Production, prices and mortality: Demographic response to economic hardship in rural Sweden, 1750–1860

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Abstract

Demographic responses to economic hardship are important indicators of the robustness of a society, and the efficiency of its institutions. Considerable attention has been devoted to the impact of grain price fluctuations on mortality in preindustrial society. Often, prices are assumed to be a proxy for harvest outcome, and even though this might be a reasonable assumption at very high levels of aggregation it is clearly not as reasonable when looking at local communities. In this paper we study the mortality response to short-term fluctuations in local grain output, and focus special attention on the impact of harvest failures in different farming region using panel data for 274 localities in southern Sweden between 1750 and 1860. The outcomes are measured by the age-specific mortality rates, and local grain production is assessed using data from a recently assembled production database covering more than 2,000 farms (about 80,000 observations). The findings show a clear mortality response to harvest fluctuations in general, and to harvest failures in particular. The response differed greatly between different farming areas, being strongest in the areas most dependent on grain production. The response also diminished during the agricultural transformation, showing the increasing efficiency of the local economy. At the same time vulnerability to fluctuations in market prices remained high and was also quite similar across different farming regions. This shows that prices and output serve as independent indicators of the economic conditions that faced people in preindustrial society.

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Introduction

In preindustrial society people were highly vulnerable to short-term economic fluctuations. Especially in times of crisis, when food became scarce, mortality increased and child births were postponed. By now there is overwhelming empirical support for this kind of demographic response to economic fluctuations in general, and to economic crisis in particular. The evidence comes from both aggregate level studies covering entire countries and from micro level studies of small areas. The latter studies have also been able to show how the response differed according to socioeconomic status or sometimes position in household hierarchies (e.g. Bengtsson et al. 2004).

Almost all this empirical evidence comes from data on wages and prices, reflecting conditions on wider markets. Especially in the case of eighteenth and nineteenth century Europe grain markets were highly integrated (Persson 1999) and prices were thus products of demand and supply conditions in quite large geographical areas. This means that the demographic response to short-term fluctuations in grain prices or real wages give important insights into the response to cost of food and general standard of living. It is not clear, however, how well the market prices reflect economic conditions at the local level beyond the price of food given the importance of payments in kind, e.g. through transfers of grain. Moreover, local output conditions can be expected to have been decisive in determining the demand for labor (Abel 1980; Utterström, 1957) and thus earnings of landless laborers.

The aim of this paper is to bring new insights into this research area by studying the mortality response to fluctuations in harvest outcomes of grain and compare it to the mortality response to fluctuations in rye prices. In addition to looking at the overall relationship between grain output and mortality we also look in more detail at the mortality response to economic crisis, as measured by low grain output or high grain prices. The analysis is based on data for Scania, the southernmost province of Sweden, in the period 1749–1859 using parish level information on mortality, micro-level data on grain production and regional grain prices. We study the response in three different farming regions, with highly diverging economic structures.

In addition to the mortality response to price fluctuations, there was a substantial response to harvest outcomes as well, but the patterns differed a great deal. While the different agricultural economies in the farming regions were similarly affected by grain prices, the one-sided grain producing plain lands was hardest struck by bad grain harvests. People in the forest regions were sensitive to annual harvest fluctuations as well, but due to a diversified economy harvest failures did not have the same impact in this area. Over time the mortality response to grain output also diminished, which points to a better functioning economy, but at the same time vulnerability to price fluctuations remained more or less unchanged.

Output and prices as indicators of economic hardship

A large number of studies has shown that in preindustrial societies all around the world short-term fluctuations in prices of food or real wages, led to demographic responses in form of lowered fertility and nuptiality and, in worst cases, increased mortality (e.g. Lee 1981, 1990; Weir 1984; Bengtsson and Ohlsson 1985; Eckstein, Schultz and Wolpin 1985; Galloway 1985, 1988; Feeney and Kiyoshi 1990; Hammel and Galloway 2000; Palloni, Pérez-Brignoli and Arias 2000). When populations were exposed to economic hardship they tried to protect themselves by postponing childbirths and/or marriages, by migration, or by seeking relief through markets or aid from major economic actors (Bengtsson et al. 2004; Bengtsson and Dribe 2006; Dribe and Scalone 2010; Ò Grada and O'Rourke 1997). Since the local and regional economy often was one-sided, and thereby hit by the same shock, and since institutional arrangements, such as credit markets and state relief organization, were underdeveloped these measures in many cases were insufficient, resulting in increased mortality (e.g. Dribe 2003; Bengtsson et al. 2004; Dribe, Olsson and Svensson forthcoming). The mortality response was most significant among children over the age of one and among adults in working ages, while infants and elderly seem to have been affected more by other factors than by economic fluctuations (Bengtsson and Ohlsson 1985; Oris, Derosas and Breschi 2004).

More recently, research on the aggregate level have been supplemented by studies on the micro level (e.g. Allen, Bengtsson and Dribe 2005; Bengtsson et al. 2004; Tsuya et al. 2010). These studies have shown clear differences in the demographic response by socioeconomic status and also by gender and household context. Not surprisingly, but nonetheless very important, people with less resources were hit harder by economic fluctuations than people who were better off in these terms; individuals or families without access to land or groups living on the margin in other respects were more vulnerable than the landed groups. This was due to the former being dependent on working for others and thereby lacking their own production of food as well as being exposed to variations in labor demand.

In most of the research in this field grain price variations have been interpreted as variations in grain production. This is perhaps to make a virtue of necessity, because reliable output series are rare for preindustrial agriculture. The problem, however, is that grain prices, in reality, entail different information than local harvest outcomes. 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. Accordingly, they were not locally determined, but highly correlated throughout Early Modern northwestern Europe (Persson 1999). Hence, most people lived in local agricultural economies that were more or less open to trade and to the influence of markets. The dominant part of the budget for families in preindustrial society was directed towards buying food. This meant that the price of food was of utmost importance for survival and, thus, that changes in food prices affected short-term economic conditions in a significant way. At the same time, in an integrated market prices did not vary to a full extent with the local harvests; fluctuations in harvests across a broader region existed due to similar climatic shocks but also local conditions mattered.

If prices to a large extent were determined exogenously, local production data provides valuable additional information on the well-being of the people in the local communities. The reason is twofold. First, local harvest conditions tended to affect the demand for labor and accordingly the income of the laborers in the community. A bad harvest led to less work in harvesting and in work after harvest, for example in threshing (Abel 1980; Utterström 1957, p. 240; see Dribe 2000, Ch. 7 for a more detailed discussion). While exogenous prices take account of the fact that people spending a higher share of their income on food spend less on products from other sectors, they cannot tell us anything about the local demand for agricultural labor (Jütte 1994, p. 31).

