Living Standards and Mortality since the Middle Ages

Morgan Kelly and Cormac Ó Gráda, University College Dublin

Living Standards and Mortality since the Middle Ages.

Morgan Kelly and Cormac Ó Gráda*

Abstract

Existing studies find little connection between living standards and mortality in England, but go back only to the sixteenth century. Using new data on inheritances, we extend estimates of mortality back to the mid-thirteenth century and find, by contrast, that deaths from unfree tenants to the nobility were strongly affected by harvests. Looking at a large sample of parishes after 1540, we find that the positive check had weakened considerably by 1650 even though real wages were falling, but persisted in London for another century despite its higher wages. In both cases the disappearance of the positive check coincided with the introduction of systematic poor relief, suggesting that government action played a role in breaking the link between harvest failure and mass mortality.

JEL Classification: N33

1 Introduction.

While the Malthusian model underpins our understanding of pre-industrial development, its empirical performance is unimpressive, particularly when it comes to the prediction that mortality should rise as living standards fall. In England, where reliable population estimates go back to the mid-sixteenth century, bad harvests increased deaths until the mid-seventeenth century, but their impact then vanishes. Although well known, the weakness of the positive check has attracted little notice: the assumption appears to be that England in the sev-

---

enteenth and eighteenth centuries was simply too prosperous a place for food prices to be a matter of life and death.

However, while average living standards in England were high by contemporary standards, a substantial fraction of the population nonetheless lived in deep poverty. Gregory King, in 1688, estimated that one fifth of England's population had annual incomes of £2, placing them at the edge of biological survival (Lindert and Williamson, 1982). In an era when annual rises in wheat prices of 20 per cent were not unusual, it is hard to see how bad harvests would not have been followed by marked rises in mortality.

To understand how living standards affected mortality, we begin by extending estimates of mortality back to the late middle ages. Where existing studies start in the mid-sixteenth century, we go back three hundred years earlier to the thirteenth century. Direct records of deaths from this time do not exist, but we can infer mortality among nobles and unfree tenants ("serfs") from records of property transfers.

Our results are striking: in the eighty years before the Black Death in late 1348, poor harvests were deadly at both ends of society, with tenants dying immediately and nobles with a lag of a year, but showing similar increases to tenants.

While mortality after 1540 has been intensively analyzed, all existing studies rely on one data set: the aggregate population estimates of Wrigley and Schofield (1981). Here, instead, we analyze the hitherto unused raw data from 404 parishes from which Wrigley and Schofield derived their national estimates. Besides reducing standard errors by a factor of twenty compared with aggregate data, this allows us to see how the positive check varied across regions.

We find that the positive check effectively disappeared between the late sixteenth and late seventeenth centuries (see Figure 6) despite a fall in real wages of around one third (see Figure 3). However, the positive check did return temporarily but strongly during the early eighteenth century, and some parishes continued to experience a significant positive check until 1800. We also examine mortality in London and find that a strong positive check persisted there until the mid-eighteenth century, despite real wages that were more than fifty per cent above the rest of England; while deaths in Paris continued to move in line with real wages until the Revolution.

Our findings raise two issues for Malthusian models. First, how could medieval nobles have been affected by food shortages among the peasantry? Secondly, what caused the positive check to fall sharply between the mid-sixteenth

and mid-seventeenth centuries even though real wages were falling; and why did London continue to sustain a strong positive check for another century despite its higher wages? To answer these questions, we first must understand how the positive check operated.

In the standard Malthusian cross diagram (see Clark, 2007*a* for a lucid exposition) a fall in living standards increases mortality; but there is little discussion of what exactly it is that causes deaths to rise. The assumption appears to be that the poor fade away through starvation. However, it is only with improved public health in the twentieth century that people began literally to starve to death: before this most famine victims succumbed to epidemic disease (Mokyr and Ó Gráda 2002, Ó Gráda 2007).

That epidemics followed poor harvests was not simply because of hunger— the connection between nutritional status and immune functioning is not straightforward, with malnourishment increasing susceptibility to some diseases but not others (Chandra, 1996)—but to the interaction between malnutrition and vagrancy. As hungry people took to the roads in search of work or charity, the combination of malnutrition, poor hygiene, exposure to the elements, and psychological stress turned them into both victims and vectors of contagious disease. As a result, while mortality of the very poorest rose immediately after a poor harvest (a pattern we find among medieval tenants and in *ancien regime* Paris), the main impact occurred one or two years later as epidemic illness spread through the general population.

With bad harvests leading to vagrancy, disease, and social disorder, governments had a clear incentive to ameliorate their impact, but the only state sufficiently well organized to act decisively was England. Historians divide English efforts at poor relief into two broad stages: a reliance on interventions in grain markets from the late sixteenth century, supplemented by municipal relief in larger cities and extensive private charity; followed by a national system of parish poor rates that appeared in the 1620s and endured for two hundred years (Walter 1989, Leonard 1900).

Against the existing view of pre-industrial economies as passive victims of iron Malthusian processes, it would appear instead that societies not only had the incentive, but sometimes also the ability, to mitigate the positive check through public and private charity. In other words, living standards were not the sole determinant of mortality: well designed institutions could also matter. As Sen (1981) has argued, starvation is as much a matter of politics as of food supply. In the medieval period there was little extra charitable assistance to cope

with crises, and poor harvests caused heavy mortality at all levels of society. During the late sixteenth and early seventeenth centuries, increased provision of charity softened the impact of bad harvests; and after 1650 local poor relief and quarantining of infected families were sufficient (usually: we shall see that the system broke down twice in the early eighteenth century) to prevent episodes of dearth transforming into national epidemics.

That the positive check endured in London for a century after it had largely vanished in poorer rural areas is consistent with the looser organization of its public charity, and the tendency of the poor to migrate there in search of work after poor harvests. Again, the disappearance of the positive check in London coincides with the development of systematic public charity there.

Existing literature.

This paper draws together three literatures that have existed almost independently of each other: those on living standards and population growth after the sixteenth century; on medieval mortality; and on the evolution of the English Poor Law. The monumental reconstruction of English population after 1541 from parish records by Wrigley and Schofield (1981) allowed the interaction of living standards and population to be studied in detail. Beginning with Wrigley and Schofield (1981, 412–417) and Lee (1981), and continuing to Lee and Anderson (2002) who survey the intervening literature, no study finds evidence of a substantial positive check after the mid-seventeenth century. However, what is notable about these all these studies is that they do not go on to ask why the positive check diminished, and whether state intervention had anything to do with this.

Death rates in medieval England have been studied by Razi (1980) and Ecclestone (1999) for the fourteenth century; and by Gottfried (1978), Hatcher (1986), and Hatcher, Piper and Stone (2006) for the fifteenth. However, these studies only describe the pattern of mortality, and do not examine its possible connection with living standards. The classic exception is Postan and Titow (1959) who looked at the relationship between harvests and mortality on five Winchester manors, but their use of heriots (where the lord took a dead tenant's best beast) as a proxy for mortality remains controversial: see Nightingale (2005, 40–43).

Classic histories of the English Poor Law are Leonard (1900) and Slack (1989). Although the concern of most recent historical study, surveyed by Hindle

(2004), is with the micro-politics of the Poor Law, there is increasing interest in its effectiveness, as shown by Smith (2008). Most economic historians focus on the late eighteenth century and after (for example Boyer, 1989 and Lindert, 2006); but two notable exceptions that look at the evolution and effectiveness of early poor relief are Walter (1989) and Solar (1995), while Post (1976) argues that variations in European death rates can be explained by different levels of public charity, and Fogel (1992) links the absence of English mortality crises after the sixteenth century with the development of public charity.

