An evaluation of *British Economic Growth* before 1700: Recovering "the Malthusian Delusion"

By C. Knick Harley
September 2026

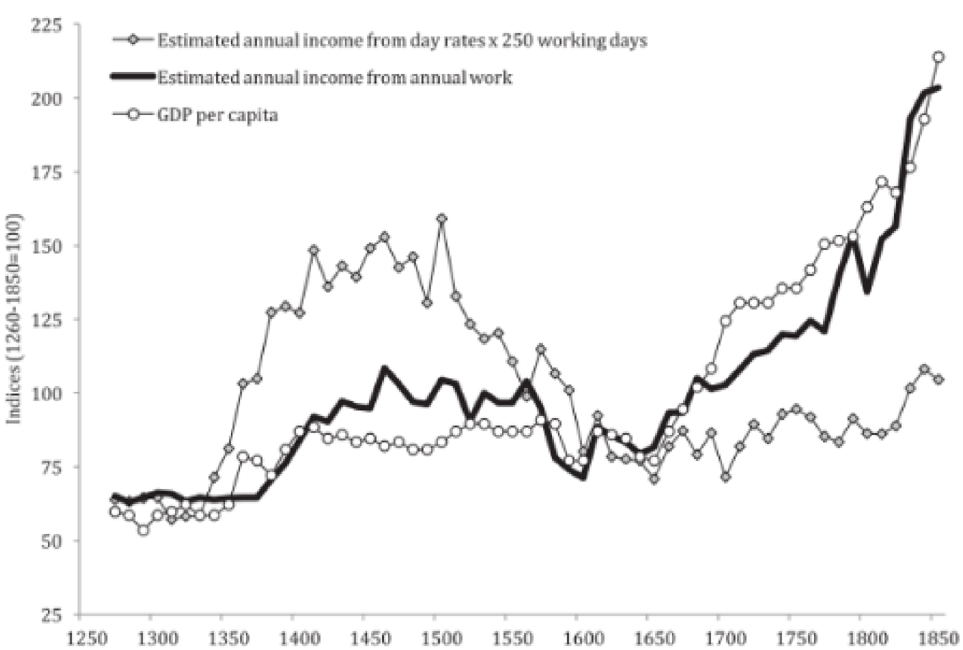
Abstract

British Economic Growth 1270 - 1870 by Steven Broadberry, Bruce Campblell, Alexander Klein, Mark Overton and Bas van Leeuwen has become a standard source on very long-term British economic growth. As such it is appropriate to consider the robustness of its conclusions, the most novel of which is probably that their estimate deny significant decline in per capita national income in the face of renewed population growth in the sixteenth century. Their conclusion rests primarily on their estimates of the growth of the iron, coal and woollen textile industries. This paper reexamines the evidence on the output of these industries and concludes that Broadberry et al have seriously exaggerated their sixteenth century growth. Reconstructing Broadberry et al's national income estimate for comparison with a revised estimate reveals that agriculture, iron, coal and woollens make up almost all of the data directly relating to individual industries while the remaining estimates are based on suppositions about per capita output and/or the role of urbanization. Revised these generate rate of growth of industry and of national income in the sixteenth century significantly slower than Broadberry et al's estimate. The process of construction consistent national income estimates also reveals lack of robustness of many of the other component series of their income estimates.

British Economic Growth 1270 - 1870 by Steven Broadberry, Bruce Campblell, Alexander Klein, Mark Overton and Bas van Leeuwen has become a standard source on very long-term British economic growth with well over a thousand citations according to Google Scholar (accessed 5 Sept 2026). Perhaps, most strikingly, their estimates reject the long-standing view on the broad historical contours of the English per capita income that rested on data of daily wage rates and the cost of living that derive from surviving records from multiple sources, initially records from King's College, Cambridge and Merton College, Oxford (Clapham, (1929) pp. 12-13). Recent work on yearly wages has somewhat modified this view but they indicate that demographic influences had a dominant effect on per-capita income from the medieval times until the eighteenth century, declining when pre-Black Death population increased, increasing after the halving of population and declining again as population grew in the sixteenth and seventeenth century. Figure 1 traces this time path of these daily

Figure 1

Real Wages and Per Capita Income Estimate



Source: Humphries and Wisendorf (2015) Figure 2

real wage estimates, recently revised estimates of annual wages and Broadberry et al's per capita national product. A striking aspect of the comparison is that the Broadberry et al product estimates hardly record a decline in income as population growth returned after 1550[1].

Broadberry et al explain the divergence between their income estimates and the real wage data by wide variation in the days worked annually (p. 260-265). Table 1 shows their calculations of the days worked annually (the report per cent changes over the various intervals. Table 1 links these to a (somewhat arbitrary)1800 working year of 300 days). Table 1 also includes independent estimates of the working year that Broadberry et al report (Blanchard's estmate for 1433 and 1598 are entered as 1450 and 1650; the entry for 1650 for Clark and van der Werf is the average of their 1600/49 and 1650/99; the 1750 figure for Voth is his 1760).

Table 1

Broadberry et al and Other Estimated days worked 1300 - 1800

	Broadberry et all		Other estimates of days worked		
	Implied days worked	% increase from previous	Blanchard/ Allen and Weisdorf	Clark and van der Werf	Voth
1300	143				
1340	126.24	-11.5			
1450	116.14	-8	165		
1560/99				257	
1650	207.65	78.8	259	271	258
1750	264.55	27.4			
1800	300	13.4			333

Source: Broadberry et al, Table 6.01, p. 262 and Table 6.02 p. 264.

Broadberry et al argue (as does Blanchard (1978))that the change in working days arose from workers' aim at achieving a target income. It is certainly plausible that the medieval population chose to enjoy some of the fruits of higher productivity occasioned by a major increase in available resources per person after the Black Death in the form of greater leisure. However, the change Broadberry et al

[1] For recent reassessment of these real wage estimates see; Hatcher (2011; 2019); Humphries and Weisdorf (2015; 2019)).

suggest indicate a preference for leisure that would surely have occasioned contemporary comment. Furthermore they show extraordinarily low working hours for the low wage years at the beginning of the fourteenth century. Allen and Weisdorf (2021, Figure 1, p. 719) calculate that in the early fourteenth century it would have required more than earning the daily farm wage every day of the year to afford a "basket of goods ... taken to correspond to a "poverty" line" (Allen, (2001, p120) this is not a subsistence basket; it includes meat and beer). Even if we accept Broadberry et al's radical change in the choice of intensity of work between 1450 and 1650, if leisure was chosen over work because it was more valued than wages, the income Broadberry et al's output based aggregate output measures is a very poor indicator of economic welfare.

