UNIVERSITY OF OXFORD

Discussion Papers in Economic and Social History

Number 66, March 2007

CITIES, MARKET INTEGRATION AND GOING TO SEA: STUNTING AND THE STANDARD OF LIVING IN EARLY NINETEENTH-CENTURY ENGLAND AND WALES

Jane Humphries and Tim Leunig

For a full list of University of Oxford
Discussion Papers in
Economic and Social History
see pages 35–38

CITIES, MARKET INTEGRATION AND GOING TO SEA: STUNTING AND THE STANDARD OF LIVING IN EARLY NINETEENTH-CENTURY ENGLAND AND WALES[1]

Jane Humphries

(All Souls College, Oxford)

<Jane.Humphries@all-souls.oxford.ac.uk>

Dr Tim Leunig

(Department of Economic History, LSE)

<Tim.Leunig@lse.ac.uk>

[1] We would like to thank Greg Clark for supplying us with his parish location dataset, Humphrey Southall for supplying us with the population data (via the Essex data archive) and Judith Allen for painstakingly entering the data from microfilm. We also thank the National Archives for supplying us with the data so efficiently. We are grateful to seminar audiences in Oxford and Cambridge, and conference audiences at the Keio Conference on anthropometrics and the Helsinki International Economic History Conference for comments. All remaining errors are ours alone. We thank the British Academy for paying for the data copying and entry and the Japanese Government Ministry of Education Grant-in-Aid and Keio Economic Society for funding attendance at both conferences.

Abstract

A new source, 1840s Admiralty seamen's tickets, is used to explore three anthropometric issues. First, did being born in a city, with its associated disamenities, stunt? Second, did being born near a city, whose markets sucked foodstuffs away, stunt? Third, did child labour stunt? Being born in a city stunted although the effect was limited except in the largest cities. In contrast, opportunities to trade did not stunt. Finally although adults who went to sea young were shorter than those who did not enlist until fully grown, going to sea did not stunt. Rather the prospect of plentiful food at sea attracted stunted adolescents, who reversed most of their stunting as a result. But child labour at sea was unique: wages were largely hypothecated to the child as food and shelter, rather than paid in cash that might be spent on other family members.

Introduction

Anthropometric history, the use of physical measurements, notably height, as a means of investigating living standards historically, has generated a lot of interest, some excellent books, including but not limited to Floud et al., *Height, health and history*, Komlos, *Stature, living standards and economic development*, and Steckel, *Backbone of history,* as well as many scholarly articles. It continues to be a major area of research in economic and social history.

Initially evidence on stature was used to supplement conventional economic indices of well-being, to run alongside and so check, nuance and even query standard accounts, or to extend into time-periods for which conventional evidence had petered out. Today anthropometric history is going in two – complementary – directions. On the one hand some anthropometric historians, armed with serious financial support, are able to assemble and analyse records from countries as yet uncharted by economic or anthropometric history.[2] Societies that are currently holes in our global knowledge, because the paucity of written records has made the construction of conventional measures of economic development impossible, become accessible for study.

On the other hand, historians are using anthropometric measures to expose variations in living standards within populations for which only aggregate income data is available. Indeed anthropometric evidence's most important contribution may be to probe the extent, nature and causes of inequality.[3] Thus Nicholas and Steckel tracked the heights of English convicts transported to Australia before 1840 in search of evidence on secular trends in living standards but also compared the heights of English and Irish convicts explaining the formers' relative stunting by the effects of rapid industrialization, bad harvests and the Napoleonic wars.[4] Other attempts to use differences in attained heights to expose the effects of deprivations of various kinds include: Horrell et al's account

---

[2] Steckel's leads two large National Science Foundation projects, BCS-0527658, 'Collaborative Research: HSD: The Living Environment and Human Health Over the Millennia', and SES-0138129 'A History of Health in Europe from the Late Paleolithic Era to the Present'. See also Moradi on 'Anthropometric history of Ghana'.

[3] Aggregate inequality has been shown to influence average height. Steckel for example contends that a 0.1 decrease in the gini coefficient is associated with a height advantage of about 1.5 inches, see Steckel, 'Height and per capita income'; Leunig and Voth, 'Living the high life'. Here the focus is on differences in the heights of subgroups of the population that can be correlated with other characteristics in order to illuminate the economic and social processes that invoke advantage or disadvantage.

[4] Nicholas and Steckel, 'Heights and living standards'.

of the effects of growing up in a female-headed household, and Voth and Leunig's, and Oxley's investigations of the effects of disease.[5] These studies share a common feature: they aim to understand things that are not captured in GDP, but which we know to be important in determining living standards, such as leisure, a functioning family, and health.

This second strand of the anthropometric literature has a dual purpose. As well as telling us something about the society that is being studied, it tells us something about anthropometric history. Height, its proponents argue, is a composite measure of many different things that make up the standard of living. Those who are more sceptical want to know exactly what is captured, and what effect a particular benefit or harm has on attained height.[6] We know, for example, that leisure is an important and valuable commodity. Nicholas and Steckel are able to show that this is captured in Irish heights: the Irish were poor but tall, and tall, they conjecture, because of (among other things) relatively low levels of child labour.[7] This is a useful result for advocates of anthropometric history, because height is positively correlated with an aspect of the standard of living, and furthermore, an aspect – leisure – that is not captured in GDP per head. If in contrast the evidence had suggested that additional leisure in childhood did not lead to greater stature, we would be forced to note that, although height is an aggregate measure, it was not one that included leisure as a component.

This paper focuses on three pieces of as yet unfinished anthropometric business. The first is the effect of where you were born within a country on height. This is an important issue. A large, traditional literature has established that although workers in cities were better paid, they suffered in many other ways. Many popular works describe in some detail the dreadful conditions of cities in this era, and the horrors of life in London have been rigorously depicted in John Landers' book *Death and the Metropolis*. But many historians are sceptical as to whether life in the countryside was quite the idyll some have portrayed. Life there, too, could be pretty bleak. Nor was it the case that all diseases of dirt and under-feeding were primarily urban. Tuberculosis, for example, that most important Victorian disease, afflicted the large urban centres at only average rates

[5] Horrell et al, 'Stature and relative deprivation'; Horrell et al, 'Destined for deprivation'; Voth and Leunig, 'Did smallpox reduce height?'; Oxley, ' "The seat of death and terror" '.

[6] For a sceptical view see Crafts, 'Cliometrics'.

[7] Nicholas and Steckel, 'Heights and living standards'; see also Mokyr and O Grada, 'Heights of the British and the Irish'.

while some of the highest rates were in rural districts.[8] Is it then the case that cities stunted? If so, how large did a city have to be to cause stunting? How large was the stunting effect for any particular city size? Did it matter where in a city you were born: that is, was London a single anthropological place or were the outskirts different from the more congested centre?

Floud et al. try to find out whether there was an urban height penalty for Great Britain in what we think is the least successful chapter of their book. Their data are given only at county level, and as such do not allow a meaningful comparison of urban and rural height differences. They define each county either as 'urban' or as 'rural', which means that they deem everyone living in Cheshire and Northumberland as living in urban England, and everyone in Bristol (one Britain's largest cities at the time) as living in rural Britain, because Bristol is in the otherwise largely rural county of Gloucestershire. London is defined to include all of the counties of Essex, Kent, Middlesex and Surrey. On this basis Floud et al. find the perplexing result that whilst English urban dwellers were taller than their rural counterparts, Scottish urban dwellers were shorter than their rural equivalents.[9] Given the flaws in the way that the data are assembled, this result is probably best placed to one side. Nicholas and Steckel in their study of convict heights also test for an urban disadvantage. Their rural–urban distinction is based on whether a man reported his birthplace as a city or town, a measure of birth location superior to the use of urban or rural county, but still unable to distinguish between towns of very different sizes.[10] Interestingly, Nicholas and Steckel found an urban shortfall in heights overlaid by significant regional variations, with convicts from London and the south shorter than those from the north.[11] Clearly much remains to be understood about this pattern, not least whether it extended into the period following the poor harvests and food shortages of the Napoleonic wars.

The second item on the anthropometric research agenda concerns the effects of market development and the growth of trade. The development of markets, the commercialization of agriculture and better transport can lead to deterioration in heights in rural areas, as people in the hinterlands of growing towns and cities produce more cash crops and sell their food stuffs in urban areas in order to earn money to purchase newly-available manufactured goods. In some cases

[8] Woods and Shelton, *Atlas*.

[9] Floud et al., *Height, health and history*.

[10] Nicholas and Steckel, 'Heights and Living Standards', p. 944.

[11] Nicholas and Steckel, 'Heights and Living Standards', p. 956.

this process of market integration appears to have left people in the countryside short of essential nutrients leading to a lower 'biological standard of living'. Adverse effects of this kind have been identified in evidence both for continental Europe and antebellum Pennsylvania.[12] Were those living in rural areas but close to British cities at this time shorter than those living further away? Against that, we know that agricultural intensification and farmers' responsiveness to opportunities to trade date back to the middle ages in Britain, and that the industrial revolution had long roots in trade and commerce.[13] To find that proximity to a substantial market did not affect rural heights would strengthen our perception that Britain had become an integrated economy well before the mid-nineteenth century.