However, the first author to share our reservations about the crude Malthusian model was Thomas Malthus (1800). In *An Investigation of the Cause of the Present High Price of Provisions,* Malthus was struck by how poor harvests across northern Europe in 1799 had caused near famine in Scandinavia, but no more than hardship in England. With notable intellectual honesty, Malthus conceded that "The system of the poor laws, in general, I certainly do most heartily condemn, as I have expressed in another place, but I am inclined to think that their operation in the present scarcity has been advantageous to the country."

The rest of the paper is as follows. Section 2 shows similar patterns of mortality among tenants and nobles in the eighty years before the Black Death, while Section 3 finds that this mortality is strongly predicted by real wages. To contrast our medieval results with the intensively studied period after the mid-sixteenth century, Section 4 shows how the positive check waned steadily despite falling real wages from the late sixteenth century, but with a strong upsurge during the early eighteenth century. In London, by contrast, the positive check remained strong and constant until the mid-eighteenth century, and it persisted in Paris until the Revolution. Section 5 suggests that the weakening impact of harvests on mortality was due to the creation of a national system of poor relief from the 1620s, and its extension to London from the 1720s, and investigates how the strength of the positive check related to local conditions.

2 Mortality before the Black Death: Tenants and Nobles.

In this section we use records of property transfers before the Black Death to look at mortality at opposite ends of the social spectrum: among unfree tenants, and the nobility.
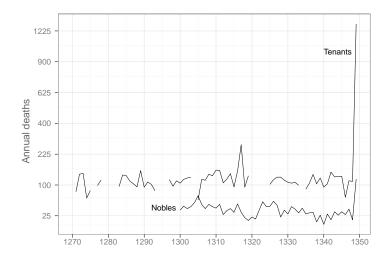
Figure 1: Annual deaths among nobles and tenants, 1270–1349.

2.1 Mortality among tenants.

On medieval estates, unfree tenants had to pay a fine at the manorial court
to transfer tenancy of land, and the records of these payments survive in large
numbers. A typical account roll entry, for 1325, translates "And for 30 shillings
from Isabella, who was Roger's le Muleward wife, to retain one messuage and
half-virgate of land [i.e. a cottage and about 20 acres] in Downton which be-
longed to the said Roger her husband" (Titow, 1969, p. 123). The more than
12,000 fines paid on each manor of the large estates of the Bishops of Winch-
ester in the south of England between 1263 and the arrival of the Black Death
in 1349 have been compiled by Page (2003), who was interested in the growth
of land transfers between unrelated individuals as evidence of the emergence of
a peasant land market. By counting the annual number of these transfers that
Page lists as inheritances, we can see how strongly deaths responded to living
standards.[1]

We have records of 12,378 inheritances on 77 manors whose annual totals
are plotted in Figure 1. Gaps occur in years when there was no bishop. The
accounting year started after the harvest, on 29 September (Michaelmas), and
manorial courts where fines were paid usually met only a few times a year, so

---

[1]By measuring mortality directly by inheritances, we avoid the potential problem with
heriots encountered by Postan and Titow (1959).

some of the inheritances recorded correspond to deaths in the previous calendar year. The number of inheritances shows two spikes where we would expect them: in 1317, at the peak of the Great Famine; and in 1349, the first year of the Black Death. Inheritances do not show a trend, suggesting that the relevant population of tenants was approximately constant, although total population probably fell by around 10 per cent during the Great Famine (Kershaw, 1973).

We can gauge the approximate social level of the dead by entry fines their heirs paid. To be a middling farmer required about a half-virgate of land which, in the early fourteenth century, commanded an entry fine of at least 30 to 40 shillings, and considerably more on some manors. This corresponds to the largest 10 to 15 per cent of fines in most years in our sample, where the median fine after 1300 is 7.5 shillings. Titow (1969, 78–81) estimates that only about half of all tenants in the early fourteenth century owned more than a quarter virgate, the minimum for subsistence. In other words, most tenants in our sample were smallholders, many with too little land to support themselves and having to work for wealthier farmers.

The manors in our sample vary considerably by number of tenants, and in the continuity of their records. The 20 largest manors account for roughly 70 per cent of recorded inheritances before 1349; and these large manors provide almost continuous records. Only fragmentary records survive, by contrast, for smaller manors. For all manors there are three problematic periods of data. While most large manors in most years always report some inheritances, before 1269 most large manors report none: there is clearly under-registration (Kelly and Ó Gráda 2010 find that recorded harvest yields before 1269 are similarly unreliable). The same clear under-registration occurs in 1323, a year in the middle of a 4 year break in records when many larger manors do not furnish returns; and to a lesser extent in 1305.

2.2   Mortality before the Black Death: Nobles.

The English nobility were, by definition, direct tenants of the king, and when a noble died without children, or those children were minors, their land was supposed to revert to the crown. To determine the value of the property and the existence of possible heirs, an Inquisition Post Mortem was carried out within weeks of the death, usually by neighbouring nobles. The records of all 1,819 surviving Inquisitions from 1300 to 1349 were used by Campbell (2005) to assess the income of the English nobility, and we use his numbers here as a

proxy for annual deaths among the nobility.[2] Again, because we are looking at a tenurial series, the number of nobles will remain reasonably constant even if population falls, so death rates will move in line with numbers of deaths if the series is accurate.

This proxy has the potential for under-counting: reversion of land to the crown was effectively a tax on the most powerful and potentially dangerous elements of society, and its collection relied on the cooperation of the local nobility. It is possible that in periods of weak central authority, such as the reign of Edward II (1302–1327), numbers of IPMs may underestimate deaths of nobles without adult heirs.

Figure 1 plots the numbers of inquisitions each year. Immediately apparent is the absence of a spike at the peak of the Great Famine in 1317, and the smaller rise in deaths among nobles compared with tenants in 1349, suggesting under-registration during mortality crises.

2.3   Death the Leveller.

We have independent data on deaths at opposite ends of society: the rich, and the, mostly, poor. Our expectation was that the two series would be weakly correlated because of measurement error in each; and because of the different mortality experiences in the two groups. In fact, they turn out to be closely correlated.

As Figure 2 shows, peasant mortality on the largest 20 manors, measured by inheritance fines, moves in line with mortality of nobles, measured by IPMs, with the exception of two years where we already suspect under-counting: 1317 for nobles, and 1305 for tenants.

This correlation between two mortality series constructed in quite different ways suggests three things. First, that both series are reasonably accurate measures of deaths, without severe under-registration in most years. Secondly, given that deaths of nobles were recorded within weeks, the correlation with tenant deaths suggests that most entry fines were paid soon after the death of a tenant, rather than in the following accounting year. Finally, and most importantly, that nobles were dying at similar rates to tenants is unexpected, and suggests that epidemic disease was a major factor in mortality. Hollingsworth's (1975) famous finding that English peers in the late fourteenth and fifteenth cen-

---

[2]Nash (1980) reports the number of IPMs for Wiltshire from 1242–1377, but the annual numbers are small (typically 4 or 5) and poorly correlated with the totals here.
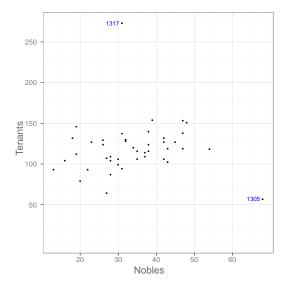
Figure 2: Annual deaths of nobles versus tenants, 1300–1348.

turies had similar life expectancies to poorer commoners is sometimes cited as evidence against any connection between living standards and mortality. What we see instead is that rich and poor are succumbing at similar rates to the same epidemic diseases.[3]

What precisely these epidemic diseases were is impossible to say: even the nature of the Black Death is disputed.[4] The mortality among nobles suggests some form of influenza, that has been identified as the main killer during the last national famine in England in 1556–58 (Hoskins, 1964). We now consider whether these epidemic outbreaks were exogenous events or the result of harvest failure.

