LAND RENTAL VALUES AND THE AGRARIAN ECONOMY: ENGLAND AND WALES, 1500-1912

Gregory Clark, University of California, Davis, CA 95616 (gclark@ucdavis.edu)

February, 2001

I use the rents and prices of land held by charities in England and Wales to estimate statistically the nominal and real rental value of farmland from 1500 to 1912. Real land rental values increased fourfold between 1500 and 1912. Combining these estimates with farm wages and rates of return I calculate agricultural output from factor payments, as well as output per worker, from 1500 to 1912. Finally the productivity of agriculture is calculated. These new series suggest that measured agricultural productivity doubled between 1500-39 and 1860-69. But the productivity growth was fairly evenly spread over this long period, and was much less in the years 1760 to 1860 than standard accounts of the Industrial Revolution such as Crafts (1985) assume. Thus these estimates imply a substantial reduction in estimates of output growth in England in the Industrial Revolution era. Further the rate of productivity growth in England in the years 1500-1789 is no greater than the growth rates Philip Hoffman finds for the Paris Basin. Finally, contrary to expectation, the source of productivity growth before 1869 is overwhelmingly growing yields as opposed to growth of labor productivity.

Introduction

The rental value of farmland in England in the years 1500 to 1914 is not just a matter of antiquarian interest. For this value is the key to understanding when productivity growth took place in English agriculture in the years 1500 to 1914. In combination with information on wages, capital returns and product prices we can use rents to measure agricultural progress. This paper employs a statistical method to measure farmland rental values which is explained and tested below. Using the derived rental values the implications of the new rent series, in combination with series on wages, returns on capital and prices, for the agrarian history of England is then explored.

Determining the rental value of farmland is not easy, since in early years much farmland was not rented for its current rental value. Instead land was held on a bewildering variety of tenures – customary leases well below market values, leases for lives where the current rent has little relation to current market conditions, renewable leases with low annual rents but large entry fines and so on. This paper seeks to abstract from the real conditions of tenures to estimate for the years 1500 to 1912 what land in general would rent for if offered for rent in a free market. Estimates are derived for land of constant characteristics for four regions in England and for Wales. To adjust to actual rental values allowance is made for the extent of common land in each period. The series is then compared to existing rent series. It proves to be similar to some, but to diverge sharply from the recent series offered by Turner, Beckett and Afton (1997).

Sources

The source of rental values for this paper is land held by charitable trusts. Here I give a brief description of the sources. A much more detailed analysis is given in Clark (1998a). Over the course of the eighteenth and nineteenth centuries the British Parliament conducted a number of investigations of the activities of charities which documented the known history of the land they held, and its current rental value. The earliest set of reports, the Gilbert Returns, show the

responses to a request sent to local parishes for information on the current incomes of charities in 1786. This was followed by the mammoth Charity Commission or Brougham Commission of 1818-1837. This inquiry published 32 reports containing 26,987 pages, which give not just the current state of charity assets, but also often a history of how and when the land was acquired. The 28,880 endowments for charity reported on held 442,915 acres of land, nearly 2% of all farmland.

A permanent Charity Commission was established in 1853. This published a digest of the current income from land and securities of all charities in the years 1868 to 1875. It also issued annual reports, which contain some information about the property of charities whose affairs were brought to the attention of the commission. In 1884 the Commission issued a report on the City of London Livery Companies which gave details of the current leases of their property, and the state of the property circa 1860. Finally in 1889 the Commission launched a parish by parish update of the Brougham Commission inquiry. This new inquiry lasted till 1913, but succeeded in covering only Berkshire, Devon, Durham, Lancashire, London, Wiltshire, and the West Riding of Yorkshire in England and about half of Wales. These later inquiries often contain information about land values and returns on capital even in the years before 1837. Thus the charity inquiries can give information on the value of land before 1786, in 1786, in the years 1818-37, in the years 1862-75, and in the years 1889-1912.

In addition to the various Charity Commission sources, the rent of this charity land is sometimes recorded in other sources. The reports on the Charities for Elementary Education printed in the Parliamentary Papers in 1906 and 1908 give the current rents of land held by charity schools in Cornwall, Kent, Northampton and Stafford. The volumes of the Victoria County Histories devoted to individual parishes give details of the current rents of charity lands, or of the

sale year and price at sale. Those counties where at least some of the parish volumes were completed before 1914 thus give information on current land rents in the years 1905-1914.

The problem with the 1786 Gilbert Returns, the 1860s Digest, the reports of the Charities for Elementary Education, and the Victoria County Histories is that they give only the current rental value of land, which may have been leased some time before. But the two sets of detailed Charity Commission reports confirm that in the course of the nineteenth century there was a large-scale move towards shorter leases of charity lands. Thus in the years 1818 to 1829 65 percent of land was on yearly leases, but by the 1890s this had increased to 85 percent. Consequently for the later nineteenth century the current rent of land will generally indicate the current market rental value of the land.

From these reports I have extracted a subset of observations where an estimate of the rental value of land can be made from the rent on a newly formed lease, or the price of land at purchase, or the current rental value, or just the current rent paid where there are indications this rent was effectively paid on a yearly tenancy without any formal lease. These observations on the rental values of charity land have been formed into a data set containing 32,202 observations on 19,475 land holdings. Many pieces of land are observed more than once. The location by parish of most of the plots is given, as is the land area. There is also a variety of information on the physical characteristics of the land available for many of the plots: land use, associated farm buildings, enclosure status, enclosure history, land tax status, tithe status.

Table 1 shows the information available on plots observed more than once with at least 5 acres per house, in total and by five major regions. There are 19,696 such linked observations drawn from 7,236 farms and plots of land, of which 7,733 observations are of plots or farms of 20 acres or more. The average plot size is 47.8 acres in this sample of linked observations. This

Table 1: Linked Observations on Land Rental Values by Decade

Period	All	All holdings 20+ acres	North	Midlands	South East	South West	Wales
1500-39	25	16	-	8	14	3	-
1540-59	35	22	4	18	9	4	-
1560-79	27	18	-	11	14	2	-
1580-99	45	22	3	6	31	5	-
1600-09	34	19	2	13	14	4	1
1610-19	77	35	11	19	36	9	2
1620-29	120	56	7	30	60	22	1
1630-39	114	56	17	29	35	31	2
1640-49	91	47	7	20	43	20	1
1650-59	123	57	15	42	37	24	5
1660-69	92	38	16	24	29	22	1
1670-79	171	73	34	46	56	30	5
1680-89	185	61	24	71	34	52	4
1690-99	211	91	31	58	55	61	6
1700-09	205	101	29	63	64	45	4
1710-19	235	108	44	65	59	66	1
1720-29	288	132	47	93	59	79	10
1730-39	320	125	63	117	65	61	14
1740-49	250	86	59	68	43	60	20
1750-59	222	83	47	67	36	54	18
1760-69	214	84	56	60	37	54	7
1770-79	212	89	47	59	43	55	8
1780-89	550	167	73	224	122	116	15
1790-99	312	148	40	78	91	94	9
1800-09	780	380	117	247	197	196	23
1810-19	1,879	847	333	476	392	633	45
1820-29	4,099	1,535	1,118	1,288	920	718	55
1830-39	2,573	979	108	875	932	429	229
1840-49	97	45	33	10	21	8	25
1850-59	222	112	90	45	31	14	42
1860-69	1,648	584	254	513	521	311	49
1870-79	1,179	438	353	265	363	77	121
1880-89	368	175	109	35	67	39	118
1890-99	1,245	482	824	52	88	86	195
1900-09	1,144	340	200	373	105	464	2
1910-12	304	82	11	86	56	151	-
all	19,696	7,733	4,226	5,554	4,799	4,099	1,038

Sources: Land Values data set.

Notes: The earliest period 1500-39 includes two observations for the south east for the 1480s included in hopes of extending the data as much as possible. The areas are composed as follows:

North - Cheshire, Cumberland, Durham, Lancashire, Northumberland, Westmorland, Yorkshire.

Midlands - Bedford, Berkshire, Buckingham, Derby, Huntingdon, Leicester, Lincoln, Northampton, Nottingham, Oxford, Rutland, Stafford, Warwick

South East - Cambridge, Essex, Hampshire, Hertford, Kent, Middlesex, Norfolk, Suffolk, Surrey, Sussex.

South West - Cornwall, Devon, Dorset, Gloucester, Hereford, Monmouth, Shropshire, Somerset, Wiltshire, Worcester.

is not much less than the average occupancy size of 60.5 acres for England and Wales in 1888, though since the charity land was often leased by persons owned or leased other land we cannot directly compare these averages. The regions are the North, Midlands, South-East, South-West and Wales. These regions were drawn more for convenience than for any underlying presumption about geology or climate. But they do have differences in climate that make the south-east the predominantly arable area of the country, with only 26% of land in permanent pasture in the South-East in 1866, compared to 51% in the North. Thus rent trends may differ across the regions.

The charity sample of land is not representative of land as a whole. Aside from a relatively small average plot size charity land is also found more where there were more people. Thus it also over samples densely populated parishes. Table 2 shows, for example, the distribution of the land area of England across parishes of different population density in 1841 versus the distribution of charity land observations. While only 7% of all land was in parishes with more than 10 people per acre in 1841, 14% of the rent observations from the charity data were in such parishes. Thus if rent trends in the more densely populated parishes in 1841 were different than for the less densely populated parishes the charity data will be misleading about national trends.

A national rent index is calculated from the charity data by using statistical methods to correct for the ways in which charity land is unrepresentative in terms of regional spread, amount of common land, plot size, and distribution across parishes of different population densities. The calculation is done in two stages. First a benchmark is established for the level of rents nationally and by region in the years 1820-24 using the broad cross section of rent data available for charity estates in the years 1818-1837. Average levels of rents for each county in England

Table 2: Share of Parishes by Population Density, England

Population Density (people per 10 acres, 1841)	Land area (m. acres)	Share of Land Area	Share of all charity rent observations	Share of all large plot observations
0-1	4.77	0.15	0.04	0.06
1-2	9.94	0.31	0.20	0.25
2-3	7.67	0.24	0.28	0.28
3-4	3.32	0.10	0.15	0.15
4-5	1.61	0.05	0.07	0.06
5-10	2.40	0.08	0.13	0.09
10+	2.10	0.07	0.14	0.10
All	31.81	1.00	1.00	1.00

Sources: Parish Land Areas and Population Densities, Parliamentary Papers 1852-3a, 1852-3b.

and Wales are estimated. In the next stage the sub sample of plots observed more than once over time are used to estimate indices of average rents for each of four regions of England and for Wales for the years 1500-1912, which are then adjusted to the 1820-24 benchmark.

Tithe

Throughout I estimate rents inclusive of the tithe paid by the tenant, since this is what matters for use of these series to estimate agricultural productivity or the relative rental of land compared to wages. But in only about one sixth of the cases do I know whether land paid tithe or not. And where the tenant paid tithe again in only about one sixth of cases do I know the amount of the tithe paid. For land which paid tithe but the amount paid is unknown I estimate the amount of tithe paid using the information from the cases where we know both tithe payments and rent. The tithe as a proportion of the total rental value of the holding (including tithe) varied by region. Table 3 shows the estimated share of the total rental that the tithe represented for each of the four regions of England and also Wales for the years before and after 1840. I split up the data in this way because the Tithe Reform Act in 1836 changed the way tithe was levied which might affect the future tithe burden.

