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Short-term economic stress and mortality differentials in rural Estonia, 1834–1884

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ABSTRACT

This study examines the influence of short-term economic stress on mortality in nineteenth-century rural Estonia. We utilised vital registration, 'soul revisions' and listings of migrants from 1834 to 1884 to focus on two parishes in the northern part of Livland (now southern Estonia). In this period, rural areas were transitioning from the old manorial system to a more market-oriented society, and we hypothesise that some groups were more vulnerable during this process. We investigate whether the type of local manor – state – or privately owned – was related with the level of mortality and moderated the association between mortality and grain price changes. Our second question concerns the importance of social status as a predictor of mortality rates. The results indicate that infant and child mortality rates were lower in the state estate, compared with privately owned manors, but child mortality in the state estate was more responsive to price changes. Socio-economic status appears to be a relevant predictor for child and adult mortality, as landless and semi-landless labourers experienced a higher level of mortality risk compared with farmers and skilled workers. Increases in grain prices, however, were mostly related to mortality risk of farmers.

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1. Introduction

For decades, researchers have debated whether a social gradient in mortality existed in pre-industrial societies and if so, when it emerged and widened. Changes in the economy shaped mortality levels from at least the mid-nineteenth century onwards (see Bengtsson, 2015 for a review). Researchers who assert that social inequality in mortality has passed through different historical phases often claim that this inequality increased during transitional phases when mortality declined and more affluent groups used their economic and human resources to secure health gains (Antonovsky, 1967; Bengtsson & Dribe, 2005; Edvinsson, 2004; Van Poppel, Jonker, & Mandemakers, 2005; Willführ & Störmer, 2015; Woods & Williams, 1995). Clouston and colleagues have posited that social inequalities in cause-specific mortality systematically change over time in relation to human intervention as human knowledge about and ability to control diseases evolves (Clouston, Rubin, Phelan, & Link, 2016). The mechanisms through which inequality in health are produced, reduced, and eradicated change over time. Researchers agree that mortality decline in nineteenth-century Europe was a multi-causal phenomenon, but differ over the contribution of specific factors to it. An influential, but much-contested theory advocates the primacy of economic growth, rising living standard and better nutrition (recently, e.g. Floud, Fogel, Harris, & Hong, 2011). The theory of epidemiological transition proposes that a shift occurred in patterns of disease and mortality from primarily infectious diseases to degenerative diseases. In his theory, A. Omran, proposed also that the mortality

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decline was faster and the take-off earlier for the more privileged groups (see Edvinsson & Linkvist, 2011, p. 378). Towards the end of the century, also improvements of public health gained importance in the reduction of mortality. Earlier studies have detected short-term mortality responses to variations in pre-industrial living standards in many settings, but have also indicated that the magnitude of the response differed among countries. For example, the higher the level of economic welfare, the more muted the mortality response to fluctuations in grain prices (Galloway, 1988).

Studies of associations between economic conditions and mortality have in the past been largely based on aggregate data for countries and regions. Recent studies using longitudinal micro-data have examined differentials at the individual, family, household, local, and regional levels. They have called into question the validity of the hypothesis that better resources, housing and nutrition usually ensured longer lives for the more affluent, or that industrialisation increased mortality differentials in every country (Bengtsson & Van Poppel, 2011; Schenk & van Poppel, 2011). While an analysis of the aggregate data from the censuses might suggest that survival chances were strongly conditioned on occupational status, studies making use of individual records have shown that, once other factors are controlled for, the status effect is rather small (Reid, 1997, pp. 150–151).

A weak or non-existent socio-economic mortality gradient in pre-industrial societies has been related to factors that counteract the gains from better resources. Such factors include a shared living environment (Bengtsson & Van Poppel, 2011; Edvinsson & Linkvist, 2011), behavioural patterns, and cultural norms. Among the most noteworthy are close contacts between different social groups (e.g. unmarried servants living with the farmer's family on the farmstead), the general health environment (e.g. water quality and sanitation), abuse of alcohol, smoking, similar child care practices, the common lack of knowledge regarding health, etc. In more advanced regions, the absence of large social class differences in mortality has been associated with high wages and relatively generous relief for the poor (Schenk & van Poppel, 2011).

Research based on individual-level data that explores the response of individual mortality risks to aggregated price or real-wage data has been able to identify sizeable differentials in the historical mortality response to economic fluctuations by socio-economic status in Europe (Bengtsson, Campbell, & Lee, 2004; Dribe, Olsson, & Svensson, 2017a; Jennings, Quaranta, & Bengtsson, 2017; Willführ & Störmer, 2015). Such studies have indicated that socio-economic mortality differentials are evident during the period of agricultural transformation, but appear to be negligible pre- and post-transformation. However, a recent study has shown that demographic responses to price fluctuations in Europe are not necessarily limited to the above-mentioned period. In a setting characterised by a marginal standard of living and a high proportion of non-agricultural workers, such as the islands of North Orkney, a strong sectoral gradient in mortality continued well into the twentieth century (Jennings et al., 2017). The mortality response to economic fluctuations generally disappeared as the pre-industrial society was transformed into an industrial society. Studying the mortality response to variations in income or food prices from one year to the next is not conducive to understanding mortality differentials among infants and the elderly, who were more affected by factors other than external economic stress (Bengtsson & Dribe, 2005, pp. 357–358).

Socio-economic differences in mortality often varied by age. Mortality of children and people of working ages rose significantly in times of economic distress (Dribe, Olsson, & Svensson, 2012, p. 294). The complexity of the factors underlying infant mortality is commonly emphasised. While infant mortality differentials by socio-economic status have been found in some historical Europe settings (Van Poppel et al., 2005, pp. 275–276, 304), many scholars believe that the role social status or affluence played in the decline of infant mortality is unclear (Edvinsson, 2004; Edvinsson, Gardarsdottir, & Thorvaldsen, 2008, pp. 459, 473). In the Nordic countries, however, the transition towards lower infant mortality rates in the late nineteenth century benefitted the higher social strata disproportionately (Edvinsson et al., 2008, p. 473). It is assumed that during childhood (ages 1–14) mortality becomes more sensitive to standard of living. In fact, mortality at young ages has long been recognised as an important indicator of living standards. Earlier case studies of pre-industrial rural Europe have produced divergent results. Some have shown a strong social gradient in child mortality

(Bengtsson, 1999; Bengtsson & Dribe, 2005; Breschi, Manfredini, & Pozzi, 2004; Willführ & Störmer, 2015), especially in times when crop prices were high. Others have concluded that the role of socio-economic status was negligible (Drozd-Lipińska, Klugier, & Kamińska-Czakłosz, 2015; Knodel, 2002). Studying mortality differences by social class among working-age adults and the elderly is even more difficult because of the complexity of life-course accumulation, occupational transitions, and a potential of reverse causality in its estimation (see Edvinsson & Broström, 2017).