A third question that remains extant in the anthropometric literature concerns the effect of child labour on heights (and on wellbeing). Although child labour has directly and indirectly been associated with stunting, the evidence is seldom fine enough to facilitate comparisons holding all other relevant variables fixed. Thus one expert suggests that 'The identification of occupational ill-health among children is probably impossible … against the very high background levels of urban illness and mortality in eighteenth- and early nineteenth-century Britain'.[14] Furthermore, apologists of child labour, old and new, argue that while straining children physically, work compensated for this insult by providing income, and therefore food, clothing and shelter, leaving them better off. Nardinelli, for example, has gone so far as to argue that the net advantage of child labour is self evident in families' decisions to send their children to work; child labour is revealed as preferred and therefore superior.[15] In this story a child worker might appear relatively stunted but would have been even more stunted without the combination of work and the resources such as food and shelter purchased by that work. Clearly much depends here on the nature of the work, the level of remuneration, how the child's wages were spent, and how the incremental food, clothing and shelter were shared within the family. Perhaps child labour was not always and everywhere the worst thing that could happen,

---

[12] Komlos, 'West Point Cadets'; Komlos, 'Shrinking in a Growing Economy'; Cuff, *The Hidden Cost of Economic Development;* Ewert 'Episodes from Germany'.

[13] Stone, *Decision-making*.

[14] Kirby, *Child Labour*, p. 15; see also Kirby, 'Causes of short Stature among coalmining children'; Kirby, 'Height, urbanisation and living standards'; Humphries, 'Comment'; Kirby, 'Rejoinder'.

[15] Nardinelli, *Child Labor*.

but the circumstances under which it was on balance ameliorating can only be uncovered by the accumulation of studies of different kinds of children's work undertaken in different kinds of circumstances. Because we know the age at which a boy first went to sea we are able to say something about the effects of precocious enlistment. We can see whether those who joined the merchant service at relatively young ages were on average taller or shorter than those who were more mature at their first voyage. We can also compare the growth trajectories of the early and late enlisters, and so learn something about the quality of life on board ship. This allows us to answer the question: did going to sea as a child worker lead to stunting or to catch-up growth?

Data sources

We use three separate sets of data, one that documents heights as well as other standard variables used in anthropometric analysis; one that documents population; and a third that details the location of places relative to each other. We describe each in turn.

Our principal source is the 'Register of Seamen's Tickets', kept by the Admiralty and Board of Trade's General Registry and Record Office of Seamen. The United Kingdom National Archives has the surviving 546,000 records preserved on 273 reels of microfilm.[16] The origins of the Registry lie in the Admiralty's persistent concern in the 1820s and 1830s with the problem of naval recruitment and particularly how men could be raised speedily in emergencies. In the past, impressment had been the main method but it was increasingly viewed as an anomaly in a more humanitarian age. Graham, the reforming First Lord of the Admiralty, initiated work on a scheme to persuade merchant seamen to volunteer in the event of war for service in the Royal Navy.[17] Initially the Merchant Seamen's Registration Acts 1844 (7 & 8 Vict c. 112) were intended to provide the basis for a ballot system that could be used in wartime. The Acts provided that no British seamen should leave the United Kingdom without a Register Ticket, which was to be procured by personal application. Although there was little progress towards the replacement of impressment, the Acts constituted the first tentative step towards the establishment of a bureaucratic machine whereby

[16] National Archive reference BT113.

[17] Graham wisely insisted on the retention of the pressgang until the new scheme was shown to be effective! See, Bartlett, *Great Britain and Sea Power*.

Merchant Seamen of certain ages and skills could be summoned to serve in an emergency.[18] This system continued until 1853, when the Board of Trade used its powers under the Mercantile Marine Act 1850 (13 & 14 Vict c 93) to replace it with a new form of registration.

In order to identify merchant seamen and prevent impersonation, detailed descriptions were taken. These include the name, date and place of birth, age, date of first going to sea, place of residence when unemployed, height (to the nearest quarter inch, a good sign of accuracy), and a physical description: hair colour, deformities, tattoos and so on.[19] Places of birth and residence were generally recorded in a quite detailed fashion – usually to the level of the parish or town. This is much more accurate than other sources, which as noted often give place of birth only at the level of the county. This is crucial for our purposes, as it means we are able to accurately judge not only whether a person was born in a rural or urban area, but also the size of the place of birth. The tickets also record whether or not individual seamen were judged able to write, and whether they could remember their exact date of birth. Both can proxy for childhood conditions in the statistical analyses as well as provide a basis for comparison with the general population.

We have had the first 20 reels of microfilm duplicated and all documented cases entered into a database.[20] These reels contain 39,901 observations. We exclude illegible entries, those born outside of England and Wales, those born before 1801, those whose heights were not recorded (one recording officer simply wrote 'growing' on every entry, no matter the age), those whose recorded ages are inconsistent with their given dates of birth (we allow a one-year margin of error), and those whose place of birth could not be traced conclusively. We are left with a little over 22,000 observations suitable for regression analysis.

In order to test whether city population size affected heights, we need to know the population of each of the places in which people were born. Humphrey Southall has computerised the parish-level population census for England and Wales from 1801 onwards, and we interpolate between census years so that we have a good estimate of the population of each parish in each year from that date.

---

[18] Bartlett, *Great Britain and Sea Power*, p. 49; p. 305.

[19] Smallpox was not accurately recorded. Only 3% of sailors were recorded as having had the disease.

[20] BT113/1 – BT113/20.

Finally, we need to be aware that places do not exist in isolation: the population of the parish of St George's in the East, in London, may not have been large in and of itself, but it was surrounded by the rest of London. We need to consider the population of the wider locality as well as the immediate vicinity in testing whether population caused stunting. To do this we need to know the distance between every place in Britain. Greg Clark has found the latitude and longitude of every parish in England and Wales.[21] It is worth noting that there is always some discretion in allocating a parish to a particular point. Parishes are not always of regular shape, and clearly there will be parishes for which one could make a case for a slightly different latitude and longitude. Some seamen gave a town rather than a parish as their place of birth. Where this cannot be traced in the Clark dataset, we have used the modern OS Gazetteer to find the geographical location. Both the Clark and OS datasets locate places to the nearest kilometre. We can therefore find the location of St George's in the East, and, using Pythagoras' theorem, we can find the distance between this parish and any other in England and Wales. We use crow-flies distances, neglecting issues such as the curvature of the earth, estuaries, mountains and the like. The loss of precision is very small. We matched Clark's parish dataset with that of Southall, so that we know the location and population of every place in every year from 1801. This means that we know not only the distances between any two places, but the populations of places a given distance apart. This allows us to calculate the population within any given distance from the place of birth of each of our seamen.

Data description

We begin with a discussion of the data.[22] The average person in this dataset was 25 years old. The youngest person in the dataset was just 8 years and one month, but people aged under 14 made up fewer than 1 per cent. In total 5 per cent were under 16, 25 per cent aged 16–20, 30 per cent 21–25 with the remaining 40 per cent aged 26 or over. Three per cent of seaman did not know their exact date of birth, but gave only the year in which they were born. 77 per cent

[21] The details of the Clark dataset are given in Clark 'The Charity Commission as a Source in English Economic History'. It is the absence of equivalent information for Scotland that leads us to exclude Scotland from our analysis.

[22] Earle, *Sailors,* discusses the characteristics of sailors some 50 years earlier and although these are based on a small selected sample (220 depositions in the High Court of Admiralty) the samples share many common features.

were recorded as being able to write, a percentage which increased slowly over time, from 74.9 per cent for those born in the 1800s to 76.5 per cent of those born in the 1810s, and 77.5 per cent of those born in the 1820s. The percentage fell off dramatically in the 1830s, reflecting the relatively young average age of people in the dataset born that late. These figures are consistent with evidence for the early nineteenth century from marriage registers and with literacy rates for the mid-nineteenth century published by the Registrar General.[23] Not surprisingly an ability to write was negatively correlated with the inability to recall exact date of birth. Fourteen was the most common age to go to sea for the first time, echoing the standard age for apprenticeship to a trade. 25 per cent of seamen went at a younger age, 17 per cent at 14, 27 per cent at 15 or 16, 20 per cent at 17 to 21, and the remaining 7 per cent at ages over 21. The average seaman was 5 feet 5¼ inches tall. The origins of sailors are disproportionately but by no means exclusively coastal.[24] Towns and villages along Britain's coasts are very well represented, whereas inland towns appear comparatively less often. London is – inevitably – the most common place of birth, because it was the largest city, because it was a major port, and because most of the tickets are London tickets.

