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Human capital and payments systems in Britain, 1833-1914.[1]

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This paper shows how the concept of human capital and human capital theory may be used to help investigate some important issues in the history of the British economy and labour market in the nineteenth century.[2] The first part of the paper establishes the importance of human capital to the long-run performance of the British economy, and the next two sections discuss some of the theoretical and practical problems involved in the analysis of human capital, particularly the role of and returns to education, and the relationship between earnings and productivity. This is followed by two illustrative case studies in which we show how the application of human capital theory to historical data can enhance our understanding of the working of the nineteenth century labour market and the contribution of human capital to British economic growth.

Human capital and British economic performance

Economic historians have frequently been concerned with identifying and explaining the components of economic growth. They have emphasised the diversity within the economists' formulation of the components of growth - 'land', 'labour', 'capital' and 'enterprise'. 'Capital', for example, could include machinery, animals, stocks of raw materials or buildings. It would also include slaves. Slaves were more of a capital than a labour input because a large part of their lifetime labour services - and even the labour of their unborn children - was purchased for a single payment.

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[1] We are indebted to the Staff Research Fund of the LSE and to Roy Edwards for research assistance.

[2] Modern human capital theory is associated with the work of Gary Becker who was the first to analyze the acquisition of transferrable and non-transferrable skills. Becker, *Human capital*, Mincer, *Schooling*, Hutchens, 'Seniority wages' and Blaug 'Empirical status' are important surveys.

It is easy to visualise the different forms of physical capital. The idea that capital could be intangible is much more difficult. The simplest way to think about human capital as a component of economic growth is that it is the quality of the labour that a worker brings to his or her employment. The quality of labour can be seen as the skills that a worker possesses (although, as we will see, human capital usually means more than skills). The ability to work to a higher standard has been acquired by investment; in other words, some sacrifice has been made in the past which increases the quality of the worker at the moment. Hence, it is appropriate to view the quality of work as *capital* rather than *labour* which relates to the quantity of work. To an individual, investment in human capital and labour would normally be alternatives; for example, staying on at school forgoes the income from employment.

The stock of human capital in the economy is, therefore, the sum of the investment that individuals have made, or have had made on their behalf, up to that point. The human capital endowment of a worker is not fixed. What is called 'disembodied' human capital may be thought of as that possessed by the worker when he or she begins employment for the first time. 'Embodied' human capital is that which is acquired from work experience. Embodied human capital can include formal training, as in an apprenticeship, but also may be 'learnt by doing' - picked up informally at the place of work.[3] The ability to learn new skills is, of course, itself a skill. We would expect human capital to increase with age up to some point. It is likely to be acquired rather quickly at the young ages and then at a slower rate. But as the worker ages he or she is unable, or occasionally unwilling, to acquire new skills and so their human capital endowment remains static or falls. All these qualities which are acquired by the worker have a cost and it is important to consider who has paid for the worker to acquire them. For example, the cost of creating a prime age industrial worker is first paid by his or her parents. There is an implication here: that women made a disproportionate contribution to the human capital embodied in a prime age

[3] See, More, *Skill*, pp. 107-30.

industrial worker since the upbringing of children was predominantly entrusted to women.

The important role played by human capital in economic development can be seen in the history of international migration. For example, by the late nineteenth century emigrants from Europe to the United States, Canada, Argentina and other countries were predominantly young adults who were at the peak of their producing and consuming power.[4] Because the cost of their upbringing had been met in Europe they were a free gift of capital to the countries that they entered. This meant that *ceteris paribus* the human capital stock of those countries was higher than it would have been if their labour forces had grown entirely by natural increase. In turn, this meant that their economic growth was faster.[5] Migration was also important in the transfer of technology which in the earlier nineteenth century was accomplished through the migration of workers with specific skills. Examples where individual migration was important include the transfer of textile technology from Britain to the United States[6] and to Norway.[7]

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[4] See, Baines, *Emigration*, pp. 58-65.

[5] One estimate is that the benefit of immigration to the American economy in the early twentieth century was the equivalent of five years' investment. In other words, if all the growth in the American labour force had come from natural increase and the cost of rearing the immigrants had been borne by the American economy, the capital stock in, say, 1910 would have only been at the level it was in 1905. This calculation is fraught with difficulties but is likely to be of the right order. Neal & Uselding, 'Immigration', pp.84-8.

[6] It did not follow that British technology would be copied exactly. Labour was relatively more expensive in the United States than in Britain. Hence, the American cotton masters were forced to adapt the British technology. See, Jeremy, *Transatlantic industrial revolution*, pp.76, 148-9, 256.

[7] Bruland, *British technology*, pp. 126-36.

Although it is *a priori* probable that human capital has played a significant role in British economic growth in the past, this is extremely difficult to measure. The most careful attempt has been by Matthews, Feinstein and Odling-Smee (hereafter MFOS);[8] they calculated the contribution of changes in the input of human capital to the growth of the UK economy between 1856 and 1973. In the absence of more direct measures of the human capital stock they used three 'proxy' variables. These were the age distribution of the labour force; the intensity of work and the amount of formal education the workers had been given. The age distribution of the labour force was chosen because we would expect a fall in the proportion of children in the labour force to increase its average quality.[9] The effect of age distribution on the human capital stock could then be calculated by assuming that the wage paid at each age was equal to the marginal product of each age group. In other words, it was assumed - reasonably - that the labour market was competitive.

The intensity of work was calculated from an estimate of the number of hours worked in different periods. In more recent periods shorter hours of work have not led to lower output. Hence, the hours of work estimate was subject to an 'efficiency offset' which was designed to take account of this change.[10] The number of years of formal education that had been taken by each cohort was not too difficult to estimate. The problem was to estimate the increase in output attributable to each additional year of schooling - i.e., how to weight it. There are few data sets that address this question and none for the UK for any long run of years. Recourse had to be made to a study

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[8] Matthews, Feinstein and Odling-Smee, *British economic growth*, pp.96-117.

[9] The effect of gender and nationality distribution on the human capital stock was also estimated but was not significant. Matthews, Feinstein and Odling-Smee, *British economic growth*, pp.100-102.

[10] The 'efficiency offset' was assumed to be 100% in 1856-73 falling to zero in 1951-73. Matthews, Feinstein and Odling-Smee, *British economic growth*, pp.102-4.

based on the impact of formal education in the French economy covering the years after the Second World War.[11]

The MFOS estimates led to some important results. Taking the period 1856-1973 as a whole, total factor productivity (the measure of the relation between the increase of inputs and outputs in the economy) increased by some 1.1% p.a. The growth in labour quality accounted for 0.6% - i.e more than half of the growth in the output of the economy.[12] We can see, however, that this important result depends on a rather rough and ready set of estimates of the human capital input, of which the authors are only too aware. They suggest that a margin of error of plus or minus 50% is possible.[13] There are two crucial assumptions underpinning the MFOS estimates - that education makes a positive contribution to worker performance, and that the wage paid relates to the productivity of the worker. Neither of these assumptions are self-evidently true, and in the next two sections we discuss the ways in which economists and historians have attempted to evaluate these assumptions.

