulted in the victims being emotionally distressed or suffering from depression, and elderly survivors tended to report fewer complaints than younger ones (Salcioglu, Basoglu, and Livanou 2003; Lima et al. 1989; Lin et al. 2002).

As to the suicidal behavior, studies that focused on this issue mainly used the monthly or annual suicide rates both before and after the disaster and the results were inconclusive. Krug et al. (1999) showed that the suicide rate increased from 19.2 to 31.3 per 100,000 with $p<0.001$ in the first year after a particular earthquake and, while it increased to 19.7 per 100,000 in the fourth year, it demonstrated no statistical significance compared with the pre-earthquake 19.2 per 100,000. Yang et al. (2005) indicated that the suicide rates first increased significantly and then fell to the baseline level after 10 months. These two studies support the theory that disaster influenced victims to adopt radical behavior such as committing suicide, at least for a short period of time. However, the suicide rates from the Kobe earthquake exhibited a completely different result; a significant reduction was found in the year of the disaster; and it gradually returned to the former average within 2 years of the earthquake. The reduction in the suicide rate was due to the decline in the rate among males (Shioiri et al. 1999).

Ideally, identifying the true victims and following them through to observe their behavior is a much better approach. Chou et al. (2003) used an administrative data file that was compiled to provide timely support for the victims and by comparing them with the non-victims for the periods 2-15 months after the 921 earthquake was able to prove that the victims were 1.46 times more likely than non-victims to commit suicide.

From the evidence shown above, we are in almost no doubt that natural disasters do have strong psychological effects and do entice victims to commit suicide. However, as to whether the psychological effects would result in less marriage, less divorce, more babies being born and more people dying has yet to be explored. By utilizing the household registration records and all the records for the status changes in Taiwan for the households affected by the 921 earthquake and the nearby areas, we could establish an event history data for the members of those households.

The four logit models, which refer to four status changes, demonstrate that gender and education level play important roles. In general, females were found to be less likely to get married, less likely to get divorced, and less likely to be dead than men.

The regression results also indicated that the higher the education level a person had, the higher was the probability of that person getting married, and the lower the probability of him or her getting divorced or ending up dead. Besides, when compared with those married couples, singles had higher chances of being dead. These findings all conformed to past results. In addition, those married women of the childbearing age who came from households in which there were children left after the disaster had a lower probability of delivering a baby in the later period.

The target variable, the dummy for the 921 earthquake, was significantly different from zero in the regressions of birth and death. It indicated that the household member's childbirth decision and probability of being dead had been affected by whether they were the victims of the disaster. Other things being equal, those married females of the childbearing age from the 921 earthquake-affected households had higher chance of delivering a baby than those from the households that had not been affected; and members from the 921 earthquake-affected households had higher chance of being dead than those from the households that had not been affected. However, there were no differences in the decisions to enter a marriage or get a divorce among the members of these two types of households.

In other words, of the four hypotheses tested in this study, according to the data, in the last two were members from households with 921 earthquake-related deaths more likely to have new children and subject to a higher probability of death. As for the other two hypotheses, members from households with 921 earthquake-related deaths were less likely to get divorced and less likely to get married were not supported by the data.

The dearth of studies that have examined the impact of natural disasters on demographic behavior has been due to no event history data being available. By employing Taiwan's administrative data we have been able to look at the impact of the Chi-chi Earthquake on people's marriages and divorces as well as births and deaths throughout the 9-year period following the incident. However, since the status change of the households was performed according to the household identification number, therefore, if the number was missing or had been incorrectly recorded in any link, the information on the household members within a particular household would not have been correct. Although all the datasets had been used by the government to establish the most up-to-date household registration records, and there were no missing data in regard to the household identification numbers in any of the datasets we used, there was still the possibility that errors were embedded. This was the limitation of this study.

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Drought and the Lifecycle/Landuse Trajectory in Agricultural Households

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Abstract

The life course of household heads and the composition of the household during the lifecycle are linked to the labor requirements of farming. Using the Demography and Environment in Grassland Settlement database, we have shown that the life course of farm household heads, household life cycle, and the availability of male labor were key elements in land use and land use change in Kansas from 1875 to 1930. The acquisition of more farm land is better explained by head's life course, while investment in more cropland is better explained by labor availability and household lifecycle. Moreover, the timing and environmental context of change did not diminish the effect of the head's life course trajectory or of the household lifecycle. We extend this work to ask whether climatic shocks—in particular the droughts for which Kansas is famous—uncoupled lifecycle from land-use cycle. We test a hypothesis that during droughts farmers were not able to use their available household labor effectively with multi-level growth models over 25 townships in Kansas that had a variety of drought experiences, weather conditions and principal agricultural land uses. Support for our hypothesis is mixed. The land-use/labor connection is unaffected by introducing a measure of drought in our model. However, drought did slow the process of farm building. There is contextual evidence that until at least 1930 droughts which truly displaced population were those that closely followed periods of in-migration to different areas. Later, youth out-migration in Kansas was reflective of learning the optimum balance of farm size and labor as land clearing was completed, all available land was incorporated into farms, and mechanization increased.

Introduction

We have shown in earlier analyses of Kansas farm households between 1860 and 1930 that there is a strong and robust relationship between a farmer's life course, the potential male laborers in his household, and the size of his farm and the number of acres he has in crops (Leonard et al. 2007). This relationship holds for all of the sub-regions of Kansas, both those where the climate is relatively moist and well-suited to cropping, and those where rainfall is less abundant and very unpredictable. In this paper, we ask whether the land-labor relationship holds up in times of extreme climate stress. The story we uncover is one of drought winners and losers, but in the context of a population-wide adjustment to the realities of farming in a semi-arid region. Droughts during the settlement years were more disruptive, slowing growth and causing greater population turnover, yet both the population and the farm sector recovered. The limits of arable acreage were reached shortly after the turn of the 20^{th} century, however, and the widespread drought of the 1910s ushered in a trend towards farm consolidation.

Thereafter, the number of farms and total acres in farms stabilized. There was less turnover in farm households, farmers were older, and the population aged and shrank. When looking at individual farms, in the most arid Western section of Kansas, lower yields and greater uncertainty meant more acres were necessary to make a living from the land. As a result, farms were larger, with more acres cropped. Periods of drought, which were more frequent in the western portion of the state, had a negative impact on the ability of farmers to increase the overall size of their farms and the area that they had in crops. Despite those limitations, the basic connection between land and labor remained. Farmers in mid-life and those with more laborers had larger farms and more cropped acres, regardless of drought conditions.

The focus of our study is the state of Kansas, located near the center of the continental United States (Figure 1). We describe our data and the approach we have taken later in this paper, but it is important at the beginning of our discussion to emphasize that Kansas lies at the eastern edge of the dry upland region of the U.S. called the Great Plains, and spans the transition from the tall grass prairie of the Midwest to the short grass steppe of the High Plains. This location has a varied climate that makes it possible to study the impact of changing weather.

Our research is based on a widely dispersed sample of households and farms that are spread across the state in 25 townships located in 25 different counties.[1] We have data about farms and households from the 1860s to the 1940s, drawn from a mixture of state and federal sources (Sylvester et al. 2002, publ. 2006). We will say more about those sources later. We also make use of a large body of aggregate data about population and agriculture collected at the level of the township and the county, and known as the Great Plains Population and Environment Database (Gutmann 2005a; 2005b).

[1] In Kansas, as in much of the United States, the county is the principal administrative subdivision of the state, and the township is the principal subdivision of the county.

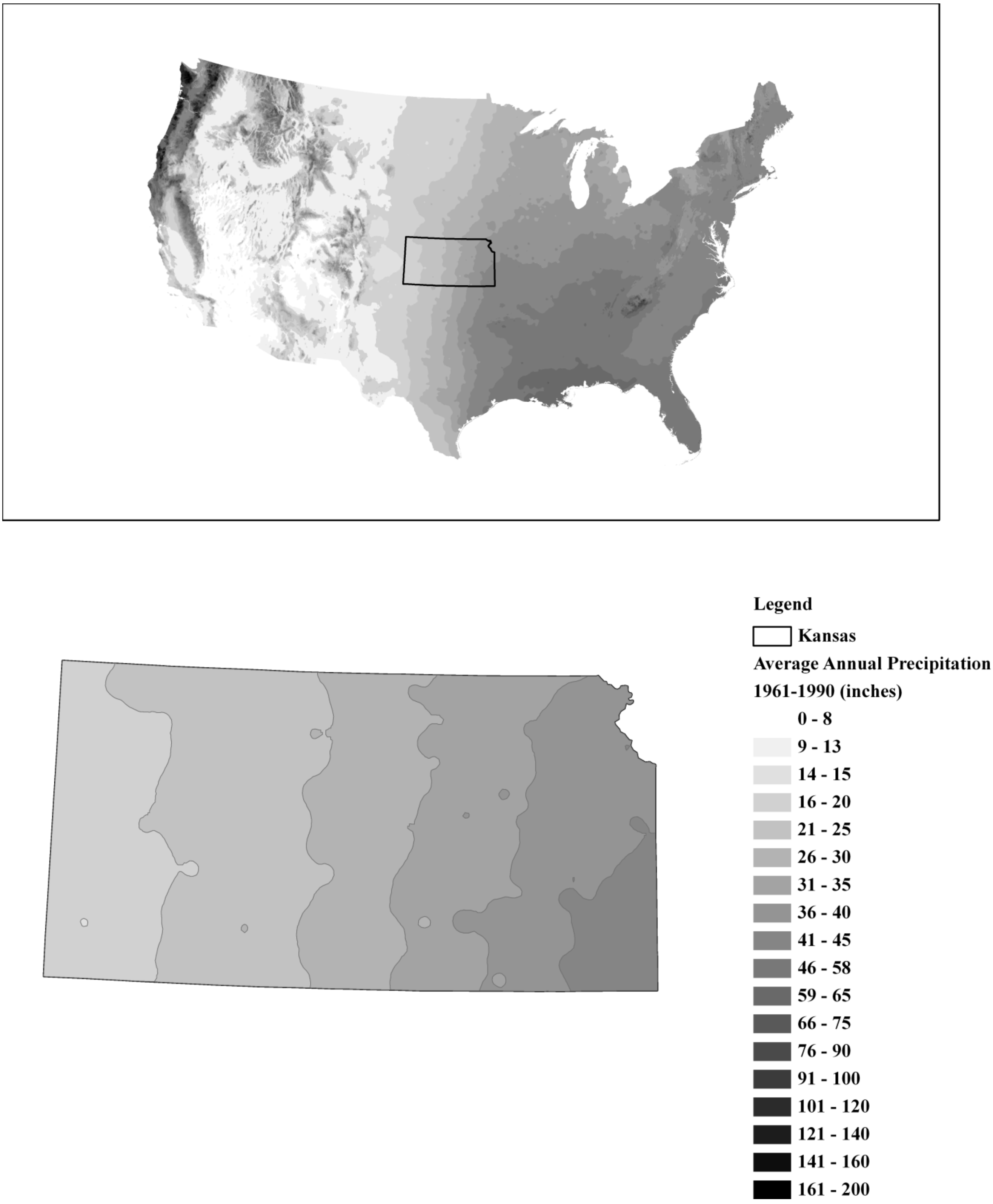


Figure 1. Precipitation in the United States, with special reference to Kansas.
Source: National Atlas of the United States, United States Department of the Interior.

Historical demographers have explored the connections between demographic and meteorological events for decades, focusing on the ways that weather determined food availability (often measured by prices), and the ways that food availability determined births, deaths, marriages, and migration (for example, Gutmann 1977; Wrigley and Schofield 1981; Bengtsson, Fridizius, and Ohlsson 1981; Bengtsson and Dribe 2006; Gutmann 1980). More recently, this work has been extended to Asia and the United States, including our own work in the Great Plains (for example, Bengtsson, Campbell, and Lee 2004; Deane and Gutmann 2003; Gutmann, Pullum-Piñón, and Pullum 2002; Gutmann et al. 2005). There is also an extensive literature about population in arid and semi-arid environments in more contemporary contexts. Much of the literature about the developing world focuses on inadequate precipitation as a catalyst for individual and household coping strategies, including population displacement. This literature explores factors leaving families and individuals vulnerable to negative consequences of drought, ranging from short-term absence from the family through permanent out-migration and even death (e.g., Findley 1994; Meze-Hausken 2000). Advantaged households have more opportunities to use multiple coping strategies to help them resist migration and increase future options for adaptation by consolidating holdings of land, livestock and machinery. Working-aged members are a great advantage to some families; they can either move off-farm and remit wages, or undertake labor-intensive strategies such as carrying water or herding animals further afield.

Drought was seen as a major influence on Kansas population movements, even before the Dust Bowl of the 1930s, with newer and less-well capitalized households understood to be more at risk of either migrating out of Kansas, requiring relief of various types, or actual starvation (Cutler 1883; Blackmar 1912; Holloway 1868). The ebb and flow of the population of the Great Plains as an agricultural economy of family-owned farms has also been explained as an information problem (Libecap and Hansen 2002). Contemporaries did not understand the mechanisms leading to drought occurrence, accurate data on weather phenomenon were inadequate, and periodic fluctuations in rainfall hampered clear decision-making about the potential success of particular crops and of farming in general. Popular theories of human impact on the environment, such as cultivation leading to increased rainfall and techniques of dryland farming conserving soil moisture, encouraged settlers to downplay the importance of dry years and overplay the importance of intervening wet years (Libecap and Hansen 2002).

Kansas was settled beginning in the 1850s and more rapidly after the U.S. Civil War by a wide variety of immigrants from other U.S. states and from other countries, most of whom came to farm or to settle in small towns in farming communities. Beginning with the passage of the Homestead Act in 1862, public lands were made available to would-be settlers at little to no cost. In the beginning, these lands were allocated in units of 160 acres (about 65 hectares), and most settlers began with a farm of that size. Later, larger homesteads became available in more arid regions, recognizing the need for larger farms and ranches where rainfall could not support continuous cropping. The availability of land was one of the main factors that drove migration to Kansas and other western states.

Despite a succession of widely publicized and sensationalized droughts between the 1860s and the 1930s, families continued to migrate to Kansas and the rest of the Great Plains with the intention of farming. Even with that continued flow of immigration, there was a significant pattern of out-migration. Well before the 1930s, the rural population of Kansas had stabilized and then began to decline. Most land suitable for farming was in production by 1900, and the number of farms began to decline by 1920 (Gutmann 2005a, 2005b). With fewer farmers, consolidation created both larger farms and a division of farms into some that were very small and some that were very large. The agricultural labor force began to shrink, as did the young working-age population (Gutmann, Pullum-Piñón, and Pullum 2002; Gutmann 2005; Hautaniemi Leonard and Gutmann 2005; Cunfer 2005). These conclusions are valid using both county-level aggregate data and the individual-level data from our 25 township sample. Over time, as the limitations of a 160-acre homestead to provide for families' short- and long-term needs were understood, average farm size increased, with important differences related to aridity. While 160 acres or even less could be adequate in eastern Kansas, many more acres were necessary to support the extensive crop and cattle production suited to the drier west.

Aridity and Drought in Kansas

Writing in 1894, on the eve of widespread and reliable weather data collection, the U.S. Department of Agriculture made this optimistic statement: "It is generally conceded that 20 inches of well-distributed rainfall in Kansas will make an abundant crop of wheat or corn" (Whitney 1895). The 20 inch benchmark is optimistic in its assumptions both about how much rainfall was necessary to farm in the Great Plains, and how much rain actually fell. Rainfall amount and predictability divides Kansas into three areas. Only in the eastern portion could farmers anticipate adequate annual rainfall. Townships in the middle of the state fell short of 20 inches in one out of four years, on average, and the western townships in more than three out of five years. Furthermore, the odds of several dry years in a row increased as one went west. Stevens County in the southwestern corner of Kansas only received 20 inches of precipitation in four years between 1895 and 1930.

The land-use zones developed by James Malin (1947, 1955) are particularly useful in visualizing the consequences to agriculture of the state's variation in precipitation, elevation, temperature, topography and soil quality (see Figure 2). Malin divided the state into five regions, each with a particular set of characteristics. Kansas becomes higher and drier as one moves east to west, gaining some 2000 feet in elevation and losing about 15 inches in annual rainfall from its eastern boundary with Missouri to its western border with Colorado. In addition, the land surface is cut by sharp gullies in some portions of the state, rendering those lands unsuitable for cropping. By design, the townships that we have sampled vary significantly across Malin's zones (Table 1). The Mixed Farming zone along the eastern boundary has the most precipitation, and can support most types of agricultural activity. It is also the lowest in elevation and has significantly more productive farmland than the other zones. The Bluestem Pastures zone, in the region known as the Flint Hills, has more productive soil and receives enough precipitation for continuous cropping and good pasture, but rocky limestone soils interfere with cultivation. Malin called the area from the northeastern corner of the state west along the Nebraska border the Corn Belt. Located in the northern tier of Kansas counties, it has significantly lower summer and winter temperatures. Of our townships, those in the Corn Belt have the highest percentage of non-productive farmland. This area has adequate moisture for corn, but topography and soil quality less well-suited to wheat cultivation. The Central Wheat Belt is south of the Corn Belt and west of the Bluestem Pasture zone. This area is too dry for reliable corn crops, but has near perfect weather conditions for growing wheat and little poor-quality farmland. Development of this area during the 1870s helped shift Kansas' economy from cattle to crop production. The western quarter of Kansas forms the Wheat-Cattle-Sorghum zone. The region is very dry, and gullies and breaks contribute to the high percentage of unproductive land. Aridity, annual rainfall shortages and strong yearly fluctuations in precipitation are more severe in this zone, encouraging farmers to diversify into ranching and drought-resistant crops, and requiring more land per farm.

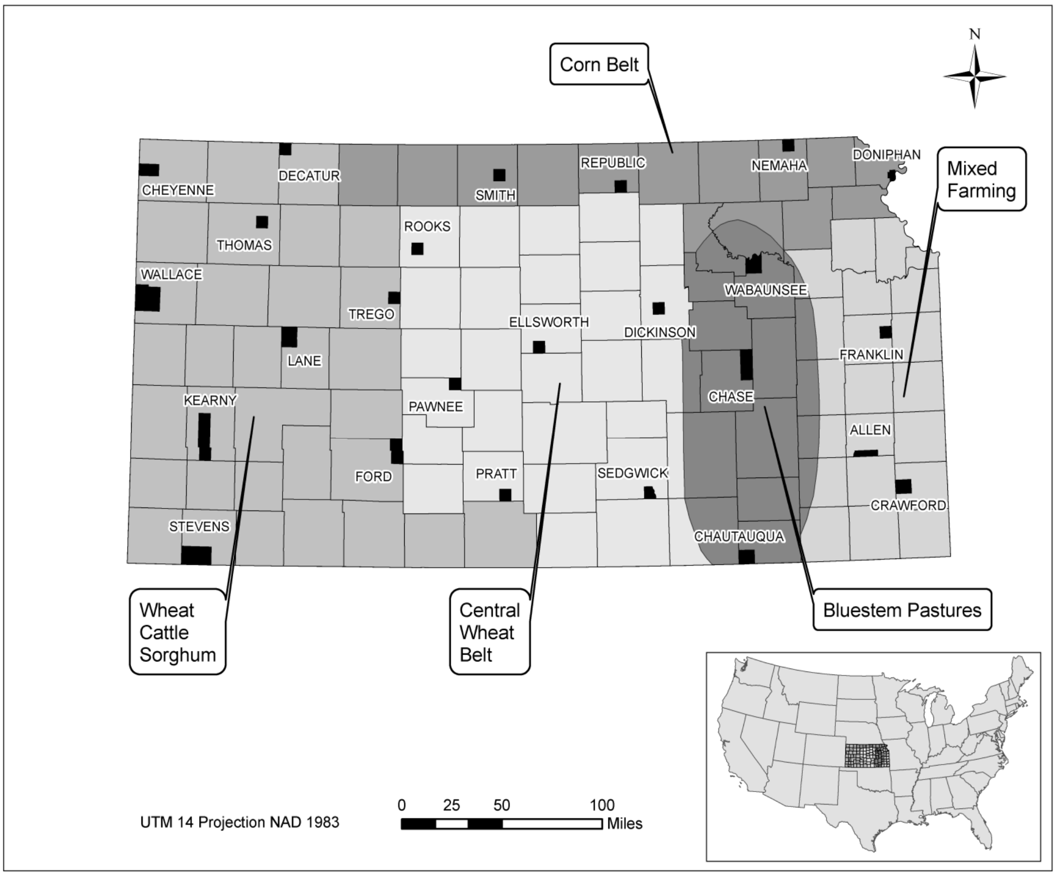


Figure 2. Sample townships in Kansas, United States, showing Malin's land-use zones.
Source: Malin, Winter Wheat in the Golden Belt of Kansas, preface From: Sylvester and Cunfer 2009).

Table 1. Characteristics of Malin zones.

	Mixed Farming	Bluestem Pastures	Corn Belt	Central Wheat Belt	Wheat, Cattle, Sorghum
Elevation (feet)	929.67	1150.33	1396.50	1659.17	2973.22*
Mean Annual Precipitation (inches)	32.66*	27.33*	23.85*	20.98*	15.04*
Relative July Humidity	53.67	52.67	54.50	47.33*	41.67*
Mean July Temperature (F)	79.37	79.37	78.58	79.92	78.22
Mean January Temperature (F)	32.43	31.10	26.65*	30.55	30.33
Non-productive Farmland (%)	16.61*	10.20*	29.57*	5.63*	23.95*
Topography	Irregular plains	Open hills	Irregular plains Open low hills	Irregular plains, Plains w/hills, Tablelands w/mod. relief	Smooth plains Irregular plains
Farm size (acres)	167.79	229.05	162.81*	248.02*	509.03*
Cropped land (acres)	67.24	69.48	79.28*	153.22*	188.85*

Note: *Different from all other Malin zones at p > .01 in OLS regression with Wald post-estimation tests for equivalence of the betas.

Measuring drought is not an easy task. Many of the standard measures of climate variation, such as aridity indexes and ratios of actual evapotranspiration to potential evapotranspiration, capture only the propensity for different areas to be generally more or less arid. In order to understand how a semi-arid region such as western Kansas was transformed into an agricultural landscape, we want to look at droughts. The term "drought" is generally understood to indicate an extended period of time with unexpectedly insufficient moisture, resulting in crop failure. There is no single scientific definition of drought, either in the past or today. Contemporaries described months or years passing with "not a single drop of rain," but the descriptions are unlikely to be accurate. Rather, in drought years very little rain falls and that which does evaporates quickly.

In order to overcome this lack of general rules and scientific certainty, we use information about droughts drawn from published histories of Kansas, reports of the Kansas State Board of Agriculture, and the annual weather data series available from 1895. We begin by looking at annual precipitation, noting years where rainfall was more than one standard deviation below the mean annual precipitation for the same township from 1895 to 1930 (Figure 3). Grouping townships by Malin zone shows the difference in average annual precipitation across the zones, with the western zone's long-run average below the benchmark of 20 inches. Temporal fluctuations in precipitation are remarkably regular across the state. These differences and similarities suggest that farmers across Kansas had to deal with difficult years but that the consequences were more severe further west, where crops received less than the minimum precipitation required for success in most dry years.

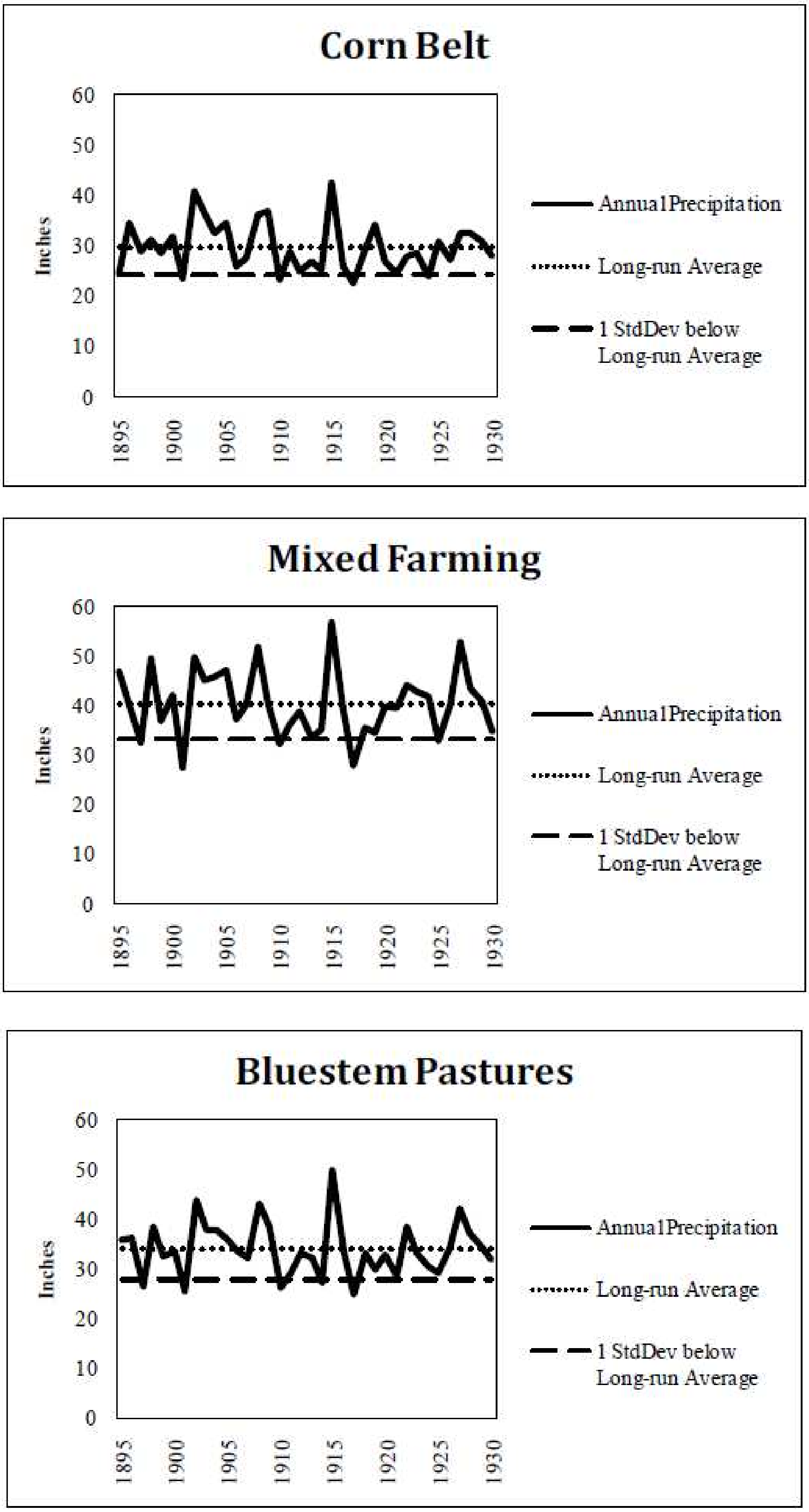
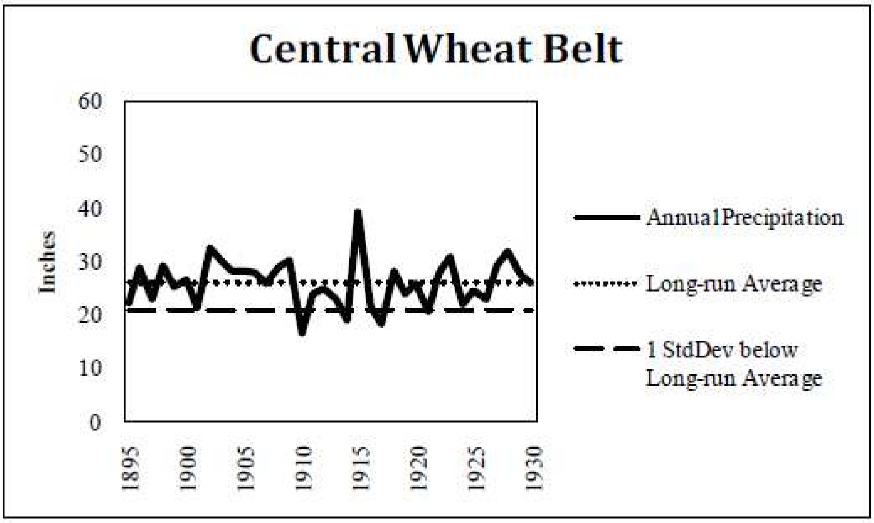


Figure 3. Precipitation by Malin zone.



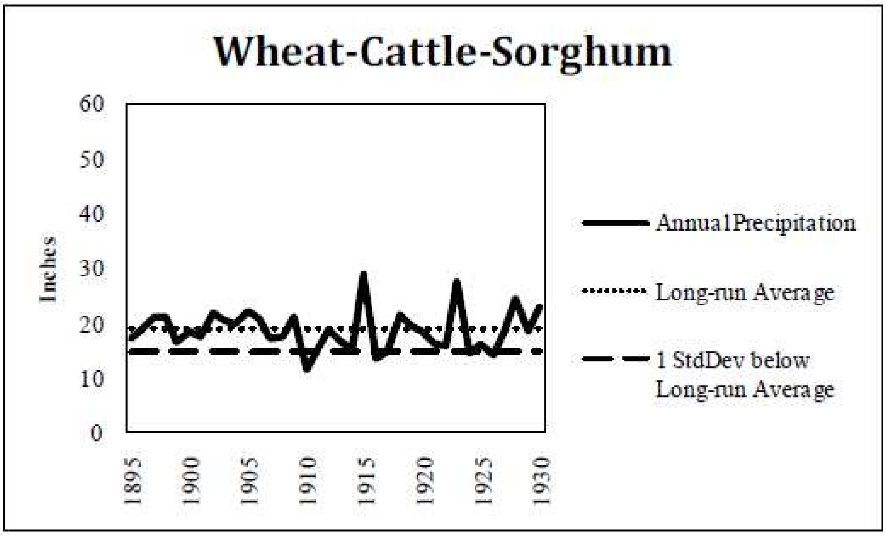


Figure 3. Precipitation by Malin zone (cont.).