3   Living Standards and Mortality.

We assume a simple log-linear Malthusian model

$$\ln(D_t/N_t) = \beta_0 + \beta_1' \ln(w_t) + \beta_2' \ln(D_{t-1}/N_{t-1}) + \beta_3' \ln(X_t) \tag{1}$$

---

[3]Nobles were also at risk of death in battle, but the risk was low at this time: in Rosenthal's (1973) sample of peers, fewer than 5 per cent of those born in the early fourteenth century died violently, compared with one third a century later. The only major battle of this period, Bannockburn in 1314, does not stand out in Figure 1.

[4]Cohn (2002) has argued influentially that the lethality and rapid spread of Black Death are more consistent with a haemorrhagic fever, like Ebola, than bubonic plague.
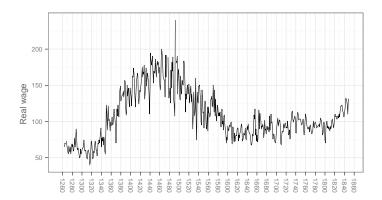
Figure 3: Real wage of agricultural labourers in England, 1274–1800 (Clark, 2007*b*) .

where D are annual deaths, N is population, w is a measure of living standards: either harvest yields or the real wage, and X are other variables, such as technology, medical knowledge, public charity, and urbanization. The right hand side variables are vectors of current and lagged values. Taking first differences we have

$$\Delta \ln(D_t) = \beta_1' \Delta \ln(w_t) + \beta_2' \Delta \ln(D_{t-1}) + \beta_3' \Delta \ln(X_t) + (\Delta \ln(N_t) - \beta_2' \Delta \ln(N_{t-1})) \tag{2}$$

For our populations of tenants and nobles we assume that $\Delta N = 0$: the population is roughly constant. This appears consistent with the absence of trends in Figure 1. For annual differences, we assume that the impact of changes in other factors X is negligible: it makes sense for a fall in mortality from one year to the next to be caused by higher real wages, but not by better technology or medical knowledge, although these variables can exert a strong influence over longer periods. We therefore estimate

$$\Delta \ln(D_t) = \beta_1' \Delta \ln(w_t) + \beta_2' \Delta \ln(D_{t-1}) \tag{3}$$

To measure living standards w we start by looking at harvest yields, and then consider real wage estimates.

While wheat was the primary commercial grain, oats and barley cost less per calorie, grew on worse land, and were more resistant to bad weather, offering subsistence farmers better insurance against starvation in bad years. Ac-
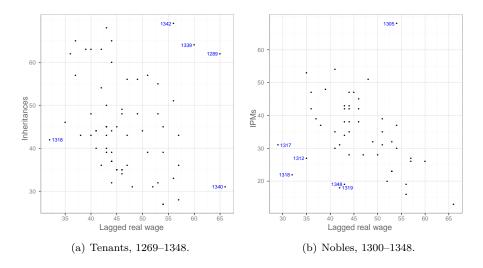
(a) Tenants, 1269–1348. (b) Nobles, 1300–1348.

Figure 4: Impact of real wages on mortality of nobles and tenants.

count records of what manors fed their servants—outside harvest time when better food was on offer to attract seasonal workers and to fuel intense physical exertion— show that the staple food of the poor before the Black Death was dredge, a mixture of barley and oats (Dyer, 1988). Yields of cheaper spring grains may therefore be most important in explaining deaths.

However, regressing inheritances on cereal yields, we found little connection between yields of spring grains and mortality. This probably reflects the fact that many tenants had holdings too small for subsistence, meaning that they had to work to buy grain; and the price of all grains closely tracked wheat yields (Kelly and Ó Gráda, 2010). The strongest relation was between wheat yields and subsequent mortality, but stronger still was the connection with the real wage series of agricultural labourers of Clark (2007*b*).

Because we have data for individual manors, we can estimate a multi-level regression, allowing the impact of wages and past deaths to vary across manors

$$\Delta \ln(D_t) = (\beta_1 + \beta_{1i})' \Delta \ln(w_t) + (\beta_2 + \beta_{2i})' \Delta \ln(D_{t-1}) \tag{4}$$

where the vector of random effects across manors $\beta_i = (\beta'_{1i}, \beta'_{2i})' \sim N(0, \Sigma_{\beta_i})$ (Bates, 2010, 12). However, when estimating this equation, we found that the restricted maximum likelihood estimates of the random effects were degenerate

	Tenants	Nobles
wage	−0.525*	−0.488
	(0.211)	(0.365)
lag wage	−0.476*	−0.922*
	(0.241)	(0.376)
lag2 wage	0.242	0.073
	(0.259)	(0.384)
lag3 wage	−0.437	−0.417
	(0.247)	(0.39)
lag deaths	−0.447**	−0.633**
	(0.032)	(0.171)
lag2 deaths	−0.272**	−0.092
	(0.029)	(0.2)
lag3 deaths	−0.09**	0.028
	(0.02)	(0.167)
d1289	0.424*	.
	(0.198)	
d1305	.	0.44
		(0.319)
d1317	0.766**	−0.422
	(0.18)	(0.33)
d1342	0.562**	.
	(0.187)	
N	663	45
$RMSE$	0.716	0.301
R^2	0.271	0.452

Regression of annual number of deaths on lagged real wages of agricultural labourers and lagged deaths. All series are first differences of logs. Standard errors in parentheses. Nobles series starts in 1300. * denotes significance at 5 per cent, ** at 1 per cent.

Table 1: Effect of real wages on mortality of nobles and tenants, 1269–1348.

at zero: there appears to be little variation in coefficients across manors. We therefore report ordinary least squares results here.

Figure 4(a) plots lagged real wages against the number of inheritances on the 20 largest manors, from the first reliable year of data in 1269 to the eve of the Black Death in 1348, leaving out the Great Famine peak in 1317. There are several outlying observations: the low value in 1318 reflects the normal fall in mortality at the end of a famine after the unhealthy have been culled from the population; while the years in the top right of the diagram probably correspond to episodes of exogenous pestilence: heavy mortality despite good harvests.

Table 1 reports the results of a regression of number of inheritances on each manor on the real wages and inheritances on the same manor in the three previous years. All series are first differences of logs. We exclude the first Black Death year of 1349 to prevent its mortality induced poor harvest (there were too few healthy people to harvest standing crops) generating spurious significance. Dummies are added for three years of unusual mortality identified above: 1269,

1317, and 1342. The wage in each year reflects wheat prices which, because wheat could be stored for a year, reflect harvests during the past two years.