Education and economic performance

There is a clear, positive relationship across countries today between the share of national income devoted to education and the level of national income per capita, yet economists are divided about the relationship at the individual level between education and future income. The main problems concern the precise factors that are measured by years of schooling, which even in contemporary studies is usually all the data that are available. It is possible, for example that the more able people can assess the future value of education better than the less able. If this is the case, what is called an 'ability bias' would be created. This is because of the way that individual returns to education are normally calculated. They are usually taken as the difference between

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[11] Denison, *Why growth rates differ*, pp. 85-7.

[12] Matthews, Feinstein and Odling-Smee, *British economic growth*, p. 211.

[13] Matthews, Feinstein and Odling-Smee, *British economic growth*, p. 105.

the future earnings of those who choose to have no more education and the future earnings of those who do. If there is an ability bias the more able will invest in more education and the future income due to education will be overstated. Conversely, the effect of education on the future income of the less educated group will be understated. The effect is to overstate returns to education as a whole.[14] A more complicated problem is what is called 'credentialism'. Employers may not be concerned with the knowledge and skills obtained from formal education *per se* but, instead, may view education as a filtering process which distinguishes those workers who are most easy to train.[15] Another argument is that years of schooling do not measure the way that children acquire human capital. Children may acquire more human capital before they go to school than later. And when they are at school they may still be gaining more human capital informally than directly through their schooling. Years of schooling would then merely be a proxy for something else. This, in fact, has been the assumption of many contemporary studies.[16]

This debate is echoed in some historical writing, where the relative importance of disembodied human capital has been disputed. Some historians deny that variables such as literacy or schooling are proxies for human capital. These historians consider that specific skills learnt at the workplace are more important for economic growth. Mitch took this extreme reductionist position in a recent survey.[17] He considered only those educational attainments which were directly relevant to specific industrial processes. A recent paper by Boot estimated that the amount invested by male cotton workers in on the job training in the 1830s was at least as much as the amount

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[14] See, Becker, *Human capital*, pp. 157-66.

[15] Blaug, 'Empirical status', pp. 840, 846-7.

[16] Blaug, 'Empirical status', pp.831-3.

[17] Mitch, 'Education'.

invested in their education,[18] though as we will show below, this calculation appears to be seriously flawed.

We believe that the extreme view taken by Mitch is unhelpful; there are likely to be both public and private returns to general education - for instance a literate society can be more easily governed and taxed than an illiterate one. Some positive economic returns from some 'non-relevant' education can be expected, but measurement is difficult. Literacy has often been taken as both an output measure of the educational system and as a proxy for the measurement of human capital, but its use is often seen as problematic.[19] Literacy rates in the past have often been measured from the ability of an individual to sign his or her name, but this measure is a very imperfect indicator.[20] For Britain there is the particular historical problem of literacy rates having reached a high level by the early part of the nineteenth century, particularly for males. That is, literacy was already high when it became possible systematically to measure it. We cannot therefore use changes in the degree of literacy or its spatial distribution as evidence of changes in the human capital stock in the later nineteenth century. This is not true of, say, Spain or Italy where literacy only began to rise fast in the later nineteenth century. There remain, therefore, considerable uncertainties about the extent to which formal education enhances human capital, and about how best to measure the relationship between educational outputs and economic performance.

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[18] This conclusion is based on a calculation of the amount invested by each worker in on the job training compared with West's calculation of average annual expenditure per child in education. Boot, 'How skilled was the British factory workforce?', p.13; West, 'Resource allocation and growth', pp. 82-8.

[19] This was the conclusion of a session at the International Economic History Conference at Leuven in 1990. The papers presented were collected in Tortella, *Education*; see the contributions by Mitch, Nicholas and the summary paper by Tortella and Sandberg.

[20] Schofield, 'Dimensions of illiteracy'.

Remuneration and productivity

Human capital theory extends beyond the question of what contribution education makes to individual performance. It also allows an assessment of the costs and benefits of acquiring disembodied and embodied skills once the individual enters the labour market, not only from the perspective of the individual but also from the perspective of the firm and the economy. The main theoretical advance in this respect in recent years has been to acknowledge the existence of an internal market for labour (internal to the firm itself). This *internal labour market* may operate on different principles to those of the external labour market (that is, the labour market described in standard economic textbooks) and its operation may have important implications for the economy and long term economic growth.[21] The basis of the internal labour market is the fact that there may be long term benefits to the relationship between employer and employee that exceed possible short term economic factors at play in the external labour market.

For the internal labour market to simply reflect the external labour market (in effect, for there to be no internal labour market) firms would have to pay workers according to their marginal product (which in turn would reflect their training, abilities and experience). This is known as a *spot wage* payments system. The MFOS assumption that workers are paid at each age a wage that reflects the marginal productivity of their particular age cohort therefore also implicitly assumes a spot wage payments system.[22] If the payments system operated by firms, or at least by a significant number of firms, in the British economy in the period 1856-1973 deviated from a spot wage system it could have serious implications for the MFOS estimates.

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[21] A useful, non-technical, introduction to internal labour markets is provided by Siebert and Addison, 'Internal labour markets' and by Strober, 'Human capital theory'. For a more technical approach see Weiss, *Efficiency wages*, and Cooper, *Wage and employment patterns*.

[22] Matthews, Feinstein and Odling-Smee, *British economic growth*.

How do we determine whether or not a particular firm operated a payments system based on spot wages? The answer is that we need to examine individual wage history profiles. Ideally, the wage profiles should be compared to the productivity of the worker at each age to assess if indeed spot wages were being paid. Unfortunately, data on individual productivity is virtually non-existent and therefore the second best solution is to make an assumption about the expected shape of the productivity profile (and hence expected spot wage profile). In most economic and historical models, including that of MFOS, age is used as a proxy for training, ability and experience: thus, the older a worker is (at least up to a certain point) the greater is their productivity and hence they should receive a higher wage. Indeed, one existing estimate of individual wage profiles for the nineteenth century shows that wages rose fast at young ages but then continued to increase well into adult life, at least for males.[23]

One of the most obvious alternatives to a spot wages payments system is one based on *seniority wages*. Seniority wages are usually related to length of service but sometimes to age, as they were in teaching in Britain between the wars. A payments system based on seniority wages is an example of an *implicit contract*: in such a system the worker and employer agree, in effect, to abide by an implicit contract in which the wage at any point in time will not be related to current productivity but distributed over the period of the contract. There are several reasons for the introduction of payments systems based on implicit contracts: the difficulty some employers face in trying to distinguish between the output of individual workers; the cost to an employer of supervising and monitoring the work of employees; the

[23] Boot, for example, states that most industries in the 1830s had similar profiles for male workers. Wages rose rapidly to the early adult years, continued to rise but at a slower rate, peaked in 'middle age' (which was about 35 in cotton spinning) then declined slowly. Boot, 'How skilled', pp. 4-5.

intangible nature of much white collar work;[24] the desire of the firm to reward employee honesty (or loyalty) by paying workers less than their output warranted in the early years of employment and more than it warranted in the later years of employment[25]; the risk averse nature of workers who may accept (at least initially) a wage lower than their marginal productivity in return for implicit job security or for training from the firm.

