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Market Forces Shaping Human Capital in Eighteenth Century London

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Abstract

We draw on quantitative and descriptive data from Robert Campbell's widely cited manual for prospective apprentices, *The London Tradesman* (1747), to demonstrate the responsiveness of apprenticeship in mid-eighteenth century London to market forces of supply and demand. We regress apprenticeship premiums on journeymen's wages, set-up costs, and a selection of employment conditions and requirements across 178 trades, and find a significant elasticity of 0.4 with respect to wages and 0.25 with respect to set-up costs. We interpret this as supporting an economic model that views premiums as bounded from above by the expected benefits of acquiring the skills of the trade (Lane, 1996); bounded from below by the expected net training costs to the master, taking into account the possibility of the apprentice terminating his service prematurely (Wallis, 2008); and reflecting the relative bargaining power of master and parent. This supports the thesis that apprenticeship played an important role in adapting the English workforce to the skill requirements of the Industrial Revolution. Moreover, by demonstrating the internal and external consistency of Campbell's observations, our findings support their further use as a unique, invaluable source of detailed, trade-specific wage data from the early years of the Industrial Revolution.

JEL classification: N33

Keywords: Apprenticeship, Industrial Revolution, tradesmen's wages, London, eighteenth century, Robert Campbell

1. Introduction

The success of the Industrial Revolution in England was made possible by a large-scale redistribution of labor from agricultural employment to industrial and other non-agricultural employment, and growing specialization in manufacturing (Thomas and McCloskey, 1981; Crafts, 1985). The role played by the long-standing English system of apprenticeship, with its medieval roots, in this process of structural change has been the subject of some historical debate. A critical tradition dating back at least to Adam Smith (1776) views apprenticeship primarily as a tool used by the craft guilds to maintain control over their respective occupations and exclude competition (Ogilvie, 2004; Rothschild, 2001). However, this view has been challenged over the last two decades by studies that highlight its important economic contribution to innovation (Epstein, 1998; Mokyr, 2009) and to labor mobility (Humphries, 2003, 2009; Wallis, 2008). As Humphries (2003, p. 74) shows in detail, the English system of apprenticeship contributed to the reallocation of labor by providing efficient training in skills directly relevant to the expanding branches of industry; by reducing transaction costs; and by easing liquidity barriers, thus enabling wider participation in the skilled industrial workforce.

The present paper continues in this vein, drawing on quantitative and descriptive data from a unique source, Robert Campbell's widely cited manual, *The London Tradesman*, first published in 1747,[1] which provides explicit quantitative information on the economic conditions of employment and on the terms and requirements of apprenticeship for a detailed classification of trades. We use this data to demonstrate through regression analysis that the variation across trades in the tuition or premium that parents paid masters for their sons' apprenticeships were shaped by economic conditions, its level bounded from above by the expected benefits to the apprentice of acquiring the skills of the trade (Lane, 1996, p. 29); bounded from below by the expected net training costs to the master, taking into account the delay before the apprentice becomes reasonably productive and the positive probability of the apprentice leaving prematurely (Wallis, 2008); and reflecting the relative bargaining power of master and parent.

[1] We use a facsimile reprint from 2010.

This paper has a twofold contribution. In the first instance it provides a better understanding of the workings of apprenticeship in mid-eighteenth century London—demonstrating its responsiveness to market forces of supply and demand and thus its ability to play a useful role in efficiently adapting the English workforce to the changing skill requirements of the Industrial Revolution. In addition, by establishing the internal consistency of Campbell's observations as a basis for quantitative analysis and demonstrating their consistency other available data sources, it should encourage their wider use in understanding the early stages of England's Industrial Revolution. Campbell's manual is well-known to historians studying the formation of industrial skills in eighteenth-century England, and frequently cited, however, as far as we know his detailed, trade-specific evidence on wages has not previously been incorporated in quantitative analyses of this period.

Our theoretical analysis of the economic factors that shape apprenticeship premiums follows Wallis (2008) and Minns and Wallis (2013) in taking as its point of departure the hypothesis that "premium size served to mediate the likelihood of early departure among apprentices." The master bore a greater net cost of instruction—and the apprentice reaped greater net benefit—in the early years of the apprenticeship, anticipating that this advantage would be reversed in its later years when the apprentice became more skilled. Premiums were necessary to guard the master against the possible but unforeseeable eventuality that an apprentice might leave before making good the master's initial investment.

Building on their seminal effort, we identify factors associated with the minimal premium that the master of a specific trade would be willing to accept from an apprentice; with the maximal premium that parents would be willing to pay for an apprenticeship in that trade; and with their relative bargaining power. We hypothesize that the master's minimal acceptable premium is positively associated with factors that increase the likelihood of early departure, such as the opportunity cost to the apprentice of time in the master's employ; and factors that delay the point at which the apprentice becomes productive, notably the complexity of the trade. Parents' willingness to pay, on the other hand, is positively associated with the pecuniary and non-pecuniary benefits of the trade that is to be acquired.

We further posit that the market for apprenticeships in mid-eighteenth century London is competitive except in trades in which high set-up costs limit masters' entry and allow them some market power. As parents apprenticing their children are typically credit-constrained and more sensitive to the level of the premium than the generally wealthier masters, we expect premiums levels to more closely follow the expected net costs of apprenticeship to the master, except possibly where high set-up costs allow masters to command a greater share of the surplus—the difference between the smallest premium they are willing to accept and the highest premium parents are willing to pay.

