

Adam Smith revisited: coal and the location of the woollen
manufacture in England before mechanization, c. 1500-1820

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Abstract: This study uses male occupational data abstracted from the Court of Common Pleas to determine the location of the English woollen manufacturing industry circa 1500, and from county probate records to track temporal change 1601-1801. It shows that the onset of de-industrialization in textile counties in southern England occurred toward the end of the seventeenth century when the industry began to shift to the West Riding of Yorkshire. Occupations of fathers recorded in Anglican baptism registers 1813-20 indicate that the industry relocated to a relatively small number of places. This study establishes a clear association between these places and the proximity of water and the coalfields. This relationship concurs with the views of Adam Smith to show that coal was important to the woollen manufacture decades before the mechanization of spinning and weaving and the use of steam power.

Introduction.

Nicholas Crafts and Nikolaus Wolf have noted that ‘explaining the location of cotton textiles in the 19th century is clearly an important task for economic history given the role that the industry played in industrialization’.¹ A similar, but unanswered premise, applies to the location of the woollen cloth manufacture, the staple industry in England for centuries, long before cotton grew to importance.² That textile counties in southern English de-industrialized as the woollen manufacture shifted to the north is well-known. The change has long-interested academic historians but has never been studied in detail or satisfactorily explained. Eric L. Jones notes that industries in southern England collapsed before the use of coal-fired steam engines,

¹ Crafts, ‘British cotton textiles’, pp. 1103-139.

² Deane, ‘Output’. Broadberry, *British economic growth*, pp. 144-50.

but for him the historiographical accounts of the seventeenth and eighteenth centuries pay little regard to the role played by inter-regional competition.³ Jones notes also that southern counties held a competitive advantage in agriculture which provided a greater economic return than could be gained from manufacturing.⁴

The work reported here utilizes new data generated by the Occupational Structure of Britain, 1379-1911, project and identifies the changing geography of the woollen textile manufacture in a more precise temporal and spatial manner than has been possible hitherto.⁵ The analysis draws two interesting, and perhaps unexpected conclusions: first, the shift of the woollen manufacture to the West Riding of Yorkshire began in the late seventeenth century and was essentially complete by the second half of the eighteenth century, the traditional starting point of the industrial revolution. Textile re-location, therefore, was not a consequence of steam-powered factory industrialization. Second, there is a clear association between location and the availability of both water and coal. The timing of the shift throws up the challenge of explaining why coal was important before steam-powered production was introduced.

There is an extensive literature that discusses the importance of coal to the English industrial revolution in England.⁶ Yet, historians have made little of the role coal played before the classical period beginning in 1780, even though eighteenth-century commentators clearly recognized its importance to the woollen manufacture. For instance, in 1727, Daniel Defoe wrote that the availability of local coal and running water were essential to the wool manufacture in

³ Jones, *Locating*, pp. 3, 7.

⁴ Jones, *Agriculture*, pp. 128-42.

⁵ The Occupational Structure of Britain, 1379-1991, project is led by Leigh Shaw-Taylor and Tony Wrigley, Cambridge Group for the History of Population and Social Structure, with an ultimate aim to reconstruct the occupational structure of Britain from the late medieval period down to the early twentieth century. Funding for the project has been provided by the ESRC, the Leverhulme Trust, the British Academy, and the Sir Isaac Newton Trust. It has been designated a British Academy Research Project since 2007.

⁶ Deane, *First industrial revolution*. Mathias, *First industrial nation*. Wrigley, *Continuity*. Wrigley, *Energy*, 2010. Wrigley, 'Energy', 2013. Pomeranz, *Great divergence*. Fernihough, 'Coal and the European industrial revolution'. Warde, *First industrial revolution*, pp.129-247. Allen, *British industrial revolution*. Allen, *The industrial revolution*

Halifax in the West Riding of Yorkshire.⁷ In 1748, the Essex historian, Philip Morant wrote that the Colchester trade ‘had removed in great measure into the west and northern parts of this kingdom where provisions are cheaper, the poor more easily satisfied, and coals are very plentiful’.⁸ A decade later, R. Massey noted the cloth trades had moved ‘Northward where greater Plenty of Firing, and Cheaper Rates of other Common Necessities of Life, or small Taxes, favour their Increase much more than in our Southern Counties’.⁹ No commentator expressed it more succinctly, however, than Adam Smith who in 1776 wrote explicitly of the need for cheap space heating:

‘in a country where the winters are so cold as in Great Britain, fuel is, during that season, in the strictest sense of the word, a necessity of life, not only for the purpose of dressing victuals, but for *the comfortable subsistence of many different sorts of workmen who work within doors*; and coals are the cheapest of all fuel. The price of fuel has so important an influence upon that of labour, that all over Great Britain manufactures have confined themselves principally to the coal countries; other parts of the country, on account of the high price of this necessary article, not being able to work so cheap’.¹⁰

Jones considers this connection between early industry and coal to be tenuous.¹¹ The aim of this work is to test this view by gaining a better understanding of the onset, geography and timing of the movement of textiles northwards. This study is set out as follows. First, the woollen manufacture and its importance to the national economy is briefly discussed. Second, industry

⁷ Defoe, *Tour*, pp. 98-9.

⁸ Morant, *History*, p. 75. See also Darby, ‘Age’, p. 57.

⁹ Gregory, *Regional transformation*, p. 48. Szostak, *Role of transportation*, p. 171.

¹⁰ Author’s italics, Smith, *Wealth of nations*, book IV, pp. 338-39.

¹¹ Jones, *Locating*, p. 3.

mechanization and the timing of the introduction of steam power is noted. Third, new data are presented and analyzed. Several sources are used. These include aulnagers' accounts and occupations of male defendants abstracted from the records of the Court of Common Pleas, both of which are employed to locate the industry circa 1500 and to identify the major woollen manufacturing counties. Occupations recorded in probate documents, 1601-1801, are utilized to track temporal change and identify the onset and duration of de-industrialization in each of these counties. The data show that some established woollen counties began to de-industrialize during the late seventeenth century. Others began to do so in the early eighteenth century. An analysis of the occupations of fathers abstracted from Anglican baptism registers collected for the 1813-20 period, shows a clear association between the parochial location of the industry on rivers and the proximity of the coalfield. The shift to the coalfields began long before the introduction of steam power and was not driven, therefore, by the need for cheap coal to generate energy. Potential explanations for the association are postulated and avenues for further research noted.

The woollen manufacture.

Two distinct types of woollen cloth, wool and worsted, were manufactured. These cloths required different raw materials and were often produced in different places.¹² Wool cloths were produced from the fleece of short-haired sheep which were regularly grazed upon fallow land. Worsteds were made from long-haired sheep that were grazed upon pasture.¹³ Most fleeces in medieval England, with their reputation for fineness, were likely short wool, and it was only later that the coarser and longer wools were introduced.¹⁴ Worsteds, the New Draperies, were introduced into various places in England with the influx of skilled weavers from the low

¹² Ponting, *Baines's account*, pp. 13-14, 37.

¹³ Bowden, 'Wool supply' pp. 44-58.

¹⁴ Stephenson, 'Wool yields', pp. 368-91.

countries, perhaps as early as the twelfth century, but boosted through to the sixteenth century by successive rounds of immigration.¹⁵ The processes of manufacture of the two types of cloth differed. Short wool was disentangled and prepared for spinning by hand carding. The longer worsted fibres were separated, straightened prior to spinning by combing with hot oil. Combers, therefore, worked only with worsteds. The wool weave was loose and required fulling, a process that involved saturation with water and fullers earth and beating, a process that shrank and rendered the felted weave invisible. Wool cloth, therefore, could not be produced without the availability of a source of water. Wool cloths were originally fulled by hand, but the introduction of mechanization with the construction of water-powered fulling mills from the late thirteenth century onwards, necessitated the availability of a flowing stream.¹⁶ The worsted weave was woven with various warp/weft combinations of different yarns. It was much tighter, visible, did not normally require fulling, and the manufacture did not need to be adjacent to flowing water. Fullers, therefore, worked only with wool cloth.¹⁷

Short-haired, medieval English wool was considered one of the finest in Europe and was in much demand elsewhere. As such, unprocessed wool and not cloth was the dominant export. Between the mid-fourteenth and mid-fifteenth centuries, the market began to change and by the sixteenth century, cloth production had trebled to become the chief export.¹⁸ In 1700, textiles accounted for over 70 per cent of all English exports by value, over 95 per cent of which were from woollens, 40 per cent of which were worsteds.¹⁹ By 1770, woollens still accounted for more

¹⁵ Coleman, 'Innovation and its diffusion', pp. 417-29. Blakely, *History*, pp. 2-3. James, *Worsted manufacture*, pp. 36, 67. Lipson, *History*, p. 23.

¹⁶ Carus-Wilson, 'Industrial revolution', pp. 39-60. Pelham, 'Distribution of early fulling mills', pp. 52-56.

¹⁷ There were some exceptions to this. For instance, serge woven with a worsted warp and wool weft did require fulling, particularly if the wool content was high.

¹⁸ Broadberry, *British economic growth 1270-1870*, p. 144-47.

¹⁹ Schumpeter, *English overseas trade statistics*, p. 35.

than 70 per cent of national exports.²⁰ It was not until the last 25 years of the eighteenth century, following the introduction of mechanized spinning and the lifting of the prohibition of all-cotton weaving and printing in 1774, that cotton cloth output began to increase markedly and move to prominence.²¹ The geographical location of the cotton manufacture, therefore, is not of primary importance in this study.

In medieval England, the location of woollen manufacture was governed by practical, local advantages. Cloth production could not flourish without the availability of water for cleaning and scouring wool, dyeing and fulling. Wool cloth manufacture, therefore, was never far from a river. It was not necessary for the river to be navigable, but it was essential that the water flow was sufficient to drive a fulling mill. The type of cloth woven was dictated by the availability and nature of the local wool. The presence of fallow sheep was a chief reason for the establishment of the West of England broadcloth industry. Likewise, mountain sheep gave rise to coarse cloth weaving in hill counties.²² Whilst this supply sufficed for a manufacture concerned only with local demand, it was not enough for a growing business supplying distant markets.²³ As the cloth industry developed and expanded, markets opened elsewhere and the local raw material supply became insufficient to meet demand. By the mid-seventeenth century, the counties producing the most wool, such as Northamptonshire, Lincolnshire and Cambridge, were not important wool cloth producers.²⁴ The wool grown in those places was largely sent elsewhere in England. By 1800, Lincolnshire wool growers produced over one-third of the worsted wool supply, whereas Yorkshire, which by now was the centre of the industry, generated less than 3

²⁰ Ibid, pp. 25, 38.

²¹ Chassagne, 'Calico printing', p. 521. Ashworth, *Customs*, p. 352.

²² Kerridge, 'Wool', 25.

²³ Thirsk, *Rural economy*, pp. 217-18.

²⁴ Fuller, *The Church History of Britain* cited by Thirsk, *Rural economy*, p. 218

per cent.²⁵ Local wool supplies were no longer a major factor influencing the location of cloth manufacture.