Since tithe was in principle 10 percent of gross output, and rent and tithe together was only about 40 percent of gross output in the nineteenth century, the tithe should have been about 25 percent of the sum of rent and tithe. On average I find that tithe was a much smaller share of the sum of rent and tithe than this, being only 12.2 percent before 1840 and 14.8 percent after. Tithe as a share of rent was lowest in the north, being there only about 7 percent of the sum of rent and tithe. It was highest in the southeast where it averaged about 19 percent of the sum of rent and tithe. The adjustment to rents in cases where tithe was known to be paid by the tenant

Table 3: Tithe as a Share of the Total Rental Value of Land (in Percent)

Region	Pre-1840 Observations	Pre-1840 Mean	Pre-1840 Standard Error	Post-1840 Observations	Post 1840 Mean	Post-1840 Standard Error
North	23	6.5	1.09	175	7.7	0.49
Midlands	49	11.5	1.09	97	16.5	1.03
South East	23	15.9	2.64	27	21.7	2.24
South West	9	14.9	2.14	67	13.4	1.14
Wales	-	-	-	36	10.6	1.47
England	104	12.2	0.93	402	14.8	0.69

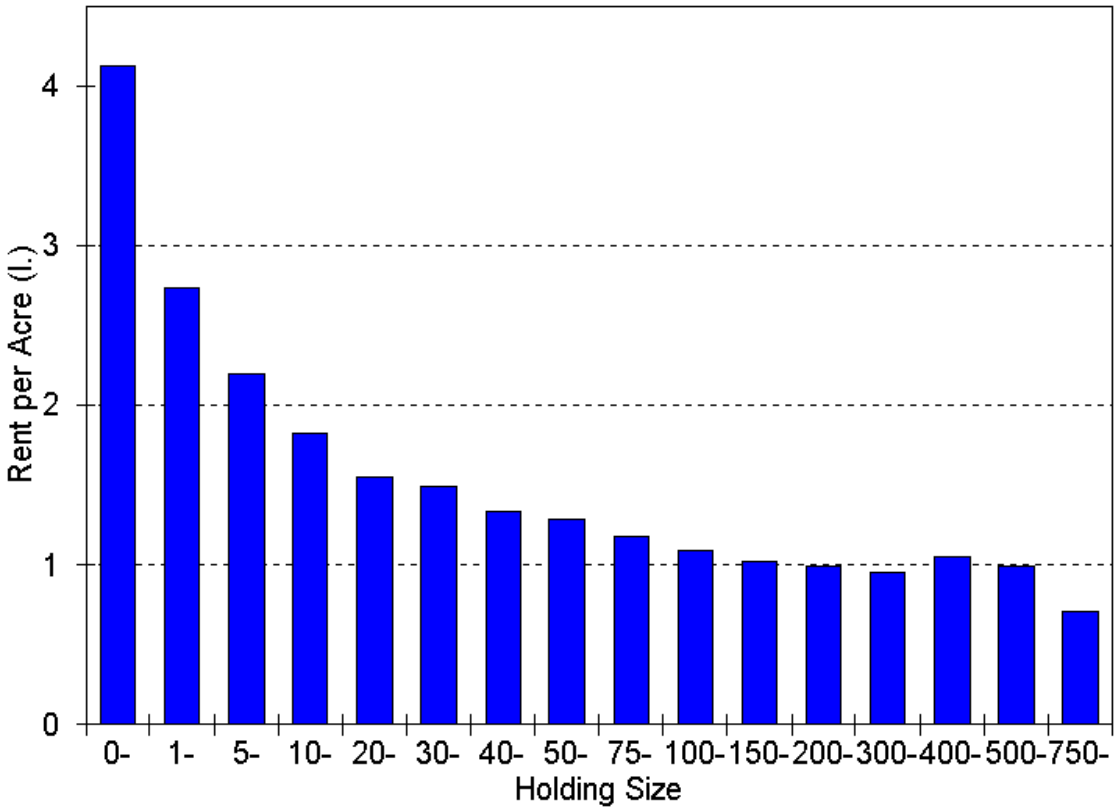
were made according to the estimates in table 3 by region and time period. Then in the regression estimates an indicator variable was included where the tithe status was unknown. We shall see below that in both the cross section estimates of 1817-1837 and the time series estimates the statistical estimate is that land of unknown tithe status rented for average 5.5 percent less than land where I know the sum of rent and tithe. This implies that in less than half the cases where the tithe status was unknown was tithe actually paid by the tenant. Either the tithe had been commuted or the landlord paid the tithe.

The 1820-24 Benchmark

To construct this I use 14,934 observations on the rental values in the years of the first charity commission was conducting its inquiries, 1817-1837.[1] Table 4 lists the observations by county. As can be seen there are some observations for each county in England and Wales. The observations are drawn from 4,093 separate parishes within these counties, though some parishes have many more observations than others. For the mainly rural parishes, those with a population density in 1841 of less than one person per acre, there is data from 3,601 parishes out of a total of 9,060 in England, and for 178 out of a total of 813 in Wales.

To establish a benchmark level of farmland rents in 1820-24 we have to correct for fact that the charity land oversamples small plots of land and plots in more densely populated parishes. These dimensions of oversampling are connected since charity plots were larger on average the less densely populated was the parish. Thus the average size of a charity holding was 81 acres in parishes with less than 1 person per 10 acres in 1841, but only 7 acres in parishes with

Figure 1: Raw Average Rents per acre versus holding size, England and Wales, 1817-37



Source: Charity Commission Reports.

over sampling I run a regression on the cross section of charity data available for the years 1817-1837 of the following form:

---

1 Allotments of waste land for fuel for the poor or to support schools were excluded, since these plots would be untypical of private land.

$$\ln(RENT_i) = \sum_j \beta_j DCNTY_i + \sum_k \beta_k DDEN_k + \sum_m \beta_m DYEAR_m + \beta_1 \ln(AREA_i) + \beta_2 \ln(AREA_i) \cdot DWALES + \beta_3 \ln(AREA_i) \cdot FPASTURE_i + \beta_4 DNTINFO_i + \beta_5 FCLEAR_i + \varepsilon_i$$

more than 5 persons per acre. There is a strong relationship between holding sizes and average rents per acre. Figure 1 shows for the charity land holdings for 1817-37 average rent per acre versus farm size. Thus to correct for the *RENT* is the rent and tithe per acre of the charity plots. *DCNTY* are a set of 54 indicator variables for each of the counties of England and Wales. DYEAR is a set of 21 indicator variables for each of the years 1817 to 1837. *DDEN* are a set of 4 indicator variables for various levels of population density across parishes. *AREA* is the area of the holding. *DWALES* an indicator variable which is 1 for land in Wales. *FPASTURE* is the fraction of land in each county, which was pasture in 1866. *DNTINFO* is an indicator variable which is 1 if there was no tithe information on the holding, *FCLEAR* is the fraction of the land which paid a rent to the owner reported to be "clear" of any expenses.

I do not control in these cross section estimates for other information about charity plots such as the amount of housing because I have no information on the average numbers of houses per acre across counties. The logarithmic form was chosen because it fitted the data better than estimating the rent in levels. The area effect was estimated separately for England and for Wales because of evidence that small plots were relatively more valuable in Wales. The area variable was interacted with the fraction of each county which was pasture land in 1866 because again there are signs that in pasture counties small plots were relatively more valuable.[2] The regression

---

2 Turner, Beckett and Afton report a similar finding by the Royal Commission on Agriculture in 1894 that the rent gradient with size was steeper in the West of England than in the East. Turner, Beckett and Afton (1997), p. 120.

allows me to estimate what the average rent of a given sized tithe free holding in a parish of given population density was in each county.

Table 4 gives the estimated values of the control variables in this cross section regression as well as the standard error of the estimates. The adjusted R^2 of the regression was 0.39, and the F-statistic 118.3. Even controlling for plot size land is much more valuable in parishes with higher population densities. This consistent and strong effect of plot size, which survives even if we include other controls such as the amount of housing per acre and land use, is a little puzzling. For it raises the question of why landlords ever rented out plots in larger holdings when it would seem more profitable to subdivide them. There are plausible explanations for this though, that are consistent with landlord profit maximization. There are, for example, aspects of the plots that we cannot control for. In particular even within any parish land located close to the settlement was much more valuable than land located at the edge of the parish. This was the land used for labor intensive activities such as garden crops and milk cows. Many of these activities demanded land in smaller units than general agricultural activity. And converting large plots into smaller ones demanded investment in fencing and access roads.

The regression estimates of the coefficients $?_i$ show the level of rents in each county standardizing for plot size and parish population density. The actual level of rents in each county is then estimated by adjusting for the average level of population density in each county and the average size of land occupancy. There is no good data on the average size of land occupancy in the early nineteenth century, so the statistics in the 1888 Agricultural Returns which give a pretty complete account of the

Table 4: Estimated Coefficients from the Cross Section Rent Regression

Variable	Estimated Coefficient	Standard Error of the Estimate	t-statistic
Ln(AREA)	-0.166	0.008	-22.09
Ln(AREA)×DWALES	-0.054	0.016	-3.30
Ln(AREA)×FPAST	-0.031	0.018	-1.72
0.3-0.49 people per acre	0.108	0.011	9.68
0.5-0.99 people per acre	0.279	0.014	19.31
1 or more people per acre	0.582	0.014	42.84
No tithe information	-0.056	0.015	-3.87
Fraction of land rented "clear"	-0.006	0.020	-0.29

Note: Parishes with population densities in 1841 of less than 3 people per 10 acres were the omitted category in the regression, so that the coefficients reported here show the level of rents in parishes of greater population densities relative to these parishes.

number of land occupants and the area occupied is used. Table 5 shows the resulting estimates of average rents per acre for farmland in each county for the years 1820-24.

From these estimated average rents, multiplied by the agricultural area of each county in 1888 we get an estimate of the total rental value of land in 1820-24 and of the national average rental and tithe value per acre. For England this is £1.30, and for Wales £0.78. The estimated average rental value per acre in 1820-24 can be compared to the assessed rental value of land estimated from the 1842 Property Tax returns, again using the 1888 agricultural returns to estimate the amount of farmland in each county. These estimates are shown in the last column of table 5. Figure 2 shows the average assessed rent per acre from the Property Tax versus the rent per acre by county estimated from the charity plots. As can be seen there is a very good correlation between average county rents from the two sources. Indeed the correlation coefficient between the two measures is 0.87. But interestingly the Property Tax records imply an average rent and tithe per acre for England in 1842 of £1.49. We shall see below that on average in the years 1842 to 1912 the charity estates imply an average rent per acre, which is 6 percent less than the Property Tax Assessments. The reasons for the higher assessments of gross rents by the Property Tax assessors are unclear. The agricultural area is estimated from the agricultural returns, which were completed by land occupiers listing the areas of each type of land use. These areas may understate the quantity of land in agricultural use. Occupiers were not asked to return the area of rough hill grazing. Also occupiers may not have included fences, roads and farmyards in the areas they returned.[3]

---

3 A surveyor in the West of the country estimated that in 1845 somewhat more than 7% of all land in 10 parishes in Devon was occupied by hedges. The proportion of farmland so occupied would be correspondingly higher. Grant (1845).