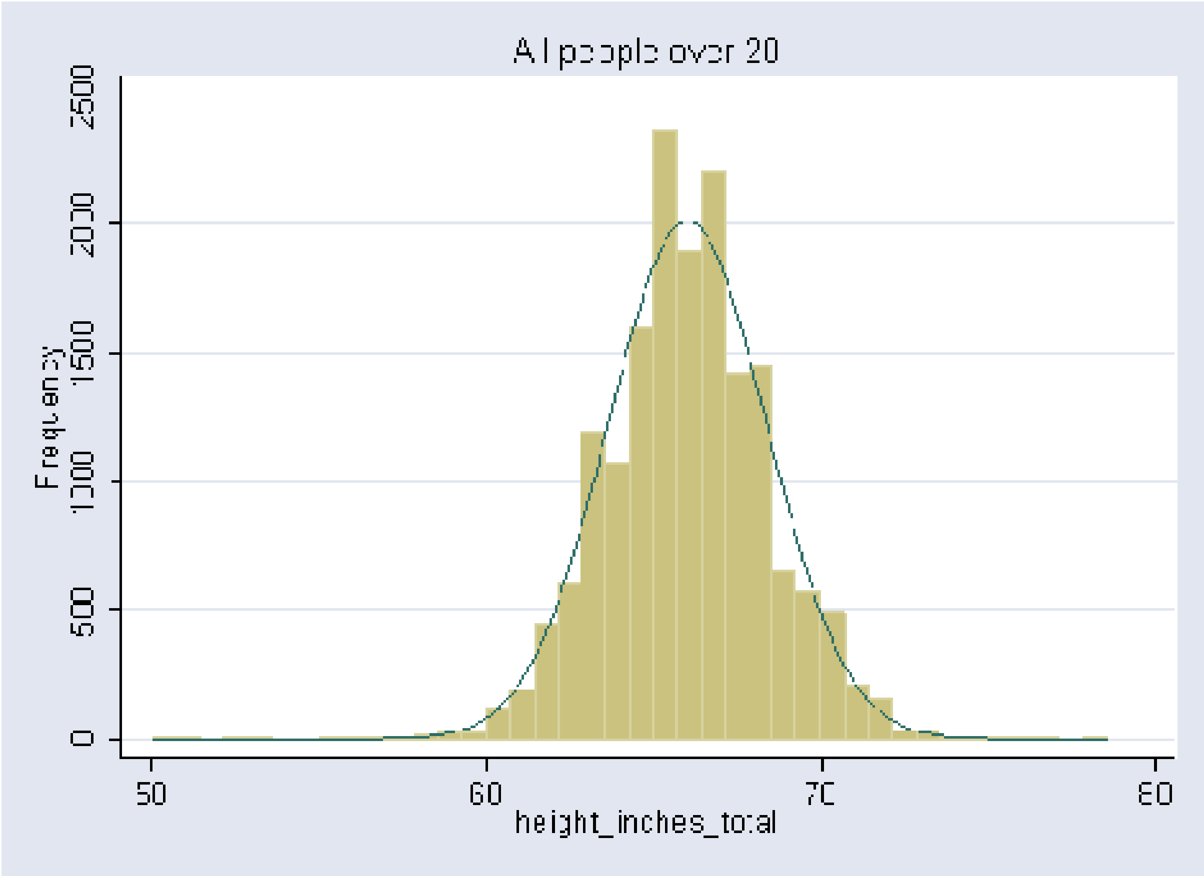
There has been no suggestion that the merchant navy operated a *de facto* or *de jure* minimum height standard, nor is there evidence to suggest that men who were particularly tall found life uncomfortable on board ship. This implies that the data will be normally distributed, an implication that is borne out by inspection. Figure 1 gives the frequency distribution of the heights of all seamen aged over twenty in our dataset. It shows a distribution that is as normal as researchers could realistically hope for, and means that some of the difficult and contentious issues about the appropriate techniques to overcome issues of truncation bias need not concern us.[25]

[23] The latter suggest that 67.3 per cent of men were literate in 1841 and 69.3 per cent in 1851, see Sanderson, *Education, Economic Change and Society*. Earle, found that about two thirds of ordinary foremast men were able to sign, a literacy rate he judged very much like 'other respectable working men', *Sailors*, p.19.

[24] Earle, also found that unless they were Londoners, sailors were overwhelmingly drawn from the maritime counties and the great majority from within sight of the sea, see *Sailors,* p.19.

[25] The computational difficulties associated with truncated samples produced by (changing) minimum height standards are discussed in Heintel and Baten, 'Smallpox and nutritional status'; see also Heintel, 'Height samples'.

Figure 1. The heights of seamen aged over twenty



Analysis

We begin by running a standard height regression which seeks to explain height by using age and measures of social status as explanatory variables. As is now usual, we include age as a series of dummy variables, one for each year. Unlike most studies, we know the exact date of birth, and we include a variable that measures months as well, so that the difference between a person who is 16 and 4 months and one who is 16 years and 5 months will be captured econometrically. As is usual, we use a dummy variable to capture the ability to write as a (positive) indicator of social class. In addition, we also include a dummy variable for 'age-heaping', that is, knowing only the year rather than the exact date of birth, as a negative measure of social status.

Table 1. Heights by age and social status

	coefficient	t-statistic
Age 8	–8.73	–4.90
Age 9	–12.51	–11.10
Age 10	–12.71	–10.09
Age 11	–10.01	–16.31
Age 12	–9.61	–23.53
Age 13	–8.84	–37.99
Age 14	–7.16	–47.43
Age 15	–5.14	–41.73
Age 16	–3.25	–30.54
Age 17	–2.12	–20.92
Age 18	–1.06	–10.92
Age 19	–0.47	–4.81
Age 20	–0.28	–3.02
Age 22	0.10	1.10
Age 23	0.28	2.96
Age 24	0.34	3.48
Age 25	0.16	1.57
Age over 25	0.27	3.81
months	0.19	4.07
write	0.26	6.40
heaping	–0.32	–3.47
constant	65.52	854.26

N = 22,229
Adj R^2 = 0.30
F (21,22207) = 460.1
Root MSE = 2.52

Notes: The dependent variable is height measured in inches. The omitted category is a 21-year-old who could not write, but could remember their date of birth.

The regression performs well. All of the coefficients are correctly signed, and exhibit plausible magnitudes and degrees of significance. Age is an important variable: older boys are generally taller, but the effects peter out in importance among young men. There are no significant increases in height after age 22. Being able to write is positively associated with being taller, whilst the inability to recall your exact date of birth is associated with being shorter, both results are statistically significant at the 0.1 per cent level of confidence. Age heaping appears to be a useful proxy measure for anthropometric historians, in addition to literacy.

Having shown that the sample performs well in standard anthropometric analysis, we now turn to the first of the questions that we wish to investigate: the effect of city size. At first sight the obvious function form for the regression is as follows:

Height = age + social variables + population 0–1km,
population 1–2km, population 2–3km, etc + ε.

Unfortunately this leads to strong multicollinearity. If you are born in a central London parish then not only are there many people living immediately where you were born, but there are also many people living near where you were born. In contrast if you were born in a rural village, not only are there few people where you were born, but there are few people living near where you were born. If we regress the number living within 1km on the number living at other distances the R^2 is over 0.75. This means that the proposed equation will generate unreliable standard errors, and we will not, therefore, be able to say which of the variables are, in fact, significant.

The correct way forward, therefore, is to use exogenous information to define city size *ex ante*, and to run a regression of the form:

Height = age + social variables + population 0–*n* km + ε

where n is the exogenously defined radius of the city. It is plausible to make a case that a typical town in this period is as small as 3km in radius from the centre, or that we should include the population up to 10km away, in order to include all of London. No answer will be correct for all towns. A small radius will exclude part of London, whereas a large radius may include a few villages that are near a small town, but are not part of it. We proceed, therefore, by running multiple regressions for each of the different plausible definitions of typical city size. We can then compare the results, both in terms of statistical results, and in terms of what they imply for the extent – if any – of stunting. Only if the different definitions give significantly different results do we need to be concerned as to which definition is most appropriate. In each of our eight regressions the coefficients on age dummies, the ability to write, and on age heaping are similar to each other and to those reported in table 1. We include both population and population squared, since the relationship between population and height may be non-linear.[26]

Table 2. Heights by city size

	Population		Population squared		
	coefficient	t-statistic	coefficient	t-statistic	Adj-R2
Population 1 to 3	–2.63	–7.5	2.34	3.93	0.311
Population 1 to 4	–1.77	–8.46	1.07	4.57	0.311
Population 1 to 5	–1.42	–6.60	0.703	3.04	0.311
Population 1 to 6	–1.08	–6.40	0.423	2.97	0.311
Population 1 to 7	–1.04	–5.97	0.412	2.92	0.311
Population 1 to 8	–0.963	–5.56	0.346	2.57	0.311
Population 1 to 9	–1.02	–5.84	0.4	3.12	0.311
Population 1 to 10	–1.1	–6.05	0.459	3.54	0.311

Notes:
The population bands are radii measured in kilometres from the centre of the place, defined according to the Clark dataset.
Populations are measured in millions.

