The Impact of Short-term Economic Stress on Infant and Child Mortality in Southern Sweden, 1705-1812

TOMMY BENGTSSON, LUCIANA QUARANTA

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Centre for Economic Demography
Lund University School of Economics and Management
P.O. Box 7083
SE-220 07 Lund, Sweden

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The impact of short-term economic stress on infant and child mortality in southern Sweden, 1705-1812

Tommy Bengtsson, tommy.bengtsson@ekh.lu.se

Luciana Quaranta, luciana.quaranta@ekh.lu.se

Centre for Economic Demography and Department of Economic History, Lund University

Abstract

The ability to overcome short-term economic stress has been shown to be a good measure of the standard of living of populations in the past. From micro-level studies conducted across Europe and Asia we have learned that measures taken to smooth consumption, such as delaying births and marriages, and out-migration, were not sufficient to prevent all family members from dying in years with high food prices. Children and adult in working ages were found to be particularly sensitive to food prices. While the vulnerability in Asia depended on household position, in Europe it depended on access to land. Following these concepts and using family reconstitution data combined with information from poll-tax registers, this work examines economic inequality and social differences in child mortality to short-term economic stress in Scania from 1705 to 1812. We hereby extend further back in time the studies conducted previously in this region. Whereas no significant effects were observed in 1705-1765, in 1766-1812 children of all socioeconomic groups were vulnerable to increases in grain prices, showing higher mortality in years with high food prices, particularly from smallpox. We argue that this is unlikely an effects of changing nutritional status but rather to spread of disease caused by temporary job migration.

Introduction

Standard of living is a central concept in studies of the relationship between population and economy, past and present. Most concepts focus on income or total consumption, some on the particular goods that are consumed, such as food, housing, and clothing, others on health and education. In this paper, we measure the standard of living as the ability to overcome short-term economic stress using a concept introduced at the end of the 1980s (Bengtsson, 1989), then developed and applied to various contexts (Bengtsson, 2004; Jennings, Quaranta, & Bengtsson, Forthcoming; Lundh & Kurosu, 2014; Tsuya et al., 2010). By short-term economic stress we mean variations in income or food prices from one year to the next. If you can fulfil your long-term plans—to be in good health, to marry, to have children—in the face of acute changes in your environment, then you have a high standard of living. Sensitivity to short-term economic stress, conversely, reveals a lower standard of living.

We expect children and elderly to be vulnerable, since they depend on others for their consumption. We expect that food price variation will have stronger effects on smaller households than on larger households because of economics of scale and opportunities for risk sharing (Bengtsson, 2004). We also expect food price variation to have stronger effects on consumers than on producers. The most obvious defensive to changing food prices measure would be to store food, but storage was very costly in the past. A granary was not only costly to build, but also costly to sustain. It was similarly costly for farmers to store food from one year to the next, as much food was lost through wastage and nutritional degradation. Moreover, some foods could not be stored until the next harvest. Diversification of production may have allowed farmers, but not works, to create a stable income, but this was a measure that lowered average production. Similarly, other strategies to smooth effects of variations in harvests and food prices, including rent and tax relief, were mostly only available to those who owned or rented land. Landed households could also stabilize consumption by lowering labour costs in harsh years and thus smoothing annual farm costs. Since loans often required real security, they were typically only available to the landed. Families with no land therefore had fewer options, one was selling the few valuables they possessed, such as household equipment and clothes; else they depended on poor relief. They were accordingly more likely than the landed to be vulnerable to short-term economic stress and therefore more prone to taking risks, possibly even to commit burglary (Hellstenius, 1871).

The extent to which the group of net consumers was affected depends on whether they bought all their food from the market or if they had a small plot of land. We expect this group to be more affected if they were paid in money than in kind, since wages were more stable than food prices. The population category that should have been most disadvantaged by a price increase was those artisans who produced common consumer goods, since the majority of the population could not afford such products as food became more expensive. The most well off among the net producers should not in any way be affected by short-term changes in food prices since they should be able to save or at least borrow. The way it works depends, however, very much on how the tax or rent on land was paid. It therefore differs depending on tenure arrangements, in other words whether a farmer is freeholder, tenant, sharecropper, and the character of their contracts.

Using demographic data from family reconstitutions together with information on landholdings from poll-tax registers, this work analyses the impact of short-term changes in food prices on infant and child mortality in an area in southern Sweden during the period 1705-1812. We use food prices as an indicator of consumption costs. A large fraction, up to 80 percent of a workers' spending, was on food (Bengtsson, 2004). Estimates for Copenhagen in the 18th century (Thestrup, 1971, 258-9) show that the average calorie intake per head was as much as 14 percent lower in a bad harvest year than in a normal year. Thus in bad years, lower strata likely saw a calorie decline of some 10 to 20 percent, similar to developing countries of today (Dasgupta, 1993).