Table 5: Rents Nationally and by County from the Charity Land in 1817-1837

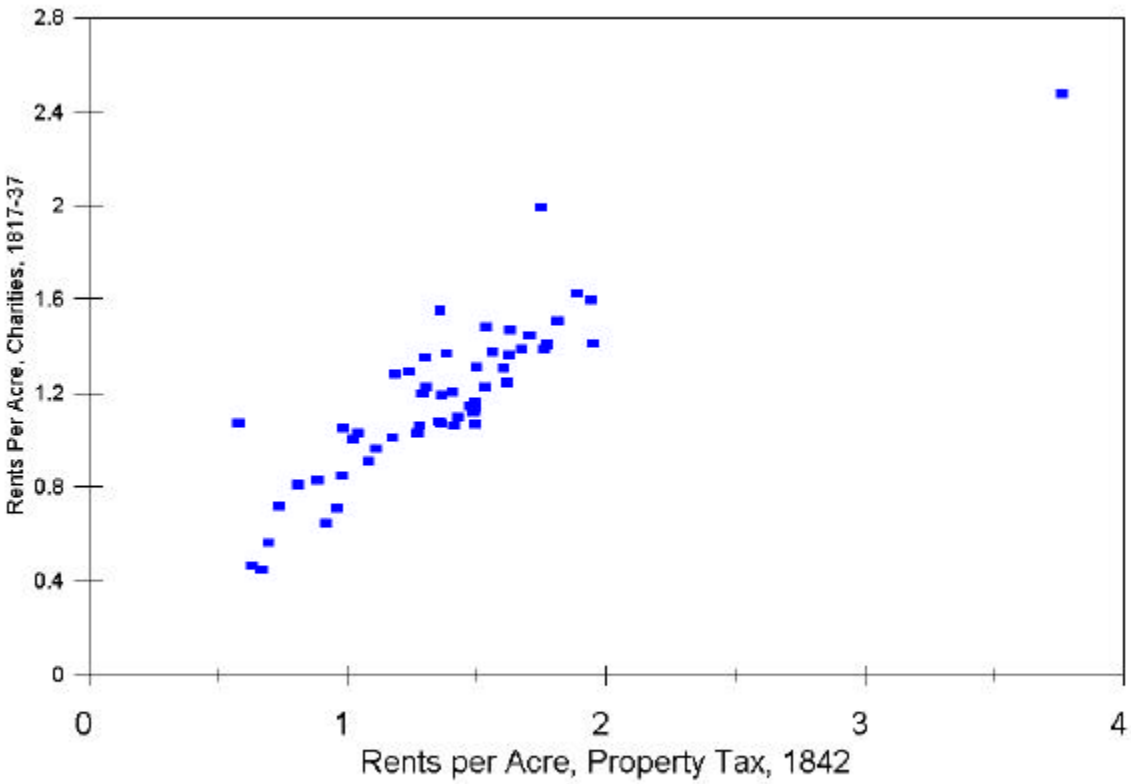
County	Observations, 1817-1837	Agricultural Area 1888	Average Occupancy Size 1888	Average Rent Per Acre, 1820-24	Rent Per acre, 1842
ENGLAND	**14,478**	**26,523,900**	**62.1**	**1.30**	**1.49**
North	2,307	6,416,357	49.1	1.34	1.42
Midlands	5,295	6,692,549	61.3	1.35	1.59
South East	4,163	6,605,002	75.4	1.22	1.49
South West	2,715	6,809,992	59.9	1.28	1.47
Bedford	204	302,476	72.9	1.03	1.27
Berkshire	348	408,260	97.1	1.23	1.53
Buckingham	287	435,026	80.9	1.06	1.41
Cambridge	543	493,398	58.2	1.36	1.63
Cheshire	166	564,325	39.2	1.99	1.75
Cornwall	55	625,541	41.4	1.55	1.36
Cumberland	60	622,436	78.9	1.05	0.99
Derby	462	537,134	40.3	1.31	1.60
Devon	640	1,279,549	67.4	1.23	1.31
Dorset	255	523,392	89.7	1.06	1.28
Durham	147	462,577	65.2	1.29	1.24
Essex	636	862,749	91.7	1.19	1.62
Gloucester	245	712,244	58.9	1.25	1.63
Hampshire	179	823,669	87.8	1.47	1.08
Hereford	209	486,221	67.1	0.91	1.36
Hertford	289	364,331	82.7	1.07	1.36
Huntingdon	152	214,768	63.7	1.08	1.49
Kent	546	844,852	74.5	1.12	1.71
Lancashire	519	862,459	39.5	1.45	1.94
Leicester	509	486,411	58.2	1.60	1.89
Lincoln	1,118	1,554,971	58.8	1.62	1.53
Middlesex	167	117,369	42.4	2.48	3.77
Monmouth	93	277,076	48.6	0.96	1.11
Norfolk	821	1,146,610	68.9	1.16	1.50
Northampton	407	587,697	82.7	1.39	1.67
Northumberland	73	761,356	123.6	1.01	1.18
Nottingham	354	479,367	55.3	1.31	1.50
Oxford	216	437,610	91.3	1.10	1.43
Rutland	27	90,985	75.2	1.14	1.47
Shropshire	251	767,923	58.7	1.20	1.41
Somerset	335	908,421	49.3	1.41	1.95
Stafford	584	641,243	44.3	1.41	1.77
Suffolk	665	811,318	81.3	1.07	1.50
Surrey	197	344,482	59.7	1.37	1.38
Sussex	121	796,224	84.8	1.28	1.19
Warwick	628	516,601	66.1	1.51	1.82
Westmoreland	106	267,790	69.5	1.00	1.02

County	Observations, 1817-1837	Agricultural Area 1888	Average Occupancy Size 1888	Average Rent Per Acre, 1820-24	Rent Per acre, 1842
Wiltshire	259	807,094	101.1	1.19	1.36
Worcester	371	422,531	46.3	1.39	1.76
YER	232	683,864	83.5	1.35	1.30
YNR	192	911,222	62.0	1.20	1.29
YWR	812	1,280,328	40.9	1.37	1.56
WALES	**464**	**3,009,267**	**48.4**	**0.78**	**0.84**
Anglesey	68	149,721	38.7	0.71	0.96
Brecon	16	218,385	64.0	0.56	0.70
Cardigan	2	298,338	46.1	1.07	0.58
Carmarthen	12	464,846	54.0	0.72	0.74
Carnarvon	29	200,274	32.5	0.81	0.81
Denbigh	122	289,863	47.3	1.03	1.04
Flint	49	135,759	32.8	1.14	1.50
Glamorgan	28	305,744	48.9	0.83	0.89
Merioneth	16	175,239	54.2	0.46	0.63
Montgomery	34	283,346	51.0	0.85	0.98
Pembroke	24	317,201	52.7	0.65	0.92
Radnor	64	170,551	76.2	0.45	0.67

Notes: The agricultural area in 1888 includes land in woods and plantations, and in market gardens.

Sources: Charity Commission Reports. Stamp (1920), pp. 54-55. Parliamentary Papers (1888).

Figure 2: Rental Values per acre by county, Charity Commission versus Property Tax



Source: Table 5.

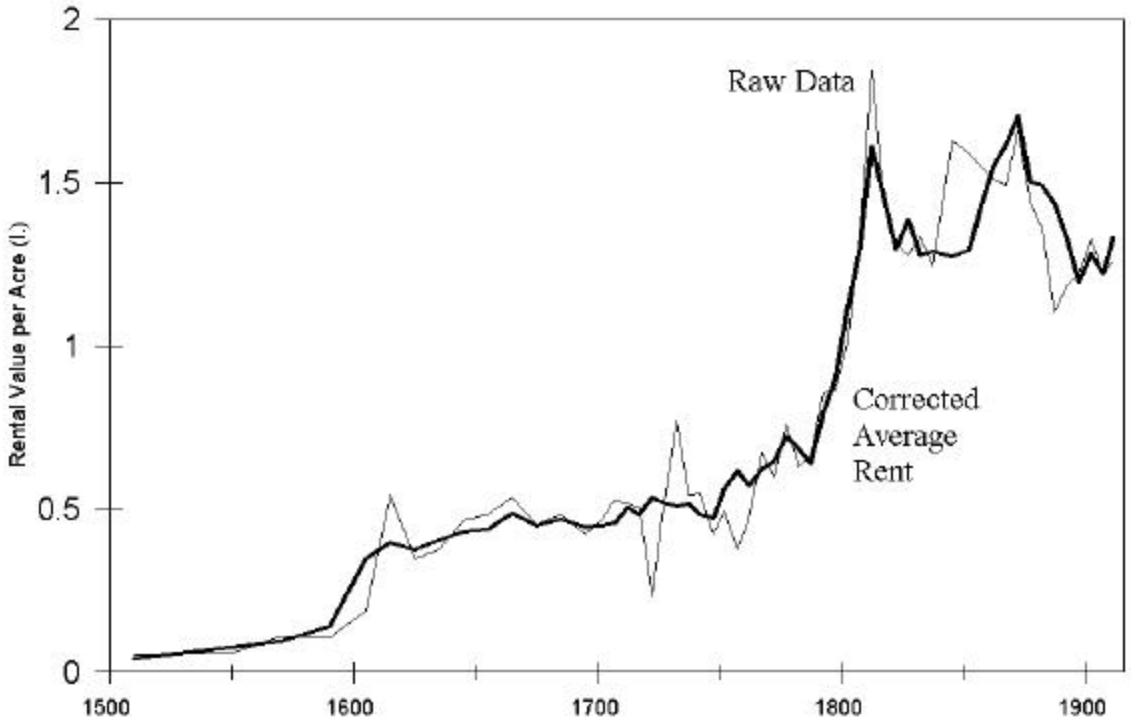
Using the county average rents in Table 5 I can fix the average rent per acre in each region of the county in the benchmark years of 1820-24. These regional benchmarks are also shown in Table 4. Rents at this time vary little across the four different regions I have defined for England.

Rents 1500-1912

To move from the benchmark estimate of rents to an index of rents over time I again use regression estimates to correct the charity sample for the ways in which it is unrepresentative. Figure 3 shows the raw average rent per acre from the sample of farms and holdings from 1500 to 1912 that record an area, calculated as the total rent recorded in each period divided by the total area. I need to correct this raw series to allow for differences in the frequency with which different regions appear in the sample, for potentially different movement of rents over time on smaller plots which appear more in the charity sample, and for potentially different movement of rents in more densely populated parishes which are again overrepresented in the charity sample.

To derive a national rent index the strategy employed here is to first derive regional rent indexes for land of constant type. Then I allow for the effects on rents of differences in the amount of common and enclosed land over time by region, before amalgamating these into general rent indices using as weights the total amount of land rent from each region in 1820-24 from the benchmark estimates. To estimate the land rent movement by region over time I estimate the coefficients of the following regression

Figure 3: Raw Average Rents versus a Corrected Rent Series, England, 1500-1912



Note: The raw average rent per acre for each period is the total rent and tithe paid divided by the total land area recorded.