It can be seen that real wages exert a substantial immediate impact on mortality, with an elasticity of one half, with a similarly large impact in the following year. The relatively low population density on these manors (Campbell, 2007) and their mild climate, means that the impact of bad harvests was probably lower than in other parts of England, and this elasticity of mortality with respect to real wages of unity is probably close to a lower bound nationally. It can also be seen that increased mortality in one year is followed by a fall in mortality of nearly four fifths in the following years: much of the increase in mortality represents an acceleration of deaths among the elderly or already ill, but over one fifth represents deaths among otherwise healthy individuals. Among the outliers in Figure 4(a), only 1289, 1317 and 1342 are significant.

If we used average wheat yield (using the annual median of yields in Campbell 2007) to measure living standards instead of real wages, only the first lag of yield is significant at conventional levels, but with an elasticity of only -0.37. Yield varied substantially across manors each year. Using wheat yield on individual manors as the measure of their living standards, we did not find any large or significant effects. A manor could experience a poor harvest without any impact on mortality, so long as other manors experienced good harvests and prices remained low: these fourteenth century peasants were not subsistence farmers but integrated into a market.

The size distribution of fines allows us also to see if years of severe epidemic mortality—1317 and 1349—had different social distributions of mortality than ordinary years. After 1303, the median fine is 80 pence, identical to the median fines in 1317 and 1349, suggesting that tenants at all levels suffered equally during these crises.

Adding summer and winter temperature as explanatory variables, using the reconstructions in Kelly and Ó Gráda (2010), to test if weather conditions had direct effects on mortality, did not produce effects that were substantial or significant.

3.1   Mortality among nobles.

Figure 4(b) shows the relationship between real wages in one year and IPMs the next. The low entries for 1317–1319 suggest under-enumeration in the aftermath
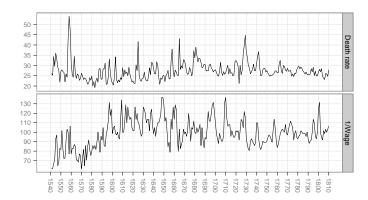
Figure 5: Deaths per thousand and the inverse real wage in England; 1541–1810.

of the Great Famine, but 1305 is a puzzling outlier that does not correspond to any battle or known demographic event.

The second column of Table 1 gives the results of a regression of the annual number of IPMs on current and lagged real wages and IPMs. None of the outliers in Figure 4(b) is large or significant. It can be seen that the dynamics of mortality among nobles are somewhat different from those among peasants, with the significant impact of a real wage fall occurring with a lag of one year. An increase in deaths one year is followed by a two thirds fall in deaths the following year.

That the mortality of the richest group in English society moved in response to food prices shows that wealth was no armour against death from epidemic disease that had incubated among hungry peasants. This vulnerability to epidemic illness is further suggested by Nash's (1980) Wiltshire data which shows that nobles died predominantly during the summer months, at the time of greatest hunger before the new harvest.

What is notable about the results in Table 1 apart from the large coefficients for both tenants and nobles is the large standard error for both groups, that reflects the high volatility of mortality on individual manors for tenants, and the small sample size of nobles. While we can conclude that the positive check before the Black Death was large for both groups, it is not possible to say with much confidence precisely how large it was. To do this requires much larger samples, something that we have after 1540.

14

	wage	wage (-1)	wage (-2)	wage (-3)	deaths (-1)	deaths (-2)	deaths (-3)	$\tilde{R}^2$	loglik	N	Parishes
1600	−0.1273	−0.2623	−0.5465	−0.2786	−0.5854	−0.3714	−0.2035	0.2876	−6023.2	8563	237
	(0.0452)	(0.0486)	(0.049)	(0.0442)	(0.0105)	(0.0113)	(0.0099)				
1650	0.0718	−0.4623	−0.0837	−0.1356	−0.5983	−0.3863	−0.2066	0.2795	−7575.7	13791	297
	(0.0385)	(0.0371)	(0.0376)	(0.0387)	(0.0083)	(0.0091)	(0.008)				
1700	−0.0549	−0.0832	−0.0515	0.2574	−0.5677	−0.364	−0.2095	0.2767	−6949.9	15353	310
	(0.0263)	(0.0265)	(0.0285)	(0.0248)	(0.0079)	(0.0086)	(0.0079)				
1750	−0.1576	−0.4236	−0.5078	−0.39	−0.5974	−0.4017	−0.231	0.3025	−6973.9	15479	310
	(0.0368)	(0.0433)	(0.0378)	(0.0382)	(0.0078)	(0.0085)	(0.0078)				
1800	−0.167	0.1261	−0.2058	0.3735	−0.6595	−0.4344	−0.218	0.3241	−5020.5	15488	310
	(0.0469)	(0.0544)	(0.0523)	(0.0548)	(0.0078)	(0.0088)	(0.0078)				

Mixed effects regressions by half century of annual number of deaths in parishes on lagged deaths and real wages. All series are differences of logs. $\tilde{R}^2$ is squared correlation between actual and fitted values.

Table 2: Effect of real wages on parish mortality by half century.

4 Living Standards and Mortality after 1540.

Having seen the strong positive check at work before the Black Death, we now consider how living standards affected death rates after the sixteenth century. We start by looking at mortality across England after 1539, when every parish was required to keep systematic records of funerals. Where existing studies exclusively use national data computed by Wrigley and Schofield (1981), we look at mortality in the 404 parishes that Wrigley and Schofield aggregated to compute their national estimates. This not only makes our standard errors twenty times smaller than existing studies, but also allows us to see how the positive check varied with geography and other characteristics of parishes, in particular their Poor Law spending.

A major omission in Wrigley and Schofield (1981) is London (whose share of English population rose from around 8 per cent to 12 per cent between 1650 and 1750, and share of deaths from around 8–10 per cent to 15–20 per cent), where parish records from before the Great Fire of 1666 do not survive. However, we have estimates of London deaths after 1640 from the *Bills of Mortality* that were compiled by government to monitor plague outbreaks. For comparison, we also examine death rates for another metropolis close to London: Paris.

4.1 English parishes.

Table 2 looks at the impact of living standards on parish mortality by half-century, starting with the first complete year of observations in 1540. In estimating the Malthusian equation (2) we again assume that the annual impact of long run factors $\Delta \log X$ is negligible. In the absence of migration data, we cannot reliably estimate the population of individual parishes before the census
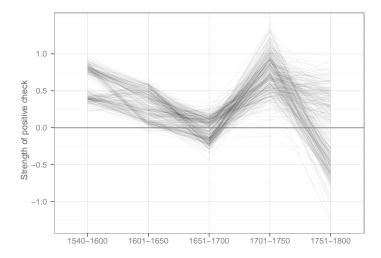
Figure 6: Strength of positive check across parishes by half century, 1540–1800.

of 1811.[5] However, we do know national population, and if we estimate equation 2 using national data (which gives almost the same coefficients as the average across individual parishes reported in Table 2), we get almost exactly the same coefficients for lagged wages and deaths whether we include the final population term or not.

To examine the evolution of the positive check β_1, we estimate a multi-level regression (4) across parishes by half-century intervals from 1540 to 1800. In the absence of long run data on regional prices, we use national averages of prices. Some parishes in the sample are small (37 had a median of five or fewer funerals per year over the estimation period), leading to large percentage variations in annual deaths which caused some convergence problems, especially during the first half of the eighteenth century. We therefore focus on the 310 parishes with a median number of deaths each year of at least 10.

Including random effects for lagged mortality again led to convergence problems for the early eighteenth century. For other periods, setting this random effect to zero (assuming, in other words, the same impact of lagged mortality in every parish) did not change the fixed effects coefficients β_1 and β_2 materi-

---

[5]If we use natural increase to estimate parish populations backward from 1811, assuming no migration between parishes, we find that a large proportion of parishes have negative population by 1600.