For the same area that we are analysing in this paper we have previously found that while all socioeconomic groups suffered from short-term economic stress in the latter part of the 18th century, only the landless were vulnerable in the first half of the 19th century and at the end no groups suffered from changing food prices to such an extent that mortality increased (Bengtsson & Dribe, 2005; Bengtsson, 2000; Bengtsson, 2004). We found that children and adults in working ages, but not infants and elderly, were particularly vulnerable. The reason why infant were not vulnerable to food price changes is likely due to breast feeding. Our conclusion was that due to the spread of epidemic diseases in the 18th century in years of high food prices, an effect of temporary job migration, mortality in all socioeconomic groups increased. In the beginning of the 19th century several of the highly virulent diseases almost disappeared. Foremost, this was the case for smallpox that became rare already before vaccinations started in 1801 (Bengtsson, 2015). Meanwhile, diseases where the outcome was dependent on the nutritional status of the host became relative more important, which is why we find a socioeconomic gradient in the response. And the response was also strong among individuals in working ages. This clearly shows that a large fraction of the rural population lived close to the margins in this period. With an increase in real wages, due to industrialization, urbanization, and overseas migration, the workers escaped the trap. The workers, in response to short-term economic stress in the first part of the 19th century not only wandered around to find jobs (Utterström, 1957) but also delayed pregnancies in harsh years (Bengtsson & Dribe, 2006).

In this paper we extend the analyses further back in time, back to the beginning of the 18th century, into a period not only with different epidemiological climate, but also with a different economic context. While about every second household had no access to land in 1800, it was about one out of five in 1700. While land became both fragmentized and agglomerated in the 19th century, it was far more stable and equal among the landed in the 18th century. The big change was the sale of crown land to the peasants and the increase in the landless population, a slow but consistent process. While the population increased throughout the period, production increased at the same rate until the 1780s, leaving per capita production stable. Thereafter, improvements in agriculture were rapid and production outstripped population growth. Production per capita increased by 0.5-0.6 percent per year from 1780 to 1860 (Olsson & Svensson, 2000).

Area, data and methods

This work is based on data for the parishes of Halmstad, Hög, Kävlinge, Kågeröd and Sireköpinge, for the period 1705 to 1812. The five parishes are located near one another in the southernmost area of Sweden in the region of Scania, and they present variations that were common in peasant societies with regards to topography, size, and socio-economic conditions. The entire area was open farmland, except for the northern part of Halmstad, which was more wooded.

The data used was extracted from the Scanian Economic Demographic Database (SEDD) (Bengtsson et al., 2014), which consists of records of births, marriages and deaths obtained from parish registers. The family reconstitutions from these records were linked to data about farm size and tenure obtained from the poll-tax records and land registers (*mantalslängder*)[1]. These registers were used annually for the collection of taxes and, among other things they provide information on the size of the landholding, therefore evidencing the productive potential of the farms (Dribe, 2000). The quality and representativeness of the poll-tax records

[1] The dataset for analysis was constructed using the program developed by Quaranta (2015).

improved starting from 1766, when a much greater proportion of landless families were included in the registers[2]. Separate models are therefore estimated for the periods 1705-1765 and 1766-1812.

The study focuses on individuals under the age of 15, which is the age when children generally left home (Dribe, 2000). Mortality is studied separately for infants and children, to account for possible differences in the effects that are linked to breastfeeding. The dataset for analysis is constructed using family reconstitution techniques and in addition, where available, poll-tax registers were also considered to define which individuals were under exposure, this way using a mixture of family and farm reconstitutions. Individuals are considered under exposure from the time of birth until death (if this occurred before age 15) or until age 15 if the individual's death or marriage or the death of a parent or a declaration of poll-tax was observed on a date that followed the individual's fifteenth birthday. Those who could not be studied until age 15 were studied until the last year of a poll-tax declaration for their family. All other children were excluded from the analytic samples (i.e. those for whom only the date of birth was observed). When interpreting the results it should be noted that given that poll-tax registers are not available for the majority of landless families before 1766, for the first time period the sample of landless children does not include most out-migrants.[3]

From the poll-tax registers information on the type of landholding and the *mantal*, which was a measure of the wealth of the farm that depended on the size and productivity of the land, was also used in order to distinguish net consumers from net producers. Children were classified into two socioeconomic groups: landed and landless. The landless group includes children belonging to families which had a *mantal* of less than 1/16 or who had no poll-tax declarations, while the landed group includes children of freeholders, Crown tenants, and tenants on noble land, each having a *mantal* of 1/16 or greater. Previous works have shown that up to the last decades of the 19th century, a *mantal* of 1/16 was sufficient for subsistence (Bengtsson & Dribe, 2006; Dribe, 2000). Nobles and highly educated families or those having a *mantal* greater than 3 were excluded from the analysis since they are very few[4].

