Working Skills Derived From Occupations: The 'Deskilling Hypothesis' Revisited[1]

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Abstract

We use occupational titles from English parish registers (CAMPOP) to study the *deskilling hypothesis*, i.e. the idea that England's Industrial Revolution was mainly skill saving. We code the occupational titles of over 30,000 male workers according to the skill-content of their work (using HISCLASS) to track the evolution of working skills between 1550 and 1850. We observe a small rise (from 4% to 5%) in the share of 'high-quality workmen' deemed necessary to facilitate the Industrial Revolution, such as joiners, turners, and wrights. But we also find considerably growth in the share of unskilled workers, from 20% around 1700 to 40% around 1850, fed by falling shares of lower- and medium-skilled blue-collar workers, such as tailors, shoemakers, and weavers, supporting the view that the Industrial Revolution was chiefly skill saving.

Keywords: Deskilling, HISCLASS, Industrial Revolution, Occupations, Working Skills

JEL Codes: J24, N34, O10

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I

Introduction

Economic historians have long debated whether England's Industrial Revolution was skill saving or skill demanding. One side holds that the transition from artisan workshops to factory production reduced the need for skilled workers (Goldin and Katz 1998). This view has received support from studies such as Humphries (2010, 2013) and Kirby (2005) showing how mass production in Britain substantially raised the demand for unskilled workers (including women and children); from Mitch (1999, 2004) and Nicholas and Nicholas (1992) observing a pause during the late 18th century in the rise of male literacy rates; and from Nuvolari (2002) noting that early industrialization witnessed a considerable number of machine-braking riots. The other side stresses the undeniable need of skilled workers to facilitate the innovations and the mechanizing that made the Industrial Revolution possible in the first place (Mokyr 2009; Meisenzahl and Mokyr 2011). This view has received support from work by Van der Beek (2012) documenting a rising number of apprentice contracts in 'high-quality' trades (joiners, turners, wrights etc) during the 18th century.

In this paper we look at human capital acquisition among the general population, studying the evolution in working skills derived from a large set of occupational titles recorded in English parish registers between the 16th and 19th centuries. Our data include more than 30,000 male workers holding over 280 distinctly different occupational titles. We use the so-called HISCLASS scheme, developed by Van Leeuwen and Maas (2011), to code our occupational title according to the working skills required for an average performance on the job. We study the evolution of working skills among different social groups (blue-collar versus white-collar workers) and within the different

sectors of production (primary, secondary, tertiary). We also study different professional categories, with particular focus on occupations commonly thought to help facilitate the Industrial Revolution (joiners, turners, wrights etc). Our spot checks against census data and social tables show our sampled share of unskilled male workers provide a reasonable representation the entire England.

We find that our sampled workforce was remarkably well trained during the 16th century, with only 20% of all workers coded as 'unskilled' according to the HISCLASS scheme. But we also find a dramatic shift after 1700, so that by the 19th century the share of unskilled workers had doubled, reaching 39% of our workforce. Some of this deskilling stems from upward social mobility across the life cycle: 41% of the sampled workers were unskilled at the time of their marriage, but only 33% were unskilled at the time of death. Our findings are robust to a variety of specifications, including a collapse of lower- and unskilled workers and controls for compositional effects.

By splitting our sampled workforce into blue-collar (manual) and white-collar (non-manual) workers, it becomes clear that the deskilling we observe was chiefly a blue-collar phenomenon. The shares of lower- and medium-skilled blue-collar workers declined substantially from 1700 on while the share of unskilled blue-collar workers grew from 24% to 43%. The skill structures among white-collar workers, however, remain largely constant during the Industrial Revolution. Our in-depth analysis of the professions believed to be vital to England's Industrial Revolution shows an increase in what Mokyr (2009) calls 'high-quality workmen': the share of professions including joiners, turners, and wrights displayed modest growth, from 3.9% to 4.7% between the 16th and the 19th centuries. But this was clearly not enough to counterbalance the vast

decline in the shares of lower-skilled and (particularly) medium-skilled craftsmen (weavers, tanners, glovers, tailors, shoemakers, coopers, smiths, etc) observed after 1700. We thus conclude that England's Industrial Revolution was chiefly skill saving.

II

Data and Analysis

Our occupational titles come (primarily) from the Cambridge Group's *Family Reconstitution Data* (CAMPOP). This dataset was built on information derived from ecclesiastical events recorded in a total of 26 English parishes (see Wrigley et al 1997).[3] The full data set covers more than three centuries of English demographic history, from the first emergence of parish registration, in 1541, until population census became common, in 1871. The sampled parishes were selected by the Cambridge Group due to the high degree of detail in the data and with the intention of making them representative of the entire country. The parishes range from large market towns to remote rural villages, including proto-industrial, retail-handicraft, and agricultural communities.

The sampled occupational titles were recorded on the following ecclesiastical events: marriage, burial, and baptism or burial of offspring. Some individuals were recorded several times, others only once. Multiple entries, notably in the context of baptising offspring, introduce a potential bias in the data, since individuals who baptise many children enter the data more often. Previous research has shown that the rich had more children than the poor, and that the rich were also often more skilled (Clark and

[3] These parishes are: Alcester, Aldenham, Ash, Austrey, Banbury, Birstall, Bottesford, Bridford, Colyton, Dawlish, Earsdon, Grainsbro, Gedling, Great Oakley, Hartland, Ipplepen, Lowestoft, March, Methley, Morchard Bishop, Odiham, Reigate, Shepshed, Southill, Terling, and Willingham.

Hamilton 2006; Boberg et al 2011). This means the rich would be overrepresented in the sample, which in turn would overestimate the skill acquisitions of the sampled population. We remove this bias by including each individual only once. We always use the earliest recorded occupational title. This means 20% of our sampled males were recorded at their marriage; 29% at their burial; and 51% some time in-between. In a later robustness analysis we control for potential composition effects arising from the fact that some were recorded early in life and others later.

Four occupational titles – 'Gentleman', 'Esquire', 'Pauper', and 'Widower' – were excluded from the original sample. These titles (making up 4% of the sampled population) do not refer to an actual profession, and hence could not be coded using the HISCLASS scheme (see description below). Our findings are robust to the inclusion of gentry and paupers on the assumption that paupers are unskilled and gentry and esquires are highly skilled. We have also removed one of the 26 parishes of the original sample. The parish of Birstall usually counts less than 100 recorded occupations per fifty-year sub-period; but the sub-period 1750-99 has a staggering 2,200 observations, which is more than one-fourth of our total sampled population in that period. This means Birstall heavily distorts the skill-structure in 1750-99 and is why we decided to exclude it. Including Birstall, but not the period 1750-99, does not alter the qualitative nature of our conclusions below.

Our goal is to use the recorded occupations to infer information about the working skills of the sampled workforce and to study the evolution of working skills across time, notably during the classic years of the Industrial Revolution (1750-1850). To this end, we code the sampled occupational titles using the so-called HISCO-

/HISCLASS schemes. The HISCO (Historical International Standard Classification of Occupations), developed by Van Leeuwen et al (2002, 2004), comprises 1,675 distinct job categories. In a follow-up book, titled, *HISCLASS. A historical international social class scheme*, Van Leeuwen and Maas (2011) applied the principles of the Dictionary of Occupational Titles (DOT) to extract information about the working skills of incumbents of historical occupations coded in the HISCO system. The DOT was developed in the 1930s by the US Employment Service in response to a rising demand for standardized occupational information to assist job-placement activities (US Department of Labor, 1939). In order to efficiently match jobs and workers, the public employment service system required that a uniform occupational language be used in all of its local job service offices. Through an extensive occupational research program, occupational analysts collected and provided data to job-market interviewers, to help them match the specifications given in job openings to the qualifications of job applicants. Based on the data collected by occupational analysts, the first edition of the DOT was published in 1939, containing some 17,500 job definitions, presented alphabetically, by title, with a coding arrangement for occupational classification.