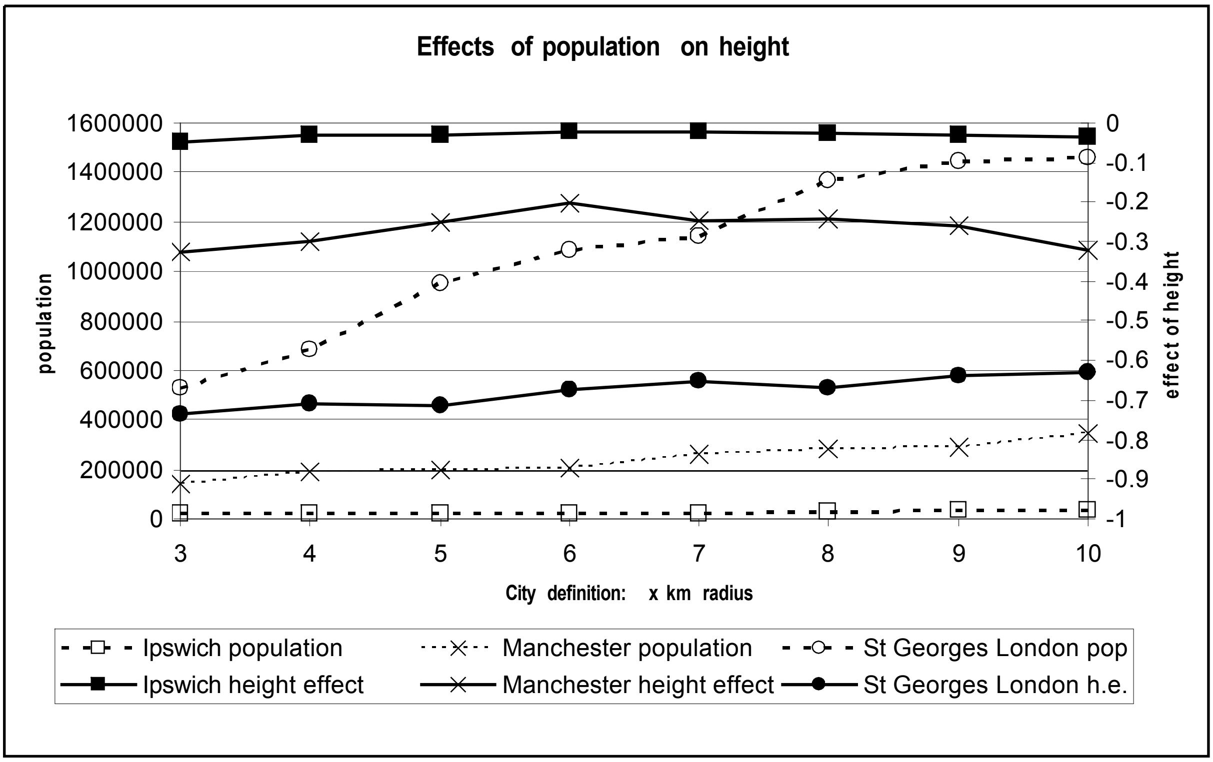
Table 2 show that the coefficients on population and population squared are always statistically significant, no matter how the city is defined. This is an important result since it confirms the finding that cities stunted for any sensible definition of city. Furthermore, the R^2 statistics differ only trivially, which tells us that standard statistical goodness-of-fit tests are not able to usefully distinguish the quality of one definition of the city versus another. Instead we look to the estimated effect on height of the different definitions of city size, to ask whether the exact definition of the geographical size of city matters.

The clearest way to present these results is graphically, by looking at three places: Ipswich, a town of around 20,000 people (no matter whether we look at

[26] Including the cube of population is only erratically significant, and does not improve goodness of fit.

the population within 3 or 10km), Manchester with 140,000 within 3km and 340,000 within 10km, and St George's in the East, in London, with a population of 500,000 within 3km, and 1,400,000 within 10km.[27]

Figure 2. Effects of Population on Height



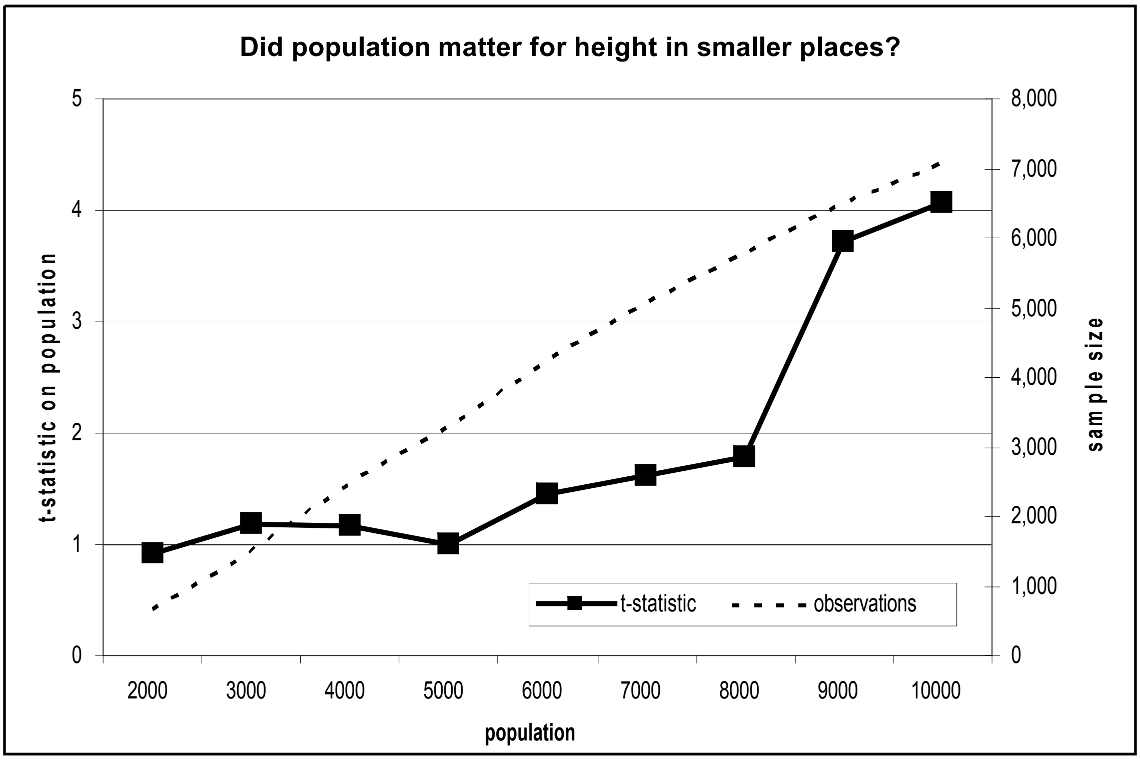
Two results stand out from Figure 2. First, the estimated effect of population on height does not depend critically on the definition of the city. Instead the magnitude of the effect, in terms of how it affects our understanding of urban disamenity, is essentially independent of the functional form of the regression equation. Second, the effect is tiny for Ipswich – around 1 millimetre, relatively small even for a city the size of Manchester – around a quarter of an inch or so, and noticeably larger for London – around two-thirds of an inch. Cities, however defined, clearly stunted, but equally clearly cities had to be of a certain – large – size to have had a discernable effect on height.

We have found that the estimated effect of being a city the size of Ipswich was to cause stunting of around one-thirtieth of an inch. We now go on to refine this finding, by testing whether or not height remains statistically significant when we restrict ourselves to towns of under a certain size. It is intuitive that there must be a population size sufficiently small as to have no statistically sig-

[27] These figures are for 1825.

nificant effect on height. The question is whether that size is a small hamlet, a village, a market town or a regional urban centre. We can answer this question by the simple expedient of restricting our sample to places with populations smaller than *n* people. We start with a very small definition of *n*, at which population is not a significant determinant of height, and increase it until we reach the size of *n* at which population becomes a significant determinant of height for the first time, as judged by the t-statistic on population in the regression. As Figure 2 shows, the critical value of n proves to be 8,000 people within 5 kilometres radius of the centre. For towns with populations of 8,000 and below, population had no effect whatsoever; with t-statistics consistently lower than two. But once population reached 9,000, the t-statistic on population becomes and remains statistically significant.

Figure 3. Effects of population on heights in smaller places



A population of 8,000 is clearly a town, rather than a village or hamlet. In this era, places such as Fareham, St Austell, Beverley, Sittingbourne, Hastings, Stockton, Aylesbury, Havant and Cirencester would all have been small enough to have had no effect on the heights of their residents. Furthermore, as we have seen, although places the size of Ipswich did have a statistically significant effect on height, the magnitude was of no importance either to the boys themselves, or to historians seeking to capture the disamenity value of living in a city. The anthropometric evidence suggests that while living in Ipswich was technically harmful, it did not cause stunting in any meaningful sense. Indeed, places the size of Halifax, Plymouth, Nottingham and Wolverhampton are estimated to have stunted by only about a tenth of an inch, which even places the size of Liverpool, Birmingham or Leeds would have had stunted by no more than a fifth of an inch. Stunting was very much a big city phenomenon.[28]

As well as being more precise about the minimum town size to cause stunting, we can be more precise about London. Fulham, for example, located 9km from Blackfriars, was at the edge of London in this era. There were only 35,000 people living within 3km of Fulham in 1826, rather than the 500,000 living with 3km of St George's in the East. Yet both were part of London – there were 185,000 living within 5km of Fulham, and a million within 10km. Did it matter for heights that some places in London were at the centre, and some at the periphery? Is London one city, with a unified set of anthropometric conditions? We can test whether being born at the outskirts of London had the same effect on height as being born in the centre of London in two ways. First, we can ask whether, for those people who were born in London, immediate population mattered. If it did, being born in Fulham was not the same as being born in central London.