This is the conceptual framework for our empirical analysis of 178 different trades described by Campbell.[2] For each of these trades, Campbell provides quantitative data on the range of premiums paid, of journeymen's wages and of set-up costs for the master, as well as qualitative descriptions of special conditions of employment, such as health hazards; prior training requirements, such as language skills; and personal qualities needed to succeed in the trade including literacy, physical strength or artistic ability. We regress apprenticeship premiums on journeymen wages, set-up costs and a set of indicator variables that describe the qualitative requirements of the various trades. We find substantial and significant positive effects of both journeymen wages and set-up costs on premiums, with an elasticity of about .40 for wages and 0.25 for set-up costs. We also find significant positive effects for trades requiring artistic talent and prior literacy, and a significant negative effect for trades requiring physical strength.

From the master's point of view, journeymen wages are a measure of the opportunity cost of the apprentice's time and hence an indication of the probability of early departure, suggesting a positive association with premium levels. From the parent's point of view we interpret journeymen wages as an indication of the pecuniary benefits of the trade, and as such should also be positively associated with parents' willingness to pay higher premiums.

[2] We exclude from our analysis over one hundred additional trades described by Campbell. These include trades with insufficient information for the purpose of our analysis as well as all shop-keeping trades and liberal professions. We expand on this in our description of the data.

We interpret high set-up costs as indicating a more complex trade and hence a longer and more expensive gestation period until the apprentice becomes reasonably productive. This raises the expected net costs of apprenticeship for the master, implying a positive association with tuition. We also view high set-up costs as a barrier to entry for masters and hence as an indicator of the master's market power vis-à-vis parents, suggesting a further reason for a positive association with tuition levels.

Specialized skills are viewed as indicators of the complexity of the trade, and hence of a longer delay until the apprentice is productive, leading masters to demand a higher premium. From the parent's point of view they indicate non-pecuniary benefits such as social status and the quality of the work environment, which should raise their willingness to pay. Trades requiring bodily strength indicate the opposite: they are more easily learned, impart lower status and indicate a more arduous profession, all of which point to lower premiums.

This extends Minns and Wallis' (2013) empirical analysis of individual apprenticeship contracts, which focuses on the personal circumstances of apprentice and master: the apprentice's age, his geographic origins and his father's occupational background as well as the master's prior experience with apprentices and his association with a guild; our focus is on the attributes of the different trades.

In the next section we provide some brief background on Campbell's unique manual for aspiring London tradesmen. Section 3 then describes the data we have drawn from it, and compares it to data from other sources; Section 4 presents our regression analyses; and Section 5 concludes.

2. Apprenticeship manuals: *The London Tradesman*

Apprenticeship was the main formal system for acquiring skills in eighteenth century England. While its general structure can be traced back to the practices of guilds and cities in the Middle Ages, it was first regulated nationwide in 1563 in the *Statute of Artificers* which legally determined the core of English apprenticeship contracts

(*indentures*).[3] It involved a written contract binding master and apprentice for a pre-specified period, usually of seven years, during which the master undertook to teach the apprentice and introduce him to the *modus operandi* of his trade, provide him with board and lodging and safeguard his moral welfare. Apprentices were under the quasi-parental authority of their masters: their manners, entertainment, and freedom to marry were limited. The apprentice, on his part, took it upon himself "duly and truly to serve"; and a *premium* or cash payment was commonly paid to the master at the beginning of the apprenticeship.

A considerable number of manuals providing guidance and advice to young apprentices began to appear in print from the early seventeenth century (Lane, 1996, p. 164). The advice in these manuals concentrated particularly on the child's dutiful relationship with the master and the host family. We focus here on a unique manual published in 1747 by T. Gardner, in London, entitled: *The London Tradesmen* authored by Robert Campbell, esq., of whom little is known. It clearly sets out its ambitious aims on its cover:

Being a Compendious View of All the Trades, Professions, Arts, both Liberal and Mechanic, now practiced in the Cities of London and Westminster. Calculated for the Information of Parents, and Instruction of Youth in their Choice of Business.

It is unique in setting out explicitly and in great detail the conditions of employment and range of wages earned by journeymen in each trade; the financial and other requirements a master would make of an entering apprentice; specific qualities each trade requires; the range of set-up costs required of a master; and in many cases the general profitability of the trade for a master.[4] Campbell's treatment of the occupation of the gunsmith, for example, begins with a technical description of the profession before setting out wages and conditions of employment (spelling as in the original):

[3] The act, although devised by central government, was administered almost entirely by local guilds. The clauses of the Statute limited masters to no more than three apprentices each; stipulated a minimal term of seven years; and required a written indenture for private apprenticeship. The Poor Law Act of 1597 gave Overseers of the Poor and Churchwardens the power to put out to pauper apprenticeships children who could not be cared for by their own family, thus reducing the poor rate in their parish.

[4] As Lane (1996) points out, the very existence of manuals such as Campbell's is in itself a strong indication that parents considered future earning potential in choosing a trade for their children.

The Gun-Smith is a Compound of the Joiner and Smith; he works both in Wood and Iron: The Gun or Pistol Barrel is none of his making: they are made at the Foundery, and he buys them in Parcels, makes them and mounts them. It is a very ingenious Busines, requires Skill in the Tempering of Springs, a nice Hand at forming a Joint to make his Work close, and a good Hand at the File to polish it handsomely … The Trade of a Gun-Smith, in this fighting Age is tolerably beneficial: The Trade is not much over-stocked with Hands; and the Journeymen when employed earn Twelve or Fifteen Shillings a Week. A boy may be bound at Fourteen and requires no extraordinary Strength or Education. (Campbell, 1747, p. 242)

In an appendix, Campbell presents each of the occupations in a table, noting the Company it belongs to and whether it is a Livery Company; the range of premiums required for an apprenticeship; working hours; and the range of set-up costs required of a master.