Assessing the evidence

Broadberry et al have produced an apparently impressive annual time series of national income back to 1270. It is, nonetheless, appropriate to bring a historian's skepticism to their evidence. John Clapham comment in his 1927 inaugural address at Cambridge seem appropriate:

> I sometimes see the economic worker [in history] as a sort of osteologist, a collector and student of historical bones, old defective fossil sets and pretty complete sets of well-articulated modern ones....It is easy, when modesty wanes, for us economic historians to glorify in this bone business of ours. We can hint at the very unreal or lop-sided or dropsical historical monsters which might be reconstructed –have indeed been reconstructed – through neglect of it. (p. 39)

I want to look at the "bones," primarily of the industrial output estimates, in Broadberry et al's estimates before 1700. This exercise suggests that they constructed something of a "dropsical historical monster".

Some of Broadberry et al's underlying evidence is truly impressive. Their project arose (p. xxv) as an attempt to utilize the agricultural information in careers' work by Bruce Campbell on medieval demesne records and Mark Overton on early modern probate records and farm accounts. These records, in fact, provide almost all of the actual data in the underlying the estimates prior to 1500. and much to 1700. They, of course, provide the basis for estimating agricultural output. They also underlie much of the estimate of industrial production. The output for woollen cloth, leather goods and food production (see note to Figure 4.04, p. 151) all arise from the agricultural output estimates. Direct primary evidence for industry and services is much less abundant. Data on iron and coal begin only in 1500. The estimates for building rely on estimates of urban population. The long time series of tin output covers almost the entire time span but tin was a small and localized industry that occupied a unique position of being Europe's major source of tin (needed for bronze). Book production is also estimated from 1500 by the number of new titles published annually but this was a small industry. The balance of their industrial output and most of their service sector estimates are built on assumptions about per capita output and the influence of urbanization rather than on data relating to the industries whose output they are estimating.

Broadberry et al have little direct evidence beyond agriculture before 1500 and, unfortunately, the nature of the agricultural data leaves a discontinuous gap between 1492 and 1553, consequently my discussion has had to concentrate primarily on 1550 to 1700. I have directed my attention primarily to direct evidence on iron, coal and woollen cloth. Reassessing of the output of these industries indicates that Broadberry et al exagerated the increase in output of these industries particularly from 1550 to 1600. Recalculating their nationa product estimates leads to considerable modification of their conclusions.

Industrial Output

Broadberry et al see industrial growth to be the principal force propelling continued per capita income growth after population growth resumed in the late fifteenth century. They break down growth by sectors in their Table 11.01 (p. 404) reproduced as Table 2 below and observe that

> England's progress ... was founded upon the expansion of industry (building upon the advances made by its late-medieval wool-textile industry, the re-

expansion of tin mining, and, from the end of the sixteenth century, the rise of iron smelting and coal mining), the fusion of industrial with commercial growth, and a greatly enhanced role for the state. (p. 210)

Table 2

Broadberry et al's Annual Growth Rates, by Sector 1270-1860

Years	Agriculture	Industry	Services	GDP	Population	GDP per head
1270s–1340s	0.09	0.27	0.25	0.11	0.11	0.00
1340s–1470s	-0.33	0.27	-0.46	-0.34	-0.53	0.20
1470s–1650s	0.43	0.64	0.69	0.56	0.52	0.04
1650s–1770s	0.51	0.75	0.73	0.66	0.22	0.44
1770s–1860s	0.95	2.35	1.88	1.80	1.15	0.64

Source Broadberry et al Table 11.01 p. 404

Table 2 shows that Broadberry et al's GDP per head estimate continued to rise during the rapid population growth between 1470 and 1650 because of relatively rapid growth of industry and services. The estimate of agriculture grew more slowly than population. Broadberry et al state (p. 156):

> Industrial output finally began to revive during the closing decades of the fifteenth century, when a phase of sustained growth began which returned output to the level of the late thirteenth century by the 1550s and to more than double that level by the 1650s (Figure 4.01 and Table 4.03). Growth was particularly driven by coal and iron, although output of the relatively large wool-textiles industry also played a part. For industrial output before 1700,

They present data-based estimates for tin, iron, coal and an estimate of the woollen industry from their agricultural data. For iron and coal, data only begin in 1500 so they can provide no direct evidence for comparison with pre Black Death levels or the years of low and stable population between 1400 and 1500. Woollen cloth production, resting on their agricultural data, extends to earlier years. The rest of the sector's output is estimated on the bases of assumptions about output based on population and urbanization. These may be characterized as "if...then" numbers and cannot present direct evidence about per capita growth since they are based on assumptions about per capita growth. The main contribution of this paper is to reexamine the evidence for the key manufacturing industries – iron, coal and woollen cloth. This reassessment challenges Broadberry et al's conclusions.

Metal and mining

Broadberry et al divide the manufacturing sector into three sub-sectors – metal and mining, textiles and leather, and other industries. The metal and mining sub-sector contains three industries. Tin, with a series that begins in 1300, iron and coal both of which enter the calculations in 1500. Table 3 reproduces Broadberry et al's output figures for the three industries and an aggregate index for metal and mining. Glancing at the table (see particularly the entries before 1500 and for 1600s) reveals, disconcertingly, that the reported metal and mining index cannot be the weighted average of the three components.

The notes to Broadberry et al's Table 4.03 indicate the metal & mining index is "(d)rived from Table 4.02 using weights from Table 4.01". Unfortunately Table 4.01 does not provide clear weights for the aggregation but rather is a four page-long table indicating changing weights used to calculate industrial output after 1700. It appears to have been constructed to show how various series were incorporated into the post 1700 index while avoiding the distortion of over-weighting exceptionally

Table 3

Metal and Mining Industries 1270 to 1700
1700 = 100

	Broadberry et al				Index w/ Table 4.01 wts
	Tin	Iron	Coal	Metal & mining	
1270s	nd	nd	nd	nd	
1300s	25	nd	nd	16	
1350s	14	nd	nd	9	
1400s	47	nd	nd	30	
1450s	26	nd	nd	17	
1500s	43	9	8	26	11

1550s	51	36	27	40	33
1600s	42	124	50	46	84
1650s	19	108	77	47	88
1700	100	100	100	100	100

Source: Tin, Iron and Coal: Table 4.02 p. 138;
Metal & mining: Table 4.03 p. 139

fast growing sections (particularly cotton textiles) that Harley (1982) pointed out distorted Hoffmann's classic industrial output series. For 1700 – 1711, the weight of M&M in the industrial production index is 24.9% of made up coal, 11.4, Iron, steel and machine building, 11.8 and tin 1.7 indicating M&M index weights of Coal .46; Iron .47; Tin .07. I have added a final column to Table 3 with an index calculated using these weights. The calculated index shows extremely rapid growth between 1500 and 1600. Prior to 1500 it is difficult to see what can usefully be derived from the aggregate.