Second, even if prices were set exogenously, and thereby markets to some extent were integrated, this does not necessarily mean that markets were fully integrated and worked perfectly. There may have been institutional obstacles as well. One example is producers of food in a locality regularly selling their grain to consumers outside the community through pre-arranged purchases by merchants, industrial facilities, or the state (Thompson 1971; Fridlizius 1981; Chaudhuri 1984). In years of bad harvests the effect of this would be severe regardless of the price level. Grain being transported out of an area in need for food has been observed all over preindustrial and early industrial Europe (e.g. Tilly 1971; Thompson 1971, p. 98; Gailus 1994), and has by some authors been connected to the rise of moral claims from the local population (Thompson 1971). Most of this effect would be due to prices being higher outside the area, or rather, people outside of the area being able to pay more for food than people living inside the area. However, there is another factor affecting this as well. In regions normally producing a surplus, markets are adapted and organized for exports not for imports or distribution within the region. Even in years of bad harvests, this system may be hard to change due to vested interests and institutional rigidities (Chaudhuri 1984, p. 136); trade networks, transportation systems and key actors, including the state, are all designed to deal with exports from local producers via the towns to the outside area. This means that in a region accustomed to exports, fulfilling needs for the local inhabitants during harvest failures may have been hard.

Moreover, it also means that if institutional barriers and trade organization prevented food from being transported to non-subsistence areas within the region prices might underestimate the true demand in the locality. When a harvest failure struck a local community which in normal years was barely producing enough to cover subsistence, food would become scarce, or even non-existent, as a commercial good. The inhabitants had to turn outside the community to buy food, either to surplus producing areas or to towns. This meant that they had not only to face the prices in towns but also to include transport costs to acquire the food. For some people, mainly those with the largest needs, i.e. the landless workers, this cost could have been significant (Utterström 1957, p. 214). Using exogenously set prices in towns, when no prices existed in the locality due to no food being available there, would underestimate the total cost for the inhabitants in these localities.

Taken together, prices on food serve as good indicators of economic conditions at wider markets but using production as an alternative indicator makes it possible to expand the knowledge on the effects of economic hardship on the population in local communities. Through this we can analyze differences and similarities of the impact of grain prices and local harvests on the wellbeing of the villagers. Important in this respect is if responses found and their magnitude varied between villages with different local economies, between villages with a one-sided grain production strategy vis-à-vis villages with a more diversified economy, and between villages with an almost constant surplus production and villages where production in normal years were on subsistence level.

Farming regions and the impact of harvests and prices on mortality

The concept of a farming region means a territory in which the conditions of soil, topography and climate have formed farm practices and a rural economy that can be contrasted to its neighboring territories (Overton 1996, p. 47). Typical farming regions in England were arable, pastoral, and intermediate types. For Sweden, a similar classification included plain lands, forest lands and brushwood or intermediate lands (Campbell 1928), which reflected the prevalence of forests in large areas into modern times, in contrast with the situation in England. In the plain lands the three-course rotation system was predominant (in Sweden until the 1810s); typically a season of winter rye was followed by barley, and then a season of fallow. In the forest lands, where the fields were smaller and the supply of manure and organic material abundant, there were typically no fallows but the soil was cropped continuously (Dahl 1942, p. 137; Myrdal 2011, pp. 84–85). Ester Boserup stated that harvest failures are frequent under rain-fed and mono-cropping short-fallow cultivations. The tendency to concentrate on cereals makes things worse, because if climate conditions in any year are unfavorable all the crops are likely to fail (Boserup 1965, pp. 85, 39). While the plain lands economy in preindustrial Sweden was dominated by grain production, the economies of the forest and brushwood areas were more diversified. The households worked in a diverse range of activities rather than specializing in a single profit-maximizing business in order to diversify some of the income risk. This measure reduced average output, and thus the level of living standards, but also reduced the variability of income (Bardhan and Udry 1999, p. 106). How could these patterns have affected the mortality response to economic hardship?

Earlier studies have shown that rural mortality was affected by economic fluctuations contemporaneously as well as with a delay (Lee 1981; Galloway 1988). The peasants in the forest lands were self-sufficient in a more universal way than those in the plain lands, and in normal years they did not have to buy any grain from outside the local community (Hansen 1952, pp. 150–151, 161, 193). But the forest land was certainly closer to the subsistence level in terms of grain supply, which meant that they were dependent on buying food from other areas in times of bad harvests.

In the plain lands, the pattern of one-sided grain production led to huge differences in occupation between summer and winter season. This even encouraged a contemporary discussion on stereotyped human traits, in which the indifferent and lazy plain-lander was contrasted with the industrious and lively forest dweller (Utterström 1957, pp. 244–249). In the plains, the labor demand was especially low during the winter after a bad grain harvest. A long and cold winter would then worsen the situation. The late winter and early spring was the most critical period for those who were dependent on income from temporary employment (Utterström 1957, p. 240).

Forest villages had an economy all of their own. They experienced a kind of inverted seasonality of labor demand with a good deal of winter employment (Samuel 1975, p. 7; Utterström 1957, p. 234). But the labor demand was not only more evenly distributed over the year, it was also less sensitive to fluctuations in grain harvests, since annual change in labor demand above all was determined by the grain harvests (Utterström 1957, p. 240). Thus, while the dependency on the market for buying food was as large as in any other area, the local economy was not as dependent on grain production as was the case in the plain areas.

Our study area is the region of Scania (*Skåne*), the southernmost province of Sweden, which contains a variation in some of the most common types of North European agricultural settings with respect to socio-economic and topographic conditions as well as in land management. Two hundred years ago this region 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 peasant farmers. The region contained plain land areas as well as forest areas and intermediate (brushwood) areas. About half of the land was owned by the nobility and the other half was owned either by the Crown or by owner-occupiers (freeholders). Thus, Scania can be said to have contained all sorts of different peasant ecotypes with a mix of manorial tenants, freeholders, and crown tenants on the plains as well as in more wooded areas.

Map here

The preceding discussion implies that the mortality response to local grain harvests should have been more prevalent in the plain areas than in the forests due to the greater dependency on grain production and a strong impact on labor demand from the harvest outcome in these areas. The more diversified economy in the forest and brushwood areas should have lowered the dependency of labor demand on the harvest outcome, which in turn should have reduced the vulnerability to harvest failures in these areas.

Grain prices, on the other hand, can be expected to have affected people more similarly across the different farming regions, because they reflected actual costs of buying grain on the market, or the amount of grain received as payments in kind, because such payments were calculated on the basis of the same prices.