Campbell surveys in his manual over 300 occupations, most of them in some depth, others more briefly, often noting of the latter that they have no demand for apprentices or that their conditions are very similar to those of another trade described more fully elsewhere. The quantitative information he provides on the conditions of employment and on the terms and requirements of apprenticeship for a detailed classification of trades is unparalleled for eighteenth-century England, and all the more so because it comes from the systematic observations of a single source. We have extensive Stamp Tax records on apprenticeship premiums paid to masters but nothing of similar scope and detail on journeymen wages or on the costs of setting up as a master in different trades.

In the following section we assess the accuracy of Campbell's data by verifying its external consistency with Stamp Tax data on apprenticeship premiums and with what other information we have on trade-specific wages and setting up costs in mid-eighteenth century England. Though we know hardly anything about the author, his motives, or the circumstances in which the manual was written, these comparisons

indicate, as far as they can, that Campbell conducted a thorough and careful investigation.[5]

3. The Data

Of the 300 and some trades that Campbell surveys in his manual, focus here on 178, omitting trades that do not take apprentices; trades for which Campbell fails to provide information on premiums, journeymen wages, and set-up costs; and shop-keeping trades that chiefly train apprentices in general book-keeping and related skills. Summary data on occupational groups are presented in Table 1, which presents mid-point values of the ranges provided by Campbell for journeymen wages, premiums and setting up costs, by occupational groups, as well as the coefficient of variation within each group (the standard deviation divided by the mid-point value). In the appendix we provide a full tabulation of the data for each of these 178 trades, with their assignment to occupational groups (Table A1).

As Table 1 shows, journeymen's weekly wages show limited variation both within and between occupational groups. The group with the highest variation is 'weavers', which according to Campbell is *very extensive and divided into innumerable Branches: as many as there are different Fabricks of wrought goods*. The highest wage earners were the *tapestry weavers*, who could earn, according to Campbell: *from a Guinea to Three Pounds a Week, according to the Branch they are employed in.*[6] The rest of the weavers earned less than 20 s. p/week, while the lowest wage earners were the narrow weavers (weavers of ribbons, livery-lace, tapes, incles) who earned around 9 s. p/week and the weavers of simple carpets who earned some 6.5 s. p/week. Naturally there is also large variation within the trades included in 'other manufactures', which includes high wage earners such as compositors, enamellers and potters as well as low wage earners such as book binders, cork cutters and button makers.

[5]This recalls the case of Arthur Young, examined by Allen and O'Grada (1988), who conclude that Young's research on English agriculture was conducted carefully and did not reflect his political views.

[6] Campbell (1747), p. 246.

Table 1. Premiums, journeymen wages, and setting-up costs

Occupational group	No. of trades (1)	Journeymen's wages *s/week* Mid-point (2)	Journeymen's wages *s/week* Coeff of var* (3)	Premium, £ Mid-point (4)	Premium, £ Coeff of var* (5)	Setting up costs, £ Mid-point (6)	Setting up costs, £ Coeff of var* (7)
Instrument and machines	11	18	0.39	17	0.66	276	1.38
Goldsmiths, jewelers, artists	18	21	0.32	16	1.45	317	2.03
Carpenters, joiners, coopers	18	19	0.36	16	1.00	656	1.85
Weavers	10	16	0.62	16	0.22	351	0.81
Victualing and services	13	11	0.24	13	1.44	393	1.74
Leather and leather goods	17	14	0.29	12	0.59	384	1.15
Metalwork	19	13	0.30	11	0.67	154	1.00
Smiths and founders	17	16	0.17	10	0.47	322	1.20
Yarn and cloth	15	15	0.37	10	1.41	385	1.29
Building trades	7	11	0.03	10	0.48	271	0.69
Clothing and upholstery	11	9	0.33	9	0.33	232	0.96
Wood workers and turners	10	12	0.27	9	0.85	144	0.75
Other manufactures	12	14	0.58	21	1.92	694	1.62
Total	178	15	0.42**	13	1.23**	351	1.75**

Source: Table A1
* The coefficient of variation within each group, equal to the standard deviation divided by the mean
** The coefficient of variation between occupational groups