Tin

Tin was a small extractive industry (as its weight in the index indicates) located in a small area in Devon and Cornwall. The deposits in the English southwest were Europe's dominant source of the metal which was a vital input to the production of brass and pewter. Much of the tin was exported. The industry's concentrated location and its easily identified markets made it an obvious source for taxation. Consequently, tax generated records that have survived provide an index of the industry's output. The fact that much of the output, although a widely varying proportion, was exported presents a potential modest problem since as an indication of British industrial production domestically retained tin should be weighted more heavily than exported metal since domestic sales were further processed into brass and pewter. This, however, is clearly a minor issue given the much large output and greater uncertainty in iron and coal production.

Iron

For the iron industry, Broadberry et al draw on data from Peter King (2005). King provides estimates of production and consumption (including imports) of bar iron between 1490 and 1815. Unfortunately, Broadberry et al use King's data on British production of bar iron as their output series. Bar iron was not, however, the final product of the industry but an input into a wide variety of final products – nails, tools, horse shoes, metal fittings for a wide range of uses, military weapons and armour and a host of other goods. In the early sixteenth century, bar iron production in Britain experienced a fundamental technological change. The age-old bloomery production process of refining ore directly into bar iron was replaced by blast furnace production which produced pig iron that was subsequent conversion into bar iron in forges. This major technological changes led to the rapid expansion of bar iron production. King's (p. 13) documents a period of rapid growth "with iron production growing at 4.5 per cent per year from the 1540s to the 1580s". This expansion of primary iron was, of course, an important expansion of the iron industry. However, it is not an adequate index of the industry's output becayse prior to the domestic expansion of bar iron production from new blast furnaces, most bar iron was imported.

The converting bar iron into finished products added value approximately equal to the value of the bar iron input[2]. This would not be a problem for an index of the industry if the supply of bar iron were confined to British production, but it emphatically was not. As King documents (Figure 7 p. 21 and Table 2, p. 23) a very substantial portion of the increased British bar iron production displaced imported bar iron (primarily from the Basque region of Spain) which around 1500 provided nearly eighty per cent of the bar iron made into final goods by the British iron industry. Reassessing the iron index, therefore, requires a series that combines British bar iron production with British conversion of bar iron into final products. King provides the underlying data to produce that index with information

Table 4

Iron Production: Total and per capita, 1700=100

	Revised Bar Iron plus Processed Iron		King, Bar Iron made in England and Wales		Broadberry et al Table 4.02	
	Total	Per capita	Total	Per capita	Total	Per capita
1450	*3*	8				
1500	12	28	7	15	9	21
1550	25	42	31	51	36	60
1600	80	97	119	145	124	151
1650	84	82	117	114	108	105
1700	100	100	100	100	100	100

Source: see text. King (2005) Table 2, p. 23 and Broadberry et al, Table 4.02, p.138.

[2]This problem also exists for the seventeenth century when imported Swedish bar iron was replaced by British production. Harley (1982, p. 274) estimates that making bar iron into finished products roughly doubled its value. Strangely, Broadberry et al also used King's bar iron production series as their index of iron production in the post 1700 period (which is not analysed here) with the same problem.

on British bar iron production and British processing of bar iron that can be combined with equal weight. The resulting series is compared with the bar iron series in Table 4.

Iron production was, of course, widespread in Britain before 1500. W. R. Childs (EHR 1981) provides rough estimates of iron imports and domestic production for the mid 15th century that provides a useful, if uncertain, link to earlier in the era of low population. Imports were already important by the mid-fifteenth century and although records are spotty, they probably amounting to about 1,500 tons per year. The imports increased in the final decades of the century (Childs, 1981 Figures 1(b) and 2(b) pp.31-32). Domestic production of bar iron is even harder to estimate since it was often undertaken in small and dispersed locations, but may have been of the same order of magnitude and probably even higher before the increase of imports from Spain. Table 4 compares indices of iron output (1700 = 100) for the Broadberry et al index with a revised index in aggregate and per capita (using Broadberry et al's estimate of population) for 50 year intervals. Childs' approximate measure has been added for 1450 to provide a (weak) link to the earlier period. Including the conversion of bar iron into final products dramatically alters the perception of the industry's growth. It was impressively, about six and a half-fold, during the sixteenth century but dramatically less than the near fourteen-fold that Broadberry et al indicate.

Coal/fuel

Broadberry et al's estimate of coal production also only begin in 1500. although locally-mined, often on a small scale, coal was widely used long before that. Their estimate, based on Hatcher's history of the industry (Broadberry et al p. 142), although less secure than an annual index suggest cannot be seriously faulted. Hatcher only estimated output for the various coalfields in the 1560s and around 1700. It is appropriate to quote his introduction to Chapter 4 "Regional and National Trend"

> There was no British coal industry before 1700. Nothing which remotely resembled a national industry ever existed within our period. At best there was a series of regional

> industries, at worst a torrent of local, even individual, mining operations. (Hatcher 1993 p. 59)

He then spends over a page (67-68) pointing out the shortcomings of his estimates concluding "these estimates should be used only as the broadest of indications of dimensions". Broadberry et al create their annual coal series by interpolating from the two benchmarks

> using shipments of coal from north east ports also taken from Hatcher (1993, 487-95)...By 1700 the northeastern coalfield accounted for 50 to 60 percent of total English production, and 40 to 50 percent of total British production so that shipments from the northeastern ports can be taken as representative of the national cycle" (Broadberry et al p. 142).

Hatcher might have taken exception to this justification of interpolation given his repeated insistence that there were only local markets and not national ones. The North-east in 1700 was by far Britain's largest coal feild. However, Hatcher emphasizes the importance of transportation links on the evolution of various local coal fields and the Northeast's unique position relative to the populous but coal-free southeast of England with the rapidly growing London. Nonetheless, the interpolation is probably the best available. To quote Hatcher at length again (p. 69)

> The absence of precise quantification does not, however, obscure a broad symmetry in the patterns of change and development which are discernible across the sweep of British coal elds. From the widespread stirrings of mining in the thirteenth century to the surge of interest and investment experienced from the later sixteenth or early seventeenth centuries, there is a strong measure of conformity. The timing and pace of the advance varied, of course, not only between but within coal fields, for Britain in the early modern era consisted of a series of interdependent regional and local economies, rather than a national economy. Yet the broad trends of demographic and industrial development had ramifications in all parts of the country, not least upon the demand for coal and those who sought to meet it.