To sum up we expect people in preindustrial rural society to have been affected not only by fluctuations in market prices of food, which is a well-established fact, but also by variations in the local output of grain. Through the effects on the demand for labor, and thus the earnings of landless and semi-landless laborers, years of bad harvests led to economic hardship not only for the producers of grain but for most of the local community. Due to the high vulnerability to economic hardship in the rural economy we expect mortality to have increased in years following bad harvests. We expect mortality in ages above one to have been more severely affected than infant mortality. Moreover, we expect the mortality response to local output conditions to have varied with the economic structure of the community. In plain areas where the dependency on grain production was very high, the effects of bad harvests should have been greater than in areas with a more diversified economy, such as the forest area, even though the latter might have experienced lower average living standards. Finally, we expect the vulnerability to local harvest outcome to have declined over time as a result of the agricultural transformation, which increased the efficiency and productivity of the agricultural economy.

Data and methods

We look at the mortality response at parish level in the period 1749–1859. In total we have 25,270 observations for 274 geographical units consisting of a single parish or a pair of parishes (*pastorat*). The data comes from the Tabular Commission, a predecessor to Statistics Sweden, which started to gather nation-wide data in 1749 (Sköld 2001). Vital events were recorded annually, while the populations at risk (divided by age, sex, etc) were usually recorded every three to five years. We have merged parishes into larger geographical units to construct coherent units over time in order to link annual vital events from the Mortality tables to the triennial or quinquennial Population tables, containing the population in the parishes divided by age and sex. In this process over 400 units have been reduced to 274.

The mortality response is analyzed separately for infants, children (1–14 years) and adults (15–84 years). We also disaggregated the analysis of adult mortality into smaller age groups, but as this did not affect the results, adults 15–84 were treated as one group in the analysis. In total we study 564,890 deaths and this means that there is an average of about 6 infant deaths, 4 child deaths, and 12 adult deaths across all observations (see Table 1). Underlying populations at risk average from about 28 for infants to 628 for adults (see Table 1).

Table 1 here

Economic conditions are measured by two different indicators: rye prices and grain output. Rye was the dominating bread grain in this period. The price data comes from the Market Price Scales and was published by Lennart Jörberg (1972) in his price history of Sweden. 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 (Jörberg 1972, vol. 1, pp. 8–18). Despite the administrative character of the prices, they closely reflected the real market prices, and hence they are an invaluable source for Swedish price history (Jörberg 1972, vol. 1, Chapter 3). The price scales were set in the fall each year after the harvest. There was no immediate relationship between the local harvest outcome and market prices as they reflected harvests in other parts of the economy as well as last year's harvest to the extent that these factors affected the supply of food. Hence, we interpret the grain price as an overall indicator of economic conditions, rather than a simple reflection of the current local harvest. In years of high grain prices we expect large parts of the population to have suffered economic stress, with a clear impact on mortality. 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. The developments of the prices in the two counties were highly similar in terms of both trends and fluctuations.

The grain 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 for each farm, 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 output series were estimated from these flexible tithe payments in 32 parishes with a total of about 2,000 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 annual mean values were calculated.[1] Output is estimated as total production (in hectoliter) per average farm in the sample, using the measurement of farm size in 1770 in the poll-tax registers (*mantal*). The reliability of the output estimates is indicated by their congruence with contemporary qualitative harvest reports, their correlations with each other, and their negative correlations with regional grain prices.[2]

Separate production series for the three farming regions – plain, brushwood and forest – has been constructed with 8, 16 and 8 parishes respectively. The series are displayed in Figure 1 but due to lack of sources it was not possible to construct a plain land series beyond the year 1849. For the first five years (1749–1753) the annual harvests in the plains, brushwood and forests were 70, 41 and 35 hectoliters per average farm, respectively. A hundred years later the averages for the same farms were 304, 95 and 120, which gives a clue about the strength of the agrarian revolution in Sweden. The absolute levels also indicate that farming in the plains was heavily reliant on grains while the other to farming regions had a more diverged economy.[3]

[1] For further information on the methods of constructing the output estimates in the HDSA, see Olsson and Svensson 2010 and 2011.

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

[3] After trend elimination the correlation coefficient plains–brushwood was 0.80 while the forests correlated 0.73 (plains) and 0.75 (brushwood).

Figure 1 here

To measure the short-term fluctuations we have 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 2 and 3. To look more specifically at the impact of economic crises on mortality we use residuals lower than –0.12 for output (which roughly corresponds to a 13 percent lower output than the trend level) and higher than 0.2 for prices (corresponding to 22 percent higher rye prices than normal) to identify crisis years. In terms of grain production there were 23 such crisis years, while in terms of rye prices there were 14 crisis years. The higher number of crisis years in terms of production is due to the lower level of aggregation. Not all bad years were shared between all farming regions, while the short term price variations were very similar between the two counties because the markets were highly integrated. In fact, aggregating production to the Scania level there were 14 crisis years also in terms of grain output, although not the same years as for prices. Only 4 of the 14 crisis years coincided and in only one year did a high price year come after a low output year. This supports the idea of prices being exogenously determined, thereby reflecting conditions on much wider markets than the province of Scania. The overall correlation between the output and price series was also quite modest. Between the output series for the plains and the price in Malmöhus county the correlation coefficient was –0.49, and the corresponding figures for the brushwood area was –0.53 and for the forest –0.44. For an aggregated all-Scania series (not used in the estimations) the correlation with the price series was –0.53.

Figures 2–3 here

We analyze the mortality response to fluctuations in output and prices by estimating a series of geographical unit fixed effects regression models where the dependent variables are the age-specific mortality rates for the three age groups (0, 1–14, 15–84). Mortality rates were calculated as the number of events divided by the population at risk. The fixed effects capture all unobserved factors at the geographical unit level, such as differences in social structure, production structure, geographical conditions, etc. Results are reported as elasticities, which indicate the percent change in the demographic rate of a one percent change in grain output. We control for period by including a set of 10-year period categorical variables. We use output data specific to three farming regions: plain, brushwood and forest. Each geographic unit has been defined as belonging to one of the three farming regions and output data for each region is used in the estimates. These estimates give a picture of the mortality response to the local output situation. We also look at separate models for each farming unit to see if patterns are different between them. In the models analyzing the response to price fluctuations we use prices at the county level.

Results

The results are reported in Tables 2–5. First we look at the linear mortality responses to short-term variations in grain output and grain prices, and then we turn to crisis responses as measured by low output and high grain prices.

Table 2 shows the estimates for an assumed linear mortality response to variations in grain output measured by the deviations from a logged HP-trend. Looking at the entire period 1749–1859 there appears to have been a clear mortality response to output fluctuations in all age groups. For infants a 10-percent decline in output increased mortality by 1.1 percent in the same year and by 1.8 percent in the year after. For child mortality and adult mortality the effect was about 4 percent in the year following the output change, but there was no significant immediate response. Thus, the mortality response was stronger for children and adults and stronger the year after the output change than in the same year. These results are clearly in line with previous research using grain prices at different levels of aggregation. What is perhaps a bit different here is the response also for infants, even though it is quite modest.