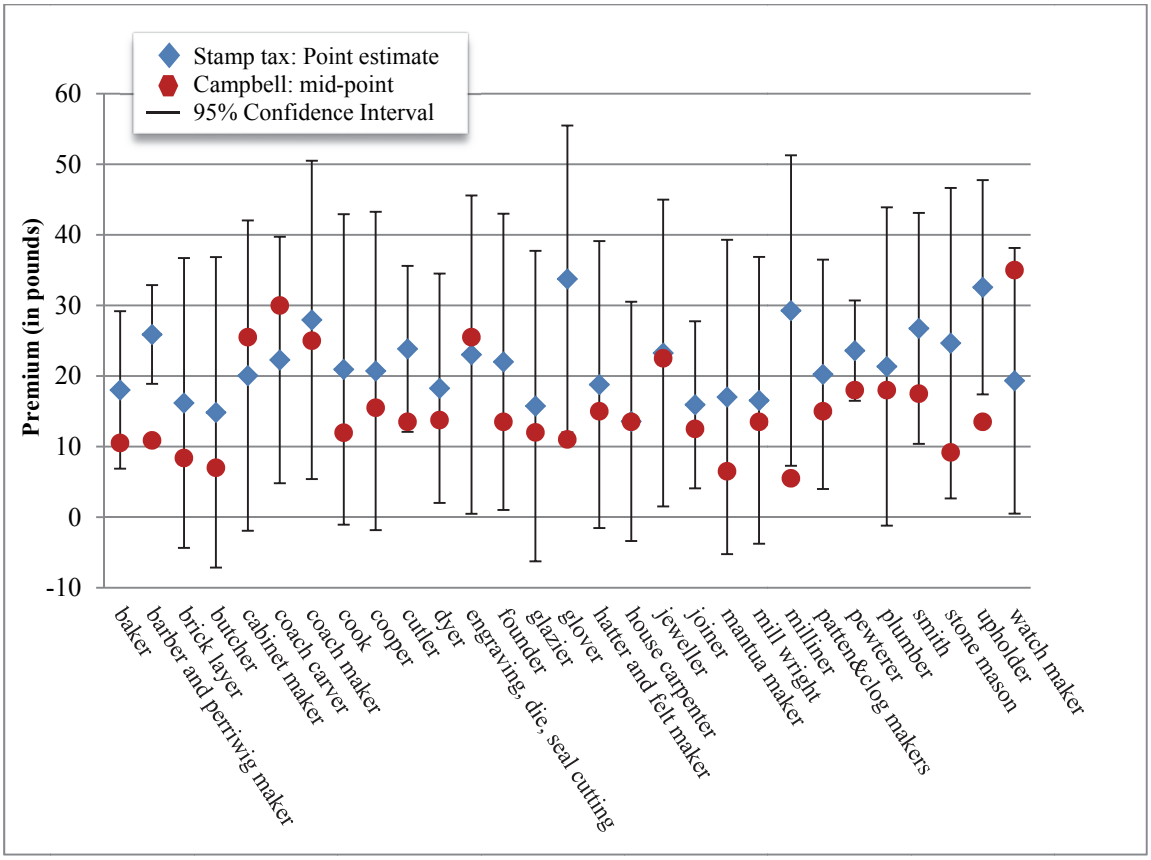
We describe these variables in further detail below, comparing Campbell's quantitative data on apprenticeship premiums, journeymen wages, and setting up costs to information from other available sources on these variables. Other, qualitative variables from *The London Tradesman* described in this section have no counterparts in other sources, as far as we know.

3.1 Premiums

Campbell's data on premiums, in pounds sterling, are collected in a summary table over several pages at the end of the book (pp. 331-340). We compare it to data from the payment register of the Board of Stamps. In 1710, after the introduction of a stamp duty payment on private indentures of apprenticeship, records of the duty paid

on apprenticeship premiums were kept, with stamp tax registers recording indentures upon which duty had been paid running to the first decade of the nineteenth century.[7]

Figure 1. Premium comparison: Campbell and the stamp tax data



Source: For Campbell's mid-point estimates see Table A1; Stamp tax data from Feldman & van der Beek (2013), Table A1.

As Campbell's observations refer to 1747 we limit our attention to tax register entries on premiums paid for apprenticeships in London between 1735 and 1755. Matching trade definitions in the stamp tax register to Campbell's trade classification, we regress individual premiums on a constant with random trade effects. Figure 1 presents point estimates and 95% confidence intervals for each of 28 trades for which

[7] The stamp tax registers are available on microfilm at the National Archives, Kew, in London under Series IR 1. In the early years of the twentieth century the Society of Genealogists compiled an index of these records for the period 1710-1774, recording in each case the date of apprenticeship, the name, location and trade of the master, the name and location of the apprentice, and the premiums paid. We use a stratified 14.3% sample dawn from this index comprising 50,200 entries. See Feldman and van der Beek (2013) for further details.

the tax register has at least 20 observations in the relevant period, along with the midpoint of Campbell's reported range of premium values. In all but three of these trades Campbell's midpoint is within this confidence interval, and in roughly two-thirds Campbell's midpoint is close to the point estimate. In all cases Campbell's range of values (not shown on Figure 1) intersects the confidence interval derived from the stamp tax data. We take this as an indication of a high level of consistency between Campbell's observations and the stamp tax data. We next compare Campbell's observations on trade-specific wages to what we know from other sources of wages in mid-eighteenth century England.

3.2 Journeymen's wages

Data on wages are interwoven in the text in several formats, most commonly in shillings per week but sometimes on an annual or daily basis. In the latter cases, we transformed the data into weekly wages in shillings, basing our calculation on the assumption of a five-day workweek and, allowing for holy days, 46 weeks in the year.[8] Where journeymen were said to receive bed and board we added 5 shillings to the weekly wage; and where Campbell noted that work was available for only part of the year, say eight of twelve months, we adjusted the weekly wage pro rata.

Several important studies have sought to trace the wage and price history of England from medieval times to the present. However data on the eighteenth century are scattered and scarce. Alternative sources from this period exist for building trades, compositors and shipwrights. A summary of the comparison of wages in these trades from different sources is presented in Table 2.

[8] Following Voth (2000), we assume two weekly rest days, Sunday and Monday, and 53 holy days some of which fall on weekly rest days. Voth shows that from 1750 to 1830 annual working hours increased by about a fifth in London and the northern counties; and that what drove the change was the demise of 'St Monday' and a plethora of religious and political festivals.

Table 2. Comparison of sources on mid-18th century wages in selected trades, *shillings per week, London 1747*

	Bowley&Wood	Clark	Campbell
Building trades (carpenters and plasterers)	*15* (1740-49)	*12*	*12-15*
Printing (compositors)	*19*		*21*
Shipwights	*19*		*18-20*

Sources: External sources for building trades, Phelps-Brown and Hopkins (1955) drawing on Bowley and Wood (1901) and Gilboy (1934); Clark (2005, Table A2 and Figure A1); on compositors, Bowley and Wood (1899, Table 1); on shipwrights Bowley and Wood (1905, Table 6). See text for details of adjustments for time and place. Campbell's data from Table A1 below.