Mechanization.

The spinning wheel was introduced into England during the later middle ages and replaced the distaff, at least in part.²⁶ Other than the wheel and the fulling mill, the woollen manufacture experienced few game-changing productivity gains until the eighteenth century. The next significant change was the application of the flying shuttle to handloom woollen broadcloth weaving. Introduced in 1733, the hand-operated shuttle could quadruple a weaver's output.²⁷ Hargreaves' spinning jenny followed, first adopted in 1771 to spin cotton warp and then in 1776 to spin wool.²⁸ The early jenny was small, hand operated, often by children, and it remained a domestic machine until the nineteenth century.²⁹ Arkwright's spinning frame was used to spin cotton warp and worsted by the late eighteenth century, but these early machines were powered by water and independent of steam.³⁰ Crompton's mule, introduced in 1780, was rapidly taken up by the cotton manufacturers but had limited application with worsted and was not used to spin wool at this time.³¹ Steam power was first introduced into the textile manufacture in England in the 1790s to drive cotton spinning mules in Manchester.³² By the turn

²⁵ Luccock's estimates on the number of sheep and packs of wool in England cited James, *Worsted manufacture*, p. 320-22.

²⁶ Styles, 'Spinning in the era of the wheel'.

²⁷ Broudy, *Looms*, pp. 147-48.

²⁸ Wadsworth, *Cotton*, p. 477. Hammond, *Skilled labourer*, p. 145-46. Knowles, *Industrial*, p. 51.

²⁹ Pinchbeck, *Women workers*, p. 153. Aspin, *Hargreaves*, pp. 19 and 50. von Tunzelmann, *Steam power*, pp. 241-44.

³⁰ Berg, *Age*, p. 241. Arkwright's frame became the machine of choice for worsted spinning by the late eighteenth century but had little commercial application for wool.

³¹ Crompton Papers, General Correspondence and Papers 1800-1802, Microfilm ZCR 6, (1802), Bolton History Centre, Bolton.

³² Platt, *Shock cities*, p. 39.

of the century, some carding and scribbling woollen mills were powered by steam.³³ Weaving looms were not steam driven to any significant extent until the second decade of the nineteenth century.³⁴ The first machines were used for cotton but uptake up was slow. Steam-powered worsted weaving was introduced in the third decade of the nineteenth century, but it was not until the 1850s that wool weaving became a factory industry.³⁵

Location of the woollen manufacture circa 1500.

Most wool cloth sold in sixteenth-century England, either at home or abroad, was subject to a tax called the aulnage.³⁶ On payment, the state inspector, the aulnager, sealed the cloths to confirm the statutory requirements of length and breadth.³⁷ From 1353, aulnagers were required to impose a tax of 4d on all wool cloths, plus 0.5d for the aulnage, and report to the Exchequer annually.³⁸ The surviving aulnage accounts are an incomplete record of the national manufacture.³⁹ For instance, some accounts are duplicated and for a number of northern counties, such as Cumberland, Cheshire, Lancashire, and Westmorland, were either never made or have been lost. In addition, through bribery, the aulnager sometimes forwarded under-statements to the Exchequer. Nonetheless, despite their imprecision, the accounts are a useful indicator of the quantity of cloth produced in England. H. Heaton used these records to suggest that that 90 per cent of cloth sold, 1468-73, was woven in 15 counties, and that 62 per cent of the total came

³³ Seward, 'Wool', p. 42.

³⁴ Chapman, *Cotton*, p. 21. Hammond, *Skilled labourer*, pp. 70, 72.

³⁵ Knowles, *Industrial*, p. 16.

³⁶ Some cheap wool cloths and worsteds were exempt.

³⁷ Gray, 'Production', p. 14.

³⁸ Merrick, 'Taxing medieval cloth', pp. 218-33.

³⁹ Carus Wilson, 'Aulnage', pp. 114-23.

from five counties only, that is Suffolk, Somerset, Yorkshire, Gloucestershire, and Wiltshire (Figure 1).⁴⁰

Another source of information are occupations recorded by the Court of Common Pleas. The Common Pleas was one of two central courts at that time, the other being the King's Bench. The Common Pleas sat four times a year, normally at Westminster Hall, and had exclusive jurisdiction over rights of ownership, debt, and eviction. Jurisdiction of over trespass and other breaches of statute was shared with the King's Bench.⁴¹ Many of the common plea records have survived but until very recently have been under-utilized in occupational studies. Latterly, some common pleas for selected years, 1381-1554, have been transcribed by the University of Houston, Texas, USA, and utilized by Nicholas Amor in his study of the English textile manufacture, 1480-1500.⁴² Amor's analysis is valuable in that it calculates the county shares of English adult male textile occupations. It shows that over 17 per cent of these men lived in Suffolk, 5-10 per cent in each of Devon, Essex, Gloucestershire, Kent, Norfolk, Somerset, Yorkshire, and London, 4 per cent in Wiltshire and 3 per cent in each of Berkshire, Hampshire, and Warwickshire. Whilst this analysis provides an indication of the leading textile counties, and the textile towns and places within, it takes no account of either the population or the actual number of common pleas heard in each county. Hence, Amor's analysis has a bias towards those counties that recorded the largest number of pleas. Moreover, Amor did not distinguish between the types of charge, mixing those accused of debt with those accused of trespass or other charge.

⁴⁰ Heaton, *Yorkshire woollen*, pp. 84-88. See also Ponting, *Baines's account*, pp. 18-9.

⁴¹ Hastings, *Court of Common Pleas*.

⁴² Transcriptions of the Court of Common Pleas, 1381-1554. Amor, *Wool to cloth*.

This study corrects for these two issues and analyzes 57,343 pleas recorded between 1483-1524.⁴³ Of these, 69 per cent were for debt, 11 per cent for trespass, and the remaining 10 per cent for a range of other misdemeanours. With some exceptions, all pleas involve men. Few females are recorded, and then often those with an occupation such as Abbess or Prioress. It was not unusual for the occupation of the plaintiff to be left unrecorded, whereas the occupations of defendants were recorded in over 95 percent of pleas. Consequently, our analysis is of the occupations of male defendants only. The 39,643 pleas for debt contain 2,817 entries for male defendants working in the textile manufacture. Of the 11,675 pleas for trespass, 606 men worked in textiles. The occupational share of textiles in each county for both types of plea is shown in Figure 2. Differences are apparent, highlighting data bias and the need to treat the charges separately. Pleas for debt involved considerable sums of money, between 40 shillings to thousands of pounds. To put these amounts into perspective, circa 1500 a craftsman, such as a mason or carpenter, likely earned around 5-6d per day.⁴⁴ For these men, 40s was therefore the equivalent of over 3 months' work. Pleas for debt, therefore, are likely to bias towards the more affluent members of the textile manufacture. Pleas for trespass included several types of misdemeanour, such as assault, theft, forgery and are not necessarily skewed to the wealthy.

Figure 2 takes no account of the different populations of each county and, as such, does not necessarily show the comparative importance of textiles in each. County estimates of the actual number of men in the industry are calculated using E. A. Wrigley's population data for 1600, and Wrigley and R. S. Schofield's determination that 23 per cent of the population were males aged 20 years and over.⁴⁵ Although the resultant estimation is imperfect, it does provide a

⁴³ There are 163 Common Plea rolls 1483-1524. Of these, thirteen were analyzed; CP883, 885, 888, 911, 919, 931, 951, 971, 990, 998, 1013, 1023, 1031 and 1042, an 8% sample.

⁴⁴ Craftsmen employed by Durham Priory, Newman, 'Work and wages', pp. 357-78.

⁴⁵ Wrigley, *English censuses*, Table 4.1. *English population history*, pp. 42-50.

reasonable indication of relative importance. It shows that four major manufacturing regions, Yorkshire, East Anglia, Kent, and the West Country including Hampshire, were already established by 1500 (Table 1 and Figure 3). These data also lend support to the aulnage accounts in which the counties of Suffolk, Somerset, Yorkshire Gloucestershire, Wiltshire, Essex, Hampshire and Devon also figured prominently.

The relationship between location of the manufacture and the proximity to rivers and principal roads is illustrated from the pleas heard for men living in the counties of Somerset and Suffolk (Figures 4 and 5).⁴⁶ Some of these men lived on the roads but all lived in places located on a river, few of which, and none in either Somerset or Suffolk, were navigable.⁴⁷ Bury St. Edmunds was a key Suffolk wool town, but it was not until the early eighteenth century that the River Lark on which the town sat was made navigable to the port of King's Lynn, and only then from Fornham, a village situated one mile north of Bury St. Edmunds.⁴⁸ Water, therefore, was used to sour, dye, and full wool, but it was the roads that were used for transport.

Woollen de-industrialization, 1601-1801.

Temporal change is tracked by drawing upon Sebastian Keibek's estimates of occupational structure that were derived from probate documents, 1601-1801.⁴⁹ These documents are a rich source of occupational information, but by themselves they are problematic because a probate was more likely to be left by those with something of value to leave than it was by those with relatively little. Probates are socially biased towards the wealthy and reflect a

⁴⁶ The water courses shown in the Figures are taken from mapping and geographic information available from OS Open Rivers. The principal roads are constructed from Ogilby, *Britannia* (1675). There are no accurate maps of English roads before this time.

⁴⁷ By 1585, the River Ouse was navigable between King's Lynn and Thetford, but the latter was approximately 13 miles distant from Bury St. Edmunds. Willan, *Inland trade*, map of England and Wales opposite p.1, and pp.14-18.

⁴⁸ Kirby, *Suffolk traveller*, pp. 211-12.

⁴⁹ Keibek, 'Using probate data'.

hierarchy of occupations from gentry-to-yeoman-to-tradesman-to-husbandman-to-labourer.⁵⁰ To overcome the bias, Keibek has devised a robust methodology linking occupations recorded in probates to those entered into baptism registers, using the latter to recalculate the former to provide more reliable estimates of occupational structure. These estimates are used here to show the change in the textile manufacture in the leading counties of 1500 (Figure 6). They indicate that the onset and speed of textile de-industrialization was not uniform across England. The counties of Kent, Essex, and Hampshire were the first to begin to fall away with decline, attributable to the proximity and impact of London, beginning before 1700. The population of London grew from 400,000 to 750,000, 1650-1750. The city accounted for 7 per cent of the national total in 1650, and 13 per cent 100 years later.⁵¹ This growth in population, and the concomitant rise in demand for food, strongly influenced the need for agriculture in Kent and East Anglia. Cereals were imported into London from Kent, particularly, and from Essex and Sussex.⁵² Butter was brought in from Suffolk, and to a lesser extent from Essex and Norfolk. Agricultural production within a 60-80 miles radius of London became more profitable than was industry. This demand drove up regional agricultural production and wages, forcing manufacture to move to places where food, labour and fuel were cheaper.⁵³ According to F. J. Fisher,

‘...the result was to intensify the agriculture nature of south-eastern England and to push the major industrial areas away from the capital even before that process was completed by the use of steam power. In the sixteenth and early seventeenth centuries, there were considerable

⁵⁰ Weatherill, *Consumer Behavior*. Keibek, ‘Correcting the probate inventory’.