In trying to assess whether a firm paid spot wages or seniority wages a problem arises: the average wage profile under a seniority wage payments system will be something akin to a straight line or a series of upward steps but this is very similar to the wage profile we would expect under a spot wage system if it is assumed that productivity rises with age. Thus, the shape of any *individual* wage profile will not tell us if we are observing spot wages. However, if the wage profiles of large numbers of workers were similar we can be sure that they were not being paid spot wages since there should be some variation in their productivity (unless one makes the unrealistic assumption that all workers were homogenous in terms of both their disembodied human capital and their rate of acquiring disembodied human capital). In a spot wage payments system one would expect to see some variation in individual wages relative to the mean wage for their age group (this can be assessed by examining the coefficient of variation of age related wages for each age group). If the individual

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[24] Thus, the Bank of Scotland introduced an age related salary structure in the early nineteenth century (Boot, 'Salaries', pp. 645-6) and the remuneration of Victorian clerks tended to be based on annual increments (see Anderson, *Victorian Clerks*, p.25, for a table of salaries in a Liverpool insurance company, 1890-1914).

[25] There are contemporary cases where seniority wages continue to increase even when productivity is falling. The explanation is that these wage profiles embody implicit contracts where workers are paid more than their marginal productivity in the later stages of employment to encourage honesty. The implication is that the seniority wage profile is relatively steep. These workers are paid relatively less while undergoing training than those workers who eventually earn their marginal product or less.

wage profiles were similar, and if they rose through the adult years[26], some sort of seniority wage was being paid:[27] in such a situation the relevant coefficient of variation should be close to zero.

An alternative explanation as to why spot wages might not be paid is that a delayed payment schemes may be used to compensate workers for the costs and benefits of acquiring skills. We know that in the skilled trades apprenticeship remained important into the early twentieth century as More and others have shown. An apprenticeship offered a valuable *general* training. The skills were readily transferrable and there was no obligation to stay with the firm where the worker had trained. In this case the cost of acquiring an apprenticeship was paid almost entirely by the worker. The apprentice was willing to accept low wages which were below his marginal product while he was training because he was investing in skills that increased his productivity and, hence, his income in the future. It was rational for firms to offer training to people who might take their skills elsewhere since the worker had borne the full cost of the training.

By the late nineteenth century Britain had developed an additional method of training which combined specific and general training. Apprenticeship taught general and specific skills at the workplace. Technical schools, where the workers usually attended part-time, taught general skills.[28] In other countries the training mix was different.

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[26] If we accept a human capital explanation, then the age at which wages peaked would have been partly dependent on life expectancy. Life expectancy would affect the period in which investment in human capital could be realised. Hence, other things remaining equal, we would expect the age at which wages peaked to rise in the nineteenth century.

[27] In a set of seniority wage profiles we would expect any variation in income between individuals to decline with age. This would reflect different rates of acquiring skills at the younger ages.

[28] More, *Skill*, pp. 64-93. For the development of technical education in Britain, see Cotgrove, *Technical education*.

For example, there was far less part time instruction in the United States and in Germany. The dominant form of training in the United States took place at the workplace. Hence, it was job specific. The dominant form of training in Germany took place in technical schools and was general. The distinction has been analyzed by Floud using the insights of human capital theory. He argued that there was little demand for the German pattern of formal instruction in the United States because workers thought that the short run costs outweighed the benefits. The demand for formal training was high in Germany because it was a way that workers who were entering industrial occupations for the first time could be 'screened' - i.e., they could demonstrate their ability to benefit from further training. On the other hand, there was a demand for part-time technical training in Britain.[29]

The development of, so called, process industries, for example, boots and shoes, meant that the distinction between skilled and unskilled workers was further eroded. The skills that were needed related to a particular production process (a production line would be an example). This meant that many workers in the nineteenth century acquired skills that were only useful in the firm in which they were working at the time. The skills were not transferrable. Many of these workers were willing to accept a delayed payments system rather as the apprentices did. But, for these workers, the terms of the implicit contract had to be different. It was not in the workers' interests to bear the full cost of training. The skills that they acquired were less valuable in another firm. If they could not transfer their skills their bargaining position was weak and they could not expect their employer to pay them the full benefits of their training. In which case, why did they sacrifice current income to invest in training?

This problem was first addressed in terms of human capital theory by Becker.[30] Applying Becker's argument to the nineteenth century: the wage that the workers were

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[29] Floud, 'Technical education', pp. 8-9.

[30] Becker, *Human capital*, pp. 16-26.

paid after they had been trained must have been higher than it would have been if they had not undertaken the training. If they had not expected to increase their income they would not have trained in the first place. But they would not have been paid a wage consonant with their new skills. This made them more valuable to the employer than the unskilled workers, which, in turn meant that they were less likely to be laid off. Hence, where the skills were not transferrable wages also grew with seniority, but employees and employers shared the cost of training. The employee was paid more than his marginal product while training and less afterwards.

Case studies

Few attempts have been made by historians explicitly to address the questions raised by human capital theory: how much does education enhance productivity? were wages paid in the past spot wages, i.e., directly related to productivity? for how long, and in what sectors, have seniority wage systems and internal labour markets existed? Although much time and effort has been spent processing nineteenth century wage data, the overriding objective of this research has been the construction of real wage series which can be used to address questions about changes in living standards since the industrial revolution. Below we give two illustrative examples of the way in which human capital theory can be applied to historical wage data in order to draw inferences about the economic role of education and internal labour market structures.

i) The returns to education in the early nineteenth century

There has been a long and inconclusive debate about the role of and return to formal education in the rapidly industrialising economy of early nineteenth century Britain.[31] Descriptive statistics about the costs and benefits of education have been exchanged, but few attempts have been made to assess quantitatively the relative returns to formal

[31] West, 'Resource allocation'; West, *Education*; Hurt, 'Professor West'; Kiesling, 'Nineteenth-century education'.

education and learning-by-doing. Human capital theory, however, points to a well-tried method of conducting such tests through the estimation of earnings functions.

A standard Mincer-Becker earnings function for a homogeneous workforce is of the sort:

$$\ln WAGE = \alpha_1 + \alpha_2(AGE) + \alpha_3(AGE^2) + \alpha_4(EDUC) + \alpha_5(EDUC^2) + \alpha_6(WORK) + \alpha_7(WORK^2)$$

where lnWAGE is the natural log of (weekly/monthly/annual) earnings, AGE is age in years, EDUC is years of full-time-equivalent education, and WORK is years of work experience (with a distinction sometimes drawn between total labour market experience and work experience with the current employer). Second order terms for AGE, EDUC and WORK are included because it is believed that there is a diminishing marginal return to each of these factors; the assumption, therefore, is that the coefficients will be positive on AGE, EDUC and WORK, but negative on all the squared terms.