The most reliable wage data we have from other sources pertains to the building trades. Phelps-Brown and Hopkins (1955) marshaled systematic wage data going back to 1264, basing their estimates for the eighteenth century on the earlier work of Arthur Bowley and G. H. Wood (1901) and Elizabeth Gilboy (1934). They estimate a craftsman's wage in 1740-49 to equal 24*d* for a ten-hour day, or 10*s* for a five-day week, in Oxford. This is based on an extrapolation of trends in London wages compiled by Bowley, and on his assessment that from 1700 to 1780 the Oxford rate was usually "London less a third". This implies a weekly craftsman's wage of 15*s* in London.

More recently, Gregory Clark amassed an extensive data set on which he based revised estimates that are about 15% lower (Clark, 2005; Table A2, Figure A1) equivalent in London in 1778 to 13*s* per five-day week. He further estimates that wages in the building trades rose 15% between 1740 and 1789, which if evenly distributed in this period implies an increase of 9% in building-trade wages between 1747 and 1778, indicating a weekly wage of just under 12*s* in 1747, the year Campbell published his manual. Campbell indicates a range of 12-15*s* per week for journeymen in the building trades, the lower end of the range conforming to Clark's estimate and the higher end to Phelps-Brown and Hopkins'.

Information on eighteenth century wages for compositors and shipwrights is available for later periods from related work by Bowley and Wood. They estimate compositors'

weekly wages in London to be 21*s* between 1777 and 1792 (Bowley and Wood, 1899, Table 1); and shipwrights' weekly wages to equal 21*s* between 1770 and 1793 (Bowley and Wood, 1905, Table 6).[9]

To gauge movement in wages in the 25-45 years between Campbell's observations in 1747 and the period covered by Bowley and Wood, we refer to Phelps-Brown and Hopkins (1955, Table 1) who estimate that wages in the building trade were initially constant, between 1736-1773, and then rose by about 20% in the following 20 years, while Clark (2005, Table A2) estimates a rise of 15% between 1740 and 1789. Both indicate a rise of 10% in wages between 1747 and 1782-85, the midpoint of the period covered by Bowley and Wood.[10] If the wages of compositors or shipwrights moved in tandem with wages in the building trades this would imply a weekly wage of about *19s* for both compositors and shipwrights. Campbell, in 1747, reports a mid-point of 21*s* for compositors' weekly wages, and that a ship's carpenter earns 18-20*s* a week in the dock yard, and a bolt and anchor smith *a guinea a week and upwards*.

We conclude that Campbell's observations on journeymen wages are consistent with from the limited information available from other sources on the period.

3.3 Setting-up costs and other circumstances of the master's trade

Setting up independently as a master required a considerable amount of capital, which usually implied dependence on credit. Interestingly, this cost seems to have played an important role in determining the premium charged by masters, mainly through its implications on his training costs. The *Sums necessary to set up as master* are provided in Campbell's appendix, in a table entitled: *A General Table of the Several Trades mentioned in this Treatise*, which also includes apprenticeship premiums and information on companies. Campbell listed ranges of the amounts he estimated necessary for setting up in each trade; in our regression analysis we use the middle value of this range. In Table 3, we compare this range with data collected by Schwarz

[9] Bowley and Wood (1899, Table 1) find compositors' wages in London in 1777-1792 equal to 73% of their level in 1860, which Williamson (1982, appendix Table 4) finds equal to 28.7 *s* per week.

[10] As noted above, Clarke's estimate of 15% in 49 years, evenly distributed, implies an annual increase of 0.285%; this comes to 10% in the 35 years between 1747 and 1782. Phelps-Brown and Hopkins estimate no increase from 1736 to 1773 and 20% from 1773 to 1793, which if evenly distributed implies an increase of 10% from 1747 to 1783.

(1992, Table 2.7) on trade-specific mean and median insured values, in policies against fire with the Sun Fire Office and Royal Exchange Assurance between 1775 and 1787 for trades on which both report sums.

Table 3. Comparison of Campbell's setting up costs with insured values (£)