⁵¹ Wrigley, ‘Simple model’, pp. 44-5, 55. Wrigley, *English censuses*. Table A2.6.

⁵² Fisher, ‘Development’, pp. 47-49, 50.

⁵³ Fisher, ‘London as an engine’, pp. 3-16.

textile industries in Kent, Surrey, Hampshire and Berkshire...by the end of the seventeenth century those textile industries had virtually disappeared'.⁵⁴

Jones notes improvements to agriculture, 1650-1750, were adopted more rapidly in southern England than in the north, further emphasizing the former's competitive advantage.⁵⁵

The decline of Suffolk began around 1700. Bowden believed the wool manufacture had disappeared by that time, but the Suffolk industry evolved and shifted to worsted production, particularly in woolcombing and spinning, supplying the Norwich worsted weavers with yarn.⁵⁶ Change also took place in Norfolk during the last half of the seventeenth century as the rural worsted weaving industry fell away and became concentrated in Norwich and where it flourished until the first half of the eighteenth century.⁵⁷ Also in East Anglia, in Colchester, Essex, the worsted trade collapsed as the town went from a major worsted producer to a grain shipping and marketing centre.⁵⁸ In the West Country, manufacture began to fall away later, after 1700. This delayed onset of de-industrialization may be related to the nature and types of cloth produced. Gloucestershire, for instance, was well known for its superior broadcloths which were perhaps not made to the same quality elsewhere. The Devon industry differed from that in other parts of the West Country in that the county had a large nationally significant worsted industry, centred upon serge manufacture in Exeter.⁵⁹ It was not until the first half of the eighteenth century that this manufacture shifted to the West Riding of Yorkshire, notably to Halifax parish.⁶⁰

⁵⁴ Fisher 'London and the English economy' p. 196.

⁵⁵ Jones, *Agriculture*, p. 131.

⁵⁶ Bowden, *Wool trade*, p. 52. James, *Worsted manufacture*, p. 230.

⁵⁷ Keith Sugden, 'An occupational analysis'. Sugden, *Clapham revisited*.

⁵⁸ Burley, 'Essex clothier', pp. 289-301. Sharpe, 'De-industrialization', pp. 77-96.

⁵⁹ Hoskins, *Industry*.

⁶⁰ Sugden, unpublished PhD thesis.

By the 1760s, the textile share of employment in most southern counties had dropped by at least one-half from their peak. These probate data confirm the opinions of Fisher and Jones and provide the first quantitative, and chronologically precise, evidence that wool manufacture in some southern counties was in terminal decline by the end of the seventeenth century, and in all counties by the first quarter of the eighteenth century.

We do not yet have the probate documents to permit an occupational study of seventeenth and eighteenth-century West Riding of Yorkshire. It is known from other sources, however, that the county maintained its leading position in textiles. For instance, despite de-industrialization in southern England, and before there were major technology-led productivity gains, the national woollen industry output continued to rise. The average annual growth was 0.65 percent between the mid-fifteenth and mid seventeenth-centuries.⁶¹ The output of the West Riding manufactures necessitated the opening of cloth halls in Halifax, Wakefield and Leeds in the first two decades of the eighteenth century.⁶² In 1700, woollen exports were valued at £2,989,394. By 1750, they had reached £5,350,299.⁶³ Much of this increase likely came from the West Riding of Yorkshire where annual broadcloth production rose from 31,500 pieces, 1728-1732, to 60,720 pieces, 1748-50.⁶⁴ The supremacy of the West Riding was noted by R. G. Wilson who remarked that essentially all woollens cloths exported in 1700 were shipped from the East Yorkshire port of Hull.⁶⁵

⁶¹ Broadberry, *British economic growth*, 146-48.

⁶² Three further halls were opened in Leeds in 1755 and 1775 and in Halifax in 1779. James, *Worsted manufacture*, p. 80.

⁶³ Schumpeter, *English overseas trade statistics*, pp. 35 and 37.

⁶⁴ Wilson, *Gentleman Merchants*, p. 40.

⁶⁵ Wilson, *Gentleman Merchants*, p. 38. See also Gregory, *Regional transformation*, p. 46.

Location in 1813-20.

A recent study of the Anglican baptism registers collected for the period of 1813-20 has shown that the location of the textile industry was fixed by that time and would remain broadly unchanged across the remainder of the nineteenth century.⁶⁶ The location, by county, had changed markedly from that of 1500 (Figure 7). In that year, 14 percent of men in textile manufacture lived in Yorkshire. By the early nineteenth century, approximately one-quarter of the textile manufacturing in England and Wales resided in West Riding of Yorkshire. A further two-fifths lived in Lancashire, mainly, but not exclusively, in cotton manufacture. The baptism registers contain 48,000 entries for West Riding of Yorkshire fathers at work in the textile industry, four-times as many as those in Gloucestershire, Somerset, Wiltshire, and Devon combined, and twenty six-times as many as those in the North and East Ridings of Yorkshire.⁶⁷ The industry was focussed in a small number of places, with two-thirds of male textile workers in England and Wales living in 36 locations only (Figure 8). A striking feature is that, other than in Shoreditch and Bethnal Green, both in London, and in Norwich, coal miners were resident in each of these places, all of which were on, or in close proximity, to a coal field (Table 2). In 1813-20, over three-quarters of West Riding weavers lived in parishes in which coal miners also resided. In Warwickshire, the proportion who did so was over 90 per cent. These data are the first indications of a strong relationship between the industry and ready availability of coal. London and Norwich were exceptional in this regard but by now neither was a nationally significant producer of woollens. The London industry was of silk. Norwich, the chief centre for fine

⁶⁶ Sugden, 'Location'. Occupations were abstracted from the Parish occupational database created by the Cambridge Group for the History and Social Structure. See Kitson, Peter, Shaw-Taylor, Leigh, Wrigley, E. A., Davies, Ross, Newton, Gill and Satchel, Max, 'The creation of a 'census' of adult male employment for England and Wales for 1817, Cambridge Group for the History of Population and Social Structure, working paper no, 21, available at <https://www.campop.geog.cam.ac.uk/research/projects/occupations/abstracts/>, [accessed in September 2017].

⁶⁷ 1813-20 Baptism registers, Cambridge Group for the History of Population and Social Structure.

worsted manufacture in England 100 years previously, had shifted to the use of more silk, producing niche cloths, an ongoing trend that continued through to at least 1851.⁶⁸

The proximity of West Riding of Yorkshire wool manufacture to the coal fields is further illustrated in Figure 9.⁶⁹ All of the leading places where wool manufacture was undertaken were on the coal field. Moreover, each of place was situated in close proximity to water. This link between the manufacture, coal and water is observed not only in the West Riding of Yorkshire but also elsewhere in those non-northern counties which still had a significant textile presence. For instance, in the south Midlands, Kidderminster, home to 76 per cent of all Worcestershire weavers, and Coventry and Nuneaton in Warwickshire, were linked by river to coal fields only a few miles distant (Figure 10). In the West Country, the remnants of the industry in Bradford upon Avon, Trowbridge, and Frome were similarly connected. The canal linking Stroud to the River Severn was opened in 1779, providing water transport for coal mined in the Forest of Dean (Figure 11).

Discussion and Summary

There is clear evidence to show the English woollen began to move away from southern, counties during the late seventeenth century. As these counties textile de-industrialized, the industry moved to places where water and coal were readily accessible, decades before steam

⁶⁸ Sugden, 'Clapham revisited'.

⁶⁹ The maps are constructed from a dataset by A. E. M. Satchell, P. M. Kitson, G. H. Newton, L. Shaw-Taylor, L., and E. A., '1851 England and Wales Census Parishes, Townships and Places (2006)', and created with funding from the ESRC [RES-000-23-1579], the Leverhulme Trust and the British Academy. A description of the dataset can be found in A. E. M. Satchell, 'England and Wales Census Parishes, Townships and Places Documentation [2005, 2015]'. The dataset is an enhanced and corrected version of N. Burton, J. Westwood, J., and P. Carter, 'GIS of the Ancient Parishes of England and Wales, 1500-1850', (Colchester, UK Data Archive, 2001: SN 4828), which is a GIS version of R. J. P. Kain, and R. R. Oliver, 'Historic Parishes of England and Wales: An Electronic Map of Boundaries Before 1850 with a Gazetteer and Metadata', (Colchester, UK Data Archive 2001, SN 4348). Exposed coal measure data are taken from the British Geological Survey, and the location of the towns from Digimap®.

power had any meaningful impact upon woollen cloth production. The data presented here concurs with the view of Adam Smith that the price of fuel was such an important influence upon labour, that the textile manufactures confined themselves principally to the coal countries.

De-industrialization in southern counties occurred too early for the industrialization in the north to have been a significant factor. The switch of the woollen industry to the West Riding of Yorkshire was a consequence of a reversal of comparative advantage that first favoured the south, and then favoured the north. There are a number of factors that influence industry location, including supply of raw materials, governance, transport, wages, and sources water, heat , and power.⁷⁰ To consider each in turn, the West Riding of Yorkshire was not a major producer of wool and did not have competitive advantage over raw material supply. Guilds governed and controlled the medieval trade but their influence waned as the woollen manufacture moved to other places, long before southern counties de-industrialized. The role played by ecclesiastical cities and towns such as Beverley and York in Yorkshire, Bath in Somerset, Winchester in Hampshire, and Lincoln became less significant.⁷¹ There was movement away from towns and into villages in East Anglia also.⁷² R. A. Pelham suggested it was the introduction of the fulling mill that allowed the manufacture 'to migrate from urban centres, where gild organization was all-powerful, and opposition to mechanization correspondingly strong, to rural sites where gilds had no control'. For Pelham, the mill gave the opportunity for ecclesiastical and lay landlords to obtain a manorial monopoly on the process.⁷³ E. M. Carus-Wilson remarked that the concentration of fulling mills in rural places and not

⁷⁰ Jones, *Locating*, pp. 78-87, 92-3, 107.

⁷¹ Haddon, *Bath*, p. 61. Patten, *English towns*, pp. 47 and 156-60. Rosen, 'Winchester', pp. 143-95. Palliser, *Medieval York*, pp. 240-41, 262-63.

⁷² Clay, *Economic expansion*, p. 2.