Even with modern data sets it is often difficult to find adequate measures of or proxies for education or work experience, and few attempts appear to have been made to locate usable historical data. Some data does, however, exist. Below we present an estimated earnings function for child workers employed in British factories in the early 1840s. The data is drawn from the interviews conducted in 1843 with child workers aged 7 to 14 years by assistants to the Royal Commission on the Employment of Children.[32] The interviews were not conducted on a systematic basis, and only 261 cases contained the necessary information about earnings, age and work experience.

[32] Royal Commission on the Employment of Children in Trades and Manufactures, Supplementary Reports. PP 1843 XIV and XV.

Direct information about education was impossible to gather from these interviews, and so literacy (ability to write) was taken as a proxy for previous formal education.

Results of an ordinary least squares estimate of a Mincer-Becker earnings function for this group of child workers are presented in equation 1 of Table 1. Only the dummy variable for literacy is statistically significant in this equation, but the main reason for this poor result appears to be multicollinearity between AGE and AGE^2 and WORK and $WORK^2$; the correlation coefficients between these pairs of variables are .996 and.943 respectively. Inspection of the data shows why this is so. Over the age range 7 to 14 there is no obvious reduction in the rate of growth of earnings, so the higher order terms are not serving to catch the reduction in the rate of earnings growth with age which is common at higher adult ages. The squared terms are excluded in equation 2, in which all the variables are significant. The coefficients show that, between the ages of 7 and 14, the wage increases by 13 per cent for each extra year of age, by 5 per cent for each extra year of work experience, and by 11 per cent for the achievement of literacy. On the basis of this (admittedly small and fragile) data set we can say that, in terms of employment income, the achievement of literacy by children was worth about two years work experience.

How much reliance can be placed on these results? We have not yet found other data sets from this early nineteenth century period which contain information on work experience or literacy, but some idea of the validity of the coefficient on AGE can be drawn from a comparison of equation 2 with an alternative earnings function estimated on the grouped data relating to child workers aged 7 to 14 recorded by Dr James Mitchell in his 1833 report to the Royal Commission on the Employment of Children in Factories.[33] In this report Mitchell presents average weekly earnings for children of each age in 23 different locations and employments in Britain. A simple earnings

[33] Mitchell's report is included in: Supplementary Report of the Royal Commission on the Employment of Children in Factories, Part I. PP 1834 XIX.

function based on age alone and estimated from this 1833 data is presented in equation 3 of Table 1. The almost identical intercept term and coefficient on AGE found in this entirely separate data set is a strong indication that the coefficients in equation 2 are plausible.

TABLE 1
OLS Earnings Functions
Independent Variable = log of average weekly earnings in pence

Equations 1 & 2: 1843 individual data
Equation 3: 1833 grouped data

	[1]	[2]	[3]
n	261	261	263
AGE	.267	.127	.125
	(1.61)	(6.79)	(16.7)
AGE^2	-.006	-	-
	(-.86)		
WORK	.086	.049	-
	(1.78)	(2.87)	
$WORK^2$	-.006	-	-
	(-.76)		
LIT	.116	.111	-
	(2.42)	(2.32)	
C	1.24	2.04	2.05
	(1.35)	(11.9)	(24.4)
R^2	.35	.35	.52
F	28.9	47.7	280

(t-statistics in brackets)

The results in equation 2 are clear support for the assumption used by MFOS and others that education makes a positive contribution to economic performance, and they also allow us to begin to address the question of whether Britain was under or over-investing in human capital creation through formal education in the first half of the nineteenth century. The Mitchell data shows that the average weekly wage for 7-14 year old workers in 1833 was 33 pence per week. West has suggested that the average weekly cost of education to parents at this date in terms of expenditure on fees was 9 pence per week,[34] so the total opportunity cost to parents of buying one week's education for a child was 42 pence per week, or, assuming a 45-week working year, £7 17s. 6d. per annum.[35] According to equation 2, the achievement of literacy had about the same effect on age-standardised earnings as two years' worth of work experience. If this reflects the real relative marginal productivity of literacy and experience, so that at the margin literacy would be traded for two years of child labour income, we can determine how many years of literacy-enhanced earnings were required to justify the costs of up to two years of foregone earnings together with the educational expenses of acquiring literacy; these costs together total around £15 15s.

If we assume that educated children acquired their literacy by the age of 10 and that the personal discount rate was 4.5 per cent per annum (the Consol rate plus a personal premium of 1.5 per cent), we can use the average age-specific income recorded by Mitchell in 1833 to calculate the number of years of literacy-enhanced earnings required to compensate parents for the cost of educating a child. As Figure 1 shows, over the age range 7 to 16 the average wages of boys and girls in 1833 were indistinguishable, but at 16 male earnings begin to accelerate so that by age 21 average male wages are double those of females. This means that any wage premium on

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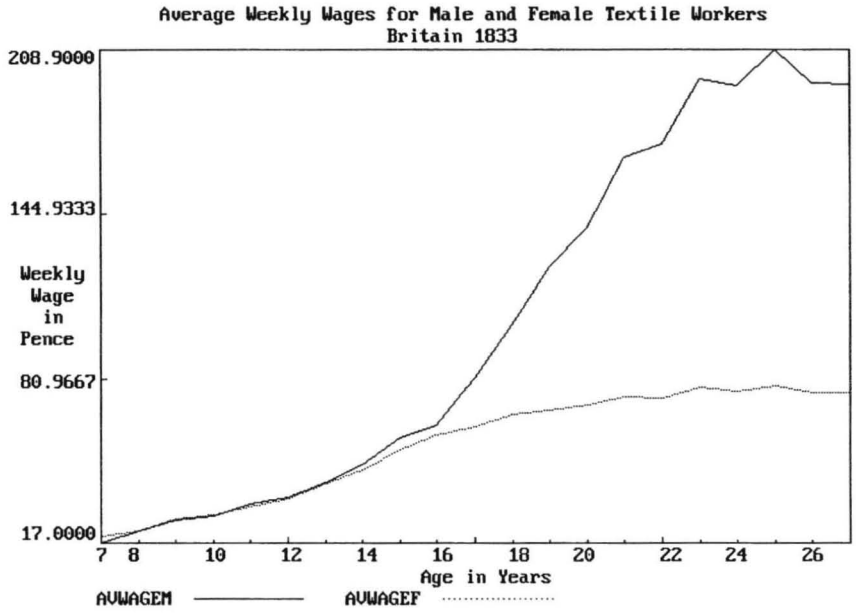
[34] West, 'Resource allocation', p. 85.

[35] As mentioned above, the recent comparison made by Boot of the cost of formal education and on-the job training is flawed, because the opportunity cost of foregone earnings is omitted from the estimation of the overall cost of formal education. See Boot, 'How skilled', pp. 12-13.