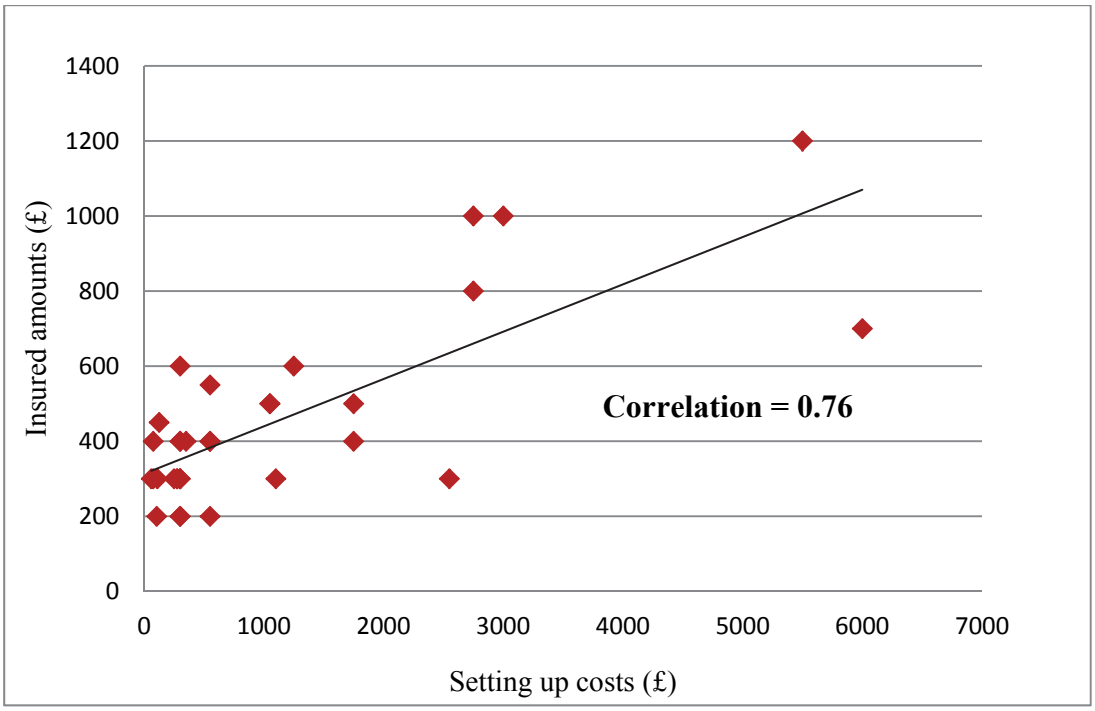
	Insurance				Campbell	
Trade	no of policies	median	mean	Trade	min	max
Mercer	159	1200	1700		1000	10000
Distiller	73	1000	1993		500	5000
Draper	530	1000	1539	woolen draper	1000	5000
Bookseller	129	800	1064		500	5000
Brewer	282	700	1398		2000	10000
Pawn broker	243	600	1025		500	2000
Vintner	282	600	998		100	500
Upholster	48	550	908		100	1000
Goldsmith and Silversmith	235	500	680		500	3000
Haberdasher	504	500	729		100	2000
Stationer	152	500	845		100	2000
Apothecary	248	450	544		50	200
Bricklayer	453	400	586		100	1000
Coach maker	138	400	712		500	3000
Cooper	309	400	891		200	500
Glazier	181	400	458		100	500
Milliner	355	400	516		100	1000
Plumber	109	400	541		100	500
Printer	187	400	826	compositor	50	100
Baker	609	300	420		100	500
Butcher	554	300	364		20	100
Cabinetmaker	481	300	554		200	2000
Carpenter	1492	300	516		50	500
Cheesemonger	405	300	424		100	500
Clock and Watch maker	322	300	381		50	100
Jeweller	110	300	414		100	5000
Poulterer	81	300	409		20	200
Smith	227	300	479	anchor smith	100	500
Tailor	947	300	402		0	500
Turner	118	300	420		50	500
Chandler	983	200	235	wax chandler	100	500
Fishmonger	62	200	384		100	1000
Shoe maker	540	200	319		100	500
Peruke maker	270	200	273	barber and perriwig maker	10	200

Sources: For Campbell's estimate, Campbell (1747), p. 331. For insurance policies with the Sun Fire Office and Royal Exchange Assurance, Schwarz (1992), Table 2.7, p. 62.

Although Campbell's figures cover a broad range and were probably intended to be indicative rather than definitive, their orders of magnitude were found by Schwarz (1992, pp. 62-3) to 'compare quite well' with the trade-specific insured values he reports, though he finds that 'Campbell's own figures were on the high side,' which he attributes to a general movement in prices, noting that insured values in most trades

were 'still tending towards the lower end of his [Campbell's] estimates.' The median sums insured fall within Campbell's range in 26 of the 34 trades we compare (76.5%). They are below the minimal cost in the case of *brewers* and *coach-makers*, but higher than the maximal for *vintners*, a*pothecaries*, *printers*, *butchers*, and, *clock- and watch-makers*. Figure 2 illustrates the strong correlation between these two sources, equal to 0.76.

Figure 2. Linear correlation between setting up costs and insurance policies



3.3.1 Evidence on livery-companies

By serving an Apprenticeship of seven Years, a Youth becomes Free of this great City and may hope one Day to be exalted to the Mayoralty. (Campbell, 1747, p. 303)

Campbell provides information on the company to which each trade belonged and whether it was a Livery Company, collected in a summary table in the appendix to his manual. Apprenticeship was one of the methods of acquiring the Freedom of the City of London, which was essential to anyone who wished to trade or exercise his craft within the City's bounds. It required being an apprentice with a freeman for seven years. Some trades were bound to specific companies while others had the liberty to

bind and make free with any of the companies. Companies that were denoted to be Livery-Companies gave the right to vote at elections of the government of the City of London and certain of its officers.

There are several Companies who have no Livery and the Apprentices bound to them can only be Freemen of the City, and have a Liberty to exercise their Trade or Profession within its Liberties, but cannot be of the Livery, nor have a Vote in chusing Magistrates in the City, or Members to represent it in parliament, when the Livery-Men can.[11]

We find no significant effect of the company being a livery-company on the premium.

3.4 Other characteristics

One of the more intriguing aspects of Campbell's manual is his explicit description of the characteristics that each trade requires, in keeping with his advice to parents to identify the trades that are most suitable to their children's "Genius, Temper, and Disposition" and prepare them appropriately.

The tender Parent, the conscientious Guardian, the true Friend, ought to begin early to make an Inquisition into the Youth's Capacity, Disposition, and Constitution: When they have obtained a perfect Knowledge of his Genius, they ought to be governed in their Choice of a Trade for him by that only: they ought to cultivate his Understanding by all the Helps of Education, suitable to that Bent of Mind which they have discovered in him, and that in his most early Years. ... And how void of Understanding or natural affection must that parent be, who has it in his Power, and yet neglects to improve these critical Minutes, Upon which the Happiness of his Child an Individual, his Usefulness to Society, and the Prosperity of his Offspring to latest Ages, so intimately depends[12]*?*

Campbell begins his treatment of every trade with a technical description of the job and the conditions of employment, followed by a description of the qualities it requires, as in the case of the gunsmith discussed above:

[11] Campbell (1747), p. 303.