⁷³ Pelham, 'Fulling mills', p. 3.

towns in the period from the thirteenth to the early fourteenth-centuries, shows a ‘startling change’ in the location of the cloth manufacture.⁷⁴

Water transport was likely a key factor because it was a major contributor to the cost of coal. The positioning of the woollen manufacture upon a river had been necessary from the moment that fulling was mechanized, but by the end of eighteenth century it was also essential to move coal. At the pithead, coal was cheap, a high density/low value commodity, but the price doubled if carried ten miles by land, whereas for the same cost it could be carried 200 miles by water.⁷⁵ Flinn noted that ‘the economics of coal distribution in the early eighteenth century thus very obviously dictated the use wherever possible of water rather than overland transport’.⁷⁶ Places distant from the coalfield were disadvantaged, therefore, especially if there was no direct link by navigable water. The West Riding of Yorkshire was at the vanguard of improvements to river transportation and canal construction.⁷⁷ For instance, in 1699, the Aire and Calder Navigation was created and the two rivers were made navigable to Leeds and Wakefield respectively.⁷⁸ In 1758, an Act was passed to extend the navigation of the River Calder as far as Halifax parish in Sowerby.⁷⁹ By 1770, the construction of the Leeds-to-Liverpool canal linked Bradford, Bingley and Keighley to Leeds, and hence to Hull and Liverpool.⁸⁰

The eighteenth century improvements to the road infrastructure through the construction of turnpikes came too late to influence location. Whilst improved roads facilitated the transport of light, high value goods such as textile cloth, the majority of Turnpike Acts were not passed

⁷⁴ Carus-Wilson, ‘Industrial revolution’, pp. 47-51.

⁷⁵ Szostak, *Role of transportation*, p. 118. Wrigley, *Energy*, 2010, p. 103.

⁷⁶ Flinn, *History*, p. 146. Wrigley, *Energy*, 2010, p. 107.

⁷⁷ Turnbull, ‘Canal’, p. 542.

⁷⁸ J. Priestley, *Historical account*, p. 5. Wilson, *Gentleman Merchants*, pp. 137-38. J. Mayhall, *Annals*, p. 108.

⁷⁹ Priestley *Historical account*, p. 124.

⁸⁰ Mayhall, *Annals*, pp. 150-51.

until the second half of the century.⁸¹ The number of Acts passed is not necessarily an indication of the number of turnpikes constructed, but recent work has confirmed that the turnpike building programme did not take off until after 1750.⁸² In 1720, only 1,092 kilometres of road were turnpiked. By 1750, the length of turnpiked road had risen 6,341 kilometres, but by 1800 it reached 31,702 kilometres.⁸³

Wages were the largest contributor to the cost of a woollen cloth, twice as much or more than the cost of wool.⁸⁴ Minimisation of labour costs was a key component for profit maximization, and it would be expected that woollen manufacturing moved to those places where wages were lowest. Derek Gregory contends that Smith ‘believed that the price of coal affected the location of industry through its effect on the wage bill rather than as a factor of production in its own right’.⁸⁵ As we have seen, however, Smith explicitly refers to the heating of spaces where people worked. D.C. Coleman noted the importance of coal and iron to manufacture, believing that counties with a strong proto-industry developed further and industrialized only if they were on or close to a coalfield. He went on to suggest that ‘nobody, however, would suppose that causation was as simple as that’.⁸⁶ Stephen Broadberry and others argue ‘that textile manufacture increasingly gravitated towards regions where cheap land kept the costs of provisions and therefore labour low’.⁸⁷ Gregory Clark’s wage analysis lends support to this argument. He calculates that nominal winter day wages for farm workers in northern England were lower than they were elsewhere in England in the last quarter of the seventeenth

⁸¹ Albert, *Turnpike*, pp. 45-9.

⁸² Shaw-Taylor, ‘Turnpike roads’.

⁸³ Shaw-Taylor, ‘Turnpike roads’.

⁸⁴ Anon., *Short essay on trade*, pp. 53–6 cited by Muldrew, ‘Ancient distaff’, p. 516. Bischoff, *Comprehensive history*, p. 185.

⁸⁵ Gregory, ‘New and different face’, p. 373.

⁸⁶ Coleman, ‘Proto-industrialization’, p. 443.

⁸⁷ Broadberry, *British economic growth*, p. 147

century and remained below the national average throughout the eighteenth century.⁸⁸ Similarly, Hunt believes the West Riding of Yorkshire, Lancashire, and Cheshire were still low wage economies circa 1770. For him also, carpenters' wages in Manchester lagged those of Exeter until after 1765.⁸⁹ Relative wage differentials may have provided an incentive for the textile industry to move, but they do not explain why the industry did not spread ubiquitously across the entirety of low wage counties. The industry concentrated in a small number of places in which wages were low but also where coal and water were readily accessible.

Jones contends that the high price of coal in southern England did not become a major competitive advantage until the introduction of heavy industry and the coal-fired steam engine.⁹⁰ The data presented here challenges that view. It is interesting to note that the onset of textile de-industrialization and the move to northern counties came at the time when coal became significantly cheaper than alternative fuels. Peat and coal were burned in the sixteenth century, especially when close to where they could be readily dug, but heat energy in the main was supplied by firewood sourced from coppiced woodland.⁹¹ The demand for wood, from industry and from a growing population that near-doubled from 2.8 million to 5.1 million in England, 1541-1641, became so strong that the supply was put under severe pressure.⁹² It was suggested that, since the process of dyeing was so wasteful of an already scarce resource, manufacturers should switch to using Newcastle coal.⁹³ Similarly, the Privy Council was lobbied for an order to force Exeter dyers to use coal.⁹⁴ By 1620, coal was displacing firewood and began to become the

⁸⁸ Clark, 'Farm wages', pp. 477-505.

⁸⁹ Hunt, 'Wages', pp. 60-8. Hunt, 'Industrialization', pp. 935-66.

⁹⁰ Jones, *Locating*, pp. 91-3.

⁹¹ Warde, *Energy consumption*, pp. 32-40. Warde, 'Fuel supply', pp. 61-82.

⁹² Wrigley, *English population history*, p. 614. Hammersley, 'Charcoal', pp. 593-613.

⁹³ Tawney, *Tudor Economic Documents*, pp. 135 and 144.

⁹⁴ Hoskins, *Industry*, p. 101.

dominant source of heat energy in England.⁹⁵ In early seventeenth century southern England, the price of coal, to supply the same calorific content, was approximately half that of firewood. By 1700, it was around one-third.⁹⁶ In the north, adjacent to a coal field, the differential would have been even greater. As the supply of firewood in the south was increasingly inadequate to meet needs, coal was being mined across the West Riding of Yorkshire, around Leeds, Wakefield, Huddersfield, and Halifax.⁹⁷ It was mined also in the south Midlands close to Coventry.⁹⁸ Kidderminster, Worcestershire, was linked to the early coal mines in Stourbridge via the River Stour.⁹⁹ Circa 1700, coal was extracted in the Forest of Dean, Gloucestershire, and in Somerset and in the south and west Midlands.¹⁰⁰ By 1700, coal was used significantly as a source of heat energy.¹⁰¹ It is surely no coincidence that the textile industry moved towards it. Sir Frederick Morton Eden was aware of the advantages to the labourer of cheap coal fuel. In 1797, referring to the Weald of Kent, he wrote ‘300 years ago, the woollen manufactory here was very considerable: it is supposed that the decrease of fuel was the cause of its migrating to the coal counties’.¹⁰² Eden attributed coal to enabling more hot dishes to be eaten in the north.¹⁰³ He reckoned that the household income of an Oxfordshire labourer was around £20 per annum, of which £2 10s was spent on fuel. Eden writes ‘the extreme dearness of fuel, in Oxfordshire, compels him [a labourer] to purchase his dinner at the baker’s’.¹⁰⁴ At the end of seventeenth century, a London man spent 10 per cent of his wages on coal, ‘even when coal prices in the

⁹⁵ Malanima, ‘Pre-industrial Economics’, p. 57

⁹⁶ Ibid, p. 108

⁹⁷ Hatcher, *History*, p. 119.

⁹⁸ Hatcher, *History*, p. 160.

⁹⁹ Hatcher, *History*, p. 150.

¹⁰⁰ Glennie, ‘Industry’, p. 210.

¹⁰¹ Hatcher, *History*, p. 458.

¹⁰² Eden, *The State of the Poor*, ii, p. 282-83.

¹⁰³ Eden, *The State of the Poor*, i, pp. 524-25, and ii, p. 587, and cited by Zylberberg, ‘Fuel prices’, p. 95. Horrell, ‘Bringing home the bacon’, p. 1363.

¹⁰⁴ Eden, *The State of the Poor*, ii, pp. 586-87. Zylberberg, ‘Fuel prices’, p. 106.

capital were at their lowest'.¹⁰⁵ By 1800, the proportion had risen to one-seventh. In a typical weekly budget of an eighteenth-century Exeter family with an income of 10s, 1s went on rent, but 1s 6d was needed for fuel and light.¹⁰⁶

It is well known that some textile processes such as dyeing, scouring, and hot pressing required heat. Although coal was an unsuitable heat source for some industrial processes, particularly those in which the flame was in direct contact with the object to be heated, it was less of a problem to heat a dye vat.¹⁰⁷ London dyers were burning sea coal as early as 1578.¹⁰⁸ It seems unlikely, however, that this process was a chief factor that drove location because only a relatively small share of textile workers was employed in this work. Moreover, those that were involved in these trades were concentrated in a small number of places. For instance, the 1813 Anglican baptism registers of England and Wales record 12,330 weavers and 2,229 clothiers but only 640 dyers and 35 hot pressers.¹⁰⁹ Over one-third of these dyers lived within a ten miles radius of Manchester, presumably dyeing cotton cloth, and one-quarter lived in London. Another 17 dyers lived in Norwich, dyeing silk-rich worsteds, but only 63 dyers resided in either of Leeds or Halifax. Dyers, therefore, were not likely to dictate the location of the industry. Neither were hot pressers, whose role was to impart a glaze to some worsteds, 74 per cent of whom lived in London or Norwich.

Whilst this study confirms Adam Smith's observation that Great Britain manufactures confined themselves principally to the coal countries, there is more work to do to prove causality.

¹⁰⁵ Nef, *Rise*, vol. II, pp. 203-04.

¹⁰⁶ Hoskins, *Industry*, pp. 134-35.

¹⁰⁷ Tann, 'Fuel Saving', pp. 149-59. Hatcher, *History*, pp. 442-43. Wrigley, *Path*, p. 180.

¹⁰⁸ Nef, *Rise*, vol. I, p. 214.

¹⁰⁹ Hot pressing, also known as calendering was a technique applied to some worsted cloths to impart a glaze.

Work to more thoroughly understand and compare early eighteenth-century wages, the price the coal at the point of use, and the cost of providing space heat, is ongoing. Work is also continuing to determine the influence of coal upon other industries, for example framework knitting and home baking.

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Table 1

Common Pleas: Estimates of the number of men working in the textile manufacture and the ranking of importance, by county, 1483-1524.