Kansans tend to downplay the role of weather fluctuations. As recently as 1948, the Kansas State Board of Agriculture declared that the eastern portion of the State was no more susceptible to drought than states east of the Mississippi, that there had been "but six periods of dry weather of exceptional note" up through the late 1940s, and the impact of two (1860-68 and 1894-95) was exaggerated because they occurred during times of rapid in-migration (Flora 1948). The Board of Agriculture characterized the prolonged drought in the 1860s when Kansas was first being heavily settled as "a process of natural selection." "Many of the less courageous of the early settlers went back to their old homes, but those with more grit and determination remained and saw their faith in the climate of the State justified" (Flora 1948). This drought began in June of 1859, just as heavy settlement was beginning, and rainfall was scant through November of 1860. Most settlers began the drought with little or no reserves, and as many as one-fourth left the Territory (Blackmar 1912; Cutler 1883; Holloway 1868).

> Thirty thousand settlers left the Territory for the old homes from whence they came, abandoning claims, improvements, and all hope of success in the West. The long procession crossed the border day after day, and the disheartened, disappointed emigrants returned to their friends, bearing ill reports of "God-forsaken Kansas." About seventy thousand remained, -- of whom perhaps, forty thousand were able to weather the stress of the times, but unable to aid the thirty thousand, too destitute even to get away (Cutler 1883, Part 61).

Kansans reportedly faced actual starvation, and received food, seed, clothing and nearly $84,000 in money from eastern states (Cutler 1883). With the exception of 1863 and 1865, the drought lasted over eight years, ending in March of 1868 (Flora 1948). Not all portions of the Territory were equally affected by the rainfall shortage. Farms near the Missouri River and in the wetter northeastern portion of the state were less affected than those further west, and settlement in the northeast was further along. The condition of the western portion of the territory was poorly understood because there was as yet little settlement in the more arid western half of Kansas and weather data were collected in only a few locations. However, overall the drought is thought to have ranked with the Dust Bowls years in severity (Flora 1948).

Most of the state was free of drought during the 1870s and 1880s (Blackmar 1912), but in the early 1870s a severe drought hit western Kansas, and portions of Missouri, Nebraska and Colorado. By this time precipitation was being measured in central and western Kansas locations, so the record is more complete, showing less than eight inches of rainfall in some years. As in the 1860s drought, the northeast portion of Kansas had sufficient rainfall, but the drought culminated in the infamous “Grasshopper Year” of 1874, the heaviest recorded infestation of grasshoppers, affecting the entire state (Blackmar 1912; Flora 1948). The early 1880s again saw the western portion of the state in drought and receiving relief. Writing as settlement was first pushing into the area, Cutler reported the seasons were so uncertain Western Kansas should not fairly be classified agricultural, and that Trego County was “next to worthless for agricultural pursuits” (Cutler 1883).

Despite these hardships, the population of western Kansas quadrupled between 1880 and 1890 (Worster 1994), and tripled in the western counties in our sample (Gutmann 2005a). The subsequent drought of 1894-95 was reminiscent of the drought of 1860, leading to widespread crop failure, dust storms, and out-migration of recently-arrived settlers. Worster claims that many as 90 percent left in the mid-1890s (1994). While we do not find so precipitous a drop in population in the western counties we study, some experienced population declines of 25% to over 50% between 1890 and 1900 (Gutmann 2005a). In addition, the number of farms fell steeply. For the most part, acres in farms continued to rise, reflecting farm consolidation among those who were able to stay or in-migrate (Gutmann 2005b). Stevens County, later to be in the heart of the Dust Bowl, experienced a 60% decrease in the number of farms (and people) along with a 20% decline in the number of farm acres.

The last reported drought before the 1930s extended from 1910 to 1917, with a year of respite in 1915 (visible in all panels of Figure 3), setting records for low rainfall and high temperatures not broken until the 1930s. "The five-year period ending with 1914 was marked by an almost unbroken series of months with deficient precipitation and an average annual amount of 23.40 inches for the State, which is almost as low as that of the average for the five driest years during the drought of the 1930's" (Flora 1948). By this time the population included relatively few new arrivals, and seemed better able to withstand adverse conditions. Some of the western counties continued to grow, while population in the eastern regions stabilized. Further evidence of farm consolidation is reflected in fewer farms, but not fewer farmed acres, between 1910 and 1920. Kansas experienced a succession of relatively wet years between 1918 and 1929, ending with the onset of the "dirty-thirties" drought, which lasted until 1942.

The objective of this paper is to understand the consequences of these droughts for families and farms, making use of census population and farm records. The Demography and Environment in Grassland Settlement project uses individual-level population and farm records from the 25 townships shown in Figures 1 and 2, chosen to capture variation in environment. The Kansas State Board of Agriculture conducted a population and farm census every 10 years from 1865 to 1925. Together with the federal census records, we have a nearly complete dataset at five-year intervals, with the exception of 1890 when no microdata are available, 1900 and 1910 when there are no farm microdata, and some township-specific gaps where the original data have been lost. These records have been digitized and linked both cross-sectionally (farms to individuals) and longitudinally (individuals to individuals across censuses). Farm records include the number of acres in each farm and specifics about land use, livestock and value. Household context is drawn from the population censuses, which are organized by dwelling. From these records, we know the age and sex and can infer the relationship of each household member. We identify farm households as those where at least one member linked to a farm record. We expect greater impact of drought on farm size at census observations following more frequent and severe droughts (years with total rainfalls well below both expected and necessary amounts) and in the more arid western zones.

We explore three hypotheses: 1) during the time of settlement droughts will interrupt trajectories of population growth and incorporation of land into agriculture ; 2) after settlement, droughts will accelerate the trajectory of farm consolidation resulting in fewer farm households on larger farms; and 3) in this period before widespread adoption of mechanization, the underlying relationships we have shown between lifecycle, labor and land will not be altered by consolidation, which should also result in more laborers per household while leaving the ratio of laborers to land unchanged.

Describing Families and Farms over Time

The amount of land in farms in our Kansas townships generally grew at an increasing pace for the first 15 to 20 years after settlers began arriving in each township. After that, the pace of growth slowed for a decade, and then the amount of farmland leveled off

(Table 2). The number of farms followed a similar trajectory, but fell in later decades as farms consolidated.

There were differences between the Malin zones which reflect environmental differences and perhaps settlement during drought conditions. Initial settlement coincided with a drought period in all but the western Wheat-Cattle-Sorghum zone. In the other zones, the slower rate of growth during the early years of the 1860s drought as compared to the next decade could have been a feature of the settlement process, or drought could have retarded the rate of growth, particularly in the Bluestem Pastures. The drought and grasshopper plague of 1874 does not seem to have discouraged farming overall; the number of farmed acres and the number of farmers continued to increase from 1870 to 1875.

The interval between 1885 and 1895, in which there was severe drought in the western regions combined with accelerating interest in settlement, saw acres in farming stagnate for the sampled townships in the Central Wheat Belt and Wheat-Cattle-Sorghum zones. Some farm consolidation also occurred at this time, with more acres in large farms and fewer farms (Table 2). The Corn Belt and Bluestem Pastures continued to gain farm acres. The decade between 1895 and 1905 was nearly free of dry years, and smaller farms held fairly steady as a proportion of all farm acres. We look for effects of the drought of 1910-17 in changes between 1905 and 1915, and between 1915 and 1920. Across the state, land in farms increased slightly from 1915 to 1920. Yet, before 1915 there were declines in the number of farms, more acres in larger farms, and stabilization of acres in farms.[2] The widespread series of dry years in the 1910s ushered in the long-term trend toward greater farm consolidation.

[2] The number of farms and acres in farms in the Wheat-Cattle-Sorghum zone is exaggerated by township boundary changes in Stevens County in 1920.

Table 2. Farms, acres in farms, and percentage farm acres in large farms: by Malin zone and year.

	Mixed Farming			Corn Belt			Bluestem Pastures			Central Wheat Belt			Wheat Cattle Sorghum		
	Number of farms	**Total farm acres**	**% in large farms***	**Number of farms**	**Total farm acres**	**% in large farms***	**Number of farms**	**Total farm acres**	**% in large farms***	**Number of farms**	**Total farm acres**	**% in large farms***	**Number of farms**	**Total farm acres**	**% in large farms***
1860	65	11562	33.6	39	5915	5.4	83	11905	2.8	4	280	0.0			
1865	98	20491	48.1	93	17625	23.6	75	13921	20.4	66	14212	32.6			
1870	332	41884	13.3	306	46202	13.4	219	30767	12.0	360	78761	17.8			
1875	361	53954	19.0	348	53047	16.8	354	52533	14.3	309	36598	21.1	54	13504	42.0
1880	439	63507	16.4	309	41719	16.0	434	59598	12.8	433	100172	27.3	406	108674	1.0
1885	307	44470	21.7	372	59810	20.4	445	93683	38.7	449	100818	28.9	363	74796	13.5
1895	444	69699	22.5	450	70069	23.8	422	97082	40.0	504	101095	44.6	348	82795	21.8
1905	478	78000	27.4	487	72895	21.9	456	116230	37.8	515	123157	56.1	452	277633	76.1
1915	456	73812	24.8	390	62662	23.5	420	100928	51.7	509	121127	58.1	567	265507	67.2
1920	413	75913	31.4	405	71172	28.6	401	104238	38.4	518	132823	59.7	737	394058	71.9
1925	424	72759	27.1	420	70714	22.9	409	106744	55.4	494	135063	60.8	638	298740	65.1
1930	426	74574	30.6	407	71336	24.8	409	97239	33.0	474	127572	63.9	582	317058	73.5
1935	415	65624	27.3	404	73185	30.2	404	101690	41.2	522	134658	62.4	590	294089	70.2
1940	413	75939	33.4	410	74792	32.2	385	123961	66.5	497	132366	63.9	492	321454	84.0

Notes: *Large farms defined as 320+ acres except in WCS where defined as 480+ acres; Farmland in two Central Wheat Belt townships undercounted in 1875; Data missing for one Mixed Farming township in 1875; One Wheat-Cattle-Sorghum township had large change in area in 1920.

Population was affected by drought in Kansas, but recovered from dry years during settlement. The infamous drought of 1860 may well have slowed settlement in eastern Kansas, while the dry years before the 1895 census disrupted settlement in the western part of the state. The population rebounded by the end of the century, reaching peak numbers in 1910 and declining thereafter. The situation is less clear for the drought in the 1910s, however. It is possible that repeated droughts led to out-migration without replacement in-migration, and to fewer and larger farms. However, in addition to aridity, drought, and maximization of acres in farming pushing farmers and potential farmers to leave, expanding employment opportunities elsewhere and war in Europe also pulled population out of Kansas.

Thus far, the changes we describe make use of cross-sectional data from full enumerations of farms in the 25 townships. We now turn to the population data to ask whether changes in labor at the township or household level accompanied farm consolidation, and whether such changes were initiated or accelerated by drought. Similar to the county populations, the townships were aging, with older household heads, and starting in about 1900 fewer children and in 1910 fewer young adults, particularly women. Based on census occupation, the majority of persons with a listed occupation were employed in agriculture, a fact that did not change over the years.[3] However, in the later years as the number of farms began to decline there was a shift in the composition, with a greater proportion of farm laborers among those employed in agriculture. In addition, there were a small but growing percentage of adult farm laborers in non-farm households. Roughly one-third of all households had a working-aged adult man (aged 18-65) in addition to the household head, with farm households having more working-aged males than non-farm households (1.35 and 1.23, respectively p=.0000).[4] Households with more than one adult male were more common in the earlier years, in farm households beginning in 1875, and less common in the Corn Belt and Wheat-Cattle-Sorghum zones. In all areas, the percentage of farm households with more than one man was volatile during settlement, steadied for 20 or 30 years, and then began falling (Table 3).[5] Such households again became more common between 1925 and 1930 as the Great Depression pulled some population back to rural areas. In the Bluestem Pastures the decline was most pronounced, from a peak of nearly half of all farm households in 1880, to a low of less than one fifth in 1925 and back up to one quarter in 1930. Farm consolidation occurred in the context of decreasing numbers of male laborers in farm households, and a smaller proportion of households with multiple adult laborers in the zone with the most farm consolidation.

[3] There was some discrepancy between the number of persons enumerated as farmers and the number of farms listed in the agricultural records. While over 90% of those with farm records were identified as farmers in the population census, nearly one-fifth of the heads with the occupation of farmer did not link to a farm record. This mismatch was much greater in the earlier years and lessened over time, probably due to a combination of increased completeness of the farm census, accuracy of the population census, and success in linking farms and farmers. It occurred more frequently in the Bluestem Pastures and less so in the Central Wheat Belt.

[4] Excluding households of more than 7 persons where all were adults, which eliminates group quarters, railroad camps, army garrisons, etc. Using all adult males produces similar results.

[5] A similar pattern occurs for teen-aged boys in farm households.

Table 3. Percentage of farm households with more than one working-aged man (18-64).

	Mixed Farming	Corn Belt	Bluestem Pastures	Central Wheat Belt	Wheat-Cattle-Sorghum
1860	37.1	14.3	32.3	28.6	
1865	38.6	19.3	24.3	11.8	
1870	35.3	19.8	39.9	43.8	
1875	29.1	21.1	33.5	25.5	
1880	34.1	31.1	43.8	32.1	18.0
1885	33.8	35.0	38.2	34.2	24.4
1895	35.8	33.6	35.5	31.5	29.0
1900	31.7	28.3	33.1	30.5	32.3
1905	36.7	32.9	34.3	32.0	24.7
1910	31.9	27.4	28.5	29.5	21.3
1915	24.3	29.3	28.8	26.3	25.3
1920	22.2	33.2	23.9	23.2	24.8
1925	25.3	26.7	17.2	19.9	23.1
1930	25.6	27.2	25.3	25.3	27.9

Given stabilization of farmed acres and an aging population, consolidation did not necessarily imply out-migration of existing farmers. Our data allow us to follow individuals over time, as they form households and enter (or exit) farming.[6] Compared to others, farmers were less likely to leave (or more likely to be present in the sources so that we can link them from census to census). The proportion of farmers who previously resided in the township dropped from 40 percent in 1865 to 20 percent in 1870, as more recently settled townships were included in the data and perhaps with some effect from the 1860s drought. The proportion then climbed continuously except between 1885 and 1895, during the drought period which interrupted settlement of the western counties. After 1885, less than half of all farm households were new to the township, and by 1930 three-quarters of farm households in the sample townships could be linked to a prior census, meaning that at most only one quarter were in-migrants. At the same time, the overall population, including farm operators, was aging. Farm consolidation could have been as much about managing with an aging and shrinking population as it was about technology and increased longevity pushing out would-be farmers.

Farmers were a fairly stable group occupationally. Most farm household heads who linked forward (for example from 1915 to 1920) remained farmers, something we can judge both from their occupation in the population census and the fact that they were enumerated in the farm census. There was both lateral movement and downward occupational mobility, however, with about one-fifth listed in the succeeding census as tradesmen and a small percentage reported as agricultural or unspecified laborers. Some farmers changed occupations more than once, and it was not uncommon to have

[6] Linkage affects all estimates of in- and out-migration.

both a trade and be a farmer (e.g., Farmer, to Farmer and Carpenter, to Carpenter).[7] A slightly larger proportion changed occupations in the Bluestem Pastures and Wheat, Cattle, Sorghum regions as would be expected with consolidation. There was perhaps a slight tendency for more farmers to change occupation over time, but no evidence of drought periods affecting occupational change among household heads. Adults who were employed but not household heads were less likely to be listed as farmers, and non-head farmers showed both upward and downward shifts in occupation, with slightly over half remaining farmers and one-third next listed as agricultural laborers. Those listed as agricultural laborers were quite likely to be farmers in the next census (62%), but most of these were farm sons establishing their own farm households. There were very few heads of household who were farm laborers, but they showed remarkable mobility, with half listed as farmers in the subsequent census. A greater percentage of farm laborers were able to climb this rung of the agricultural ladder after the periods leading up to the 1905 and 1915 censuses, and this change in occupation was more common in the Corn Belt and Bluestem Pastures. The opportunity for farm laborers to establish farms of their own could have been influenced by droughts but may have been an unexpected outcome of farm consolidation. Although most farmers we followed forward in time remained in farming whether they were heads of a household or otherwise, a small proportion left farming while remaining in the township and a larger but declining proportion left farming and the township. Of those establishing their own households, sons of farmers already residing in the township were more likely to become farm operators than were others.

There are three possibilities to reconcile farm consolidation with static numbers of laborers in households. One is that the laborers are not household members, and we do see that in our Kansas townships. There were a small but growing percentage of adults listed as farm laborers living in non-farm households. Another is that early mechanization, such as harvesters, reduced the need for year-round labor. Occasional farm laborers may have been itinerant and not enumerated, or local but enumerated with the occupation they followed for the rest of the year. The third is that labor formerly needed for land clearance was freed for regular farm work at about the same time that consolidation got underway, shifting tasks while keeping the number of laborers fairly constant. On the other hand, opportunities elsewhere may have been the driving force, and farm consolidation and rising technology responses to a reduced pool of both farm labor and farm operators.

Testing Relationships on Individual Farms

Relationships between events, household structure, location, and time unfolding on several dimensions are difficult to assess in a series of one or two dimensional comparisons, so we turn to multivariate modeling to see whether observations hold when many factors are taken into account simultaneously. We use individual growth models in a multi-level mixed regression to make the best use of our longitudinal unbalanced panel data. The method compares detrended population averages along a

[7] There was no evidence of this resulting from differences in the federal and state censuses.

time continuum (in this case age of the household head), letting us model changes in farm size using information from all cases, including those with only one observation, and minimizing potential linkage bias. Fixed-effects coefficients are interpreted as shifts, up or down, in the change in farm size between one time point and the next, so that positive coefficients denote affects towards larger farms and negative coefficients towards smaller farms. In earlier analyses we have shown household land-use changing predictably over time as the head ages and children are born, mature and leave home, the importance of a labor cycle incorporating non-family household members, and a strong association of adult males with larger farms and more cropped acres.

To ask whether these land-labor relationships are robust to extreme climate events, we include as a series of covariates the number of droughts in the years immediately preceding our census observations (Table 4). When we include drought in our model, all other effects have the same direction and magnitude as we found earlier (Table 5).[8] Farm size increases and then decreases across household heads' lifecycles. Farms were smaller in the earlier years, smaller in the east, larger in the west and largest in the Wheat, Cattle, Sorghum zone.[9] Importantly, the relationship of male labor to farm size was also unchanged in direction or magnitude. Adult males in each age group were associated with larger farms, with a greater effect for men who were not the sons of the head.

The important finding of this analysis is that, the number of droughts in the five years before the census had a strong downward effect on the size of farms, with each drought increasing the magnitude. One drought is estimated to decrease farm size by 42 acres (compared to times where there were no droughts in the previous five years and net of the effects of other coefficients). Farms in townships experiencing drought in three-fifths of the years preceding the census were nearly 150 acres smaller, on average. The droughts of the early 1890s coinciding with settlement in the western Wheat Cattle Sorghum townships did indeed retard farm growth, even for those who had male labor at hand. Dry years in the 1910s and 1920s were widespread, and took their toll on individual farmers, even while farm consolidation was underway.

[8] In order to be comparable to earlier results, we restrict the analysis to years where crop acreage data are available (1875, 1885, 1895, 1905, 1910, 1915, 1920, 1925 and 1930). There are 16281 observations, over 9828 individuals.

[9] A model without Malin zones in the fixed effects returned similar results, but this model had slightly better fit.

Table 4. Number of droughts in the 5-year period prior to the census, by county and Malin zone.

		1875	1885	1895	1905	1915	1920	1925	1930
Corn Belt									
	Doniphan	0	0	0	1	2	1	0	0
	Nemaha	0	0	0	1	2	0	0	0
	Republic	0	0	0	0	0	1	2	0
	Smith	0	0	0	0	0	1	1	0
Mixed Farming									
	Allen	0		0	1	1	1	0	0
	Crawford	0		0	1	1	1	0	0
	Franklin	0	0	0	1	1	1	0	0
Bluestem Pastures									
	Chautauqua	0	0	0	0	2	1	0	0
	Chase	0	0	0	1	0	2	0	0
	Wabaunsee	0	0	0	1	0	0	0	0
Central Wheat Belt									
	Dickinson	0	0	0	0	1	1	0	0
	Ellsworth	0	0	0	0	2	1	1	0
	Pawnee	1	0	0	1	2	1	0	0
	Pratt		0	0	1	2	1	0	0
	Rooks		0	0	0	1	2	1	1
	Sedgwick	1	0	0	0	2	1	0	0
Cattle Wheat Sorghum									
	Cheyenne		0	2	0	1	1	0	0
	Decatur		0	2	0	1	1	0	0
	Ford		0	3	1	1	0	0	0
	Kearny			3	0	2	0	0	0
	Lane		0		0	1	0	0	0
	Stevens			3	0	1	1	0	0
	Thomas			2		1	1	0	1
	Trego			2	0	1	2	1	1
	Wallace			2	0	1	0	1	0

Notes: Droughts before 1895 from historical sources; droughts after 1895 based on deviation from normal. Blank cells have no census data, or census data lacks household (dwelling) identifier.

Table 5. Coefficients from the multilevel regression of acres in farms: Kansas farm households in 25 sample townships, 1875-1930.

	Model 1			Model 2			Model 3			Model 4			Model 5		
FIXED EFFECTS	B	se(B)		B	se(B)		B	se(B)		B	se(B)		B	se(B)	
Head's Lifecourse															
Head's age	9.67	1.40	***	10.65	1.40	***	10.65	1.40	***	6.31	1.59	***	6.11	1.58	***
Head's age squared	-0.09	0.02	***	-0.10	0.02	***	-0.10	0.02	***	-0.07	0.02	***	-0.07	0.02	***
Year															
1875				-88.98	12.98	***	-87.88	12.98	***	-97.09	12.86	***	-91.31	12.87	***
1885				-92.97	12.12	***	-92.73	12.12	***	-115.99	12.08	***	-116.57	12.07	***
1895				-70.48	11.42	***	-70.21	11.42	***	-85.06	11.34	***	-73.22	11.56	***
1905				13.66	10.97		13.96	10.97		0.48	10.88		21.08	11.60	
1915				-30.16	10.50	**	-30.22	10.50	**	-36.32	10.42	***	1.73	12.05	
1920				21.39	10.54	*	21.25	10.54	*	16.33	10.47		48.72	11.91	***
1925 (1930 omitted category)				-20.61	10.19	*	-20.66	10.19	*	-18.63	10.12		-12.30	10.15	
Regional Land-use Zones															
Corn Belt							-329.17	56.42	***	-330.78	57.03	***	-340.23	55.94	***
Mixed Farming							-332.34	62.40	***	-333.47	63.08	***	-340.38	61.87	***
Bluestem Pastures							-266.23	62.38	***	-268.58	63.06	***	-281.03	61.86	***
Central Wheat Belt							-225.82	49.71	***	-224.30	50.24	***	-226.74	49.28	***
Wheat, Cattle, Sorghum (omitted category)															

Table 5. Coefficients from the multilevel regression of acres in farms: Kansas farm households in 25 sample townships, 1875-1930 (cont.).

	Model 1		Model 2		Model 3		Model 4		Model 5	
FIXED EFFECTS	B	se(B)	B	se(B)	B	se(B)	B	se(B)	B	se(B)
Household Lifecycle and Labor										
Household size							11.57	2.24 ***	11.41	2.23 ***
Children (0-10)							-12.68	8.51	-12.65	8.49
Children (11-17)							-3.94	7.57	-3.50	7.55
Daughters (18 - 22)							8.18	7.47	8.90	7.46
Daughters (23 - 29)							-5.54	10.22	-5.69	10.20
Other women (18 - 22)							17.04	15.56	17.36	15.53
Other women (23 - 29)							3.14	17.09	5.05	17.07
Sons (18 - 22)							-28.77	18.78 ***	-28.71	18.75 ***
Sons (23 - 29)							36.56	9.07 ***	36.73	9.06 ***
Other men (18 - 22)							48.87	12.33 ***	50.32	12.30 ***
Other men (23 - 29)							121.48	13.45 ***	121.35	13.43 ***
Sons (30+)							111.78	14.28 ***	111.53	14.26 ***
Other men (30+)							72.69	20.64 ***	73.16	20.58 ***
Droughts in previous 5 years										
1									-42.24	8.47 ***
2									-69.34	12.65 ***
3									-147.53	36.93 ***
Intercept	82.24	46.25	96.26	45.75 *	275.53	44.62 ***	327.55	46.93 ***	340.28	46.52 ***
RANDOM EFFECTS										
Township-level intercept	29645.41	8682.28	27173.40	7970.90	8476.87	2819.36	8677.62	2879.75	8331.80	2767.06
Household-level head's age slope	12.59	1.47	12.83	1.46	12.75	1.46	11.80	1.42	11.53	1.41
Household-level intercept	11231.38	3118.52	10362.99	3092.66	10506.35	3094.23	9874.36	3000.23	10388.34	2987.78
Residual	102965.20	1615.83	101882.10	1597.22	101880.10	1597.01	100771.20	1570.82	100367.50	1564.12

Note: *** p =.000; ** p<.01; * p<.05

Conclusions

The history of Kansas farming families is largely one of adaptation to new environments, including levels of uncertainty. Newcomers to Kansas were less able to adapt, unprepared as they were for an environment where dry periods were widespread, frequent, severe and prolonged. Farmers in the more vulnerable and arid middle and western parts of the state learned that they needed more pasture and larger fields to be successful. Rapid growth in farms and population followed the settlement period, interrupted by drought, but resumed after. A period of stasis followed, and then consolidation following the droughts of the 1910s. Drought interfered with individual farmers' ability to increase land holdings and may have played a role in starting Kansas on the path to a smaller, sparser and older population.

What makes our analysis interesting is the capacity to see a clear relationship between population, agriculture, environment, and weather at the decadal scale that we have used. In this and earlier work, we show that there were definite relationships in Kansas between farmer's age, farm size, and the size and structure of farm households, controlling for the environmental zone and the time period in which the farming was taking place. In this paper we show that environmental shocks like a period of drought do not change those relationships, but they appear to reduce average farm size temporarily, on the way to allowing further settlement and eventually consolidation. The lessons learned are important: when examined carefully and in context, both the broader environment and short-term changes in weather mattered in the American past.

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Changes in Broad Demographic Behaviors After the 2003 European Heat Wave

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Abstract

More than 40,000 additional deaths occurred in Europe during the 2003 August heat wave. Such extreme meteorological events are expected to greatly increase in the coming years as a consequence of global warming. Casualties had been essentially the oldest old people. This paper aimed at assessing possible changes in individual and family broad demographic behaviors after the 2003 European heat wave regarding the oldest old, as well as public health and migration policies in relation with their care. Demographic behaviors are defined not only as giving birth or migrating but also as raising children and caring for the elderly. Modifications under consideration comprise changes in type of housing (nursing home versus individual household), type of living (alone versus with children), type of daily care (institutional versus family care, formal versus non formal care) and evolution of the oldest old support ratio as well as migration policy for caregivers and delocalization of nursing homes. This paper discusses data availability for assessing such changes dealing with the life and care conditions of the oldest old members of European societies.

Introduction

The 2003 heat wave has brutally revealed to the public and health authorities the existence of a large number of frail oldest old within the European populations. After comparing the daily numbers of deaths during the summer of 2003 to those occurring during the 1998-2002 period in sixteen European countries, an additional 70,000 deaths were observed, including 44,572 additional deaths during the August heat wave in the 12 countries detailed in this paper (see Table 1) (Robine, Cheung, Le Roy, et al. 2008). The oldest old and women represented the largest share of this mortality crisis.

In this paper we examine how families and national administrations organized themselves to take care of these persons before and after the occurrence of this major event.

Table 1. Delta between the number of deaths recorded in August 2003 and the average number of deaths recorded during the months of August in the 1998-2002 reference period and excess mortality ratio (expressed as a percentage) for 12 European countries.

	Delta	Ratio
Austria	159	2.63
Belgium	438	5.31
Denmark	-49	-1.04
France	15251	36.93
Germany	7295	10.97
Italy	9713	21.81
Luxembourg	73	25.00
Netherlands	578	5.24
Portugal	2196	27.75
Spain	6461	22.86
Switzerland	469	9.81
United Kingdom	1987	4.90

Method

Extensive searches were performed using scholar databases (Medline, Google scholar) with the following keywords: "elderly" and "heat wave", "illegal migration" and "elderly care", "illegal migrants" and "care" and "elderly", "institutionalization" and "foreign workers", as well as the same plus the term "statistics".

We also checked for specific indicators in official statistical databases such as the Human Mortality Database (HMD)[1], the Organization for Economic Cooperation and Development (OECD Health data 2008 CD-ROM. www.ecosante.org/oecd.htm), EuroStat[2] as well as some country statistical offices which were directly contacted. All cited numbers are value observed at the end of the month of December. As data from HMD are provided on January 1st, and data from the OECD are given on December 31st, we shifted back HMD data by one year to allow for direct comparisons across all tables and figures.

Finally given the small number of hits we had to extend our searches on the internet using the Google search engine.

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1 Human Mortality Database. Available at www.mortality.org or www.humanmortality.de. Accessed: 13.4.2006.

2 Eurostat. Expenditure on care (% of Gross Domestic Product, GDP) for elderly. Data from Eurostat. Accessed: 5.8.2009. The indicator is defined as the percentage share of social protection expenditure devoted to old age care in GDP. These expenditures cover care allowance, accomodation, and assistance in carrying out daily tasks. http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdde530.