Figure 1


Average Weekly Wages for Male and Female Textile Workers
Britain 1833
208.9000
144.9333
Weekly
Wage
in
Pence
80.9667
17.0000
7
8
10
12
14
16
18
20
22
24
26
Age in Years
AVWAGEM
AVWAGEF

literacy that extends into adult ages will differentially affect the returns to education for males and females, making education less attractive for females. On the other hand, a literacy premium paid to an adult worker is much less likely to be captured by parents than is a similar premium paid to a child worker, and parents are unlikely to obtain any return after the marriage of a child (mean ages of marriage were 26.9 years and 25.7 years respectively for males and females in 1851, slightly lower in the 1830s).[36] This would diminish the impact of adult male/female wage differentials on earlier education decisions. Using the Mitchell wage data, a constant 11 per cent wage premium for literacy, and again assuming a 45 week working year to make some allowance for short-time and stoppages, we find that at age 10 males require 12 years and females 14 years of literacy enhanced wages for the discounted present value of the literacy wage premium to match the cost of two years of education and foregone earnings.

The Registrar-General's estimates of literacy derived from the 1841 census were 67.3 per cent for males and 51.1 per cent for females[37], a difference which may be explained by the relative returns that parents could expect to capture from the literacy of their male and female children up to age 22. If literacy rates were a direct function of literacy-enhanced wage premia secured by parents up to the 22nd birthday of their children, with male literacy rates of 67.3 per cent, the economic returns to education would justify female literacy rates of 55.2 per cent. These are illustrative estimates, and they depend crucially on assumptions about the amount and cost of schooling required to achieve literacy, and on the appropriate discount rate. Nevertheless they indicate that an economic explanation may account for the differential literacy rates of males and females in the 1840s.

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[36] Wrigley and Schofield, *Population history*, p. 437.

[37] Sanderson, *Education*, p 17.

Whether this economic explanation is also a human capital explanation must remain, for the present, an open question. The age-wage profiles plotted in Figure 1 would seem to support a human capital explanation of earnings up to age 16, but it is not clear that rapidly growing male/female earnings differentials from age 16 can be accounted for in human capital terms. The existence of a 'female wage' in the nineteenth century has most frequently been explained in cultural terms,[38] and we intend to undertake a quantitative evaluation of alternative explanations in a subsequent paper. For the moment we can note that Mitchell's 1833 wage data may be consistent with human capital explanations of remuneration for children and adolescents, and with dual labour market/discrimination explanations for adults.

ii) Internal labour markets

In order to assess whether or not spot wage were prevalent, or whether internal labour markets operated, we need to analyze individual wage profiles of groups of workers in particular firms. One rich, and surprisingly neglected, source of individual wage histories is provided by railway company staff records. The importance of the railway companies in terms of the national labour market was obvious: in 1873 their workforce of 275,000 accounted for approximately 3 per cent of the occupied male labour force and by 1913 these figures had increased to 643,000 and 4.5 per cent.[39] Further, the railway companies of the late nineteenth century were perceived to be good employers who offered 'secure jobs for life' and thus potentially operated an internal labour market. Indeed, the business history literature on railway companies liberally uses the term 'internal labour market'. What this actually means, however, is either left vague or is used from the perspective of industrial relations (in that it

[38] Baines, 'Labour supply', pp. 164-6; Hunt, *British labour history*, pp. 23-5. For a discussion of the origins of the exclusion of women from certain occupations, the development of patriarchy and the idea of the 'family wage' in Europe, see Honeyman and Goodman, 'Women's work', pp. 611, 622-3. For a review of sex discrimination in the British textile industry see Freifeld, 'Technological change'.

[39] Gourvish, *Railways*, pp. 9-10.

captures the idea that railway companies offered industrial welfare, in one form or another, to their workers) and not in an economic sense.[40] What follows reports some preliminary results based on a sample of the weekly paid traffic staff records of the Great Eastern Railway Company (henceforth GER).[41]

The sample was based on the life histories of all those traffic staff who entered employment with the GER before 1880.[42] To avoid problems associated with World War One and the wages explosion in its aftermath it was decided to only record the life histories up until 1913. Further, individuals were excluded if: their records were incomplete or showed signs of erratic changes that were not explained; if they transferred from another part of the GER, such as the "Goods" division, (on the grounds that in such cases we lacked their previous company history); and if the records revealed that they rented property from the company (since it would be difficult to compute the true imputed value of their rent). The GER traffic wages staff records are collected in 20 volumes and contain records on over 10,000 individuals: our sample reduced this to an initial pool of 851 individuals. In most of the results reported below wages were actually converted into real wages using the Feinstein consumer goods and service price index and since this series begins in 1870 this

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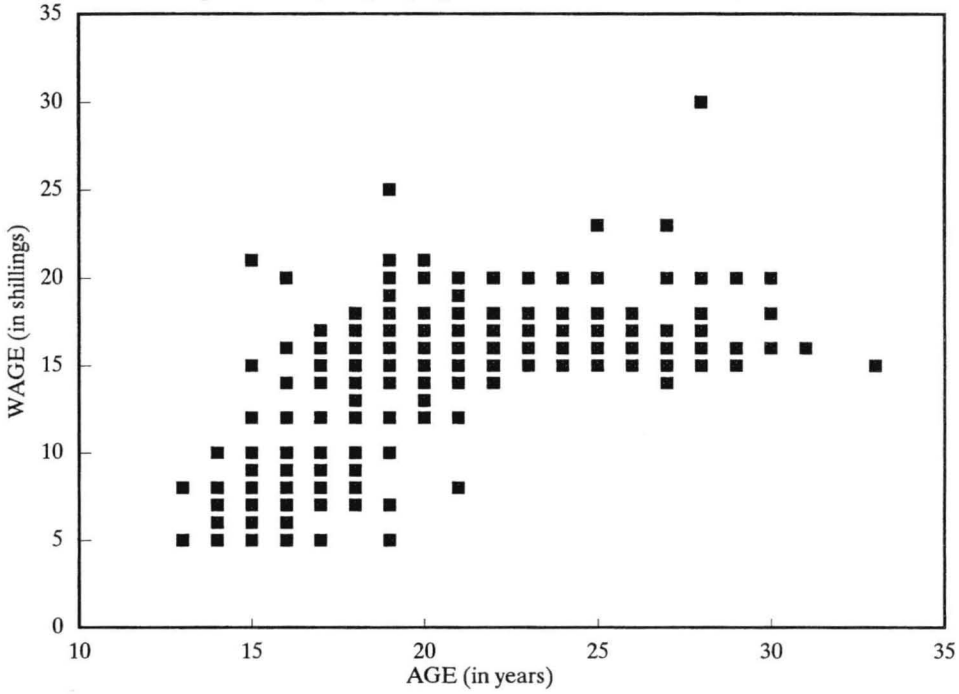
[40] Drummond, 'Specifically designed?'; Turner, 'Man and Braverman'; Melling, 'Employers'; Fitzgerald, British labour management.