The transformation of occupational titles into working skills in the HISCLASS scheme builds on two main scores used in the DOT: the General Educational Development score and the Specific Vocational Training score. The score concerning general educational development captures three key features regarding intellectual competencies necessary to fulfil the tasks and duties of an occupation: the incumbent's reasoning development; his or her ability to follow instructions; and the acquisition of language and mathematical skills needed to conduct the work. The score concerning specific vocational training captures the time investments needed in three main areas:

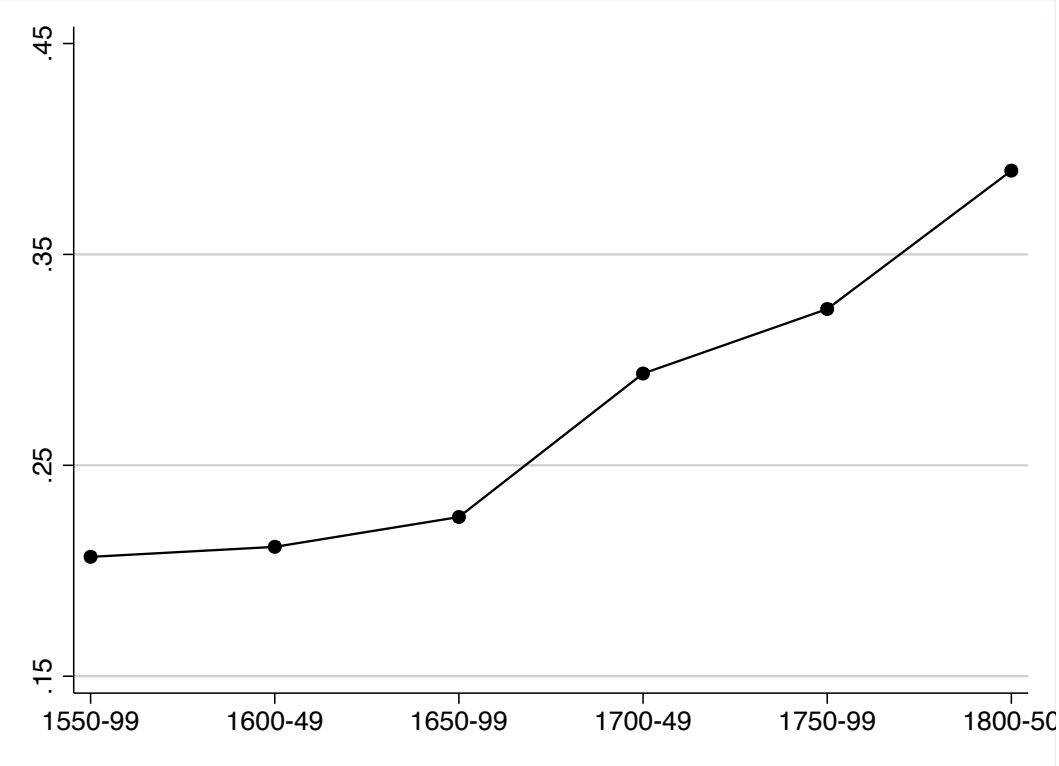
that required by the worker to learn the techniques used on the job; that needed to acquire the relevant information to conduct the work; and that necessary to develop the competencies required for an average performance in a job-specific working situation.

Building on the expertise provided by Bouchard (1996) and a team of labour historians, Van Leeuwen and Maas used the two DOT scores to code the occupational titles categorized in HISCO according to the skill-content of the worker, as part of a procedure to create the HISCLASS scheme. In the HISCLASS scheme, occupational titles were grouped in four categories as *unskilled*, *lower-skilled*, *medium-skilled*, or *higher-skilled*. Our sampled workforce contained 284 distinctly different occupational titles identified by the HISCO and hence code-able in the HISCLASS scheme. Table A1 in the Appendix lists the most common occupational titles and how they were coded in the HISCLASS scheme.

Figure 1 shows the share of workers in the sampled workforce whose professions were deemed 'unskilled' in the HISCLASS scheme. We have split the sampled workers into fifty-year intervals covering the full period from 1550 to 1850. Table A2 in the Appendix reports the share of unskilled workers for each sub-period. Figure 1 speaks a very clear language: up until 1700, the sampled workforce was rather well trained, with only one out of five workers coded as unskilled. Between 1700 and 1850, a profound process of deskilling took place, with the share of unskilled workers rising to two out of five workers in the first half of the nineteenth century.

Figure 1

The Share of Unskilled Male Workers, 1550-1850

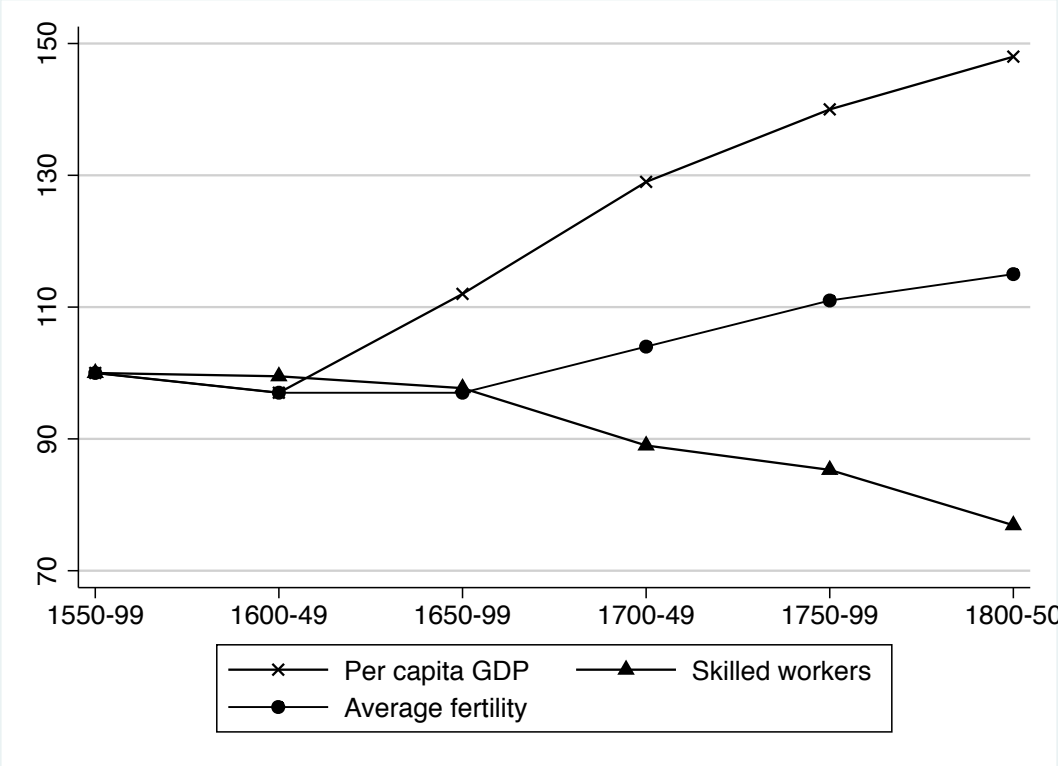


Note: Unskilled workers are workers whose occupational title is labelled 'unskilled' in the HISCLASS scheme (see van Leeuwen and Maas 2011). *Source*: CAMPOP data (see text).