Results

We can identify two types of responses destined to cope with the heat wave, an immediate reaction characterized by the health authorities recommendation to rehydrate elderly people, avoid overheated spot (South oriented windows, living under an uninsulated roof), to provide emergency care and manage the dead bodies by setting up temporary morgues in refrigerated warehouses.

A second set of delayed responses dealt with the detailed count of casualties, adapt or fix the health care systems, develop research strategies and recommendations through international projects, such as the EuroHeat project [3] which was coordinated by the World Health Organization—Regional Office for Europe and co-funded by the European Commission (EC). It proposed the development of national heat-health action plans which have been implemented by several countries.

The immediate demographic consequences of the 2003 heat wave were a mortality increase and a temporary apparent decrease in the proportion of residents aged 85+ in some European countries in the year following the event, like Italy, France or Germany (Table 2).

Table 2. Yearly proportion (%) of the population aged 85+ (both gender) for 12 European countries at the end of December.

	2000	2001	2002	2003	2004	2005	2006
Austria	1.79	1.70	1.61	1.53	1.57	1.69	
Belgium	1.79	1.73	1.63	1.55	1.58	1.71	1.84
Denmark	1.84	1.84	1.84	1.85	1.85	1.90	1.94
France	2.06	1.94	1.85	1.77	1.79	1.96	2.14
Germany	1.88	1.78	1.66	1.56	1.60	1.74	1.89
Italy	2.20	2.19	2.10	1.98	1.98	2.12	2.27
Luxembourg	1.35	1.32	1.30	1.24	1.25	1.33	1.35
Netherlands	1.42	1.43	1.44	1.43	1.46	1.53	1.60
Portugal	1.50	1.53	1.53	1.51	1.52	1.57	1.63
Spain	1.77	1.80	1.80	1.81	1.84	1.89	1.97
Switzerland	1.98	1.99	1.99	1.98	2.00	2.07	2.16
United Kingdom	1.90	1.91	1.88	1.85	1.90	2.00	2.09

Note: Data from the Human Mortality database.

But as shown in Table 3, there have been no change in the larger 65+ population. To verify the existence of a cohort effect distinct from the 2003 heat wave effect, we looked at the number of births, which occurred 85 years before the heat wave which corresponds to the year 1918 and before. Figure 1 shows a sharp decrease in the number of births in the European countries (F, I, B) engaged in the First World War (WWI) which is not the case for Spain. This translates in a relative deficit of the 85+ cohort size of these countries as shown in Figure 2 which starts in the year 2000 and reach a

[3] WHO 2008. Heat-health action plans (eds M. Franziska, B. Graham, M. Neus Cardeñosa , *et al*). WHO Regional Office for Europe, Copenhagen.

minimum in 2003. In contrast Spain shows a local minimum in its 85+ cohort in the year 2003, which can reasonably be attributed to the 2003 heat wave.

Table 3. Yearly proportion (%) of the population aged 65+ (both gender) for 12 European countries at the end of December.

	2000	2001	2002	2003	2004	2005	2006
Austria	15.4	15.5	15.5	15.5	16.0	16.5	
Belgium	16.9	16.9	17.0	17.1	17.2	17.2	17.1
Denmark	14.8	14.8	14.8	14.9	15.0	15.2	15.3
France	16.1	16.2	16.3	16.3	16.4	16.4	16.4
Germany	16.6	17.0	17.4	17.9	18.5	19.2	19.7
Italy	18.5	18.7	19.0	19.2	19.5	19.7	19.9
Luxembourg	13.9	13.9	14.0	14.1	14.3	14.4	14.0
Netherlands	13.6	13.7	13.7	13.8	14.0	14.3	14.5
Portugal	16.3	16.6	16.7	16.8	17.0	17.1	17.3
Spain	16.9	17.0	16.9	16.9	16.8	16.7	16.7
Switzerland	15.4	15.5	15.6	15.7	15.8	16.0	16.2
United Kingdom	15.8	15.9	15.9	16.0	16.0	16.0	16.0

Note: Data from the Human Mortality database.

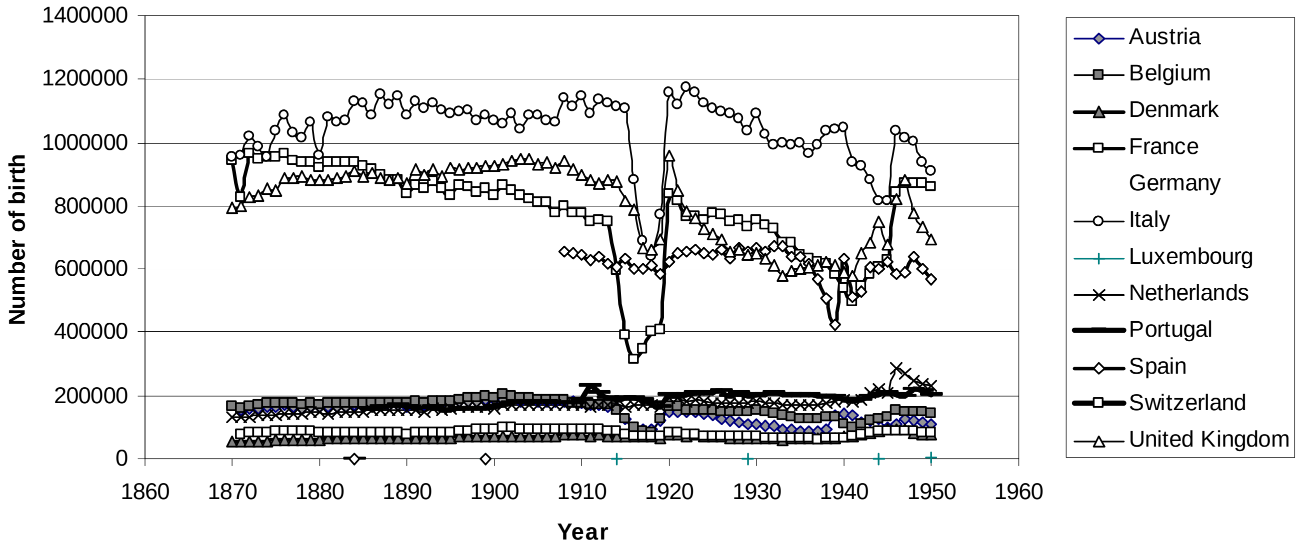

Figure 1. Number of births by year in 11 European countries.

Note: German data are not available before 1946 and thus are not presented. Data from the Human Mortality database.

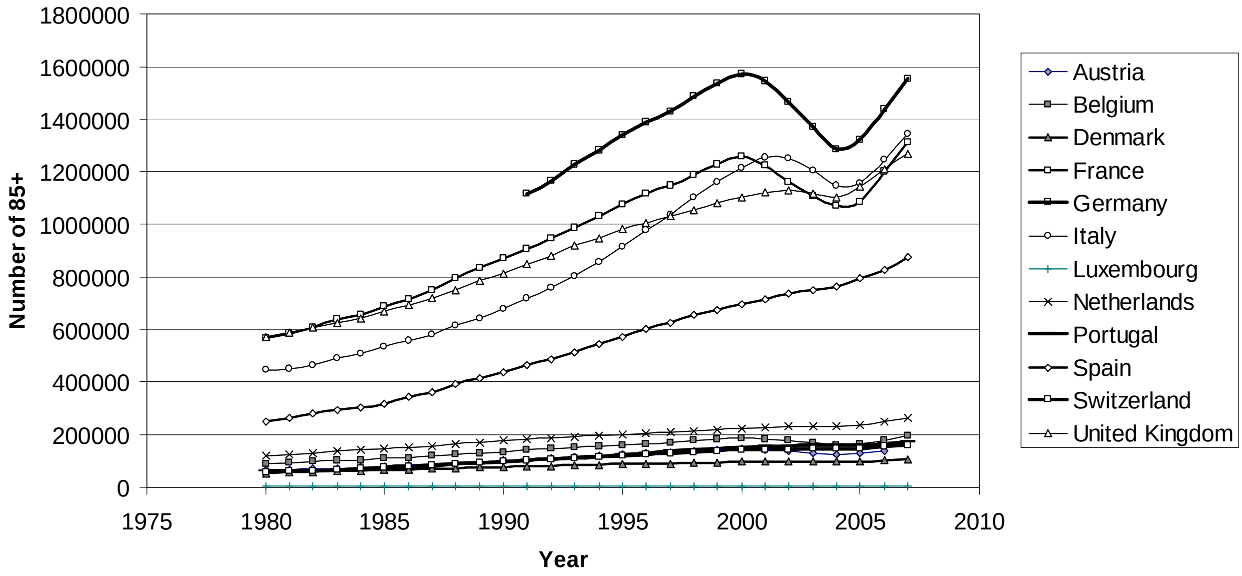

Figure 2. Number of 85+ by year in 12 European countries.
Note: Data from the Human Mortality database.

Beside infants and children, people with chronic diseases and the elderly are the populations most vulnerable to a heat wave (Kovats, Hajat and Wilkinson 2004). As elderly persons tend to loose their thirst feeling thus not drinking enough they need close surveillance and stimulation to drink regularly during the hot period. Depending on the dependency level of the elderly persons and their socio-cultural environment which vary from country to country, there are different possibilities to provide them with adequate care: to stay at home alone or with the family, to receive formal home care services, or to be placed in a nursing home.

While trying to evaluate the changes in the proportion of elderly cared in these different settings before and after the year 2003 we could not find many of such indicators. The organization for economic cooperation and development (OECD) introduced some indicators in their 2008 CD-ROM database addressing issues related with the elderly, but they are available for only a few countries and cover only a limited number of years.

Staying at home or with the family

Spouses of dependent people significantly contribute to informal care as long as they are able to provide such help. Moreover studies have shown the key role of middle aged women (50-74) who not only care for their parents or in-laws but also help their children raise their grandchildren (Spillman and Pezzin 2000).

The oldest old support ratio defined as the ratio of people aged 50-74 to those aged ≥85 is useful for monitoring changes in the population age structure. This ratio also provides proxy information on the number of people potentially available to provide informal care for one person aged ≥85 (Robine, Michel and Herrmann 2007). The secular trend of this ratio indicates a regular decrease, but as shown in Table 4 in the year 2004 following the European heat wave the OOSR reach a local maximum particularly for the countries who sustained most of the deaths during the heat wave (France, Germany and Italy) but which were also the most concerned by the deficit of birth during WWI. An exception is Spain who kept its downward trend.

Table 4. Oldest old support ratio (number of people aged 50-74/number aged ≥ 85) for 12 European countries at the end of December.

	2000	2001	2002	2003	2004	2005	2006
Austria	14.4	15.2	16.1	17.0	16.7	15.6	
Belgium	14.7	15.3	16.3	17.3	17.1	15.9	14.8
Denmark	14.5	14.6	14.8	14.8	15.0	14.7	14.6
France	12.2	13.0	13.9	14.6	14.6	13.4	12.4
Germany	15.1	16.1	17.3	18.6	18.2	16.9	15.8
Italy	13.1	13.2	13.8	14.6	14.6	13.6	12.7
Luxembourg	18.0	18.4	18.8	19.8	19.9	18.8	18.3
Netherlands	17.6	17.7	17.9	18.2	18.1	17.5	17.0
Portugal	17.7	17.4	17.5	17.8	17.9	17.4	16.8
Spain	14.5	14.2	14.1	14.0	13.7	13.4	12.9
Switzerland	13.2	13.2	13.3	13.4	13.4	13.0	12.6
United Kingdom	13.6	13.6	13.8	14.1	13.7	13.1	12.6

Note: Data from the Human Mortality database.

Most of the European countries are encouraging elderly people to stay at home and some even provide monetary incentives for the family to take care of them either directly (Denmark, Ireland, Norway, Sweden, and the United Kingdom) or through care recipients (e.g. France, Germany, the Netherlands, Norway and Sweden) (Fujisawa and Colombo 2009). But this was not always the case as in some countries admission to nursing homes was encouraged due to lack of housing. The EUROFAMCARE - Services for supporting family carers of elderly people in Europe: characteristics, coverage and usage - a project funded by the European Union describes in its final reports a detailed account of the situation in 23 European countries regarding the profile of family caregiver as well as migrant care and domestic workers (both legal and illegal).

The 23 detailed reports published between 2004 to 2005 provides excellent information on each countries statistics and policies, but neither they address the effect of the 2003 heat wave, nor provide trends data to address our study question.

Table 5 shows the proportion of formal home care recipient aged above 65+. This indicator was recently introduced by the OECD, but is available for only 6 countries and one of them has no data before the year 2004. France demonstrates a marked increase in this kind of long term care going from a lowest 3.1% to 5.1% the year after the 2003 heat wave. As a comparison, Denmark and Switzerland provide formal home care to more than 12% of their 65+ citizen and these rates did not change much in relation to the heat wave.

Table 5. Long term care recipients at home (% among aged 65) in 12 European countries.

	2000	2001	2002	2003	2004	2005	2006
Austria							
Belgium							
Denmark	12.4	12.8	13.1	13.3	12.7	12.7	12.9
France			3.1	4.4	5.1	5.5	6.0
Germany	7.0	6.9	6.9	6.6	6.6	6.7	6.6
Italy							
Luxembourg					6.4	6.6	5.9
Netherlands							
Portugal							
Spain							
Switzerland	12.6	12.1	12.0	12.0	12.1	12.3	12.4
United Kingdom							

Note: Data from the OECD 2008 CD-ROM database.

Nursing home placement

As it can be seen in Table 6, the evolution in the number of long term care beds in nursing homes follows two main trends: either large or small increase from below 15 beds per 1000 resident aged 65+ in Italy in 2000 to 17 in 2006, or a decrease from 42.9 to 22.1 in Denmark. France shows large fluctuations with a data gap in 2002 and a leap going from 13 in 2003, to 29 in 2004 and 39 in 2006, which can be reasonably linked to the 2003 event.

Table 6. Long term care beds in nursing homes per 1000 population aged 65+ in 12 European countries.

	2000	2001	2002	2003	2004	2005	2006
Austria							
Belgium				71.0	70.8	71.5	
Denmark	42.9	39.8	37.5	34.0	30.2	25.5	22.1
France	16.9	16.7		12.9	28.7	34.4	39.2
Germany		46.5		46.5		47.8	
Italy	14.0	14.5	15.7	16.3	16.0	16.5	17.4
Luxembourg					47.5	48.8	44.6
Netherlands	26.9	27.3	26.5	27.3	28.1	28.2	
Portugal							
Spain						18.9	21.3
Switzerland	22.0	21.0	19.9	19.6	18.7	18.2	
United Kingdom	71.5	70.4	70.3	69.8	69.4	71.1	

Note: Data from the OECD 2008 CD-ROM database.

As it takes time to plan and build nursing home, the fastest and only way to achieve such a rapid increase is to convert whole or parts of acute care public hospitals to nursing homes, a policy applied since many years in Switzerland to decrease its large number of public acute care beds or to revert to the public sector as it occurred in

France. But, increasing the number of beds is not enough; adequate staffing and financing policies must be implemented in parallels.

Table 7 shows the proportion of long term care institutionalized recipients among the population aged 65+, which displays a large variation across countries and a low within countries fluctuation with a magnitude of less than 1%. Once again data are scarce which makes the comparisons with other related indicators difficult.

Table 7. Long term care institutionalized recipients, % among the population aged 65+ in 12 European countries.

	2000	2001	2002	2003	2004	2005	2006
Austria							
Belgium	6.4	6.6	6.1	6.3	6.3	6.4	6.6
Denmark							5.4
France				6.3			
Germany	3.6	3.6	3.6	3.6	3.6	3.7	3.7
Italy							
Luxembourg					4.5	4.7	4.3
Netherlands							
Portugal							
Spain							
Switzerland	4.2	4.2	4.1	4.3	4.2		
United Kingdom	6.6	6.5	6.5	6.4	6.4	6.5	

Note: Data from the OECD 2008 CD-ROM database.

Long-term-care workforce

Nurses, nursing assistants, nurse aides, personal care attendants, home care workers, and other paraprofessional workers compose the long-term-care workforce and provide direct care to the elderly in hospitals, nursing homes, along with community based services and private homes. It is difficult to identify the long term care workforce (Montgomery, Holley, Deichert, et al. 2005). In the United States, direct care workers are defined in the following way: "An individual who provides hands-on personal care (e.g., assistance with bathing, dressing, transferring and feeding) as a significant part of their job at a nursing facility, home health agency, assisted living organization, adult day center or other personal care organization. Although activities may sometimes overlap, licensed practical nurses or registered nurses are not included in this definition. Also excluded are workers who help with cleaning, meal preparation and chores, but do not provide personal care. Typical job titles include nurse aide, home health aide, and personal care attendant. However, direct care workers are not limited to these job titles" (Kemper, Heier, Barry, et al. 2008).

Most of the jobs consist in low wages; labor intensive activities and the position are filled mainly by women and frequently by women from foreign origin. This is confirmed by an extensive study of the US 2000 census (Montgomery, Holley, Deichert, et al. 2005). Data from the French census of 1999 confirm in part this information (Borrel and Boëldieu 2001): with 2% of the male and 12% of the female

French active population working in direct services to person, as compared to 4% respectively 23% among migrants. But, the definition of direct services to person includes also restaurant and hotel employees, and we have no data on yearly trends.

Almost no data are available to address our question on the impact of the 2003 heat wave on the number of LTC workers. The expected shortage of the long-term-care workforce (Jorgensen, Parsons, Reid, et al. 2009; Kaye, Chapman, Newcomer, et al. 2006; Kemper, Heier, Barry, et al. 2008; Stone and Wiener 2001) is based in the US on extrapolation from "studies from individual states and professional associations, projections on job growth compared with demographic changes, and what is known about vacancies and job turnover" (Browne and Braun 2008).

It is only in 2008, that the OECD performed a pilot data collection on the characteristics of the LTC workforce in 14 countries (Fujisawa and Colombo 2009), including European States.

As stressed in a recent OECD report the identification and count of LTC workers is a complex task due to the variation in the organization of care and job categories across countries (Fujisawa and Colombo 2009). The legal migration of skilled health workers like nurses, which depletes the « poorest parts of the lowest-income countries » (Pond and McPake 2006), is difficult to quantify because of not fully comparable and incomplete statistics, thus making it difficult to analyze trends and compare the involvement of most source and destination countries (Diallo 2004). Moreover when LTC workers are recruited through unmanaged migration and becomes undocumented workers (like in Austria, Greece and Italy), as "they often offer needed services at low costs compared to other domestic alternatives" (Fujisawa and Colombo 2009), it is even more difficult to identify them because of their illegal status and their fear of deportation. For instance, the United Kingdom immigration service raises in a restricted document (Leppard 2008) the issue of "illegal employment of foreign nationals in the care industry", which is "widespread and constitutes a significant proportion of the total workforce who are engaged in illegal employments". The same reports stresses that further work is needed to determine its true scale in the UK. These issues are also regularly discussed in the lay press (Leppard 2008; Newman 2006), as well as regularization programs which consist in issuing work permits to undocumented migrant workers (like in Austria, Germany, Greece, Italy, Portugal and Spain) (DeParle 2008; Phalnikar 2005).

An alternative to migration might be the delocalization of elderly people to cheaper places. For now we are aware that Norway has built 5 medical centers in Spain, staffed by Norwegian teams, where costs are lower and temperature higher (Fuchs 2007). But, no country affected by the heat wave has done it yet.

Expenditure data might bring additional insights on the changes in spending devoted to the care of the oldest old. Indeed the European sustainable development indicators include as the "Public expenditure on care for the elderly" the percentage share of social protection expenditure devoted to old age care in Gross Domestic Product (GDP). These expenditures cover care allowance, accommodation, and assistance in carrying out daily tasks. As shown in Table 8, France, Spain and the Netherlands have increased the proportion of its GDP devoted to the care for elderly in 2004 and the following years. It is sensible to hypothesize that a part of this increase was triggered by the 2003 European heat wave.

Table 8. Expenditure on care (% of Gross Domestic Product, GDP) for elderly in 12 European countries.

	2000	2001	2002	2003	2004	2005	2006
Austria	1.007	0.985	0.964	0.968	0.968	0.959	0.996
Belgium	0.035	0.037	0.042	0.044	0.047	0.051	0.060
Denmark	1.639	1.666	1.720	1.754	1.770	1.738	1.729
France	0.167	0.165	0.257	0.308	0.322	0.323	0.328
Germany	0.185	0.178	0.178	0.174	0.167	0.163	0.156
Italy	0.100	0.110	0.117	0.120	0.119	0.114	0.120
Luxembourg	0.018						
Netherlands	0.663	0.601	0.658	0.670	0.872	0.873	0.791
Portugal	0.176	0.205	0.215	0.234	0.253	0.257	0.257
Spain	0.208	0.201	0.242	0.306	0.318	0.359	0.340
Switzerland	0.272	0.282	0.299	0.306	0.299	0.299	0.291
United Kingdom	0.810	0.844	0.902	0.952	1.011	0.988	0.993

Note: Data from Eurostat.

Discussion

In summary, the heat wave did not have the same impact on the different European countries. For this reason it is not possible to provide global results at the European level. The largest amount of deaths occurred essentially in France where the heat wave was strong and the country not well prepared. But Germany, Spain and Italy were also hit. We found only limited evidence of the direct impact of the 2003 heat wave on demographic indicators. In particular OECD data is still limited to the 65+ age group and does not provide information on the 85+. Long term care indicators have been introduced recently but their availability is limited in term of type, countries and time span. For instance there are no data available on adult day care. Moreover the definition of long term care and nursing home might vary among countries. Another approach to tackle these issues and evaluate changes associated with the care of the elderly before and after the heat wave consists in accessing economical information such as State’s budget and financial flows devoted to long term care and home care. The data we found provides some evidence of a heat wave effect in a few countries.

The policy implications of these results are to better standardize the definition of the diverse forms of long term care, to provide more detailed information on the oldest old age group and to extend the number of countries and years for which LTC indicators are available. More research is also needed on medical, social, economical and behavioral issues affecting older people. This information is needed to track changes and to allow benchmarking as population ageing alone will increase the disabled older population by over 80% and the numbers of cognitively impaired by almost 50% over the next 20 years with serious implications for the provision of care.

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Smallpox and Population Change in 18th and 19th Century Amakusa Islands, Kyushu, Japan

Satoshi Murayama and Noboru Higashi

Abstract

The western shore of Amakusa has few good harbors. Only Sakitsu had a valuable fishing port in this region, and the village also had certain official privileges for port transportation. The inhabitants of Sakitsu had good contact with only one large city outside of Amakusa, Nagasaki, but also suffered dangerous influences because of this contact; for example, the introduction of smallpox, which twice caused epidemics. In 1808, Sakitsu had its largest population at 2,466 (Bunka 5), but by 1856 it had decreased its population to only 1,346 (Ansei 3). In Takahama of Amakusa Islands, a neighboring village of Sakitsu, 150 people contracted smallpox from 1807 to 1808, and 57 of them died. In comparison with Sakitsu, Takahama has succeeded to control the spread of epidemic disaster. This paper investigates the differences of the two villages in demographic data.

1. Introduction

Infectious diseases, especially smallpox, are often assumed to have been the main causes of human death in pre-industrial Japan (Fujikawa 1969; Fukase 1999). However, we know of little statistical evidence regarding the death or recovery of individuals who contracted smallpox.

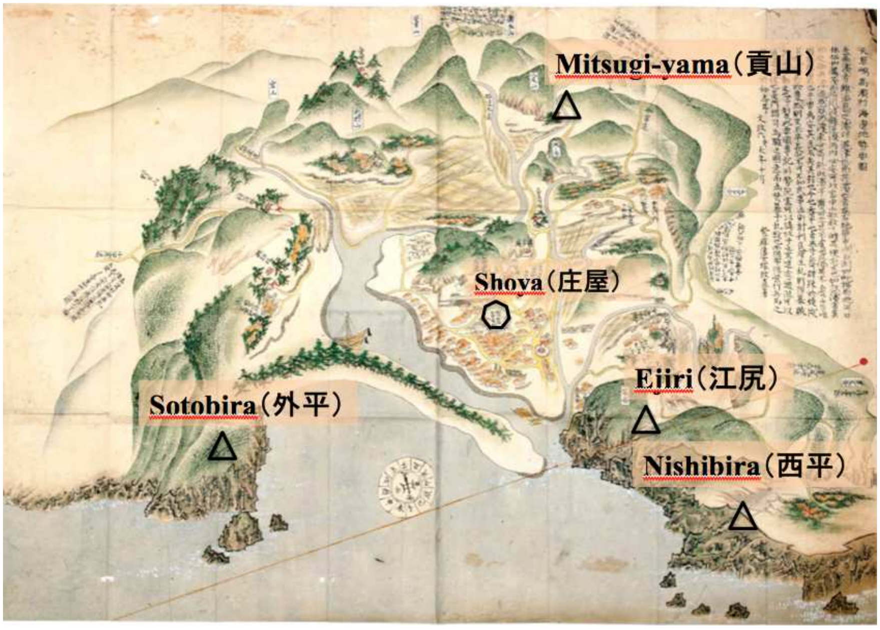
From the carefully kept population records of the time we know that in Takahama, a town located in the Amakusa Islands in Japan (Map 1), 183 people contracted smallpox in the 5-month period between December 1807 and April 1808, and 78 of them died. Before the introduction of vaccination, the only way to bring the outbreak under control was to quarantine the people who had contracted the disease. According to historical sources, there were quarantine huts in Amakusa from the start of the 18th century (Higaki 1952: 7).

In comparison with Takahama, Sakitsu, a village situated close to Takahama, suffered a dramatic population loss because of the three outbreaks of smallpox in 1801, 1813 and 1834. The population reduced from 2,400 to 1,400. These facts raise a question: What was the difference between Sakitsu and Takahama?

Map 1. A drawing map of Takahama, measured in 1808(Bunka 5) and subscribed in 1823(Bunsei 6).

Source: “Amakusa-tou Takahama-mura Kai-hen Chisei Youzu” (Kyushu University).

Historical sources on the smallpox outbreak in Takahama from 1807 to 1808 show that there were two types of quarantine huts; one of them, which was called “Yama-goya” (a mountain hut), was built at that time in a mountainous place, and the other, which was named “Nozoki-goya” (an exclusion hut), was standing within the village on the way to “Yama-goya” (Map 2). The sources list the name, sex, and age of all of the people who suffered from smallpox, and the relation of their families.



Map 2. Shoya and four mountain huts in Takahama.

This paper will investigate the quarantine policy in Takahama. How many of those who were moved to those huts died, and how many recovered? The age structure of the victims of the disease and the causes of death will be analysed according to documents relating to the quarantine huts in combination with demographic and household data derived from the Japanese population register, *Shumon-cho* (*Ueda-ke Monjo*; *Sakitsu Monjo*).

2. Traditional and Modern Medical Understanding of Smallpox Disease

Smallpox is a serious, contagious, and sometimes fatal infectious disease. There is no specific treatment for smallpox, and the only prevention is through vaccination. Variola virus is a severe form of smallpox. According to the report of the Centres for Disease Control and Prevention, variola major smallpox historically has an overall fatality rate of about 30%. Smallpox outbreaks have occurred from time to time for thousands of years, but the disease has now been eradicated after a successful worldwide vaccination program. The last case of smallpox in Japan was in 1949.

Generally, direct and fairly prolonged face-to-face contact is required to spread smallpox from one person to another. Smallpox also can be spread through direct contact with infected bodily fluids or contaminated objects such as bedding or clothing. Rarely, smallpox has been spread by a virus carried in the air in enclosed settings such as buildings, buses, and trains. Humans are the only natural hosts of variola. Smallpox is not known to be transmitted by insects or animals.

A person with smallpox is sometimes contagious with the onset of the fever (the prodrome phase), but the person becomes most contagious with the onset of the rash. At this stage the infected person is usually very sick and is not able to move around in the community. The infected person is contagious until the last smallpox scab falls off.

Modern medical knowledge has surpassed the traditional understanding of smallpox. However, the symptoms and the changing conditions of smallpox patients were carefully observed in the past. “Toso-Tebiki-Sho” (Handbook for Smallpox) published in 1778 (Anei 7) describes the symptoms quite exactly (Rotermund 1995: 15-17, Table 1). However, the central problem is the degree of understanding of the contagiousness of smallpox. The only way to prevent the spread of smallpox was to keep patients in quarantine facilities. On the other hand, medicine rites and magic rituals were also customary.

Table 1. Modern medical and traditional understandings of smallpox disease.

Day	Modern medical understanding				Traditional understanding in Japan from the 18th century		
	Duration	Phase name	State of contagiousness	Condition of illness	Duration	Phase name	State of contagiousness
	7 to 10 days	Incubation period	None	Exposure to the virus is followed by an incubation period during which people do not have any symptoms and may feel fine.	Unknown?		
1st to 4th	2 to 4 days	Initial symptom	Sometimes	High fever, malaise, head and body aches, and sometimes vomiting.	2 to 3 days 1 or 2 days	*"Jyonetsu"* *"Kenten"*	Unknown Unknown
5th to 8th	about 4 days	Early rash	Most contagious: Rash distribution	A rash emerges first as small red spots on the tongue and in the mouth. These spots develop into sores that break open and spread large amounts of the virus into the mouth and throat.	1 or 2 days 1 or 2 days 1 or 2 days	*"Syussei"* *"Kicho"* *"Yusho"*	Unknown Unknown Unknown
9th to 13th	about 5 days	Pustular rash	Yes	The bumps become pustules—sharply raised, usually round and firm to the touch as if there is a small round object under the skin.	1 to 2 days 1 to 2 days	*"Kuwannou"* *"Siuen"*	Unknown Unknown
14th to 18th	about 5 days	Pustules and scabs	Yes	The pustules begin to form a crust and then scab. By the end of the second week after the rash appears, most of the sores have scabbed over.	1 to 2 days	*"Rakuka"*	Unknown
19th to 24th	about 6 days	Resolving scabs	Yes	The scabs begin to fall off, leaving marks on the skin that eventually become pitted scars. Most scabs will have fallen off three weeks after the rash appears.	At the 15th day: End of Smallpox		
		Scabs resolved		Scabs have fallen off. Person is no longer contagious.			