With regard to protection against economic stress among peasantry, our study considers the role of the manor. In East-Central Europe, where the manorial system was a central feature of the pre-industrial economy, the question of mortality response to short-term economic difficulties was intrinsically related to the protective role of manorial lords. There is a widespread view that the estates, for several reasons, insured their tenants against uncertainties (for a summary, see Dribe et al., 2012, pp. 296–297). Yet there is little evidence that the measures taken were efficient. On the basis of parish-level information on vital events, Dribe, Olsson and Svensson have studied the impact of grain prices on mortality to measure the efficiency of the manorial system in protecting its inhabitants against economic stress in southern Sweden 1749–1859 (Dribe et al., 2012). For infant mortality, there appears to have been no protective effect of living in manorial parishes. For children living in parishes, characterised by a high degree of manorialism, there appears to have been a protective effect in the short run, as there was no mortality response to current prices, but this insurance effect disappeared with a 1-year lag. For adults, the pattern of mortality response was similar to that of children. Dribe, Olsson and Svensson concluded that the manorial estate was able to insure its inhabitants against the risks of economic stress, but the protective effect was highly imperfect, and only short-term (Dribe et al., 2012).

In this study, we make use of individual-level data ($N = 21{,}524$) from parish registers, poll-tax lists and listings of migrants to estimate relative mortality risk models by socio-economic status (SES) and manor type in nineteenth-century Estonia. Lutheran parish registers combined with civil records of migrants allow to keep track of individuals' comings and goings, which has been difficult in most studies based on family reconstitution as information about out-migration and return migration is unavailable (Jennings et al., 2017, p. 317).

It is common to estimate the effect of annual variation in food prices on mortality and compare different groups' response to price dynamics. In this paper, information on yearly rye prices is used for this purpose. In addition to that, based on previous historical research we distinguish one plausible crisis period and condition our regression models accordingly. To the best of our knowledge, this is the first study of mortality among a rural population-based on an individual-level dataset for the Russian Baltic provinces (Estland, Livland and Kurland) in the early stages of modernisation and demographic transition.

2. Setting: Helme and Paistu parishes

The Baltic provinces of the Russian Empire were rural economies that experienced a capitalist transformation as well as increasing social stratification in the nineteenth century. While the manorial economy underwent a stronger change towards market economy compared with the peasant economy, the latter was characterised by the transition to money rents and the transformation of tenancies into freeholds.

According to the Emancipation Law of 1819, heads of farmsteads and their families, and labourers and their families, were freed from serfdom (LTS 1819, part I, § IV). Still, until the mid-nineteenth century, virtually all agricultural land belonged either to nobles or to the Russian crown. State estates as well as noble manors were large-scale agricultural enterprises based on corvée. Thus, the emancipation of 1819 did not significantly change the basic economic relationships: peasant labour obligations were now transformed into labour rent based on the 'freely negotiated contract'. By mid-century, the mutual economic dependence of manors and peasants had come to an end so that only a cash nexus in the form of rent or mortgages between the estate owner and the peasant farmer

remained. Farms were no longer 'parts of the manorial economy', but started to develop in parallel. Gradual changes in peasant economy were accompanied by a transition to money rent, transformation of peasant land into freeholds, consolidation of the farmsteads into amalgamated lots, and enclosure of common pastures. New crops, crop rotation and improved tools also appeared which increased yields and agricultural output. In addition to providing for their own needs, farms also started to produce for the market. Landowning peasants took advantage of the new opportunities created by the transformation of agriculture in the second half of the nineteenth century to increase their incomes. The major cash crop in the study area was flax, which the manorial lords had generally avoided, as it drained the soil. Thus, farm production became more market-oriented, but only gradually. Flax production was commercialised, but in general, the production for market was limited until the 1880s when dairy farming became an important agricultural activity.

The area of our study includes seven adjacent communities (or manors) in the parish of Helme, and one in the parish of Paistu in Viljandi County in southern Estonia. In state estate of Holstre, most of the farms were sold to their current tenants in the early 1870s. On noble land in Helme, the process started in the 1850s and was completed in the early 1870s. The residential segregation of farmers and married farmhands has been reported for some places in that region (Troska, 1985). These developments refer to an increasing income disparity within the peasant group (Troska, 1985, pp. 5–13). Yet it is likely that the persistence of the habit of living and eating together, and of old rural hygiene and sanitary customs (Pärdi, 2017), diminished the potential effects of income inequality for a considerable time. As the peasant household, and to a lesser extent the community, cared for the maintenance of the orphans, the elderly, the sick and the poor, who lived (as 'lodgers') in peasant households, this may have further diluted the effects of income differences on mortality.

There was at least one identifiable episode of famine in the region, taking place in 1844–1846. These years were characterised by successive harvest failures and heightened grain prices. In 1844 and 1845, two successive crop failures resulted in lack of food and put the subsistence of peasants at risk. In Viljandi County (including the parishes of Paistu and Helme), rye yielded roughly three grains per seed sown in 1844 and 2.5 grains in 1845; barley yielded two grains in 1845. In 1845, yields fell to about a half of average. Crop failures also turned tenants into 'deficit producers' who were forced to apply for loans to meet the needs of their households. As far as the estate administrations' reports tell, the yields were probably slightly lower in Holstre than on the manors in Helme. Substantial government-level subsidies to communities and high turnover among tenant farmers provide further evidence of the economic hardships (Lust, 2013, 2017).

2.1. Types of manor

Practices in manorial societies varied across manor types and from landlord to landlord. A range of indicators is more likely to reveal contrasting experiences than just one. For example, the permanence of farms serves as an appropriate indicator of protective measures taken by different manorial lords in times of short-term crisis. On the state estate of Holstre and on manors owned by 'paternalistic' lords in Helme, only 10% to 25% of tenants lost their farms due to the crises of the 1840s, whereas on other manors the proportion varies from 25% to 50%. In this article, we attempt to determine whether living at a particular manor also affected mortality risks.

Our study encompasses six privately-owned manors and one church estate in the parish of Helme. For comparison, we use the large state estate of Holstre in Paistu. The legal as well as economic situation of the state peasants was better than that of their counterparts living on noble manors and church estates (Lust, 2008, pp. 60, 62, 64–67). Holstre in Paistu was a state estate, on which there was less exploitation than on noble manors. The ratio of demesne to peasant land on Holstre was 1:5.3; while on the Helme manors the ratio ranged from 1:2.4 to 1:1.6. The farms on state estates were permanent, which meant that they were normally passed from father to son over decades. Unlike on noble manors, the tenants of state estates had the prerogative to renew the farm contract if they had fulfilled their duties and obligations to the estate and crown. The maximum amounts of

labour dues payable to the leaseholders of state estates, as well as money rent paid to the crown, were fixed. Moreover, the rent and redemption prices were considerably lower than on noble manors. Expanding demesne was not favoured. On noble land, by contrast, the labour dues were unlimited and landlords could extract as much labour and money rent from the tenant farmers as could be obtained without compromising the viability of farm households. In 1849, the Holstre farmers switched to money rent, which significantly increased their incentive to improve farm productivity. In Helme, this only occurred in the early 1860s. It is interesting to note that Holstre, which constitutes one category of our manor groups variable, was one of the centres of the Estonian national awakening in its early phase.