[2] In the selected sample, in the period 1705-1765 25.7% of the families with poll-tax registers were landless, whereas in the period 1766-1812, the proportion increased to 58.5%.
[3] In future versions of this work, children born outside of the studied parishes and who in-migrated to the parishes will also be included in the sample. In addition, it will include a sensitivity analysis to test whether the results obtained are dependent on the way in which individuals under exposure were defined. More specifically, the same models will be estimated on a sample defined using pure family reconstitution rules.
[4] There were 14 families belonging to such groups.

The quality of the source material is good. The proportion of infant deaths taking place in the first month for the period 1705-1765 was 33.0% for the landless and 36.0% for the landed and for the period 1766-1812 40.4% for the landless and 35.2% for the landed. The proportion of male births was 52.3% for the landless and 51.6% for the landed for the period 1705-1765 and 50.9% for the landless and 50.6% for the landed for the period 1766-1812.

Data on rye prices is also employed. This cereal is considered because it was the most common grain in this part of the country (Bengtsson & Dribe, 1997). Each year the prices were reported shortly after the harvest in the fall. The price of year t can therefore affect mortality from October 1st of year t to September 30 of year t+1. Rye prices were detrended by taking the natural log of prices and then applying a Hodrick-Prescott (HP) filter (Hodrick and Prescott 1997) with a filtering factor of 6.25, which is the recommended value to remove the trend from yearly series (Ravn and Uhlig 2002). Figure 1 shows the natural logarithm of rye prices and the deviations from the trend.

Estimations are made using Cox proportional hazard models (Therneau & Grambsch, 2000). All models control for SES, sex, year of birth (continuous) and parish of birth. Tests based on Shoenfeld residuals are conducted after each Cox model in order to attest the validity of the proportional hazards (PH) assumption. The PH was violated for the SES and rye price variable in some of the models that considered infants aged 0-1. For this reason we only focus on infants aged 0-6 months. Among children aged 1-15 the PH assumption is never violated for the SES and rye price variables, although some violations are observed for parish and birth year. Since these variables are only considered as controls in the models, such violations are not problematic for the purposes of the current study.

Figure 2 shows the percentage of families in the selected sample who were landed, based on the specification described above. As can be seen from this figure the proportion decreased largely with time. It was discussed earlier that there were improvements in agriculture and in production during these periods (Olsson & Svensson, 2000). The increase in the proportion of landless families runs in parallel with an increase in production and in the labour intensity of the land.[5] Figure 3 shows the distribution of land ownership among families in the selected

[5] In future versions of this work Figure 2 will be made considering all families and not just those of the selected sample, in order to better describe the contextual setting of the area and period. Part of the variation currently observed in the figure could be related to fluctuations in fertility across time. Changes in data quality caused by the fact that poll-tax registers did not include all landless families before 1766 could also explain some of the variation observed in the figure. A sensitivity analysis will be conducted in future versions of this work in order to attest this.

sample at three different time points: 1705, 1766 and 1812. As can be seen from this figure, land was quite equally distributed among the landed throughout this period, the major difference being was whether you had access to land or not.

Yearly rates of infant and child mortality (ages 1-15) are shown in Figure 4. Both series show high year to year fluctuations and a slow rate of decline from around 1750. Out of the 13 peak years in the 18th century in this area, at least 10 are due to outbreaks of smallpox (Bengtsson & Lindström, 2003: Table 4).

Table 1 shows descriptive statistics, evidencing for the periods 1705-1765 and 1766-1812 and for the age groups 0-6 months and 1-15 years, the percentage of person years by each control variable included in the model. As can be seen from this table, the distributions across sex and parish are similar for the different age groups and time periods. Whereas for both age groups the proportion of landed children was higher than that of landless in 1705-1765, in 1766-1812 the proportion of landless exceeded slightly that of landed. Some of the differences in the proportion of individuals in the two SES groups between the two time periods could be related to the lower quality of the poll-tax registers for 1705-1765, as was evidenced in Figure 2. In future versions of this article a sensitivity analysis section will also be included evaluating, among other things, the dependence of the results on the inclusion of the group of individuals with unknown occupations (i.e. those with no poll-tax declaration recorded) among the landless group and also excluding the use of poll-tax registers to define exposure.