Table 6: Variables used in the Rent Regression

Variable Name	Description
$RENT_{it}$	Value of rent and tithes for each of 7,236 plots in any year observed.
DT_k	Set of 56 indicator variables, which equal one in each period k and 0 otherwise.
$DREG_l$	Set of 5 indicator variables, one for each of the four regions of England, and one for Wales.
HPA, CPA, BPA	Houses, cottages and barns per acre of land. Where there is no information these numbers are set to 0.
DNBUILDINFO	Indicator which equals 1 if there is no information for that year on the stock of buildings on the land, 0 otherwise.
FCOM	Fraction of land with common rights of some sort. This variable is set to 0 if there is no information on the enclosure status of the land.
FCOMW	Fraction of land with common rights and unrestricted access. This variable is set to 0 if there is no information on the enclosure status of the land.
FCOMP	Fraction of land with common rights of some sort as indicated by the Parliamentary records. This variable is set to 0 if there **is** information on the enclosure status of the individual plot.
DNTI0, DNTI1	Indicators that equal 1 if there is no information on the tithe status in the years before 1840, or after 1839, 0 otherwise.
FCLEAR	The fraction of the land for which the rent received is net of any deductions for repairs, tithe etc.
DCURR0, DCURR1, DCURR2	DCURR0 is an indictor that equals 1 in 1560-1609 if the rent observation is of the current rent of the land (rather than a newly formed rental contract), 0 otherwise. DCURR1 and DCURR2 are the same indicator for other years of rent inflation – 1795-1819, and 1850-1874.
SMALL16, SMALL17, SMALL181	Indicator variable which is 1 if the plot is smaller than 20 acres, 0 otherwise for the years 1500-1699, 1700-1799, and 1850-1912.
MDEN, HDEN, VHDEN	Indicator variables which are 1 when the parish the land is located in has a population density in 1841 of .3-.499, .5-.999, 1.0-, people per acre respectively, 0 otherwise.

$$\ln(RENT_{it}) = \alpha_{it} + \sum_{k,l} \gamma_{kl} DT_k \cdot DREG_l + \beta_1 HPA_{it} + \beta_2 CPA_{it} + \beta_3 BPA_{it} + \beta_4 DNBUILDINFO_{it} + \beta_5 FCOM_{it} + \beta_6 FCOMW_{it} + \beta_7 FCOMP_{it} + \beta_8 DNTINFO0_{it} + \beta_9 DNTINFO1_{it} + \beta_{10} FCLEAR + \beta_{11} DCURR0 + \beta_{12} DCURR1 + \beta_{13} DCURR2 + \beta_1 DSMALL16_i + \beta_2 DSMALL17_i + \beta_3 DSMALL18_i + \beta_1 MHDEN16_i + \beta_2 MHDEN17_i + \beta_3 MHDEN18_i + \beta_4 HDEN16_i + \beta_5 HDEN17_i + \beta_6 HDEN18_i + \beta_7 VHDEN16_i + \beta_8 VHDEN17_i + \beta_9 VHDEN18_i + \varepsilon_{it}$$

on all linked observations where the variables in the regression are as defined in table 6. The regression controls for variations in the fertility and location of individual plots by use of 7,236 intercept terms, one for each plot (the α_k). The thirteen "?" variables control for features of plots that affect the rental value and that change on any given plot over time over time: whether the land is held in common or not, what buildings are being rented with the land, whether the tithe status of the land is known, whether the rent is clear of all deductions to the landowner, and lastly whether the rent recorded is just that currently being paid for the land. The regression has as a dependant variable the logarithm of rent because then the estimated coefficients for the control variables can be interpreted as showing the percentage influence of these variables on the levels of rents. Thus we shall see that common land rents on average for nearly 30% less than the same land when enclosed.

The regression estimates the level of rent in each region in each of the time periods 1500-39, 1540-59, 1560-79, 1580-99, 1600-09,…, the set of 56 period indicator variables DT_k and 5 region indicator variables $DREG_l$. The estimated coefficients γ_{kl} are the estimated levels of rents in each period and region for enclosed land in plots of 20 acres or greater in parishes with less than 0.3 persons per acre of land, where the land is tithe free and has no buildings on it. The remaining variables identify the rent movements in the long run on different types of land. Thus the "?" variables identify how rents in the long run were moving on small plots relative to large

plots. The "?" variables estimate how rents were moving in parishes of different levels of population density in 1841.

Table 7 reports the estimated coefficients from the regression as well as the standard errors of each coefficient. As can be seen the "?" coefficients all have the expected sign. Thus plots with accompanying houses, cottages and barns were worth more than those without buildings. And the effect was greater for houses than for cottages. Holdings where the rent paid was stated to be clear of all deductions rented at 5.5% lower on average than those where the landlord might be paying for repairs etc.

Common arable and meadow rented for 25% less than such land when enclosed. Common waste rented for 47% less than waste that was enclosed. These results are in very close to those reported in Clark (1998b) on the effects of enclosure on rent. They suggest that the enclosure movement had little aggregate effect on rents or productivity over time since as Clark (2001b) indicates most of England was already enclosed by 1600.

The estimated values for the variable for plots less than 20 acres suggests that in general the movement of rents on large plots was very similar to that on small plots. In the years before 1700 small plots are estimated to rent for 7.5% more than large plots. Again in the years after 1850 small plots are estimated to rent for 3.4% more than the large plots. Thus in the long run rent trends on small plots were very similar to those on large plots. Rents in the more densely populated parishes did rise much more between the years 1500-1699 and 1800-49 than in the least densely populated parishes. Rents rose 27% more in parishes with a population density by 1841 of one or more persons per acre than they did in parishes with less than 0.3 persons per acre in 1841.

Table 7: Estimated Coefficients in the Rent Regression

Variable	Coefficient Estimate	Standard Error	T-statistic
Holding Characteristics			
HPA**	1.181	0.240	4.92
CPA**	1.062	0.141	7.52
BPA	0.376	0.219	1.71
DNBINFO	-0.009	0.019	-0.48
DCURR0*	0.128	0.065	1.96
DCURR1**	-0.139	0.024	-5.92
DCURR2**	-0.093	0.021	-4.48
FCLEAR**	-0.058	0.016	-3.70
DNTI0*	-0.055	0.028	-2.00
DNTI1	0.019	0.029	0.63
FCOM**	-0.253	0.020	-12.62
FCOMW**	-0.347	0.065	-5.35
FCOMP**	-0.171	0.040	-4.24
Holding Area			
DSMALL16**	0.075	0.023	3.36
DSMALL17	-0.018	0.016	-1.13
DSMALL18**	0.034	0.013	2.66
Parish Population Density			
MDEN16	-0.007	0.028	-0.26
MDEN17	0.008	0.020	0.41
MDEN18	0.029	0.015	1.94
HDEN16**	-0.168	0.034	-4.90
HDEN17	0.012	0.024	0.48
HDEN18	0.031	0.019	1.63
VHDEN16**	-0.285	0.032	-8.97
VHDEN17**	-0.105	0.025	-4.24
VHDEN18	-0.013	0.021	-0.63

Note: ** indicates the coefficient is estimated to be significantly different from 0 at the 1% level, * indicates significantly different from 0 at the 5% level.

Using the coefficients estimated from the regression I estimate for each of the four regions of England the rental value of an average acre of farmland adjusted for the estimated amount of common land in each period and for the regional distribution of land across parishes of different densities.[4] These estimates are shown in table 8. The level of rents in 1820-4 is set to the benchmark levels for each region in table 3. The basic pattern in the regional movement of rents is first that the North moves from being region of low rents in the years 1600-1750 to being a period of the highest rents by the late nineteenth century. Secondly the South East moves from being the region of high rents in the sixteenth century to being the region of low rents by the nineteenth century.

For most of the period before 1750 rents in the North are estimated to be much below the other three regions of the country. In the seventeenth century northern rents were typically only 70 percent of those in the Midlands, South-East and South-West. In the eighteenth century rents in the North begin to catch up with those in the rest of the country and by the 1770s there is little difference. Average rents are pretty similar across regions from 1770 until 1775 when a divergence sets in in the late nineteenth century. After 1875 rents in the more arable areas, the South-East in particular, begin to fall relative to rents in the most pastoral districts. By the 1900s rents in the South-East are only 89 percent of the national average.

---

4 Since the amount of common land varied over time by region we need an estimate of the amount of common land in each region over time to control for this. This is obtained from another data set constructed from the charity data that looks at the fraction of land common over time.

Table 8: Land Rental Values by Period and Region (£/acre)

Period	Average of England	Approximate Standard Error (%)	North	Midlands	South East	South West
1500-39	0.044	8.9		0.041	0.040	0.058
1540-59	0.077	8.1	0.097	0.046	0.093	0.072
1560-79	0.095	9.5		0.106	0.134	0.068
1580-99	0.141	8.0	0.110	0.152	0.212	0.096
1600-09	0.351	8.5	0.464	0.389	0.272	0.275
1610-19	0.398	5.1	0.236	0.382	0.427	0.551
1620-29	0.373	4.8	0.279	0.401	0.426	0.394
1630-39	0.404	3.9	0.327	0.484	0.414	0.396
1640-49	0.429	5.0	0.287	0.476	0.480	0.483
1650-59	0.440	3.9	0.293	0.444	0.434	0.593
1660-69	0.487	4.1	0.390	0.464	0.551	0.553
1670-79	0.451	3.2	0.313	0.487	0.462	0.549
1680-89	0.470	3.2	0.318	0.556	0.497	0.516
1690-99	0.447	3.0	0.303	0.470	0.466	0.554
1700-04	0.450	4.3	0.359	0.519	0.487	0.439
1705-09	0.458	3.8	0.353	0.534	0.463	0.487
1710-14	0.506	4.0	0.390	0.539	0.572	0.531
1715-19	0.484	3.3	0.388	0.542	0.446	0.563
1720-24	0.536	3.3	0.409	0.602	0.534	0.605
1725-29	0.519	3.5	0.383	0.579	0.496	0.623
1730-34	0.510	3.1	0.445	0.529	0.501	0.570
1735-39	0.517	3.4	0.457	0.535	0.539	0.542
1740-44	0.482	3.6	0.400	0.548	0.498	0.487
1745-49	0.474	3.6	0.399	0.515	0.492	0.494
1750-54	0.560	3.8	0.536	0.548	0.566	0.594
1755-59	0.618	3.7	0.631	0.624	0.515	0.697
1760-64	0.572	3.6	0.563	0.582	0.525	0.616
1765-69	0.620	3.9	0.582	0.781	0.582	0.538
1770-74	0.648	3.6	0.626	0.760	0.612	0.597
1775-79	0.722	3.8	0.696	0.770	0.694	0.731
1780-84	0.686	3.2	0.728	0.662	0.631	0.720
1785-89	0.641	2.3	0.623	0.616	0.619	0.710
1790-94	0.793	3.8	0.686	0.948	0.763	0.779
1795-99	0.898	3.1	0.793	0.941	0.926	0.942
1800-84	1.110	2.3	1.108	1.136	1.018	1.180
1805-09	1.294	1.9	1.220	1.332	1.353	1.285
1810-14	1.611	1.7	1.517	1.590	1.570	1.774
1815-19	1.454	1.3	1.477	1.532	1.423	1.390
1820-24	1.295	0.0	1.334	1.349	1.225	1.275
1825-29	1.387	1.3	1.383	1.459	1.314	1.395
1830-34	1.279	2.2	1.243	1.323	1.240	1.314
1835-39	1.290	1.9	1.282	1.401	1.206	1.274

Period	Average of England	Approximate Standard Error (%)	North	Midlands	South East	South West
1840-49	1.275	5.3	1.194	1.447	1.224	1.242
1850-54	1.292	5.5	1.345	1.430	1.340	1.065
1855-59	1.433	4.3	1.444	1.507	1.332	1.450
1860-64	1.550	2.9	1.577	1.619	1.477	1.531
1865-69	1.614	2.4	1.583	1.686	1.642	1.556
1870-74	1.705	2.3	1.679	1.838	1.669	1.643
1875-79	1.501	3.0	1.558	1.588	1.377	1.480
1880-84	1.491	3.7	1.709	1.529	1.387	1.337
1885-89	1.435	4.0	1.443	1.739	1.149	1.398
1890-94	1.331	3.2	1.382	1.408	1.190	1.341
1895-99	1.198	2.6	1.356	1.260	0.963	1.203
1900-04	1.284	2.6	1.458	1.323	1.058	1.282
1905-09	1.222	2.0	1.221	1.172	1.182	1.315
1910-12	1.332	3.8	1.545	1.262	1.158	1.351

Note: The average for England 1480-1539 and 1560-79 is the weighted average of the Midlands, South East and South West alone adjusted to the level of the general average in 1580-1599. The standard error of the estimated rent level for 1820-4 is 0 since the standard errors report the likely estimate error for these rents relative to their level in 1820-4.