16

ally. Table 2 therefore reports regression results assuming the random effect on lagged mortality is zero.

We can see that before 1750, the main impact of falling living standards on mortality occurs after one, and especially, two years. Figure 6 plots for each parish minus the sum of the wage elasticity of mortality for these two years. It can be seen immediately that the strength of the positive check diminishes from 1540 to 1700, despite a declining trend in real wages.

This decline of the positive check, however, is sharply reversed in the first half of the eighteenth century which experienced two sharp mortality crises, in the early 1740s and, especially, the late 1720s when, as Figure 5 shows, death rates rose to levels not seen since the late 1550s. During the second half of the seventeenth century, the positive check resumed its secular decline although the variation across parishes rose substantially compared with earlier periods, with a subset of parishes continuing to experience a substantial positive check until 1800.

Also notable in Figure 6 is how much the strength of the positive check in individual parishes varied through time in early periods: individual lines frequently cross, so that parishes with a strong positive check in one period have a weak positive check in the next. The correlation between the positive checks in 1540–1600 and 1601–1650 is 0.3, and between 1540–1600 and 1651–1700 is 0. What is not evident in Figure 6, due to the jump in the early eighteenth century, is that the strength of the positive check is strongly correlated between the late seventeenth and late eighteenth centuries, with a correlation coefficient of 0.8.

Figure 7 maps the strength of the positive check in each parish, assigning it to three categories (for the late sixteenth century, parishes fall into two clear clusters as Figure 6 shows, so we group by these two clusters). It can be seen that the strength of the positive check goes from being geographically random in the late sixteenth and early seventeenth centuries to showing a strong spatial trend from south-east to northwest in the eighteenth. The final panel shows Poor Law expenditure in 1784 relative to parish population in 1811, and the pattern of expenditure again shows the same south-east north-west trend as the positive check.
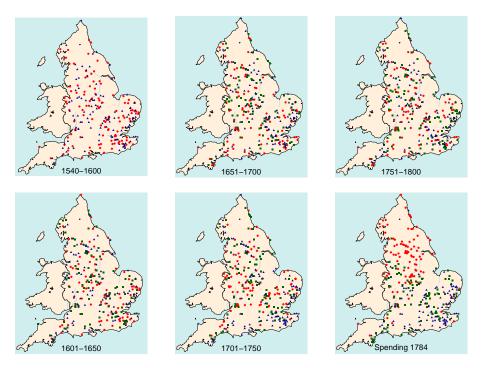
Figure 7: Strength of positive check by half century, and Poor Law spending in 1784. Red circles denote the strongest positive check or lowest spending, blue trianges denote the weakest positive check or highest spending.

4.2 London and Paris

Our London data start in 1647. They are taken from the Bills of Mortality which tracked numbers and causes of deaths as a way to monitor plague outbreaks; while Paris data, based on parish records of funerals, run from 1551 to 1788, with a gap between 1726 and 1739. We graph estimated crude death rates for both cities (London population comes from interpolating Wrigley's 1967 estimates, and Paris population from interpolating Biraben and Blanchet 1999). The London spike corresponds to the Great Plague of 1665, while the the two Paris
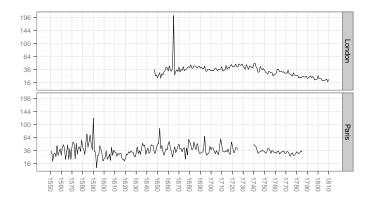
Figure 8: Deaths per thousand in London (1647–1810) and Paris (1550–1788).

spikes are associated with political turbulence: the siege of Paris in 1590, and the Fronde in 1652.[6]

Table 3 gives the results of a regression of death rates on lagged deaths rates and real wages, using Allen's real wage series for London and Paris. All series again are first differences of logs.

Early observations for London are volatile and exert high leverage on regressions. We therefore begin the reported regressions in 1653. It can be seen that lagged real wages affect mortality with an elasticity of −0.4 before 1700 (significant at 8 per cent), and −0.5 before 1750, but wages have no impact on mortality after 1750. The pattern of London mortality differs substantially from the rest of England. During the late seventeenth century when, as Table 2 and Figure 7 show, the positive check had waned in most places and especially in the area around London, it remained substantial in London. The positive check persisted in London despite higher real wages than in the rest of England: building labourers in London earned between 1.5 and 2 times as much as in Oxford (Allen, 2007). Similarly, although London did not experience the same crisis mortality as the rest of England during the 1720s and 1740s (compare Figures

---

[6]It is notable that the average annual death rate in Paris is not substantially higher than in London, although this may represent worse under-enumeration of infant deaths: whereas in London funerals usually exceed baptisms by around one third—in keeping with the idea of pre-industrial cities as demographic sinks—in most years the number of recorded baptisms in Paris exceeds the number of funerals. The low death rates for London in the late eighteenth century may be due to a more casual recording of deaths as the threat of plague waned, but may reflect the large numbers of young adults working there as servants, who had lower death rates than the general population: Davenport, Boulton and Schwarz (2010).

		London			Paris		
	1700	1750	1800	1600	1650	1725	1789
wage	−0.25	0.089	−0.249	−1.07**	−0.154	−0.746**	−0.485*
	(0.202)	(0.192)	(0.205)	(0.34)	(0.336)	(0.195)	(0.205)
lag.wage	−0.375	−0.485*	0.225	−0.211	0.019	−0.478*	0.008
	(0.206)	(0.198)	(0.226)	(0.39)	(0.35)	(0.213)	(0.215)
lag2.wage	−0.145	−0.208	0.402	0.688	−0.246	−0.195	−0.216
	(0.208)	(0.209)	(0.221)	(0.402)	(0.341)	(0.218)	(0.206)
lag3.wage	0.046	−0.262	0.328	0.367	0.152	−0.308	0.021
	(0.218)	(0.203)	(0.243)	(0.38)	(0.33)	(0.206)	(0.186)
lag.death	−0.246*	−0.496**	−0.475**	−0.683**	−0.519**	−0.48**	−0.029
	(0.101)	(0.146)	(0.156)	(0.152)	(0.15)	(0.119)	(0.165)
lag2.death	−0.055	−0.475**	−0.194	−0.149	−0.26	−0.238	−0.51**
	(0.093)	(0.149)	(0.164)	(0.17)	(0.159)	(0.131)	(0.155)
lag3.death	0.034	−0.254	−0.031	−0.139	−0.25	−0.123	−0.073
	(0.065)	(0.138)	(0.153)	(0.143)	(0.142)	(0.123)	(0.157)
d1665	1.728**	.	.	.	.	.	.
	(0.137)						
d1666	−1.566**	.	.	.	.	.	.
	(0.221)						
N	47	49	50	46	50	75	43
$RMSE$	0.12	0.097	0.092	0.382	0.228	0.244	0.078
R^2	0.929	0.366	0.282	0.543	0.26	0.342	0.387

Impact of living standards and past mortality on total deaths for London and Paris. All variables are differences of logs, standard errors in parentheses. * denotes significance at 5 percent, ** at 1 percent.

Table 3: Living standards and mortality in London and Paris.

5 and 8), its positive check remained as strong as during the late-seventeenth century.