The fact that Broadberry et al's coal series is well devised does not, however, remove a more substantial concern regarding the role of the expansion of coal production played in sustaining per capita income during the sixteenth and seventeenth century population growth. Coal production certainly enhanced the per capita supply of thermal energy as population pressure rapidly reduced the per capita availability of traditional, mostly woodland, sources. However, Hatcher insists that the use of coal grew not by technical advance but by consumers adopting coal obtained in a traditional manner. Coal was, in fact, seen to be an inferior domestic heating fuel (Hatcher p.39 quotes contemporary references to 'horrible thick' smoke and 'virulent or arsenical vapours'). However, it was adopted as rising wood prices made it a cheaper heat source. The timing of coal adoption of varied widely depending of relative availability of wood and coal. The exceptionally extensive records of Cambridge and Oxford colleges illustrates this well. King's College, Cambridge, where local wood sources were scarce and access to northeastern coal was relatively easy via King's Lynn and the Cam, adopted coal in the final quarter of the sixteenth century (Hatcher, p.44). "[B]ut Oxford colleges, in a well-wooded region and a

Table 5

Annual energy consumption 1560s – 1700s

	per head						total	
	megajoules			Index 1700 =100			Index1700=100	
	Fire wood	Coal	Wood + coal	Fire wood	Coal	Wood + coal	Wood + coal	Broad-berry et al Coal
1560-9	6324	2039	8363	161	14	45	27	27
1600-9	4729	3153	7882	120	21	42	35	50
1650-9	3849	6772	10621	98	46	57	59	77
1700-9	3939	14719	18658	100	100	100	100	100

Source: Wrigley 2016 Table 3.2 p. 34; Broadberry et al Table 4.02,
Note: Wrigley's 1560-9 coal corresponds with Hatcher Table 4..1

difficult and costly journey by land and water from London or overland from inland collieries in Warwickshire and Staffordshire, relied solely upon wood and charcoal for their firing right through to the 1650s, and in some cases far later still." (Hatcher p. 59).

Appropriate accounting of growth needs to be based on final consumption. In this case the final good is not coal but heat or fuel. Therefore the decline in wood use per capita as well as the increase in coal should be combined. Tony Wrigley (2016 Table 3.2 p. 34) provides a basis for such a calculation. Table 6 below reproduces his estimate of annual energy consumption per head of wood and coal before 1700. Hatcher demonstrates the approximate equality of cost of coal and wood at the margin, so the sum of the energy from the two sources provides an index of heat energy per capita. The result is radically different story from that of coal alone. Certainly coal's role in off-setting the decline in firewood per head was impressive and hinted at its future role. During the population increase between the mid sixteenth century and the mid seventeenth century coal production per head increased more than three-fold and contributed importantly to aggregate output but heat energy and its contribution to income per head increase by only a quarter. Its contribution was likely less than in first half of the sixteenth century when population was only about two thirds its mid-century level.

Revised Metals and Mining Index

Table 6 compares revised estimates for the metal and mining sector with Broadberry et al's index. Because of the obvious inconsistency between Broadberry et al's indices of individual industries in their Table 4.02 and the index of the sub-sector in Table 4.03, I have not included the Table 4.03 index but a recalculation of the index with appropriate Table 4.01 weights for comparison with two revised indices. The first shows the impact of the revised output series for iron and coal on an aggregate index. The second, which I think is the more appropriate, also includes the effect of substituting an index of fuel output for the coal output index. The per capita calculations make it easier to see the effects of the data changes on aggregate output per person.

Table 6

Revised Metal and Mining sub category 1500s – 1700 (1700=100)

	Tin	Iron revised	Coal	"Fuel"	Metal and Mining revised: With Iron & coal	Metal and Mining revised: W/ rev. Iron & "Fuel"	Broadberry et al Metal and Mining (my aggregation)
1500s	43	12		19		*18*	11
1550s	51	25	8	27	19	28	33
1600s	42	80	18	35	49	56	84
1650s	19	84	47	59	63	68	88
1700	100	100	100	100	100	100	100
per capita							
1500s	100	28		*45*		*41*	25
1550s	85	42	14	45	32	46	55
1600s	51	97	21	42	59	69	103
1650s	18	82	46	57	61	66	85
1700	100	100	100	100	100	100	10

Sources: See text.
Notes: Coal and "Fuel" (Wood + coal) from Table 5. "Fuel" for 1500 is estimated to yield the same level of per capita fuel as 1550. Broadberry et al my aggregate from Table 3

<u>Textile and Leather</u>

Textiles and Leather, Broadberry et al's second data-based industrial sector before 1700. It consists of woollen cloth and leather goods. Their estimates of the output of both these are derived from their agricultural output estimates.

Woollen cloth

Woollen cloth is the third major industry that Broadberry et al see contributing to growth of per capita output after 1500 despite rapidly increasing population. They estimated woollen cloth production, quite reasonably, as follows (p. 144-5):

It can be presumed that unexported wool was spun and woven into cloth for the domestic market. Total production of raw wool from domestic agriculture is estimated in Chapter 3. Since the scale of manufacturing output was in large measure a function of the supply of wool, production estimates of textile output can therefore be inferred from output estimates of this key agricultural raw material, net of exports.

John Oldland has recently published a substantial volume assessing the English woollen industry from the thirteenth century to the mid sixteenth century (Oldland 2019) and provides significantly different estimates of woollen production (and also sheep numbers and raw wool). His new numbers appear in his Table 1 for 1391-5 and fifty year intervals to 1590 (much of this material appeared earlier in Oldland (2014) which Broadberry et al used to estimate fleece weights but otherwise ignored). Data for 14991 are not in 2019 volume but appear in Oldland (2014)). Table 7 compare Broadberry et al's estimate of woollen cloth with that of Oldland (the two series differ slightly

Table 7
Woollen cloth, Broadberry et al and Oldland, total and per capita
(1700 = 100)

	Oldland Woollen cloth		Broadberry et al Woollen cloth	
	Total	per capita	Total	per capita
1300s	16	18	20	22
1350s			32	63
1400s	17	43	24	60
1450s	23	63	24	65
1500s	33	76	23	54
1550s	51	85	34	57
1600s	68	83	68	83
1700	100	100	100	100

Source: See text

in date: Oldland data for the 1311 are entered as 1300s and others at the nearest half century. Oldland data has been converted to an index on 1700 by setting his 1590 index to equal Broadberry et al's 1600s value of 68).