[41] Public Records Office, Kew (hereafter PRO)/RAIL 227/459 - 479 (GER. Wages Staff Histories Registers. Traffic Staff). It is unclear exactly when or why the records were created but it appears that were compiled into the ledgers now held in the PRO in the early 1920s (probably in 1923, at the time of the amalgamation) from other records that no longer exist. It would also appear that the records recount the life histories of the existing workforce at the time they were compiled and they therefore give a curious picture of a very stable workforce that experiences no voluntary exits; the only exits recorded are for those workers who retired, died or were dismissed (although unless we believe the GER was a very benevolent employer the latter category is almost certainly far from complete).

[42] Although the company was founded in 1862 some of the individuals in our sample have life histories which start before that date, the earliest being 1853.

Figure 2. Entry wage by age of GER traffic staff entrants, 1858–79



eliminated workers who entered before that date and effectively reduced the pool to 757.[43]

Figures two and three use the nominal entry wages of 851 workers to assess if older workers were judged to be more productive than younger workers - did they receive higher wages? Figure two is a simple scatter diagram plotting the age of each entrant at point of entry against their initial nominal wage. It shows a clear break in the minimum entry wage received after the age of 20: between the ages of 13 and 17 the minimum entry wage received was 5 shillings; this then jumped to 7 shillings at age 18 and increased by a further 70 per cent to 12 shillings by age 20.[44] By age 23 the minimum entry wage settled down to a fairly standard figure of 15 shillings. In real terms the minimum entry wage received by each age group increased progressively with the largest jumps occurring before the age of twenty: between the ages of 15 and 19 the increase in the minimum age received by each successive age group ranged from 16 per cent (at age 19) to 35 per cent (at age 17) whereas after the age of 20 the maximum increase was only 6 per cent.[45]

Figure three attempts to add some more flesh to the scatter diagram by showing the average entry wage for each age. It suggests that GER operated two different age-related payments systems: one for workers under the age of 20 and a different one for workers over the age of 20. The average entry wage profile in figure three is steepest during the early years, when it might be expected that young recruits needed some on the job training which should have yielded rapid gains in productivity, but thereafter progresses at a much slower pace (possibly reflecting the fact that most traffic workers

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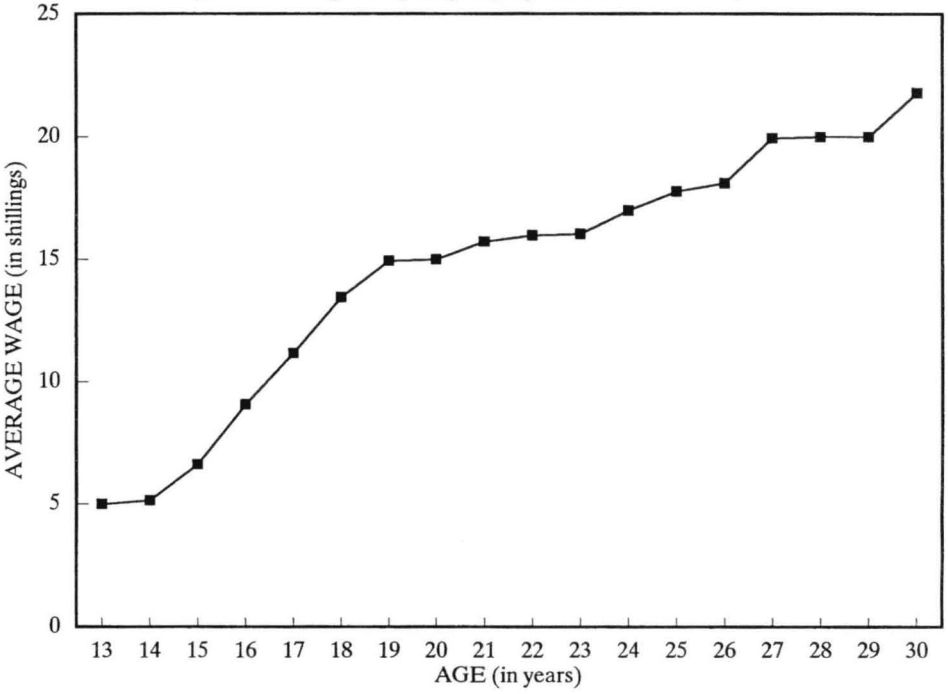
[43] Feinstein, National income, table 61, T132.

[44] The minimum entry wage for the 19 year old group is shown as 5 shillings in figure one but this was received by only one individual and is therefore misleading.

[45] The sample for the real wage calculation excludes those who entered the company before 1870.

Figure 3. Average entry wage by age of GER traffic staff, 1858–79

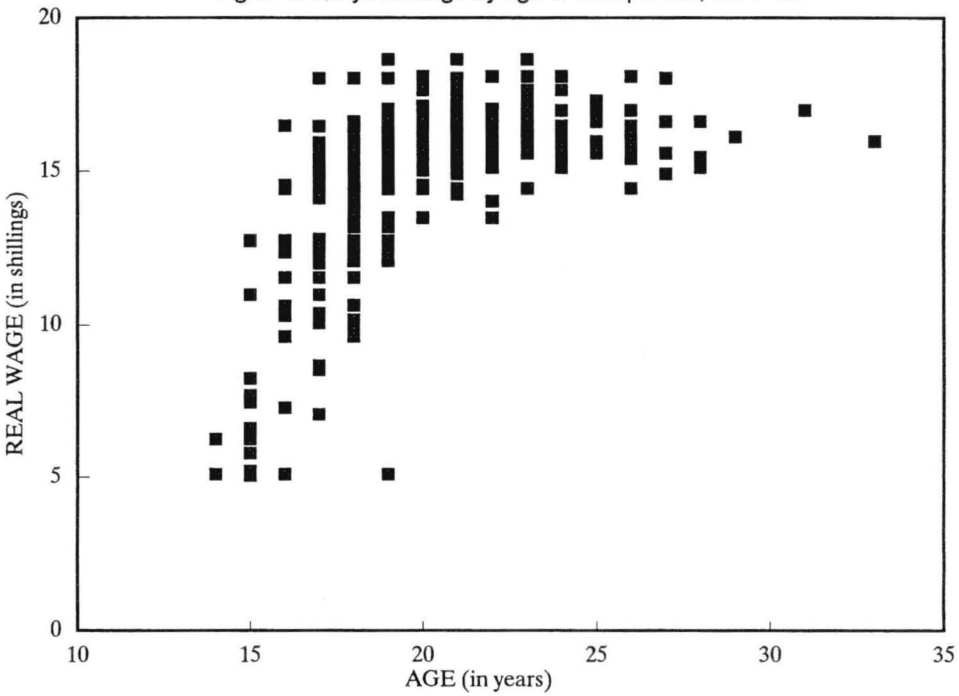


were engaged in tasks, such as portering and ticket collecting, where the scope for increased productivity was limited). However, one of the most striking features of this sample is the very low variation in entry wages relative to the mean entry wage of each age group for those workers aged above 19: the coefficient of variation on entry wages by age fluctuates between 0.01 and 0.03 between the ages of 19 and 29 (with the exception of the 26 year old age group who register a figure of 0.10). This suggests that young workers were paid a spot wage but that for workers over the age of 19 no human capital explanation is appropriate (unless their productivity did stagnate) since it appears they were paid a relatively fixed standard wage of between 15 and 17 shillings.[46]