We categorise the noble manors in Helme according to the characteristics of the manorial lord and the relationship between the lord and the peasants. First, we consider the manorial lord paternalistic if the farms were permanent and seldom changed hands; if labour dues and monetary payments were lower than on nearby manors; and if in- and out-migration levels were low. Second, the rate of conversion to the Orthodox Church in the mid-1840s gives insight into the nature of the lord-peasant relationships. In those years, approximately one fifth of the peasants in the Estonian part of Livonia converted to Russian Orthodoxy, or 'the Tsar's faith', in the hope that doing so would provide them with some relief and material benefits.[1] The converts were seeking freedom from manorial authority, tax relief, monetary aid, and so on. If the conversion rate remained low, (less than five percent, according to Riidaja and Jõgeveste), the landlord-peasant relationships were likely better. Third, the manorial lord is considered to be paternalistic if folklore, oral tradition collected in the 1920s and 1930s, and published memoirs support it. According to these criteria, Riidaja manor, Jõgeveste manor, and the Helme church estate were owned by paternalistic landlords until the early 1860s. These three were grouped together and coded as 'paternalistic'. The other four manors in Helme – Helme, Patküla, Lõve, and Leebiku-Vanamõisa – were owned by conventional landlords. This resulted in three manor groups: one state estate, one paternalistic group and one conventional group.

2.2. Socio-economic status

In rural areas, access to land largely determined an individual's and family's socio-economic status. The population of our study is divided into three broad categories: farmers with large and medium-sized farms (there were no small farms in the study area), skilled workers, and the semi-landless (cottagers) and landless. The semi-landless and landless groups comprised nearly two-thirds of the study population (Table 1). Cottagers had only a small parcel of land or no land at all, and normally worked for wages. Those without land circulated among the farmsteads and manors as hired labour. Parish registers normally do not differentiate between different segments of rural labourers or do so inconsistently. Females' socio-economic status, which is always more difficult to follow in historical data, was the same as their father's. With the marriage, she gained the husband's status.

Landless workers were given a small patch of land, foodstuffs, clothes, lodging, heating, and the right to keep cattle, a pig, etc. The share of cash in the remuneration was small but increased over the second half of the century. Thus, changes in grain output (harvests) probably affected their subsistence more than the level of prices. In general, the importance of home production and non-monetary remuneration was greater in less market-oriented settings like Estonia than in north-western Europe.

Researchers have determined that deep social differences among the various categories of peasants already existed in pre-emancipation Estonia (Kahk, Palli, & Uibu, 1982, pp. 79–81). In many cases, however, the positions of landless peasant and tenant farmer were not a class distinction but two stages in the life cycle. Social boundaries between different strata became increasingly

[1]Russian Orthodox registers (1847–1891) do not indicate socio-economic status; therefore, this religious group has been excluded from our study. However, many who reconverted to Lutheranism in the following decades are included.

Table 1. Study sample by manors.

Manor	Type	*N*	Deaths	Manor share in sample %	Male % in manor	SES: Farmers %	SES: Skilled workers %	SES: Landless %	SES: Other %
Jõgeveste	Patern.	2245	805	10.4	49.9	30.9	3.9	62.1	3.2
Riidaja	Patern.	1922	691	8.9	50.8	33.4	5.1	59.0	2.4
Helme pastor.	Patern.	428	164	2.0	51.8	38.0	4.6	53.6	3.9
Helme	Conv.	3921	1565	18.2	49.9	29.2	3.1	65.3	2.4
Patküla	Conv.	2746	1101	12.8	49.6	28.5	4.7	64.3	2.4
Lõve	Conv.	2326	885	10.8	50.6	31.3	5.6	60.8	2.3
Leebiku	Conv.	1914	743	8.9	49.1	28.5	4.7	64.7	2.2
Holstre	State	6022	2102	28.0	48.6	29.4	3.3	65.8	1.5
Total	–	21,524	8056	100.0	50.1	31.2	4.4	62.0	2.5

Source: Birth and death registers and migration records and poll tax lists from the parishes of Helme and Paistu, preserved at the National Archives of Estonia.

pronounced in the mid-nineteenth century, and movement from one group to the other became uncommon (Kahk et al., 1982). In Helme, it was less common for kin to be living in a household as farmhands than it was in Holstre. Their position was ambivalent, as they were both kin and workers. Quantitative sources do not provide insight into the nature of the working relationship. Studies based on narrative accounts and folklore use illustrative examples rather than treating the subject systematically (Kahk, 1969, pp. 152–157; Tedre, 1970). Such works depict their relations as conflictual.

Population growth increased the relative proportion of the landless due to the fixed minimum size of farms, the prevailing pattern of impartible inheritance of land, and the expansion of demesne on noble manors. The growing share of landless was partly rooted in the high concentration of land in the hands of Baltic German nobles and the under-development of other sectors of the economy. In 1863 and 1897, the percentage of the Estonian urban population was only 8.7 and 15.5 respectively.

3. Research questions and hypotheses

Our first question is whether the type of manor or manorial lord played a role in reducing the vulnerability of its population. Although the Livonian provincial authorities in 1844–1846 explicitly obliged manorial lords to grant subsistence loans to needy peasants and the state provided additional relief loans to peasant communities, the consequences of crop failures were nevertheless severe for peasants (Lust, 2017). We aim to determine whether the type of manor was associated with mortality levels. In terms of short-term economic stress, we ask whether the effect that changing food prices may have had on mortality was dependent on the manor type. We expect that mortality levels were relatively lower in the state-owned estate, where conditions were more favourable for peasants compared with privately-owned manors. We also expect that the state estate was able to shield its peasants against sudden price shocks to a larger degree than other manor types.

The second question is about the importance of socio-economic status as a predictor of mortality. Based on earlier research on Scania and East Frisia (Bengtsson & Dribe, 2005; Dribe et al., 2017a; Willführ & Störmer, 2015), we assume that the landless group, who constituted roughly two-thirds of the peasant population, was more vulnerable than farmers in terms of mortality risk. The disadvantaged position of the landless group could be revealed during times of temporary crisis, i.e. we expect them to be more responsive to sudden food price hikes. However, we also expect that the landless group in general had a higher mortality risk compared to farmers because of their limited access to resources at all times.

Since this is the first time that food price dynamics are associated with mortality in this particular region, we perform a simple robustness check to assess the importance of grain prices as a predictor of mortality. We ask whether the estimated relationship between mortality risk and food price dynamics is sensitive to controlling for a plausible crisis period. If grain prices are a strong predictor

of mortality risk over the study period, the estimated coefficients for price dynamics should largely maintain their size and statistical significance.

4. Data and methods

The period of our study, 1834–1884, is selected due to the availability and quality of sources. Most importantly, in this period, the local Lutheran parish registers include individuals' surnames and socio-economic status.

The 1834 poll-tax list (or 'soul revision') provides us with an enumeration of that year's population, comprising 4737 persons on the seven manors in Helme, and 2537 on Holstre in Paistu. Poll-tax list includes data on sex, age, marital status, and SES. To this 'initial' dataset, all following births in the area until 1891 are added from Lutheran and Russian Orthodox parish registers. In addition to births, people who migrated to the manor are recovered from migrant listings, parish member registers and church certificates (*Parochial Schein*). Annual listings of migrants include time of arrival or departure. Similarly, parish member registers provide the exact date of migration. Church certificates, issued by the pastor, also include the date of birth of the migrant. These sources were used to determine the time of arrival or departure of people moving in and out of the community. Linking migration records to poll-tax list and birth records, we obtained a combined dataset including people who lived in the area under observation between 1834 and 1891. To this combined dataset the information on time of death was linked from parish registers. As a result, for each individual we have information on the time of becoming at risk of dying (birth, in-migration) and death time or censoring (out-migration).