Here, as in the iron and coal, revised data indicate higher levels of output prior to the beginning of population growth in the sixteenth century relative levels during the years of rapid population growth. Broadberry et al's estimate of woollen cloth rises sharply in the early fourteenth century then falling back in the following half-century and stagnates until the sixteenth century when estimated output grows by nearly half in the first half of the century and then doubles in the second half. In contrast, Oldland's estimates indicate cloth output starting the fourteenth century at a lower level and remained basically unchanged for the rest of the century. Then growing by more than a third in the first half of the fifteenth century and slightly more (over forty per cent) in the second half. This rate of growth accelerates slightly (to just over fifty per cent) in the first half of the sixteenth century before declining somewhat (to a third) in the second half. The contrast between the two series is more apparent in a comparison of growth of output per capita in the two distinct demographic periods. From 1400 to 1500, Oldland estimates that per capita output increased by nearly eighty per cent while Broadberry et al estimate a decline of over ten per cent. Then in the period of renewed demographic pressure from 1500 to 1600 (unfortunately, Oldland's data does not extend into the seventeenth century), Oldland sees the growth of the woollen cloth industry slowing, in per capita terms, to an increase of less than ten per cent while Broadberry et al see it growing by more than half.

Leather

Leather is the other industry in the textile and leather sub-category. The industry's output is provided by the index of hides from the agricultural data. This index, in both its total output and per capital output, is shown in Table 8 (I have made no adjustments to reflect Oldland's different sheep

Table 8

Leather and the Textile and Leather sub sector
(1700 = 100)

	Leather total	Leather per capita	Woollen cloth (revised)	Textile and Leather sub category	Broadberry et al Textiles and leather Table 4.03
1300s	55	61	16	30	32
1350s	55	108			40
1400s	47	118	17	28	32
1450s	49	132	23	27	33
1500s	48	112	33	33	32
1550s	56	93	51	53	42
1600s	74	90	68	70	70
1650s	78	76			65
1700s	100	100	100	100	100

Source: See text. Broadberry et al Table 4.02 p. 138 and 4.03 p 139.
Notes: Broadberry Table 4.03 corresponds to aggregation of Table 4.02

population) along with my calculations for the textile and leather sub-category (aggregated with weights calculated from Tables 4.01 and 4.02: woollens .64, leather .36).

The use of hides from agricultural data to indicate the size of the leather industry seems unconvincing although I cannot offer an alternative way of proceeding. Hides, of course, are the basic input to leather production but farmers did not raise animals for their hides. Consequently, an estimate of hides available is probably a flawed measure of leather output particularly when the ratio of animals to people changed radically (see per capita leather figures in Table 8). Just as Hatcher points out for coal, output of leather was unlikely to have been constrained by the availability of the input but by the strength of demand. Transforming hides into leather was a particularly unpleasant task and its extent was almost certainly not predicated on the supply of hides, which an agricultural by-product. The per capita demand for leather likely was higher with higher income during the fifteenth century. Direct evidence does not exist, but I do not believe that per capita consumption of leather can have fluctuated to the extent or so differently than the consumption of woollens as Table 11 seens to indicate.

<u>Agricultural output</u>

I have little to say directly about the agricultural series. I admire the research reported here and have not attempted to revise Broadberry et al's estimates except to consider the effect of Oldland's reconsideration of the woollen industry. This estimates has a substantial effect on the agricultural index because mutton and wool constituted about between a quarter and a third of the late medieval agricultural index (Table 3.17, pp. 115).

A few "osteological" remarks about the overall agricultural data are appropriate, however, in a considering Broadberry et al's index of agriculture between from 1270 to 1700. The medieval data are truly exceptional and provide the most complete archival information available before at least the eighteenth century. From the beginning of the fourteenth century to the beginning of the fifteenth century there are over 50 manorial management accounts for each year (Figure 3.01, p. 81). Individual manor accounts survive over substantial runs of years and provide the basis for meaningful estimates of short-term movements, which are impossible with most of the rest of the data. In fact, the demesne data probably provide a more reliable basis for the estimation of short-term volatility than for long-term comparisons that are the volume's goal. The reliable short-term data in these records must lie behind the authors' decision to produce annual estimates for the entire six centuries despite the fact that once the manorial demesne run out in the late fifteenth century, their data sources are far too fragmentary to estimate meaningful short-term fluctuations until at least the eighteenth century and even then annual estimates are suspect. The number of manorial accounts declines rapidly in the fifteenth century to fewer than ten manors per year by mid-century and end in the 1490s. There is then a period of seventy years without any primary agricultural data until probate records provides information on about five farms each year through the seventeenth century (figure 3.01, p. 81). Unfortunately, these farms each provide only a single observation each so time series inference is indirect rather that direct as in the manorial accounts.

The discontinuity in the agricultural data is unfortunate. There is no overlap between the series that can be used to check on comparability and the data are unavailable for the very years when the long period of low and stable population give way to rapid population growth. However, they link two data series with the assumption that data on the output per acre of various crops is comparable between the two distinct sources and farming regimes. This seems a not unreasonable approach. However, glancing at the crop yield figures (Table 4.06 p. 97), it is striking that the yield per acre of wheat from the earliest probate returns in the 1550s is nearly double that in the last manorial yields in the 1450s (9.99 bu per acre vs 5.00). (Yields of other crops change much less with rye yields falling by twenty percent, barley increasing by seven percent, Oats increasing by nearly twenty percent and pulses by increasing by a little more than fifty percent.) Given importance of increasing wheat yields in calculation agricultural output growth (wheat constitutes a third of agricultural output and fifty seven percent of arable output at current prices in the 1550s (Table 3.17 p. 116)) it is unfortunate that it do not merit more discussion.

The data for the livestock sector is considerably less robust than that for the arable. Broadberry et al note (p. 100): “Calculating the output of the livestock sector is more speculative than equivalent calculations for the arable sector, since meat, milk and even wool yields have all attracted less attention from historians than crop yields, despite the wealth of information in manorial accounts.” Furthermore, the great majority of the livestock in the medieval period was held not by the demesne sector but by the peasant sector about which there is no direct evidence. Broadberry et al proceed with reasonable assumptions to estimate relevant totals from the manorial data but there is a considerable degree of uncertainty here. These are “if...then” statements rather than direct evidence. As I have already noted, new information on woollen cloth production considerably alters livestock estimates and will provide detailed adjustments below.