Paris, where real wages were as low as in early fourteenth century London, shows a different pattern of mortality with falls in real wages causing immediate rises in mortality just as we found among medieval tenants. The positive check weakened through time but still remaining substantial until the Revolution, instead of disappearing in the mid-eighteenth century as in England. The absence of a positive check in the early seventeenth century is puzzling and is not caused by outliers in the data, but if these data are added to the previous or succeeding half-centuries, they continue to show strong positive checks.

5 What Had Changed?

We have seen that, during the late thirteenth and early fourteenth centuries, and from the mid-sixteenth to mid-seventeenth centuries, a strong connection existed in England between falling real wages one year, and increased mortality the

next.[7] We found that this positive check moderated after the mid-seventeenth century, except for London where falling wages caused increased mortality for another century. What stopped bad harvests killing English people on a large scale? We consider four possible factors: higher real wages; reduced variance of grain supply; increased urbanization; and changing climate. We then go on to consider the possible role of institutions, namely improved public health measures and the Old Poor Law.

First real wages. Figure 3 shows that, while real wages were low before the Black Death, they were actually higher in the late sixteenth century than a century later when the positive check had disappeared. While average living standards in England were high by contemporary standards, about one fifth of the population in the late seventeenth century lived at the edge of biological survival. Moreover, if the disappearance of the positive check in this period were simply due to rising living standards, we would expect that the positive check would be weaker in London than in the rest of England, because wages were higher there. Instead, we have seen how the positive check persisted in London after it had disappeared elsewhere.

That living standards were not sufficient of themselves to eliminate the positive check is not to deny that they did play a large role. It was only because England was a relatively prosperous place that it was able to afford a generous system of public charity: had living standards been as low as in France, the English Poor Law would probably have been unaffordable.

Next we consider the possibility that reduced mortality was the result of a better functioning grain market. While the standard deviation of annual percentage changes in wheat prices does fall after 1600 in response to better market integration and improved storage techniques, price changes retained a strong predictable component consistent with inflexible supply, and their variance was still substantial.[8] In half the years in the seventeenth and eighteenth centuries wheat price changed by over 10 per cent, and in one fifth by over 20 per cent.

---

[7]In an earlier version of this paper we analyzed a large sample of wills from 1430 to 1480 compiled by Gottfried (1978), but found that deaths bore little relation to living standards (which were uniquely high at this time as Figure 3 shows) but were driven by exogenous recurrences of plague.

[8]The standard deviation from 1261 to 1600 is 28.5%, compared with 18.3% from 1601 to 1800. Price changes retained a strong predictable component, the correlation between price changes two and three years apart being -0.25 and -0.20 respectively, with little difference before or after 1600.

The next possible factor in reduced mortality is increased urbanization and market activity. However, probably the same fraction of the population, around 6 per cent, lived in towns of over 10,000 in 1300 as in 1600 (Campbell, 2000, 405). Moreover, greater integration into markets tended to increase vulnerability to poor harvests. As Walter (1989) shows, subsistence agriculture provided considerable insulation against steep rises in food prices, that was lost when regions began to specialize in producing one good and import grain, so that the worst mortality crises of the early seventeenth century tended to occur in such proto-industrializing areas.

Finally, lowered mortality might be the consequence of climatic change. However, Kelly and Ó Gráda (2010) find that conventional stories of a Little Ice Age are a statistical artefact arising from the practice in climatology of smoothing data prior to analysis, and that unsmoothed annual temperature and rainfall reconstructions across western Europe between 1300 and 1900 show almost no autocorrelation: climate appears constant.

5.1 The Old Poor Law.

Given that rising living standards, reduced harvest volatility, increased urbanization, and better climate have limited power to explain the weakening positive check between the fourteenth and eighteenth centuries, we consider the possible impact of a central institution of English society before the industrial revolution: the Poor Law.

Before twentieth century advances in public health, starvation-induced mortality was not an individual fate. Instead, after bad harvests, the poor migrated in search of work or charity, spreading disease and social disorder ranging from petty crime to armed rebellion.[9] Apart from the dictates of religion (whose central place in people's lives at this time should not be overlooked) and paternalistic ideology, the ruling class had strong practical incentives to mitigate the impact of harvest failures on the poor.

In medieval times the main sources of charity were monasteries. While the amounts disbursed appear to have been substantial (Rushton and Sigle-Rushton 2001, Slack 1989, 13), they were given to a fairly fixed group of permanent

---

[9]For the eighteenth century, Galloway (1985) found that deaths of young adults in London rose in the aftermath of poor harvests, reflecting an influx of the unemployed from surrounding areas. Lawson (1986) shows, for the late sixteenth and early seventeenth centuries, that prosecutions for property crime rose after bad harvests. During the sixteenth century, disorder ranging from food riots to armed insurrection occurred after harvest failures (Leonard, 1900, 303).

dependents. Large religious institutions typically devoted the income or produce from one manor to charitable purposes, which meant that after a poor harvest, the amount available for distribution fell as demand rose.

Historians see the beginning of a concern with public charity in the mid-sixteenth century, as population pressure drove down real wages (see Figure 3). Central government response took two main practical forms: punishing vagrants, and regulating grain markets in years of poor harvests through so-called Books of Orders. These prohibited exports, restricted grain movements, and allowed magistrates to inspect grain stores (Leonard 1900, 61–66, Slack 1989, 113–137, Fogel 1992). However, at this time local charity was probably more important: both private, where wealthy individuals endowed institutions; and municipal, where local governments distributed subsidized grain or gave money directly to poor families (Walter, 1989).

What distinguished England during the seventeenth and eighteenth centuries was its comprehensive, national system of outdoor poor relief funded by local property taxes. While sixteenth century parliaments routinely passed laws to enact such a system, culminating in the Vagrancy and Poor Relief Statutes of 1598, the government only began actively to force parishes to implement poor relief in the 1620s. At this time the state developed a short and effective chain of administration from the King's Privy Council, through local grandees acting as county magistrates, to prosperous farmers acting as village constables. This led most of the more populous parishes to implement a system of poor rates to subsidies local families in need of assistance. Most charity went to those in permanent need: the elderly, the disabled, and widowed or deserted mothers of small children; with some aid going to families in temporary need because of illness, unemployment, or high food prices. Another facet of increasing state activism was aggressive action against epidemic disease, to which Slack (1981) attributes the disappearance of plague in the 1660s.[10]

This system was already sufficiently well entrenched by the 1640s to continue operating through the Civil Wars. By the end of the seventeenth century, Poor Law expenditure was about 1 per cent of national income, sufficient to provide complete subsistence for 5 per cent of the population; and increased to around 2 per cent of national income by the end of the eighteenth century (Slack, 1989). For comparison, O'Brien (1988) estimates that central government taxation

---

[10]The timing of the disappearance of plague listed by Slack (1981) give an index of governmental effectiveness: England in 1660s, France in the 1730s, Moscow in the 1770s, and the Balkans in 1840s.

equalled around 3.5 per cent of national income in the 1670s and 1680s, rising to 9 per cent in the 1690s, and 12 per cent by 1790.

Was this expenditure effective? Slack (1989, 207) concludes that after 1620 the system worked to minimize outright starvation. In other words it probably worked to keep the numbers of destitute people below a critical threshold needed for epidemic disease to spread through the general population, something that was aided by the prohibitions against vagrancy, and the insistence that aid would only be offered in one's home parish. It is notable that the reduction of the positive check from the early seventeenth century coincides with the emergence of a national system of poor relief at this time.