From the total sample of 28,644 we excluded those with missing sex data ($n = 162$), missing birth time ($n = 233$), and stillbirths ($n = 496$). In total, we have 27,753 observations for the period of 1834–1891. From this we had to exclude 4585 observations with lacking information on socio-economic status. Missing socio-economic status data is not random as migrants are over-represented among the censored observations. Individuals with missing SES are more likely to be migrants who moved into parish and then moved out after some time. Excluding them thus reduces the number of mobile population and their contributed exposure time, but they have less effect on the number of deaths occurring. The benefit of excluding this group is that the study sample is more representative of local population on each manor. Finally, since rye price information is incomplete after 1884, we end our analysis with this year. This results in a study sample consisting of 21,524 individuals (shown by manors in Table 1). We have checked the data by examining sex ratios at birth and in ages 0–4 over time. No particular irregularities in sex ratios were observed. In addition, we can report that there are no considerable differences in neonatal mortality by socio-economic status.

Data on socio-economic status is derived from birth and death registers and poll tax lists. Data on the size of landholdings was obtained from rent and purchase contracts and *wackenbücher* (inventories). In order to construct our socio-economic status variable, we grouped together certain HISCLASS (History of Work Classification System) categories. The first group, corresponding to HISCLASS 8, is comprised of farmers. Estonian peasant farmers were all tenants on short-term contracts until the mid-1860s, after which time they increasingly owned their farmsteads; therefore, we did not create sub-groups by type of property rights. The second group is made up of 'skilled workers' (Classes 6–7) – families of individuals who did not make their living from agricultural production (e.g. forest wardens, peasant school teachers, storekeepers, bailiffs, foremen, gardeners, innkeepers, millers). These were often not life-long jobs but occupied a period of one's life. The third category, 'landless and semi-landless', describes those in low-skilled occupations. It consists of low-skilled (Classes 9–10) and unskilled workers (11–12), and includes families whose land holdings were below subsistence level, i.e. semi-landless cottagers, landless labourers, and artisans. Casual work and self-employment as artisans were common among those in this category. In Estonian village, artisans were not specialised skilled workers. Their families were usually unable to subsist on the male breadwinner's trade alone but had to work as seasonal labourers in order to supplement their

income. The fourth and smallest group, 'other', mainly consists of retired soldiers, their wives and children, and is too heterogeneous to be combined with any other group. Although we include it in the regression analysis as one of the SES categories, we do not interpret the results for this group. In the descriptive analysis and regression modelling, we focus on the three main groups – farmers, skilled workers, and landless and semi-landless labourers.

To identify short-term economic stress, we use local rye prices collected by the county magistrates between 1833 and 1884 (see Figure 1). These are October or November prices reported from Tartu County which bordered on Viljandi County. The respective data from Viljandi County are less reliable at several points in time and therefore we prefer prices from Tartu County (see Lust, 2013, pp. 220–223, 226–230). For our analysis, we took the natural logarithm of the time-series of rye prices and then de-trended the series using Hodrick-Prescott filter with a smoothing parameter of 6.25. This resulted in a series that has a mean close to zero and deviations from the mean represent short-term price fluctuations on the logarithmic scale (see Figure 2).

In order to determine risk of dying, we apply survival analysis, a common time-to-event technique. Event and exposure times are calculated in months. As not all individuals in the dataset are followed from birth to death, accounting for censoring is necessary. In order to compute survival times, being at risk of death starts at birth and ends when an individual reaches the age of 55 or January of 1885 (whichever comes first), after which he or she is considered right-censored (censoring after age 55 excludes from the study 1884 deaths). Right-censoring also occurs in the event of out-migration: the individual is considered right-censored as of the month of departure. For those born before 1834 or who moved into the parish after their birth, hazard rate is conditional on their survival to 1834 or to the month of in-migration.

To account for changes in mortality levels over time we include a linear term of calendar year in our models. In models that are fitted to test the robustness of the correlation between rye prices and mortality risk, we include an indicator variable for a 2-year period that we believe was a crisis in the area. Earlier studies suggest that the harvest years 1844–1846 were the only episode of serious subsistence crisis in the study area (Lust, 2017). Thus, we create a dummy variable that takes value 1 in months between October 1844 and October 1846, and 0 when otherwise.

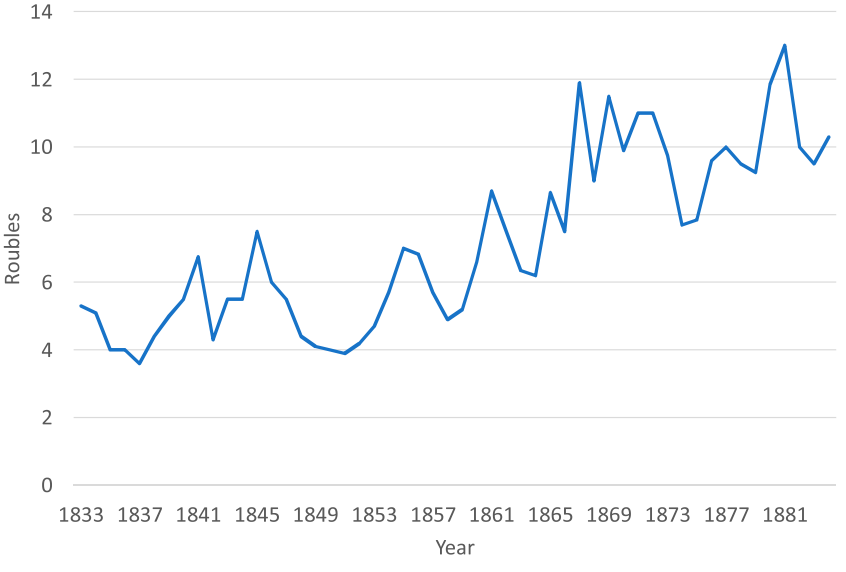

Figure 1. Prices of rye chetvert in roubles in Tartu County, 1834–1884. Source: Lust, 2013; RA, EAA (National Archives of Estonia), f. 949 (1833–1840).

Note: 1 chetvert = 147 kg, October or November prices.

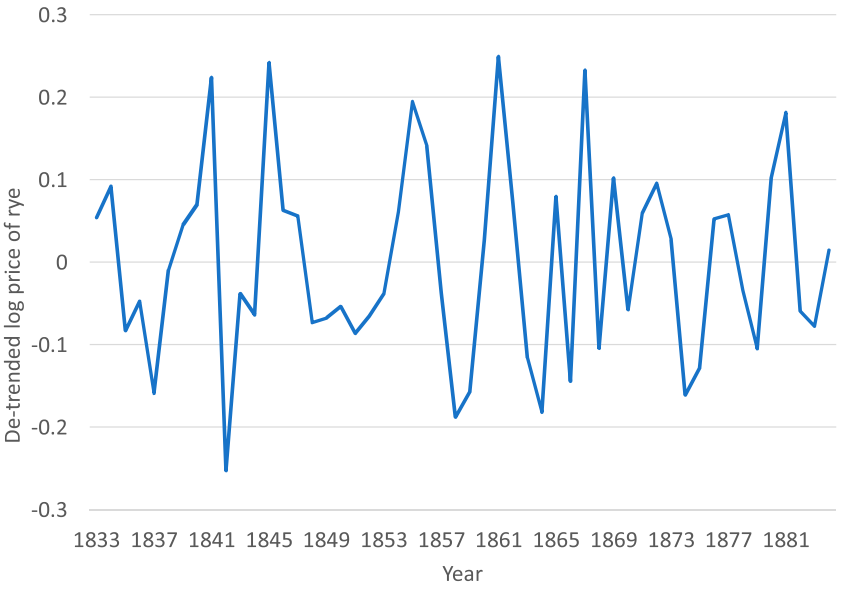

Figure 2. Natural logarithm of prices of rye in Tartu County, de-trended using Hodrick-Prescott filter with a smoothing factor 6.25, 1834–1884. Source: As for Figure 1.