Sources: www.cdc.gov/smallpox; Rotermund, 1995, 15-17.

The traditional understanding of the contagiousness of smallpox was clearly different from the modern medical understanding, which insists that the smallpox patients are contagious until their last scab falls off. In the Japanese traditional understanding, the 15th day, on which the scabs begin to fall off, was considered to be the end of the infection. Also, according to the traditional Japanese medical book, it was believed that the patients died mostly on the 11th and 12th days.

The lack of medical understanding about contagiousness increased the fear of smallpox. According to a Japanese contemporary work, “Toso-Mondo” (Smallpox dialogue) (Higaki 1952: 7), in Amakusa, people abandoned smallpox patients out of fear of contracting the terrible sickness. Patients were isolated. Fathers, mothers and other family relations who caught the disease were ignored. Even if they became well again, they could never return to their homes if they had been away for more than one hundred days.

In the case of Takahama, the conditions were different, as a doctor and others cared for the patients in the mountain hut. They were never abandoned. However, the fatality rate of the last smallpox sufferers, who moved to the mountain hut after the doctor returned to his country, was especially high. As will be addressed below, it was also not true that all of the patients were cared for effectively. Another point to be addressed is that the date of death was not always on the 11th or 12th day after the initial symptoms. Inadequate nutrition, unsuitable care and abandonment would have caused symptoms created other conditions besides the effect of the disease itself that could lead to death (Radtke 2002).

3. Population Change and the Influence of Smallpox Outbreaks in Takahama and Sakitsu

The most reliable data on the population of Amakusa is dated 1827 (Bunsei 10). This register gives a total population of 141,797, of which 68,803 were males, 67,910 were females and 5,084 were persons whose gender is unclear. The sex ratio of males to 100 females is 101.3, when these unknowns are excluded. The population increased about fivefold in the Genroku era (Higaki 1952); however, Higaki estimates the population after the rebellion, in the mid-17th century, at around 16,000. If we consider this number to be the minimum population of Amakusa, we see that it increased a little less than 10 times in the following 200 years until the end of the Tokugawa period.

The decrease in population caused by the Shimabara Revolt was rapidly alleviated by government-fostered migration. This population recovery can be particularly observed in the 17th and 18th centuries (Higaki 1952). Table 2 and Figure 1 show an example of this change in the population of the four neighbouring villages.

In these four villages, the population did not change uniformly. In Takahama, for example, there was a population increase in the late Tokugawa period, while in Sakitsu, the population suddenly decreased during the same period. In Imatomi and Oe, the population has had a tendency to either decrease or remain stagnant. Why are there such differences? Hirata suggests that, in the case of Sakitsu, smallpox and the economical isolation of Sakitsu from the other villages had a significant impact on its population (Hirata 2001).

Table 2. Population change in four villages in Amakusa.

	1691 *Genroku 4*	1808 *Bunka 5*	1816 *Bunka 13*	1817 *Bunka 14*	1827 *Ansei 10*	1856 *Ansei 3*
Imatomi	407	1,890	1,925	1,939	1,945	1,840
Sakitsu	850	2,466	1,962	1,955	1,865	1,346
Ooe	889	3,179	3,259	3,275	3,290	3,186
Takahama	958	3,336	3,414	3,440	3,629	3,826

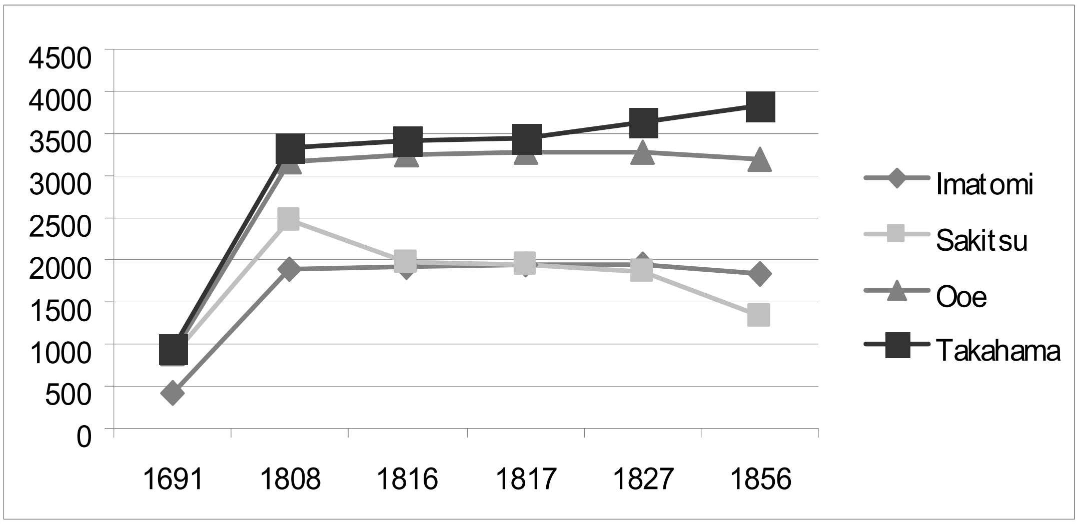


Figure 1. Population change in four villages in Amakusa, 1691-1856.

The western shore of Amakusa has few good harbours. Only Sakitsu had a valuable fishing port in this region, and the village also had certain official privileges for port transportation.

The inhabitants of Sakitsu had good contact with only one large city outside of Amakusa—namely, Nagasaki, but also suffered dangerous influences because of this contact, for example, the introduction of smallpox, which twice caused epidemics. Sakitsu had no good areas to be cultivated. The inhabitants of Sakitsu, therefore, had meshed their economy with that of Imatomi, a neighbouring agricultural village. The isolation of Sakitsu was exacerbated by the spread of smallpox. In 1808, Sakitsu had its largest population at 2,466 (Bunka 5), but by 1856 it had decreased in population to only 1,346 (Ansei 3) (Table 3 and Figure 2).

"Nagasaki-Daikan-Kiroku-Shuju" reports that in 1834 (Tenpo 5), 507 persons (27 %) out of the population of 1851 in Sakitsu contracted smallpox, and of these 338 (18%) died. The fatality rate of 66.7% was very high. Such statistical data for the smallpox outbreak in 1813 (Bunka 10) were not available, but one record shows that most people took refuge from the village in another region, and that only one hundred persons remained there (Hirata 2001: 223). Most people in the fishing village emigrated by ship.

Table 3. Average population by decade: Takahama and Sakitsu, 1690-1879.

	Takahama	Sakitsu
1690-99	958	850
1700-09		
1710-19	1272	
1720-29	1402	
1730-39	1804	1448
1740-49		
1750-59	2254	
1760-69	2714	2165
1770-79	2931	
1780-89	3076	2429
1790-99	3122	
1800-09	3302	2430
1810-19	3415	1946
1820-29	3559	1980
1830-39	3638	1920
1840-49	3666	1361
1850-59	3826	1321
1860-69	3732	1247
1870-79		1407

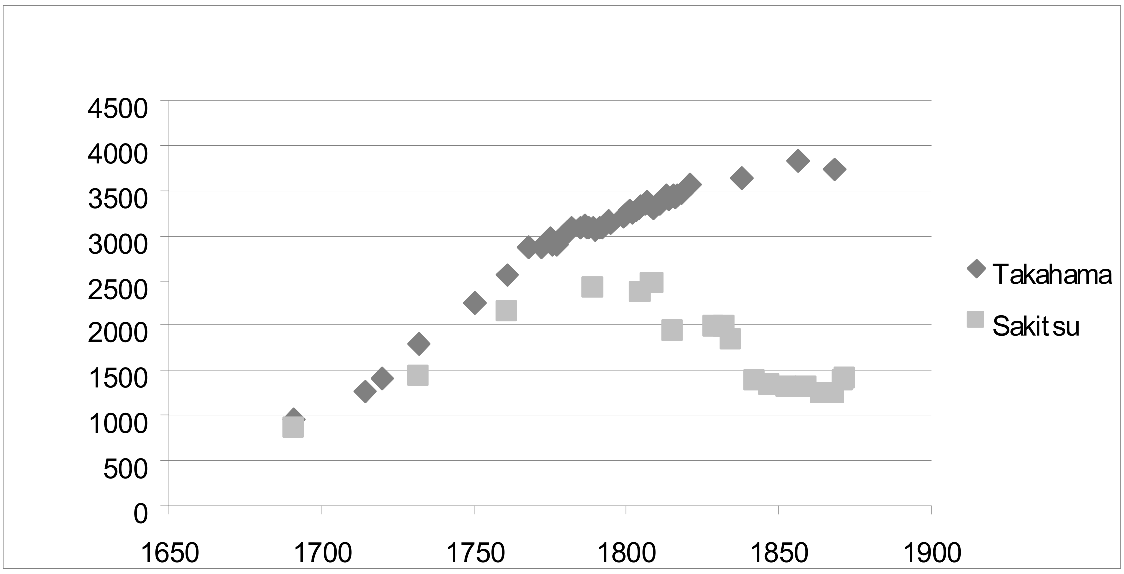


Figure 2. Population change in Takahama and Sakitsu, 1690-1879.

For the *Shumon-cho* in Takahama (*Ueda-ke Monjo*), there were several books for each district. Because some books were lost, we could not derive demographic data for the whole village. In 1803 (Kyowa 3) the population was 3270 persons, for whom the *Shumon-cho* shows only 1102 inhabitant households. For 1806 (Bunka 3), no books remained.

In the *Shumon-cho*, each person who died suddenly was listed as ‘a sudden death’. Such deaths were caused by accidents and also by smallpox. In 1807 (Bunka 4) and 1808 (Bunka 5), the numbers of deaths were markedly high; this was also true in 1803 (Kyowa 3) and 1813 (Bunka 10). It is known that in 1813 there was a smallpox outbreak in Sakitsu.

Table 4. Population change in Takahama from 1803 (Kyowa 3) to 1813 (Bunka 10).

Year		Population (=A)	Population in *Shumon-cho* (=B)	Total number of deaths (=C)	C/B in %	Number of sudden deaths (=D)	D/C in %
1803	Kyowa 3	3270	1102	39	3.5	4	10.3
1804	Bunka 1	3301	1086	21	1.9	4	19.0
1805	Bunka 2	3320	1090	15	1.4	3	20.0
1806	Bunka 3	3340	?	?	?	?	?
1807	Bunka 4	3370	2831	103	3.6	19	18.4
1808	Bunka 5	3336	2809	103	3.7	18	17.5
1809	Bunka 6	3307	2778	43	1.5	4	9.3
1810	Bunka 7	3350	2839	54	1.9	14	25.9
1811	Bunka 8	3363	2868	46	1.6	14	30.4
1812	Bunka 9	3400	2900	41	1.4	4	9.8
1813	Bunka 10	3445	2947	98	3.3	21	21.4

The fatality rates in 1807 and 1808 were, however, not very high in comparison with the other cases in Amakusa. The quarantine policy was effective in limiting the number of victims. Prompt isolation of the patients with their household members from the other village inhabitants was effective in controlling the unrestricted spread of smallpox. Rice, *miso* and other foods were sent from Takahama and other neighbouring villages. The doctor was effective. On the other hand, some famous Shinto priests were also invited for a mysterious prayer to help eliminate the sickness from the village.

4. Smallpox Outbreak and Quarantine Policy in Takahama

The beginning of the smallpox disease in Takahama of 1807 was the death of a man named Komosuke in December. He lived in “Suwa-no-tori”, one district of the village, which had 122 households with a total of 540 persons. Komosuke’s cause of death was not known; however, many people who attended his burial and also had direct contact with him while he was sick showed symptoms of smallpox at once. The number of patients increased to 75 by December 14.[1]

[1] *Sources*: *Ueda-ke Monjo*; Bunka 4-nen Takahama-mura Suwa-no Toori Housou-byonin Yamagoya-iri narabini Nozoki-goya-iri Ninzu Kakitate-cho U 12 Gatsu 14 nichi yori Yama-iri Dou 23 nichi-made; Bunka 5-nen Housou Ninzu On-todoke Moushiage-sourou-yori Kakitate-cho; *Ueda-ke Nikki*.

The local governor (*Shoya*) in Takahama decided to quarantine all of the patients in a mountain hut, and also to quarantine all of their household members in an exclusion hut. With the inclusion of five additional persons who showed smallpox symptoms by that time, a total of 80 patients were moved to the new mountain hut. A doctor, Keiniku Miyata, who visited the village by chance, was begged to care for the patients. Because the patients were mostly quite poor, the village decided to pay the cost of their medical treatment and food.

Of the 80 patients first diagnosed, 16 had died by December 23, which corresponds to January 20, 1808 on the western calendar. Six of these 16 fatalities were due to a serious illness, and these 6 died before they moved to the mountain hut. The other 10 persons died in the hut. The record of persons who moved to the huts shows only the death date for those who died before December 23. All the other persons on the list were identified using *Shumon-cho*, and their death dates were confirmed. By the end of January 1808, 16 more persons had died. A total of 32 persons (40.0 %) of the 80 smallpox patients appear to have died as a result of the disease.

A total of 101 persons lived in the exclusion hut in the village. They were household members of the 80 patients. If they exhibited symptoms of smallpox, they were moved immediately to the mountain hut (Figure 3 and Map 3).

More than the 80 patients who were quarantined contracted smallpox. Even if only one member of a household was recorded as a patient on the list, it is possible that by January of 1808 all of the household members died. A man named Fukuhei had 6 members in his household. He and all six of his household's members died between December 17 and January 28. Only his daughter, Iwa, who died on December 22, was listed as one of the 80 patients. However, before her death, Fukuhei's niece Tama, who was 7 years old (*sai* in Japanese), had already died on December 17. This case shows that the list was not perfect, and that there were some village members who were not listed but who died in the early phase of the outbreak.

A total of 166 patients were moved to the mountain hut. Of these, 15 patients were quarantined after the doctor, Miyata, left the village at the end of January. Of these 15 patients only three persons recovered, and 12 (80.0 %) died. When the doctor was caring for the patients, 61 out of 151 patients (40.4 %) died due to smallpox. The significance of this difference is unclear.

After the beginning of April, newfound patients were not quarantined in the mountain hut, but were transported out of the region by ship, while their household members lived for some time on an exclusion ship. A total of 17 patients were shipped in this way. Of these 17 patients, only 5 (29.4 %) died. The total number of patients from December, 1807 to the end of April, 1808 was 183, of whom 78 (42.5 %) died. This rate was not as high as that of Sakitsu in 1834. The quarantine policy in Takahama could be judged to be quite effective at preventing a greater spread of the disease.

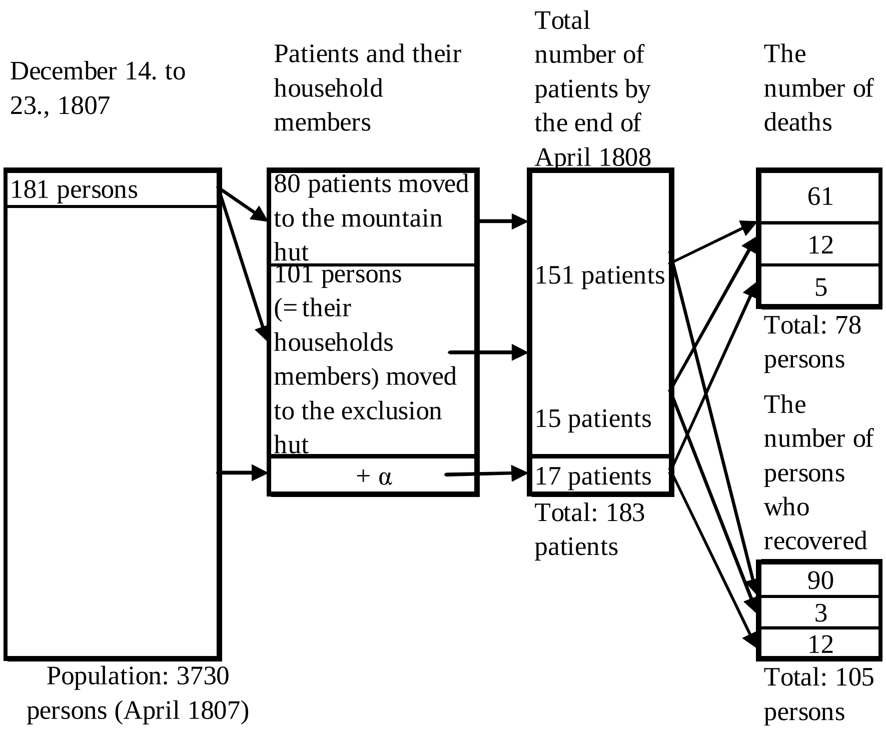
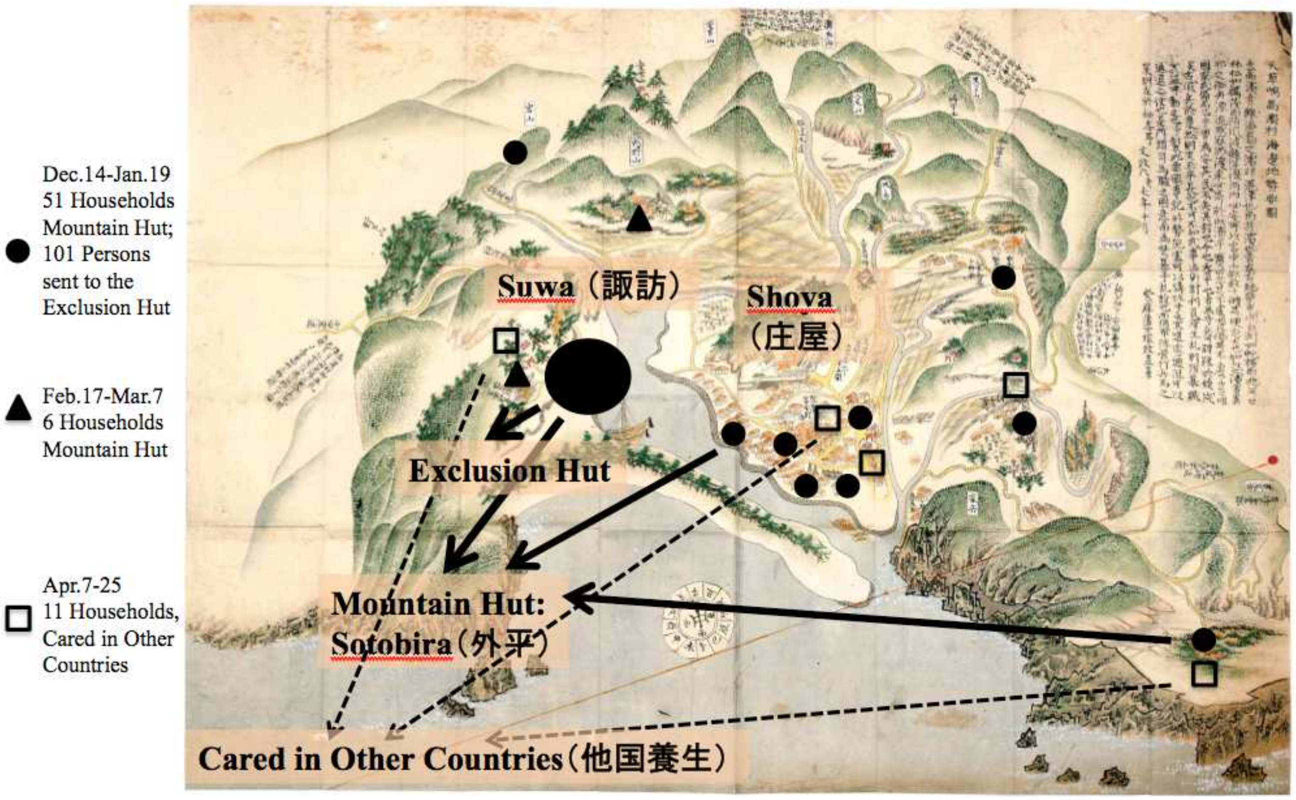


Figure 3. Quarantine policy in Takahama.



Map 3. Mountain hut and quarantine policy in Takahama, 1807-08 (Bunka 4-5).

5. Causes of Death

The age structure of the victims shows that not only the children, but also individuals between forty and fifty years of age had a higher frequency of contracting the disease(Table 5). However, the sample size is too small to draw conclusions from this data.

Table 5. Age structure of smallpox victims in Takahama, 1807/08.

Age	Female				Male				Total	Total patients	in %	No. of deaths	in %
	No.	Patients	in %	No. of deaths	No.	Patients	in %	No. of deaths					
0-5	253	3	1.19	2	185	5	2.70	2	438	8	1.83	4	50.0
-10	133	3	2.26	2	136	6	4.41	2	269	9	3.35	4	44.4
-15	126	8	6.35	1	133	7	5.26	1	259	15	5.79	2	13.3
-20	141	5	3.55	1	110	2	1.82	1	251	7	2.79	2	28.6
-25	116	4	3.45	3	110	4	3.64	0	226	8	3.54	3	37.5
-30	118	3	2.54	1	126	3	2.38	0	244	6	2.46	1	16.7
-35	108	3	2.78	1	89	4	4.49	3	197	7	3.55	4	57.1
-40	74	2	2.70	1	84	1	1.19	0	158	3	1.90	1	33.3
-45	89	2	2.25	1	90	3	3.33	3	179	5	2.79	4	80.0
-50	76	5	6.58	4	73	3	4.11	0	149	8	5.37	4	50.0
-55	68	3	4.41	2	61	1	1.64	1	129	4	3.10	3	75.0
-60	67	0	0.00	0	47	0	0.00	0	114	0	0.00	0	0.0
-65	45	0	0.00	0	31	0	0.00	0	76	0	0.00	0	0.0
-70	34	0	0.00	0	17	0	0.00	0	51	0	0.00	0	0.0
-75	23	0	0.00	0	20	0	0.00	0	43	0	0.00	0	0.0
-80	17	0	0.00	0	12	0	0.00	0	29	0	0.00	0	0.0
-85	7	0	0.00	0	5	0	0.00	0	12	0	0.00	0	0.0
-90	3	0	0.00	0	2	0	0.00	0	5	0	0.00	0	0.0
-95	0	0	-	0	1	0	0.00	0	1	0	0.00	0	0.0
-100	1	0	0.00	0	0	0	-	0	1	0	0.00	0	0.0
	1499	41	2.74	19	1332	39	2.93	13	2831	80	2.83	32	40.0

It is noteworthy that the fatality rate in the period when the doctor was absent was very high. As already mentioned, 15 patients in seven households were sent to the mountain hut after the doctor left the village, and only three of these patients recovered. We know the durations of these 15 patients' stays in the mountain hut: they were generally long, with the end usually marked by death. There is no description of the cause of death for those patients. However, it would seem that smallpox was not the decisive cause of death, because 11 of the 12 fatal victims (the exception was Yuki) died while in the last phase of the sickness (Table 6).

Table 6. Death and recovery of the last isolated patients in 1808.

Household ID	Name	Male or Female	Age	Date: moved to the mountain hut	Date of death or recovery (=R)
148C	*Sangoro*	M	27	Feb. 17	R
	San	F	64	Feb. 17	R
	Tatsu	F	29	Feb. 17	Mar. 25
	Jinjiro	M	3	Feb. 17	Mar. 25
161	*Tokutaro*	M	5	Feb. 20	Mar. 22
	Ichigoro	M	31	Feb. 20	Mar. 15
	San	F	34	Feb. 20	Mar. 17
	Torajiro	M	3	Feb. 20	Mar. 21
160	*Kumanosuke*	M	35	Feb. 20	Mar. 18
	San	F	23	Feb. 20	Mar. 15
	Yuki	F	35	Feb. 20	Mar. 2
104A	*Yoshimatsu*	M	31	Feb. 22	Mar. 20
188	*Ito*	F	59	Mar. 1	Mar. 22
123A	*Toramatsu*	M	10	Mar. 7	R
192	*Tsuma*	F	44	April 7	April 15

6. Conclusion

Quarantining the patients and their household members was an effective way of preventing an even greater spread of smallpox. The town of Takahama was able to avoid a dramatic population decrease. The fatality rate was not as high as in other outbreaks. However, smallpox seems not to have been the only cause of death for the smallpox patients. Often in this situation, the patients were abandoned and ignored. The causes of the dramatic decrease of population in Sakitsu (*Sakitsu Monjo*; Higashi 2008) will be investigated in the near future.

Acknowledgement

This study was first presented at the 6th ESSHC in Amsterdam, March 22- 26, 2006, and revised later. It has benefited from the Eurasia Project on Population and Family History funded by the Ministry of Education, Science, Sports and Culture, Japan, from April 1995 to March 2000, and was also supported by the Japan Society for the Promotion of Science Frants-in-Aid for Scientific Research(B) (1) (13410070) from April 2001 to March 2004, Grants-in-Aid for Scientific Research(B) (2) (16402018) from April 2004 to March 2007, and ongoing Grants-in-Aid for Scientific Research(A) (19203018). We want to acknowledge my gratitude to the Eurasia project funded by the Japanese Ministry of Education, Science, Sports and Culture, and also other projects supported by the Japan Society for the Promotion of Science, as we used the database sets produced by these projects.

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Decrease of Child Deaths from Smallpox After the Introduction of Vaccination on the Outskirts of Edo (Tokyo), Japan

Hiroshi Kawaguchi

Abstract

This paper analyzes the decrease of child deaths from smallpox, as well as faith healing practice before and after vaccination was introduced in Tama County in the province of Musashi on the outskirts of Edo, which was the seat of the Tokugawa shogunate. In 1849, a Dutch doctor introduced the first vaccine in Japan. It was tried in 1850 in the towns of Hachioji and Fuchu, also located in Tama County. According to Fujiakira Sashida's diary regarding faith healing practice in the hamlet of Harayama, the number of smallpox sufferers rapidly decreased from 1852, after the introduction of vaccination. Sashida, an *onmyoji* (Japanese specialist in magic or incantations), worshipped the smallpox deity with a codified ritual in the case of children infected with smallpox. During the nineteenth century, faith healing rituals in Tama County were performed not only by the *onmyoji*, but also by Buddhist and Shinto priests and mountain hermits. Peasants, village heads, intellectual townspeople, warriors and even the Shogun's family supported this traditional practice, which was maintained even after vaccination against smallpox was introduced. The number of smallpox victims dropped sharply during thirty years (1850 to 1880). Registers in some Buddhist temples show that before the 1860s, there had been several peak periods about every five years, when infant and child mortality had been higher than that of adults. This kind of periodical trend is not found after the 1860s. Therefore, we can conclude that many peasants in Tama County adopted vaccination against smallpox from the 1860s.

1. Introduction

Although historians and historical demographers recognize that one of the most serious causes of child deaths in pre-industrial Japan was smallpox, there are not many research works on this subject. We have relatively little knowledge about smallpox mortality, epidemics and traditional methods for treatment. Especially, there are practically no studies concerning the vaccination's process of introduction and its effect on infant and child mortality.

On the other hand, Japan's total population had remained stable for 126 years (1721 to 1846) and it started to increase rapidly in the 1850s (Sekiyama 1958, Hayami 1983). These were the last years of the Tokugawa shogunate and it was during this period that vaccination against smallpox was introduced in Japan. To reply to the simple question as to why the population began to increase, it seems to us important to take into consideration the decline in smallpox mortality.

Lack of research works is mainly due to the scarcity of source data (Kawaguchi 2001). Except for a few cases, the cause of death is generally not recorded in the three basic sources of data in historical demography – the Japanese religious investigation register, *Shumon-Aratame-Cho* (SAC); the household register, *Koseki-Bo* (KB); the Buddhist temple death register, *Kako-Cho* (KC). Only smallpox mortality in some villages in the province of Hida was mentioned in Buddhist temple death registers (Suda 1973; Suda and Soekawa 1983; Jannetta 1987). In the province of Aki, smallpox epidemics and treatment are mentioned in clinical records kept by a doctor who practiced Chinese medicine (Doi 1990; 1991; Sakai 1993).

Medical and science historians have written biographies of pioneer physicians who contributed to the spread of vaccination against smallpox (Ito 1916; Fujikawa 1941). Another source mentions that some peasants refused vaccination because the vaccine was made from cattle (Soekawa 1987). Therefore, it is possible that there were regional differences in the vaccination's process of introduction. Moreover, vaccination's effect on the decline of smallpox mortality is still unclear, one of the reasons being that it is not known how peasants took care of their children when they were infected with smallpox before vaccination was introduced in Japan. Only the cult of the smallpox deity is discussed in some works (Enomoto 1989; Takahashi 1992; Suda 1992; Rotermund 1995).

Smallpox symptoms are described in a wood-block-printed book on child-rearing, *Shouni Yashinai Gusa*, edited and published by Roan Katsushika in 1824, in three main cities – Edo, Osaka and Kyoto – during the Tokugawa period. The symptoms appear in five or six stages, each of them lasting about three days: fever→ skin rash→ rash swelling → pus forming → scab forming → scab peeling off. Explanations about smallpox in other books on child-rearing and Chinese medicine published in the first half of the nineteenth century carry very similar descriptions. It is possible that most peasants were familiar with particular smallpox symptoms. Even if they did not know much about medicine, probably they were able to accurately diagnose smallpox in their children. As parents knew that smallpox was serious and difficult to treat, they took care of their infected children carefully watching the different stages of the illness.

In this paper, we analyze the decrease of child deaths from smallpox and the treatment of infected children before and after the introduction of vaccination in 1850. The study comprises eight parts. After the Introduction, Chapter 2 presents the source data and the geographical area studied. Chapter 3 deals with the introduction of vaccination in the geographical area chosen for this study. Chapter 4 describes different aspects of faith healing practice for children. Chapters 5 and 6 study changes in smallpox mortality and epidemics. Finally, Chapter 7 examines the decrease of child deaths from smallpox, followed by the Conclusion.