<u>County</u>	<u>Population</u>	<u>Number, Debt</u>	<u>Rank, Debt</u>	<u>Number, Trespass</u>	<u>Trespass Rank</u>
Yorkshire	369,781	5,953	1	5,103	1
Somerset	170,910	5,110	2	2,752	3
Suffolk	139,871	3,861	3	2,574	4
Devon	261,534	3,609	4	4,210	2
Wilts	116,475	2,947	5	2,411	5
Gloucestershire	102,410	2,826	6	1,648	8
Kent	153,442	2,823	7	1,765	6
Hampshire	105,384	2,666	8	1,697	7
Essex	156,647	2,162	9	1,441	10
Norfolk	173,113	1,991	10	1,593	9
Berkshire	57,537	1,456	11	662	16
Surrey	85,770	1,183	12	591	17
Sussex	103,165	949	13	949	14
Lincolnshire	175,173	806	14	1,209	12
Oxfordshire	67,671	622	15	466	19
Worcestershire	66,362	610	16	458	20
Warwickshire	66,201	609	17	1,218	11
Shropshire	79,858	551	18	367	25
Nottinghamshire	79,039	545	19	364	26
Dorset	75,815	523	20	1,046	13
Northamptonshire	92,113	424	21	85	29
Herefordshire	58,766	405	22	67	31
Buckinghamshire	56,698	391	23	391	23
Middlesex	283,254	391	24	391	24
Staffordshire	78,443	361	25	722	15
Derbyshire	70,586	325	26	325	27
Bedfordshire	43,550	300	27	401	22
Hertfordshire	62,761	289	28	433	21
Cornwall	104,064	239	29	479	18
Cambridgeshire	73,318	169	30	168	28
Leicestershire	63,860	132	31	73	30
Huntingdonshire	27,942	64	32	0	32

Source: See the text.

Table 2

Baptism Registers: The number of fathers who worked in textiles or who were miners in 1813-20.

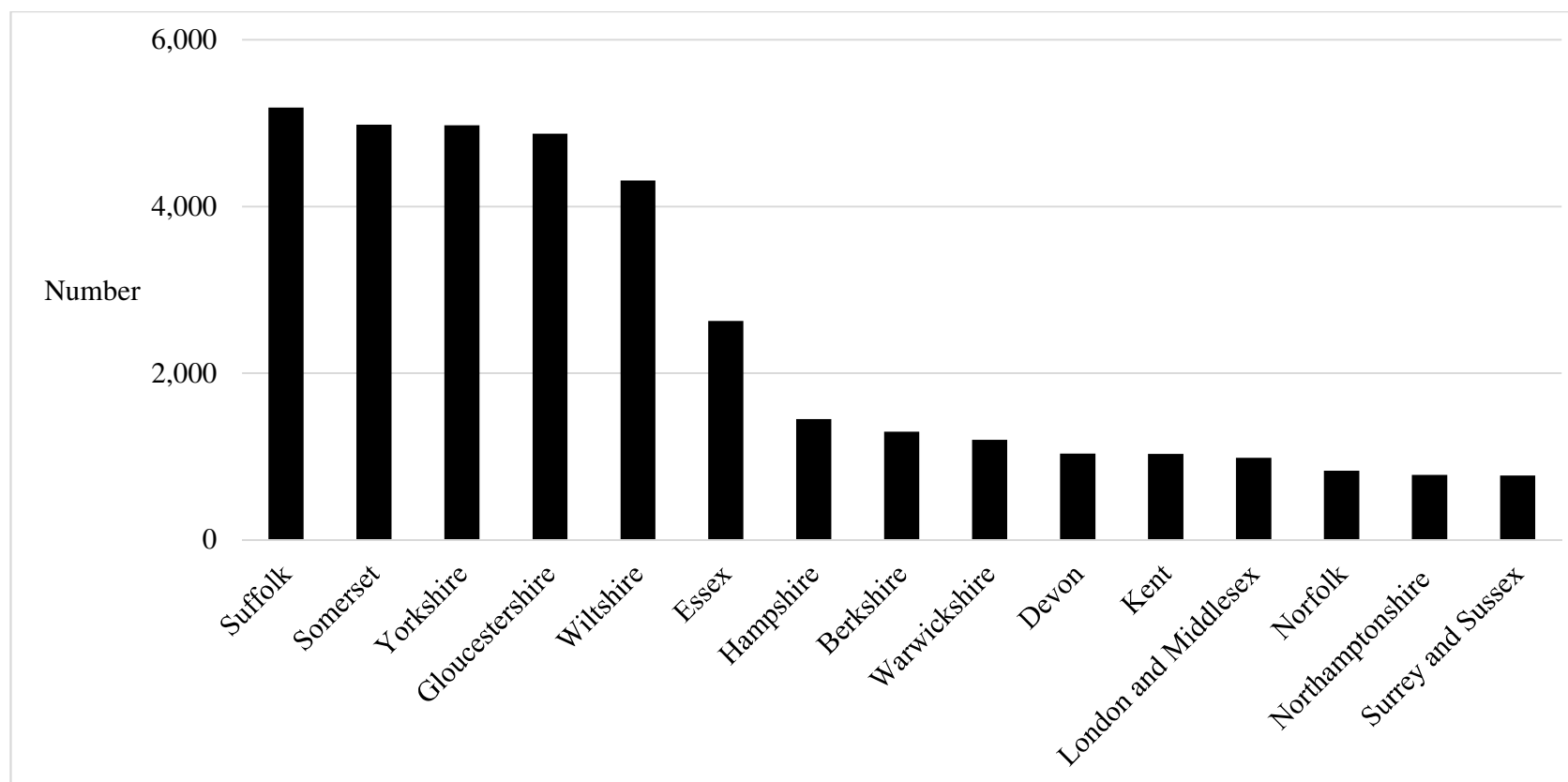
<u>Parish</u>	<u>Textiles</u>	<u>Coal Miners</u>	<u>Miners*</u>	<u>Parish</u>	<u>Textiles</u>	<u>Coal Miners</u>	<u>Miners*</u>
Manchester	11,328	94	25	Middleton	2,462	72	0
Whalley	8,675	305	30	Deane	2,416	6	266
Leeds	7,695	13	0	Eccles	2,336	57	0
Blackburn	7,545	72	6	Almondbury	2,262	39	18
Halifax	7,009	126	4	Bethnal Green	2,260	0	0
Rochdale	6,964	194	0	Birstall	2,245	280	33
Prestwich with Oldham	6,690	394	0	Dewsbury	2,197	34	64
Bolton le Moors	5,360	168	80	Coventry	2,117	9	1
Bradford	5,359	66	960	Preston	1,820	0	16
Bury	4,450	65	65	Croston	1,654	38	2
Ashton under Lyne	4,220	339	32	Kirkburton	1,467	40	3
Stockport	3,357	6	0	Silkstone	1,423	86	6
Shoreditch	3,232	0	0	Kidderminster	1,366	4	1
Wigan	3,071	25	825	Guiseley	1,319	5	4
Leigh	2,688	113	3	Wakefield	1,271	131	32
Norwich	2,686	0	0	Kirkheaton	1,219	5	46
Prestbury	2,603	77	0	Leyland	987	5	0
Huddersfield	2,603	65	65	Batley	945	22	32

*Note: Most unspecified miners worked coal, but others, for instance in Bradford, mined iron also.

Source: Baptism Registers of England and Wales, 1813.

Figure 1

Aulnage returns: The number of cloths woven by county, 1468-73

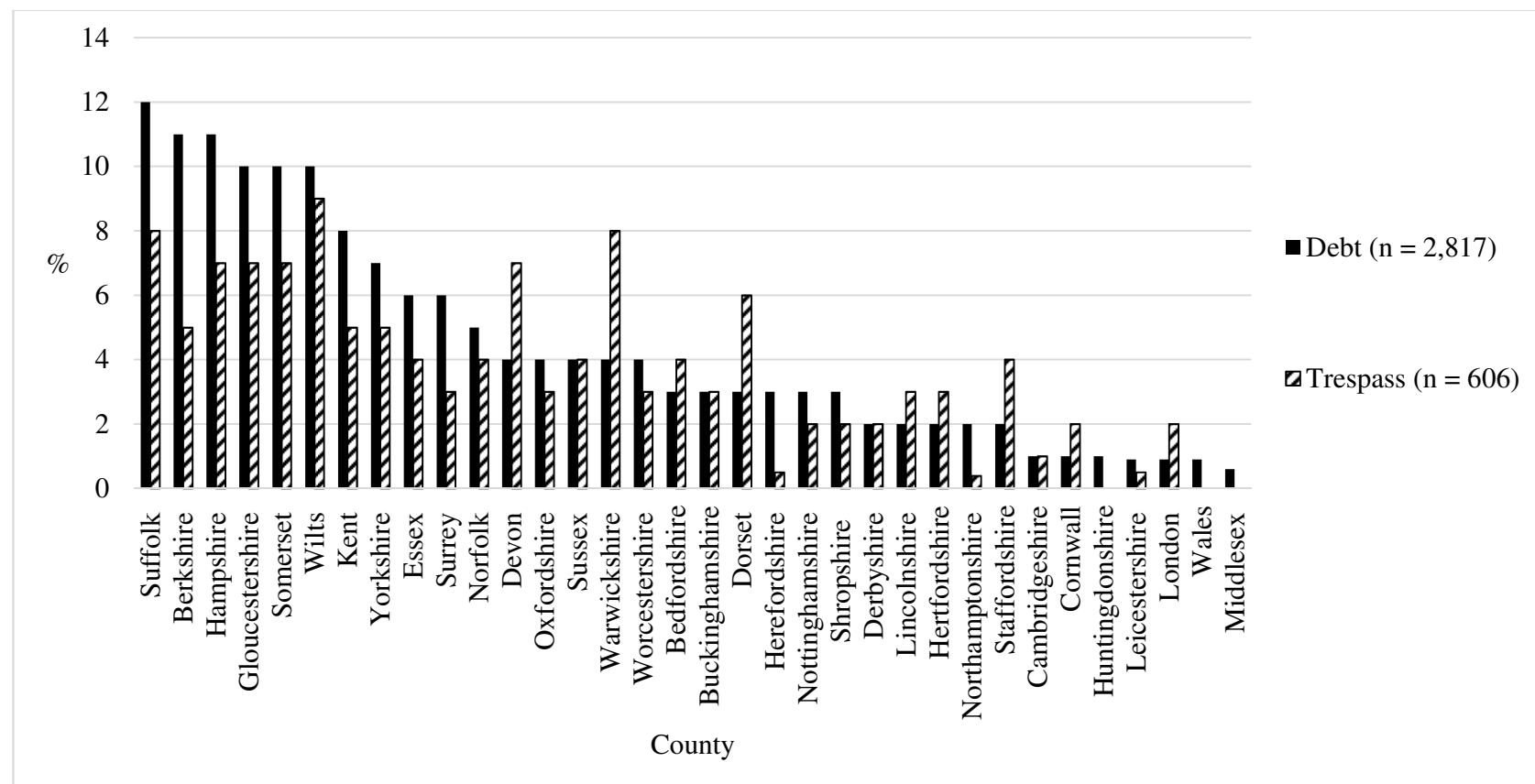


Source: Heaton 1920.