[12] *ibid*, p. 23

It is a very ingenious Busines, requires Skill in the Tempering of Springs, a nice Hand at forming a Joint to make his Work close, and a good Hand at the File to polish it handsomely … A boy may be bound at Fourteen and requires no extraordinary Strength or Education.[13]

These characteristics of the occupations give us an indication of the length of training required for an apprentice to become productive for the master and cover the expenses he incurs. We posit that apprentices in occupations mentioned by Campbell as requiring physical strength became productive in a relatively short period, implying that the premium the master had to charge to cover the risk of early departure should be relatively low. And *vice versa*, apprentices in occupations that required "higher skills"—such as ingenuity, formal education (reading and writing), a mathematical head, or drawing skills—took longer to become productive, leading masters to charge a higher premium.

To examine this hypothesis, we systematically coded Campbell's verbal descriptions as a set of indicator variables for a set of trade characteristics. We focus in our analysis on several characteristics that were regularly addressed by Campbell.

The first characteristic is ***physical strength***, which is mentioned in reference to 56 occupations of the 178 we examine, including leather dressers, founders, smiths, plumbers, butchers, dyers, farriers, founders, weavers, and many more. For example in reference to the butcher Campbell states that: *"It requires great **Strength**, and a Disposition no ways inclinable to the Coward"*[14]. Another characteristic we focus on is for occupations that require the knowledge of ***reading and writing*** (in English). There are 20 such occupations including engravers: *"Their Education may be only to **read and write English** and understand common Arithmetic"*[15]; pattern drawers: "*As to his Education, he requires neither Languages, nor any Knowledge of the Sciences; and if a boy is found to have any scrawling disposition, he .may be bound as soon as he has learned to **read and write**."*;[16] carpenters, calico printers, engineers, and others.

[13] *ibid*, p. 242

[14] *ibid*, p. 281

[15] *ibid*, p. 110.

[16] *ibid*, p. 116.

Another group of occupations that we refer to in our analysis consists of occupations that require ***drawing*** or ***mathematical*** skills and talent. In most cases Campbell refers to natural tendencies in these domains. For example: *The Mathematical-Instrument-Maker makes all kind of Instruments constructed upon Mathematical Principles, and used in Philosophical Experiments: He makes Globes, Orrerys, Scales, Quadrants, Sectors, Sun-Dials of all Sorts and Dimensions, Air- Pumps, and the whole Apparatus belonging to Experimental Philosophy,* ***He ought to have a Mathematically turned Head…"***[17]. But in some cases he talks about formal education, as in the case of potters and enamellers where Campbell states that they *"...****must acquire the Art of Drawing****; and a sufficient Knowledge in Painting"*[18]. In the case of engineers: *His Education as to Letters may consist in Knowledge of the English Tongue; but* ***he ought to learn Mathematics and Designing****, of which it is absolutely necessary he should be perfect Master*[19], and in the case of engravers: *"it is impossible for any Man to be, an accurate Engraver without* ***the Knowledge of Drawing****, and a Taste in Painting."*[20]

In 64 of the 178 occupations examined Campbell denotes that ***ingenuity*** is required. This characteristic reflects the complexity of different trades and is referred to repeatedly in regard to most trades, describing them as requiring no ingenuity, little ingenuity or to be very ingenious. Thus: *The plain Silk Weaver requires* ***but little Ingenuity****, but the Weavers of flowered Silks, Damascs, Brocades and Velvets are* ***very ingenious Tradesmen***[21]. The soap-boiler *is a laborious nasty Business, but abundantly profitable, and* ***requires no great Share of Ingenuity***[22] But the saddler ***requires a large Share of Ingenuity*** *and Invention*.[23]

[17] *ibid*, p. 253.

[18] *ibid*, p. 186.

[19] *ibid*, p. 249.

[20] *ibid*, p. 109.

[21] *ibid*, p. 259.

[22] *ibid*, p. 263.

[23] *ibid*, p. 234.

4. Estimation

We posit that apprenticeship premiums in a given trade are bounded from above by parents' willingness to pay and bounded from below by masters' anticipated net costs. Parents' willingness to pay reflects the difference in discounted lifetime income between the wages of a journeyman in the trade and the wages of a common laborer, plus the value of any non-pecuniary benefits associated with the trade, such as improved social standing, plus the probability of successfully setting up as a master multiplied by the net benefits thereof. A master's anticipated net costs are the expected difference between the costs associated with apprenticeship, including room and board, the time the master devotes to instruction, wastage of materials and so on, and the productive value of the apprentice's work under the master, *allowing for the possibility that the apprentice unilaterally terminates his contract with the master before term*. As Wallis (2008) and Minns and Wallis (2013) emphasize, this latter consideration leads the master to require a premium, as apprentices are typically more costly and less productive in the earlier years of their apprenticeship and enforcement of apprenticeship contracts was incomplete.