Table 2 here

Breaking it up into two periods (1749–1799 and 1800–1859) reveals quite dramatic changes over time in the relationship between harvest fluctuations and mortality. During the eighteenth century the lagged mortality response was much stronger than during the nineteenth century. It is interesting to note that an immediate response developed in the nineteenth century at the same time as the lagged response diminished. For children and adults in the eighteenth century a 10-percent lower output meant an 8 percent increase in mortality, which is a sizeable magnitude. In the nineteenth century immediate response to a 10-percent change was only about 1 percent. The pattern for infant mortality was highly similar. The fact that the mortality response weakened in the nineteenth century appears consistent with the changes taking place in the rural economy with increasing levels of both production and productivity (Schön 2000; Martinius 1982; Gadd 1983, 2011; Svensson 2006; Olsson and Svensson 2010, Utterström 1957) as well as an ongoing market integration (Persson 1999). It also appears in line with indications of a general intensification of labor in this period, reducing the length of the slack season (Dribe and Van de Putte forthcoming). The higher and seasonally more even demand for labor meant that employment opportunities probably got less dependent on the harvest outcome, which in turn also affected the demographic vulnerability to the local harvest outcome.

The pattern was quite different in different farming regions as indicated in Table 2. The strongest response was in the plain region. Here a 10-percent lower output was associated with an increase in infant mortality of about 3.5 percent in the year following the decline and the corresponding effects for child mortality and adult mortality was 6.5 percent and 7.0 percent respectively. The immediate response was lower and often not statistically significant. As a comparison, the effects of a similar output change in the brushwood district was about 2 percent for child mortality and adult mortality, while there was no response at all for infants in this area. Similar to the plains there was no response in the same year as the output change, but only in the year after. In the forest region the mortality response was more similar in the current year and with a lag; about 3–4 percent for children and adults and a little bit less (about 2 percent) for infants. This indicates an immediate sensitivity to fluctuations in output in the farming region were the production of grain was closest to the subsistence level.

Table 3 displays the estimation results using rye prices as measures of economic fluctuations. The main difference to the output estimates is that prices reflect conditions in larger areas while the production data reflects the local output conditions. First it is clear that mortality was highly responsive to fluctuations in grain prices, which has been shown in many studies before, including one using the same data as we use here (Dribe, Olsson and Svensson forthcoming). The response was stronger for children and adults than for infants, and the lagged response was also stronger than the immediate response for children and adults, but not for infants. Thus there was a clear difference between the mortality responses to local output conditions and to market prices in that the immediate response was only visible for market conditions (prices).

Table 3 here

Turning to the pattern by period the lagged mortality response got a bit stronger over time for children and adults, while the immediate response diminished. For infants, both the immediate and the lagged response got weaker over time, leaving only a very weak immediate response. This is in line with previous research using micro level data, indicating a stronger mortality response to grain prices among landless laborers during the agricultural transformation (Bengtsson and Dribe 2005). When looking at the results for different farming regions separately it is interesting to note that the responses were highly similar across all regions, which is in sharp contrast to the pattern for the response to local harvest variations. While we found substantial differences in the response to local output conditions in different farming regions, the price response was very similar. Again this supports the connection between the local output situation and the demand for labor. While vulnerability to food prices was similar in all contexts, the relationship between the harvest outcome and employment opportunities was strongest in areas dominated by grain production, and it was also in these areas that mortality was most sensitive to the local harvest outcome.

Thus far we have only been looking at mortality responses to economic variations assuming a linear response. In reality, however, we expect mortality to have been affected mainly by larger negative deviations in output or positive deviations in prices, what would be considered an economic crisis. Table 4 shows estimates of the mortality responses to low output, defined as an output level about 13 percent below normal (a deviation of more than 0.12 below the trend in log output). The estimates in the table indicate the percentage effect of a one percent change in output. A one unit change in a dummy variable amounts to 100 percent which implies that the estimates in the table should be multiplied by 100 to get the percentage response of low output compared to normal/high output levels.

Table 4 here

Looking first at the whole period, crisis years involved a 13–14 percent increase in child mortality and adult mortality in the year following the crisis, while there was no immediate response of an output crisis. The infant mortality response was much smaller, about 5 percent. In the eighteenth century a crisis year implied an increase of child and adult mortality by about 30 percent in the year following the crisis. For infants the lagged response was 9 percent. This clearly shows the high degree of vulnerability of rural people to local grain production in the period preceding the agricultural revolution. It affected children and adults most severely but also infants were clearly harmed by adverse economic conditions. In the nineteenth century the crisis response had completely disappeared. This seems to suggest that the economy worked much better in the nineteenth century in transferring grain to needy areas which lowered the mortality response considerably. As already mentioned, it also points to a seasonally more even demand for labor, which became less dependent on the most recent harvest, and more dependent on long term investments in land and buildings. Finally, these results also imply that the immediate response which developed in the nineteenth century, according to the linear estimates in Table 2, cannot be explained by an immediate crisis response but was instead caused by lower mortality in comparatively good years (detailed results not shown).

Turning to the pattern by farming regions marked differences are shown in table 4. There was no effect whatsoever in the year of the crisis in any of the regions, indicating that there were reserves available to cover the needs of the population in times of crisis. However, in the year following an output crisis, when we expect the supply of food to have been at its lowest in the spring, mortality for children and adults increased by about 25 percent in plain areas, and for infants by 8 percent. In the brushwood and forest areas the response was much lower, and sometimes not even statistically significant. A year of output crisis meant an increase in adult and child mortality of only about 6 percent in the year after. This result has at least two important implications. First, it shows that much of the immediate response in the forest area that we found in table 2 was not a result of a high response in years of crisis but was caused by lower mortality in times of plenty (results not shown). Second, the low mortality response in the more marginal areas (forest and brushwood) point to a lower dependency on grain due to a more diversified economy. In the plains, on the other hand, where the average standard of living no doubt was higher, the dependency on grain, and thus the level of vulnerability was also higher. To a large extent this effect was probably related to a lower demand for labor, and thus lower earnings of large segments of the population following unemployment, in the areas with the greatest dominance of grain production.

Finally, looking at the mortality response to high prices the pattern across farming regions was again much more similar than for output (table 5). A year of high grain prices led to an increase in mortality the following year by 11–19 percent for children and adults across the different farming regions. For infants the response was about 10 percent in plain and brushwood areas but insignificant in the forest area. The only notable distinction between the areas is a significant immediate response in the forest area of about 10 percent for all age groups. Looking at all regions together the pattern over time did not change much, as was the case when we looked at the continuous response in table 3. Thus, when looking at the mortality response to price fluctuations, the degree of vulnerability does not seem to have changed that much during the agricultural revolution, but the response to output crisis virtually disappeared in the nineteenth century. In other words, while employment opportunities got less dependent on the harvest outcome over time, most profoundly in the grain dependent plain areas, mortality also got less sensitive to local harvest fluctuations in general, and to harvest failures in particular. Despite the greater robustness of the economy, people were as vulnerable to food price variations as before, and it was not until later in the nineteenth century that the demographic vulnerability to these kinds of economic fluctuations vanished (see Bengtsson and Dribe 2005).