Since our focus is on mortality up to age 55, this broad age range still accommodates substantial differences in risk of death by age. For example, the hazard function for infant mortality is quite different from that of adult mortality. For this reason, we estimated regression models separately for three age groups: infants up to 12 months of age, young children aged 1–4, and older children and adults between the ages of 5 and 55. The mortality of those above working age is beyond the scope of the study.

Event history analysis applies Cox proportional hazards model. The semi-parametric nature of this method does not assume a specific hazard distribution, so it is appropriate for different baseline hazard shapes. In models of infant mortality, we include individuals born in or after 1834, who either died during the first year or were right-censored if they survived. In models of young-child mortality, the risk set is composed of all those who survived the first 12 months of life. Similarly, the risk set for mortality from age 5–55 is composed of those who survived the first five years of life.

We fitted two sets of Cox regression models for each age group. Models in the first set are: (a) base model including all predictors and control variables; (b) base model plus interaction between prices and the estate type; (c) base model plus interaction between prices and socio-economic status. The second set adds the 1844–1846 period dummy variable to each model in the first set. Thus, the first set of models tests the association between mortality risk and the price variable, including interactions that estimate differences by the estate type and socio-economic status. The second set tests whether the results are robust to specifying the 1844–1846 crisis period in the model with a dummy variable. Models pertaining to age groups 1–4 and 5–55 also include prices of rye lagged by one year. The lagged prices variable, however, is not used in interaction terms (we also tried interactions with the lagged variable but none of the interaction results appeared to be statistically significant).

5. Results

5.1. Descriptive results

First, we look at mortality rates by calendar time. Calculating deaths per sum of individual exposure time using 1-year intervals informs us about short- and long-term mortality development between

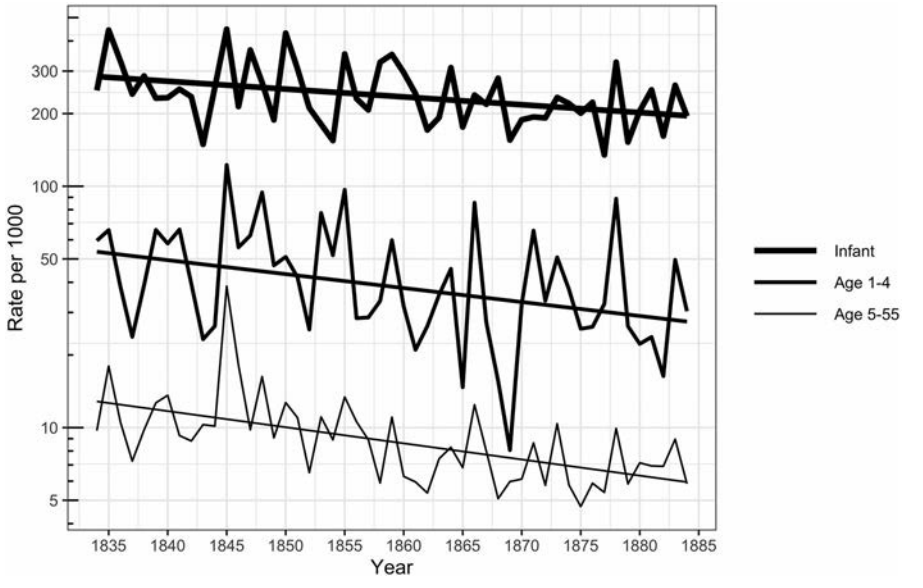

Figure 3. Yearly death occurrence/exposure rate. Source: As for Table 1.
Note: Y-axis log10- transformed. Straight horizontal lines denote the OLS-fit of each time-series.

1834 and 1884. Figure 3 presents annual occurrence/exposure rates for three age groups: infants, children aged 1–4 years, and individuals aged 5–55. As expected, the rate is highest for infants and lowest for adults and older children.

The period of 1844–1846, which we denoted as a period of crisis based on historical research, shows relatively high rates primarily for ages 5–55. Ages 1–4 also experienced high rates in this period, but for this age group we can also find other times that stand out as high mortality years. With regard to long-term changes in mortality, the rates of all age groups developed in the same direction and declined over the period, as demonstrated by the OLS-fitted line in Figure 3.

Next, entering the event history framework, we compared the survival estimates for different socio-economic groups. Figure 4 shows Kaplan-Meier non-parametric survival curves calculated separately for the three age groups. Infant group survival indicates that about 7% of newborns died within the first month. Overall, slightly more than 80% of children survived their first year of life. Of those who survived infancy, approximately 11–13% of the next age group died between the ages of 1 and 4. However, for those who survived to age 5, the chances of reaching older ages were relatively high, since approximately 75% were still alive at age 55.

The estimates in Figure 4 suggest that the infants and young children of landless and semi-landless families had a slightly higher risk of mortality than those of farmers. In all three age groups, skilled workers and their families had a somewhat higher survival rate compared with farmers. Skilled workers, however, are a very small group relative to the others, which results in more pronounced changes in the estimated survival curve. The survival curve plot supports our hypothesis with regard to the disadvantaged position of the landless and semi-landless, at least in the case of infant and young-child mortality. However, the gaps between the survival curves are quite small. In the next sub-sections, we will test whether the differences persist after controlling for other characteristics.

5.2. Regression results: infant mortality

Regression models are reported by showing hazard ratios for all variables except for prices and its interaction effects. For the latter, we report coefficients which, given that we have taken the natural

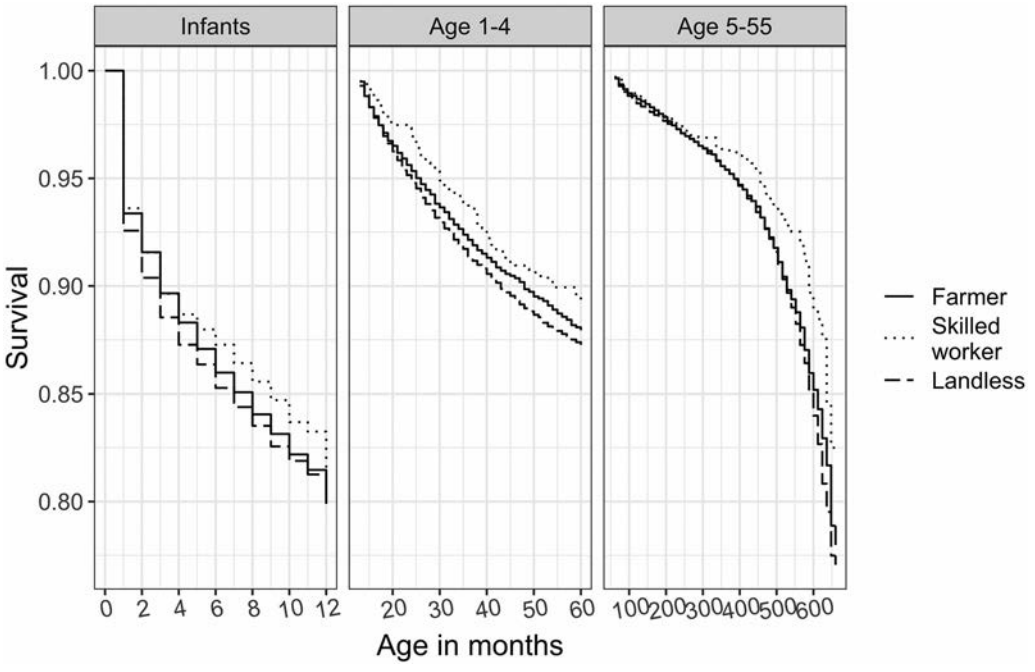

Figure 4. Kaplan-Meier survival estimates by socio-economic status and age group. Source: As for Table 1.

logarithm of the variable, can be interpreted as a percentage change in relative hazard. We have scaled the price variable so that the estimated coefficients correspond to a 10% change in prices.