2. Source Data and the Geographical Area of the Study

2.1 Buddhist Temple Death Registers

Most Japanese Buddhist temples keep death registers concerning their members. There are two types of death registers: by chronological order or by date of death, the latter usually being the basic type of registration; chronological registration is compiled from the latter too. Buddhist priests usually hold a daily ceremony for the dead using death registers by date of death.

In both types of death registers, records mention the secular name, the posthumous Buddhist name given to the deceased person by the Buddhist priest and the date of death. In a few cases the age, address and date of birth are also registered. The cause of death is seldom mentioned. In principle, according to the ending words in the posthumous Buddhist name, Buddhist priests probably attempted to divide the dead into three age-groups: infants up to twelve months including miscarried and stillborn babies, children under fifteen years old and adults as of the age of fifteen. However, before 1880 infant deaths were not always recorded in the registers.

The majority of smallpox sufferers must have been infants and children under fifteen years old. Given the fact that infant deaths were not always recorded in temple registers, it would be possible to determine the smallpox epidemics by comparing the death peaks in the three age-groups with other records such as the diaries written at the time. Some of those diaries, often written by peasants, provide precious information about smallpox epidemics, faith healing practice and mortality.

For this study, we use a database system DANJURO in order to output demographic statistics and indicators from the Japanese religious investigation registers *Shumon-Aratame-Cho* (SAC), the household register *Koseki-Bo* (KB) and the Buddhist temple death registers *Kako-Cho* (KC). The details of DANJURO is found in Appendix.

This study draws data from the Buddhist temple death registers (*Kako-Cho*) of eleven temples located in Tama County in the province of Musashi. There were 803 Buddhist temples in Tama County at the beginning of the nineteenth century. Therefore, we could collect approximately 1.4 % of all the Buddhist temple death registers in this County. This includes nearly 34,000 personal death data in the database of the KC documents (Table 1, see Appendix for more details).

Table 1. The buddhist temple death registers in the database of the KC documents.

Village/County/province	Temple	Year of the death	Number of the dead
Kawasaki village, Tama County, Musashi province	A	1736-1910	2,608
Shimo-Ishihara town, Tama County, Musashi province	B	1579-1910	1,631
Itsukaichi village, Tama County, Musashi province	C	1774-1910	1,203
Chigase village, Tama County, Musashi province	D	1786-1910	2,207
Uchikoshi village, Tama County, Musashi province	E	1494-1910	2,045
Hamura village, Tama County, Musashi province	F	1646-1910	2,415
Hino town, Tama County, Musashi province	G	730-1910	4,939
Hamura village, Tama County, Musashi province	H	1684-1910	2,905
Fukushima village, Tama County, Musashi province	I	1364-1910	2,185
Shinjo village, Maniwa County, Mimasaka province	J	1653-1910	3,862
Yokozawa village, Tama County, Musashi province	K	1550-1804 1889-1910	2,601
Sansho village, Mitsugi County, Bingo province	L	1829-1863	709
Fussa village, Tama County, Musashi province	M	528-1910	2,900

2.2 The Diaries

Among the sixteen diaries written in the nineteenth century by peasants who lived in the geographical area defined for our research, the main source has been a fifteen-volume diary written by Fujiakira Sashida (Table 2) spanning thirty-seven years, from February 9, 1834 to February 18, 1871. He wrote detailed descriptions of daily life including births, weddings, diseases, accidents, deaths and natural disasters in his village, where he held special functions. His diary provides interesting information about the peasants' behavior when their children were infected with smallpox, as well as smallpox epidemics and mortality.

Sashida lived all his life (1795 to 1871) in the hamlet of Harayama, which was located in the village of Nakato in Tama County, in the province of Musashi. He and his wife "Ko" had three sons and five daughters. Three of their eight children died of smallpox. Only two daughters and one son reached adulthood and married.

Like his father, Sashida became an *onmyoji*. He received his temporary *onmyoji* license in 1843 and the formal license in 1853 from Master Haruchika Tsuchimikado, who was head of the royal bureau of *Yin* and *Yang*. Based on the classic Chinese doctrine of *Yin*, *Yang* and the Five Agents or Elements (metal, wood, water, fire and earth), an *onmyoji* practiced faith healing performing different kinds of rituals. A book on incantations given to him by Master Tsuchimikado describes different rituals to pray for rain, family's well-being, easy delivery, healing from different diseases, posterity's prosperity, exorcising a person from evil spirit and so on. Faith healing rituals against smallpox are also described. One of Sashida's duties was to pray for children infected with smallpox in and around Harayama. Therefore, we were able to find in his diary the number of smallpox sufferers who asked for his help.

Table 2. The diaries in Tama County, province of Musashi.

Village of the author	Author	Title of the diary	Duration of the diary
Nakatou	Fujiakira Sashida	*Sashida Nikki*	1834-1871
Shibazaki	Heikurou Suzuki	*Koushi Nikki*	1837-1868
Onoji	Masanori Kojima Tamemasa Kojima	*Kojima Nikki*	1836-1866
Yaho	Kakuan Honda	*Honda Kakuan Nikki*	1832-1865
Kami-Kunokida	The Ishikawa family	*Ishikawa Nikki*	1720-1912
Yokozawa	Jimei Houmei	*Dai Higan-Ji Nikki*	1785-1817
Utsugi	Sanzaemon senuma	*Senuma Sanzaemon Nikki*	1821-1830
Nakagami	Kyujirou Nakano	*Shoyou Nikki Hikae*	1828-1868
Zoushiki	Mokuzaemon Uchino	*Risei Nisshi*	1854-1869
Tokura	Gisaburou Kuroyama	*Gisaburou Nikki*	1859-1868
Naka shinnjyuku	Hichijyurou Hiruma	*Hiruma Ke Nikki*	1859-1867
Ogiso	Shouemon Ichikawa	*Ichikawa Ke Nikki*	1859-1897
Hino	Seisuke Kouno	*Kouno Seisuke Nikki*	1866-1897
Ochikawa	Keisai Irako	*Irako Keisai Nikki*	1882-1910
Aihara	Kikutarou Aizawa	*Aizawa Nikki*	1885-1926
Hinohara	Ushigorou Uda	*Ushigorou Nikki*	1886-1913

Sashida was an educated person, who had learned Chinese classics and Chinese medicine from Kankei Saito. He also taught many children in his own private elementary school and his pupils later raised a stone tomb. He was probably not a subjective magician but a practical-minded person, who understood both the limits of Chinese medicine and the psychological effects of faith healing practice. Influenced by his family's environment, his eldest son, Kosai Sashida, born in 1839, became a physician who effectively contributed to the widespread use of vaccination in his village.

2.3 The Geographical Area

The village of Nakato lies 35 km west of Edo (now Tokyo). At the time, the village was under the direct control of the Tokugawa shogunate. Located on the Musashino plateau at the foot of the Sayama hill, most of the cultivated lands were not paddy fields but dry fields. Peasants grew wheat, buckwheat, millet, potato, sesame, radish, rapeseed, soybean, turnip, etc. (Murayama Cho Kyoiku-Iinkai 1968). Besides farm work, they bred silkworms and wove cotton which they sold at nearby markets in towns like Hachioji, Ome or Tokorozawa in order to earn additional income.

Nakato comprised nine hamlets including Harayama where Sashida lived. Although the total population is unknown, the names of sixty household heads spanning three generations are mentioned in his diary. As stated above, the diary mainly describes daily life of the families living in the hamlet. In 1997, we undertook research on all the ancestors of Harayama's inhabitants and we could verify that fifty-three families out of the sixty mentioned in Sashida's diary were still living in Harayama.

3. Introduction of Vaccination against Smallpox in Japan

In August 1849, Otto Gottlieb Johann Mohnike introduced the first vaccine in Nagasaki Harbor from Batavia in the island of Java. He was a naval surgeon working at a trading post of the Dutch East India Company, established in the island of Dejima, in Nagasaki. The Dutch had monopolized European foreign trade with Japan despite the national seclusion policy established by the Tokugawa shogunate. Therefore, the Dutch trading post in Nagasaki was the only window through which Western culture could be introduced in Japan during the Tokugawa period.

Y. Fujikawa, M. Soekawa and A. B. Jannetta's pioneer works describe the initial situation regarding acceptance of vaccination against smallpox (Fujikawa 1941; Soekawa 1987; Jannetta 1996). Lord Naomasa Nabeshima, head of the Saga Domain, had learned about vaccination from his court physician, Genboku Ito. Lord Nabeshima ordered another court physician, Souken Narabayashi, to test the vaccine. Narabayashi, who lived in Nagasaki, asked Mohnike to import the vaccine. After receiving the humanized lymph, he tested it on his own children and also shared it with physicians who studied Western medicine with the Dutch.

Ito and Narabayashi had studied Western medicine with Philipp Franz von Siebold, who worked at the Dutch trading post in Nagasaki. In 1857, to and eighty-three supporting doctors built a public office for vaccination, the *Shuto-Kan* in Edo, thus greatly contributing to the spread of vaccination.

In Tama County, the earliest description of vaccination against smallpox appeared in 1850, in a diary written by Heikuro Suzuki, who was the head of the village of Shibazaki. Vaccination was tried by Genmin Ito, who lived in the town of Hachioji, in March 1850. Kensai Oda also tested vaccination in the town of Fuchu, in May 1850. These two physicians had studied with Ito. The diary mentions that many women had brought their children to the doctor, which shows that peasants did not refuse vaccination but welcomed it from the start.

Vaccination was introduced in Nakato on December 11, 1852. According to his *curriculum vitae* written in 1875, Kosai Sashida, who was Fujiakira Sashida's eldest son, generalized vaccination in and around the village of Nakato as of 1863. He studied vaccination from Western medical books written by Russian, German and English physicians. In 1870, he also taught vaccination methods to a doctor living in a neighboring hamlet.

Inoculation, which had been introduced from China, had already been tried on children in Nakato before 1852. The oldest record in the diary concerning inoculation dates back to 1838. The method was quite primitive. The head of the village of Kinegawa put smallpox scabs into the nostrils using a thin pipe. Obviously, this method was not perfect and some children in Nakato died after inoculation.

In the 1860s, doctors who lived in Hachioji and Fuchu, and in the villages of Nakato, Kami-Mizo and Aihara, started to use vaccination. Some doctors made house calls in villages located within 10 km from their offices. Some parents also took their children to the doctor within the same distance from their houses. Figure 1 shows the distribution of these doctors' offices and the patients' houses.

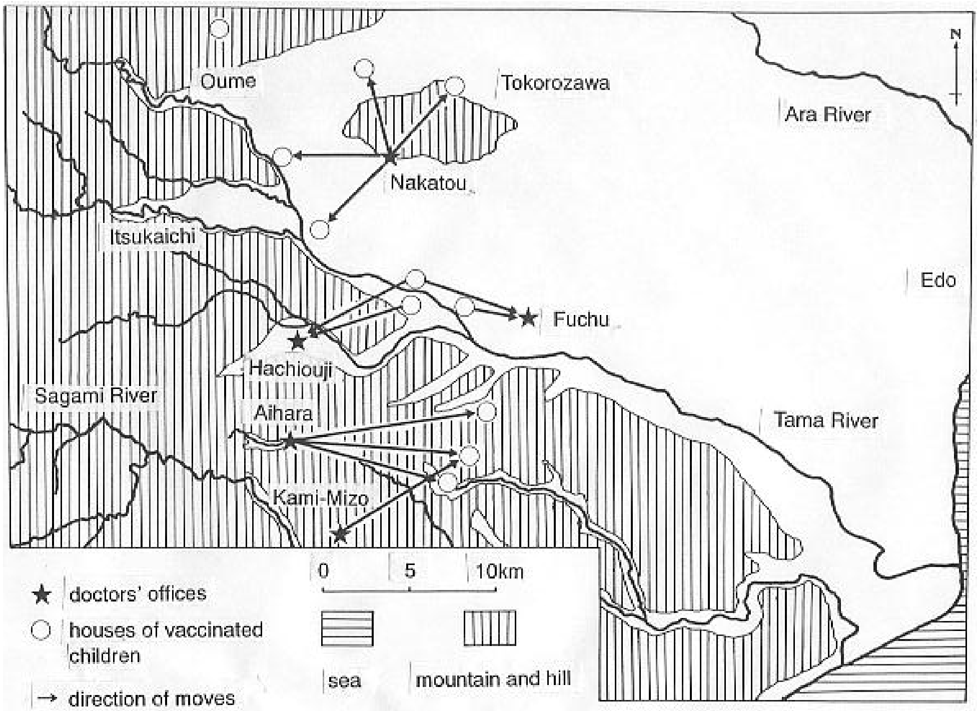

Figure 1. Spread of vaccination (1850-1870).

In 1860, Kakuan Honda, who had his office in the village of Shimo-Yaho, wrote in his diary that he had taken his young child to be vaccinated by Oda. A diary written in 1865 by Shouemon Ichikawa, a poor peasant living in the village of Minami-Osogi, mentions that his friend's son Inosuke had been vaccinated and he has requested news about him to his friend. In 1866, Seisuke Kono, who lived in the town of Hino, wrote in his diary that his nine-month-old daughter Shizu had been vaccinated by a doctor in Hachioji. These records suggest that many peasants in Tama County recognized the safety of vaccination before 1870.

A diary kept by the Kojima family mentions that Hansai Takatori had visited the village of Oyamada on April 22 and 28, 1863 to vaccinate and had also made house calls in the village of Onoji on May 10 and 16, 1863. The diary also tells that Shoan Aoki had visited Onoji and had vaccinated twenty-six people from two to twenty-one years old on January 29, as well as on February 4 and 10, 1865. Within seven days, these two doctors had probably been able to test the effects of humanized lymph and, after judging whether *Variora Vera* (*Variora major*) or Valioloid appeared or not, had practiced arm to arm vaccination.

Arm to arm vaccination is shown in Figure 2, which was used to illustrate a medical book, *Shintei Gyutou Kiho,* published in 1849. An old doctor is taking humanized lymph from a boy's arm with a scalpel and putting it into another boy's arm. The doctors in Tama County probably vaccinated in this way.

Figure 2. Arm to arm vaccination
Source: Hirose Genkyo, 1849, *Shintei Gyuto Kiho*

Parents usually paid the doctor one or two *Shu,* which was a currency unit used in the sixteenth century until 1871. It was worth 1/16 of one *Ryou,* which was the standard gold coin during the Tokugawa shogunate. According to Sashida's diary, in 1864 peasants could get one *Shu* when they sold approximately four liters of soybeans, six liters of wheat or nine liters of millet. Therefore, vaccination was not expensive even for a poor peasant.

4. Faith Healing Practice for Smallpox

If a child fell sick with smallpox, Sashida set up a special family altar (*hoso-dana*) for the smallpox deity in the child's house when the rash appeared and swelled on the face. If the child was recovering and the scabs were peeling off, he sprinkled special hot water (*sasayu*) on the child with a bamboo twig. The child's family delivered red rice (*sekihan*: glutinous rice boiled with red beans) to the neighbors, to thank them for their kindness while the child had been ill. If the symptoms worsened, Sashida went to at a temple to pray, to perform cold water ablutions (*sengori*) and recite a sutra (*Kannon Kyou*) with the neighbors until the child's last moments. He kept faith healing practice even after vaccination was introduced in Nakato, in 1852.

Details about the *hoso-dana* and *sasayu* in a child-rearing book, *Shoni Yashinai Gusa,* can be summarized as follows:

How to worship the smallpox deity? Put a straw festoon decorated with cut paper (*shimenawa*) in front of the entrance, clean the bedroom and set up a special family altar (*hoso-dana*) for the smallpox deity. Place in the *hoso-dana* offerings in red, like red confectionery, red rice, red fish such as sea bream or gurnard, a red tumbler (*daruma*) and figures representing a horned owl, a rabbit or a small cuckoo. Offer also a votive lantern and Japanese sake in a ceramic bottle decorated with red paper.

How to make *sasayu*? Prepare ritual hot water (*sasayu*) if the sufferer looks fine, welcomes a meal and the scabs are going to peel off. The ingredients for *sasayu* are *sake*, ten grains of barley, ten grains of red beans and ten grains of black beans, some rat droppings, an old nail head, ten shreds of bamboo leaves and some soil where a dog stepped on. Put them into 2.7 liters of boiled water. Sprinkle *sasayu* on the child with a bamboo twig, soak a red towel with *sasayu* and softly wipe his face and hands with it.

In the nineteenth century, an illustration of a typical *hoso-dana* appeared in a popular literary work, *Mukashi Banashi Inazuma Byoshi*, written and published in Edo by Kyoden Santo (Figure 3). In the illustration, a red tumbler, a horned owl, a round rice cake and a votive lantern are offered on the altar shrine. The wand in red paper on a small round mat made of rice straw placed beside symbolizes the smallpox deity. The child wears a red nightcap, a red nightwear and a red quilt. The illustration in this book is similar to the explanations in *Shoni Yashinai Gusa*. Both books reflect the popularity of faith healing practice.

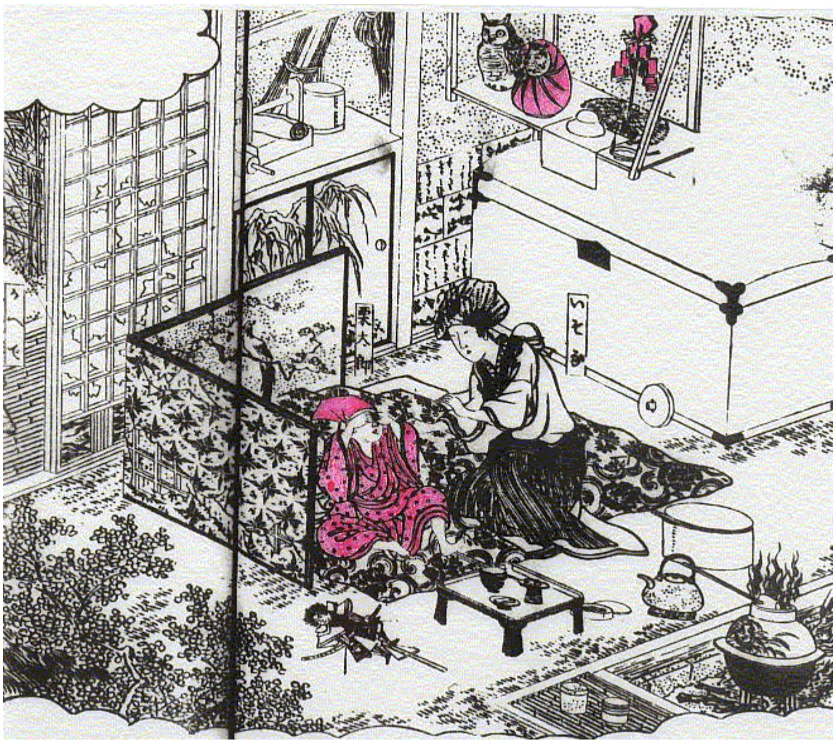

Figure 3. The bedroom of a baby infected with smallpox.

Source: Santo Kyoden, 19th century, in *Mukashi Banashi Inazuma Byoushi.*

An *onmyoji* like Sashida was not the only one to perform these faith healing rituals. A diary kept by the Ishikawa family, who lived in the village of Kami-Kunokida for generations, mentions that some priests from Koraku-ji, a Buddhinst temple, had visited the village several times to perform faith healing rituals since 1767. According to a list of smallpox sufferers which is kept in Suwa jinja, a Shinto shrine located in the village of Shibazaki, in 1816 smallpox sufferers' parents asked the *kannushi* (Shinto priests) to pray following the same faith healing rituals described above. Suzuki's diary also mentions that, in 1842, he had invited several times a mountain hermit called Rissen-in, to set up a *hoso-dana* and sprinkle *sasayu* when his eldest, second and third child had been infected with smallpox. During the nineteenth century, the faith healing rituals performed by Buddhist and Shinto priests and mountain hermits were quite similar to the ritual practiced by Sashida in Tama County.

Figure 4 shows the location of the houses where faith healing practice was performed in the first half of the nineteenth century. Not only village heads like Suzuki, but also many peasants in and around Harayama, lower warrior-class families like the Ishikawas and some intellectual townspeople like B. Takizawa requested similar faith healing rituals (Tachikawa 1996). Furthermore, the Tokugawa family also had the *sasayu* ritual performed at Edo castle (Maekawa 1976). Therefore, most people living in rural and urban areas depended on faith healing practice for recovery from smallpox. For sick children, the ritual to worship the smallpox deity was performed according to a fixed procedure, and both *hoso-dana* and *sasayu* practice were maintained after the introduction of vaccination.

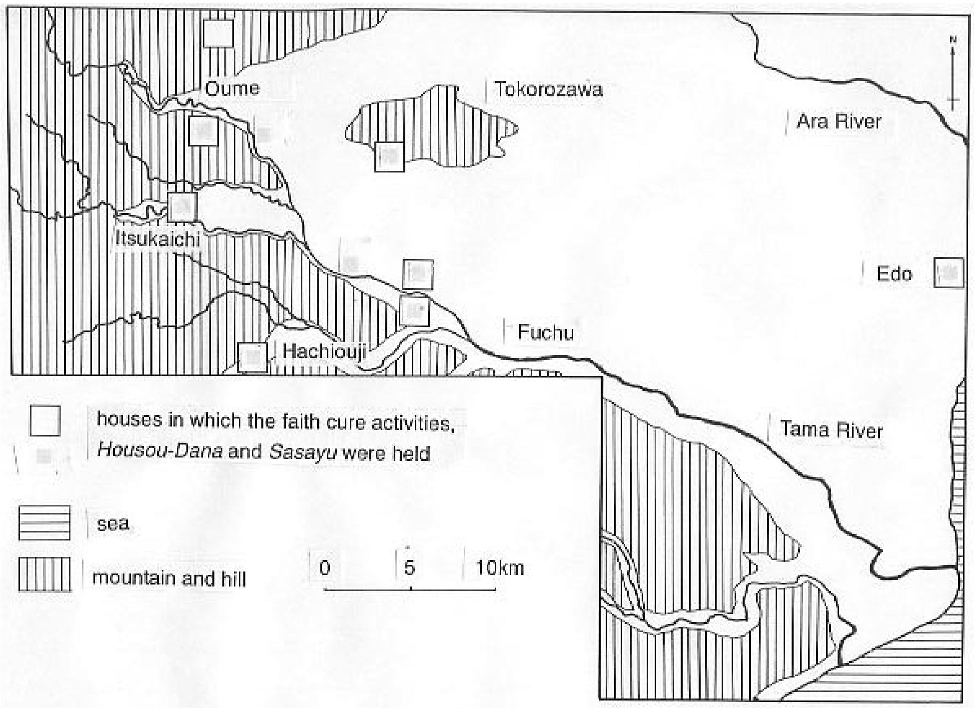

Figure 4. Geographical distributions of faith healing practice for smallpox.

5. Smallpox Sufferers in the Hamlet of Harayama

In Sashida's diary, we selected those parts that describe faith healing practice and we elaborated Figures 5 and 6 in order to draw out data on smallpox epidemics and mortality. Obviously, it is not clear whether the diary includes all deaths and patients. Moreover, also some Buddhist and Shinto priests and mountain hermits were living in the area. As we pointed out in Section 4, it is almost certain that their ritual to worship the smallpox deity was similar to the ritual performed by Sashida.

In the hamlet of Harayama, 130 infant and child deaths were recorder during a period of thirty-seven years, from 1834 to 1870 (Figure 5). From 1834 to 1852, 52 % of 90 infant and child deaths were caused by smallpox; from 1853 to 1870, 25 % of 40 infant and child deaths were also from smallpox. In addition to smallpox, there were other causes of infant and child deaths such as abortion, miscarriage, drowning, burning and pestilence (the names of the diseases are unknown).

There were 125 cases of smallpox during the same period of thirty-seven years, from 1834 to 1870 (Figure 6) of which 47% of 99 sufferers from smallpox died during a period of nineteen years (1834 to 1852) and 38% of 26 sufferers died during a period of eighteen years (1853 to 1870). These figures show that the number of smallpox sufferers and mortality rapidly decreased after the introduction of vaccination in 1852.

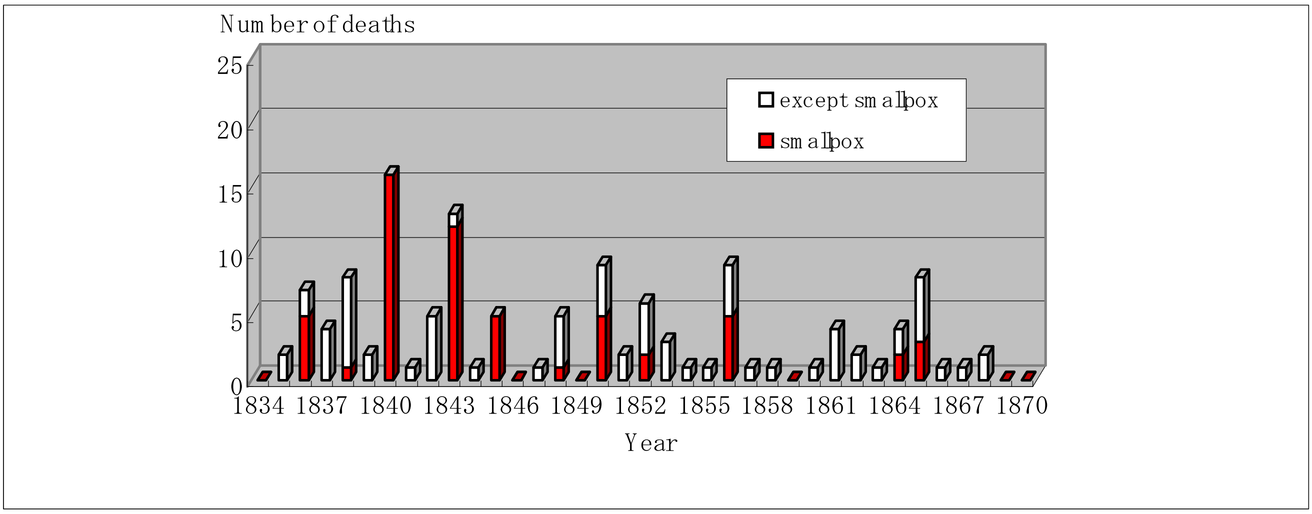

Figure 5. Infant and child deaths in Harayama.

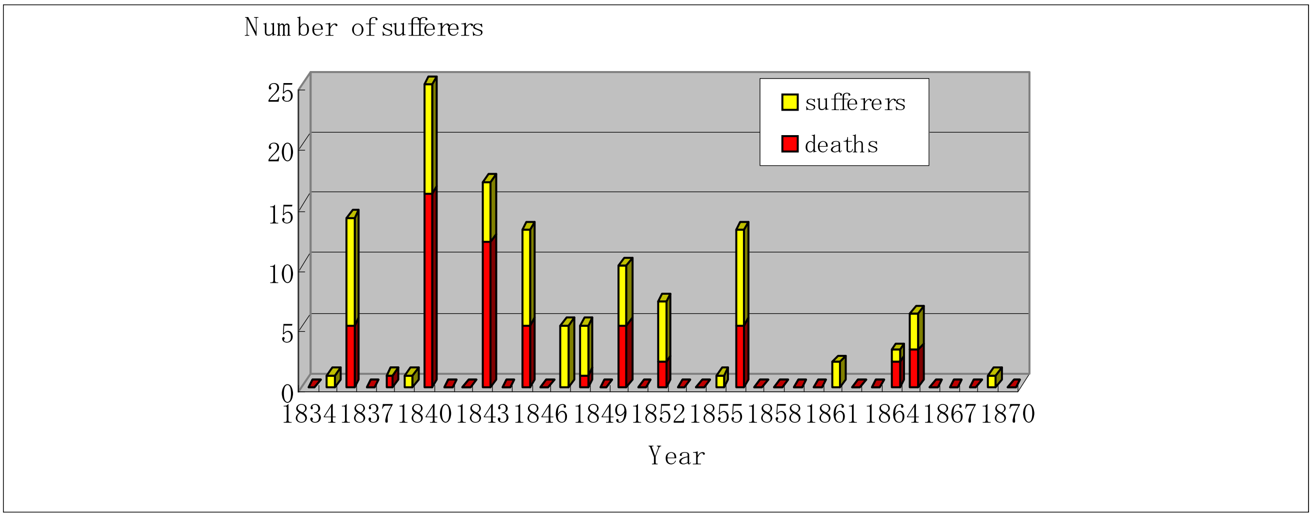

Figure 6. Smallpox sufferers in Harayama.

We counted over ten smallpox sufferers per year in 1836, 1840, 1843, 1845, 1850 and 1856, which were the years of small epidemics. Especially in 1840 and 1843, there were over fifteen smallpox sufferers. The epidemics occurred about every five years and the same periodical trend was also recorded in the province of Hida (Suda 1992).

During the years 1834 to 1870, there were more than twenty smallpox sufferers in June and July (Table 3), the beginning of summer being an epidemic season for smallpox. Conversely, there were less than five sufferers in September, October and November.

Table 3. Seasonality of smallpox sufferers in Harayama (1834-1871).