Table 3 tells us that immediate population unambiguously mattered for those born within London. Since the centre was much more densely populated than the periphery, this tells us that central London did cause more stunting than did the outskirts.

Table 3. Effects of location in London: Centre versus periphery

	Coefficient	t-statistic	Implied Fulham–St George's difference
Population 1 to 3	–0.542	–3.93	0.25″

Notes: The sample is all seamen living within 9km of Blackfriars, N=7191. All the standard right hand variables included in the regression in table 1 included but not reported. Population measured in millions

[28] Nicholas and Steckel's 'London effect' can be interpreted as supporting evidence, see 'Heights and Living Standards' p. 955.

We can also ask whether the centre was different from the periphery by testing whether, for those within London, the distance from the centre (defined arbitrarily but plausibly as Blackfriars) was a determinant of height. The results are given in table four, and again we get the same answer: the edge of London was not the same as the centre in terms of attained heights: on average, every kilometre that you were born away from the centre added about a twentieth of an inch to your final attained height, so that those born at the edge of London were likely to be a third of an inch taller than those living in the centre, that is to say, our earlier estimate that London stunted by two-thirds of an inch holds for central London, but it halved for London's periphery. There are two further comments that we can make. Firstly, when we restrict the regression reported in table 4 to those living within 3 km of Blackfriars, the distance from Blackfriars is nolonger statistically significant. Over this range there is no correlation between distance and height – Southwark, Borough, Cripplegate, St Clements, Soho and Aldersgate were all equally poor places to be born. Second, when we include a dummy variable in the regression reported in table four to distinguish between those living west from the centre to those living east from the centre, it is not significant. We interpret this to mean not that the west of London was, on average, as wretched a place to live as the east of London, but rather that, for those born and raised in the social classes who went on to join the merchant navy there was no difference between east and west London: for the poor, both places were equally bad.

Table 4. Effects of location in London: Distance from centre

	Coefficient	**t-statistic**	**Implied Fulham–St George's difference**
Distance from centre	0.039	3.42	0.35″

Notes: See notes to Table 3.

Market integration

Komlos, Cuff and others have noted that the process of market integration can reduce heights, and found evidence for this in continental Europe and Antebellum Pennsylvania.[29] The intuition is that previously well-fed agricultural workers stopped producing foodstuffs for local consumption, and started producing cash crops for sale in emerging urban markets. As a result local children were less well-fed and grew up stunted. We can test for this effect using our data. To test for potential adverse effects of market integration, we restrict the sample to small places (defined as those with a population of up to 2000 within 4km of the centre) and then ask whether population nearby was associated with lower stature. Put simply: is it the case that people living in small places proximate to large towns are shorter than those living in similarly small but more isolated places?

Table 5. Effects of proximate markets

	Coefficient	t-statistic
Population 1 to 4km	–14.00	–0.10
Population 5 to 8km	–4.160	–0.34
Population 9 to 12km	10.300	1.07
Population 13 to 16km	–5.010	–0.72
Population 17 to 20km	1.390	0.38
Population 21 to 24km	–0.682	–0.32
Constant	66.320	185.22

N = 1,349
Adj R^2 = 0.25
F (24,1324) = 18.39
Root MSE = 2.34

Notes: Age, write, heaping dummies included but not reported. Populations are measured in millions

[29] Komlos, 'West Point Cadets'; Komlos, 'Shrinking in a Growing Economy'; Cuff, *The Hidden Cost of Economic Development.*

It is clear from Table 5 that population nearby had no effect on heights. It did not matter whether there was a large town 8, 12, 16, 20 or 24 kilometres away: height was unaffected. A city that was close by neither increased height (perhaps via better availability of work) nor reduced it (perhaps via lower nutritional standards, as foodstuffs were diverted to the urban market). What can we make of the absence of an effect of nearby concentrations of population on heights? Rather than believing that English and Welsh farmers refused to trade with nearby cities and towns, a more plausible explanation is that by the 1830s and 1840s all regions were well integrated into a national market. Insofar as the British countryside was giving up essential calories or nutrients it was doing so uniformly: there were simply no areas of Britain left by this period that were not engaged in meaningful levels of trade with towns and cities. Britain was the most urbanised country in this period, and British towns and cities correspondingly needed a greater level of market integration than their continental European or North American counterparts.

Going to sea

We now turn our attention to the issue of child labour: did going to sea as a boy stunt, have no effect, or lead to increased height? Child labour has been identified as an indicator of stunting, and it is plausible to believe that the work intensity at sea was sufficiently onerous as to cause stunting.[30] Against that, there is evidence, considered below, that diets were commensurate with the work levels expected of sailors. We begin our analysis by looking at the heights of adult seaman, asking whether those who first went to sea at a younger age were taller or shorter. If going to sea caused stunting, then *ceteris paribus*, those who went to sea as boys would end up shorter than those who delayed going to sea until adulthood, with stunting greatest for those who went to sea at the youngest ages. If in contrast going to sea increased heights, we would expect to find that those who went to sea as boys were taller than those who delayed until adulthood, and again, we would expect to find the effect most strongly for those who went to sea at the youngest ages.

Neither of these two patterns is, in fact, observed in the data. As Table 6 makes clear, those who went to sea as boys were consistently shorter than those who did not join the navy until adulthood, but it is not the case that the shortfall is greatest for those who went to sea youngest.

[30] Horrell, et al., ‘Destined for deprivation’; But see also Kirby, *Child Labour*.

Table 6. Effects of going to sea at different ages

Age of going to sea	Coefficient	t-statistic
13	–0.085	–1.24
14	–0.153	–2.59
15	–0.197	–3.16
16	–0.162	–2.46
17	–0.202	–2.65
18	–0.038	–0.44
19	–0.015	–0.15
20	–0.017	–0.16

N = 15,636
Adj R^2 = 0.0142
F (11,15636) = 20.46
Root MSE = 2.35

Notes: Sample is limited to seamen aged 21 and older and excludes those whose year of going to sea is unknown. The low R^2 is typical for height regressions limited to adults. Dummy variables for literacy, heaping population within 10km and a constant were included but not reported. All were correctly signed.

We have, therefore, an apparent contradiction: going to sea as a boy made you shorter (the coefficients are consistently negative), but being at sea for longer was no worse than being at sea for a shorter period – the coefficients on age do not decline. We can safely conclude, therefore, that the *ceteris paribus* condition does not hold: those who went to sea as boys were not the same as those who went to sea as adults. The most plausible hypothesis is that those who went to sea first were poorest. Those who enlisted at young ages may not have been short because of the effect of work at sea; instead poverty may have led them independently both to be short and to go to sea. Boys who were short because of low nutritional status would have found life at sea – or at least the promise of three square meals a day – particularly appealing, and so were disproportionately represented among the youngest recruits.

We have evidence that this was the case. Frank Thomas Bullen, an (apparent) orphan who enlisted aged 12, was at pains to dispel romantic myths about the lure of the sea in later autobiographical writings, noting that

> I belonged to the ignoble company of the unwanted. In spite of hard usage, scanty food, and overwork, I ridiculously persisted in living, until at the approach of my twelfth year, an eligible opening presented itself to me to go to sea. Being under no delusion whatever as to the prospect that awaited me, since I had known intimately those who had experienced all the vicissitudes of a sailor's life, I was not wholly elated at the idea. Nevertheless, food and shelter were objects peculiarly hard of attainment ashore, while I felt satisfied that at sea these necessaries would always be provided, even if their quality was none of the best.[31]

Bullen's experience was not unique. Ben Tillett, was driven to join the Navy at thirteen, fleeing a life of '[h]unger, continuous scolding and punishment…'.[32] Rodger is right to stress that regular meals were one of the attractions of the navy.[33]

The evidence that many of the most deprived boys found life at sea to be appealing does not, of itself, show whether or not life at sea was sufficiently good to allow them to make up some of the shortfall in height that already marked them out. We know that they were unable to make up the entire shortfall. Table 6 showed that those who went to sea as adolescents were shorter as adults. The question then is simple: are the height shortfalls reported in Table 6 for those adults who went to sea as adolescents smaller than the shortfalls that we could have observed when those adolescents first went to sea? We cannot answer that question perfectly, because although we know the height of the adolescents on going to sea, aged, say, 15 we do not know the heights of those who only went to sea aged, say, 21 when they were themselves 15. What we do know, however, are the heights of two sets of 16 years old: those who went to sea aged 15, and those who went to sea aged 16. If those who went to sea earlier were from poorer backgrounds, we would expect to find that, at 16, those who went to sea aged 15 were shorter than those who did not go to sea until they were aged 16.

[31] Bullen, *The Log of a Sea Waif*, p.2.

[32] Tillet, *Memories*, p.25.