Table 8 also gives the estimated average nominal rental value per acre of farmland for England as a whole, constructed as a weighted average of these regional rent series based on the amount of farm and woodland reported in each region in the 1888 agricultural reports. In the years 1480-39 and 1560-79 where there are no observations from the North the national level of rents is estimated using just the movement of rents in the other three regions. This national series is shown in Figure 3. As can be seen the regression method successfully smoothes out many of the bumps in the raw series caused by the changing composition of observations. The average level of rents and tithe in the early sixteenth century before the Price Revolution, based on a very small number of observations, was about £0.044 per acre, or about 10.5 d. Rents rise sharply in the late sixteenth century before reaching a plateau of about £0.45 in the 1640s, at which level rents remained until the 1740s. Then another rapid rise took place, so that by 1805 nominal rents reached a rough new nineteenth century plateau at about £1.3 per acre.

Since this national rent series is based on a sample of plots that is quite small for the sixteenth century it is also useful to have a measure of how much uncertainty there is in the rent estimate for each period as a result of sampling error. The third column of table 8 shows the approximate standard error of the estimated national rent, relative to 1820-4, expressed as a percentage of the level of rents in each period. The true rent will lie within two standard errors above or below the estimated rent nineteen times out of twenty. Thus there is only one chance in twenty that the rents estimated for the seventeenth century will lie more than about 17 percent above or below their estimated level, relative to the level estimated for 1820-4. By the 1670s the rents can be estimated with a sampling error of eight percent or less in either direction in each five-year period.

Comparison with Earlier Rent Series

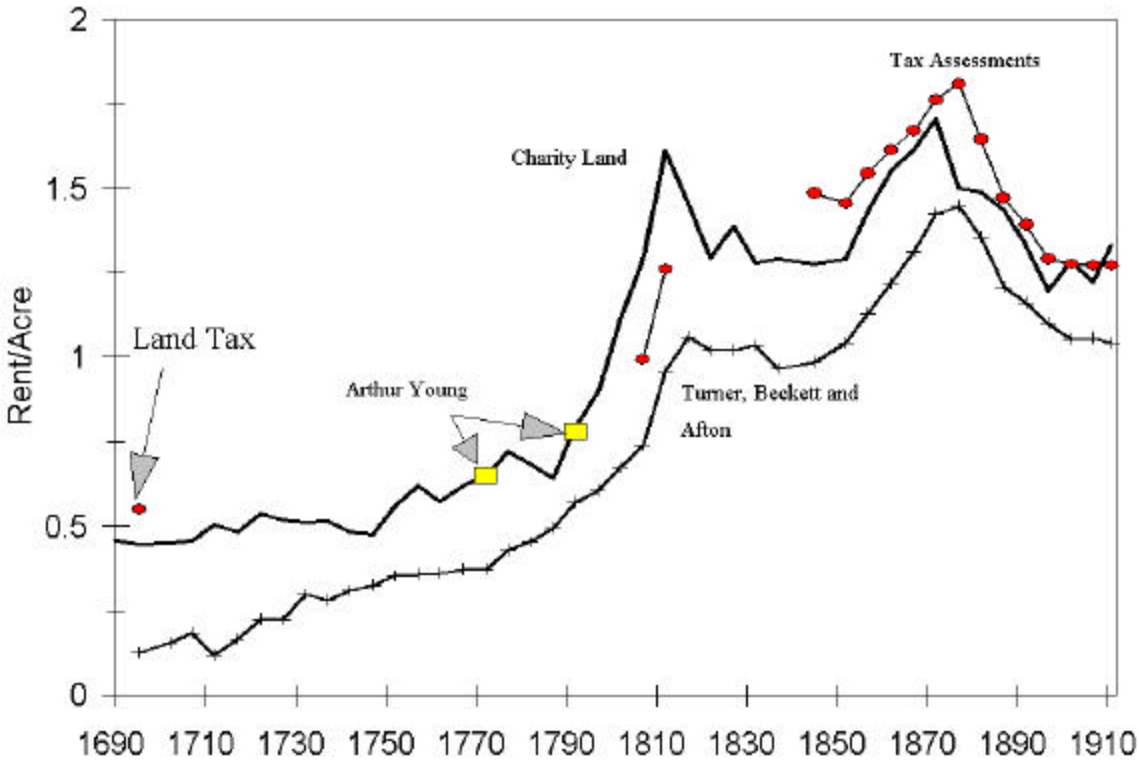
The method of construction of the regional and national rent series differs from that of others who have built rent series for parts of the interval 1500-1912. How do these results compare with these other methods? For the years after 1690 there are two national series on rents available. The first is from the Property and Income Tax assessments of land values for the years 1806, 1808, 1810, 1814 and 1842-1914. The second is the land rent series constructed recently for mainly large agricultural estates by Michael Turner, John Beckett and Bethany Afton of average rents assessed on large estates for the years 1690 to 1914. Figure 4 shows the Charity Commission series and these alternative rent series. As can be seen for the years 1842-1912 the tax valuations, though consistently about 6% higher than the Charity rental values, move in a very similar way. The earlier tax valuations for 1806-1814 are 22% lower than the charity valuations. Elsewhere I argue that there is good evidence that these early tax returns systematically under assessed land and housing by about one third.[5]

The charity rental value series is also consistent with the Turner, Beckett and Afton series for the years after 1860. Though the average estimated rent for England based on charity land is 17% higher than the average rents on the large estates Turner, Beckett and Afton look at, the series move in harmony. But the earlier we go before 1860 the more the series diverge, until finally when we get back to 1690-9 the charity rents exceed those of Turner et al. by 255%. Clark (1998d) and Turner, Beckett and Afton (1998) debate which of these series is more plausible. The charity series is much more consistent with the Land Tax assessments of 1693.

---

5 See Clark (2000a).

Figure 4: Charity Rental Values, 1690-1912 versus Alternative Estimates



Notes: The Land Tax assessment for the 1690s has been corrected for undervaluation of rental incomes in the land tax returns in accordance with Clark (1998d). Young's estimates are taken from Turner, Beckett and Afton (1997).

Sources: Turner, Beckett and Afton (1997), pp. 163-4, 314-318. Stamp (1920), pp. 49, 54-5.

The land tax collected outside major towns, where it would fall overwhelmingly on farm property, implies a rental value of £0.55 per acre in 1693, which is higher even than the charity based average rental of £0.45 in these years.[6] Though the differential between the tax based assessment and the charity series is very similar to that post 1840.

The land rent estimates here are also much closer to the contemporary estimates of Arthur Young in 1770 and the 1790s than the Turner, Beckett and Afton series. Indeed Young's estimates for 1770 and the 1790s for land in England as a whole is essentially the same as the estimates from charity sources for both dates.[7] Arthur Young has been generally dismissed as a too optimistic estimator of the state of agriculture in England in the 1760s and 1770s. But the charity lands rents suggest that his assessments were accurate. Interestingly an estimate of agricultural wages in the years 1670-1850 from farm sources suggests his wage figures were also relatively accurate.[8]

The charity data also reveal quite clearly a decline in rents in the decade 1740-9 compared to the decades 1720-9 and 1730-9. Rental values on charity plots are estimated to be 10% lower in the 1740s than in the 1720s, and 7% lower than in the 1730s. The fall in rents from the average of the 1720s and 1730s to the average of the 1740s occurs in all four regions of England, and also in Wales. Gordon Mingay in 1956 published an article suggesting that the years 1730-50 were a period of depression in agriculture based on evidence of declining rents. Interestingly the Turner, Beckett and Afton series shows no such decline in rents in these years. Instead rents are 43%

---

6 Gregory King estimates average land rents per acre in 1696 at only £0.35, but the sources of his estimates are far from clear.

7 In all these cases rentals on a national basis have been converted into rentals per acre using the reported agricultural area from the 1888 agricultural returns. Parliamentary Papers (1888).

8 See Clark (2001), table 5.

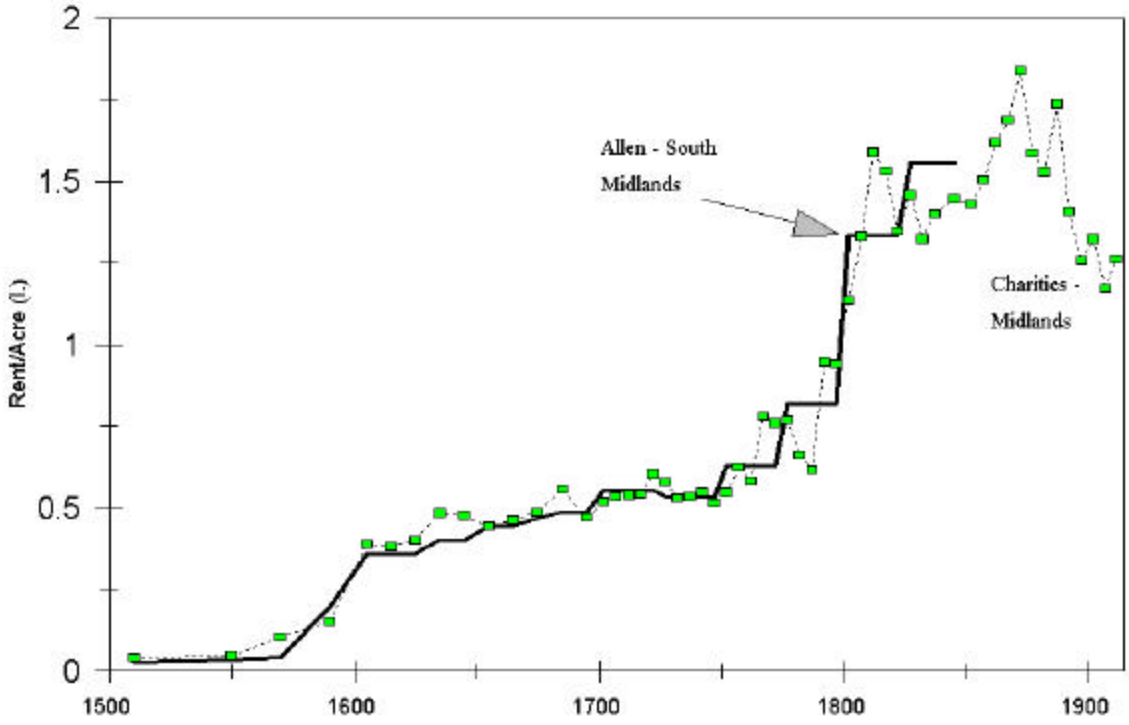
higher in the 1740s than the 1720s and 10% higher than the 1730s on their series. This I would argue is another reason for preferring the charity rent series.