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Number of deaths from smallpox	3	5	4	3	6	8	14	6	0	2	1	5
Number of smallpox sufferers	5	7	2	11	7	19	10	5	0	2	1	3
Total	8	12	6	14	13	27	24	8	0	4	2	8

6. Smallpox Epidemics around the Hamlet of Harayama

Smallpox is caused by a virus and children may contract it either by infection or contagion. Figure 7 shows places visited by the inhabitants of the village of Nakato and the home villages of visitors to Nakato in 1843, which was one of the worst smallpox epidemic years. The Sashida family maintained close ties with their relatives living in nearby villages. Sashida sometimes visited the markets in the towns of Tokorozawa and

Itsukaichi to sell his millet and go shopping. But his sphere of activity spread over to neighboring villages within a radius of 20 km from his hamlet of Harayama in Nakato. On the other hand, some peasants went on pilgrimage to the shrines in Nikko, climbed Mt. Fuji or went to Izu for hot-spring cures. These destinations were at a distance of over 100 km from Nakato. In one case, a travelling performer living in a town in Kanagawa visited the village. This shows that the smallpox epidemic in 1843 covered a large part of the region around Harayama because the infection route was closely related to the population's sphere of activity and travel patterns.

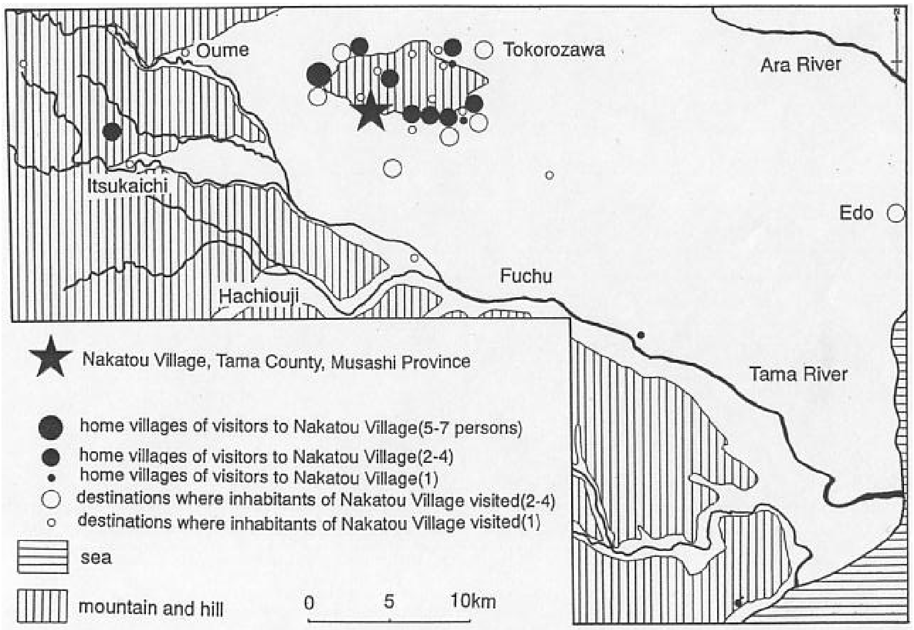

Figure 7. The sphere of activity and travel patterns in Nakato (1843).

Figure 8 shows the number of deaths in the death registers of a Buddhist temple in the village of Kawasaki. The members of this temple were all inhabitants of Kawasaki, which is located about 8 km west of Nakato. The year 1843 registered the highest epidemic peak and the number of infant and child deaths was considerably higher than that of adult deaths. The peak in 1843 is confirmed by all the *Kako-Cho* of the nine temples in Tama County. Therefore it is certain that the smallpox epidemic in 1843 spread all over the County. We think that it would be possible to find the infection route if we were able to collect more death registers in Buddhist temples.

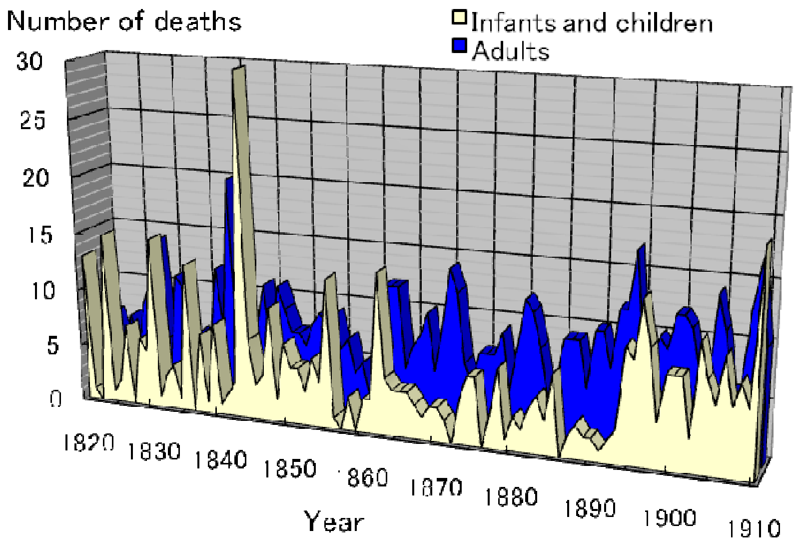

Figure 8. Number of deaths in Kawasaki.

7. Decrease of Infant and Child Deaths from Smallpox

Table 4 shows the number of smallpox sufferers and deaths according to the *Kanagawa Prefecture Statistical Yearbook*. The number of smallpox sufferers and deaths was very small after 1881 in West Tama County, North Tama County and South Tama County in province of Kanagawa. The incidence of smallpox has been under one per thousand after 1881.

Table 4. Number of smallpox sufferers and deaths.

County	1881	1884	1885	1886	1887	1888	1889	1890
West Tama	0 (0)	0 (0)	12 (0)	25 (3)	14 (1)	0 (0)	0 (0)	0 (0)
	58,324	59,837	60,895	61,387	63,525	64,474	65,734	66,280
North Tama	3 (0)	0 (0)	48 (11)	19 (2)	5 (2)	4 (0)	0 (0)	0 (0)
	68,884	71,206	72,347	72,959	76,495	77,637	79,065	79,924
South Tama	0 (0)	0 (0)	84 (25)	81 (8)	52 (12)	1 (0)	0 (0)	0 (0)
	66,666	71,438	71,784	73,701	76,927	79,969	84,397	85,100

Notes:
1. Numerical data without parentheses in the upper column show the number of smallpox sufferers.
2. Numerical data in parenthesis in the upper column show the number of deaths from smallpox.
3. Numerical data in the lower column show the current population.

According to the *Metropolitan Tokyo Sanitation Statistics*, there were five epidemic years in 1891, 1892, 1896, 1897 and 1908, when the number of smallpox sufferers was over 1,000 in metropolitan Tokyo (Tokyo-fu 1937). The number of deaths from smallpox was 274 in 1891, 1,651 in 1892, 720 in 1896, 2,071 in 1897 and 453 in 1908. The lethality rate reached 26% in 1891, 26% in 1892, 29% in 1896, 34% in 1897 and 27% in 1908. Except for these five years, the number of smallpox sufferers was under 700 from 1875 to 1932. Likewise, in metropolitan Tokyo, except for the five years mentioned above, between 1875 and 1932, there were less than 250 deaths from smallpox. No periodic smallpox epidemic years at intervals of about five years were registered after 1875. Particularly, during a period of fifteen years (1875 to 1890), the number of deaths from smallpox was under 250.

After West, North and South Tama County were incorporated into metropolitan Tokyo, in 1893, the number of smallpox sufferers in this County was only 38 in 1896, 181 in 1897 and 7 in 1908. The number of deaths from smallpox in this area was only 6 in 1896, 35 in 1897 and only 1 in 1908. These figures show that the number of smallpox sufferers dropped sharply during a period of thirty years, from 1850 to 1880.

Figure 8 shows several peak epidemic periods during the first half of the nineteenth century, when the number of infants and child deaths was higher than the number of adult deaths. Such peaks appeared periodically, at intervals of four to eight years. After the 1860s, there were no peak years registered and child deaths decreased after that date. The number of child deaths was 160 from 1830 to 1859 and only 91 from 1860 to 1889.

Table 5 shows the number of infant and child deaths in each temple death registers. As in the Buddhist temple death registers in the village of Kawasaki, after 1860, the number of child deaths clearly decreased in five temple death registers out of nine.

Table 5. Number of infant and child deaths in temple death registers.

Temple	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**M**
1830～1859	160 (3)	102 (4)	108 (0)	259 (0)	71 (8)	86 (0)	159 (13)	222 (6)	140 (0)
1860～1889	91 (17)	91 (15)	106 (16)	256 (0)	73 (17)	122 (18)	105 (117)	181 (15)	61 (3)

Notes:
1. Numerical data without parentheses show the number of child deaths.
2. Numerical data in parentheses show the number of infant deaths including miscarried babies and stillborn babies.
3. The death registers of Temple I was destroyed by fire. Therefore, the figures concerning infant and child deaths are not complete.
4. There are no data for the years 1830 to 1888 in Temple K.

The *Kanagawa Prefecture Statistical Yearbook* and the *Metropolitan Tokyo Sanitation Statistics* show a decrease in the number of smallpox sufferers from 1881.

Before 1881, the number of smallpox sufferers had also dropped sharply during a period of thirty years, from 1850 to 1880. We could verify the decrease in the number of child deaths from the 1860s in some Buddhist temple death registers. These figures show that from the 1860s, vaccination had been accepted by the population living in this area.

8. Conclusion

This study focused on the decrease of child deaths from smallpox and also examined faith healing practice before and after vaccination was introduced in and around the hamlet of Harayama in the village of Nakato, Tama County, in the province of Musashi on the outskirts of Edo (now Tokyo), which was then the seat of the Tokugawa shogunate.

Vaccine against smallpox was first introduced in Nagasaki, in 1849, by a Dutch doctor. It was tried in 1850 in the towns of Hachioji and Fuchu in Tama County and, in 1852, in the village of Nakato where Fujiakira Sashida's eldest son, Kosai Sashida, effectively applied and generalized vaccination.

Our study also shows that faith healing practice subsisted even after vaccination was introduced and widely spread. Fujiakira Sashida, who was an *onmyoji*, worshipped the smallpox deity performing a fixed ritual when he treated children infected with smallpox. During the nineteenth century, in Tama County faith healing was practiced not only by the *onmyoji*, but also by Buddhist and Shinto priests and mountain hermits. Peasants, village heads, intellectual townspeople, warriors and even the Shogun's family requested health healing rituals against smallpox.

According to the records in Sashida's diary concerning faith healing practice in the hamlet of Harayama, during thirty-seven years (1834 to 1870), 44% of 130 infant and child deaths were from smallpox. During this period, 46% of 125 sufferers died from smallpox. The number of smallpox sufferers rapidly decreased after the introduction of vaccination in 1852.

The smallpox epidemic years in Harayama were 1836, 1840, 1843, 1845, 1850 and 1856. The inhabitant's sphere of activities spread over to neighboring villages within a radius of 20 km to 100 km from the hamlet, depending on the purpose of their travels (visits to relatives, business, pilgrimages, hot spring cures, etc.). Therefore, smallpox epidemics extended to a wide area around Harayama. Particularly in 1843, one of the worst years in the hamlet, we noted the most serious peak of infant and child deaths recorded in some Buddhist temple death registers.

However, the number of smallpox sufferers dropped sharply during thirty years, from 1850 to 1880. Before the 1860s, at intervals of about five years there were peak periods when the number of infant and child deaths had been considerably greater than that of adults. We hardly find this kind of situation after the 1860s. Therefore, we can conclude that many of the peasants in Tama County accepted vaccination from the 1860s with the consequent decrease of infant and child mortality from smallpox.

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Appendix: Database System

(1) DANJURO

DANJURO version 4.0 was developed with Oracle 10.2.0.1.0 and Oracle Web Application Server 10.1.3.3.0. To get access to this database system, users need to install in their computers browsers such as Internet Explorer 6.0 or Firefox 3.5.

This system is composed of six parts: (i) data analysis systems for the religious investigation registers, (ii) data analysis system for the Buddhist temple death registers, (iii) data analysis system for the household registers, (iv) technology of how to recognize handwritten characters in historical documents with neural network, (v) research funds, publication of research results, and prize, (vi) links to the related site (Kawaguchi 2002, Kaweaguchi, Uehara and Hioki 2004). The URL of DANJURO version 4.0 is http://kawaguchi.tezukayama-u.ac.jp.

(2) Database of the Buddhist Temple Death Registers

In the database of the Buddhist temple death registers, items in bold letters represent numerical values and the other items are written in *kanji* (Chinese characters) as follows:

> *Village/County/province where the temple stands, name of the temple, religious sect, title of the temple death register, **year of death**, date of death in Japanese old lunar calendar, date of death in Gregorian calendar, posthumous Buddhist name, sex, address, secular name, **age at death**, **year of birth**, date of birth in Japanese old lunar calendar, date of birth in the Gregorian calendar, cause of death, place of death, hometown.*

When users click on *Kako-Cho* database in the Index window, the Input for retrieval conditions window appears, where they can input retrieve conditions. By clicking on the Search button at the bottom of the Input for retrieval conditions window, the retrieval program is executed and the Browsing window appears on the screen, where users can confirm the retrieval key words, the number of hit data and 20 cases of retrieval results per page.

A click on Selection of download items button in the Browsing window allows users to reach the Selection of download items window. By clicking on the Go to download window at the bottom of the Selection of download items window and clicking after on the Download button in the Download window, users can obtain the retrieval results in C.S.V. form data.

(3) Application Programs

Users need to install Microsoft Excel 2003 or 2007 in their computers to execute the application programs. These application programs can provide 51 demographic statistics and indicators with graphs.

1) Number of deaths indicators

Number of deaths, sex ratio at death, etc.

2) Age at death indicators

Relationship between age at death and posthumous Buddhist name, number of deaths by posthumous Buddhist name, number of infant and child deaths, number of adult deaths, sex ratio of infant and child deaths, sex ratio of adult deaths, etc.

3) Death seasonality indicators

Number of deaths by month, sex ratio by month, number of infant and child deaths by month, number of adult deaths by month, sex ratio by month, number of deaths by season, number of infants and child deaths by season, number of adult deaths by season, etc.

4) Cause of death indicators

Number of deaths by cause of death, number of deaths by place of death, number of deaths by hometown, number of deaths by date of birth, etc.

The Application program window appears with a click on Application program in the Index window. In order to execute the application program, it is necessary to download a macro file and a data file into the computer. First, users have to click on the floppy disk logo on the left side of each indicator and the macro file will be downloaded in the drive. Then a click on the underlined indicator in the Application program window opens the Input for retrieval conditions window. By clicking on the Search button in the Input for retrieval conditions window, retrieval and calculation is executed and the Data download window appears on the screen. C.S.V. form data is obtained by clicking on the Download button in the Download window. If users execute the macro file in the computer specifying the data file, they can obtain a graph of the corresponding demographic indicator.

Climate and Famine in Historic Japan: A Very Long-Term Perspective

Osamu Saito

Abstract

This paper sets out a new, revised chronology of famines from the eighth to the nineteenth century. Thanks to the recent publication of a fascinating database on medieval natural disasters compiled by Fujiki (2007), most revisions are made for the twelfth to sixteenth centuries. Unlike previous famine tables (cf. Saito 2002), the new chronological table enables us to examine more critically to what extent global cooling and warming were related with changing frequencies of famines in the Japanese past. One of the major findings from this new dataset is that there was virtually no correlation between the frequencies of famines and the alternating phases of cooling and warming over the so-called Medieval Warm Period and the Little Ice Age that followed. Another major finding, which is in fact a corollary of the first, is that a major reduction in the frequency occurred before the final period of global cooling around 1600. In other words, the real break with the medieval past took place half a century earlier than the start of Tokugawa rule. The paper will touch on possible factors accounting for the changes, and also on some demographic implications of the findings.

Introduction

Famine is a phenomenon of mass starvation caused primarily by a poor harvest, triggered often by any kind of bad weather such as drought, excessive rainfall and cold summer. Thus, scholars since the day of T.R. Malthus have maintained that the frequency of famines was one of the most important determinants of mortality in the past, and hence assumed that there were noticeable correlations between long-run climatic fluctuations and historical population changes (for a demonstration of this relationship, see for example Galloway 1986).

Turning to the relationship between climate and famine, one may expect that the relationship in the past must have been very close. For example, a very long spell of cold years is identified for an age after the ‘Medieval Warm Period’ by palaeo-climatologists; and this period known as the ‘Little Ice Age’ is thought to explain why there were so many severe famines in various parts of the world from late medieval to early modern times. In Japanese history, the Little Ice Age corresponds to the time period from Kamakura to Tokugawa. However, does this thesis really hold for the Japanese case?

What I would like to do in this paper is:

(i) to set out a new, revised chronology of famines from the eighth to the nineteenth century; and

(ii) to examine to what extent global cooling and warming were related with changing frequencies of famines in the Japanese past.

Task one means a reworking of my earlier counts of historic famines (Saito 2002), especially those for earlier centuries. Thanks to a recently published database on climatic disasters in medieval times, we are now in a better position to make a revision for medieval famines. For task two, we can think of there are two separate causal processes between weather change and the incidence of famine. The first is the causal relationship between weather change and harvest, and the second the relationship between harvest and famine. The first relationship will become less straightforward with improved agricultural technologies. With irrigation facilities, for example, drought can no longer be a problem. The second causal relationship may be much less straightforward even when farming methods are rudimentary. Indeed, there is enough evidence to question the conventional wisdom that a serious crop failure did in most cases result in an incidence of mass starvation.

The new famine chronology table is expected to indicate when a major break in the frequency of famines took place in the Japanese past. Conventionally it is thought to have come about with the return of peace around 1600; however, the paper will show that the real break with the medieval past took place half a century earlier, and will touch on the demographic implications of this the finding.[1]

Famine Records

There are several databooks on historic natural disasters (Ogashima 1894, Nishimura and Yoshikawa 1936), from which it is possible to identify the incidence of a famine and its cause; added to this list recently is a fascinating database compiled by Hisashi Fujiki, a leading medievalist, for the period between 901 and 1650, a period for which records have long been scanty (Fujiki 2007). Based on these materials, I have now identified the total of 281 cases as famine years with the first in AD567 and the last in 1869. In total there are 47 more than my previous count of 234 (Saito 2002).

In order to identify a famine case, it is important to distinguish two sets of mutually related descriptions. One is to separate famine-related deaths from epidemic-related deaths, and the other to separate phenomena associated with 'hunger,' 'starvation' and 'crisis' from those described just as 'crop failure' and 'disastrous harvest' since, as noted earlier, not all harvest failures resulted in famines.

Then we have to consider the intensity, coverage and duration of the 'hunger and starvation' phenomenon. The best measure of the intensity of a famine is probably the death toll or the rate of excess mortality, but given the nature of records we have for earlier centuries it is impossible to make any judgement on this criterion. On the other hand, it is not impossible to determine how geographically widespread the famine was and how long it lasted. Admittedly it is not always an easy task, but as long as data

[1] There are several estimates for population totals in the period before 1721, from which date the statistics compiled by the Tokugawa government is available. For the state of the art in Japan's medieval demography, see Farris (2006).

permits I give 1 point to a cross-regional/countrywide famine if taking place cross-regionally with the number of provinces recorded as hit by the famine exceeding five or six, and 0.5 to one which was supposed to be confined in one region (but 0 to local famine).[2] First of all, it is important to keep in mind that the mere reference to an unusual weather condition such as 'extremely hot' or 'unprecedented cold' does not necessarily imply a famine unless the reference was accompanied by descriptions such as 'everybody starved' and 'fields covered by dead bodies.' Even when starvation did happen, there are a number of cases in which it is difficult to determine whether it was a cross-regional/countrywide famine or one which was confined in one regional. For example, when a very local source of records in the medieval period gives a description of 'the whole country (*zenkoku* or *tenka*) starved,' caution must be made since sometimes no other records give any hint of mass starvation in other regions. In such a case, I regard the description as an exaggeration and consider that it was just a regional famine.

In most famines, the duration was for one harvest year, starting in late summer or autumn and ending with an increasing death toll in the next spring. Sometimes it continued into the next harvest year with another crop failure, or even with a mildly bad harvest. There are cases where different kinds of records may collectively give us an impression that a certain famine lasted for two years, but a careful reading of the records may often reveal that it was an ordinary famine that occurred in one harvest year: one source referred to situations immediately after the crop failure whereas another paid attention to death tolls that swelled in the next calendar year. I have tried to avoid the over-identification in such cases.

Famines from the Eighth to the Nineteenth Century

Figure 1 shows the distribution of the all 281 cases into centuries. Records for the sixth and seventh centuries are too few, but those for the eighth and ninth centuries are surprisingly complete. Then, there was a long period of data scarcity between the ninth and the fourteenth century. The reason is that a political vacuum created by the disintegration in the beginning of the Heian period of the ancient, Chinese-style *ritsuryo* state system meant the lack of effective control and record keeping. After the establishment of the first samurai government (called Kamakura *bakufu*) in 1192, the number of records, both official and private, started to increase gradually, but it was not until the fourteenth century when the data allow us to establish the frequencies of famine on a reasonably secure basis.

From 1300 onwards, therefore, it is possible to show the changing frequencies of famine by half-century (Figure 2), and from 1600, in which the number of written records multiplied under Tokugawa rule, by decade (Figure 3).

It is evident from the three graphs that in ancient times famine was very frequent,

[2] This is because while a local famine's impact on the nation's population was not large, the risk of overstating the frequency of famines would increase by counting such a case in as the record of such a local famine was sporadic and its survival purely by chance in the period before the seventeenth century.

and that it became less frequent in the subsequent periods. In the eighth and ninth centuries it took place in every three years. In the medieval period, or more precisely, in the period from c.1300 to c.1550, the frequency declined a little to an order of once in every four years. Then came an unexpected, substantial fall in the number of famine years in the second half of the sixteenth century, as a result of which the seventeenth-century average became a level of every seven years. From the eighteenth century on, the incidence was further reduced: in the eighteenth 10.5 famines occurred, in the nineteenth the total became 5.5, and the twentieth century saw no famine breaking out, be countrywide or regional.

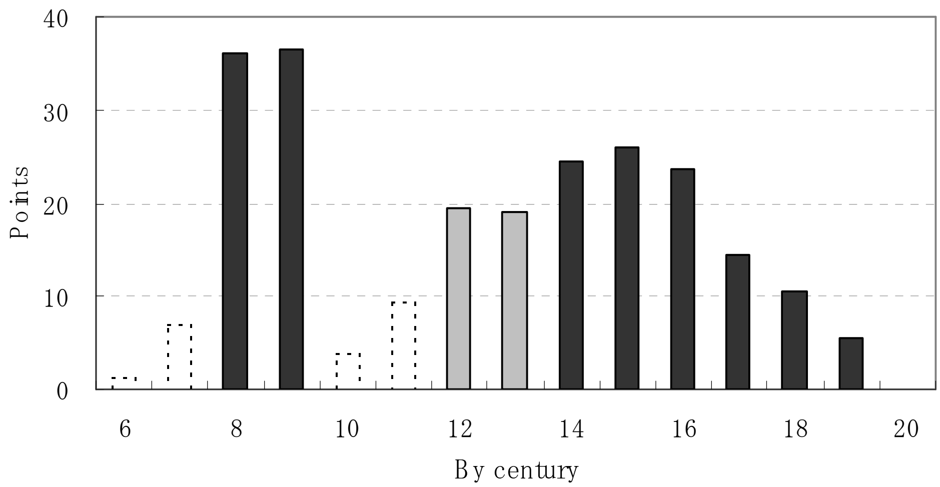

Figure 1. The number of famine points by century.

Sources: Famine chronology table compiled by the author from Ogashima (1894), Nishimura and Yoshikawa (1936), and Fujiki (2007).

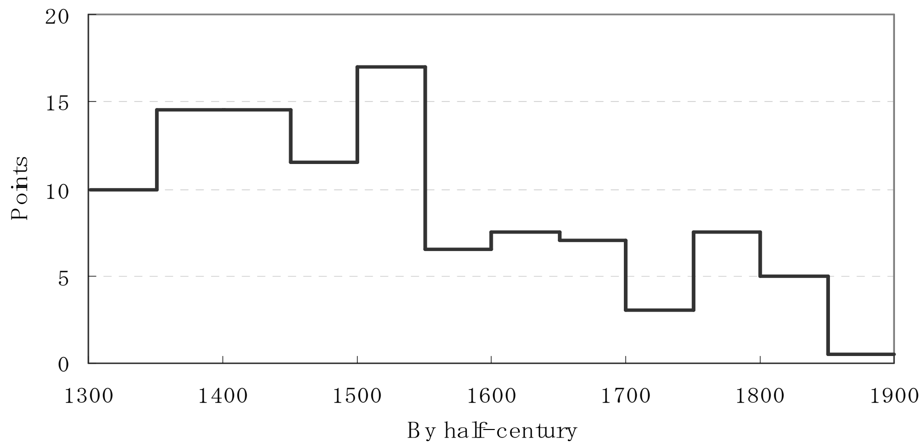

Figure 2. The number of famine points by half-century, 1300-1900.

Sources: The famine chronology.

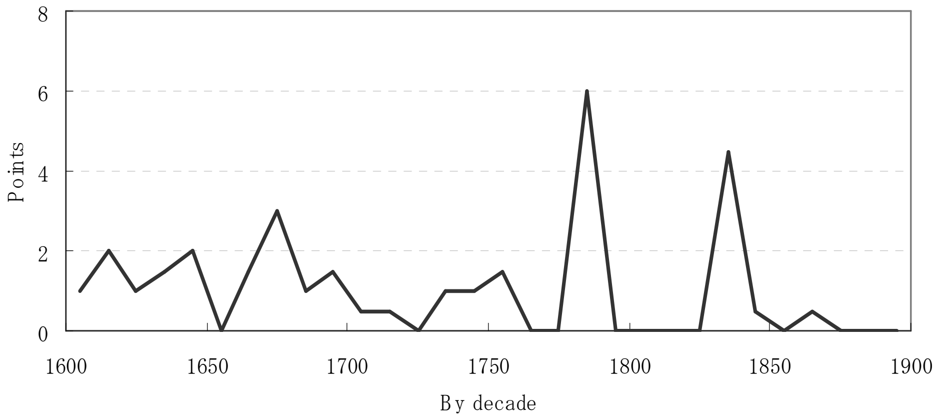

Figure 3. The number of famine points by decade, 1601-1900.
Sources: The famine chronology table.

Climate History

Historians of global climate have paid special attention to the so-called Little Ice Age. There is evidence that there were bitterly cold winters in the thirteenth and also the fourteenth century and similar climatic conditions came back in the late sixteenth and seventeenth centuries (Le Roy Ladurie 1971). For Japan, a variety of data sources have so far been used; from tree rings to diaries kept by samurai, intellectuals and wealthy commoners. The documentary sources of the latter type are particularly rich after the eighteenth century, giving the specialists detailed accounts of monthly or seasonal weather in various parts of the country. However, one drawback with this type of data is that they rarely go back to the early seventeenth century and beyond. In order to take a much longer view, therefore, data of the former kind are valuable. Based on recent surveys of evidence (Batten 2009; Mikami 2008), we may summarise what we found from the famine chronology in relation to the following periodisation of climate history (Table 1).

Table 1. Climate change, drought, cold summer, and the frequency of famines.

Period	Climate	Causes of famine Drought vs. cold summer	Famine points per century
7-12th	Warm	6 : 4	31*
13-early 16th	Cold	7 : 3	22
Late 16-17th	Cooling	5 : 5	12
18-19th	Warming	0 : 10	8

Sources: The famine chronology table.
Note: * indicates an average calculated by excluding the 7th, 10th and 11th centuries.

It should be noted that of the surveyed data series, the ones covering longer periods are for both winter and spring temperatures while the summer series tend to be shorter; thus, the climate periodisation in Table 1 is made mainly on the information about winter and spring temperatures. This is unfortunate because harvest in rice growing countries is generally more closely related to summer temperatures than to winter or springtime conditions. Also note that in Table 1 the earlier the period the longer its duration becomes, as it is more difficult to identify turning points within a broader periodisation frame. For the first periods of the table, therefore, no attempt is made to distinguish sub-periods in the Medieval Warm Period and also in the first half of the Little Ice Age. True, for the latter three and a half century period, some argue that the fourteenth century can be separated as a relatively short period of sudden cooling from the other periods. However, given the nature of the famine data for the thirteenth and fourteenth centuries, I have not separated them out in this table.

Of the series surveyed, records of freezing dates of a lake in central Japan are particularly interesting and useful as they give us an unbroken series of decadal winter temperature from the mid-fifteenth century onwards. With records of the so-called 'divine crossing' on Lake Suwa (*omiwatari* in Japanese, which is actually a crack on the ice created by the pressure of freezing) palaeo-climatologists Koichiro Takahashi and Junkichi Nemoto constructed the decadal index of warmness over a four-century period (Takahashi and Nemoto 1978). The series is shown graphically in Figure 4. This confirms that in periods before the eighteenth century the decadal difference between the number of warm winters and that of cold winters was in most cases negative, indicating that as in historic Europe, winter temperatures were generally low in medieval Japan too. It is clear from the graph that the period between the 1580s and the 1610s was particularly cold. The seventeenth century saw a mild recovery and there occurred a secular warming tendency since then. It was substantially warmer at the end of the Tokugawa era than in the early to middle periods. According to a recent work, the July temperature in the nineteenth century was about 1°C higher than in the eighteenth (Mikami 1996).

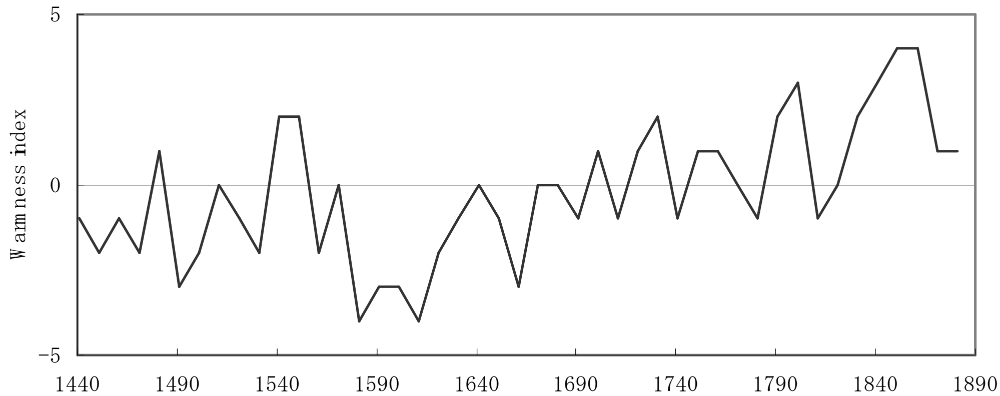

Figure 4. Changing temperature: warmness index, 1441-1890.