[33] Rodger, *Wooden World.*

Table 7. Effect of going to sea aged 15 on heights at 16

Age of going to sea	Coefficient	t-statistic
15	–0.82	–2.91

N = 502
Adj R^2 = 0.04
F (5,496) = 4.98
Root MSE = 3.02

Note: Dummy variables for age in months, literacy, heaping population within 10km and a constant were included but not reported. All were correctly signed. The omitted category is 16 year olds going to sea for the first time aged 16.

The evidence from Table 7 is clear: at age 16, those who had been at sea for a year were notably and significantly shorter than those who were going to sea for the first time.[34] Either being at sea for a year was sufficient to reduce height by almost an inch, or those who chose to go to sea at an earlier age came from more deprived backgrounds. The former is not credible: a height loss of one-inch is too large to be attributed to a single year at sea, and in addition, were life at sea to have been that bad, the coefficients in Table 6 would be much larger.

We can be certain therefore, that Bullen and Tillett were not alone. For many poor boys, the lure of the sea lay in the navy's provision of food and shelter. We can go further than this, however, and show that enlistment was a sensible strategy for such boys. Table 7 shows that at 16, boys who joined the navy at 15 were 0.8″ shorter than those who joined at 16. Table 6 shows that at 21 boys who enlisted at 15 were not statistically shorter than those who enlisted at 16: the coefficients of -0.197 and -0.162 are not statistically significantly different from each other. Thus those who joined at 15 made good the 0.82″ height penalty over the next six years. This is not to say that catch-up was total: both coefficients are statistically different from zero, that is, boys who joined at 15 and boys who joined at 16 remained around 0.2″ shorter than those who did not join until aged 21 or older.[35] Nevertheless, the extent of catch-up is dramatic: reduc-

[34] This result is not specific to these particular age combination. When we compare those who went to sea at 14, when aged 15, with 15-year-olds going to sea for the first time, or those who went to sea at 13, when aged 14, with 14-year-olds going to sea for the first time, we get the same result, albeit with levels of significance that decline with the sample size.

[35] i.e. for clarity we refer to the range 0.162–0.197 inches as 'around 0.2 inches'.

ing stunting from 0.82″ to 0.197″ represents a catch up of more than 75%. Furthermore, the 0.82″ is the deficit compared with those who went to sea aged 16, who were in turn more likely to be deprived than those who went to sea aged 21. The correct comparison would be 0.197″ with the height difference at 15 of a boy who went to sea aged 15, and one who did not go until 21. We have no estimate of that shortfall, but we know that 0.82″ represents a lower bound, that is, we can be sure than at least three-quarters of the differential in height at age 15 between those who went to sea aged 15, and those who did not go to sea until 21, was made up by the time both were 21.

Is this apparently optimistic view of life at sea plausible? We argue that there are three ways in which this story is supported. First, compared with other forms of labour, ship owners and ship captains had to be concerned about the welfare of their workers. Unlike factory owners, they could not replace a worker from one day to another if the worker was unable to work, either directly because of malnutrition, or because the weakened worker had succumbed to some form of illness. Life on board ship was an extreme form of an insider–outsider labour market, in which prospective workers could not be substituted for current workers. There are, therefore, strong reasons to believe that life at sea would involve levels of nutrition in excess of those that might be expected on land, and, critically, not lower than those needed for the work on board ship. Second, we have considerable evidence, considered below in more detail, that sailors' diets were high in calories, protein and nutrients. Finally, as we will show, what distinguished going to sea from other forms of child labour is that the working children themselves ended up with most of the fruits of their labour, because much of their pay was given to them, day by day, in the form of food and shelter. Whilst on board ship, these benefits could not be top-sliced by avaricious parents, or shared with needy siblings.

The evidence that navy diets, while monotonous, were high in calories is overwhelming. The naval provision scale of 1785, believed to have been standard in Royal Navy vessels for about 100 years, is the earliest wholly authoritative listing,[36] and sets out a diet estimated to contain 4888 calories per day,[37]

[36] See Dixon, 'Pound and Pint'.

[37] It is difficult to be exact on some items, since modern calorie counts are calculated on modern types of wine and specific cuts of meat. The calorie content of the diet was affected by the many possible variations in food issue. For example the substitution of beef with flour and raisins allowed in the naval Provision Scale of 1785 would increase the weekly calorie count from 34216 to 35560 and the daily average from 4888 to 5080. Large differences to calories consumed originated in the form of the drink issue.

similar to the levels offered by other scales that have survived, suggesting that this level was typical for the period.[38] For men aged 18 to 34 engaged in very active work the recommended intake is 3350 calories per day. Even if we are convinced that these (FAO/WHO) guidelines are conservative for men doing the physical labour required of nineteenth-century sailors, the diets explored suggest a caloric surplus that must have benefited growing boys.

Table 8. Diet for crews of slavers (1792)

Item	Weekly issue	g/ml	Calories per 100g/ml	Total calories
Bread	6 lbs	2,724	436	11,877
Beef	3 lbs	1,362	146	1,989
Pork	3 lbs	1,362	320	4,359
Pease	1½ pints (1½ lbs)	681	328	2,234
Oatmeal	2 pints (1 lb)	454	375	1,703
Butter	4 oz	113	740	839
Cheese	8 oz	227	406	920
Flour	2 pints (2 lbs)	908	310	2,815
Either: Spirits	1¾ pints	980	222	2,176
Or: Wine	3½ pints	1,960	75	1,470
Total			With spirits	28,912
			With wine	28,206

The merchant navy did not have the benefit of a statutory diet until 1906, but there were statutory provisions for two classes of seafarers (slavers and lascars) from the mid-eighteenth century onwards, while various kinds of endorsed, rec-

[38] See for example, the Liverpool scale of 1858, Dixon, 'Pound and pint'.

ommended and standard diets existed for the rest.[39] A recommended diet from 1792 is shown in Table 8 and converted into calories according to scales used by Macdonald.[40]

The authoritative naval historian of a slightly earlier period, N.A.M. Rodger, comments on the quality as well as the quantity of food provided for the Royal Navy:

> The diet supplied by the establishment was plain and very restricted in its range, but it provided more than sufficient calories for hard physical work…. By the standards of the poor naval food was good and plentiful. To eat meat four days a week was itself a privilege denied a large part of the population, if only because in many parts of the country firing was too expensive for the poor to cook every day.[41]

In addition to the rations taken on board there appears to have been real effort in both the Royal and Merchant Navies to supplement rations whenever possible with fresh fruit and vegetables, and these were taken on board in volumes that make it clear that the whole crew shared them.[42] Rodger argues that experienced seamen understood the link between diet and scurvy even if medical men did not.[43]

Of course, Rodger's viewpoint is by and large based on the provisioning of the Royal Navy. Parliament was less concerned about the merchant navy, and so enquiries, and thus evidence, is less common. But it seems plausible that competition for labour between the Royal and merchant fleets must have precluded the Merchant Navy from moving too far from Royal Navy standards. There is evidence to support these conjectures. One authoritative source notes that the merchant service had clear advantages, including roomier ships, lighter disci-

---

[39] Parliamentary interest in crew victualling was an unintended by-product of the investigations of the slave trade prompted by abolitionists. The need for regulation was exposed by the high death rate on slave ships. So when a master Archibald Dalziel suggested that seamen's provisions be regulated by law, there was backing for the suggestion. An Act of 1789 included a diet scale and instructions that the provisions be issued as 'in the usual manner in which this is done on Board his Majesty's Ships of War' (29 Geo 3 c. 66). An act of 1792 updated the scale of provisions.

[40] Dixon, 'Pound and pint'.

[41] Rodger, *Wooden World*, pp. 86–7.

[42]Davis, *Rise of the English Shipping Industry*, p.145; Lloyd, 'Victualling'.

[43] Rodger, *Wooden World.*

pline, better pay and (crucially from our viewpoint) more plentiful food.[44] According to Admiralty memoranda, the weekly meat ration on Royal Navy ships in the 1850s was 5lbs 4oz., compared with a massive 8lbs 12 oz on British merchantmen.[45] The amount of meat in the ration appears to have increased in the first half of the nineteenth century, and as Davis notes: 'If salt beef or pork, with biscuit, cheese, beans, dried fish and beer were unappetising diets for long voyages, it may nevertheless be borne in mind that few people on land had a diet which included daily meat in any form'.[46] Davis estimates that at the end of the eighteenth century 3 shillings per week was spent on food purchased at bulk prices for the average seaman. 'The farm labourer on six or seven shillings a week, or even the London craftsman with twelve or fifteen, buying at retail prices, feeding, housing and clothing a family, could hardly have spent more'.[47] It is possible that food distribution among the crew was not egalitarian and that boys' shares were top-sliced by stronger crewmen or those higher in the food chain. But even this is ambiguous: boys may well have benefited from trading some of their alcohol issue for extra nutrition.