The final part of the study looks into the impact of short-term fluctuations in rye prices on cause-specific mortality, considering the classification defined by Bengtsson and Lindström (2000). Due to the large number of missing causes of deaths among infants (82% in 1705-1765 and 64% in 1766-1812), these estimations are only conducted for children aged 1-15. The distribution of deaths by cause among children is shown in Table 2. As can be seen from this table, 59% of deaths have an unknown cause during the period 1705-1765. Given this large proportion, this part of the study only focuses on the period 1766-1812. A competing risk framework is utilised, where the death from one specific cause prevents a death from other causes from occurring. Four different types of mortality events are studied: death from all airborne infectious diseases, death from smallpox, death from other airborne infectious diseases and death from non-airborne infectious diseases[6]. The *stcrreg* package in STATA is used, which performs a competing risk regression analysis according to the model introduced by Fine

[6] Only deaths where the cause is specified are considered in this outcome.

and Gray (1999). Separate estimations are run for each outcome variable (death cause) and death due to any other cause is considered as a competing risk in every model. Controls are introduced for year of birth, parish of birth and SES (landed and landless).

Results

Among infants aged 0-6 months, short-term fluctuations in food prices had no significant effects on mortality during the period 1705-1765, while during the period 1766-1812 they caused reductions in the risk of death for the landless (Table 3). A 10% increase in rye prices lead to a 4% reduction in mortality for such group and period (Table 5). Strong SES differences are observed in both time periods, with the landed experiencing 28 and 24% lower mortality, respectively, in 1705-1765 and 1766-1812.

Among children aged 1-15, short-term changes in rye prices affects mortality only during the period 1766-1812 (Table 4 - Model 5). A 10% increase in rye prices leads to an 8.7% increase in child mortality in such years (Table 5). No statistically significant socioeconomic differences are observed in these effects, although the impacts are slightly higher for the landless (Table 4 - Model 6). In relation to short-term economic stress both landed and landless children show increases in their likelihood of dying that are highly statistically significant (Table 4 – Model 7 and 8). A 10% increase in rye prices leads to a 9.2% increase in mortality among the landless and an 8.1% increase among the landed (Table 5). Also among children significant differences in the likelihood of dying are observed between the two groups during both time periods: the landed experience 32 and 21% lower risks of dying in 1705-1765 and 1766-1812 respectively.

Table 6 shows the results of models evaluating the impact of fluctuations in rye prices on cause-specific mortality for children 1-15 for the period 1766-1812. Due to small numbers, estimations are only made for children of all SES groups in the same model. A 10% increase in rye prices leads to a 9.1 % increase in the risk of dying from airborne infectious diseases. This result is slightly higher than the result obtained when focusing on overall mortality (Table 5). When dividing airborne infectious disease mortality into two groups, it becomes evident that short-term economic stress leads to increases in the risk of dying from smallpox but not from other airborne infectious diseases. A 10% increase in rye prices leads to a 15.8% increase in the risk of dying from smallpox. No statistically significant differences in these effects are observed for the two SES groups. The increase in mortality from non-airborne infectious diseases that follows a 10% increase in rye prices is also large (6.6%), although this effect was only marginally statistically significant. SES differences are observed in the likelihood of dying from causes other than airborne infectious diseases (Table 6 – Model 4), but not from airborne infectious diseases (Table 6 – Model 1).

Discussion and conclusions

This work has examined the impact of short-term economic stress, measured by fluctuations in grain prices, on mortality among children, in a population in southern Sweden during the period 1705-1812. The data used came from family reconstitutions of births, deaths and marriages together with information on landholdings from poll-tax registers. Due to differences in the quality of the poll-tax registers, the study was divided into two time periods, 1705-1765 and 1766-1812. Individuals under exposure were defined using family reconstitution techniques combined with farm reconstitutions. Information from poll-tax registers was in fact also used for such purpose; more specifically individuals for whom a poll-tax register was observed in a given year were considered as being present in the parish during that same year. Socioeconomic differences in the impact of short-term economic stress on mortality were evaluated, and for 1766-1812 the impact of price fluctuations was also assessed on cause-specific mortality.