Table 5 here

Conclusion

Our aim has been to deepen our knowledge about demographic vulnerability in the past by looking in more detail at the mortality response to local harvest fluctuations. Our findings indicate a clear mortality response to fluctuations in local grain production, which means that not only prices, as a measure of grain supply on wider markets, but also the local economic conditions affected mortality in preindustrial society. Mortality in all ages responded, but it was strongest among children over age one and among adults. The response was also stronger before the agricultural revolution (in the eighteenth century) than during the transformation in the first half of the nineteenth century. The response to market prices was much more similar over time which seems to suggest that while the overall level of vulnerability remained unchanged, the functioning of the economy improved which made it possible to deal with local output crises without detrimental effects of mortality. When conditions were severe in larger areas, as indicated by high grain prices on wider markets, it was still very difficult to deal with economic stress as shown by the strong mortality response to grain price variations. In fact, this response to grain prices got a bit stronger over time, which points to increased vulnerability to market fluctuations.

The degree of vulnerability to harvest fluctuations was also much higher on the plains than in the brushwood and forest areas. This is explained by the greater dependency on grain in the plain areas, while people in the forests and brushwood areas had more diverse sources of income. Part of the response in the brushwood and forest areas came through lower mortality in good times, i.e. when production was high. On the other hand, there was a much weaker impact of the local harvest on the demand for labor than in the plain areas. The landless could find jobs the next winter, in spite of a bad harvest in the autumn, which is probably the reason why the impact of harvest crises was weaker or non-existent. This is in contrast to the plains, where there was a deep and profound crisis response after the harvests failures, indicating that the landless people simply ran out of job opportunities in the one-sided grain economy.

As a result of the changes in the agricultural transformation of the early nineteenth century, demand for labor increased following the massive investments in land, including enclosures, land reclamation, drainage, introduction of new crops and crop rotations, etc. This contributed to a seasonally more even demand for labor, which in turn reduced the dependency on the previous harvest for employment opportunities in rural communities dominated by grain production. In turn, this also reduced the vulnerability, as measured by the mortality response, to local harvests.

The mortality response to price fluctuations was on the other hand much more similar across the different areas. This shows that while a more diversified production structure insulated people in forest and brushwood areas from much of the uncertainties of grain production, they were as dependent on market prices as people on the plains. Similarly, the vulnerability to price variations remained unchanged in the first half of the nineteenth century, which shows that the more efficient and more productive economy that was emerging through the agricultural transformation was still unable to insulate the population from these kinds of uncertainties. Not until the second half of the nineteenth century, when these structural changes were completed, did the strong connection between the price of basic food stuffs and mortality diminish. Only then one of the most decisive characteristics of preindustrial, or Malthusian, society was gone.

Sources

Mortality figures:	Population censuses (Tabular commission), Demographic Data Base, Umeå University
Grain production series:	Historical Database of Scanian Agriculture, Dep. of Economic History, Lund University
Grain price series:	Jörberg, L. (1972). A history of prices in Sweden 1732–1914. Vol. 1. Lund: Gleerup.

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Table 1. Descriptive statistics.

	Infants	Children	Adults
Mean no of deaths	5.8	4.5	12.1
Mean population	28.5	306.0	627.5
Observations	25238	25265	25270
Geographical units	274	274	274

Source: The Tabular Commission, Mortality tables and Population tables. The Demographic Database, Umeå University.

Table 2. Fixed effects estimates of demographic response to short-term fluctuations in grain output (deviation from HP-trend).

	All regions						1749–1859					
	1749–1859		1749–1799		1800–1859		Plain		Brushwood		Forest	
	Est	p-value	Est	p-value	Est	p-value	Est	p-value	Est	p-value	Est	p-value
Infant mortality												
Grain output (t)	-0.111	0.008	-0.063	0.380	-0.194	0.000	-0.150	0.023	-0.059	0.337	-0.263	0.002
Grain output (t-1)	-0.178	0.000	-0.284	0.000	-0.037	0.517	-0.353	0.000	-0.039	0.554	-0.248	0.029
Observations	24277		10081		14196		8775		11599		3903	
Geographical units	274		239		273		102		126		46	
F	75.8	0.000	16.9	0.000	45.1	0.000	40.1	0.000	42.0	0.000	17.8	0.000
Child mortality												
Grain output (t)	-0.049	0.376	-0.028	0.777	-0.134	0.018	-0.086	0.385	0.042	0.569	-0.413	0.002
Grain output (t-1)	-0.392	0.000	-0.798	0.000	-0.009	0.872	-0.648	0.000	-0.221	0.008	-0.282	0.072
Observations	24304		10099		14205		8778		11611		3915	
Geographical units	274		239		273		102		126		46	
F	44.0	0.000	42.0	0.000	20.3	0.000	21.0	0.000	19.4	0.000	15.0	0.000
Adult mortality												
Grain output (t)	-0.050	0.390	-0.043	0.683	-0.117	0.046	-0.105	0.295	0.054	0.493	-0.392	0.004
Grain output (t-1)	-0.411	0.000	-0.817	0.000	-0.046	0.434	-0.706	0.000	-0.197	0.020	-0.362	0.027
Observations	24309		10099		14210		8783		11611		3915	
Geographical units	274		239		273		102		126		46	
F	39.4	0.000	43.5	0.000	20.8	0.000	15.2	0.000	24.2	0.000	13.3	0.000

Note: Models control for 10 year periods. Output variations are measured as deviation from HP trend. Elasticities give the percentage response in mortality of a one percent change in output.

Table 3. Fixed effects estimates of mortality response to grain price variations (deviations from HP-trend).