Robert Allen, using a variety of sources, has constructed a rent series for the South Midlands by 25-year intervals from 1500 to 1849. Figure 5 shows the rental values for the Midlands calculated from the charity land for the years 1500-1850 compared to Allen's series for the southern part of the Midlands.[9] As can be seen the two series though derived from completely different sources and by different methods are remarkably concordant for the years 1600 to 1800. There is more divergence at both ends of the series. Thus Allen finds average rents of £0.029 in 1500-49, while I find a higher level of £0.041 (but based on very small numbers of observations). This means that Allen's series shows rents in 1625-49 14.8 times those of 1500-49. In contrast the rents on charity land overall in 1630-49 are only a 9.6 times those of 1500-39.

Eric Kerridge reported rents for the chalk country of Wiltshire in the years 1510-1659 for the Herbert Estates (Kerridge (1953)). In contrast to Allen Kerridge finds rents in 1630-49 are only a 5.8 times those of 1510-39, compared to the charity ratio over the same period of 9.6. Further the level of rents Kerridge estimates for the seventeenth century are only half those I estimate nationally. Figure 6 shows my estimated national rent series, as well as the 95 percent confidence interval around these estimates, alongside the regional estimates of Allen and Kerridge for the years before 1660. Kerridge concludes that real rents, measured in farm output prices, rose only very modestly beyond inflation between the first half of the sixteenth century

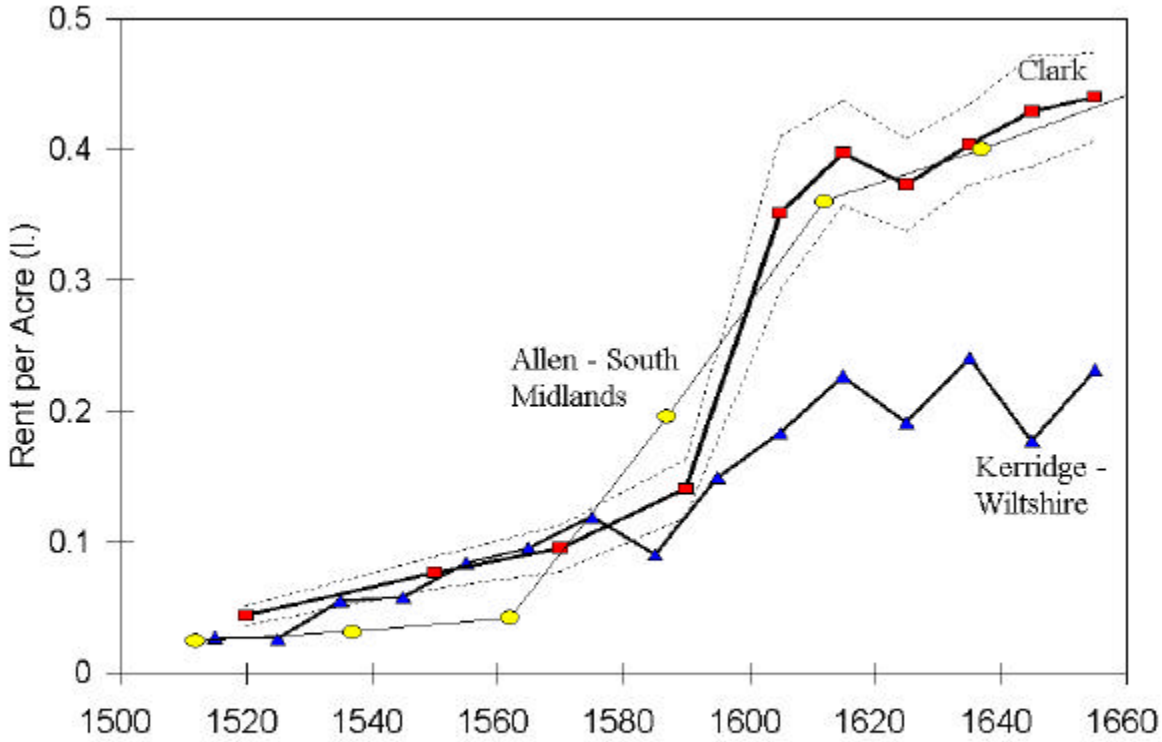
[9] Thus my midlands series includes observations from Lincoln, Nottingham, Derby and Stafford which are excluded from Allen's data.

Figure 5: Rent per Acre from Charity land in the Midlands versus Rents per Acre from Allen for the south Midlands



Source: Allen (1988).

Figure 6: Various Estimates of Rents, 1550-1660



Note: The Kerridge series is for new takings on the Herbert Estates. The dotted lines show the upper and lower bounds of the 95% confidence interval around the rents estimated here.

Sources: Allen (1988). Kerridge (1953), p. 217.

and the first half of the seventeenth century. We shall see below that I find that real rents more than doubled in this period.

Real Rents

To calculate real rents I use a price series based on the prices of eleven farm commodities. These are wheat, barley, oats, beef, mutton, tallow, butter, cheese, hay, wool and firewood. The index is formed as a geometric index of the prices of each component, with revenue shares used as weights. Thus it assumes constant revenue shares on each item as relative prices change. Thus if grain prices are unusually high relative to meat prices then it is assumed that grain output is proportionately lower. That is, if p_{it} is the price index for each commodity i in year t, and $?_i$ is the revenue share of commodity i, then the overall price level in each year, p_t is calculated as,

$$p_t \; ? \; ?_i \; p_{it}^{\,a_i}$$

This assumes that if a commodity increased in price by 10% relative to other prices its output decreased by 10% so that the share of revenue from each commodity did not change. The output shares for each of the commodities in the series are changed over time to reflect differences in the composition of farm output, in the way outlined in the appendix. To measure real output accurately where output prices of different commodities are diverging we need to know the trends in the shares of each outputs in the total value of output. At present I only have crude estimates of these share trends, but since there are no very marked differences in the movement of different output prices this is not too much of a problem. The various shares used are shown in the appendix. Table 7 shows the price index used.

Table 7: Agricultural Prices and Real Rental Values and Wages

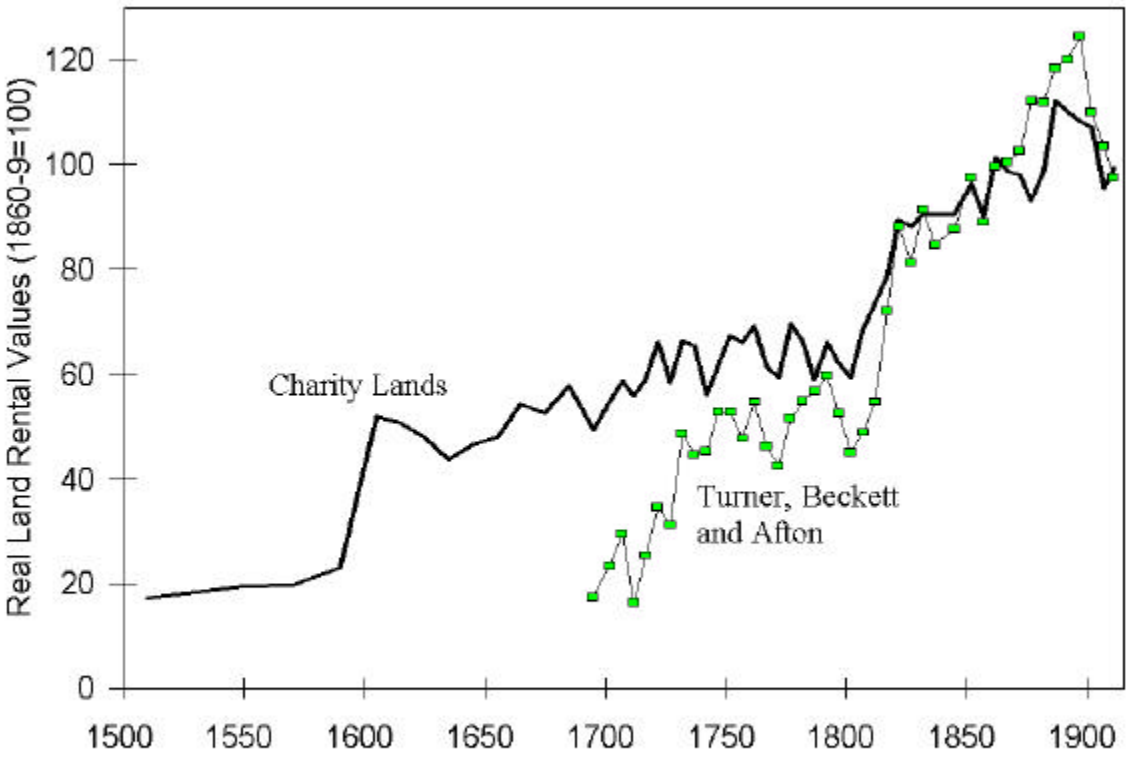
Period	Prices (1860-9 = 100)	Tax Burden as a share of Rents	Real rent and taxes (1860-9 = 100)	Farm Wages (d. per day)	Real Wages (1860-9 = 100)	Rent/Wages (1860-9=100)
1500-39	15.9	-	16.0	3.3	82.0	19.5
1540-59	24.7	-	18.1	4.4	70.6	25.6
1560-79	30.4	0.009	18.2	6.0	77.7	23.4
1580-99	38.8	0.005	21.0	7.1	71.6	29.3
1600-09	42.6	0.006	47.7	7.2	71.6	29.3
1610-19	49.5	0.004	46.5	7.4	66.5	71.8
1620-29	49.1	0.006	44.1	8.3	58.6	79.3
1630-39	58.3	0.007	40.2	8.8	66.3	66.5
1640-49	58.2	0.007	42.8	9.8	59.1	68.1
1650-59	58.1	0.009	44.0	11.0	65.9	64.9
1660-69	56.8	0.010	49.9	10.8	74.6	59.1
1670-79	54.3	0.011	48.4	11.6	74.9	66.6
1680-89	51.3	0.015	53.6	11.4	84.0	57.6
1690-99	57.3	0.021	45.8	10.7	87.0	61.6
1700-09	50.6	0.023	52.9	10.9	84.5	62.7
1710-19	54.5	0.031	54.0	10.9	78.4	68.8
1720-29	53.7	0.034	58.6	11.0	80.3	73.0
1730-39	49.2	0.032	62.1	11.7	93.1	66.7
1740-49	51.4	0.048	56.1	11.4	87.1	64.4
1750-59	55.8	0.039	63.2	11.4	80.6	78.4
1760-69	58.0	0.050	62.2	12.0	81.5	76.3
1770-79	67.2	0.058	62.1	13.4	78.3	79.4
1780-89	67.2	0.079	61.5	14.5	84.6	72.7
1790-99	83.4	0.094	63.9	16.4	77.4	82.6
1800-09	118.8	0.101	64.2	20.9	69.2	92.9
1810-19	127.4	0.104	76.5	24.5	75.5	101.3
1820-29	95.3	0.104	89.5	22.0	90.5	98.8
1830-39	89.6	0.082	89.4	21.9	95.9	93.2
1840-49	88.9	0.079	89.2	22.3	98.6	90.5
1850-59	92.5	0.056	89.6	23.2	98.6	90.9
1860-69	100.0	-	100.0	25.5	100.0	100.0
1870-79	105.8	0.101	96.2	29.6	110.0	87.4
1880-89	88.2	0.098	105.0	29.1	129.5	81.1
1890-99	73.1	0.114	111.1	29.8	160.1	69.4
1900-09	78.2	-	102.9	32.4	162.5	63.3
1910-12	84.7	-	101.0	33.0	152.9	66.1

Sources: Farm wages are day wages in pence in the winter. Wages 1500-1669 are from Clark (1999b). Wages 1670-1869 are from Clark (2001). Wages 1870-1902 are from Fox (1903). Wages 1903-1912 are from Arthur Bowley for Britain as a whole as reported in Mitchell (1988).