Comparing annual journeyman wages with premium levels leads one to conclude that for most trades the difference in discounted lifetime income between the wages of a journeyman and those of a common laborer premium exceeds typical premium levels, even before other benefits of acquiring a trade are factored in. To fix ideas, assume a youth enters into an apprenticeship of seven years on his fourteenth birthday and upon its completion begins working as a journeyman. Typical earnings for journeymen reported by Campbell range between twelve and fifteen shillings a week while a common laborer might earn five to seven shillings. The added earnings of a journeyman thus range between five to ten shillings a week, and assuming as before that both work 46 weeks a year, this comes to between £11 10s and £23 a year. Assume further that this continues until his fortieth birthday (the calculations are not sensitive to the number of working years as the contribution of later years is heavily discounted). The discounted present value at age 14 of the difference between a

journeyman's wages and those of a common laborer under these assumptions is tabulated for several possible combinations in Table 4:[24]

Table 4. Net present value of additional lifetime earnings of a journeyman, above those of a common laborer (in £)

	Annual rate of discount		
Annual difference in income	15%	20%	25%
12	26	14	8
18	40	22	12
24	53	29	17

The comparison of these sums to the premium levels in Table 1 depends very much on the rate of discount chosen. A much higher rate than we would use today is certainly in order, as it should reflect greater liquidity constraints and a large measure of certainty but it is difficult to say, how high. Taking into account that these numbers only reflect the pecuniary advantage of becoming a journeyman, and that other, non-pecuniary advantages such as improved social status and better working conditions were no doubt also valued, it seems reasonable to conclude that many parents and their apprenticed children were able to capture a large share of the pecuniary surplus between their willingness to pay and masters' willingness to accept.

This could reflect the greater sensitivity of cash-strapped parents to price than well-off masters, who would be more sensitive to the personal qualities of the apprentice—whether he is hard-working, honest, clever and so on. And where masters are numerous and largely interchangeable to the parent, competition among them for apprentices would drive down price to near their expected marginal cost. We find evidence of this in the data in the absence of a significant raw correlation between premiums and wages: only when set-up costs are included in the regression do we find a significant effect of wages on premiums.

[24] Let $w - w_0$ denote the annual difference in income and r the annual discount rate. We calculate the net present value of incremental lifetime earnings at age fourteen as $NPV = (w - w_0)\int_7^{26} e^{-rt} dt$.

Summarizing the discussion, in this and the previous section, of the effect of different variables on the level of premiums, we expect variation in premiums across trades to vary positively with set-up costs, whether because they reflect entry barriers limiting competition and allowing masters to capture a larger share of the surplus through higher premiums; or because they reflect the complexity of the trade, which therefore requires a longer period of training before the apprentice is fully productive, raising the cost to the master of early departure; or because such trades are associated with the non-pecuniary benefit of higher social status. We expect journeyman wages to be positively associated with premiums: on the part of the master because they increase the incentive for early departure; and on the part of the parent because they increase the benefit from acquiring the trade. And we test the hypothesis that trades requiring special talents or skills are more complex and therefore take longer to learn and so are associated with higher premiums while those requiring greater physical strength are acquired more quickly and carry non-pecuniary disadvantages, and so should be associated with lower premiums.

We estimate the following model across 178 trades:

$$\log(premium)_i = \beta_1 + \beta_2 \log(wage)_i + \beta_3 \log(suc)_i + \beta_4 Z'_i + \varepsilon_i$$

The dependent variable is the logarithm of apprenticeship premiums in trade *i* and the independent variables include the logarithm of journeyman wages, setting-up costs (denoted by *suc*), and a vector of trade characteristics (Z'). The results are presented in Table 5. The OLS specification indicated the existence of heteroskedastic errors and so our model was estimated using Feasible Generalized least squares (FGLS), which uses a weighting matrix with estimated variances[25]. We find, as expected, strong significant positive effects of both journeymen's wages and set-up costs on premiums, with estimated elasticities between 0.33 and 0.43 for wages and between .23 and .25 for set-up costs, with all coefficients significant at a *p*-value of 0.001 or better, and very little difference between the similarly specified OLS and GLS estimates.

The trade characteristics in the equation are also statistically significant and exhibit the expected signs: trades that require higher skills command higher premiums,

[25] White's test for homoskedasticity against unrestricted forms of heteroskedasticity rejected the null hypothesis with a Chi2 statistic of 21.21 (Pvalue=0.0007).

though only drawing and reading and writing have statistically significant coefficients, while trades that require strength demand lower premiums. Finally, the advantage of being apprenticed to a trade bound to a *liveried* company had no effect on the premium.

5. Conclusions

This paper's main contribution is the light it sheds on the workings of apprenticeships in mid-eighteenth century London. We estimate an elasticity of apprenticeship premiums with respect to wages between 0.33 and 0.43 and an elasticity between 0.23 and 0.25 with respect to a master's set-up costs. We also find that trades requiring "higher skills" demanded higher premiums while those requiring physical strength demanded lower premiums. This is consistent with premium levels that are bound from above by parents' willingness to pay and bound from below by the net expected costs of the apprenticeship to the master, taking into account the possibility of the apprentice prematurely terminating his contract (Minns and Wallis, 2013). Demonstrating the responsiveness of the supply of apprenticeships and demand for them to market forces lends support to the view advanced by Humphries (2003) and Wallis (2008) among others that apprenticeships played a useful role in adapting the English workforce to the changing skill requirements of the Industrial Revolution—as early as the mid-eighteenth century.

A second contribution of the paper is its demonstration that the detailed quantitative and qualitative observations offered by John Campbell (1747) on the economic, technical and physical characteristics of the many trades practiced in London in the mid-eighteenth century are both internally and externally consistent. Although Campbell's manual is well-known to historians studying the formation of industrial skills in eighteenth-century England, and frequently cited, as far as we know ours is the first systematic quantitative application of the evidence he provides, and should encourage its wider use in understanding of the early stages of England's Industrial Revolution.

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