	All regions						1749–1859					
	1749–1859		1749–1799		1800–1859		Plain		Brushwood		Forest	
	Est	p-value	Est	p-value	Est	p-value	Est	p-value	Est	p-value	Est	p-value
Infant mortality												
Rye price (t)	0.117	0.000	0.135	0.003	0.087	0.033	0.072	0.185	0.098	0.036	0.321	0.000
Rye price (t-1)	0.025	0.371	0.035	0.403	0.008	0.798	0.093	0.038	0.002	0.952	-0.090	0.259
Observations	25238		10081		15157		9736		11599		3903	
Geographical units	274		239		273		102		126		46	
F	89.7	0.000	16.3	0.000	56.2	0.000	49.2	0.000	41.6	0.000	12.9	0.000
Child mortality												
Rye price (t)	0.114	0.000	0.175	0.003	0.057	0.171	0.088	0.073	0.086	0.083	0.276	0.000
Rye price (t-1)	0.276	0.000	0.218	0.000	0.328	0.000	0.339	0.000	0.223	0.000	0.267	0.009
Observations	25265		10099		15166		9739		11611		3915	
Geographical units	274		239		273		102		126		46	
F	48.9	0.000	33.3	0.000	32.7	0.000	26.5	0.000	19.4	0.000	13.9	0.000
Adult mortality												
Rye price (t)	0.114	0.001	0.184	0.003	0.052	0.217	0.103	0.044	0.079	0.124	0.254	0.001
Rye price (t-1)	0.278	0.000	0.203	0.001	0.345	0.000	0.348	0.000	0.217	0.000	0.267	0.003
Observations	25270		10099		15171		9744		11611		3915	
Geographical units	274		239		273		102		126		46	
F	46.3	0.000	36.7	0.000	32.6	0.000	19.7	0.000	25.1	0.000	12.9	0.000

Note: Models control for 10 year periods. Price variations are measured as deviation from HP trend.

Table 4. The mortality response to output crisis (low output). Fixed effects estimates.

	All regions						1749–1859					
	1749–1859		1749–1799		1800–1859		Plain		Brushwood		Forest	
	Est	p-value	Est	p-value	Est	p-value	Est	p-value	Est	p-value	Est	p-value
Infant mortality												
Low output (t)	0.001	0.915	-0.005	0.835	0.011	0.475	0.016	0.501	-0.007	0.721	-0.006	0.869
Low output (t-1)	0.051	0.001	0.092	0.000	0.009	0.572	0.076	0.004	0.035	0.109	0.052	0.223
Observations	24277		10081		14196		8775		11599		3903	
Geographical units	274		239		273		102		126		46	
F	74.9	0.000	16.3	0.000	42.7	0.000	41.2	0.000	40.9	0.000	12.5	0.000
Child mortality												
Low output (t)	-0.005	0.758	0.019	0.535	-0.027	0.130	-0.006	0.826	-0.008	0.752	-0.015	0.745
Low output (t-1)	0.133	0.000	0.296	0.000	-0.004	0.811	0.256	0.000	0.062	0.017	0.069	0.211
Observations	24304		10099		14205		8778		11611		3915	
Geographical units	274		239		273		102		126		46	
F	46.3	0.000	47.9	0.000	18.8	0.000	25.1	0.000	19.8	0.000	15.0	0.000
Adult mortality												
Low output (t)	-0.007	0.684	0.025	0.441	-0.033	0.076	0.005	0.860	-0.017	0.500	-0.030	0.523
Low output (t-1)	0.137	0.000	0.307	0.000	0.002	0.921	0.273	0.000	0.057	0.030	0.069	0.229
Observations	24309		10099		14210		8783		11611		3915	
Geographical units	274		239		273		102		126		46	
F	40.4	0.000	47.4	0.000	19.6	0.000	18.7	0.000	24.5	0.000	13.3	0.000

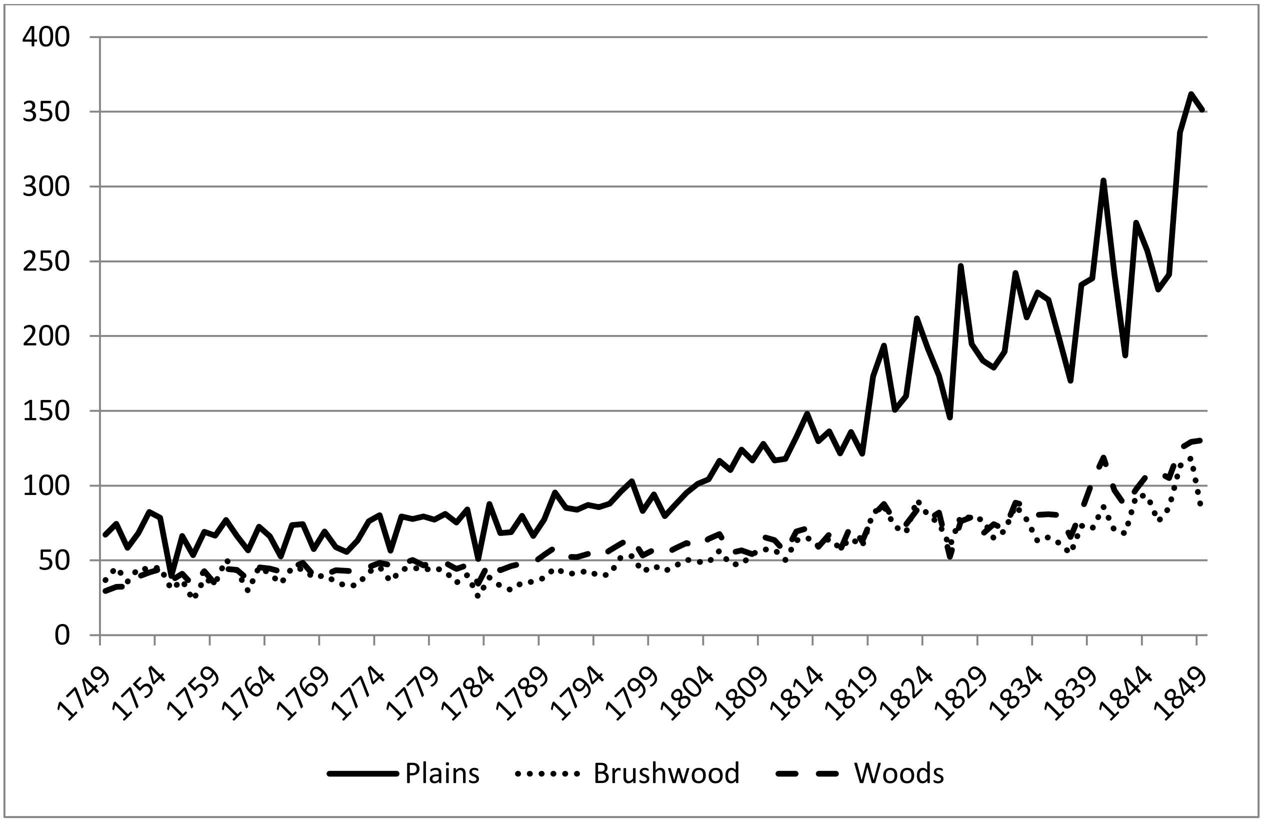
Note: Models control for 10 year periods. Low output compared to normal/high output. Low output is defined as 13 % below normal (log output deviations<-0.12).

Table 5. Fixed effects estimates of mortality response to grain price variations.