Nominal rent plus tithe is shown in table 6. But for the purpose of estimating total agricultural output and agricultural productivity we also need to know any taxes paid by land occupiers. For these taxes effectively make the state a partial landowner, entitled to receive some of the land rent. Taxes paid by the landlord we need not consider since these will be included in the rents and tithe as calculated. Appendix 2 details how the incidence of local taxes relative to land rents was estimated for the various years. For some periods such as before 1570, the 1860s, and the years 1894-1912 where sources were not available the estimates given in table 7 were extrapolated or interpolated. The series on local taxes in table 7 shows that these tended to rise over time as a share of rents. Before 1670 they were 1% or less of rents, but by 1815-19 they had risen to more than 10% of rents.

Table 7 and figure 7 show the resulting estimate of the real rental value of farmland (inclusive of tithe and taxes paid by occupiers) in England as an index, where the decade 1860-9 is fixed at 100. Figure 7 also show in comparison the implied real rents from the Turner, Beckett and Afton (these rents do not include local taxes). Real rents increase fivefold between the sixteenth century and the 1860s. The most dramatic period of increase is in the late sixteenth century when real rents increase by about 150%. From 1600 to 1809 real rents show a very modest upward trend, never exceeding 70 percent of their level in the 1860s. The next big jump in real rents, but still a modest jump in proportionate terms compared to the jump in the late sixteenth century comes at the end of the Napoleonic Wars. By the early 1820s real rents are nearly 90 percent of their level in the 1860s.

Figure 7: Real Rental Values per Acre, 1500-1912



Notes: Real rents for both series have been set to average 100 in 1860-9.

Sources: Table 7.

Rent versus Wages

Clark (2001, 1999b) calculates the day wages of agricultural laborers outside harvest in the interval 1500 to 1869. Using these wages, and the wages for 1870-1912 calculated by A. Wilson Fox and Arthur Bowley, table 7 shows the nominal winter wage of farm workers from 1500-1912 and the implied real wage measured in terms of farm output.

Figure 8 shows the implied ratio of rents to farm wages from 1500 to 1912 for England as a whole based on table 7, with 1860-9 fixed at 100. As can be seen the factor distribution of income switches sharply in favor of land in the first decade of the seventeenth century, when land rents relative to wages more than triple. Thereafter the ratio is fairly constant at about 70% of the level of 1860-9 until the late eighteenth century when it begins to rise, reaching a peak of 101 in 1810-9, before declining in the nineteenth century to be eventually only about two thirds of the ratio of 1860-9. Part of the reason for this later rise and decline was undoubtedly the Corn Laws in force between 1696 and 1846, which restricted the import of cheaper foreign foodstuffs as population in England grew after 1760. Another element in the late nineteenth century decline was the reduction of transportation costs and the subsequent opening up of the British economy to large-scale food imports.

The finding here of a huge switch of factor incomes in favor of land in the late sixteenth century was pre-figured by Allen's work on rents in the south Midlands compared to Bowden's estimates of farm wages (Allen (1992), p. 286). However, Allen finds a rise in rent/wage ratios from 1500-24 to 1600-24, which is twice as great as the one I find. Whichever of these estimates is correct the sharp rise in land rents relative to wages (and to prices) in the early seventeenth century implies that the portion of society which relied heavily on land rents as a source of income faired well economically in the Elizabethan period.

Figure 8: Land Rental Values relative to Wages, 1500-1912

Land Rental Values and Net Agricultural Output, 1500-1912

Having constructed rent per acre of land from 1500 to 1912, wages, and a price index for agricultural output I can estimate the total output of English agriculture over these years if I can estimate two further things: the number of workers employed by period and the payments to capital. For the net output of the agricultural sector will equal in value the sum of the payments to labor, and land and capital owners.

This measure of net output will have a number of advantages compared to attempts to estimate output by estimating crop yields, such as the probate inventory studies of Mark Overton and others, or the labor input method used by Clark. For these methods are confounded by the need to also estimate land use allocations to get an idea of overall net output per acre. But the rental data incorporated here for the same sets of plots of land over time allows for the changing uses of land in estimating overall net output.

To estimate the number of workers employed we have information from the population censuses from 1801 onwards. The first good census in terms of occupations, that of 1851, shows 1.036 m. male farm workers (including farmers themselves) between the ages of 15 and 64, 24 percent of the occupied male population. Using census records of occupations for male workers, or earlier for families, suggests that the share of males employed in agriculture declined from about 37 percent circa 1801 to 10 percent circa 1911. This gives the figures shown in table 8 for males in agriculture from 1800-9 on. For the earlier years I assume that the male farm labor force started as 60% of the

Table 8: Net Agricultural Output, England, 1500-1912

Period	Population (m.)	Share of males in Agriculture	Males in Agriculture (000)	Farm Wages (£. m.)	Total land rents and local taxes (£. m.)	Assumed Capital Payments (£. m.)	Nominal Net Farm Output (£. m.)
1500-39	2.55	0.60	369	2.1	1.2	1.0	**4.4**
1540-59	2.92	0.60	422	3.3	2.2	1.6	**7.1**
1560-79	3.14	0.60	455	4.8	2.7	2.2	**9.7**
1580-99	3.62	0.60	523	6.5	4.0	3.0	**13.5**
1600-09	4.12	0.60	596	7.6	9.9	5.1	**22.6**
1610-19	4.43	0.60	641	8.3	11.2	5.7	**25.3**
1620-29	4.70	0.60	680	9.9	10.5	5.4	**25.9**
1630-39	4.88	0.60	706	10.9	11.4	5.8	**28.2**
1640-49	5.08	0.60	735	12.6	12.1	6.3	**31.1**
1650-59	5.26	0.60	760	14.7	12.4	5.6	**32.9**
1660-69	5.23	0.60	756	14.4	13.8	6.0	**34.3**
1670-79	5.11	0.60	739	15.1	12.8	6.2	**34.2**
1680-89	5.06	0.59	720	14.4	13.3	5.7	**33.6**
1690-99	5.05	0.58	705	13.2	12.6	5.3	**31.4**
1700-09	5.16	0.57	709	13.5	12.8	5.2	**31.9**
1710-19	5.33	0.56	720	13.8	14.0	5.3	**33.5**
1720-29	5.45	0.55	723	13.9	14.9	5.6	**35.0**
1730-39	5.36	0.54	698	14.3	14.5	5.4	**34.7**
1740-49	5.67	0.53	724	14.5	13.5	4.9	**33.5**
1750-59	5.87	0.52	735	14.8	16.6	5.4	**37.4**
1760-69	6.25	0.49	738	15.6	16.8	5.7	**39.0**
1770-79	6.56	0.46	728	17.1	19.4	6.5	**44.1**
1780-89	7.14	0.43	740	18.8	18.8	7.2	**46.3**
1790-99	7.77	0.40	749	21.6	23.9	8.9	**56.7**
1800-09	8.59	0.37	756	27.8	34.0	12.5	**77.6**
1810-19	9.77	0.35	813	35.0	43.3	15.9	**98.7**
1820-29	11.35	0.33	894	34.5	37.9	14.2	**90.6**
1830-39	13.16	0.30	937	36.0	36.3	14.0	**89.3**
1840-49	15.78	0.26	975	38.2	36.0	14.1	**91.2**
1850-59	17.77	0.24	1036	42.3	38.5	15.3	**98.2**
1860-69	19.97	0.21	1013	45.3	44.7	17.7	**111.7**
1870-79	22.75	0.17	956	49.8	45.3	18.3	**117.9**
1880-89	25.78	0.15	921	47.1	41.3	15.9	**108.4**
1890-99	28.83	0.12	845	44.2	35.7	13.5	**97.6**
1900-09	32.12	0.10	810	46.0	35.4	14.0	**99.5**
1910-12	34.30	0.10	843	48.8	37.6	14.9	**105.7**

population before 1680, fell linearly to 52% by 1750-9, and then fell linearly to 37% by 1801.[10] The share in agriculture in 1680-1801 is based on the work of Peter Lindert on occupations (Lindert (1980), Lindert and Williamson (1982)). The assumed share for the years before 1680 is arbitrary. Allen (2000) assumes a higher share of 74% of labor in agriculture in 1500. But the estimated outputs and productivity change little before 1700 if we assume a lower share of male labor in agriculture, since a reduction of 10% in the assumed share of male labor in agriculture reduces estimated farm output, given the methods used here by only about 5%.

Multiplying the estimated population of England by the share of adult males assumed to work in agriculture gives the estimated male labor force of table 8. This rises in line with population until the 1680s when the number of workers employed in agriculture from then until the 1790s remains fairly constant despite rising population. From 1800 to the 1850s, however, the male labor force rises by over a third, despite the falling share of males employed in agriculture. Thereafter the labor force begins a slow decline.

These labor force numbers in turn estimate an estimated wage bill, including an allowance for the labor of farmers. The census of 1851 suggests even if women's and youths' wages were 60 percent those of men in agriculture, 83 percent of all wages were paid to adult males. Thus the wage bill throughout is calculated as 120% of the annual earnings in full employment of adult men. If more women and youths were employed earlier the corresponding wage bill would be somewhat higher earlier. Clark (2001) explains why the assumption of full employment for agricultural laborers is a reasonable one, at least for the years after 1640.

---

[10] These assumptions are similar to those of Allen (1999).

There are various estimates on the value of the capital supplied by the tenant per acre of land in England in the nineteenth century, with general agreement on the rough magnitudes involved. The most detailed, by Charles Wratislaw in 1861, and the one I use as a benchmark, suggests that the tenant needed to supply on average £8.68 per acre. Other estimates from 1838 and 1878 suggest respectively £10 and £12 per acre.[11] Wratislaw omits any allowance for the cost of the maintenance of the farmer over the course of the year. Assuming the farmer expends £100 on himself, Wratislaw's capital per acre would be £9.2. This would be composed as follows

Live Stock	60%
Implements	11%
Seed, Labor, Horse and Cattle Food	21%
Rent, tithe and taxes in advance	3%
Maintenance of farmer	5%

If we allow 10% depreciation on the workhorses of the farm and on the implements, and nothing on the other items of capital, then the overall depreciation rate will be roughly 2.5%.[12] Allowing the farmer the return on capital from bonds or mortgages, this would imply a capital cost in the 1860s of £0.67 per acre. Added to our estimates of rent, tithe and local taxes, and wage payments, this makes total output per acre in the 1860s £4.2. Wages are 41% of costs, rent, tithe and taxes 46% and the farmer's capital 16%. The land rent actually includes a substantial amount that is a return to capital in the form of buildings and land improvement.