A very similar social gradient in mortality was observed across all ages and periods, with landed children showing lower risks of dying than the landless. When it comes to the effect of short-term economic stress, as expected, the impacts on infant mortality were not strong. No significant effects were observed for such age groups in 1705-1765, while in 1766-1812 landless infants experienced lower mortality in years with high prices. A possible explanation for this effect could be selection caused by reductions in fertility following increases in food prices. Among children, aged 1-15, mortality was positively related to price increases in 1705-1765, although such result was not statistically significant, something which could be an artefact of the way in which individuals under exposure were defined during this period. In 1766-1812 strong and statistically significant effects were observed; landed as well as landless children were strongly affected by short-term economic stress during such years. The results obtained in this work are in line with those of previous studies for this area, which had found that all socioeconomic groups suffered from short-term economic stress in the latter part of the 18^{th} century (Bengtsson, 2000; Bengtsson, 2004).

The models that evaluated the impacts of short-term economic stress on cause-specific mortality for the period 1766-1812 showed that increases in prices resulted in greater mortality from smallpox among children of all socioeconomic groups. Similar models could not be estimated for the first time period due to a large proportion of deaths from unknown causes. Smallpox was a major non-nutritionally related disease among children during the time period considered in this work, which probably explains why no social differences in mortality were found during the second period. Immunity to smallpox is only incurred from previous contraction of the disease or from vaccination, but vaccination became available to this population only in the first decade of the nineteenth century. A link between short-term economic stress and mortality from smallpox has been found previously in this area (Bengtsson, 2000) as well as in an area in the middle of Sweden (Bengtsson, 1999). As has been argued previously, the similarity in the response to short-term economic stress of children from different socioeconomic groups could in part be related to a greater spread of diseases caused by temporary work migration in these years. Studies conducted in developing countries have shown a relationship between famines and smallpox mortality (Dawson, 1979). It has been argued that nutrition affected the mortality rate of individuals infected by smallpox and not the rate of morbidity, and that the higher rates of morbidity from this disease during years with famine resulted from greater migration flows, trade and crowding in areas with food (Ibid).

In future refinements of this work a sensitivity analysis will be conducted to measure the dependence of the results on the choices made concerning exposure and socioeconomic classification. More specifically, the current results will be compared to those estimated on a sample defined using pure family reconstitution rules without taking into consideration poll-tax registers to define which individuals were under exposure. Moreover, taking advantage of poll-tax registers, in future versions of this work children in-migrating to the parishes will be considered in addition to those born in the parishes. In order to try to capture possible links between migration during years of high prices and the spread of smallpox, estimations of migration flows will also be made by looking at the distribution of births as well as by using the poll-tax registers to observe the number of families moving into and out from the parishes.

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Figures and tables:

Figure 1: Rye prices and deviations from the trend

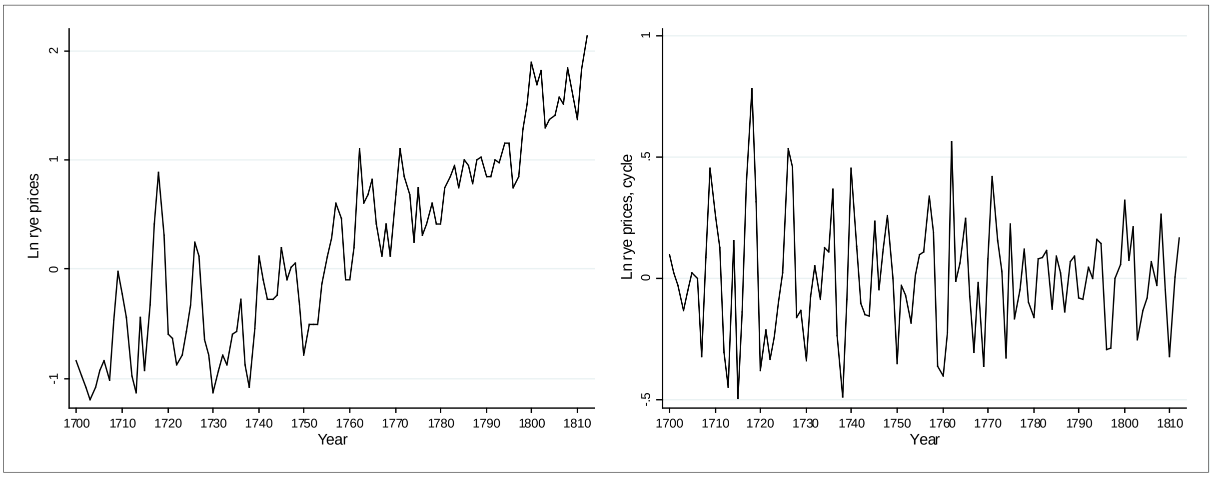
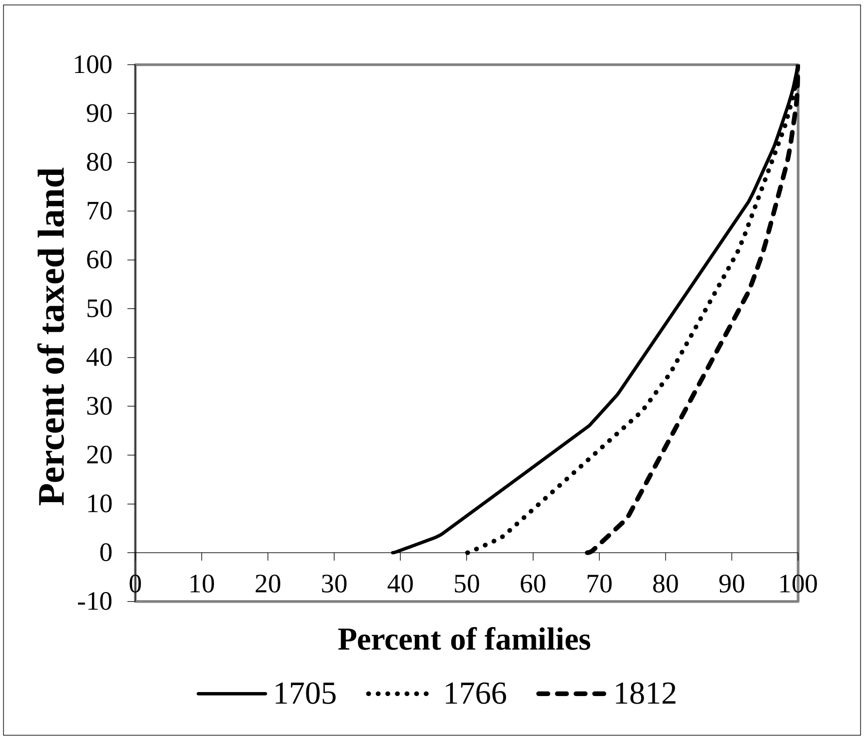