There is also evidence, albeit less comprehensive than the dietary material, that the disease environment was better at sea than on land. Rodger argues that men-of-war were healthier communities than similar size communities ashore. They were manned by fit young men and isolated from diseases that proliferated on land. Certainly, sailors faced no comparable risks to those faced by soldiers in barracks. Cleanliness aboard was motivated by the miasma theory of disease, and if a ship became infected it was widely understood that it had to be stripped and disinfected. '… It was a great strength of the Royal Navy that it did regard dirt and disease as closely linked, even if the nature of the connection was misunderstood'.[48] Rodger's views are perhaps rosy: Dr Herbert Williams said that the smell of a forecastle in a merchantman was so strong that you could lean against it![49] But again the comparison has to be with a world where stench, dirt, and disease were commonplace.

Joining the Merchant Navy appears to have benefited the boys involved by enabling them to make good most of their initial relative height disadvantage.

[44]Bartlett, *Great Britain and Sea Power.*

[45] Bartlett, *Great Britain and Sea Power.*

[46] Davis, *Rise of the English Shipping Industry*, p.145.

[47] Davis, *Rise of the English Shipping Industry*, p.146.

[48] Rodger, *Wooden World*, p.109.

[49] Quoted in Home, *Merchant Seamen*.

But before the result can be generalised to defend the employment of all impoverished (relatively stunted) children several peculiar circumstances of boy sailors' lives should be noted. First, the very youngest recruits may have been the most disadvantaged of children, sent to sea by parish officers and Magistrates, 'the sweepings of the Unions' as one authority put it.[50] The condition of such children was probably so low that it would be incorrect to generalise from their experience to that of children more generally. Second, as we noted earlier, sailor boys enjoyed an advantage not available to other working children. Part of their wage was given to them in the form of food and shelter while on board ship. This was dedicated for their use. Neither selfish parents nor hungry siblings were able to take any of it away. Insulated from the demands of other family members, young sailors could devote their ration to making good the ravages of work on their insubstantial frames. While this clearly benefited the sailors in our sample, it thwarted any intra-family resource flows that may have been to vital to the wellbeing of younger children or non-working family members.

Conclusions

This paper has looked at three features of nineteenth-century life. It found that being born in a city stunted, although the degree of stunting was limited for those born outside of the largest cities. Those born in central London could expect to grow up to be two-thirds of an inch shorter, those born on London's outskirts, one-third of an inch shorter, and those born in Manchester a quarter of an inch shorter than those born in communities of up to 8000. Those born in places between 8000 and the large industrial cities were stunted, but the effect was too small to be readily apparent.

Contrary to the finding for Germany and the United States, we found no evidence that rural communities close to cities were losing nutrients and becoming stunted as a result. We found no evidence that opportunities to trade had any effect on heights in England and Wales in this period. For those living in the countryside it did not matter whether there was a town nearby: England and Wales was already a single market in this era, integrated by commerce and trade. Any rural stunting effect from food moving from countryside to city was a nationwide effect.

[50] Berkeley, quoted in Bartlett, *Great Britain and Sea Power*, p. 314. For additional evidence on the extent to which both dedicated charities and the poor law channelled destitute boys into the navy, see Rodger, *Wooden World*.

Finally we looked at the effect on heights of going to sea as a child. We found that although those who had first gone to sea at an early age were shorter as adults than those who did not enlist until they were fully grown, this does not mean that going to sea caused stunting. Rather, the direction of causation is the other way around. Impoverished, stunted adolescents found the attractions of regular meals on board ship particularly strong, and so were more likely to sign on to become merchant seaman at an early age. They were right to do so: the merchant service allowed them to make good most of their height shortfall compared with those who joined at later ages. But the ability to compensate for earlier disadvantage arose from the peculiar nature of life on board ship and in particular from the way in which a significant part of the wage took the form of calorie-rich meals ring-fenced from the depredations of other family members by being at sea. We cannot infer that other forms of child labour would have such beneficial effects on the heights of the poor.

References

Bartlett, C.J., *Great Britain and sea power 1815–1853* (Oxford, 1963).

Bullen, F.T, *The log of a sea waif, being recollections of the first four years of my sea life* (London, 1899).

Clark, G., 'The Charity Commission as a source in English Economic History' *Research in Economic History*, 18, 1998, pp. 1–52.

Crafts, N., 'Cliometrics,1971–1986: A survey', *Journal of Applied Econometrics*, 23 (1987), pp. 171–92.

Cuff, T., *The hidden cost of economic development: The biological standard of living in Antebellum Pennsylvania* (Aldershot, 2005).

Davis, R., *The rise of the English shipping industry in the 17th and 18th centuries* (London, 1962).

Dixon, C. 'Pound and pint: Diet in the merchant service, 1750–1980', in S. Palmer and G. Williams, eds., *Chartered and unchartered waters. Proceedings of a conference on the study of British maritime history* (London, 1981).

Earle, P., *Sailors; English merchant seamen 1650–1775* (London, 1998).

Ewert, 'The biological standard of living on the decline: Episodes from Germany during early industrialisation', *European Review of Economic History*, 10 (2006), pp. 51–88.

Floud, R., Wachter, K., and Gregory, A., *Height, health and history* (Cambridge, 1990).

Heintel, M., 'Height samples with shortfall: a persisting problem revisited', in J. Komlos and J. Baten, eds., *The biological standard of living in comparative perspective* (Stuttgardt, 1998).

Heintel, M., and Baten, J., 'Smallpox and nutritional status in England, 1770–1873: on the difficulties of estimating historical heights', *Economic History Review*, 51, 1998, pp. 360–71.

Home, W.E., *Merchant seamen: Their diseases and their welfare needs* (London, 1922).

Horrell, S., Humphries, J., and Voth, H-J., 'Stature and relative deprivation: Female-headed households in the industrial revolution', *Continuity and Change*, 13 (1998), pp. 73–115.

Horrell, S., Humphries, J., and Voth, H-J., 'Destined for deprivation: human capital formation and inter-generational poverty in nineteenth-century England', *Explorations in Economic History*, 52 (2001), pp. 339–65.

Humphries, J., 'Short stature among coalmining children: A comment', *Economic History Review*, 50 (1997), pp. 531–7.

Kirby, P., 'Causes of short stature among coalmining children, 1823–1850', *Economic History Review*, 48 (1995), pp. 687–99.

Kirby, P., 'Height, urbanisation and living standards in the north of England, 1822–1837', *Manchester Working Papers in Economic and Social History*, 35 (1996).

Kirby, P., 'Short stature among coalmining children: A rejoinder', *Economic History Review*, 50 (1997), pp. 538–42.

Kirby, P., *Child labour in Britain, 1750–1870* (Basingstoke, 2003).

Komlos, J., ed., *Stature, living standards and economic development* (Chicago, 1994).

Komlos, J., 'The height and weight of West Point cadets: Dietary change in Ante-bellum America', *Journal of Economic History*, 47 (1987), pp. 897–927.

Komlos, J., 'Shrinking in a growing economy? The mystery of physical stature during the industrial revolution', *Journal of Economic History*, 58 (1998), pp. 779–802.

Landers, J., *Death and the Metropolis*: *Studies in the demographic history of London, 1670–1830* (Cambridge, 1993).

Leunig, T. and Voth, H-J., 'Height and the high life: What future for a tall story?' in P. David and M. Thomas, eds., *The economic future in historical perspective* (Oxford, 2003), pp. 419–38.

Leunig, T. and Voth, H-J., 'Did smallpox reduce height? Stature and the standard of living in London, 1770–1873', *Economic History Review*, 49 (1996), pp. 541–60.

Lloyd, C., 'Victualling of the fleet in the eighteenth and nineteenth centuries' in J. Watt, E.J. Freeman, and W.F. Bynum, eds., *Starving sailors. The influence of nutrition on naval and maritime history* (Greenwich, 1981).

Mokyr, J., and O Grada, C., 'The heights of the British and the Irish c. 1800–1815: Evidence from recruits to the East India Company's army', in J. Komlos, ed., *Stature, living standards and economic development* (Chicago, 1994).

Moradi, A., 'The anthropometric history of Ghana, 1880–2000: An exploration', unpublished paper (2006).

Nicholas, S., and Steckel, R., 'Heights and living standards of English workers during the early years of industrialization, 1770–1815', *Journal of Economic History*, 514 (1991), pp. 937–57.

Oxley, D., ' "The seat of death and terror": urbanization, stunting and smallpox', *Economic History Review*, 56 (2003), pp. 623–56.

Rodger, N.A.M., *The wooden world. An anatomy of the Georgian navy* (London, 1986).

Sanderson, M., *Education, Economic change and society in England, 1780–1870* (London, 1991).

Steckel, R. 'Height and per capita income', *Historical Methods*, 161 (1983), pp. 1–7.

Steckel, R. *The backbone of history* (Cambridge, 2002).

Stone, D., *Decision-making in medieval agriculture* (Oxford, 2005).

Tillett, B., *Memories and reflections* (London, 1931).