Extending demesne evidence to total output also has potential further issues. The large, mainly ecclesiastical, land owners whose demesne management documents provide the amazing evidence about medieval agriculture made up only a small part of the agricultural sector. The demesne sector cultivated about a quarter of the sown acreage in the late thirteenth century and that proportion decline until it had disappeared by the end of the fifteenth century (Table 3.01, p. 83). The large estates which provided the documentation were a modest portion of the demesne sector. Broadberry et al justify their use the yield data for the managerial demesne to estimate output for the entire agricultural sector (p. 83):

> Seigniorial and non-seigniorial producers faced the same environmental conditions and commercial opportunities and employed a common technology. There was also much overlap between their labour-forces. Hence, where peasants led, lords were likely to follow and vice versa (Campbell, 2000: 1). Nevertheless, there were important differences in their respective scales of production, capital resources, consumption priorities, vulnerabilities to risks and hazards and methods of decision-making.

John Hatcher (Hatcher, 2024) has recently challenged this assertion emphasizing the importance of the "nevertheless" sentence above. He provides some data and more extensive argument that the differences in scale, objectives and incentives led to considerable higher yields per acre on peasant land than on the market-orientated large estate demesnes. A further challenge in estimating agricultural output arises because while the documents provide good evidence on yields per acre they do not provide evidence on the nationwide acreage to which it should be applied. Broadberry et al spend a good deal of effort on estimating acreage (Chapter 2). Their procedure, broadly speaking, is to extrapolate from land-use data that is available in the nineteenth century and the physical characteristics of the land to estimate agricultural land in use at various dates. Greg Clark (2018) has challenged their land use estimates and claims they are seriously too low for the medieval period. He provides alternative estimates of harvested land basised on harvest labour available. These eliminate the discrepancy between wages and output. Broadberry et al (2018) defend their position in an article entitled "Clark's Malthus delusion". Here I have accepted Broadberry et al's agricultural estimates except where new data on the woollen industry indicates changes in sheep numbers and wool output.

Implications of woollen data for agricultural output

Table 9

Sheep, Wool and Mutton (1700 = 100)

Broadberry et al and Oldland

	Sheep		Wool		Mutton	
	Broadberry	Oldland	Broadberry	Oldland	Broadberry	Oldland
c 1300	91	79	53	53	43	37
c 1400	65	77	39	39	35	42
c 1450	68	68	34	38	40	40
c 1500		74		49		
c 1550	55	86	36	73	37	58
c 1600	96	91	72	89	74	70
c 1700	100	100	100	100	100	100

notes: Indices use Broadberrry et al's 1700 values for Oldland's series. values for 1500 missing due break in Broadberry et al's underlying data

Oldland's revisions have considerable effect on estimates of agricultural output since the 1700 base estimate for the agricultural series assigns wool a weight of 6.1% and mutton a weight of 16.4%

Table 10

Broadberry et al Agricultural Output Index (1700 = 100)

	Calculated from Tables 3.07 & 3.15			Calculated from Table 3.16			Appendix 5.3 Agriculture
	Arable	Live-stock	Total	Arable	Live-stock	Total	
1270s	69	50	61	69	56	61	66
1300s	69	57	64	72	63	66	71
1350s	40	56	47	(1340s) 67	62	62	55
1400s	37	44	40	40	48	42	45
1450s	31	45	37	33	49	39	42
1500s				(1470s) 31	49	38	50
1550s	51	58	54	55	56	54	58
1600s	70	80	74	75	81	76	82
1650s	91	80	87	89	79	85	91
1700s	100	100	100	100	100	100	100

Sources: See text

(1700s shares in Table 3.17 p. 117)[3].

As I have noted, Oldland's estimate of the sheep population differs from that of Broadberry et al. Table 9 lays out estimates of sheep and wool and a revised output of mutton following Oldand by adjusting Broadberry et al's estimate in proportion to the estimates of sheep population. It should hardly be surprising that the differences between series resemble the differences in their 1550 and 1600

[3]This introduces the issue of whether wool has been double counted in the output estimates. This is primarily an issue of the weighting of the woollen industry. If the weight is based on value added there is not an issue. This also raises the question of what woollen output is representing. The final output is clothing and other final uses of cloth and probably should be included in the weight of the woollen industry. This, in turn, raises an additional issue: shouldn't exported cloth and domestically consumed cloth be treated differently? These, however, are issues beyond the aims of this paper.

estimates of livestock productions. The revised index declines by eight percent while the Broadberry et al based index is basically unchanged.

Table 11

Revised Agricultural Output

	After Oldland			Broadberry et al Table 9 aggregate from Tables 307 & 3.15		
	Live-stock	Agriculture		Live-stock	Agriculture	
			per capita			per capita
1300s	53	62	69	57	64	71
1400s	47	41	103	44	40	100
1450s	46	37	100	45	37	99
1550s	71	59	99	58	54	90
1600s	81	74	91	80	74	90
1700s	100	100	100	100	100	100

Sources: See text. Broadberry et al Agriculture T. 3.07 & 3.15

The modifications to wool and mutton output imply considerable differences in agricultural output. I have calculated an aggregate index and its sub-aggregates for agricultural output at 50 year intervals. Broadberry et al do not report sub-indices for arable and livestock. However, Table 3.07 lists net output of various arable crops and Table 3.15 lists the output of the livestock sector. I have aggregated these into 1700 based indices using the current price shares of major outputs for 1700 in Broadberry et al's Table 3.17 as weights. For comparison it is possible to recover Broadberry et al's sub-indices from "Table 3.16 Annual real agricultural output growth, 1270s–1860s (constant 1700 prices)". These results are all reported in Table 10. Unfortunately, these indices differs and both differ considerably from the figures for Agriculture in Appendix 5.3.

For comparison, I have calculated a index, like the one reported above based on Table 3.17 wieghts, incorporating Oldland's revions for the livestock sub-sector. These results, along with the index calculated in the same manner using Broadberry et al's numbers are reported in Table 11. The difference between the two indices is most striking between 1450 and 1550 (the absence of data from Broadberry et al for 1500 is unfortunates here) where the per capita index constructed from Broadberry et al's data declines by ten percent, the revised index is basically unchanged and between 1550 and 1600 where the revised index declines by eight percent while the Broadberry et al based index is basically unchanged.