Figure 2: Percentage of landed families, Scania 1705-1812

Note: families in the selected sample (i.e. having any children below the age of 15). Landed families are those with a *mantal* of at least 1/16.

Figure 3: Use of taxed land in Scania



Note: families in the selected sample (i.e. having any children below the age of 15). Landed families are those with a *mantal* of at least 1/16.

Figure 4: Infant and child mortality rate, Scania 1705-1812

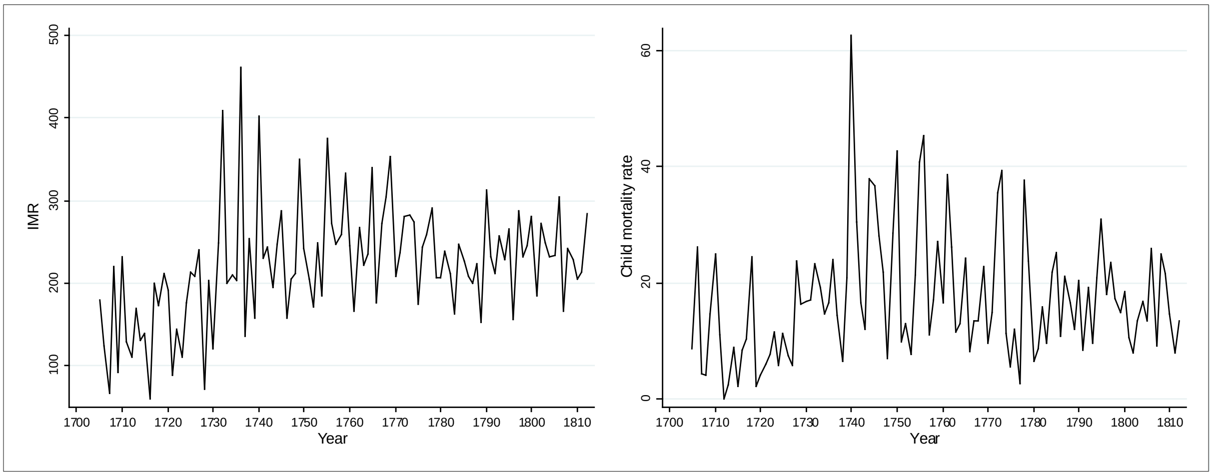


Table 1: Descriptive statistics. Percentage of person years by control variable, infants 0-6 months and children 1-15 years, Scania 1705-1812