	All regions						1749–1859					
	1749–1859		1749–1799		1800–1859		Plain		Brushwood		Forest	
	Est	p-value	Est	p-value	Est	p-value	Est	p-value	Est	p-value	Est	p-value
Infant mortality												
High price (t)	0.048	0.001	-0.005	0.880	0.081	0.000	0.029	0.284	0.041	0.041	0.120	0.003
High price (t-1)	0.089	0.000	0.089	0.007	0.092	0.000	0.094	0.000	0.100	0.000	0.034	0.317
Observations	25238		10081		15157		9736		11599		3903	
Geographical units	274		239		273		102		126		46	
F	92.1	0.000	15.7	0.000	54.7	0.000	49.2	0.000	43.6	0.000	13.3	0.000
Child mortality												
High price (t)	0.036	0.029	-0.050	0.224	0.077	0.000	0.005	0.831	0.039	0.128	0.106	0.015
High price (t-1)	0.137	0.000	0.140	0.003	0.139	0.000	0.143	0.000	0.114	0.000	0.187	0.003
Observations	25265		10099		15166		9739		11611		3915	
Geographical units	274		239		273		102		126		46	
F	49.5	0.000	31.8	0.000	29.9	0.000	24.6	0.000	19.9	0.000	18.5	0.000
Adult mortality												
High price (t)	0.036	0.040	-0.045	0.318	0.073	0.000	0.010	0.710	0.039	0.144	0.093	0.061
High price (t-1)	0.141	0.000	0.125	0.005	0.152	0.000	0.155	0.000	0.118	0.000	0.167	0.001
Observations	25270		10099		15171		9744		11611		3915	
Geographical units	274		239		273		102		126		46	
F	49.1	0.000	35.0	0.000	33.3	0.000	19.3	0.000	26.5	0.000	18.8	0.000

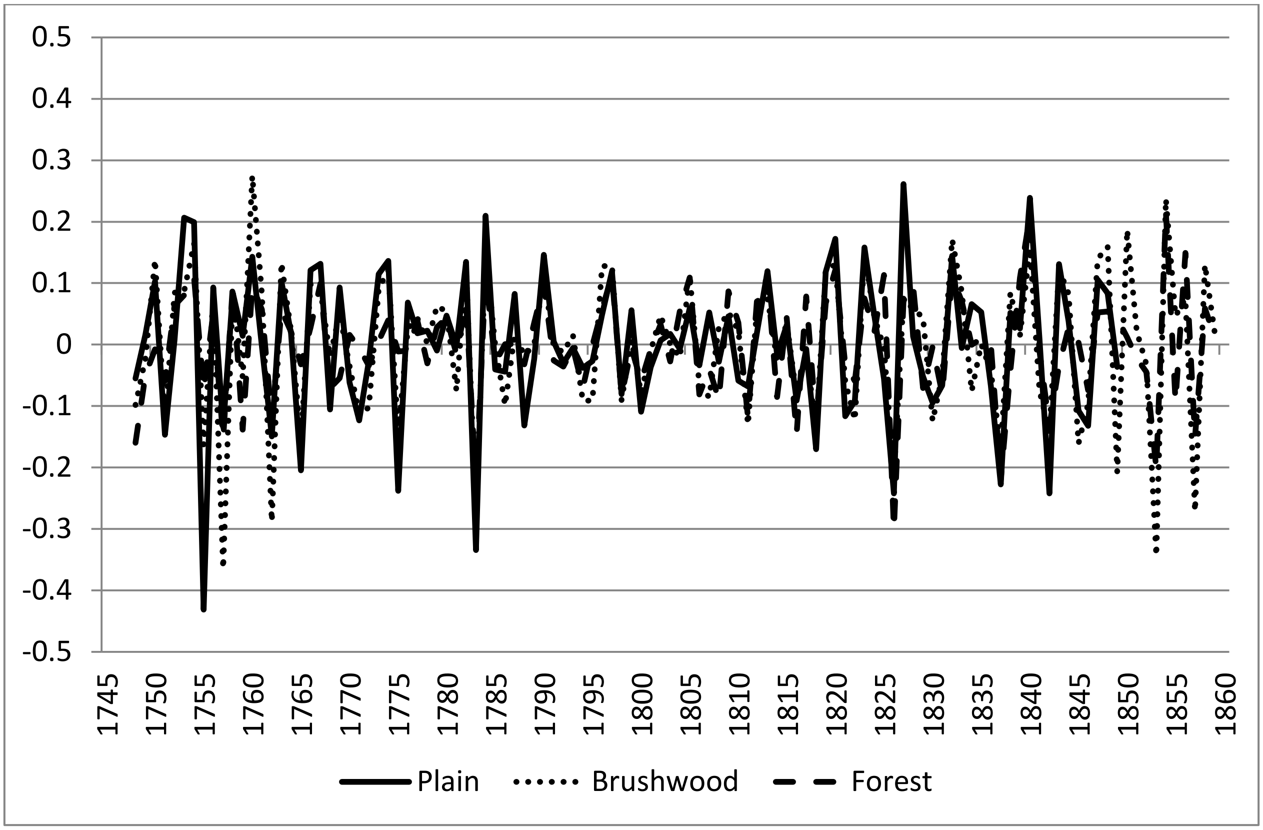
Note: Models control for 10 year periods. High prices compared to normal/low prices. High prices are defined as 22 % above normal (log price deviations>0.2).

Figure 1. Grain production by farming regions (hectolitres per farm)



Sources: Historical Database of Scanian Agriculture.

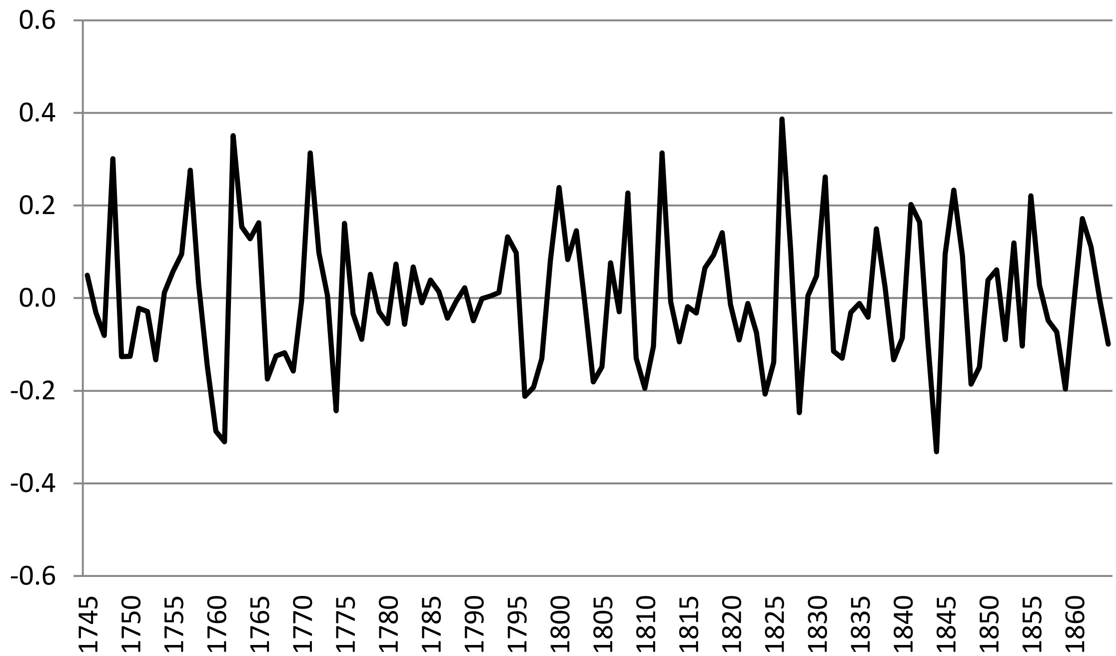
Figure 2. Grain output in different farming regions. Deviations from HP trend.