Strikingly, the deskilling episode shown in Figure 1 coincides a period of economic growth. Figure 2 captures this by plotting the share of skilled workers against the evolution in GDP per capital and marital fertility (indexed with 1550-50=100). Between 1650 and 1850, GDP per capital rose by 30% and marital fertility by 15% (see Table A3 in the Appendix). At the same time, the share of skilled workers declined by about 23%. In light of these developments, and that economic growth is commonly viewed as driven by human capital growth (not decline), there is reason to believe the deskilling observed in Figure 1 is based on a misreading of the data, or that the data is not representative of the entire England. The reminder of our paper is thus devoted to study the representation of our data and the robustness of the deskilling result.

Figure 2

The Share of Skilled Workers, GDP per Capita, and Marital Fertility, 1550-1850



Note: Index: 1550-99 = 100. *Sources*: GDP per capita: Broadberry et al (2012); the share of skilled workers and marital fertility: CAMPOP data (see text). Skilled workers are workers whose occupational title is coded as 'low-skilled', 'medium-skilled' or 'high-skilled' in the HISCLASS scheme (see van Leeuwen and Maas 2011).

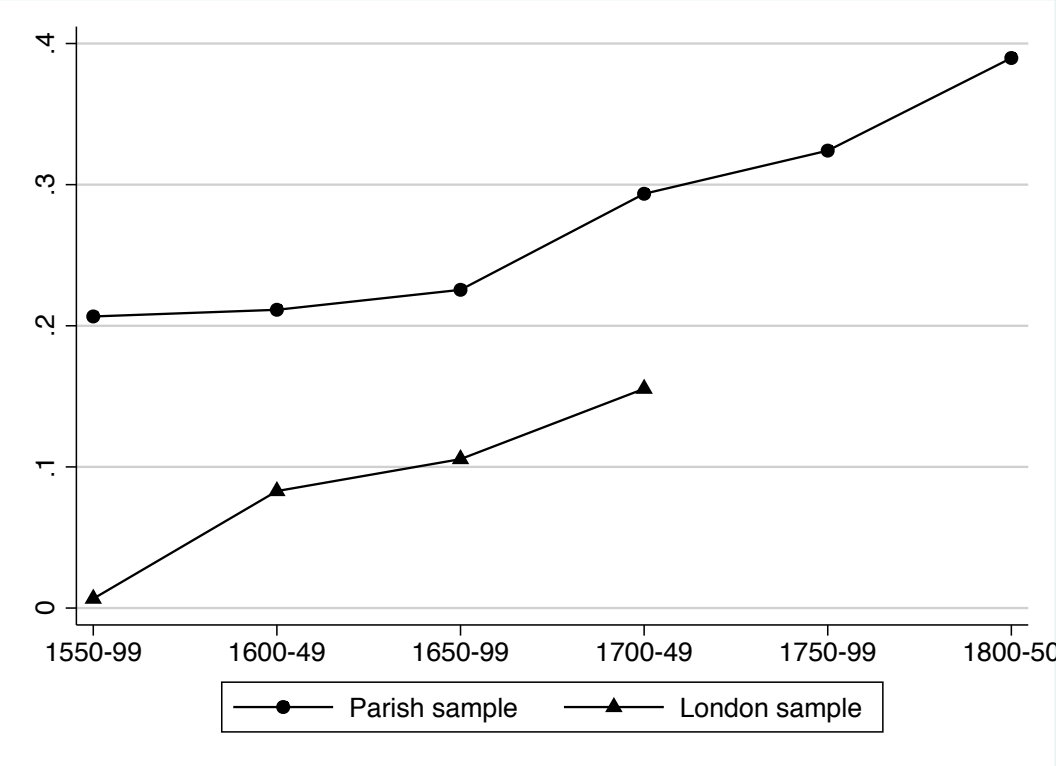
According to Wilson (1984), the sampled parishes, although most of these were provincial locations, were prone to faster population growth and a quicker shift to manufacturing than England as a whole. But our sampled locations do not include large cities such as London. Hence, the deskilling observed in our sampled parishes could have been caused by skilled workers migrating from the provinces to urban centres. Work done by Newton (2007) and Newton and Baker (2007) allow us to investigate the evolution of working skills among male workers of seven parish registers in London (five from Cheapside, two from Clerkenwell). Figure 2 shows the share of unskilled workers in London against that in the provinces (i.e. our sampled workforce).

Unfortunately, the London data runs only up until 1750. It nevertheless inform us (as expected) that the sampled Londoners were even better trained than their provincial counterparts, with barely any unskilled workers before 1600. But the London data also shows patterns of deskilling: although this starts earlier than in the provinces, the share of unskilled workers grew remarkably over the period of observation: from 8% in 1600-49 to 16% in 1700-49 (Tables A2 and A4 in the Appendix). This analysis does not support the notion of a 'brain drain' from the provinces to the city.

A more substantial assessment of the representation of the provincial parishes can be made by comparing the working skills of our sampled workforce with England more broadly. To this end, we have been able to make three spot checks using occupational information from pre-existing census data and social tables. The English social table of 1688, revised and reported in Lindert and Williamson (1982), can be used to calculate the share of unskilled workers for that year. This social table includes nearly 1,39 millions male workers out of which 29% are classified as 'unskilled' in the HISCLASS scheme. Furthermore, Shaw-Taylor et al (2010)'s account of adult male employment in England and Wales circa 1710 leaves us with 1,48 millions occupational titles (after removing 'gentry', 'paupers' and those of 'no occupation'). Among these, 31% were coded as 'unskilled' workers in the HISCLASS scheme. Finally, Booth's grouping of the occupational titles included in the 1841 population census provides a share of unskilled workers equal to 42% (Booth 1886). Booth's census data is particularly interesting since it includes the entire English work force at the time: 6,63 millions males.