Woods, R. and Shelton, N., *An atlas of Victorian mortality* (Liverpool, 1997)

University of Oxford Discussion Papers in Economic and Social History

1 Hans-Joachim Voth and Tim Leunig, *Did Smallpox Reduce Height? Stature and the Standard of Living in London, 1770–1873* (Nov. 1995)

2 Liam Brunt, *Turning Water into Wine – New Methods of Calculating Farm Output and New Insights into Rising Crop Yields during the Agricultural Revolution* (Dec. 1995)

3 Avner Offer, *Between the Gift and the Market: the Economy of Regard* (Jan. 1996)

4 Philip Grover, *The Stroudwater Canal Company and its Role in the Mechanisation of the Gloucestershire Woollen Industry, 1779–1840* (March 1996)

5 Paul A. David, *Real Income and Economic Welfare Growth in the Early Republic or, Another Try at Getting the American Story Straight* (March 1996)

6 Hans-Joachim Voth, *How Long was the Working Day in London in the 1750s? Evidence from the Courtroom* (April 1996)

7 James Foreman-Peck, *'Technological Lock-in' and the Power Source for the Motor Car* (May 1996)

8 Hans-Joachim Voth, *Labour Supply Decisions and Consumer Durables During the Industrial Revolution* (June 1996)

9 Charles Feinstein, *Conjectures and Contrivances: Economic Growth and the Standard of Living in Britain During the Industrial Revolution* (July 1996)

10 Wayne Graham, *The Randlord's Bubble: South African Gold Mines and Stock Market Manipulation* (August 1996)

11 Avner Offer, *The American Automobile Frenzy of the 1950s* (December 1996)

12 David M. Engstrom, *The Economic Determinants of Ethnic Segregation in Post-War Britain* (January 1997)

13 Norbert Paddags, *The German Railways – The Economic and Political Feasibility of Fiscal Reforms During the Inflation of the Early 1920s* (February 1997)

14 Cristiano A. Ristuccia, *1935 Sanctions against Italy: Would Coal and Crude Oil have made a Difference?* (March 1997)

15 Tom Nicholas, *Businessmen and Land Purchase in Late Nineteenth Century England* (April 1997)

16 Ed Butchart, *Unemployment and Non-Employment in Interwar Britain* (May 1997)

17 Ilana Krausman Ben-Amos, *Human Bonding: Parents and their Offspring in Early Modern England* (June 1997)

18 Dan H. Andersen and Hans-Joachim Voth, *The Grapes of War: Neutrality and Mediterranean Shipping under the Danish Flag, 1750–1802* (September 1997)

19 Liam Brunt, *Nature or Nurture? Explaining English Wheat Yields in the Agricultural Revolution* (Oct. 1997)

20 Paul A. David, *Path Dependence and the Quest for Historical Economics: One More Chorus of the Ballad of QWERTY* (Nov. 1997)

21 Hans-Joachim Voth, *Time and Work in Eighteenth-Century London* (Dec. 1997)

22 Tim Leunig, *New Answers to Old Questions: Transport Costs and The Slow Adoption of Ring Spinning in Lancashire* (Feb. 1998)

23 Paul A. David, *From Keeping 'Nature's Secrets' to the Institutionalization of 'Open Science'* (July 2001)

24 Federico Varese and Meir Yaish, *Altruism: The Importance of Being Asked. The Rescue of Jews in Nazi Europe* (May 1998)

25 Avner Offer, *Epidemics of Abundance: Overeating and Slimming in the USA and Britain since the 1950s* (Nov. 1998)

26 David Stead, *An Arduous and Unprofitable Undertaking: The Enclosure of Stanton Harcourt, Oxfordshire* (November 1998)

27 Oliver Grant, *The Diffusion of the Herringbone Parlour: A Case Study in the History of Agricultural Technology* (December 1998)

28 Antonia Taddei, *London Clubs in the Late Nineteenth Century* (April 1999)

29 Liam Brunt, *Estimating English Wheat Production in the Industrial Revolution* (June 1999)

30 Matthew Braham, *Volunteers for Development: A Test of the Post-Materialism Hypothesis in Britain, c.1965–1987* (June 1999)

31 Paul A. David and Gavin Wright, *General Purpose Technologies and Surges in Productivity: Historical Reflections on the Future of the ICT Revolution* (September 1999)

32 Liam Brunt, *An Arbitrage Model of Crop Rotation* (September 1999)

33 Paul A. David and Gavin Wright, *Early Twentieth Century Productivity Growth Dynamics: An Inquiry into the Economic History of 'Our Ignorance'* (October 1999)

34 Avner Offer, *Economic Welfare Measurements and Human Well-Being* (January 2000). Rev. version, March 2000.

35 Liam Brunt, *'Where there's Muck, There's Brass.' The Market for Manure in the Industrial Revolution* (February 2000).

36 Alasdair Crockett, *Variations in Churchgoing Rates in England in 1851: Supply-Side Deficiency or Demand-Led Decline?* (August 2000).

37 Martin West, *State Intervention in English Education, 1833–1891: A Public Goods and Agency Approach* (October 2000).

38 George Speight, *Who Bought the Inter-War Semi? The Socio-Economic Characteristics of New-House Buyers in the 1930s* (December 2000)

39 Peter Temin, *A Market Economy in the Early Roman Empire* (March 2001)

40 Michael Biggs, *Positive Feedback in Collective Mobilization: The American Strike Wave of 1886* (April 2001)

41 Charles H. Feinstein and Mark Thomas, *A Plea for Errors* (July 2001)

42 Walter Eltis, *Lord Overstone and the Establishment of British Nineteenth-Century Monetary Orthodoxy* (December 2001)

43 A. B. Atkinson, *Top Incomes in the United Kingdom over the Twentieth Century* (February 2002)

44 Avner Offer, *Why has the Public Sector Grown so Large in Market Societies? The Political Economy of Prudence in the UK, c.1870–2000* (March 2002)

45 Natàlia Mora Sitjà, *Labour and Wages in Pre-Industrial Catalonia* (May 2002)

46 Elaine S. Tan, *'The Bull is Half the Herd': Property Rights and Enclosures in England, 1750–1850* (June 2002)

47 Oliver Wavell Grant, Productivity *in German Agriculture: Estimates of Agricultural Productivity from Regional Accounts for 21 German Regions: 1880/4, 1893/7 and 1905/9* (August 2002)

48 Oliver Wavell Grant, *Does Industrialization Push up Inequality? New Evidence on the Kuznets Cure from Nineteenth-Century Prussian Tax Statistics* (September 2002)

49 Alexandre Debs, *The Source of Walras's Idealist Bias: A Review of Koppl's Solution to the Walras Paradox* (January 2003)

50 Robert Dryburgh, *'Individual, Illegal, and Unjust Purposes': Overseers, Incentives, and the Old Poor Law in Bolton, 1820–1837* (March 2003)

51 David R. Stead, *Risk and Risk Management in English Agriculture, c.1750–1850* (October 2003)

52. Pablo Astorga, Ame R. Bergés, and Valpy FitzGerald, *Productivity Growth in Latin America during the Twentieth Century* (December 2003)

53. Teresa da Silva Lopes, *Evolution of Corporate Governance in Global Industries: The Case of Multinationals in Alcoholic Beverages* (February 2004)

54 Pablo Astorga, Ame R. Bergés, and Valpy FitzGerald, *The Standard of Living in Latin America during the Twentieth Century* (March 2004)

55 Regina Grafe, *Popish Habits vs. Nutritional Need: Fasting and Fish Consumption in Iberia in the Early Modern Period* (May 2004)

56 Nicholas Dimsdale: *Unemployment and Real Wages in Weimar Germany* (October 2004)

57 Pablo Astorga, Ame R. Bergés, and Valpy FitzGerald, *The Standard of Living in Latin America During the Twentieth Century* (March 2005)

58 Richard H. Steckel, *Fluctuations in a Dreadful Childhood: Synthetic Longitudinal Height Data, Relative Prices, and Weather in the Short-Term Health of American Slaves* (April 2005)

59 Federico Varese, How Mafias Migrate: The Case of the `Ndrangheta in Northern Italy (July 2005)

60 Avner Offer, *The Markup For Lemons: Quality And Uncertainty in American and British Used-Car Markets c.1953–1973* (September 2005)

61 Natalia Mora-Sitja, *Exploring Changes in Earnings Inequality during Industrialization: Barcelona, 1856–1905* (April 2006)

62 Camilla Brautaset and Regina Grafe, *The Quiet Transport Revolution: Returns to Scale, Scope and Network Density in Norway's Nineteenth-Century Sailing Fleet* (June 2006)

63 Mohammad Niaz Asadullah, *Educational Disparity in East and West Pakistan, 1947–71: Was East Pakistan Discriminated Against?* (July 2006)

64 Jane Humphries, *'Because they are too menny…' Children, Mothers, and Fertility Decline: The Evidence from Working-Class Autobiographies of the Eighteenth and Nineteenth Centuries* (September 2006)

65 M. A. Irigoin and R. Grafe, *Bargaining for Absolutism: A Spanish Path to Nation State and Empire Building* (November 2006)

66 Jane Humphries and Tim Leunig, *Cities, market integration and going to sea: stunting and the standard of living in early nineteenth-century England and Wales* (March 2007)

University of Oxford
Discussion Papers in
Economic and Social History

are edited by:

Papers may be downloaded from
http://www.nuff.ox.ac.uk/Economics/History/