Regression results in Table 2 indicate that girls had an approximately 19% lower risk of dying during their first year than boys. We also find differences by manor group, as paternalistic and conventional groups exhibit a significantly higher (17% and 47%, respectively) risk of infant mortality

Table 2. Cox PH model of infant mortality.

	Base model		Price × Estate		Price × SES	
	HR	SE	HR	SE	HR	SE
Year	0.991***	0.001	0.991***	0.001	0.991***	0.001
Female	0.810***	0.030	0.810***	0.030	0.811***	0.030
Paternalistic estate	1.173**	0.068	1.170**	0.068	1.172**	0.068
Conventional estate	1.470***	0.070	1.470***	0.070	1.469***	0.070
Skilled worker	0.943	0.091	0.945	0.091	0.946	0.091
Landless labourer	1.034	0.042	1.034	0.042	1.036	0.042
Other SES	1.026	0.119	1.027	0.119	1.012	0.119
	Coef.	SE	Coef.	SE	Coef.	SE
10% price	−0.114	1.522	1.241	3.317	−3.446	2.684
10% price × Paternalistic			−5.489	4.716		
10% price × Conventional			−0.373	3.868		
10% price × Skilled worker					4.852	7.816
10% price × Landless labourer					4.207	3.321
10% price × Other SES					19.497*	9.107
Observations	14,096		14,096		14,096	
N deaths	2977		2977		2977	

Notes: 10% price denotes the change in the price variable that corresponds to a 10% increase in prices. Reference categories are male, state estate, and farmer.

Source: Birth and death registers and migration records and poll tax lists from the parishes of Helme and Paistu, preserved at the National Archives of Estonia, own estimation.

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 3. Cox PH model of infant mortality including the period dummy.

	Base model		Price × Estate		Price × SES	
	HR	SE	HR	SE	HR	SE
Year	0.992***	0.001	0.992***	0.001	0.992***	0.001
Female	0.811***	0.030	0.811***	0.030	0.811***	0.030
Paternalistic estate	1.173**	0.068	1.169**	0.068	1.172**	0.068
Conventional estate	1.468***	0.070	1.468***	0.070	1.467***	0.070
Skilled worker	0.945	0.091	0.946	0.091	0.947	0.091
Landless labourer	1.034	0.042	1.034	0.042	1.037	0.042
Other SES	1.026	0.119	1.026	0.119	1.011	0.119
1844–1846 period	1.245*	0.116	1.245*	0.116	1.246*	0.116
	Coef.	SE	Coef.	SE	Coef.	SE
10% price	−1.012	1.572	0.311	3.332	−4.340	2.707
10% price × Paternalistic			−5.432	4.697		
10% price × Conventional			−0.335	3.854		
10% price × Skilled worker					4.983	7.797
10% price × Landless labourer					4.183	3.310
10% price × Other SES					19.501*	9.073
Observations	14,096		14,096		14,096	
N deaths	2977		2977		2977	

Notes: 10% price denotes the change in the price variable that corresponds to a 10% increase in prices. Reference categories are male, state estate, and farmer.
Source: As for Table 2.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

than the state estate. None of the SES categories are estimated to be different from farmers. These results are very similar in the base model and in models that include interaction effects with rye prices. A 10% increase in rye prices has no statistically significant effect in these models (except for the SES group 'Other').

Models shown in Table 3 add the indicator variable for the period of 1844–1846. Compared with the results in Table 2, the addition of the period dummy does not change hazard ratios associated with other variables. However, infant mortality in the 1844–1846 period is estimated to be about 25% higher compared to other years, while the calendar year variable predicts less than 1% annual decline in infant mortality (similar to the model without the period indicator). Introduction of the period indicator does not change the estimates for rye prices and its interaction terms. We conclude that infant mortality was not associated with rye prices dynamics but nevertheless increased during the years that we defined as a subsistence crisis. Infant mortality level was generally lower on the state estate and highest on conventional manors. This supports our hypothesis about the protective effect of the state estate.

5.3. Regression results: age 1–4 mortality

The second set of models examines young child mortality. First, we look at models without the period indicator (Table 4). In this age group there is no statistically significant difference by sex. Paternalistic and conventional estates associated with about 20–27% higher mortality compared with the state estate. Among the SES categories, landless labourers had about 12% higher mortality risk than farmers, but this difference is statistically significant only if the model includes an interaction between prices and SES.

Regarding the influence of short-term economic stress, the models suggest that current rye prices and prices lagged by one year are both positively linked with child mortality risk. In the base model, a 10% increase in rye prices is associated with a 5.7% increase in child mortality risk. The model suggests that the influence of a price increase extended to the next year as the lagged price is also positively associated with a higher mortality risk: a 10% increase in prices meant a 4.4% increase in mortality in the following year.

Table 4. Cox PH model of age 1–4 mortality.

	Base model		Price × Estate		Price × SES	
	HR	SE	HR	SE	HR	SE
Year	0.987***	0.002	0.987***	0.002	0.987***	0.002
Female	1.054	0.050	1.053	0.050	1.054	0.050
Paternalistic estate	1.201**	0.083	1.209**	0.084	1.201**	0.083
Conventional estate	1.250***	0.073	1.265***	0.075	1.251***	0.073
Skilled worker	0.880	0.114	0.881	0.114	0.890	0.115
Landless labourer	1.103	0.057	1.104	0.057	1.116*	0.058
Other SES	0.998	0.159	1.000	0.159	0.984	0.161
	Coef.	SE	Coef.	SE	Coef.	SE
10% price	5.679**	1.933	12.304**	3.893	12.524***	3.418
10% price lagged 1 year	4.381*	1.966	4.332*	1.967	4.339*	1.966
10% price × Paternalistic			−4.359	5.552		
10% price × Conventional			−10.812*	4.735		
10% price × Skilled worker					−10.812	10.421
10% price × Landless labourer					−9.112*	4.208
10% price × Other SES					−34.729*	13.824
Observations	12,540		12,540		12,540	
N deaths	1846		1846		1846	

Notes: 10% price denotes the change in the price variable that corresponds to a 10% increase in prices. Reference categories are male, state estate, and farmer.
Source: As for Table 2.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Models in Table 4 use current prices to construct interaction effects with manor type and SES. Interaction with manor type indicates that a 10% increase in prices associates with a 12.3% rise in mortality risk on the state estate. Paternalistic estates experienced a smaller increase in mortality due to prices but the result is not significantly different from the state estate. The interaction effect for conventional estates, however, is negative and suggests a 10.8% lower risk compared with the state estate, which means that the positive effect of the price hike is almost neutralised in the conventional group. While it is puzzling that this particular group seems to be immune to short-term stress compared with other estates, it could be that price influence was smaller on estates that had a relatively high level of mortality. Considering that conventional estates in this model had a 26.5% higher relative risk of mortality compared with the state estate if prices did not change, it required at least a 20% increase in prices on the state estate to reach a mortality level similar to conventional estates.