Source: Takahashi and Nemoto (1978, 184-185).

Our interest is in the relationship between climatic changes and the frequency of famines. As the famine data allow us to determine, though not in all cases, whether it was triggered by drought or cold summer/prolonged rain, we can check if global cooling meant that there were more crop failures and, hence, more famines. Table 1 above enable us to examine these relationships by periodisation in climate history over the whole period, and Table 2 below by half-century from 1441-1890.

Table 2. The warmness index, drought, cold summer, and the frequency of famines by half-century.

	Warmness index	Drought vs. cold summer	Famine points
Late 15th	-7	8 : 2	11.5
Early 16th	-3	7 : 3	17
Late 16th	-7	6 : 4	7
Early 17th	-10	4 : 6	7.5
Late 17th	-5	3 : 7	7
Early 18th	4	0 : 10	3
Late 18th	1	0 : 10	7.5
Early 19th	1	0 : 10	5
Late 19th	0	0 : 10	0.5

Sources: Takahashi and Nemoto (1978, 184-185), and the famine chronology table.

The two tables suggest, first, that drought became less problematic over the long run. Second, its relationship with global cooling and warming was more complex than one may have imagined. Third, on the other hand, both tables unambiguously show that medieval famines were not caused by global cooling in the Little Ice Age. This was particularly the case in the period from 1550 to 1650: famines were less—rather than more—frequent compared with other centuries in the same Age.

This finding may not be particularly surprising if due attention is paid to the fact that what is crucially important for the growth processes of rice is abundant rainfall in the spring and early summer period and sufficiently high temperature in the high summer season. Indeed, the causes of famine tables above have indicated that earlier famines were more to do with drought which affected the early growth processes, while once it was overcome, cold summer came to the fore affecting the final growth process.

Discussion

The evidence we now have in the form of famine chronology seems to suggest that there were two broad tendencies in the history of famines in historic Japan.

The first is a long-run tendency of decline in the frequency of famines. Generally it was a very slow progress. But the progress is likely to have been sustained even in the centuries when the Little Ice Age is believed to have begun: situations in the fourteenth and fifteenth centuries seem to have been somewhat better than in warmer centuries of the ancient period. Then came an unexpected decline in the second half of the sixteenth century—unexpected because the decline in the famine frequency took place during another phase of global cooling in the Little Ice Age, and also because in Japanese history it was in the middle of a warring state period, not in the post-unification period of returned peace.[3] Given the nature of records we have for the period before Tokugawa, one may question the timing of this decline in the famine frequency. However, a close scrutiny of the chronological data suggests that this is a fairly robust observation. Famines did become less frequent in the middle of the rise of war lords and resultant military confrontations between the warring states.

The second tendency was for drought to become less problematic as a cause of famine. In earlier centuries a majority of famines were triggered by drought, but from about 1550 on the number of famines caused by either extreme warmness or short rainfall started to decline. Crucial for this shift were agrarian changes that took place in rice growing—variety selection, reclamation of lowland river deltas, and other forms of investments in land infrastructures (for a brief account of shifting causes of famine, see Saito 2002, 225-226). Thus, by the end of the eighteenth century almost all famines were those caused by either cold temperature or prolonged rain in the summer, suggesting that summer temperature was still a problem, a big problem for people in the north-eastern region. This too was a gradual process, although it is worth noting that it gained momentum well before the Meiji Restoration.

All these may be taken to imply that towards the end of Tokugawa rule, peasants must have been virtually freed from famine disasters. However, as we all know, there took place two Great Famines in the late Tokugawa period: Tenmei in the 1780s and Tenpo in the 1830s. Both lasted for several years, and although our weighting system cannot measure the magnitude of those famines, levels of crisis mortality must have been substantial.

We have to ask, therefore, first, why there was a sudden decline in the frequency of famines despite disadvantaged climatic conditions in the second half of the sixteenth century, and second, why the country was struck abruptly by two devastating famines despite a general warming trend throughout the late Tokugawa period. It seems certain that climatic variables cannot answer the two questions. This is obvious in the first case. In the latter two cases, cold summer has been blamed for the disasters; however, while coldness of the 1780s was global, abnormally cold weather of the 1840s seems to have been a local phenomenon. Indeed, a comparative analysis of diary data for two places in the period 1714-1864 reveals that even if there were more cool-summer triggered than drought-triggered famines in those places, lean years did not invariably result in mass hunger and starvation (Saito 2002, 228-230).

Perhaps we have to turn to economic and political factors for explanation. It is certain that the disappearance of drought as a cause of famine was an important pre-condition for the decline in the frequency of famines in the eighteenth and nineteenth centuries, and hence that agricultural progress was the key to account for this

[3] This is the observation that I was not quite sure about in the previous article because of the data uncertainties for the late medieval period (Saito 2002).

change. However, it cannot explain why the reduction in the famine frequency became possible in the late sixteenth century since much of the agricultural progress was made in the seventeenth rather than the sixteenth century. What we can say at this stage, therefore, is that unintended consequences of changes in the governance structure made by emerging overlords may have been crucially important to prevent the aggravation of any poor harvest into a famine. What happened during the period of warring states is that a warlord consolidated power over his whole territory, which probably meant greater security for the peasantry who came under his rule.

On the other hand, for the latter half of the Tokugawa regime, it is suggested that some subtle but important shifts are said to have taken place between the ruling and the ruled. One of the shifts was concerned with the issue of who was responsible for disaster prevention and relief, and the eighteenth and early nineteenth centuries saw the *bakufu* government becoming less keen in such matters while intermediate-level bodies such as the village and regional communities were more involved in decision-making processes, affecting the long-held notion of 'benevolence' between the ruling and the ruled. According to this interpretation, the Tenmei and Tenpo famines, especially the former, were aggravated due primarily to a coordination failure between the central and regional authorities created during the transition in governance structure (see Kikuchi 2002). How such changes altered the famine processes in the middle of changes, we have to await future research in the political economy of famine and other disaster management.

Finally, it should be remembered that whatever the causes of famines, their changing frequencies must have had implications for population history. This may sound Malthusian. It is well known that there are now revisionist re-assessments on historic famines as demographic correctives (see for example Watkins and Menken 1985), yet a close examination of Tokugawa data has revealed an unmistakably negative impact of cross-regional famines such as those in the Tenmei and Tenpo periods, although it is thought to have reflected the combined effect of both mortality-enhancing and fertility-reducing influences (Saito 2002, 230-235). Given this effect derived from late-Tokugawa demography and also given the finding from our famine chronology table, we should now think that population growth began in the mid-sixteenth century. It has long been assumed that population did not increase until peace returned at the beginning of the seventeenth century, and Akira Hayami's thesis of comparatively strong population growth for that century is considered a recent consensus (Hayami 1967; see also Hayami 2001, 43-46.). However, what our finding suggests is that it started half a century earlier before Tokugawa. In order to explore why in the middle of the warring states period and how it began—we need more evidence, both socio-political and demographic, but once we accept that it all started in c.1550 rather than 1600, the implied rate of population increase during the seventeenth century will inevitably be lowered compared with levels Hayami and others have postulated.

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An Estimation of Spanish Influenza Mortality in Imperial Japan: 1918-20

Akira Hayami

Abstract

This paper re-estimates the number of death during the Spanish Influenza in 1918-1920 in the home land of Japan as well as its colonies in southern Sakhalin, Korea, and Taiwan at the time. Researchers both in Japan and elsewhere have hitherto accepted figures based on incomplete statistics. The author proposes a method to estimate “excess deaths” due to Influenza from the number of deaths due to respiratory diseases. The new estimates are much larger than what has been believed. Also, the damages inflicted were far greater in the colonies of Imperial Japan than on the Japanese mainland.

1. Introduction

Between 1918 and 1920, not even Japan could be spared from Spanish Influenza, which blanketed the world. In May 1918, influenza patients occurred among the crew of a naval vessel anchored at Yokosuka naval port. The influenza spread immediately to the nearby cities of Yokohama and Tokyo, and many people exhibited high fever, but those who died owing to this were not reported at the time. The infection spread rapidly among *sumō* wrestlers, and owing to the impact on the end-of-May tournament in Tokyo, several bouts were cancelled. People of the time called this infectious disease *sumō kaze*. Thereafter, between June and July, patients were discovered in local barracks, but this ended without becoming a major disaster. In July, newspapers started reporting the spread of influenza in Spain and along the Western Front of the war in Europe (*Keijō Nichinichi Shimbun*: 15 July 1918), but no one thought that this was particularly serious.

There was no coverage of the spread of the disease in America and Europe, which started in September, either, but the spread began within Japan in earnest that same month. The appearance of feverish patients was reported spreading from central to all regions of western Japan. This is thought probably to be a symptom caused by Spanish Influenza. From the latter half of October, this infectious disease spread throughout Imperial Japan, including the colonies in Southern Sakhalin, Korea, Kwantung Leased Territory (including Port Arthur), and Taiwan,[1] which were called the “outer territories *(gaichi)*” at the time, with a ferocious power, and gradually burned out by May 1919.

[1] Taiwan became a Japanese colony as a result of the Sino-Japanese War (1894-95), Southern Sakhalin became a Japanese colony in 1905 because of the Russo-Japanese War, Kwantung Territory was leased from China in 1905, and Korea was annexed to Japan in 1910.

In Japan, the spread during the spring of 1918, which is called the first wave of Spanish Influenza internationally, is called the "spring herald," the second wave, from autumn of the same year to spring 1919 is called the "earlier pandemic," and the third wave, namely the spread from the end of 1919 to the spring of 1920, is called the "later pandemic." The author will denote the spreads as "earlier" instead of the second wave or "later" instead of the third wave.

The earlier pandemic, the second wave internationally denominated, was characterized by a high morbidity, but the mortality was comparatively low, whereas the later pandemic, the third wave, was characterized by a lower morbidity but a higher mortality. From this fact, there are observations that think that these two pandemics may be due to different viruses (Rice and Palmer 1993, 393). For the reasons described below, however, I personally think that these two waves were both due to the same virus unanimously recognized today as "H1N1," and therefore argue from that standpoint.

There are several figures regarding the number of deaths from Spanish Influenza in Japan. In non-Japanese publications, Richard Collier claimed 257,363 (Collier 1974, 305), as did exactly Geoffrey Rice and Edwina Palmer (1993, 393), and Niall Johnson calculated 388,000 (2006, Tab.4.1).

These figures are based on the statistics described in the *Ryūkōsei-kanbō* (Influenza Pandemic edited by Naimushō Eiseikyoku [Department of Sanitation, Ministry of Home Affairs] 1922) [hereafter abbreviated as *Ryūkan*], which was published immediately after the pandemic, calculating the number of deaths within the homeland Japan only. The figure of 257,363 is the number of registered deaths from September 1918 to May 1919 only, as Rice and Palmer noted (1993, 393), whereas the figure of 388,000 adopted by Johnson (2006) includes those who died during the period between December 1919 and spring 1920. Japanese researchers also use these figures for the number of deaths. I would like to start by re-examining these figures. Judging from the results, the calculations to date have all been far too small, and in reality it is clear that far greater number of people died.

Next, Kanagawa Prefecture, which includes the city of Yokohama, published a report on the pandemic describing the spread of infection within the prefecture, with details of the figure of deaths in Yokohama City. This must also be examined.

Finally, we shall examine how the influenza spread in the colonies of southern Sakhalin, Korea, Kwantung Leased Territory and Taiwan at the time. There has been little research on these areas. This is not to say that there is no data of these areas, but rather, with the exception of Kwantung, the administrative authorities of each colony published statistics every year, and Japanese newspapers can also be utilised. By doing these, it was possible to estimate mortality with the same reliability as within the homeland Japanese itself. Through these data with those from within Japan, the overall image of the spread of Spanish Influenza in Imperial Japan became clear for the first time (Hayami 2006).

This article mainly focuses on the human damage that occurred as a result of the spread of infection in both Japan and its colonies.

2. Questioning the Number of Deaths by Spanish Influenza that Has Been Cited Hitherto

The statistics for those killed by Spanish Influenza within Japan have until now depended entirely on the *Ryūkan* report published immediately after the pandemic. This important official document was excellently planned for the time, but statistically speaking, it is far from complete. The statistics at the end of the volume cite figures by combining the number of sick persons and deaths from the start of the pandemic until 15 January 1919 by prefecture, and then cite the number of sick persons and deaths registered every half-month thereafter until 31 July. Further, the total statistics for each prefecture are collated for all the sick and dead, and the number of sick over the total population, the number of deaths among the sick, and the number of deaths over the total population are described, as well as the national totals. The start of the earlier pandemic differed between prefectures (the earliest prefectures were touched in August 1918), and the latest was Okinawa Prefecture in November while most prefectures were already infected in October 1918.

For the later pandemic, the total of sick and total of deaths were listed by prefecture from initial onset to the end of December 1919, and from January 1920, the figures for each month were recorded until the July of that same year. The onset of the late pandemic was earliest in Kumamoto Prefecture during the middle of September, and latest in Chiba and Iwate Prefectures, during early January 1920.

At first glance, these tables appear complete as statistics of the sick people and deaths due to influenza. Consequently, researchers both in Japan and elsewhere have hitherto accepted those figures as the Spanish Influenza deaths in Japan without doubting the printed records that nationally the total number of deaths in the earlier pandemic was 257,363 and in the later pandemic 127,666 for a total of 385,029.[2] When the tables are examined, however, it immediately becomes clear that statistically, they are entirely incomplete. In many cases, among the prefectures the numbers of dead and sick cease to be entered as the pandemic progresses, or there are no records at the outbreak of the disease. To cite one example, in the case of Osaka Prefecture, the sick and dead people in the earlier pandemic, including Osaka City where the influenza was at its most ferocious stage in Japan, are recorded only until 15 January 1919, with the column from 16 January onwards being blank. Further, the totals of the sick and deaths during the earlier pandemic are calculated only up until 15 January 1919.

Osaka City was the largest city attacked by the Spanish Influenza, and we have no reason to be convinced that the spread of earlier pandemic suddenly halted on 15 January 1919. There must be several thousands more who died after 16 January, as can be easily assumed. This lack of information exists either because the Osaka Prefecture did not report the statistics, or the Sanitary Bureau of the Home Ministry did not obtain them. Similarly, of the 47 prefectures existing nationally, there are ten prefectures for which records are incomplete, so the national totals for the actual numbers of sick and

[2] When the total number of 3,698 influenza deaths between autumn 1920 and spring 1921, which could be called the “fourth wave,” is added, the number of deaths rises to around 388,000.

deaths during the earlier pandemic must be considerably greater than the recorded figures.

The table for the later pandemic has fewer blank columns than that for the earlier, but even so it is far from complete. Here, too, records for Osaka Prefecture extend only as far as February 1920 and the statistics from March onwards, when the pandemic continued, are missing.

As a result of these examinations, major doubts have arisen concerning the use of the *Ryūkan* report as statistics regarding the human cost of Spanish Influenza. Undoubtedly, anyone would become aware of these deficiencies in the statistical data if they examine the original documents. There is absolutely no trustworthy foundation to these figures. It must be said that the responsibility of scholars who have discussed these figures uncritically, and in particular Japanese researchers, for whom the original data is approachable, is great.

If we assume that the statistical values in the *Ryūkan* are unreliable, how then could we calculate mortality due to influenza accurately? I found a way to solve this problem. I will not utilize the *Ryūkan* to measure mortality, but devised a method to estimate "excess deaths" due to Spanish influenza: I calculated the difference between the number of deaths due to respiratory diseases in "normal years" before and after the pandemic (1916-21), and the number of deaths due to respiratory diseases during the period of the Spanish Influenza pandemic. Moreover, luckily, Japan kept the statistics by age group, month, and cause of death,[3] and by combining these figures, Spanish Influenza mortality in Japan could be estimated both for the country and its colonies. The results of the calculations will be described below.

The spread of the earlier pandemic took eight months from October 1918 to May 1919, so the number of deaths for each prefecture during this period due to respiratory disease or for unknown or unclear reasons must be added by prefecture.[4] Mortality for respiratory illnesses rose due to influenza morbidity, and it is not difficult to imagine it exceeding ordinary times. The number of deaths determined using this method was 266,479, which is considerably higher than the figure in the *Ryūkan* report.

The later pandemic was estimated in the same way. As the later pandemic continued from December 1919 to May 1920, the number of deaths during this six-month period was determined by separating into normal years and influenza years, and then deeming the difference to be "excess deaths" due to influenza. The number was 186,673, and this also exceeds the figures in the *Ryūkan*.

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[3] Nippon Teikoku Shiin Tōkei (hereafter abbreviated as NTST), eds. Sanitary Bureau of Home Ministry (Annual report of mortality by causes, published in Tokyo).

[4] The eight categories which are handled here as having influenced the number of deaths due to Spanish Influenza as causes of deaths within NTST official Japanese statistics (*Nippon Teikoku Shiin Tōkei*) are: (1) influenza, (2) pulmonary tuberculosis, (3) acute bronchitis, (4) chronic bronchitis, (5) pneumonia and bronchitis, (6) other respiratory diseases, (7) diagnostically poorly-defined illness, (8) and unknown causes. The number of deaths due to those last two categories increased dramatically in 1918, but at the time no one knew of the Spanish Influenza pathogen (H1N1), so consequently they were likely treated as "other" and "unknown causes."

Before discussing the content of the newly estimated mortality in detail, I would like to take a brief look at the state of Japan under the Spanish Influenza[5] crisis.

3. The Earlier Pandemic

In either September or October 1918, and the specified location cannot be traced, but somewhere in Japan a mutated strain of the Spanish Influenza virus with more potent contagiousness came ashore. One newspaper, based in Nagoya in central Japan, (*Shin Aichi*, 20 September 1918) reported that workers of a weaving factory had developed a fever, and that although they suffered for three to seven days, they had not died so far. On the 26 September the same newspaper reported that there were 400 influenza patients among the infantry regiment stationed in Ōtsu near Kyoto.

By mid-October 1918, influenza-related articles had spread nationwide. Articles saying also that there were sick and dead among the soldiers being sent to Siberia could be seen on 3 and 4 October. On 12 October, it was reported that more than 60 elementary school pupils in Yamaguchi Prefecture, at the western tip of Honshū (*Yomiuri Shimbun*), were absent with nosebleeds. Probably, this was a symptom of Spanish Influenza. In the middle of October, the newspapers were covered nationwide in reports of the "influenza epidemic." In particular, reports claimed that there were numerous influenza patients among military personnel, factory workers, and school children. The influenza took less than three weeks to spread nationwide, because Japan's railway network was almost complete at that time, and people infected with the virus were able to travel long distances quickly by rail during the incubation period of the virus. Infections consequently appeared in all corners of the country, so that by the end of October 1918, the number of deaths was also gradually increasing.

The reason why articles concerning the deaths increased was probably because of the concentration of fatalities among military personnel, factory workers, and students, and was thus easy to identify. Nowadays it is clear that deaths occur mostly among the age group that normally suffers low mortality, as even healthy organs are destroyed by an excessive immune response that is called a cytokine storm. By this time, the infectious disease was clearly identified as influenza, and on 25 October 1918 the Home Ministry announced that this infectious disease was called Spanish Influenza outside Japan. Generally influenza and cold (*kaze*) were not distinguished at the time, and so the infection came to be called *Supein kaze* (Spanish cold). Even today, the tradition of wrongly calling Spanish flu as *Supein kaze* continues.

The earlier pandemic peaked between the end of October and the middle of November 1918. The majority of victims were in the three cities of Kyoto, Osaka, and Kobe. The newspapers overflowed with reports of closed schools, paralyzed transportation, and major congestion at public crematoria.

The peak seemed to have passed by the end of November. Nevertheless, after 10 December, another reversal occurred during which the numbers of sick and deaths again increased. This was influenced by the system of military conscription in Japan at the

[5] See also Rice and Palmer, 1993.

time. Because the fresh recruits entered the military on 1 December each year, a large number of young people who were uninfected with the virus swarmed into the barracks. They immediately became, for the virus, a better target to attack than ever before. Several days after being conscripted, numerous soldiers turned up in rapid succession either to enter hospitals or, if the infection was particularly severe, to die within ten days of their conscription. As suitable quarantine measures were not taken, the influenza infection passed from the soldiers to the citizenry, and many Japanese regions consequently experienced a second peak in January 1919.

Patients hospitalised in military hospitals were nearly all fresh recruits. Since hardly any veterans of two years or more could be seen, there was a clear difference between soldiers with immunity to the influenza and those without.

At the time, the influenza pathogen could not be identified anywhere in the world. In Japan as well, there was a great dispute between scholars who agreed and disagreed about the pathogen to be the same microbe identified as the influenza pathogen by the German microbiologist Pfeifer at the end of the influenza pandemic in 1890s (today known to be the H2N8 strain). Of course, today, influenza is known to be caused by the influenza virus, and not to be caused by bacteria (*Pfeifer bacterium*), but at the time, the norm was to assume that infection was caused by filterable microbes, and specific viruses had not been isolated. The Pfeifer bacterium was cultivated, however, and a vaccine created, and “inoculations” were even performed all over the world.

The earlier pandemic in Japan declined with the coming of spring, and in May disappeared from Honshū altogether.

4. The Later Pandemic

Although it is unclear whether the virus was lurking hidden in Japan and suddenly manifested itself, or whether it was brought in from the outside, in November 1919, influenza sporadically flared up again in several locations. Again serious explosion occurred in early December, and was clearly occasioned by the conscription of new recruits to the armed forces. No matter where the forces were stationed, the accompanying hospitals were filled with fresh recruits who were sick with influenza, and there were also cases of sick new recruits being sent home without being conscripted (*Touou Nippō*, 14 December 1919). Nearly all the sick were new recruits, and in the 31st regiment in Hirosaki, of the 148 people hospitalized, 127 were fresh recruits, and of the 15 dead, 13 were fresh recruits. In the end, 41 soldiers died.

The Imperial Guard in Tokyo was a collection of soldiers from all over Japan, and so suffered the greatest casualties, with the dead reaching 100 (*Touou Nippō*, 21 December 1919). All newspapers reported that the mortality was greater than during the earlier pandemic. According to the army’s published statistics, there were 531 dead in 1918, 955 in 1919, and 1683 in 1920,[6] which tells us that the deaths during the later pandemic were considerably more numerous.

[6] The Statistic Bureau of Cabinet, Nippon Teikoku Tokei-nenkan (the Annual Report of Statistics of Imperial Japan).

Conditions were similar for the navy, and as one example, I would like to introduce the case of the light cruiser *H.M.S. Yahagi*,[7] which occurred during the earlier pandemic (Yamaguchi Den'ichi 1919). During the first World War, the *Yahagi* was part of the fleet dispatched at the request of the Britain under the terms of the Anglo-Japanese Alliance, and was based in Singapore, from where it patrolled the Indian Ocean, Southeast Asia, Australia, and New Zealand. As the German fleet in this area had already been completely destroyed, the armistice was welcomed on 10 November 1918 in Singapore without having gone into battle and the ship was waiting for its relief to arrive. But as the arrival was delayed, the sailors were allowed to go ashore. There, the sailors contracted the Spanish Influenza virus and after the ship set sail on 30 November, the sick appeared one after the other. Upon barely making a scheduled stop at Manila, the sick were all taken into hospital, but a total of 48 of them died, including those who had died whilst still aboard. The proportion of deaths to all crew members was at least 11 per cent, and this rate was the highest compared to other naval ships that had been subjected to Spanish Influenza. [8]

The earlier pandemic followed the order of civilian, military, and back to civilian, but the later pandemic evidently spread along a vector of military to civilians. The spread continued domestically until around May 1920 when the virus disappeared.

This exemplifies the fact that the virus that was the pathogen of the earlier pandemic was the same one of the later pandemic. Otherwise, we cannot explain the small number of sick among the second-year recruits in service while the great number of fresh recruits became sick during the later pandemic.

5. Analysis: Inventing a New Method of Mortality Evaluation

From this point on, I utilize the concept of "excess deaths." In estimating mortality, the earlier pandemic within Japan covers eight months from October 1918 to May 1919, and the later pandemic six months from December 1919 to May 1920. The total number of deaths, based on the eight categories of respiratory diseases responsible for death previously mentioned, is drawn and estimated from the published official Japanese statistics *Nippon Teikoku Shiin Tōkei* (here called NTST). Comparisons[9] of the figures are made between "normal" months (from years 1916, 1917 and 1921)[10] and the months of the influenza epidemic.

Deaths by Month

Figure 1 shows the number of influenza deaths by month during the earlier and later

[7] The *Yahagi* was 4,000 tons with a crew of 400, and was the first light cruiser fitted with turbines.

[8] Niall Johnson, *Britain and the 1918-19 Influenza Pandemic*, p.113. Table 4.7 Influenza on board ship. This was 9 per cent on the *H.M.S. Africa* therein.

[9] I take all deaths by respiratory diseases as registered according to the eight related categories, for each month, and I take out the mean number of deaths in the same months that occurred in the two previous years, which were considered as "normal", and year 1921. I consider that the figure obtained of "excess deaths," for each period, gives a good estimation of mortality due to Spanish Influenza.

[10] In Korea, as there are no 1921 data, I use 1915, 16 and 17 as normal years.

pandemics estimated according to my method of “excess deaths.” This figure clearly shows that during the earlier pandemic, the number of death rose sharply in November1918, and was greater than that in any other month. It was so bad in Japan that it can be called “Black November” as was the case in New Zealand (Rice 2005). The excess deaths of 132,908 were 50,000 more than the deaths during the Russo-Japanese War in 1904-05, and these deaths occurred in a single month. Limited to just this month, the number of deaths due to influenza were more than half of the total deaths of 253,926. In addition, the ferocity waned somewhat in December, but the death tolls remained high, and also continued in January, February, and March of the following year (1919).

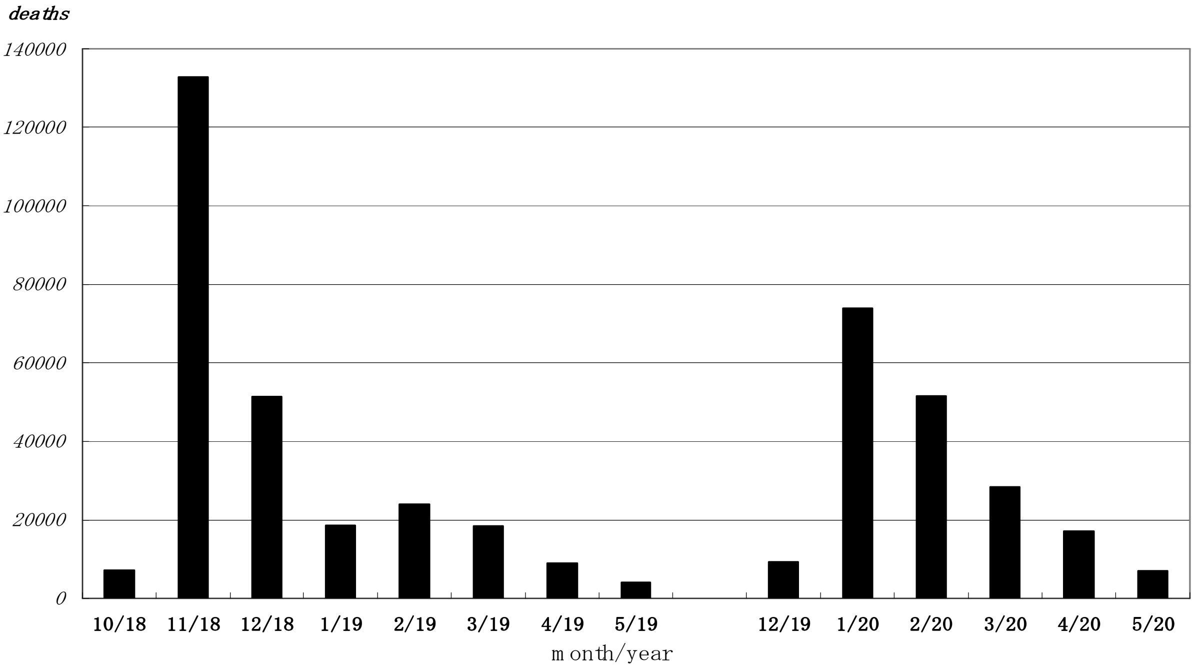

Figure 1. Influenza deaths in homeland Japan (October 1918 - May 1920).

The later pandemic appeared in December 1919, but its peak arrived in January 1920 when the number of estimated deaths related to Spanish flu was close to 80,000, which accounted for 43 per cent of all the registered deaths. As stated above, a major cause of this big number was undoubtedly the sick among the new conscripts who entered the military on 1 December of 1919. During the later pandemic, the percentage of sick against the total population was relatively low, but the mortality among the sick was considerably high. The majority of the population had probably obtained immunity during the earlier pandemic. However, for better or for worse, those who had passed through the earlier pandemic unscathed were caught unprepared at the later pandemic, and became bait for the virus, which had increased in virulence. During both the earlier and later pandemics, the number of deaths was the highest immediately after the influenza arrived, and after the number of deaths peaked sharply, displayed a pattern of slackening off gradually.