Figure 3

The Share of Unskilled Workers in London and the Provinces, 1550-1850

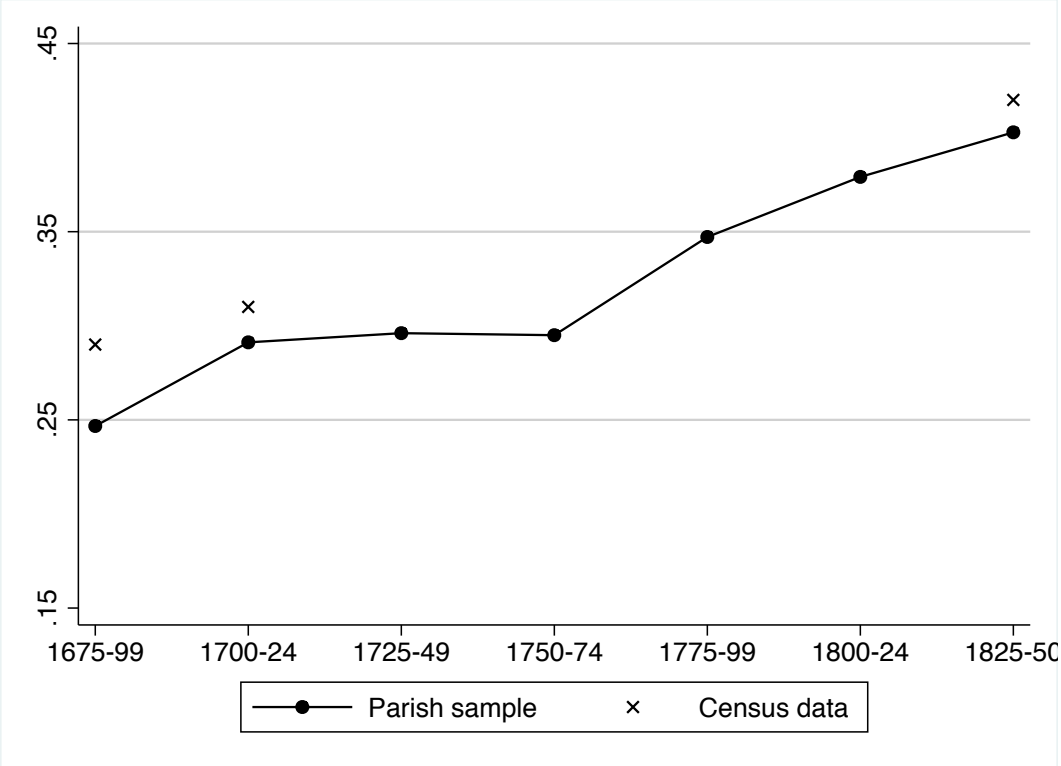


Note: Unskilled workers are workers whose occupational title is labelled 'unskilled' in the HISCLASS scheme (see van Leeuwen and Maas 2011). *Sources*: Province data (Wrigley et al 1997). London data: Newton (2007) and Newton and Baker (2007).

Figure 4 plots the three independent shares of unskilled workers up against our sampled workforce (see Table A5 in the Appendix). Not only do the independent data compare rather well to ours in terms of shares of unskilled workers; they also follow the same trend, displaying the same episode of deskilling as Figure 1 suggested. Interestingly, our sampled workforce slightly underestimates the shares of unskilled workers in the general population.

Figure 4

Comparison between the Provinces and Social Tables and Census Data, 1675-1850

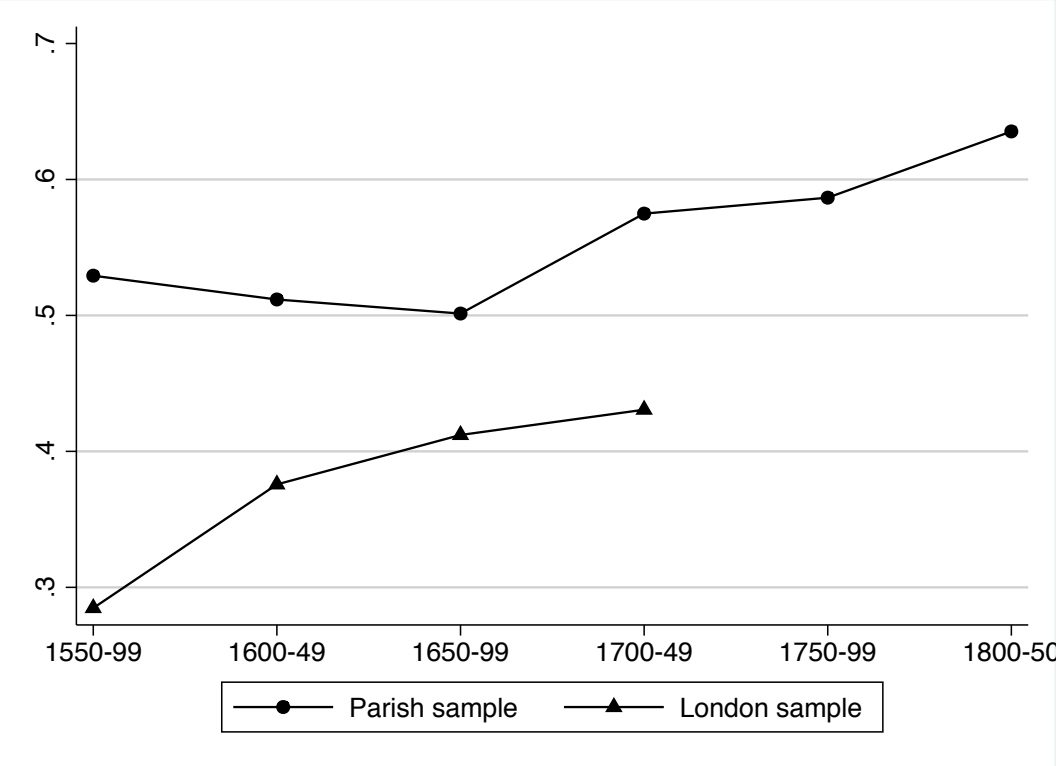


Sources: CAMPOP data (see text); social tables: Lindert and Williamson (1982); church book data: Shaw-Taylor et al (2010); census data Booth (1886).

It is no secret that much of the deskilling observed in our data comes from a growing number of workers recorded as 'Labourer' in the parish registers. Some would argue that even ordinary labourers are able to accumulate a fair amount of working skills across their life-cycle, and hence that they should be coded as 'lower-skilled' workers instead of 'unskilled'. One way to deal with this issue is by 'upgrading' our labourers (and other unskilled professions in our data) to lower-skilled workers. This is done in Figure 5, which has collapsed lower- and unskilled workers into one group, in London and in the provinces (Tables A2 and A4 in the Appendix). The graph largely replicates the findings from Figure 3: there is deskilling in London up until 1750 (from 29% in 1550 to 43%) and in the provinces after 1700 (from 50% to 63% by 1850).

Figure 5

The Share of Lower- and Unskilled Workers in London and the Provinces, 1550-1850



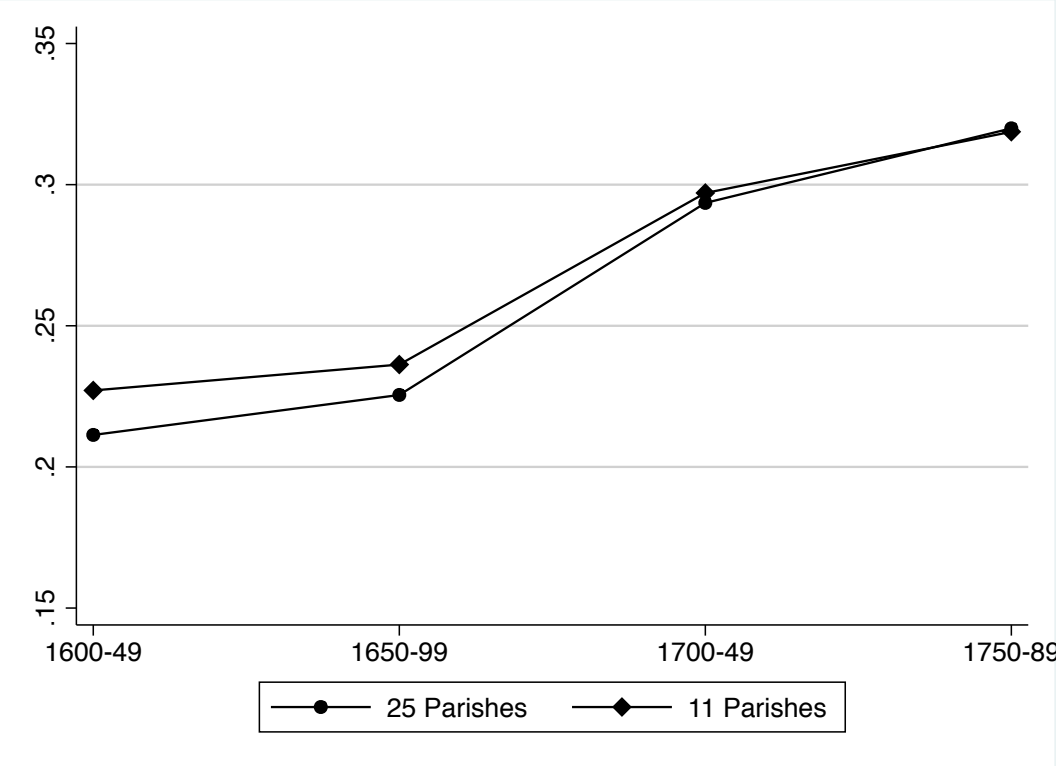
Sources: CAMPOP data (see text); London sample: Newton (2007) and Newton and Baker (2007).