Figure 2

Common Pleas: The location of male defendants working in textile manufacture, pleas for debt and trespass, 1483-1524

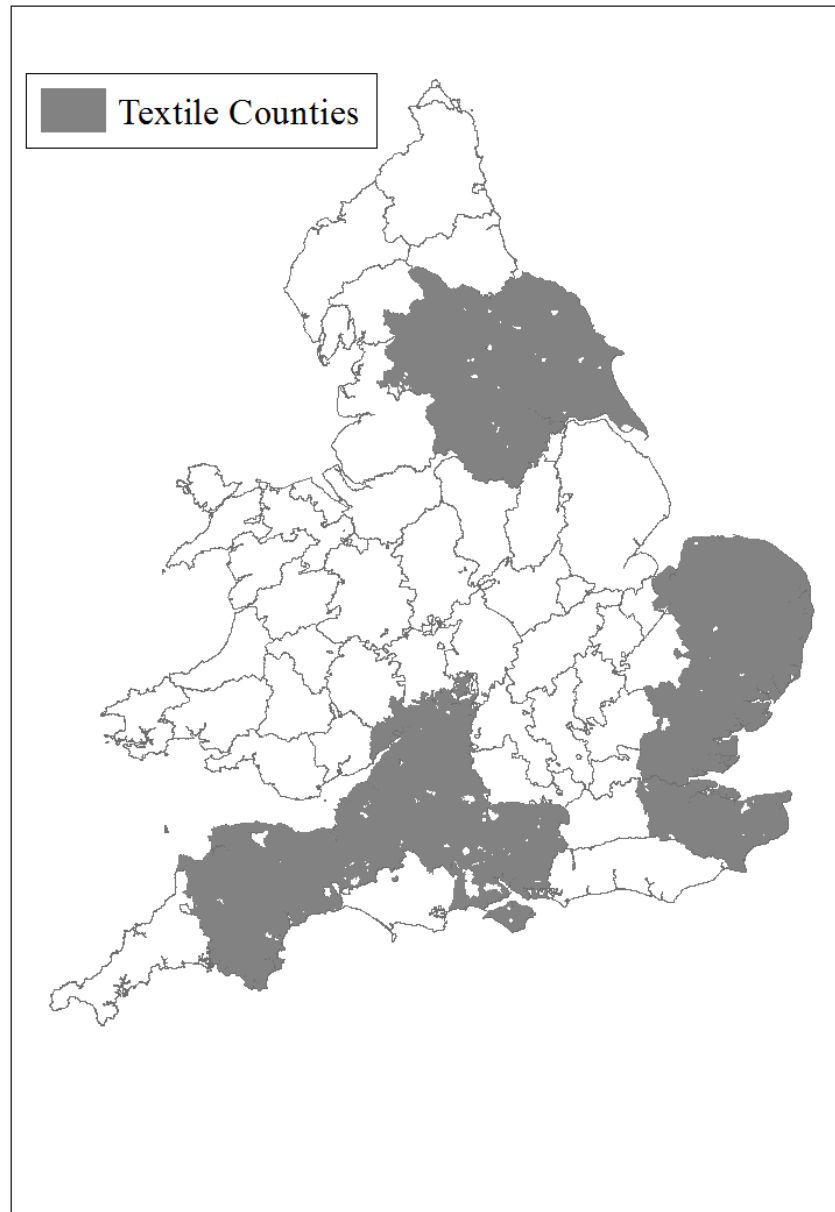
Expressed as the percentage of those employed in textile manufacture in each county



Source: University of Houston http://aalt.law.uh.edu/Indices/CP40Indices/CP40_Indices.html.

Figure 3

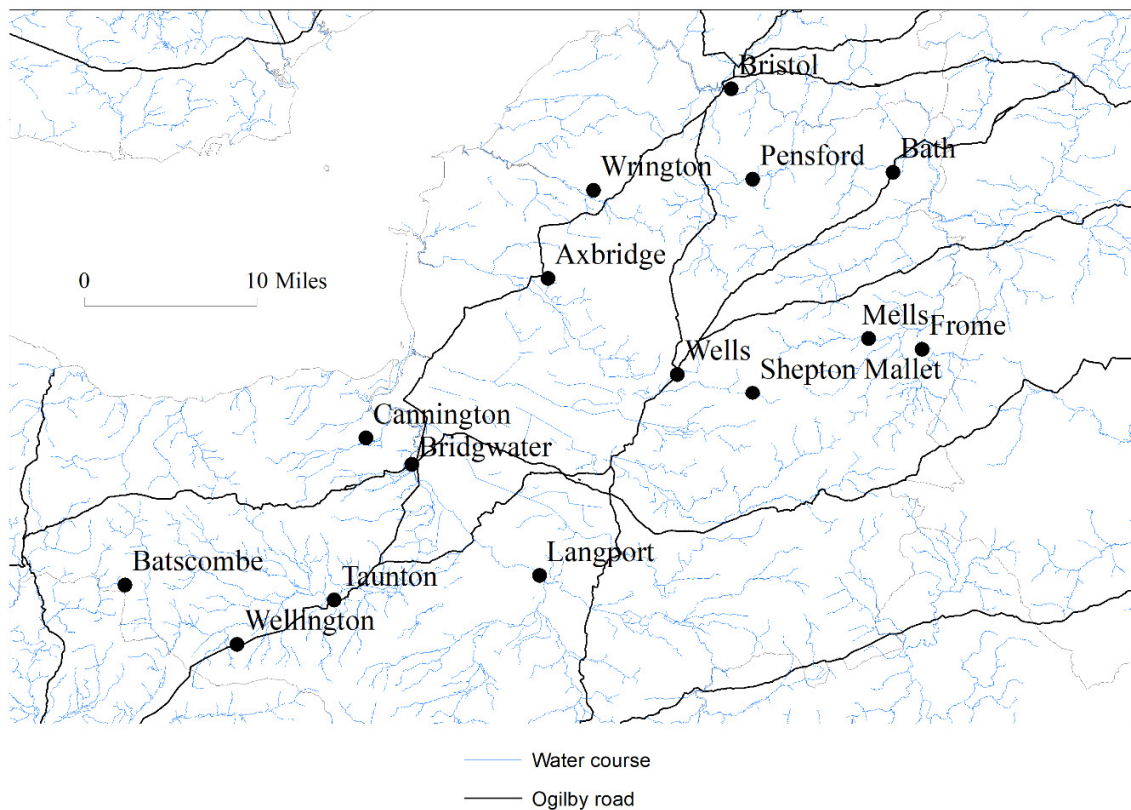
The location of the top 10 textile counties in England, 1483-1524.



Source: See the text.

Figure 4

Place of residence of common plea defendants who worked in the Somerset wool manufacture, 1483-1524.

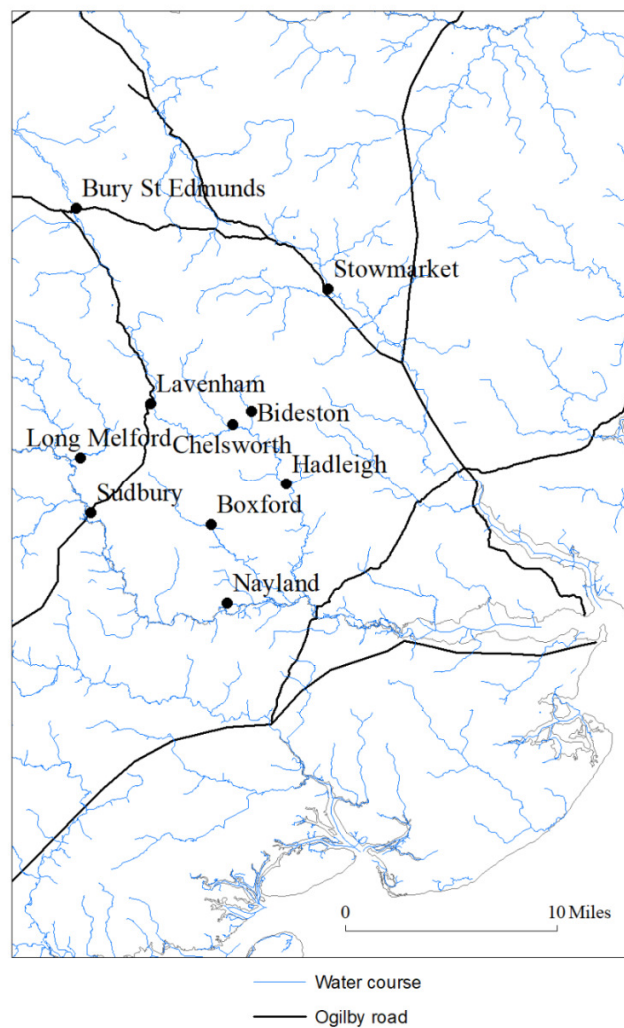


Note: Over two-thirds of all Somerset defendants in pleas for debt and who worked in wool manufacture lived in the places shown.

Sources: See the text.

Figure 5

Place of residence of common plea defendants who worked in the Suffolk wool manufacture, 1483-1524.