Interaction between prices and socio-economic status suggests that a 10% increase in prices results in a 12.5% increase in mortality risk for farmers. The interaction term for skilled workers is negative but not statistically significant. By contrast, negative interaction terms for landless labourers and 'other' socio-economic groups are statistically significant: a 9% decrease for landless compared with farmers. It is important to note, however, that in this interaction model, landless labourers have 12% higher mortality risk compared with farmers (HR 1.116*) if rye prices do not increase. If prices increase exactly by 10%, farmers would still have a slightly lower mortality risk than the landless group.

In Table 5, we add the crisis period variable to child mortality models. The estimated effect of the 1844–1846 period is about 85–86% increase in child mortality compared with the rest of the years under study. The inclusion of the period dummy also affects estimates for the price variable and its interaction effects. Annual price dynamics and its lagged variant are not any more statistically significant in the base model. Interaction models suggest that the state estate experienced an 8.1% increase in mortality as a result of a 10% increase in prices. Price dynamics, however, does not elevate mortality on conventional manors, for which the interaction term is negative and statistically significant. The second interaction model in Table 5, for a combined effect of prices and socio-economic status, suggests that farmers experienced about 8.6% increase in mortality risk for a 10% increase in

Table 5. Cox PH model of age 1–4 mortality including the period dummy.

	Base model		Price × Estate		Price × SES	
	HR	SE	HR	SE	HR	SE
Year	0.989***	0.002	0.989***	0.002	0.989***	0.002
Female	1.053	0.05	1.053	0.05	1.054	0.050
Paternalistic estate	1.200**	0.083	1.207**	0.084	1.200**	0.083
Conventional estate	1.251***	0.073	1.265***	0.075	1.252***	0.073
Skilled worker	0.881	0.114	0.882	0.114	0.890	0.115
Landless labourer	1.105	0.057	1.105	0.057	1.116*	0.058
Other SES	1.001	0.159	1.002	0.159	0.984	0.161
1844–46 period	1.860***	0.172	1.850***	0.171	1.845***	0.171
	Coef.	SE	Coef.	SE	Coef.	SE
10% price	2.085	2.016	8.136*	3.901	8.592*	3.442
10% price lagged 1 year	3.196	1.952	3.178	1.953	3.190	1.952
10% price × Paternalistic			−3.802	5.47		
10% price × Conventional			−9.908*	4.664		
10% price × Skilled worker					−10.054	10.312
10% price × Landless labourer					−8.639*	4.147
10% price × Other SES					−32.284*	13.771
Observations	12,540		12,540		12,540	
N deaths	1846		1846		1846	

Notes: 10% price denotes the change in the price variable that corresponds to a 10% increase in prices. Reference categories are male, state estate, and farmer.
Source: As for Table 2.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

rye prices. Interaction terms for skilled workers and landless labourers are both negative, which means that they were not affected by the price effect to the same degree that the farmers were. However, the coefficient is statistically significant only for landless labourers. Since landless labourers' mortality level without price fluctuations was 12% higher than that of farmers, a 10% increase in prices in this model means that farmers would still have a slightly lower mortality than the landless group.

Table 6. Cox PH model of age 5–55 mortality.

	Base model		Price × Estate		Price × SES	
	HR	SE	HR	SE	HR	SE
Year	0.980***	0.001	0.980***	0.001	0.980***	0.001
Female	0.934	0.034	0.934	0.034	0.934	0.034
Paternalistic estate	0.934	0.049	0.941	0.049	0.934	0.049
Conventional estate	1.038	0.043	1.040	0.043	1.038	0.043
Skilled worker	0.744*	0.090	0.744*	0.090	0.714**	0.090
Landless labourer	1.129**	0.046	1.129**	0.046	1.126**	0.046
Other SES	0.802	0.140	0.801	0.140	0.803	0.141
	Coef.	SE	Coef.	SE	Coef.	SE
10% price	10.364***	1.482	12.098***	2.596	8.706**	2.794
10% price lagged 1 year	1.612	1.521	1.612	1.521	1.611	1.521
10% price × Paternalistic			−5.921	4.259		
10% price × Conventional			−1.225	3.357		
10% price × Skilled worker					15.877	9.833
10% price × Landless labourer					1.905	3.318
10% price × Other SES					−3.169	14.895
Observations	15,189		15,189		15,189	
N deaths	3233		3233		3233	

Notes: 10% price denotes the change in the price variable that corresponds to a 10% increase in prices. Reference categories are male, state estate, and farmer.
Source: As for Table 2.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

To summarise this section, age 1–4 mortality confirms our hypothesis that the state estate provided a better environment for survival compared with other estate types. However, contrary to our expectations the state estate did not provide a better shield against surges in grain prices, at least when compared with conventional estates. We did not find that increasing food prices had a bigger influence on mortality in paternalistic and conventional manors. With regard to socio-economic status, these results support the hypothesis that the landless group had a higher mortality risk compared with farmers. On the other hand, the results also suggest that farmers' mortality was more sensitive to price changes than that of the landless group.

5.4. Regression results: age 5–55 mortality

Our last set of models applies to older children and adults. Table 6 shows that there were no statistically significant sex differences in mortality risk, although women are estimated to have had about 7% lower risk than men. In contrast to modelling results of infant and young children mortality, there were no differences between manor groups. Instead, socio-economic status emerges as an important predictor of mortality risk. In all models, skilled workers have about 26–28% lower and landless labourers about 13% higher mortality risk compared with farmers. In the base model, a 10% increase in rye prices translates into a 10.4% increase in mortality risk in the current year and the estimate is highly significant. Interaction with manor type increases the coefficient for rye prices in the state estate: a 10% increase in prices elevated mortality on the state estate by 12.1% and since interaction terms are not statistically significant, we conclude that this applied also to other manor types.

The second interaction model focusing on socio-economic status suggests that for a 10% increase in prices farmers' risk of dying increased by 8.7%. For the landless group, the increase in mortality risk due to price changes is predicted to be fairly similar to that of farmers' as the interaction coefficient is not significant. A bigger positive price effect for skilled workers is not statistically significant either.

The results pertaining to grain prices in Table 6 change considerably when we add the dummy variable for the 1844–1846 period. Shown in Table 7, the estimated hazard ratio suggests that

Table 7. Cox PH model of age 5–55 mortality including the period dummy.