A well-known problem of our data is that the parishes included in the sample change across the period of observation (Wrigley et al 1997). This could give rise to compositional effects. For example, deskilling could be cause by shifting from parishes with relatively few unskilled workers to parishes with relatively many. Fortunately, we are able to control for such compositional effects. This can be done by comparing those 11 parishes that cover most of our period (i.e. 1600-1789) with the 25 parishes included thus far.[4] Figure 6 plots the results, showing the trends in the two samples are remarkably similar (Table A6 in the Appendix).

[4] The 11 parishes are: Aldenham, Banbury, Bottesford, Colyton, Grainsbro, Gedling, Methley, Odiham, Shepshed, Southill and Terling.

Figure 6

Controlling for Compositional Effects, 1600 -1789



Source: CAMPOP data (see text).

Another potential problem concerning compositional effects arises from the fact that our individuals are observed at different points across their life-cycle: some at their marriage, some at their burial, some in-between (when baptising or burying a child). This consists of a problem if individual skills shift across the life-cycle. For example, a person's skill-level may grow because of learning-by-doing or decline because of loss of physical or mental abilities during old age. If skills increase across the life-cycle, and if we mostly observe buried people to begin with and mostly married people later on, then that could potentially account for the deskilling we observe.

Figure 7

The Share of Unskilled Workers: Marriage versus Burial Occupations, 1550-1850

Source: CAMPOP data (see text).

We can control for compositional effects by grouping and studying occupations recorded at the time of the marriage and the burial, respectively, against all our sampled occupations. Figure 7 illustrates this, showing some remarkable patterns. Up until 1700, it makes no difference at what point during the life-cycle our sampled individuals are caught: all three graphs overlap (Table A7 in the Appendix). After 1700, it is clear that deskilling is more dramatic among the marriage cohorts than among the burial cohorts, suggesting upward social mobility is taking place across the life-cycle. For example, in the period 1800-50, 41% of the workforce was unskilled at the time of their marriage, but only 33% were unskilled at the time of their death. Note that we still observe each individual once, so our burial cohorts are not identical to the earlier marriage cohorts.

III

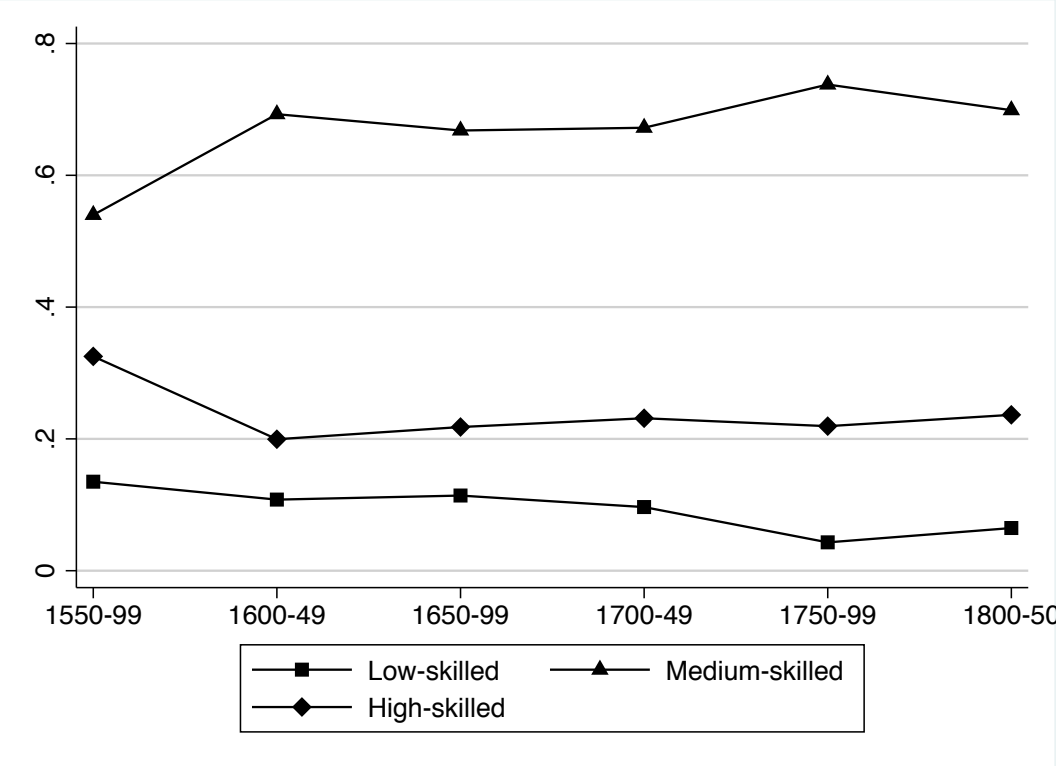
A Deeper Look

The increase in the share of unskilled workers found in the previous section does not tell us whether deskilling was a broad phenomenon or whether it took place within certain sectors of production, such as industry (or even among certain categories of professions). To cast light on these matters, we decompose the sampled population into blue-collar and white-collar workers to study the evolution of skills within each group. We also decompose our sampled population by sector of production, i.e. primary, secondary, and tertiary, using the PST system (Wrigley 2010) to see if deskilling was a purely manufacturing phenomenon or whether it adhered to other sectors of production.

We re-use the HISCLASS scheme to split our sampled occupations into blue-collar (manual) workers and white-collar (non-manual) workers. White-collar work means semi-professional office, administrative, and sales-coordination jobs, counting professions such as 'Clerk', 'Salesman' and 'Manager'. This is opposed to blue-collar work, which means jobs requiring manual labour including professions in fields such construction, mining, and farming. Blue-collar workers make up 87% of the sampled population in 1550-99, growing to 91% in 1800-50.