The effectiveness and limitations of Poor Relief are shown in Figure 5 which shows, after the mid-seventeenth century, the weakening link between harvest failure and crisis mortality. In particular, deaths do not rise in 1647, the 1690s, 1709 and 1800 despite sharp rises in wheat prices. However, it is equally apparent that public charity could be overwhelmed when poor harvests were accompanied by epidemic illness that left large fractions of the population too ill to work, of the sort that occurred in 1740–42 and, especially, 1728–30.

While most of England introduced systematic poor relief based on parish rates and monetary payments in the second quarter of the seventeenth century, the great exception was London. Serious efforts at public charity only began in London under the new Hanoverian monarchy in the 1720s, and took a different form than the rest of England, being centred on hospital and workhouses (Boulton and Schwartz, 2010). Most discussions of mortality decline in the late-eighteenth century focus on infectious disease, especially smallpox. However, Davenport, Boulton and Schwarz (2010) find that most of the improvement in London mortality occurred among infants under 6 months (between the 1740s and the 1840s infant mortality in London declined from around 350 per thousand to the national average of 160), a group whose death rate from infectious disease was low, something that is consistent with improving maternal health and infant nutrition resulting from public charity.

5.2   Determinants of the Positive Check.

What determined the strength of the positive check in different parishes? We have some information on parish characteristics from the late eighteenth and early nineteenth centuries compiled by Schofield (1998): type of farming; population in 1811; Poor Law expenditure in 1784 and 1832; the number of poor,
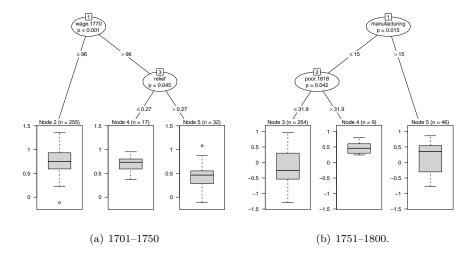
(a) 1701–1750   (b) 1751–1800.

Figure 9: Determinants of positive check in parishes during the eighteenth century.

and whether their support was satisfactory or not in 1818; taxable value for 1524 and 1832; and employment by sector for 1831. We also have Hunt's (1986) estimates of agricultural wages by county for 1767–1770.

We wish to see how well these variables predict the strength of the positive check across parishes during the first and second halves of the eighteenth century. Because most potential explanatory variables refer to later periods, our results rely on the assumption that local variables remained fairly constant through time, and must necessarily be tentative. All variables involving total expenditures, tax value, and employment structure are divided by 1811 population.

To determine the pattern of positive check we use a classification tree approach, using the unbiased recursive partitioning framework of Hothorn, Hornik and Zeileis (2006). This is a two step procedure where the covariate with the highest association with the dependent variable (based on a Strasser-Weber permutation test) is chosen, and this covariate is then split to maximize the difference between the dependent variable in the two subsets. The procedure continues until the p-value of the test for independence between the dependent variable and the covariates, reported at each node, falls below 5 per cent.

Figure 9(a) shows that for the crisis period of the early eighteenth century, the strongest predictor of the positive check in a parish are county wages, with

low wage areas having a stronger reaction of mortality to real wage changes. For higher wage area we see that the amount of poor relief in 1784 also mattered, with areas with low levels of poor relief having a positive check as strong as low wage areas, with parishes with more generous poor relief suffering the lowest impact.

For the late eighteenth century when, as Figure 6 shows, the positive check had disappeared in most areas, the main predictor is the size of manufacturing employment, with areas of high manufacturing employment still experiencing a strong positive check indicating a greater impact of food prices than in food producing areas. In areas with less manufacturing, having a large poor population led to a higher positive check.

6   Conclusions.

To Laslett's (1965) famous question "Did the peasants really starve?", the current answer is a fairly unambiguous "No". However, while numerous earlier studies have noted that bad harvests after the mid-seventeenth century tended not to kill many English people, this paper asked why. Constructing new series of mortality among tenants and nobility in the century before the Black Death, we found that bad harvests in this period were deadly at all levels of society. Similarly, while rises in food prices ceased to cause widespread mortality after the mid-seventeenth century (although there is a serious reversal in the early eighteenth century) despite falling real wages, we found that the positive check persisted in London for another century, despite wages there that over fifty per cent higher than elsewhere. This leads us to suggest that the disappearance of the positive check in England was not simply a reflection of living standards, but also the result of deliberate public charity, that emerged in rural England in the mid-seventeenth century and in London a century later.

Appendix: Data Sources and Estimation

- Crop yield data are from Campbell (2007): http://www.cropyields.ac.uk.

- Entry fines on the Winchester manors are from M. Page, "Peasant Land Market in Southern England, 1260-1350" available from http://ahds.ac.uk/catalogue/collection.htm?uri=hist-4086-1.

26

- Annual numbers of IPMs from 1300 to 1349 from Campbell (2005) were provided by the author.

- Annual numbers of wills in the Diocese of Norwich from 1430 to 1480 were calculated from Graph 4.1.1 in Gottfried (1978).

- Real wages of agricultural labourers are taken from Clark (2007b). Real wages in London and Paris are taken from Robert Allen's database of Prices and Wages. (http://www.nuffield.ox.ac.uk/General/Members/allen.aspx).

- Vital rates per 1,000 population from 1541 to 1870 are from Wrigley and Schofield (1981) Table A3.1. In estimating crude death rates in Figure 5, London population is interpolated from Wrigley's (1967) estimates, and Paris population and funerals are from Biraben and Blanchet (1999).

- London deaths from the Bills of Mortality are taken from Marshall (1832).

- Parish Poorlaw expenditure in 1784, mortality and population are from Schofield (1998).

- Estimation was carried out in R. Panel regressions were estimated using the `lme4` module, coefficient stability using the `strucchange` module, and sensitivity to outliers using the `forward` module.

References

Allen, Robert C. 2007. *Prices and Wages in London and Southern England, 1259–1914.* http://www.nuff.ox.ac.uk/users/allen/studer/london.xls.

Bates, Douglas M. 2010. *lme4: Mixed-effects modeling with R.* Springer-Verlag.

Biraben, Jean-Noel and Didier Blanchet. 1999. "Essay on the Population of Paris and Its Vicinity Since the Sixteenth Century." *Population* 11:155–188.

Boulton, Jeremy and Leonard Schwartz. 2010. The Parish Workhouse, the Parish and Parochial Medical Provision in Eighteenth-Century London. Working paper Newcastle University: The Pauper Lives Project. http://research.ncl.ac.uk/pauperlives/workhousemedicalisation.pdf.

Boyer, George R. 1989. "Malthus Was Right after All: Poor Relief and Birth Rates in Southeastern England." *Journal of Political Economy* 97:93–114.

Campbell, Bruce M. S. 2000. *English Seigniorial Agriculture 1250–1450.* Cambridge: Cambridge University Press.

Campbell, Bruce M. S. 2005. "The Agrarian Problem in the Early Fourteenth Century." *Past and Present* 188:3–70.

Campbell, Bruce M. S. 2007. *Three Centuries of English Crops Yields, 1211–1491.* http://www.cropyields.ac.uk.

Chandra, Ranjit Kumar. 1996. "Nutrition, Immunity and Infection: From Basic Knowledge of Dietary Manipulation of Immune Responses to Practical Application of Ameliorating Suffering and Improving Survival." *Proceedings of the National Academy of Sciences of the United States of America* 93:14304–14307.

Clark, Gregory. 2007*a*. *A Farewell to Alms.* Princeton: Princeton University Press.