Before drawing firm conclusions from these results, however, we need to consider the data more closely: the term 'traffic staff' actually encompasses many different types of jobs (from the expected porters, signalmen and guards to stablemen, tram conductors, seamen, toilet attendants, and an Assistant Searcher and Footwarmer) and even entrants with similar entry point job descriptions may, at point of entry, be set on quite different career paths or their bland job description may hide subtleties in grade. In order to be more confident about what the data is telling us we therefore need to make sure, as far as possible, that we are indeed comparing like with like. The obvious way forward is to look at entrants who have the same job description. The initial pool of 851 entrants actually encompasses no less than 71 different job descriptions. Of these, 16 job descriptions (covering 532 entrants, or 63% of the total) include the word 'porter' in their title (ranging from Gateman Porter to Lad Porter Number Taker to Probationary Porter Signalman). A brief survey of these 'porters' revealed, however, that they appeared to be doing quite different jobs - 'porter' would

[46] If the nominal figures are replaced by real wages the average entry wage profile follows a similar pattern to that shown in figure three but is much smoother. Further, the very low variation in entry wages compared to the mean is even more pronounced and starts a year earlier: for those age groups 18 to 29 the coefficient of variation for entry real wages only twice exceeds 0.01, and in the case of both exceptions (age groups 23 and 26) it only reaches 0.02.

Figure 4. Entry real wage by age of GER porters, 1870–79



appear to have been used in job descriptions as a bit of a catch-all phrase, if the job entailed any portering duties then the word 'porter' appeared in its description which makes it very difficult, with the information available to us, to divine if a Porter Shuntsman was a porter who occasionally did some shunting or vice versa or whether the job entailed a large component of both jobs. The solution to this problem was to simply consider those entrants described as either 'Porter' or 'Lad Porter'.[47] Excluding workers who entered before 1870 so that real wages could be calculated yielded a pool of porters numbering 395 entrants (representing 52.2% of all entrants between 1870 and 1879).[48]

Figure four is a scatter diagram of the entry real wages of porters. Like figure two it shows a sharp break in the pattern of minimum entry wages at age 20: between the ages of 16 and 20 there is a rapid increase in the minimum entry wage but thereafter it remains relatively stable.[49] Figure five considers the average entry real wage profile of the porters. It again shows the rapid increases in entry real wages up to the age of 20 (in fact the average entry real wage doubled between the ages of 15 and 20) being followed by a basically stable average entry real wage (which fluctuated between 15.6 shillings and 16.7 shillings). However, one important difference between the 'all

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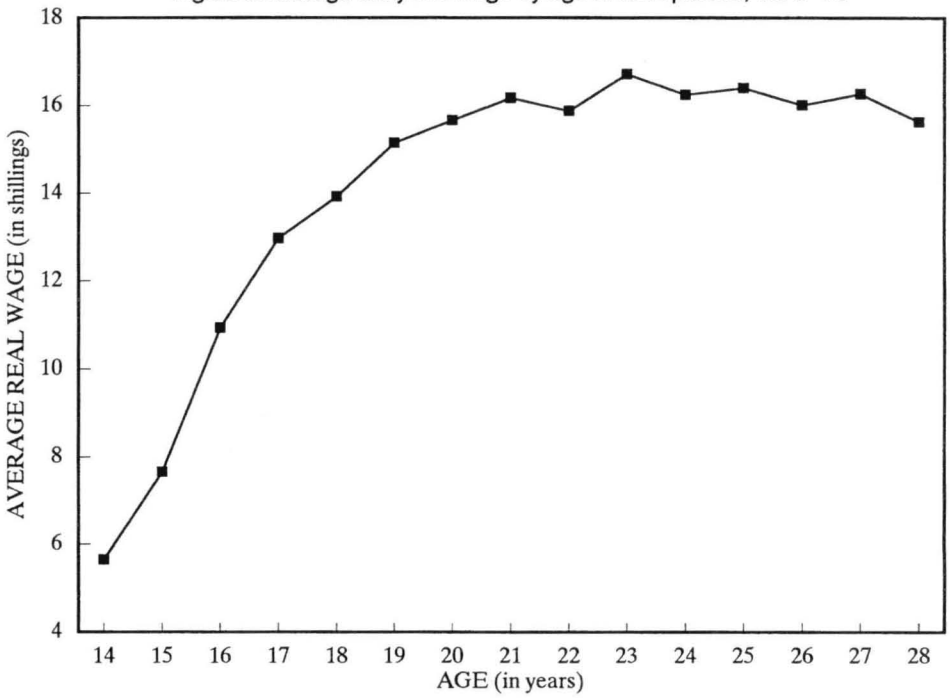
[47] The term 'Lad Porter' does not appear to have any important significance other than up to the age of 16 a porter entrant had a three in four chance of being designated a lad porter rather than a porter. Of our sample of porters (that is porters plus lad porters) 20% were lad porters and although most were aged 18 or under, with only 6 of the 87 lad porters being over that age, the oldest lad porter was 22 years old. There is no obvious difference in the wage paid to a porter or a lad porter who were of the same age at point of entry.

[48] The date of entry profile of porters is very similar to the date of entry of all entrants and thus does not appear to introduce any bias in that direction.

[49] Between the ages of 16 and 17 the minimum entry real wage increased from 5.1 shillings to 7.0 shillings (or 37 per cent), at age 18 it had increased to 9.6 shillings (another 37 per cent) and by age 20 it had leapt to 13.5 shillings (an increase of 41 per cent compared to age 18). The wage in shillings is given as a decimal figure: thus, 5.1 shillings is not 5 shillings and one pence but 5 shillings and 1.2 pence.

Figure 5. Average entry real wage by age of GER porters, 1870–79



entrants' sample and the porters relates to the coefficient of variation for the 20+ age groups: for 'all entrants' we found virtually no variation relative to the mean wage (especially in real terms) but for the porters the coefficient of variation is, with two exceptions, either 0.06 or 0.07 (for age groups 25 and 28 it is 0.04). This evidence suggests a more subtle picture of the payments system than that suggested by the 'all entrants' data (which almost certainly introduces aggregation bias into its results): that is, spot wages were paid up to the age of 20 but thereafter a standardised payments system was operated which had built into it an element of flexibility which rewarded (or punished) workers according to their marginal productivity (or perceived marginal productivity).[50]

If an internal labour market was in operation then the entry wages of workers alone do not give us enough information to investigate the human capital implications, indeed by the very nature of entry wages in such a market they would offer a biased picture. Thus, we need to look at the lifetime earnings profile of a sample of workers. In order to try and compare like with like it was decided to select a sample of workers who followed similar career paths. This was much more problematic than it first appeared since the 851 individuals in our sample followed more than 650 different career paths![51] The most popular career path was that which involved a simple two step process from porter to signalman: 37 individuals who joined the Company