	Infants		Children	
	1705-1765	1766-1812	1705-1765	1766-1812
SES				
Landless	37.6%	51.0%	39.0%	53.1%
Landed	62.4%	49.0%	61.0%	46.9%
Sex				
Female	48.4%	49.7%	48.3%	48.9%
Male	51.6%	50.3%	51.7%	51.1%
Parish				
Hög	9.7%	8.7%	10.0%	9.1%
Kävlinge	7.8%	9.5%	7.4%	8.5%
Halmstad	16.7%	16.3%	15.3%	17.6%
Sireköpinge	16.9%	19.5%	16.3%	17.9%
Kågeröd	48.9%	46.0%	51.0%	46.9%

Table 2: Number of percentage of deaths by cause, children 1-15, Scania 1705-1812

Cause of death	1705-1765	1766-1812
Airborne infectious diseases	186	378
	31.53%	*59.25%*
(of which smallpox)	(121)	(171)
	(20.51%)	*(26.80%)*
Food-borne and waterborne infectious diseases	14	42
	2.37%	*6.58%*
Other infectious diseases	2	11
	0.34%	*1.72%*
Cardiovascular diseases and diabetes	1	14
	0.17%	2.19%
Accidents, crimes, etc	9	15
	1.53%	*2.35%*
Cancer	4	11
	0.68%	*1.72%*
Other specified non-infectious diseases	28	163
	4.75%	*25.55%*
Not specified	346	4
	58.64%	*0.63%*
Total	590	638
	100%	*100%*

Table 3: Effect of short-term changes in rye prices on mortality among infants 0-6 months, Scania 1705-1812

	1705-1765				1766-1812			
	Model 1 All	Model 2 SES interaction	Model 3 Landless	Model 4 Landed	Model 5 All	Model 6 SES interaction	Model 7 Landless	Model 8 Landed
Ln rye cycle	1.14	1.29	1.29	1.02	0.84	0.65*	0.65*	1.20
	[0.88,1.48]	[0.88,1.89]	[0.88,1.88]	[0.71,1.46]	[0.59,1.21]	[0.41,1.05]	[0.41,1.04]	[0.69,2.11]
SES								
Landless	Ref.	Ref.			Ref.	Ref.		
Landed	0.72***	0.72***			0.76***	0.76***		
	[0.62,0.83]	[0.62,0.83]			[0.67,0.86]	[0.67,0.87]		
Landed* Ln rye cycle		0.80				1.84		
		[0.47,1.34]				[0.88,3.85]		
Birth year	1.01***	1.01***	1.01***	1.01***	1.00	1.00	1.00	0.99**
	[1.01,1.02]	[1.01,1.02]	[1.00,1.02]	[1.01,1.02]	[0.99,1.00]	[0.99,1.00]	[0.99,1.01]	[0.98,1.00]
Sex								
Female	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Male	1.05	1.05	0.99	1.10	1.12*	1.12*	1.10	1.14
	[0.91,1.21]	[0.91,1.21]	[0.81,1.22]	[0.90,1.34]	[0.98,1.27]	[0.98,1.27]	[0.93,1.30]	[0.94,1.39]
Parish								
Hög	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Kävlinge	1.41**	1.40**	1.20	1.57**	0.82	0.82	0.77	0.89
	[1.05,1.89]	[1.04,1.89]	[0.74,1.94]	[1.08,2.29]	[0.59,1.14]	[0.59,1.14]	[0.51,1.16]	[0.52,1.52]
Halmstad	0.80	0.80	0.95	0.69*	1.18	1.18	1.02	1.44*
	[0.60,1.07]	[0.60,1.06]	[0.62,1.46]	[0.47,1.01]	[0.90,1.55]	[0.90,1.55]	[0.71,1.45]	[0.95,2.17]
Sireköpinge	0.85	0.85	0.97	0.77	1.18	1.18	1.23	1.14
	[0.64,1.13]	[0.64,1.13]	[0.62,1.49]	[0.53,1.12]	[0.91,1.54]	[0.91,1.54]	[0.87,1.72]	[0.75,1.72]
Kågerod	0.84	0.84	0.84	0.85	1.02	1.02	0.87	1.27
	[0.66,1.07]	[0.66,1.06]	[0.57,1.22]	[0.62,1.16]	[0.80,1.30]	[0.80,1.30]	[0.64,1.19]	[0.87,1.86]
Individuals	4295	4295	1677	2631	4847	4847	2523	2336
Deaths	769	769	360	409	945	945	543	402
Risk time	1860.77	1860.77	700.42	1160.35	2065.04	2065.04	1053.05	1011.99

Note: Exponentiated coefficients; 95% confidence intervals in brackets, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Effect of short-term changes in rye prices on mortality among children 1-15 years, Scania 1705-1812