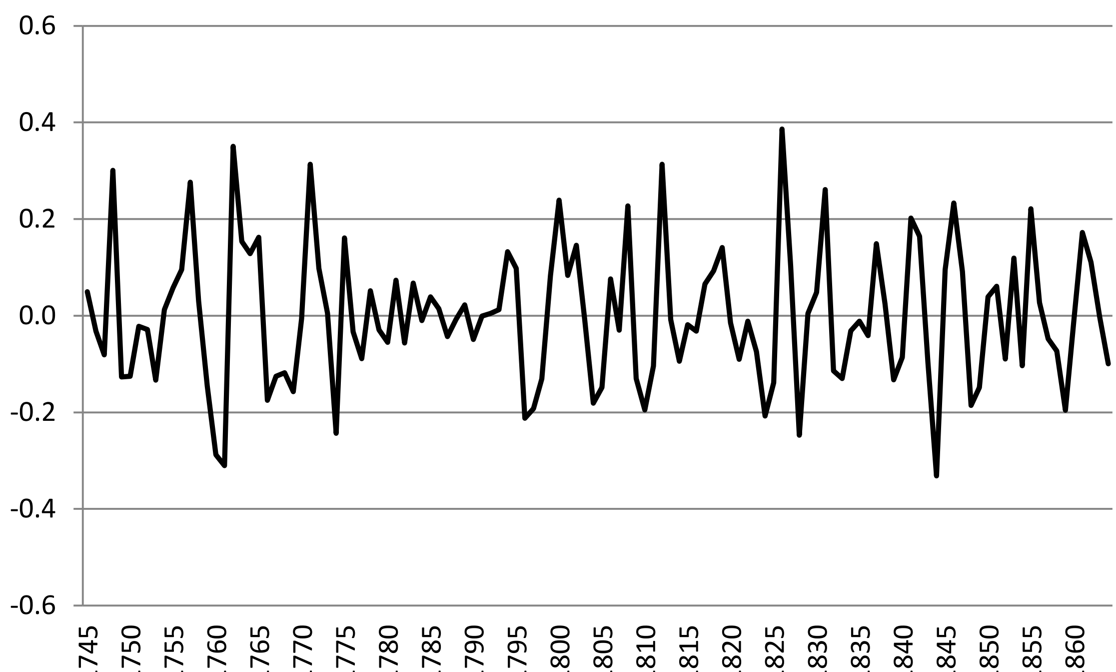
Source: See Figure 1.

Figure 3. Rye prices in the Scanian counties. Deviations from HP trend.

A. Kristianstad

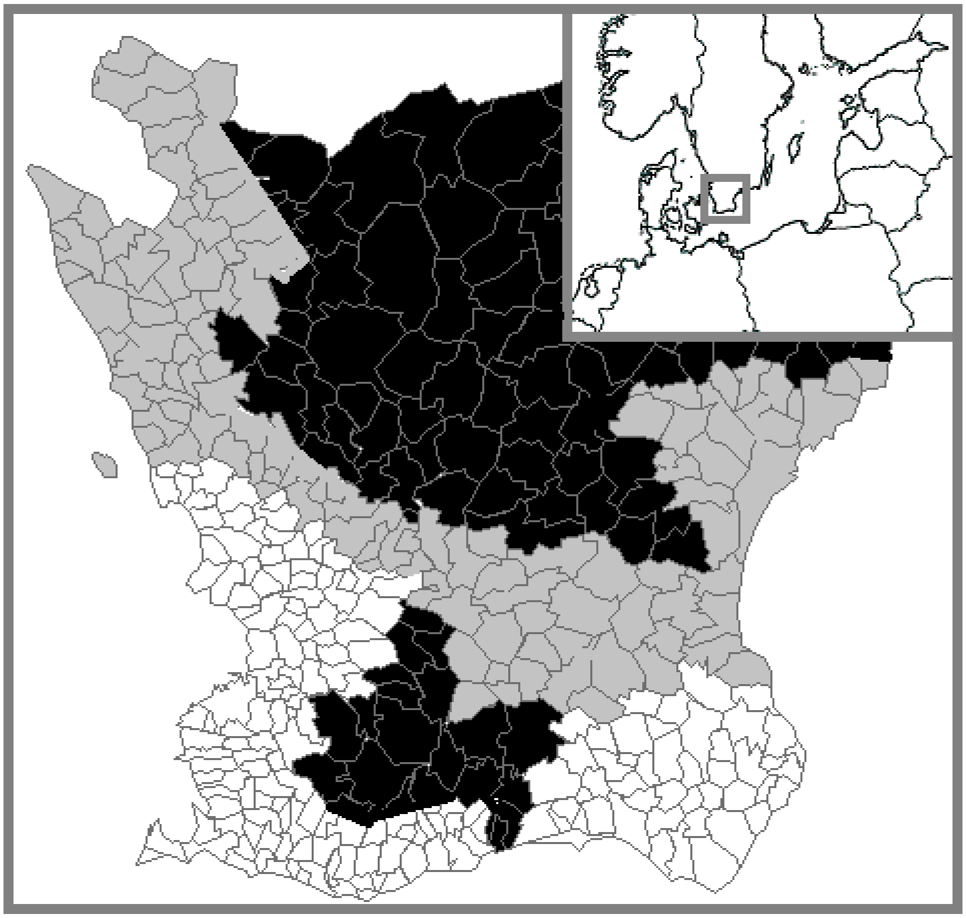


B. Malmöhus



Source: Jörberg 1972.

Map. Farming regions and parish boundaries in Scania



Note: Dark = forest lands; uncolored = plain lands; Grey = brushwood lands. Everything covered by the inset is forest.

Sources: Campbell 1928