Clark, Gregory. 2007*b*. "The Long March of History: Farm Wages, Population, and Economic Growth, England 1209-1869." *Economic History Review* 60:97–135.

Cohn, Samuel K. 2002. "The Black Death: End of a Paradigm." *American Historical Review* 107:703–738.

Davenport, Romola, Jeremy Boulton and Leonard Schwarz. 2010. Infant and Young Adult Mortality in London's West End, 1750–1824. Working paper Newcastle University: The Pauper Lives Project. http://research.ncl.ac.uk/pauperlives/infantandchildmortality.pdf.

Dyer, Christopher. 1988. "Changes in Diet in the Late Middle Ages: The Case of Harvest Workers." *Agricultural History Review* 36:21–38.

Ecclestone, Martin. 1999. "Mortality of Rural Landless Men before the Black Death: the Glastonbury Head-Tax Lists." *Local Population Studies* 63:6–29.

Fogel, Robert W. 1992. Second Thoughts on the European Escape from Hunger: Famines, Chronic Malnutrition, and Mortality Rates. In *Nutrition and Poverty*, ed. S. R. Osmani. Oxford: Clarendon Press.

Galloway, P. R. 1985. "Annual Variations in Deaths by Age, Deaths by Cause, Prices and Weather in London, 1670 to 1830." *Population Studies* 39:487–505.

Gottfried, Robert S. 1978. *Epidemic Disease in Fifteenth Century England: The Medical Response and Demographic Consequences.* Rutgers: Rutgers University Press.

Hatcher, John. 1986. "Mortality in the Fifteenth Century: Some New Evidence." *Economic History Review* 2nd series 39:19–38.

Hatcher, John, A.J. Piper and David Stone. 2006. "Monastic mortality: Durham Priory, 1395–1529." *Economic History Review* 59:667–687.

Hindle, Steve. 2004. *On the Parish?: The Micro-Politics of Poor Relief in Rural England c. 1550-1750.* Oxford: Oxford University Press.

Hollingsworth, T. H. 1975. "A Note on the Mediaeval Longevity of the Secular Peerage 1350-1500." *Population Studies* 29:155–159.

Hoskins, W. G. 1964. "Harvest Fluctuations and English Economic History." *Agricultural History Review* 12:27–47.

Hothorn, Herbert, Kurt Hornik and Achim Zeileis. 2006. "Unbiased Recursive Partitioning: A Conditional Inference Framework." *Journal of Computational and Graphical Statistics* 15:651–674.

Hunt, E. H. 1986. "Industrialization and Regional Inequality: Wages in Britain, 1760-1914." *Journal of Economic History* 46:935–966.

Kelly, Morgan and Cormac Ó Gráda. 2010. The Economic Impact of the Little Ice Age. Working paper University College Dublin.

Kershaw, Ian. 1973. "The Great Famine and Agrarian Crisis in England 1315–1322." *Past and Present* 59:3–50.

Laslett, Peter. 1965. *The World We Have Lost.* London: Methuen.

Lawson, Peter. 1986. "Property Crime and Hard Times in England, 1559–1624." *Law and History Review* 4:95–127.

Lee, Ronald D. 1981. Short Term Variation: Vital Rates, Prices, and Weather. In *The Population History of England, 1541–1871: A Reconstitution*, ed. E. A. Wrigley and R. Schofield. London: Edward Arnold.

Lee, Ronald and Michael Anderson. 2002. "Malthus in State Space: Macro Economic-Demographic Relations in English History, 1540–1870." *Journal of Population Economics* 15:195–220.

Leonard, E. M. 1900. *The Early History of English Poor Relief.* Cambridge: Cambridge University Press.

Lindert, Peter H. 2006. "Poor Relief before the Welfare State: Britain versus the Continent, 1780–1880." *European Review of Economic History* 2:101–140.

Lindert, Peter H. and Jeffrey G. Williamson. 1982. "Revising England's Social Tables, 1688–1812." *Explorations in Economic History* 19:385–408.

Malthus, Thomas. 1800. "An Investigation of the Cause of the Present High Price of Provisions." *Gentleman's Magazine* 70:1165–1167.

Marshall, John. 1832. *Mortality of the Metropolis.* London: .

Mokyr, Joel and Cormac Ó Gráda. 2002. "What Do People Die of during Famines? The Great Irish Famine in Comparative Perspective." *European Review of Economic History* 6:339–364.

Nash, A. E. 1980. "The Mortality Pattern of the Wiltshire Lords of the Manor, I242-I377." *Southern History* 2:31–43.

Nightingale, Pamela. 2005. "Some New Evidence of Crises and Trends of Mortality in Late Medieval England." *Past and Present* 187:33–68.

Ó Gráda, Cormac. 2007. "Making Famine History." *Journal of Economic Literature* 45:5–38.

O'Brien, Patrick. 1988. "The Political Economy of British Taxation, 1660–1815." *Economic History Review* second series 61:1–32.

Page, Mark. 2003. The Peasant Land Market on the Estate of the Bishopric of Winchester before the Black Death. In *The Winchester Pipe Rolls and Medieval English Society*, ed. Richard Britnell. Woodbridge: Boydell.

Post, John D. 1976. "Famine, Mortality, and Epidemic Disease in the Process of Modernization." *Economic History Review* New Series 29:14–37.

Postan, Michael and J. Z. Titow. 1959. "Heriots and Prices on Winchester Manors." *Economic History Review* 11:392–411.

Razi, Zvi. 1980. *Life, Marriage and Death in a Medieval Parish: Economy, Society and Demography in Halesowen 1270–1400.* Cambridge: Cambridge University Press.

Rosenthal, Joel T. 1973. "Mediaeval Longevity and the Secular Peerage, 1350-1500." *Population Studies* 27:287–293.

Rushton, Neil S. and Wendy Sigle-Rushton. 2001. "Monastic Poor Relief in Sixteenth-Century England." *Journal of Interdisciplinary History* 32:193–216.

Schofield, Roger. 1998. *Parish Register Aggregate Analysis: The "Population History of England" Database and Introductory Guide.* Colchester: Local Population Studies.

Sen, Amartya. 1981. *Poverty and Famines: An Essay on Entitlement and Deprivation.* Oxford: Clarendon Press.

Slack, Paul. 1981. "The Disappearance of Plague: An Alternative View." *Economic History Review* 34:469–476.

Slack, Paul. 1989. *Poverty and Policy in Tudor and Stuart England.* London: Longman.

Smith, Richard M. 2008. Welfare Citizenship, Rural Poverty and Epidemiological Patterning: Extending the Solar Case for the Relative Efficacy of Poor Relief Provisions under the English Old Poor Law. Technical report Department of Geography, University of Cambridge.

Solar, Peter M. 1995. "Poor Relief and English Economic Development before the Industrial Revolution." *Economic History Review* 1:1–22.

Titow, J. Z. 1969. *English Rural Society 1200–1350.* London: George Allen and Unwin.

Walter, John. 1989. The Social Economy of Dearth in Early Modern England. In *Famine, Disease and Social Order in Early Modern Society*, ed. John Walter and Roger Schofield. Cambridge: Cambridge University Press.

Wrigley, E. A. 1967. "A Simple Model of London's Importance in Changing English Society and Economy, 1650-1750." *Past and Present* 37:44–70.

Wrigley, E. A. and R. Schofield. 1981. *The Population History of England, 1541–1871: A Reconstitution.* London: Edward Arnold.