Deaths by Day

By determining the daily deaths during the influenza pandemic, we are able to learn the spread of the disease more accurately. In November 1920, the police and sanitary department in Kanagawa Prefecture, which includes the city of Yokohama with a population of 460,310, published the *Ryūkōsei-kanbōshi* (Kanagawa-ken: 1920, [On Influenza] hereafter abbreviated as *Kanagawa-Ryūkan*) immediately after the pandemic. This included vital information concerning the daily total deaths by pneumonia in Yokohama City. The most valuable statistics is the table that compares daily the number of total deaths and deaths by pneumonia for three periods; 1) normal years before the arrival of the Spanish Influenza virus (1 October 1917 to 31 March 1918), 2) the earlier pandemic (1 October 1918 to 31 March 1919), and 3) the later pandemic (1 December 1919 to 31 March 1920).

Firstly, Figure 2 compares the total number of deaths during the above three periods. During the years of 1917-18, the number of daily deaths from the latter half of December through the end of January was a bit high, and at approximately one and a half to twice to the other days. This, however, was before the Spanish Influenza pandemic, and the reason was probably seasonal. During 1918-19, two periods of high mortality can be observed. The first was from the end of October through the middle of November 1918, which was when the influenza spread nationwide. Probably, the influenza pandemic could also be seen in Yokohama at this time. The second was from the middle of January to the middle of February 1919, when the number of deaths peaked at the beginning of February. Apart from the two periods of the pandemic, there is almost no difference compared to the period of 1917-18.

The number of deaths for 1919-20 is remarkable. Until the beginning of January, the number was almost the same with those for 1917-18, but then rose dramatically after 10 January. The two weeks of the second half of January show the mortality nearly three times higher than that of 1917-18. This mortality crisis was also reported in the newspaper coverage of the time almost screamingly (*Yokohama Bōeki Shimpō*: 22-28 January 1920). After 10 February, however, the data converge, and from the end of February settle to approximately the same level as 1918.

In this way, the analysis of the daily records shows that the number of deaths during the influenza pandemic did not continue over a long period of time, but rather, returned to normality after between three weeks to a month during any pandemic periods.

Next, we examine deaths due to pneumonia. Yokohama has a port for overseas routes, so daily death statistics were compiled by cause of illnesses. The Spanish Influenza caused bronchitis and pneumonia when it progressed. Therefore, these death records due to pneumonia can be a proxy for the progress of the influenza. The mortality trends in this figure are strikingly similar to the overall mortality trends in Figure 2. During the period of 1917-18, the number started to rise from the second half of December and was somewhat high until the end of February. This was a cold, dry period, and was also a period of a pneumonia epidemic. Consequently, it must be acknowledged that there was a certain seasonal component to these deaths due to pneumonia. The trends in deaths due to pneumonia during 1918-19 and 1919-20, however, were no longer due to the season. Figure 3 shows the deaths due to pneumonia collated over every five-day period.

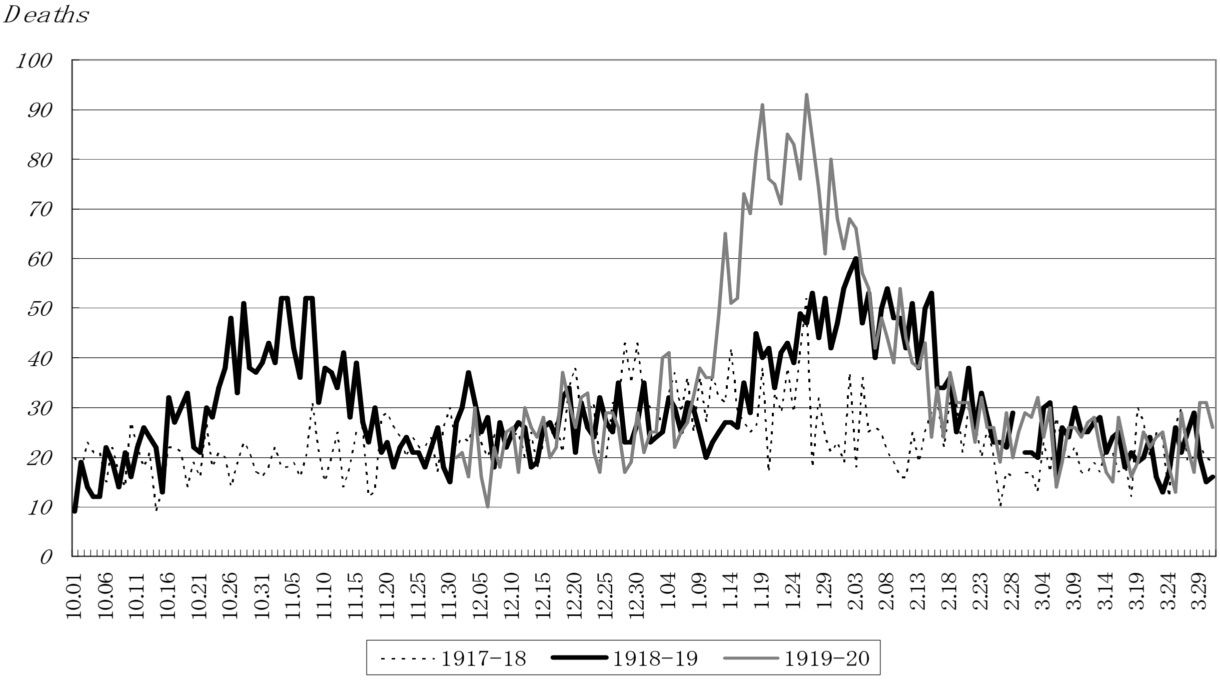

Figure 2. All deaths in Yokohama city (Daily).

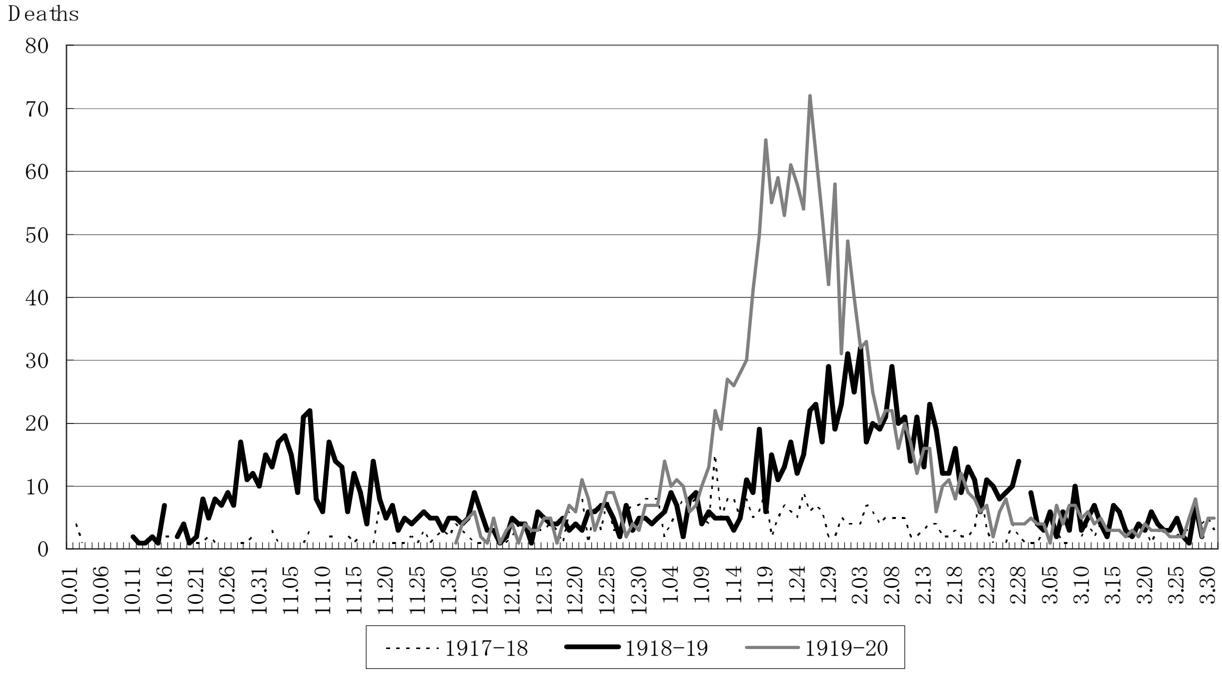

Figure 3. Deaths by pneumonia in Yokohama city (Daily).

First, looking at 1918-19, the first peak is observed during 1-5 November. The death tolls are about ten times of those in 1917-18. The number of deaths gradually declines thereafter. From the end of the year until the beginning of the following year the figure fluctuates at the levels for 1917-18. After 15-19 January, however, the trend rises rapidly, and the second peak, which considerably exceeds that of November 1918, is experienced from 30 January to 3 February. The number of deaths tends to decline thereafter, but it is not until after March that they return to the 1917-18 levels.

The trend in 1919-20 is extremely conspicuous, as we have seen in the total numbers of deaths in Figure 2. The number rose somewhat at the end of December, and then continued to jump dramatically during 10-14, 15-19, and 20-24 January 1920. During the 10-day period from 25-29 January and 30 January to 3 February, a total of nearly 600 people died. This was ten times the number during 1917-18, and was three times that of the pandemic period during 1918-19.

The characteristics that we observe in all death peaks suggest that the peaks are concentrated in three to four-week periods rather than keeping high number of deaths throughout the entire period of the pandemic. Further, the manifestations of the peaks are extremely short, and take a longer period of time to disappear.

Deaths by Age Group

Figure 4 compares the number of deaths by age during the years of the influenza pandemic and the number of deaths in "normal years." It shows the number of deaths by age during the three years of the pandemic (1918, 1919, and 1920), taking the number of deaths by age during the three normal years (1916, 1917, and 1921) as 100 (Naimusho Eiseikyoku [Ministry of Home Affairs], *Nihon Teikoku Shiin Tōkei*).

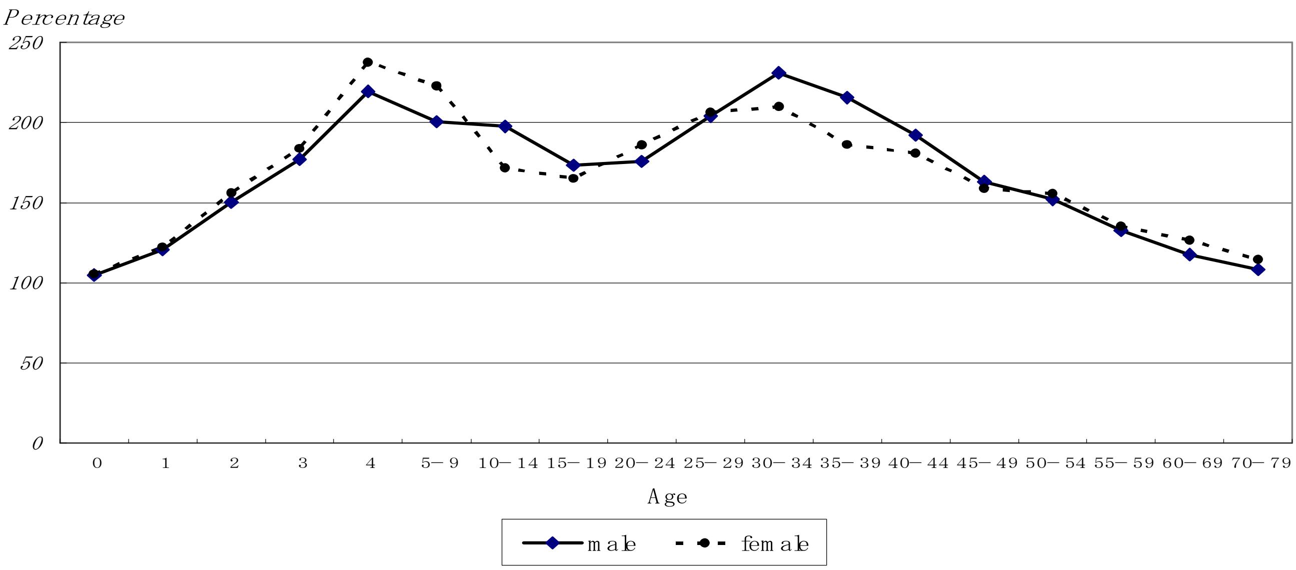

Figure 4. Pandemic year/ Normal year mortality comparison.

Note: The three normal years (1916, 1917, 1921) as index (= 100).

The figure demonstrates in which age group the number of deaths due to influenza was greater than normal years. After passing age 10, the highest was the 30-34 year-old group for both males and females. In this age group, the figure was more than twice of the normal year.

Infant mortality in Japan was always higher than those in the industrialised nations during the same period. It was not exceptionally high during the period of the influenza pandemic. Newspaper articles at the time reported that this bout of influenza had the greatest blow to the younger generations. This fact supports the reports that in the military, the deaths were greatest among the soldiers who had just joined (at age 20), who in our common sense should be the most resilient. This phenomenon is explained by the fact that healthy cells are damaged and cause death in the youthful population. This is an excessive immune reaction called a cytokine storm. The victims started to be observed at the barracks, then flowed out from there to the streets, and subsequently killed a lot of citizen.

6. Pandemic Trends in the Colonies

Japan at the time was an “empire” with colonies in the nearby regions. Of these, there are only simple population sources for the Kwantung Leased Territory at the southern tip of Liaodong Peninsula, Manchuria. There are statistics for the other three regions, and these could be utilized to examine the trends of the Spanish Influenza pandemic.

South Sakhalin

As a result of the Russo-Japanese War, the southern half of Sakhalin Island just south of 50˚N, became a Japanese colony, and before and even during the influenza pandemic period, many colonists migrated there from mainland Japan. A large number of seasonal laborers also gathered there during the fishing season because of the prime fishing grounds for cod and herring.

The influenza pandemic in Sakhalin began with a spring herald in May 1918, but in actuality this was considerably later than the case in the homeland Japan. In early November of that year, it was reported that the elementary schools in Toyohara (now Yuzhno-Sakhalinsk) had closed due to the influenza (*Karafuto Nichinichi Shimpō:* 5 November 1918). Thereafter, it spread to all regions, causing 4,063 sick and 144 deaths. It then seemed that the disease had quieted for the moment.

In March 1919, however, the influenza spread explosively on small Kaiba Island (now Ostrov Monaron) off the southern tip of the western Sakhalin coast. The fishing grounds around this island were excellent for herring and fur seals. Numerous seasonal labourers crossed over from Hokkaido and mainland Japan during the March fishing season, and lived communally in rough cottages that had been built for them. As both those infected and uninfected with influenza lived together there, the infection spread in the blink of an eye. Consequently, the telegraph and postal services were rendered incommunicado and doctors and policeman also became sick, such that there were several tens of deaths by 10 April 1919. This “earlier” pandemic in Sakhalin was characterized by being particularly fierce from the March fishing season onwards rather than during the harsh, cold winter, and by its end being retarded. It was on 19 June 1919 that reports of the pandemic in the newspapers finally ended.

The later pandemic was almost exactly the same, with its first assault being in November 1919, but the majority of deaths came from March 1920 onwards.

Employing the method of "excess deaths," the number of deaths is estimated at 667 for the earlier pandemic and at 787 for the later, giving a total of 1,481 in south Sakhalin in both pandemics.[11] The population at the end of 1919 was 82,409, so the death rate over the two years was at least 18 per mil. This mortality was higher than that on the mainland. Further, there were also aborigine Ainu, Gilyak, and Oroqin peoples living on Sakhalin. These people, who lived a hunter/gatherer lifestyle, lost space needed for living due to the invasion of Japanese and the spread of industrialisation, and their populations were declining in the long term. The Spanish Influenza also attacked them, leading to numerous deaths. The population in 1917 was 2,168. Since 88 died in 1918 and 73 died in 1919, the population in 1920 was down to 2,030. The number of deaths in normal years was approximately 40 to 50, but during the years of the influenza pandemic it was over 70 (Karafuto Chō). This was 33 per thousand of population, which was much higher than the population of Japanese in Sakhalin.

Korea

No local documentation exists regarding the Spanish Influenza pandemic in Korea in the early pandemic stages, apart from short reports from American medical doctors who were living in Seoul (Schofield and Cynn 1919). According to the Seoul newspaper (*Keijō Nichinichi Shimbun*), the attack of the influenza pandemic in Seoul was reported on 17 October 1918. The disease spread across the whole land at almost the same time as within homeland Japan, and school closures and the suspension of railway construction were reported. A newspaper article on 31 October 1918 reported that in one district of Seoul, there were 26,000 sick, and ten Japanese and 138 Korean dead. During November, the pandemic reached its peak, and the daily deaths in Seoul reached 50, which was twice the number in normal years. The cost of medicines was exorbitant, and the majority of the sick were in their 20s and 30s as in Japan (*Keijō Nichinichi Shimbun:* 22 November 1918).

The later pandemic started with the military and spread to towns and cities as well. On 15 December 1919, there were 89 deaths within Seoul, which was the largest number of deaths in a single day.

As for estimating the number of deaths from influenza, Japanese population statistics in Korea ceased to record the number of deaths by month after 1919, and therefore, the pandemic across the entire period cannot be observed monthly. At any rate, however, when excess deaths due to illnesses of the respiratory system are determined

[11] Karafuto-Cho, *Karafuto choshi ippan* (Annual Report of Sakhalin).

utilizing the statistics for 1918, between October and December, with its peak in November, there were 982 deaths among Japanese and 121,278 among Koreans. In 1918 alone, the number of deaths reached 122,260 (Chōsen Sōtokufu Tokei-sho [The Governor General for Korea]).

As I noted, if deaths cannot be calculated monthly, it is possible to determine the excess deaths for each year globally. Of the causes of death, deaths due to Spanish Influenza are thought to be included in "respiratory diseases," "colds," "infectious diseases," and "uncertain diagnoses" in the classification of illnesses in the "statistics." The total number of deaths between 1915, 1916 plus 1917, and 1918, 1919 plus 1920, can be compared in this manner. The statistics for "Japanese homelanders" and "Koreans" are separated also as shown in Table 1. Ultimately, the results of the estimated excess deaths due to influenza are 3,384 Japanese and 230,782 Koreans across the three-year period, which are 10.0 and 13.8 per thousand of registered population,[12] respectively the toll of deaths in Korea are more numerous than those in Japan. The virus would attack both Japanese and Korean indiscriminately. The difference in treatment at the contraction of the illness should account for the results shown.

Table 1. Excess death in Korea.

1.Homelanders

	Death by Respiratory Disease	Excess Death
1915	2260	
1916	2695	
1917	2453	
total	7408	
average	**2469**	
1918	3504	1035
1919	3548	1079
1920	3739	1270
total		**3384**

2.Koreans

1915	119717	
1916	131286	
1917	132431	
total	383434	
average	**127811**	
1918	256901	129090
1919	168152	40341
1920	189162	61351
total		**230781**

Taiwan [Formosa]

Data concerning Taiwan includes the "*Taiwan Nichinichi Shinbun*" journal as recoded data, and the *Taiwan Sōtokufu Tōkeisho* [The Statistics of Governor-General for Taiwan].

[12] As we have no reliable population statistics before 1920, I take the population of 1920.

The classification of diseases in the “Statistics” is the same as that for Japan. Therefore, the difference between normal years and pandemic years can be determined by calculating the deaths based on the sum of the eight causes as we did for homeland Japan.

In Taiwan, a “strange disease” broke out in between spring and early summer 1918, but there is no firm evidence that this was Spanish Influenza. Consideration must be paid, however, to records of an epidemic across the straits in Hong Kong and Amoy (*Taiwan Nichinichi Shimbun*: 21 June 1918, Chinese version).

In October of 1919, the patients appeared among the soldiers stationed in north Taiwan, and gradually spread across the whole island, such that the crematories were three times more busy than normal. This almost completely disappeared by the end of November. However, just as it did in Japan another outbreak occurred among the fresh army recruits in December 1919.

Of the later pandemic, in January 1920, it was reported that some train services were suspended (16 January), but this was during the peak of the pandemic, and normal service resumed by March.

There were aborigine people in Taiwan. Although their populations were not investigated, the influenza raged among them, too. Their dead numbered 2,727 in 1917 before the pandemic hit, and rose considerably above the 1917 level during the following three years as follows: 4,500 dead in 1918, 3,968 dead in 1919, and 3,342 dead in 1920. The reality was probably even harsher, but no more is currently known.

Luckily, statistics by cause of death and by month are recorded in Statistics of Taiwan (Taiwan Sōtokufu), so the number of dead due to respiratory system illnesses can be determined for the two years (July 1918 to June 1920) that includes the period of the pandemic. Table 2 shows the number of deaths due to respiratory diseases by month for both “Japanese” and “Islanders” (i.e., Taiwanese). As can be immediately understood from this table, there were sharp mortality peaks in November 1918 and January 1920. Needless to say, the number of death, which during these periods reached six to eight times the numbers of other months, is a mark of the ferocity of the Spanish Influenza.

Table 2. Mortality of Spanish Influenza in Imperial Japan.

	Population	Deaths	Mortality (‰)
Homeland	55,963,053	453,452	8.1
Sakhalin	105,765	3,749	35.4
Korea	17,284,407	234,164	13.5
Kwantung L.L.	687,316		
Taiwan	3,654,398	48,866	13.4
Total	77,694,939		
Total*	77,007,623	740,231	9.6

Note: Total*=without Kwantung L.L.

The two panels in Figure 5 describe the number of deaths due to influenza estimated utilizing excess deaths. According to the statistics, “Japanese” (Figure 5A) and “Taiwanese” (Figure 5B) were observed separately, but whereas Japanese deaths were concentrated on specific months, there were considerably more Taiwanese deaths during the months after the peak. In the end, the results of calculating excess deaths due to influenza during the two periods of the pandemic yield 1,373 “Japanese” deaths and 47,479 “Taiwanese” deaths. The mortality was 9.6 per thousand of Japanese and 13.6 per thousand of Taiwanese. Here too, estimated mortality was higher among the “Taiwanese” than Japanese. Evidently, the “Japanese” showed the effects of better post-illness treatment, care, and hospitalization.

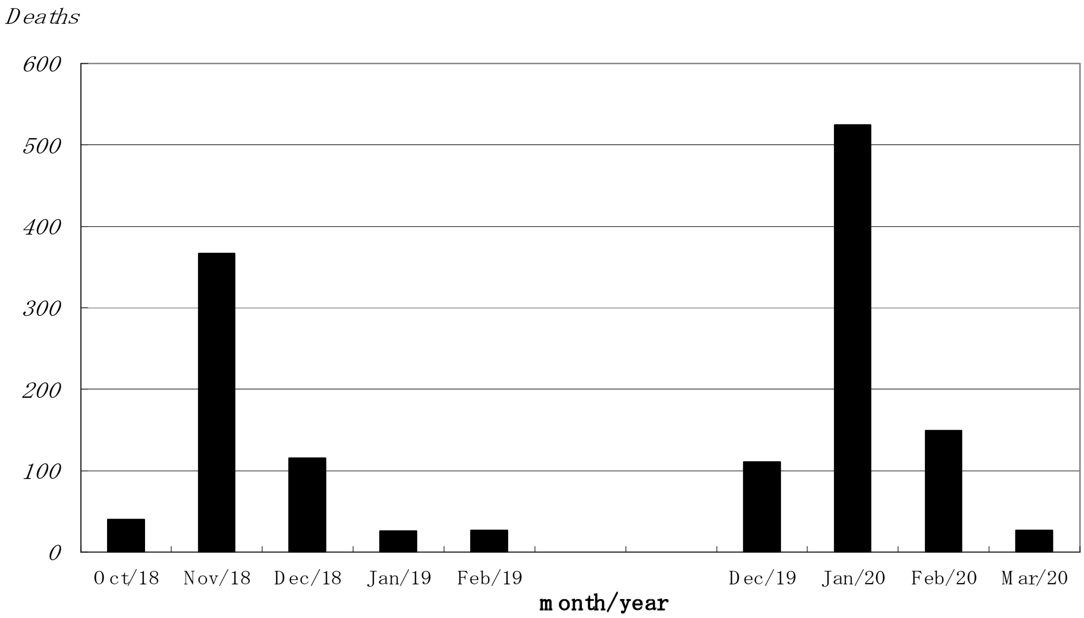

Figure 5A. Excess death in Taiwan: Japanese (October 1918 – March 1920).

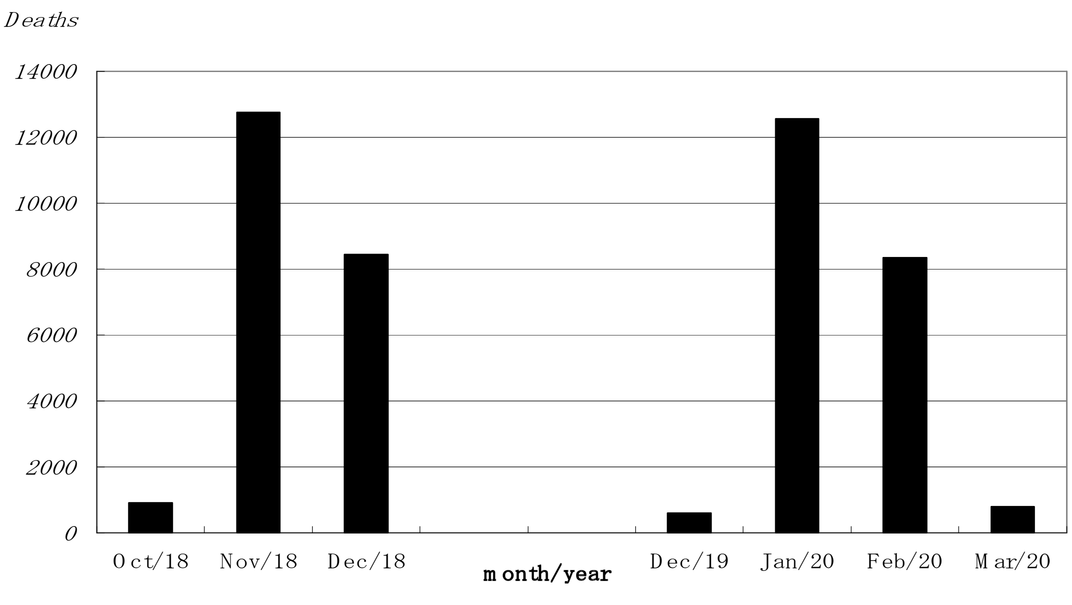

Figure 5B. Excess death in Taiwan: Taiwanese (October 1918 – March 1920).

An overview of the Spanish Influenza pandemic in the Japanese colonies of Imperial Japan suggests that the damages inflicted were far greater than those on the Japanese mainland. There was relatively higher mortality particularly among the indigenous peoples than among the “Japanese.”

7. Concluding Remarks

The overall number of deaths from influenza in Imperial Japan including the colonies (but excluding the Kwantung Leased Territory) exceeded 740,000 and if the Kwantung Leased Territory is included, the estimated number of victims may rise to over 750,000. This number is more than one per cent of the total population of Imperial Japan at the time. This is an unprecedented number. Plus there was no year until World War Two in which the deaths from a single incident exceeded this number.

Nevertheless, Spanish Influenza has passed out of memory even in Japan, and references have disappeared from nearly all written documents. Very recently, alarm has been raised concerning the “H5N2 influenza,” and voices are calling for the lessons of Spanish Influenza to be learned immediately. The type of virus is different, however. On the positive side, medical treatment, preventive systems, and public hygiene have all improved. On the negative side, increased jet travel and rising urban population density facilitate the spread of the disease. Therefore, it is extremely difficult to simply learn from the responses and conditions of the era of Spanish Influenza.

Initially in Japan there was almost no interest in the disastrous affairs wrought by Spanish Influenza, and consequently it has not been the subject of much research. Infection countermeasures dealt almost exclusively with tuberculosis, and influenza countermeasures were completely neglected. Generally, the reasons why Spanish Influenza was regarded so lightly or completely ignored are the same as those pointed out by A. Crosby regarding the U.S.A. (1989: 311-325). In Japan, there is also the major fact that interest all but disappeared due to the large scale of the damage caused by the Great Kantō Earthquake of 1923, which happened hard on the heels of the pandemic. According to recent research, the deaths due to the Great Earthquake numbered approximately 100,000, which is less than one fourth of those killed by Spanish Influenza. But memories of the earthquake have not disappeared in all documents dealing with that period of time. Although this depends on the depth of fear among the authorities and the general populace, it was enforced by the damage plainly visible on photos etc. Many photos still remain of collapsed houses and streets of Tokyo and Yokohama, which had become scorched plains, and these are burned into people’s memory as the “Great Disaster.”

Nevertheless, photos of Spanish Influenza taken in Japan are on the level of people wearing masks and of patients lying down in hospital beds. Therefore, the impact of disaster-illustrated photos is clearly far weaker than that of the Great Earthquake. Essentially, Spanish Influenza is “not photogenic.” People’s perceptions are most greatly influenced by what they can see. This can also be said to be another reason why memories of Spanish Influenza have vanished from Japan.

Demographically, Spanish Influenza did not succeed in reducing the population of Japan. In the major cities of Kyoto, Osaka, and Kobe, however, the populations were reduced temporarily. Further, fertility fell during 1918-19, but rose again during 1920-21. This could well be called a compensatory recovery. When discussing demographic transition in Japan, there is a tendency to view the demographic transition in Japan as having started during the 1920s without considering the reasons for the fall in the fertility by the Spanish Influenza, which was followed by this compensatory recovery. I personally have my doubts, however, as to whether the reasons are that simple (including regional differences within Japan), and believe that the effect of a temporary fall due to Spanish Influenza should be considered. The demographic impact by the Spanish Influenza to the long-term population trends should not be forgotten.

Acknowledgement

The author is extremely grateful to Antoinette Fauve-Chamoux for reading the draft of this paper in an early stage and giving valuable comments and suggestions. The author also thanks Dr. Liu Ts'ui-jung, Academia Sinica, Taipei, for her comments to my presentation on the Spanish Influenza pandemics in imperial Japan at the international symposium held in Reitaku University, Kashiwa, Chiba, Japan on May 23, 2009.

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