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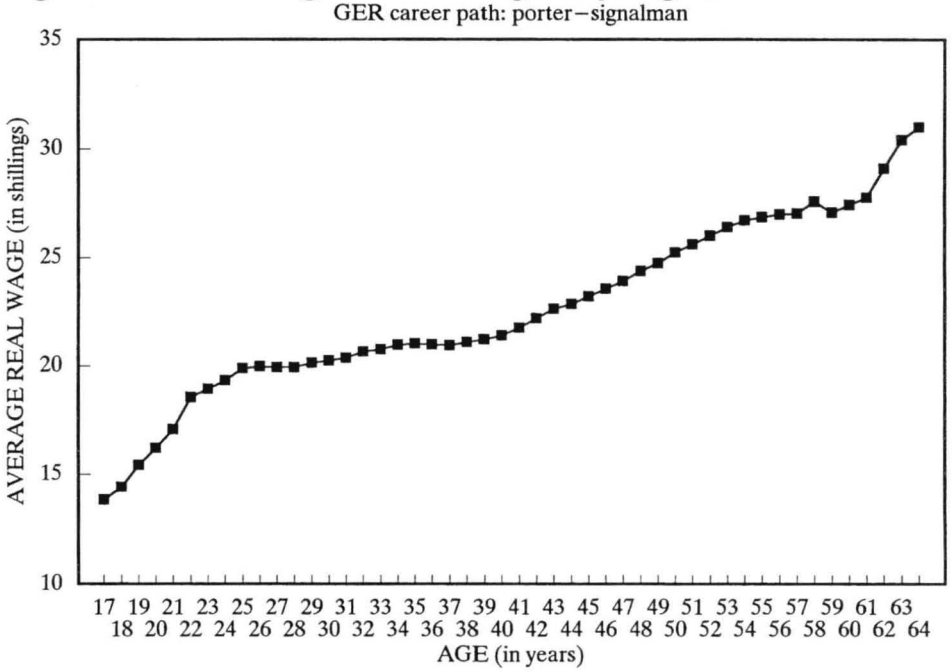
[50] In order to check that porters were representative, and that therefore the results based on the all entrants sample were guilty of aggregation bias, two other popular job categories were tested: greasers (of whom there were 43 in the 1870-79 sample) and signalmen (of whom there were 33). The average wage by entrant age profiles for both were similar to that of the porters: there was an increase in average wage for younger entrants but thereafter the profile became much shallower (although the Signalman profile did experience an unexplained but noticeable dip at age 23).

[51] The actual number of career paths is much lower than this since each job description was treated a separate step whereas, in fact, one job may have been covered by several job descriptions (as we have seen, for example, at point of entry there would appear to have been no substantial difference between the job description lad porter and porter).

Figure 6. Average real wage by age, 1870–1913



between 1870 and 1879 followed this path. The evidence from these workers implies that GER did operate an implicit contract system.

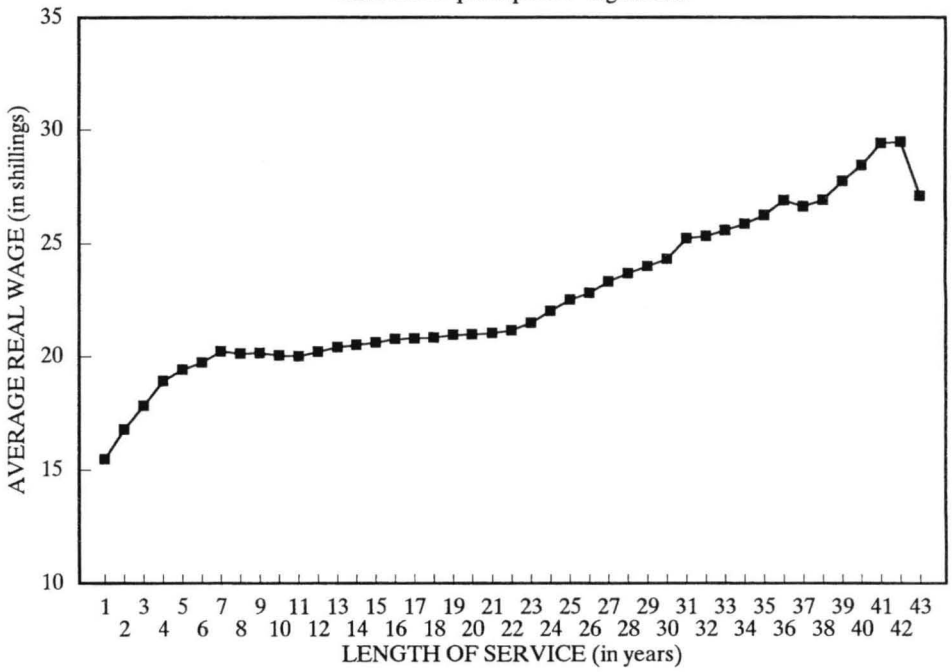
Figure six shows the average real wage by age of the porter-signalman group: the relatively low wages at the early ages increased rapidly (suggesting either that on the job training increased productivity rapidly at such young ages and/or that the young workers were deliberately paid below their marginal productivity in order to bear the cost of their training and in return for above marginal productivity wages later) and were then followed by a clear and steady upward rise before tailing off at the very old ages (a classic seniority wage profile).[52] As mentioned above, the seniority wage payments system is usually based on length of service, not age, and figure seven therefore produces an average real wage by length of service profile. This shows that workers gained rapidly in their initial years with the company (in the first seven years the average real wage increased by 30 per cent) but then experienced a relatively stable wage (of 20-21 shillings) for the next 16 years of service after which there was gradual rise in the average real wage (it reached 25 shillings after 30 years of service and 29 shillings after forty years of service). This reinforces the idea that GER operated some form of implicit contract system.

Conclusion

None of the above evidence supports the view of a spot wage payments system, a view that is implicit in MFOS. It would appear that GER did operate an internal labour market in which the implicit contract was based on some form of seniority wages; the only exception to this was possibly younger workers whose wage profile is indicative of, though not definite proof of, a spot wage system - something which also appears to be the case with textile workers in the 1830s. GER is, of course, only one firm out of many thousands operating in the British economy in this period and the results from

[52] The fluctuations shown at older ages in figure six are a reflection of the fact that only a small number of individuals in our sample reached those ages.

Figure 7. Average real wage by length of service, 1870–1913
GER career path: porter–signalman



this preliminary study cannot be simply expanded to the whole economy. However, the only other comparable work on the British economy in the nineteenth century, that by Boot, also suggests that the Bank of Scotland operated a seniority wage payments system.[53]

It would be unwise to try and draw any definite conclusions from this preliminary study of textile and railway workers: the aim was to try and show that our understanding of the human capital issues involved and their implications for economic growth in more general terms is still poor but that human capital theory offers economic historians a powerful tool to investigate these issues and should, eventually, allow us to reduce the error of plus or minus 50 per cent that underlies our best existing guesstimates of the impact of changes in labour quality on British economic growth.

[53] Boot, 'Salaries'.

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