Figure 8

The Share of Skills Among White-Collar (Non-Manual) Workers, 1550-1850

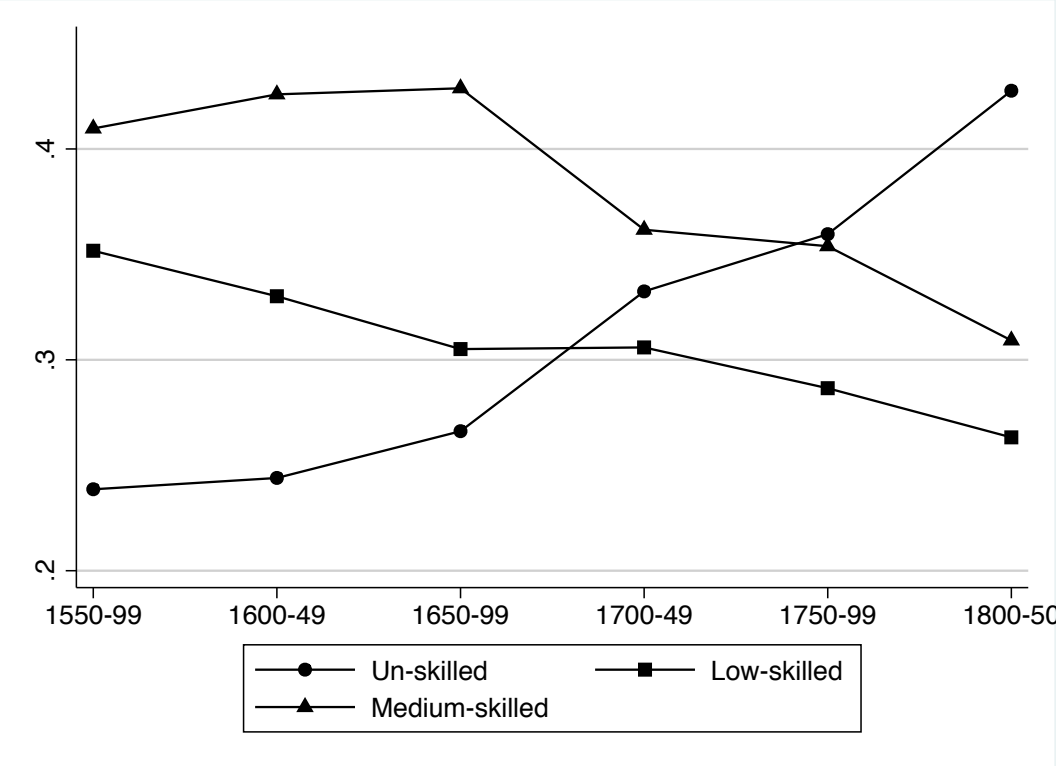


Source: CAMPOP data (see text).

White-collar workers have no category for unskilled labour. So Figure 8 tracks the evolution of the shares of lower-, medium-, and highly-skilled while-collar workers. The share of lower-skilled workers remains largely constant across time, with one in five workers falling into this category. The white-collar sample is dominated by medium-skilled workers (around 70%) while highly-skilled workers consist of about 5-10%. The early 17th century saw a rise in the share of medium-skilled workers and a comparable fall in the share of lower-skilled workers (Table A8 in the Appendix). After 1700, the share of medium-skilled workers rose again, this time fed primarily by a fall in the share of highly-skilled workers, implying a weak deskilling effect among white-collar workers during the Industrial Revolution.

Figure 9

The Evolution of Skills Among Manual workers, 1550-1850



Source: CAMPOP data (see text).

There were far more dramatic changes going on among blue-collar workers (Figure 9). This group of workers has no category for highly-skilled workers. To begin with, the blue-collar workforce is dominated by medium-skilled workers (42%) and lower-skilled workers (36%), with less then one out of four workers coded as unskilled. Up to 1700, the shares of medium- and unskilled workers rose humbly, fed by a falling share of lower-skilled workers (Table A9 in the Appendix). After 1700, the share of unskilled workers rose substantially, from 26% around 1700 to 42% around 1850. This came with a modest fall in the share of lower-skilled workers (from 31% to 26%) and a considerable drop in the share of medium-skilled workers (from 43% to 31%). From this, it is clear that the deskilling is mainly a blue-collar phenomenon.

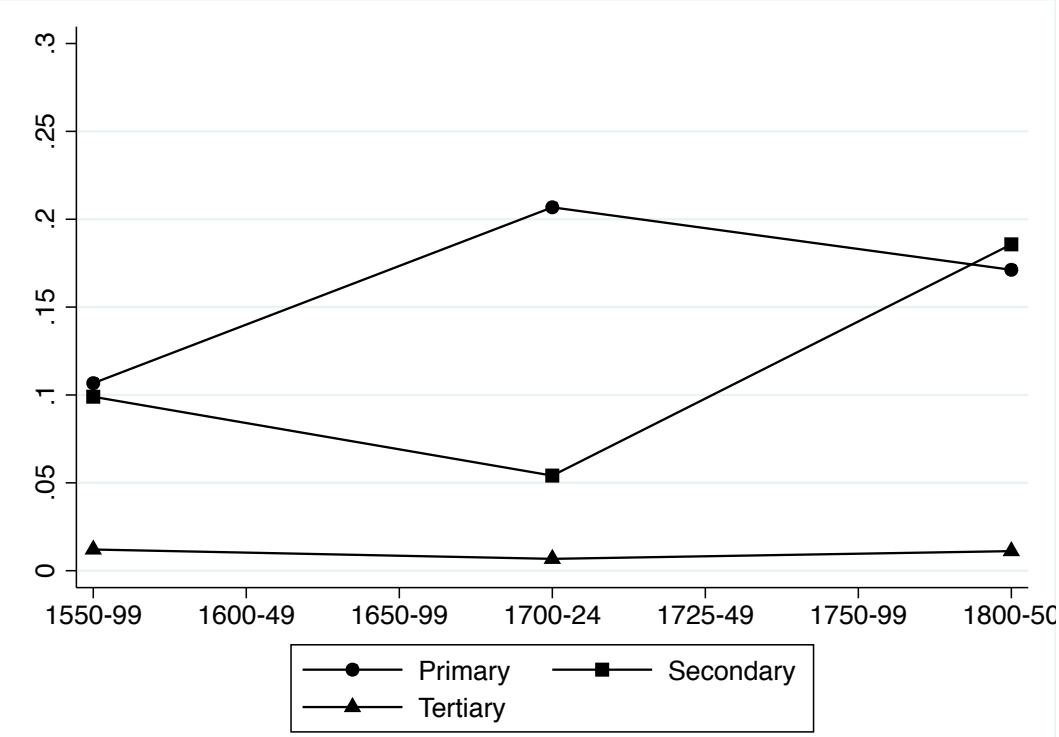
Was the deskilling mainly a secondary-sector phenomenon? Or did it occur in the primary and tertiary sectors as well? Unfortunately, a decomposition of our occupations by sector of production is not a straightforward task. The so-called PST scheme, developed by Wrigley (2010), offers a way to code our occupations in this regard. But as previous work has demonstrated (e.g. Broadberry et al 2012; Shaw-Taylor 2012) a major problem is how to distribute the workers recorded as 'Labourer' by sector of production.

To proceed, we rely on the assumptions previously made regarding three distinct periods: 1550-99, 1700-24, and 1825-50. For sub-period 1550-99, we follow the assumption made by Broadberry et al (2012), which allocates 62,8% of all labourers to primary activities and the rest to secondary activities. Underlying this assumption is the allocation of labour given in the Munster Rolls of 1522. For the period 1700-24, we follow Shaw-Taylor (2012) who assumes that 80% of all labourers belong in primary activities and the rest in secondary activities. This is based on Shaw-Taylor's study of the occupational structures from church book registers in England and Wales around 1710 as mentioned earlier (Shaw-Taylor et al 2010). Finally, for the period 1825-50, we rely on work by Schofield (1973), which sub-divides our parishes into four groups ('agricultural', 'industrial', 'retail-handicraft', and 'mixed') depending on their occupational structure in the 1831 population census. The 'agricultural' parishes (eight in total)[5] had at least 60% male workers over 20 years of age employed in the primary sector. Using this approach to calculate the share of labourers in primary activities, 47,2% of our workers went into primary activities and the rest to secondary activities.

[5] The eight parishes are Willingham, Great Oakley, Terling, Aldenham, Ash, Hartland, Morchard Bishop, and Bridford.

Figure 10

The Share of Unskilled Workers by Sector, 1550-1850



Notes: The allocation of labourers by sector is described in the text. *Sources*: CAMPOP data (see text); Booth (1886); Broadberry et al (2012); Shaw-Taylor (2012).