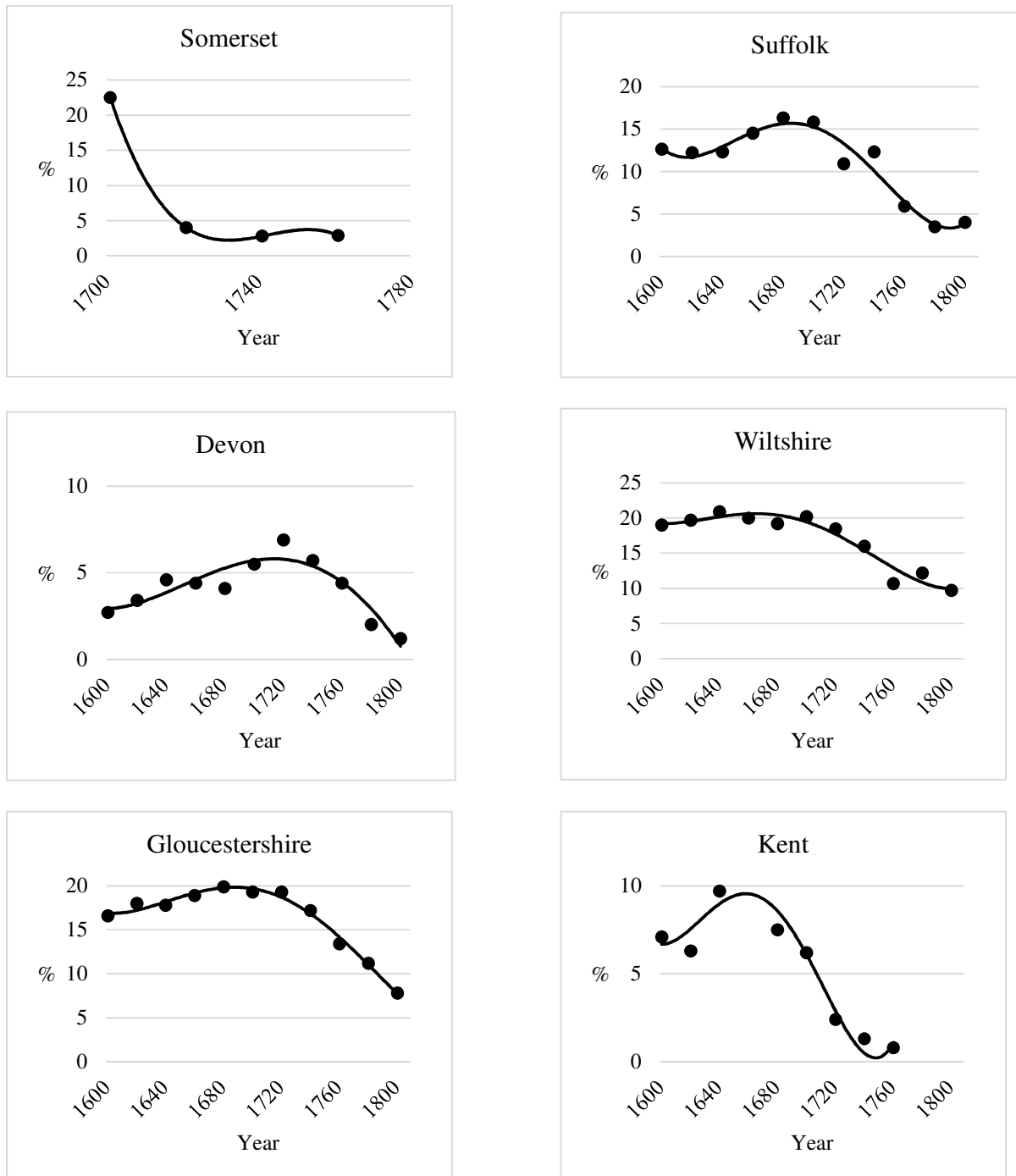


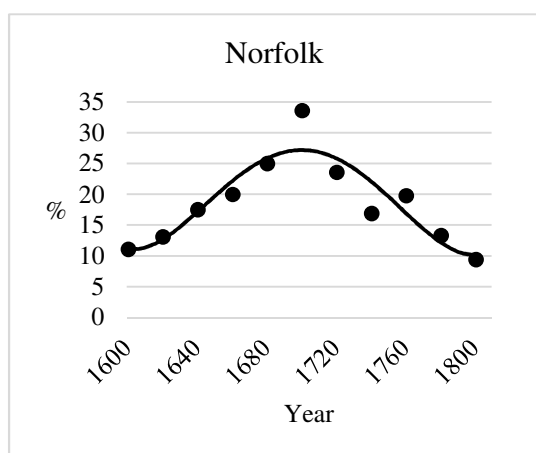
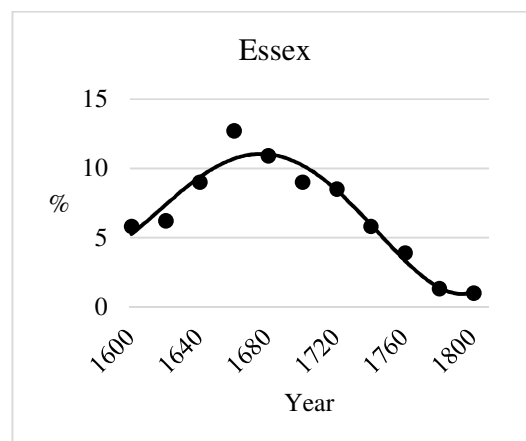
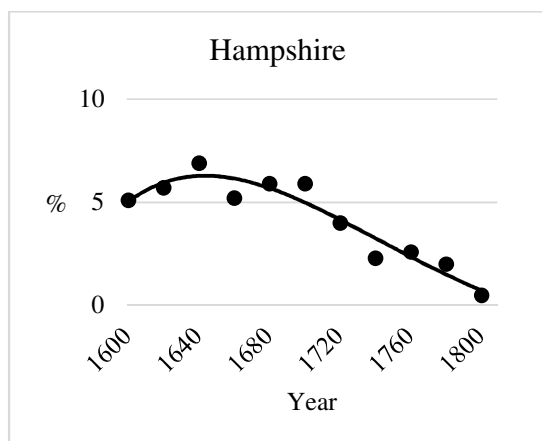
Note: Over two-thirds of all Suffolk defendants in pleas for debt who worked in wool manufacture lived in the places shown.

Sources: See the text.

Figure 6

The change in the percentage of men employed in textile manufacture, by county, 1601-1801.



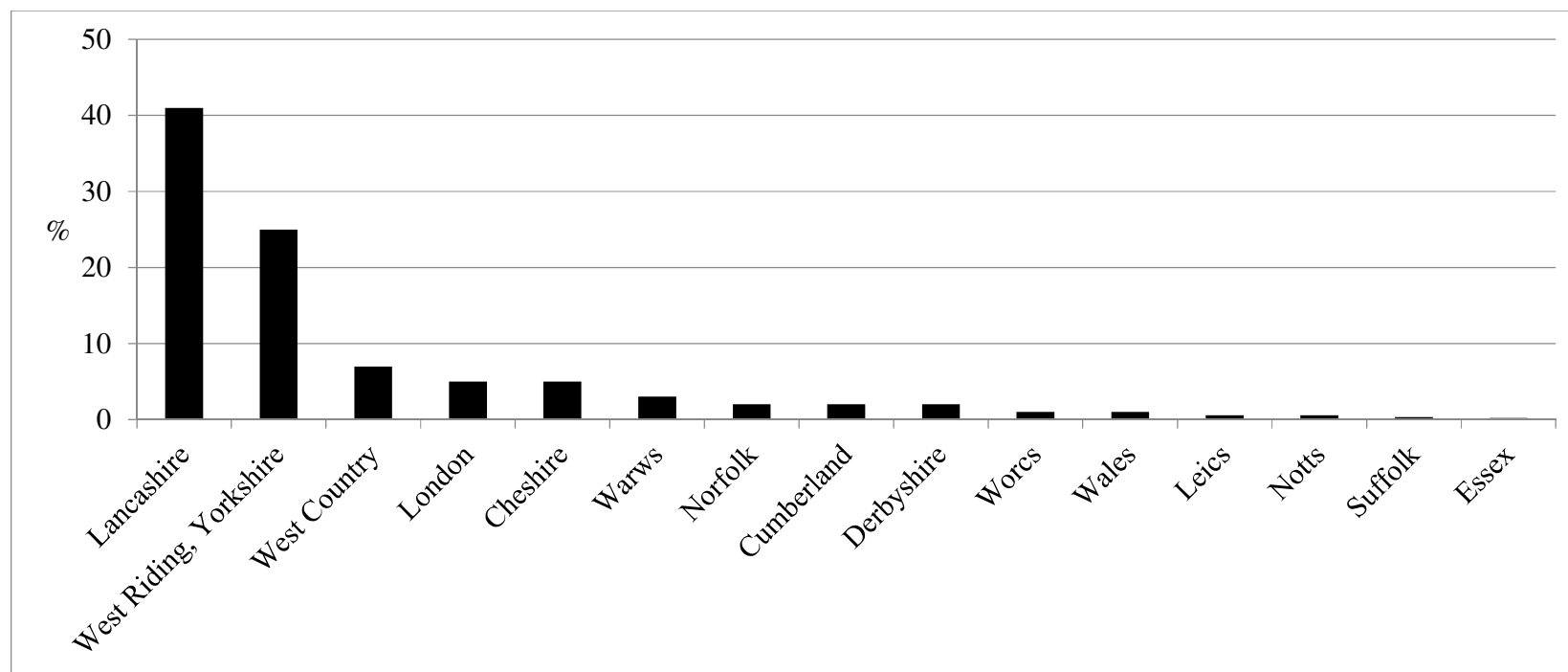


Source: Keibek, Unpublished PhD thesis, 2016.

Figure 7

The location of textile manufacture by county, 1813-20.

(Expressed as the percentage of those employed in textile manufacture of England and Wales)

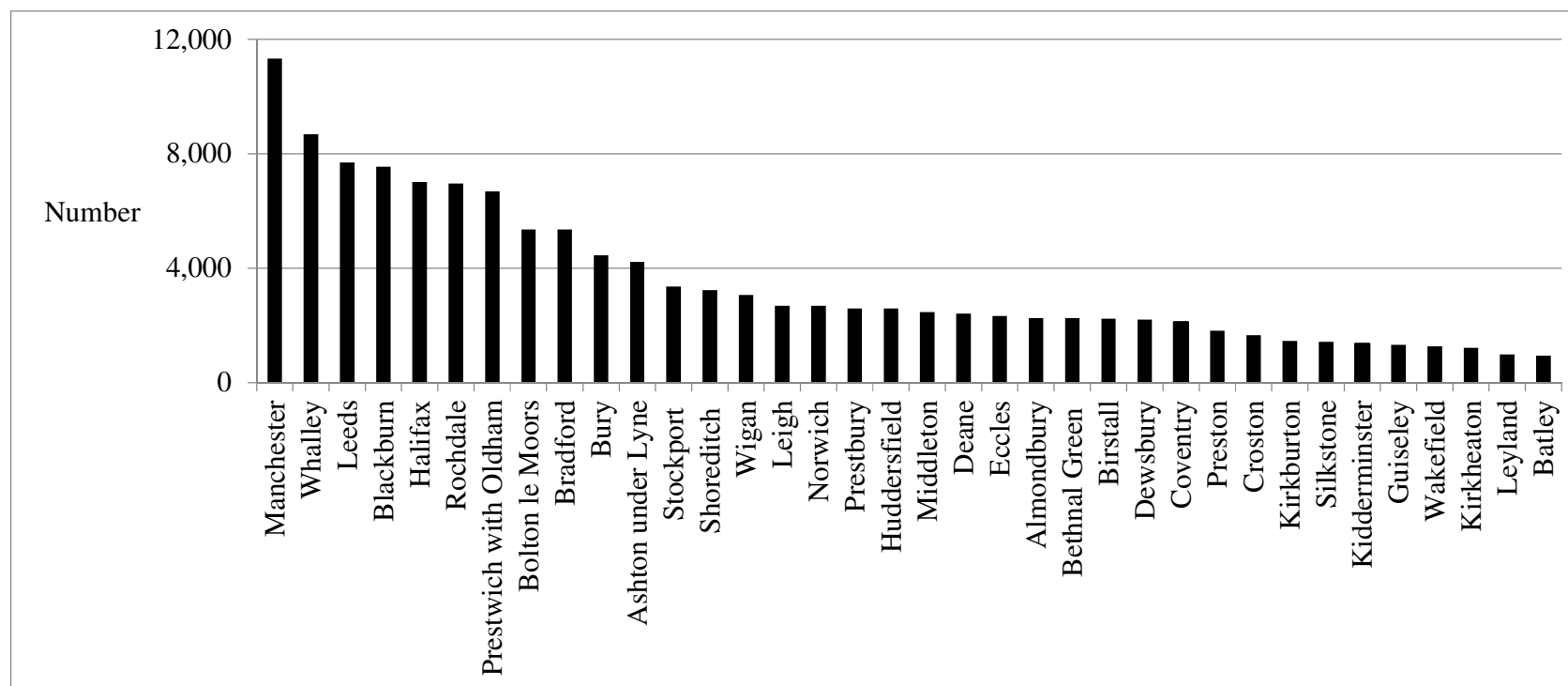


Source: See the text.