<u>Other Industries and Services</u>

In my assessment of the effects of the revised estimates of coal, fuel and woollen cloth, I have compiled national income estimates with, what I can judge, are approximately the weights used by Broadberry et al's and have accepted their estimates for the final manufacturing sub-category – other industries – and their service sectors as they present them. Nonetheless, most of the entries in these sectors require some discussion. Only a small portion of these estimates (Book Publishing, Goverment, International Trade and Transport and Finance) rest on direct evidence. The remaining (88 per cent of the weights in the 1700 weights in Table 16 below) industry outputs are estimated from assumptions related to population and/or urban population.

Other Industries

Other industries consist primarily of foodstuffs and building although it also includes, after 1500, an estimate of book publishing.

In their notes to Figure 4.04 Broadberry et al state:

Before 1700 food processing is assumed to grow in line with the agricultural output index from Chapter 3; building: assumed to grow in line with urban population.

However the foodstuffs industry the numbers Table 4.02 bare no resemblance to the agricultural output reported in Appendix 5.3 or those calculated above. Hints in the text and the procedure they employ to estimate domestic trade and transport in services suggest that the foodstuffs industry is agricultural output multiplied by the share of population in towns over 10,000 presented in Table 4.04 (p. 153). Table 12 explores that possibility and yields results that are much closer to Broadberry et al's calculations but by no means duplicate them (the other estimates of agricultural output in Tables 10 and 11 do not change the calculation substantially). This series, along with Broadberry et al's estimates for building as well as their estimate for domestic trade and transport in their service sector, is overwhelmingly determined by urbanization. It is worth noting that the urbanization index is the proportion of the population in towns over 10,000 populations. Before 1700 that would have been overwhelmingly the population of London plus perhaps three of four provincial cities.

Table 12

Foodstuffs, various estimates
(Agricultural output is weighted by urbanization)

	Foodstuffs B et al T4.02	Urbanization % B et al T4.04	Agriculture B et al App 5.3	Foodstuffs calculated estimate
1450s	4	*0.24*	42	7
1500s	6	0.26	41	9
1550s	10	0.27	58	11
1600s	31	0.45	82	27
1650s	66	0.67	91	41
1700	100	1.38	100	100

Source: See text

. Broadberry et al's use of urban population to estimate of the significant sectors of foodstuffs and domestic trade and transportation also raises an additional substantive issue. Presumably they chose to use urban population because they see these sectors growing as a result of changes in economic structure created by specialization and urbanization. This, however, may involve an inappropriate counting costs generated by the changing economic structure as expansions of output. A simple thought experiment demonstrates the problem. Consider two economies that provide consumers (for simplicity the economies only consume) with exactly the same amount of various goods but produce those goods with quite radically different economic structures. The first is a "pre-modern" economy with little resource pressure where output is locally produced and consumed without entering the market or with only local exchange. The second is a "modern" (or "Smithian") economy in which economies of specialization and scale offset resource pressure and in the process required urbanization and considerable internal trade. In this example, the "Smithian" economy overcame resource scarcity with cost savings in commodity production but in the process incurred costs involved in commercialization of some household goods and in the trade and transportation that specialization required. The income of the two economies are, by construction, equal; they produce exactly the same output for their members (consumers). However, if we included distribution costs of the specialized economy in addition to final commodity when calculating national income we would find its aggregate income larger by the amount of those distribution costs.

The index of building activity in the other manufactures sub-secton indexes output to the level of urban population and has a different problem. Certainly not all building occurred in large towns and cities. If instead of an "if..then" index of building activity based on urban population, we supposed (perhaps unrealistically given the poor accommodations most Londoners lived in by the eighteenth century) that urban areas generated twice the building per resident we get a very different estimate of

Table 13

Building, alternative assumption

	Urban Population	Total population; urban double weight
1500	11	39
1550	16	53
1600	36	74
1650	69	98
1700	100	100

Source: Broadberry et al Table 4.04, p. 153

building activity (Table 13). Instead of building activity more than tripling in the sixteenth century and nearly tripling in the seventeenth, we get a little less than a doubling in the sixteenth century and an increase of just over a third in the seventeenth.

Services

As I have said, I have not carried out detailed revision of Broadberry et al's estimates for the service sector except for domestic trade and transport where the new estimates of iron, fuel and woollens change the results. I do, nonetheless, have broad reservations. As already noted many of the estimates are based on population and/or urban population which assumes rather than provides evidence on how the economy evolved. In addition, the problem of counting output required by the structural change in the economy are relevant in several places.

I have reproduced Broadberry et al's indices of the service sector and its components in Table 14. Housing and domestic services make up nearly half the index (its 1700 weight is .466. Table 4.06, p. 162) but index of the output of the sector is constructed on the assumption of constant per capita output (p. 174). The second largest sector is domestic trade and transport (1700 weight, .215) which is the fastest growing service sector after 1500. Broadberry et al present no direct evidence for the sector instead their estimate is the sum of agricultural and industrial output weighted by urban population.

Table 14

Broadberry et al Service Sector Output by sub-sectors,(1700 = 100)

	Government	Trade and transport		Finance	Housing &	Total Services	
		Overseas	Domestic		domestic	Calculated	Ap 5.3
1300s	8	13	3	77	91	46	42
1350s	14	12	3	48	51	30	27
1400s	12	12	3	36	40	24	22
1450s	8	13	2	33	37	21	20
1500s	14	22	3	39	43	27	25
1550s	14	20	6	28	60	34	31
1600s	14	33	22	47	82	49	45
1650s	40	58	49	101	103	77	70
1700	100	100	100	100	100	100	100

Source: Broadberry et al Table 4.07 p. 164 and Appendix 5.3

The sector's output increases over sixteen-fold between 1550 and 1700 while the rest of services increased less than three-fold. In per capita terms, it increased nine-fold while the other components increase by only one-third (Table 15).

Table 15

Service Sector, Broadberry et al
Emphasizing role of domestic trade estimate 1550s - 1700

	Aggregate			per capita		
	Overall	Domestic trade and Transport	Index w/o domestic trade	Overall	Domestic trade and transport	Index w/o domestic trade
1550s	34	6	43	57	11	72
1600s	49	22	59	53	24	64
1650s	77	49	84	75	47	81
1700	100	100	100	100	100	100

I have already discussed problems with this sector whose estimated output is based mainly on the growth of London in my discussion of Broadberry et al's Other Industries. The modification to agricultural and industrial output discussed previously effects this index but are very minor compared to the impact of urban population. Consequently I have used Broadberry et al's indices of service sector industries unchanged in my national income estimates.