	Base model		Price × Estate		Price × SES	
	HR	SE	HR	SE	HR	SE
Year	0.984***	0.001	0.984***	0.001	0.984***	0.001
Female	0.934	0.034	0.935	0.034	0.934	0.034
Paternalistic estate	0.933	0.049	0.939	0.049	0.933	0.049
Conventional estate	1.036	0.043	1.037	0.043	1.036	0.043
Skilled worker	0.737*	0.089	0.737*	0.089	0.710**	0.09
Landless labourer	1.130**	0.046	1.130**	0.046	1.128**	0.046
Other SES	0.800	0.14	0.800	0.14	0.801	0.14
1844–46 period	2.633***	0.167	2.631***	0.167	2.631***	0.167
	Coef.	SE	Coef.	SE	Coef.	SE
10% price	3.480*	1.563	4.932	2.602	2.086	2.789
10% price lagged 1 year	–0.727	1.498	–0.721	1.498	–0.722	1.498
10% price × Paternalistic			–5.270	4.157		
10% price × Conventional			–0.895	3.273		
10% price × Skilled worker					14.699	9.588
10% price × Landless labourer					1.562	3.239
10% price × Other SES					–2.592	14.575
Observations	15,189		15,189		15,189	
N deaths	3233		3233		3233	

Notes: 10% price denotes the change in the price variable that corresponds to a 10% increase in prices. Reference categories are male, state estate, and farmer.
Source: As for Table 2.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

there was a 2.6 times higher mortality risk during this period compared with other years. In the base model, a 10% price increase associates with a 3.5% increase in mortality risk and this is less than half of what was estimated in the model without the period dummy. Moreover, in models that use interaction terms, the estimates for the price variable and its interactions are not statistically significant any more. We conclude that while price fluctuation had a positive relationship with mortality risk in age group 5–55, a large part of this can be explained away by high prices and high mortality during 1844–1846. Conditioning the models to specifically take into account this period also reduces the estimated differences in response to price changes by manor type and SES.

To summarise, considering age 5–55 mortality we find support to our expectation about the landless group being in a less favourable situation compared with farmers. However, we do not find that this group suffered more due to an increase in food prices, at least when the model conditions for the relatively high mortality of the 1844–1846 years. Hypotheses about mortality differences by the manor type do not find support in this age group.

6. Summary and discussion

In this paper, we analysed mortality in nineteenth-century rural Estonia. We hypothesised that the type of manor played a role in its inhabitants' mortality risk and moderated how mortality responded to food price fluctuations. We also expected to find differences in mortality between social status groups such as farmers and landless and semi-landless labourers. These questions were addressed by applying hazard-rate modelling to infants, children aged 1–4, and those aged 5–55. Short-term economic stress was measured by changes in rye prices. To determine that the estimated price-mortality relationship was not only due to the period of food shortage in 1844–1846, we also included an indicator variable for this period in some of our models.

Our first question concerned the role of the local manor in reducing the vulnerability of its population. According to our hypothesis, the population of the Holstre state estate was in a less vulnerable position than the inhabitants of paternalistic and conventional manors in Helme. We found that this was indeed true for infant and young-child mortality. Infant and young child mortality on the conventional manors was estimated to be at least 25% higher compared with Holstre. As better conditions on the state manor probably meant more favourable work schedules for mothers, a relatively low infant mortality is expected. Also, on manors owned by a paternalistic lord, infants had on average a lower risk of dying compared with conventional manors. For ages 5–55, manor type was not a statistically significant predictor of mortality.

With regard to short-term economic stress on different manors, changes in grain prices seemed to play a role only beyond infancy. This is in accord with the suggestions by earlier authors that during childhood, after infancy, mortality becomes sensitive to standard of living. Interestingly, and somewhat contrary to what we hypothesised, our results suggest that price changes had a bigger effect on young child mortality in the state estate, where the level of child mortality was lower compared with other manor types. We may speculate that this is due to a selection effect by which weaker children that survived on the state estate during normal years experienced higher mortality in times of economic stress.

Thus, while there is a view that for several reasons manors tended to insure their tenants against uncertainties, our study offers mixed results. Infants and young children on the state estate were generally less vulnerable than on noble manors, but this positive influence is limited to ages 0–4. The mortality response to short-term price changes was more evident on the state manor, which lends support to the argument that the state estate was ineffective in insuring against a temporarily elevated risk of mortality.

Regarding our second question – the role of socio-economic status – the results point towards higher vulnerability of the landless group as hypothesised. In the age group 5–55, we found the expected mortality gradient: skilled workers experienced a lower (−26%) and landless labourers a higher mortality risk (+13%) compared with farmers. For ages 1–4, a similar gradient emerged

but the estimates were weaker and statistically significant only for the landless group in interaction models. Nevertheless, our hypothesis about the relative disadvantage of landless and semi-landless labourers was somewhat supported. Young children of the landless group exhibited about 10-12% higher risk of death than those of farmers, a difference comparable with that for the 5–55 age group.

Socio-economic status differentials in response to sudden increases in food prices emerged only for young child mortality. Models interacting price changes and SES suggest that farmers' young children were more sensitive to price shocks than those of the landless group. This could be explained by selection effects among farmers, who had lower mortality in better years and therefore higher proportion of weaker children exposed to price changes.

Our results pertaining to mortality level by socio-economic status are not completely surprising, given that others have also found only small differences by status in pre-industrial agricultural societies (Bengtsson & Van Poppel, 2011, p. 354). However, in contrast with Scania, East Frisia and the Netherlands, where studies of child mortality have revealed modest social differences during certain parts of the nineteenth century, we find little disparity among this age group in economically stable years. In Scania, no social differences were found for working-age adults during the pre-industrial period (Bengtsson & Van Poppel, 2011, p. 350). In our setting, by contrast, we found a socio-economic gradient in mortality for the 5–55 age group.

The vulnerability of the families of landless and semi-landless labourers does not emerge strikingly in our results, especially given their relative lack of response to price dynamics. This result is more in line with a weak mortality response to price fluctuations during the pre-transformation phase (Bengtsson & Dribe, 2005, p. 361). There are a number of factors that may have suppressed the mortality differentials between SES groups. For instance, the similarity of mortality responses to economic fluctuations among social classes is likely due to the high mortality associated with infectious diseases. In many historical settings, epidemics followed poor harvests. The relatively homogenous levels of mortality among the two main socio-economic groups also reflect the low standard of living common among villagers, even those that were somewhat better off. The category of unskilled labourers might also be more heterogeneous than could be determined on the basis of our sources, including subgroups with a higher risk of mortality (for example, see Bengtsson & Van Poppel, 2011, pp. 347–348). The categorisation is appropriate for differentiating between the landed and landless population, but does not capture potential segmentation within the landless group. It is also possible that in some localities such as Holstre state estate, the fact that farmhands and farmers were often relatives might have diminished the effects of status differences on survival. Similarities in living arrangements, and, therefore, in sanitary conditions, childcare customs, etc., likely tempered the favourable effects of higher status.

Finally, as mentioned above, this is the first attempt to estimate the influence of food price fluctuations on mortality in this particular region. As a robustness check, we extended our models by including a separate indicator variable for the years of a severe harvest crisis. This substantially reduced the estimated impact of grain price dynamics on mortality compared with models that omitted the period indicator. It also raises questions about the relationship between grain prices and mortality risk in the region. For example, we have not explored whether there was a difference in the role of grain prices during the earlier and later decades of our study period. It is known that from the 1850s onwards, changes in grain prices became increasingly affected by export prices. Grain producers may have benefitted from higher prices (Lust, 2013). Assuming that the agricultural transformation most likely influenced market relations for peasants and other socio-economic groups, price surges as a proxy of economic hardship should be examined by sub-periods. Due to the limits of the current article, this question will be addressed in future research.

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