Figure 8

The leading 36 places engaged in textile manufacture, 1813-20.

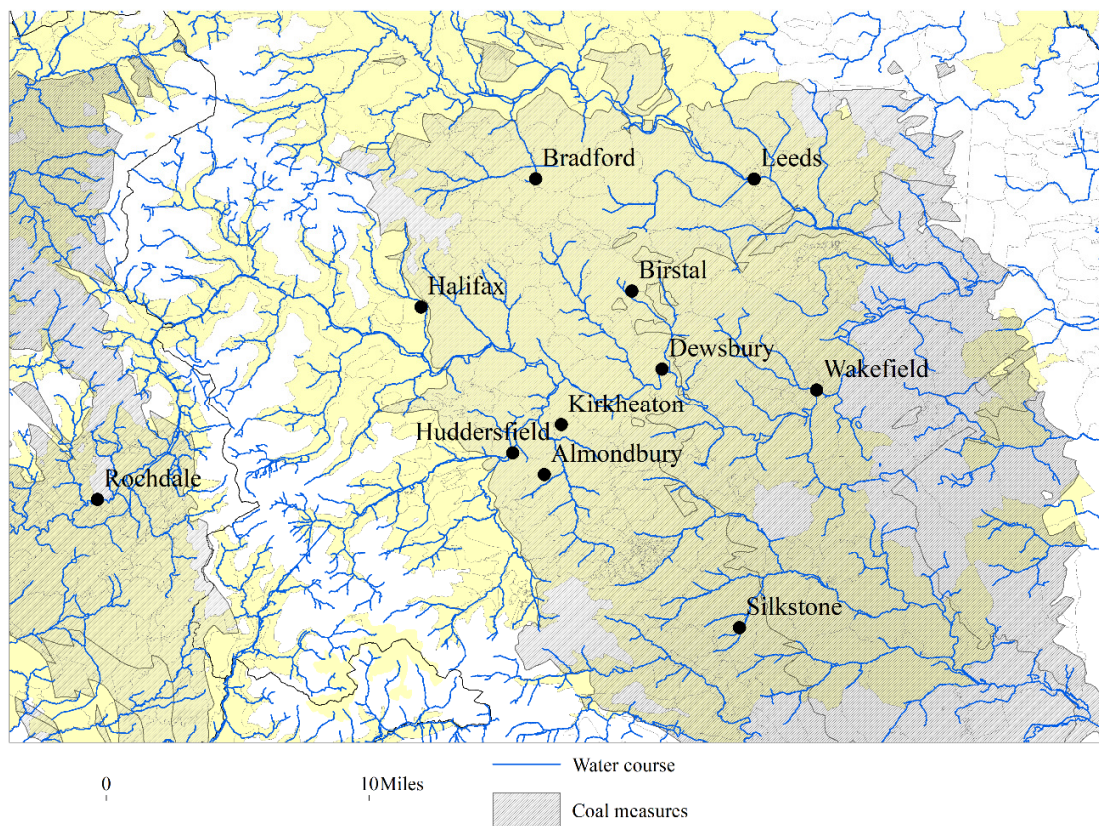
(expressed as the actual number recorded in the baptism registers)



Source: See the text.

Figure 9

The location of the textile manufacture in the West Riding of Yorkshire, 1813-20.

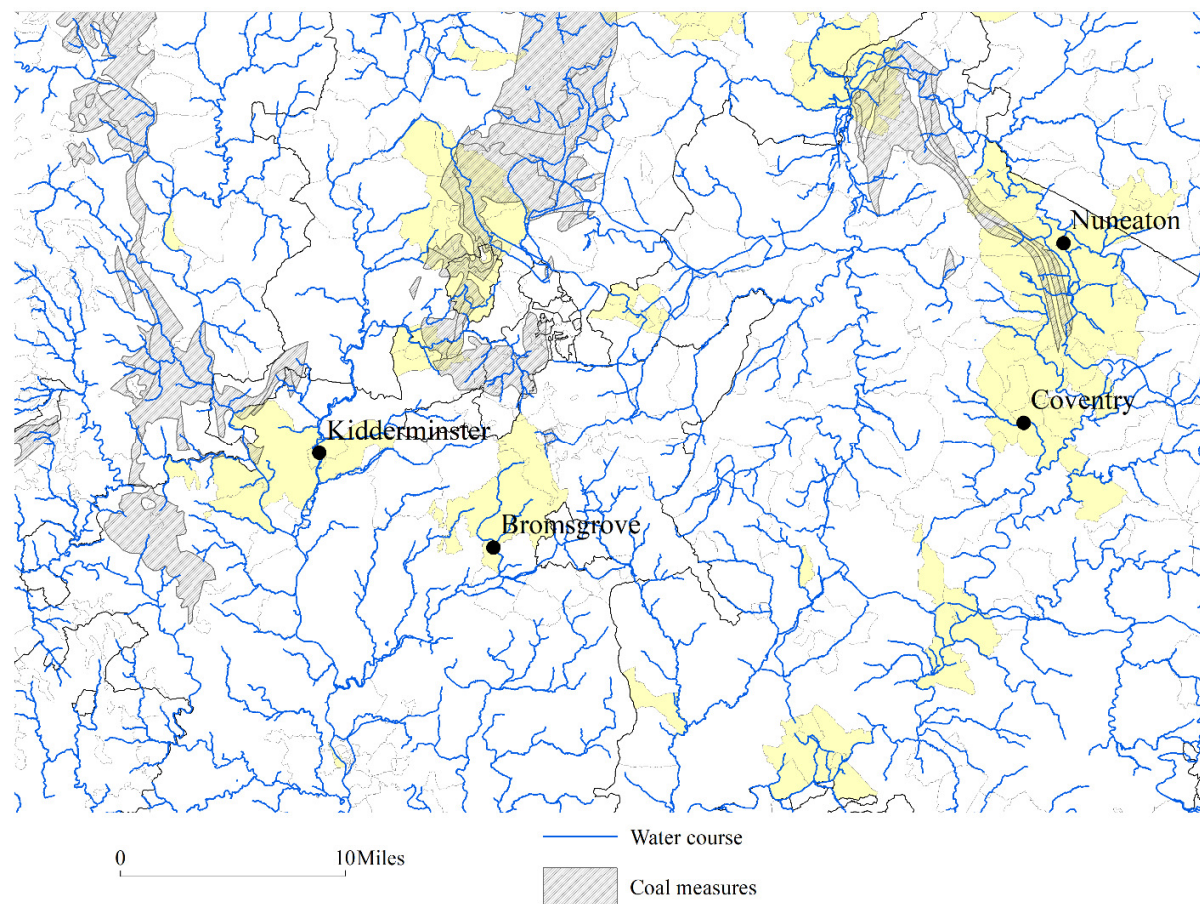


Note: The yellow shaded area shows those places where at least 10 fathers in the baptism registers, 1813-20, worked in the textile industry.

Sources: See the text.

Figure 10

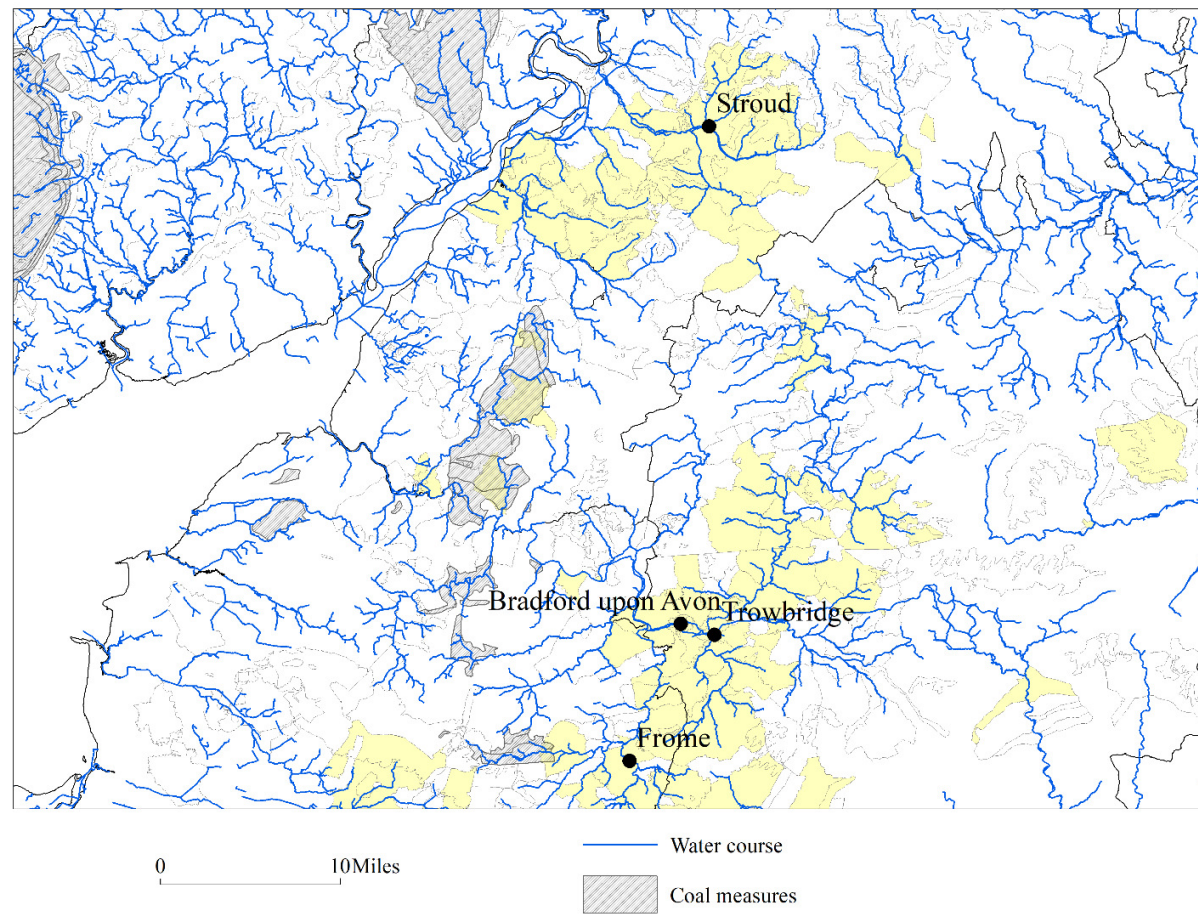
The location of the textile manufacture in the Worcestershire and Warwickshire, 1813-20.



Source: See the text.

Figure 11

The location of the textile manufacture in the West Country, 1813-20.



Sources: See the text.