Aggregate Output Growth

Table 16

1700 Weights Used in Aggregation

Major Sector	Industry	Weight in GDP		
Agriculture (sub sector weights B et al Table 3.17)				.267
Industry				.413
Metal and Mining			.103	
	Tin	.007		
	Iron	.048		
	Coal (fuel)	.047		
Textiles and Leather			.171	
	Woollens	.109		
	Leather	.062		
Other			.139	
	Foodstuffs	.111		
	Building	.028		
Services				.320
	Government	.052		
	International Trade	.034		
	Domestic Trade	.069		
	Finance	.016		
	Housing & dom. service	.149		

Source: see text

At last, it is possible to assess the affect how modifications of estimates of on iron, coal and woollen altered the estimate national income before 1700. At several points in my investigation I have not been able to derive Broadberry et al's aggregates from their industry level data, as a result, I have constructed revised estimates of gross domestic income from the underlying data on the five arable and seven livestock products in Broadberry et al's Table 3.17 using the 1700s price shares listed there for agriculture. The weights used for the seven industrial sectors and the five service sectors are listed in Table 16. I have compared aggregates using these weights with Broadberry et all's data and similar aggregates with the revisions for iron, fuel, woollen cloth and the implications of Oldland's wool and sheep estimates presented above and using Broadberry et al's series otherwise. I have not made any independent attempt to calculate or evaluate these weights but I have calculated as best I could reasonable approximate Broadberry et al's weighting. Unfortunately, Broadberry et al's do not provide much discussion of their weighting scheme. Complete reassessment of their income estimates would require a critical consideration of weights used but such a task is beyond the scope of this paper.

Since I have been concentrating of revisions of iron, fuel and woollen cloth, the first aggregate I want to present of those three industries between 1500 and 1700 (see Table 17). Not surprisingly, the revised index grows much more slowly than Broadberry et al's between 1500 and 1600 where in per capita terms it grows about a third while Broadberry et al's estimate grows nearly two and a half fold.

There has been an implicit osteological theme running through this paper of examining the "bones" of the evidence. A key point that emerges is that the evidence can be sorted into sectors for which there seems to be reasonable direct evidence and those whose output has been estimated on preconceptions about the role of population and urbanization. Table 18 divides the data using my revised data and Broadberry et al's that manner and compares aggregates by sector and in GDP.

Table 17

Aggregation of Revised Manufacturing (iron, coal (fuel) and woollen)

	Iron		Coal (fuel)		Woollen		Aggregate 1700=100		Per capita Aggregate	
	Rev	B et al	Rev	B et al	Rev	B et al	Revised	B. et al	Revised	B. et al
1500s	12	9	19	8	33	23	25	16	58	38
1550s	25	36	27	27	51	34	39	33	66	55
1600s	80	124	35	50	68	68	63	77	77	94
1650s	84	108	59	77	57	57	64	74	62	71
1700	100	100	100	100	100	100	100	100	100	100

Source: See text.

The contrast between the revised and Broadberry et al's estimate is reduced when other components of national income are included into the calculations. This, of course, is inevitable since agriculture, iron, fuel and woollens make up only forty eight percent of the weight in the national income index, and the other sectors are assumed to be the same in both calculations. Nonetheless, while Broadberry et al's estimated national income grows seventeen percent between 1550 and 1600 the revised estimate grows only three percent.

It should be apparent that I regard the overall aggregate estimates of gross national product presented in Table 18 above, including my revised estimate, to be highly tentative given the poor quality of the supporting data at many points. Since, however, we are looking at gross national product estimates of the strength of fairy tale straw houses that would stand up to a passing wolf, I would like to suggest another alternative estimare. As must be apparent, I am highly skeptical of the estimates of sector output that rely on urban population. It seems to me that better estimate (but definitely still a straw house) of the growth of output in these sectors would be to assume constant per capita

Table 18

National Income, by Sectors and Evidence

A. Revised data

	Agriculture	Industry		Services		Aggregate		
		Tin, iron, fuel, woollen	Rest	Gov, for. trade, finance	Rest	Data driven	Rest	Total
1550s	59	40	25	18	45	45	35	41
1600s	74	62	45	26	65	61	55	59
1650s	87	62	70	56	70	72	70	71
1700	100	100	100	100	100	100	100	100
Broadberry et al								
1550s	54	33	25	18	45	40	35	38
1600s	74	77	45	26	65	67	55	62
1650s	87	74	70	56	70	76	70	74
1700	100	100	100	100	100	100	100	100

consumption in these sectors. I have performed that calculation (reported as Revised 2 in Table 19) with my revisions driven by iron, fuel and woollens and compared it with the gross national product estimates in Table 19 (thankfully my last). This final speculation on national income has per capita income higher throughout, declining slightly from the 1550s to the 1600s and more sharply in the next half century. The three aggregations are reported in Table 19 with my final speculation labled "Revision 2." Of these altermatives I find this final aggregation to one to most likely approximate the true course of national income. It is also shows the least growth between the mid sixteenth century and 1700 with a slight decline per capita income in the late sixteenth century in contrast to Brodberry et al's estimate that increases seventeen percent increase. All the indixes then a decline quite sharply in the early seventeenth century.

Table 19

Speculative GDP (straw house) estimates compared

	Agregate GDP			Per capita GDP		
	Broadberry et al	Revised Table 18	Revised 2	Broadberry et al	Revised Table 18	Revised 2
1550s	38	41	44	88	95	102
1600s	62	59	61	103	98	101
1650s	74	71	76	90	87	93
1700	100	100	100	100	100	100

Source: See text

Conclusion

This paper has demonstrated that the estimations of growth of iron, fuel and woollen cloth that Broadberry et al relied on to calculate substantial growth in per capita income in the sixteenth century are seriously flawed. It they are replaced by better estimates based on available assessments of the relevant industries, per capita growth int he sixteenth century disappear

Examining the details of Broadbery et al's estimates reveal that they rest on narrow data supports. Prior to 1500, their data is virtually entirely Bruce Campbell's finding regarding the agricultural data within the demesne records. Agricultural data does not exist for the crucial years at the end of the fifteenth century and the beginning of the sixteenth century when the demographic regime shifted. Comparisons between the low pressure demographics of the fifteenth century and the more pressured sixteenth rest on the assumption that crop yields on managerial ecclesiastical demesnes are comparable to the yields Mark Overton finds early modern yeoman farms.

Finally, the majority of weight of non-agricultural sectors (57 per cent) in their calculations are depend on inferences from population and/or urbanization rather than direct evidence regarding the industries in question. There is little direct evidence beyond that relating to iron, coal and woollen cloth that has been disputed here. It seems clear that little confidence can be places on national income estimates calculated in this manner. This is even more the case if these estimates are to be taken seriously as providing estimates of national income on an annual basis.