Figure 10 shows the share of unskilled workers by sector (see Table A10 in the Appendix). With the above assumptions in mind, a prudent conclusion is that the deskilling occurring *before* the Industrial Revolution (i.e. between 1500-99 and 1700-24) was mainly in *primary* activities, and the deskilling occurring *during* the Industrial Revolution (between 1700-24 and 1825-50) was mainly in *secondary* activities. The share of unskilled workers in the tertiary sector remains largely constant (at about 1%) during the entire period.

Last but not least, our data allow us to dig one step deeper into the occupational structure within the primary and secondary sectors. This can help shed light on the types of skilled professions that were replaced by unskilled professions. It also allows us to explore the idea set forth by Ralf Meisenzahl and Joel Mokyr that technical change and the adoption of machinery increased the demand for 'high-quality workmen' such as engineers, mechanics, millwrights, instrument makers, and chemists. According to Mokyr (2009) and Meisenzahl and Mokyr (2011), these professions, which consist of 3-5% of our sampled workforce, were necessary to alleviate the technical innovations that the Industrial Revolution entailed. Karine Van der Beek has already made some headway in this regard; her observation that a growing number of people were being apprenticed as wrights, carpenters, joiners and turners between 1710 and 1770 is evidence of the hypothesis of Meisenzahl and Mokyr (Van der Beek 2012).

Is it possible to reconcile the notion that the Industrial Revolution was skill demanding with the vast episode of deskilling observed above? To find out, we have classified our occupations into six major groups (see Table A11 in the Appendix): labourers, agriculturalists, traders, lower-skilled craftsmen, medium-skilled craftsmen, and finally a category consisting of the 'high-quality workmen' identified by Mokyr et al. Labourers include 'Labourer' and 'Day-labourer', both of which are unskilled. Agriculturalists include 'Farmer', 'Yeoman', 'Husbandman', 'Cottager', 'Farm worker' and 'Farm servant'. Farmers and yeomen are medium-skilled; husbandmen and cottagers lower-skilled; and farm workers and farm servants unskilled. Trades include 'Merchant', 'Retail trader' and 'Wholesale trader', all of which are coded as medium-skilled professions in the HISCLASS scheme. Craftsmen comprise a variety of different occupational titles largely concerning the same work. Weaver is a good example. This

includes cloth-, lace-, gorter-, serge-, cord-, jersey-, linen- and silk-weavers, all of which we catalogue as 'weaver'. We distinguish between low-skilled and medium-skilled craftsmen. Low-skilled craftsmen include 'Weaver', 'Tanner', 'Glover' and 'other' (meaning 'Product finisher', 'Washer', 'Cutter' and 'Pattern maker'). Medium-skilled craftsmen include 'Tailor', 'Cooper', 'Shoemaker' and 'Smith'. Finally, we include those professions that Meisenzahl and Mokyr (2011) define as 'high-quality workmen' meaning 'Carpenter', 'Joiner', 'Wright', 'Turner' and 'Machine maker'.

Table 1
Shares of Workers by Professional Groups, 1550-1850

Group	Occupational Title	1550-99	1600-49	1650-99	1700-49	1750-99	1800-50
Labourers	(Day)-labourer	14.2	16.7	16.7	24.2	22.7	33.4
Agriculture	Farmer and Yeoman	6.4	6.7	5.8	5.6	5.2	5.1
	Husbandman, cottager	10.2	11.3	6.6	6.9	4.5	1.7
	Farm worker	0.1	0.0	0.3	0.3	0.2	0.7
	Farm servant	-	-	-	0.9	1.5	7.1
	Total	16.7	18.1	12.6	13.7	11.4	14.6
Trades	Wholesale trader	0.3	0.6	0.5	0.2	0.2	0.2
	Merchant	1.7	1.3	1.7	1.3	0.5	0.6
	Retail trader	3.0	4.0	3.1	2.0	2.1	2.0
	Total	4.9	5.9	5.4	3.5	2.9	2.8
Craftsmen: Low-skilled	Weaver	4.6	3.5	3.0	3.6	3.7	2.2
	Tanner, currier, dyer	2.7	3.0	2.4	1.9	0.9	0.5
	Glover	1.8	2.1	0.9	0.8	0.4	0.1
	Other	0.7	0.7	1.2	0.7	0.9	0.5
	Total	9.9	9.2	7.5	7.0	5.8	3.2
Craftsmen: Medium-skilled	Tailor	6.3	5.5	4.5	4.0	3.2	2.8
	Shoemaker	4.4	4.8	4.2	3.7	4.4	3.9
	Smith	4.1	3.7	3.6	2.7	2.7	2.3
	Total	14.7	14.0	12.3	10.5	10.3	8.9
'High-quality workmen'	Carpenter, joiner	3.3	3.2	4.2	3.9	4.1	3.7
	Wright, turner	0.7	0.7	1.1	0.9	1.0	1.2
	Total	3.9	3.9	5.2	4.9	5.1	4.9
	Total share of sample	64.4	67.8	59.8	63.8	58.2	67.8

Note: Carpenters are not deemed highly-skilled in the HISCLASS scheme. They appear in the group of 'highly-quality workmen', because Mokyr (2009) and Meisenzahl and Mokyr (2011) deem them important to the Industrial Revolution.

Table 1 summarizes the results. It reveals a strong decline in the shares of lower- and medium-skilled craftsmen between 1550 and 1850, from 25% to 12% of the sampled workforce. The same is true for traders whose share declines from 4.9% to 2.8% over this period. These developments happen along with a staggering rise in share of labourers: from 14% to 33% across our three centuries. The latter episode occurs in two major steps: from 17% in the latter half of the 17th century to 24% in the early 18th century, and once again from 23% in the latter half of the 18th century to 33% in the first half of the 19th century.

Accompanying this episode of deskilling is growth in the share of Mokyr's category of 'high-quality workmen'. The change is modest, from 4% up until 1650 to 5% from 1700 on. Even though the share of 'high-quality workmen' remained a largely constant after 1700, this would still involve a substantial rise in the absolute number in these professions. The English population grew from 5.2 millions in 1700 to 17.3 millions in 1850. Five per cent of the population increase would mean some 300,000 *additional* male workers who fall into the category of 'high-quality workmen', hence lending strong support to the ideas raised by Meisenzahl, Mokyr and Van der Beek.[6] New occupational titles also enter into our sample after the 1650s, including 'chemists', 'clock-maker', 'engineer', 'engine operator', 'well-diggers', and 'watch-maker'. That provides further support to Meisenzahl and Mokyr's notion that industrialization through mechanisation required a substantial amount of high-quality professionals to assist the process.

[6] Population data from Broadberry et al (2012)

By contrast, the decline in the shares of lower- and medium-skilled professions such as 'Tailor', 'Tanner', 'Weaver', and 'Glover' is consistent with the idea that these skills were relatively easy to substitute away by means of capital investments. It supports Allen's notion that the high wages paid to skilled workers was a strong incentive to mechanise Britain (Allen 2009). It also motivates the rise of resistance groups, such as the Luddites and Captain Swing of the early 19th century, underpinning why skilled workers were afraid that new machinery would make their working skills redundant (Nuvolari 2002).

Finally, the shift from peasant farming to large-scale capitalist agriculture is also visible in the data. The modest decline the shares of 'Farmer' and 'Yeomen' (from 6.4% to 5.1% across the entire period) suggests that land becomes concentrated in the hands of fewer production units. More than that, the virtual disappearance of 'Husbandman' and 'Cottager' from the data (from over 10% to less than 2% across the period) emphasizes the massive structural changes going on in English agriculture at the time. Also, the general decline the share of agricultural professions (from 16.7% to 14.6%), which occurs along with considerable growth in the size of the English population (and almost no food import in this period), highlights that the expansion of British agricultural production was achieved using less labour (especially since half of the workers engaged in agriculture were servants).