	1705-1765				1766-1812			
	Model 1 All	Model 2 SES interaction	Model 3 Landless	Model 4 Landed	Model 5 All	Model 6 SES interaction	Model 7 Landless	Model 8 Landed
Ln rye cycle	1.22	1.18	1.19	1.26	2.39***	2.50***	2.51***	2.26**
	[0.91,1.64]	[0.76,1.83]	[0.77,1.85]	[0.84,1.89]	[1.53,3.73]	[1.38,4.51]	[1.39,4.51]	[1.15,4.46]
SES								
Landless	Ref.	Ref.			Ref.	Ref.		
Landed	0.68***	0.68***			0.79***	0.79***		
	[0.58,0.80]	[0.57,0.80]			[0.67,0.92]	[0.67,0.93]		
Landed* Ln rye cycle		1.06				0.91		
		[0.58,1.92]				[0.37,2.22]		
Birth year	1.02***	1.02***	1.02***	1.01***	1.00	1.00	0.99	1.00
	[1.01,1.02]	[1.01,1.02]	[1.01,1.02]	[1.01,1.02]	[0.99,1.00]	[0.99,1.00]	[0.99,1.00]	[0.99,1.01]
Sex								
Female	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Male	1.03	1.03	1.02	1.02	0.89	0.89	0.97	0.80*
	[0.87,1.21]	[0.87,1.21]	[0.81,1.30]	[0.82,1.28]	[0.76,1.04]	[0.76,1.04]	[0.79,1.19]	[0.63,1.01]
Parish								
Hög	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Kävlinge	1.23	1.23	1.47	1.10	1.41*	1.41*	1.57*	1.30
	[0.86,1.76]	[0.86,1.76]	[0.84,2.59]	[0.69,1.76]	[0.99,2.01]	[0.99,2.01]	[0.95,2.59]	[0.78,2.17]
Halmstad	1.03	1.03	1.30	0.88	1.01	1.01	1.20	0.86
	[0.75,1.42]	[0.75,1.42]	[0.78,2.14]	[0.58,1.33]	[0.73,1.42]	[0.73,1.42]	[0.74,1.94]	[0.53,1.37]
Sireköpinge	1.28	1.28	1.43	1.20	1.26	1.26	1.60**	0.98
	[0.94,1.73]	[0.94,1.74]	[0.87,2.36]	[0.82,1.76]	[0.91,1.73]	[0.91,1.73]	[1.01,2.54]	[0.63,1.54]
Kågerod	0.75**	0.75**	0.95	0.63**	1.05	1.05	1.14	0.98
	[0.56,0.99]	[0.56,0.99]	[0.60,1.50]	[0.44,0.90]	[0.78,1.41]	[0.78,1.41]	[0.74,1.75]	[0.65,1.48]
Individuals	3775	3775	1859	2582	4373	4373	2817	2326
Deaths	590	590	273	317	638	638	359	279
Risk time	32656.25	32656.25	12750.32	19905.93	38539.97	38539.97	20475.92	18064.05

Note: Exponentiated coefficients; 95% confidence intervals in brackets, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Effect of 10% increase rye prices on mortality among infants 0-6 months and children 1-15 years, Scania 1689-1812

	Infants 0-6 months		Children 1-15 years	
	1705-1765	1766-1812	1705-1765	1766-1812
All	1.28	-1.64	1.92	8.67
Landless	2.45	-4.01	1.67	9.15
Landed	0.19	1.79	2.23	8.09

Note: the results are based on Table 2 and 3. All models control for year of birth, parish of birth and sex. The models for all individuals also control for SES.

Table 6: Effect of short-term changes in rye prices on cause-specific mortality among children 1-15 years, Scania 1766-1812

	Model 1 Airborne, all	Model 2 Airborne, smallpox	Model 3 Airborne, not smallpox	Model 4 Not airborne, cause specified	Model 5 Airborne, smallpox SES interaction
Ln rye cycle	2.49***	4.66***	1.35	1.96*	5.40***
	[1.35,4.59]	[2.15,10.09]	[0.55,3.34]	[0.94,4.06]	[1.72,16.96]
Landed	0.90	0.91	0.90	0.65***	0.92
	[0.73,1.11]	[0.67,1.24]	[0.68,1.20]	[0.50,0.84]	[0.67,1.26]
Landed * Ln rye cycle					0.74
					[0.16,3.40]
10% increase in rye prices	*9.09*	*15.79*	*2.93*	*6.61*	
Individuals	4373	4373	4373	4373	4373
Deaths from cause	378	171	207	256	171
Deaths from other causes	260	467	431	382	467

Note: The models control for parish of birth and sex. The sub-hazard ratios are obtained from competing risks survival models. These results are converted to show the percentage change in mortality in relation to a 10% increase in rye prices.