IV

Conclusion

Was England's Industrial Revolution mainly skill saving or skill demanding? Previous work has focused on literacy rates, school enrolment, and statistics about apprenticeships to measure the formation of human capital during the Industrial Revolution. Literacy and school enrolment rates are arguably very crude proxies for the acquisition and (even more so) the application of working skills in productive activities. Apprenticeship contracts, though certainly capturing a substantial investment in individual human capital, only concern a very limited share of the population after all.

We assume a new approach to quantifying human capital formation before and during the Industrial Revolution, using the HISCLASS scheme to extract information from occupational titles contained in one of the largest sets of micro data from historical England, the CAMPOP data. While the sampled workforce was very well trained before 1700, the growth in GDP per capita in England after 1700 was accompanied by a huge episode of deskilling captured by a dramatic rise in the share of workers coded as 'unskilled' in the HISCLASS scheme. This massive episode of deskilling occurred along with a modest rise in the share of 'high-quality workmen' commonly thought necessary to facilitate the mechanical change that took place during the Industrial Revolution.

Our findings unify many of the seemingly contrasting views about the evolution of human capital during the Industrial Revolution. Our work lends support to the Goldin-Katz hypothesis that the shift from artisan workshops to factory production made craftsmanship redundant by replacing artisan skills by unskilled labour. It also motivates the rise of the Luddites, a group of machine-breaking artisans formed in the

early nineteenth century by Ned Ludd who rebelled against the mechanization they felt made their working skills unnecessary (Nuvolari 2002). Finally, our findings support the Meisenzahl-Mokyr idea that high-quality workmen were in growing demand during the Industrial Revolution and Van der Beek's demonstration that the number of apprenticeships among these professions went up during the eighteenth century. Our results thus accords well with the theory proposed by O'Rourke et al (2013) showing how technical progress can be skill saving and skill demanding at the same time.

Our conclusions reinforce the pessimistic interpretation of the influence of the Industrial Revolution on the living standards in England at the time: working hours went up (Voth 1998, Allen and Weisdorf 2011); child labour increased (Humphries 2010); heights declined (Cinnirella 2008); and wages stagnated (Clark 2007). The rise in the share of unskilled professions after 1700 contributed to a much less stimulating work-life among majority of the English working class.

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Appendix

Table A1
Examples of Coding of Occupational Titles in HISCLASS

Skill-level	Occupational Titles
Unskilled:	Boatman, chapman, chimney sweeper, clothier, hostler, porter, suckler, warrener, farm worker, factory worker
Low-skilled:	Barber, basket maker, brick maker, builder, coachman, carder, cottager, shepherd, dairyman, dyer, fisherman, gardener, weaver, glover, needle maker, painter, thatcher, postman, sawyer, servant, soldier, spinner, stonecutter, turner, clerk
Medium-skilled:	Baker, brewer, butcher, carpenter, chandler, cook, clock maker, cutler, dealer, farmer, glazier, innkeeper, maltser, mason, miller, millwright, looker, plumber, printer, saddler, sergeant, shoemaker, smith, tailor, yeoman
High-skilled:	Apothecary, attorney, bailiff, captain, chemist, clergyman, doctor, lieutenant, rector, surgeon

Table A2
The Shares of Lower- and Unskilled Workers, Provinces

	Unskilled	Lower- and Unskilled	N
1550-99	0.21	0.53	1,215
1600-49	0.21	0.51	2,773
1650-99	0.23	0.50	3,273
1700-49	0.29	0.57	4,688
1750-99	0.32	0.59	6,606
1800-49	0.39	0.64	9,592
			28,147

Table A3
GDP per Capita, Marital Fertility and the Share of Skilled Workers (1550-99 = 100)

	Per capita GDP	Fertility	Share skilled
1550-99	100	100	100
1600-49	97	97	99
1650-99	112	97	98
1700-49	129	104	89
1750-99	140	111	85
1800-49	148	115	77

Table A4
The Shares of Lower- and Unskilled Workers, London

	Unskilled	Lower- and Unskilled	N
1550-99	0.01	0.28	151
1600-49	0.08	0.38	181
1650-99	0.11	0.41	398
1700-50	0.16	0.43	985
			1,715

Table A5
The Share of Unskilled Workers: Social Tables and Census Data

	Unskilled: CAMPOP	N	Unskilled: Social tables	N
1675-99	0.25	1,824	0.29	1,390,586
1700-24	0.29	2,452	0.31	1,482,803
1825-50	0.40	4,290	0.42	6,630,700

Table A6
The Shares of Unskilled Workers, 11 and 25 Parishes

	Unskilled: 11 parishes	N	Unskilled: 25 parishes	N
1600-49	0.23	1,986	0.21	2,773
1650-99	0.24	2,129	0.23	3,273
1700-49	0.30	3,040	0.29	4,688
1750-89	0.32	3,856	0.32	5,151
		11,011		15,885

Table A7
The Shares of Unskilled Workers, Marriage and Burial Sample

	Unskilled: Marriage	N	Unskilled: Burial	N
1550-99	0.21	133	0.21	610
1600-49	0.21	299	0.22	1,296
1650-99	0.23	262	0.23	1,492
1700-49	0.29	643	0.26	1,955
1750-99	0.31	2,268	0.28	1,924
1800-49	0.41	1,954	0.33	963
		5,559		8,240

Table A8
The Share of Workers by Working Skills, White-Collar Workers

	Low-skilled	Medium-skilled	High-skilled	N
1550-99	0.13	0.54	0.33	163
1600-49	0.11	0.69	0.20	371
1650-99	0.11	0.67	0.22	500
1700-49	0.10	0.67	0.23	549
1750-99	0.04	0.74	0.22	652
1800-49	0.06	0.70	0.24	850
				3,085

Table A9
The Share of Workers by Working Skills, Blue-Collar Workers

	Unskilled	Low-skilled	Medium-skilled	N
1550-99	0.24	0.35	0.41	1,052
1600-49	0.24	0.33	0.43	2,402
1650-99	0.27	0.30	0.43	2,773
1700-49	0.33	0.31	0.36	4,139
1750-99	0.36	0.29	0.35	5,954
1800-49	0.43	0.26	0.31	8,742
				25,062

Table A10
The Share of Unskilled Workers by Sector of Production

	Primary	Secondary	Tertiary	N
1550-99	0.11	0.10	0.01	1,215
1700-24	0.21	0.05	0.01	2,452
1800-50	0.17	0.19	0.01	4,290

Table A11
Occupations by Professional Categories

Group	**Professions Included**
Labourers:	Labourers, day-labourers, factory workers
Agriculture:	Farmers, yeomen, husbandmen, cottagers, farm workers, farm servants
Trade:	Dealers, chandlers, merchants, sellers, grocers and shopkeepers
Craftsmen, Low-Skilled:	Weavers, knitters, spinners, dyers, tanners, curriers, breechesmakers, glovers, cutters, carders, twisters, bleachers, product finishers, (flax)dressers, (textile)washers, and pattern makers
Craftsmen, Medium-Skilled:	Tailors, hat makers, stay makers, cobblers, shoemakers, saddlers, harnass makers, smiths, cutlers, knife makers, needlemakers, and engravers
'High-Guality Workmen'	Carpenters, joiners, wrights, turners, weelmakers, machine makers