---

11 Wratislaw (1861), Tomson (1847), Squarey (1878).

12 Animals such as horses were allowed a higher rate of depreciation of 10%, but some of the capital such as labor paid in advance

To estimate the equivalent capital costs for the other decades I make the following assumptions. First that the interest cost of the capital employed by farmers was the average of the return on bonds and mortgages. Second that the price of capital goods was the same as the price of farm output. Since live stock, seeds, and animal food were the majority of the capital stock, and implements were a small share, this assumption seems reasonably innocuous. Third I assume the depreciation rate was constant at 2.5%. Lastly I assume that the capital-output ratio for the farmer's capital did not change over time. This last assumption is the most contentious. But again when we consider the importance of animals, fodder and seeds in farmer's capital it does not seem that there was any reason to expect any change in the capital output ratio over time. With these assumptions I get the implied payments for capital shown in table 8.[13]

The final column of table 8 shows the implied nominal net output of the agricultural sector from 1500 to 1912. Purchases of inputs such as fertilizers and cattle feed (in the form of oil cake) in the later years of the nineteenth century will not show up in these calculations, and so for the latter decades if we want to calculate the implied flow of produce from the agricultural we need to make an allowance for these purchased inputs. The amounts of these purchased inputs was very small relative to the inputs of land, labor and capital, however, until after 1860. Total purchases of guano and oil cake were less than £2 m. per year before 1870. Thus the omission of these purchased inputs does not distort my estimate of output by very much before 1870, but would be potentially more important thereafter. This calculated output also assumes that the farmer earns

---

13 The value of the capital stock in each period was calculated as the sum of the payments to land and labor divided by (v-(r+d)) where v = the output-capital ratio in 1860-9 (= 2.184), r = the interest rate for each period, and d = the depreciation rate = .025). This multiplied by (r+d) gave the implied payments to farmers' capital.

nothing for his entrepreneurship beyond the manual wage plus the normal return on the capital he employs. This assumption is consistent with the idea that in a competitive sector like agriculture entrepreneurial returns were low. But if the return to farmers capital were marked up to include some return to entrepreneurship, then the implied rate of productivity growth and output growth would be smaller if that markup was constant over time since I have assumed a constant capital-output ratio.

Dividing the value of net output by the price index yields an estimate of real net output, which is shown as the second column of table 9. Figure 9 shows the real net output series, which is also by implication a series for real **net** yield per acre: gross output minus the parts used within the farm sector such as seeds and animal feed. Total net output, and hence net output per acre, increased roughly four fold between the early sixteenth century and the 1860s. There are two periods of particularly fast growth in output, around 1600 and around 1820. Since both these periods followed upon periods of price inflation there is some chance that the appearance of rapid output growth reflects just the catching up of rents with the underlying economic value of land once the inflation has ended and there is time for the land market to fully adjust to the real rental value of land. Table 10 shows the growth rates of net output over the years 1520-1605, 1605-1795, 1795-1825, 1825-1865, and 1865-1911. In both 1520-1605 and 1795-1825 implied output growth per year was 0.8% or higher. The years 1605-1795 were ones of slow output growth of only 0.13% per year, so that over these 190 years net output per acre increased by only 30%.

Table 9: Real Agricultural Output and Productivity, England, 1500-1912

Period	Real Output (1860-9 = 100)	Real Output per Male Farm Worker (1860-9 = 100)	Real Output per Capita (1860-9 = 100)	Productivity (1860-9 = 100)
1500-39	24.6	67.7	193.2	49.2
1540-59	25.6	61.5	175.4	47.4
1560-79	28.6	63.6	181.5	49.8
1580-99	31.3	60.5	172.7	49.9
1600-09	47.4	80.6	229.8	64.8
1610-19	45.8	72.4	206.5	61.1
1620-29	47.2	70.3	200.5	62.0
1630-39	43.3	62.1	177.2	56.9
1640-49	47.8	65.9	188.0	60.8
1650-59	50.7	67.5	192.5	63.3
1660-69	54.0	72.3	206.2	67.1
1670-79	56.4	77.3	220.4	69.7
1680-89	58.6	82.5	231.4	73.2
1690-99	49.0	70.4	194.2	63.8
1700-09	56.5	80.6	218.5	71.6
1710-19	55.0	77.5	206.2	69.8
1720-29	58.3	81.7	213.6	73.1
1730-39	63.1	91.6	235.2	79.2
1740-49	58.4	81.6	205.6	73.2
1750-59	60.1	82.8	204.6	74.6
1760-69	60.1	82.5	192.2	74.5
1770-79	58.8	81.8	178.9	73.4
1780-89	61.7	84.4	172.6	75.9
1790-99	60.8	82.2	156.3	74.6
1800-09	58.5	78.4	136.0	71.6
1810-19	69.3	86.4	141.8	80.0
1820-29	85.0	96.3	149.6	91.8
1830-39	89.2	96.5	135.5	93.9
1840-49	91.9	95.5	116.3	94.7
1850-59	95.0	92.9	106.8	94.9
1860-69	100.0	100.0	100.0	100.0
1870-79	99.8	105.7	87.6	102.2
1880-89	110.0	121.0	85.2	113.5
1890-99	119.5	143.2	82.8	127.2
1900-09	113.9	142.4	70.8	124.4
1910-12	111.7	134.1	65.0	120.1

Figure 9: Net Output per Acre and per Male Farm Worker, 1500-1912

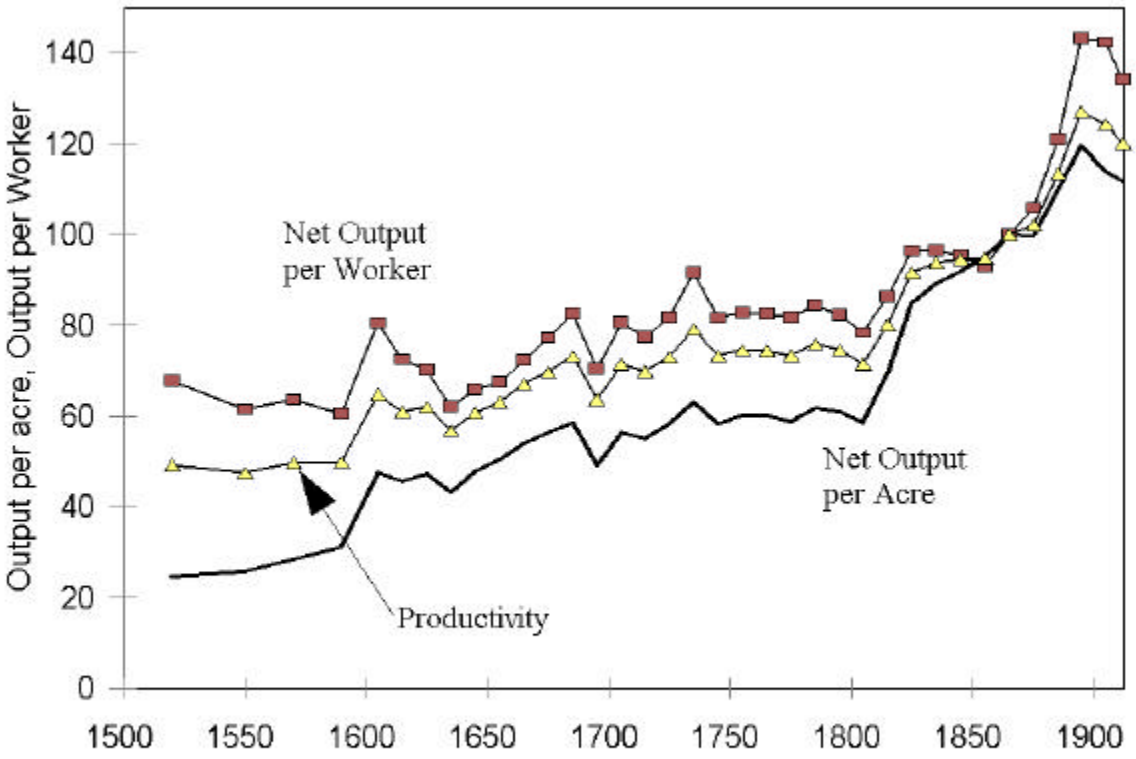


Table 10: Annual Growth Rates of Output, Output per Worker and Productivity by Period

Period	Net Output (%)	Net Output per Worker (%)	Productivity (%)
1520-1605	0.77	0.20	0.38
1605-1785	0.13	0.01	0.05
1795-1825	1.12	0.53	0.69
1825-1865	0.41	0.09	0.22
1865-1911	0.24	0.64	0.40
1520-1911	0.39	0.17	0.23
1795-1911	0.52	0.42	0.41

Implied net output per worker is shown as the third column of table 9, and also in figure 9. Output per adult male worker consistently grows much more slowly than net output per acre in the years before 1860-9. Only in the late nineteenth century does the growth of output per worker exceed that of output per acre. Thus output per adult male worker in 1500-39 is estimated at 68% of its level 350 years later in 1860-9. By the early seventeenth century real net output per worker is 75% of its level of 1860-9. The fastest rate of growth of output per worker is observed in the years 1860-9 to 1910-12, when there was mechanization of many tasks such as threshing grain, reaping grains, and mowing meadow.

These results are not particularly sensitive to the assumption that the share of male labor in agriculture was only 60% as far back as 1500. If instead I assume that 75% of male labor was in agriculture in 1500, in line with Bob Allen's recent assumption in looking at the movement of land and labor productivity across Europe, falling to 59% by the 1680s, then in 1500-39 implied net output is 28.8 (instead of 24.9), 16% higher. But that still implies a growth of output of nearly threefold between 1500-39 and 1860-9. Net output per worker is correspondingly 7.3% lower in 1500-39, but is still 63% of its level of 1860-9.

These do results imply a remarkable decline in the net agricultural output per person in England in the decades after 1760-9, as column four of table 9 shows. Domestic agricultural output per person in 1860-9 is only half the level in 1760-9. This issue will be considered further below.

Agricultural Productivity

Total factor productivity in agriculture can be approximated using the formula

$$A = \prod_{i,j} \frac{\lambda_j^{\theta_j}}{p_i^{\theta_i}}$$

where A is an index of productivity, p_i is the price of output i, and θ is the share of output i in the value of output, λ_j is the wage paid to input j, and θ_j is the share of input j in the total payments to inputs. Tables 7-9 contain all the elements necessary for this calculation, and the last column of table 9 shows productivity in each year calculated with a base of 1860-9 at 100. The weights used for labor, land and capital were 0.40, 0.43 and 0.17 respectively for the years 1600-1879, 0.46, 0.40 and 0.14 for 1880-1912, and 0.48, 0.29 and 0.23 for 1500-1599 in line with the estimated payments to land, labor and capital in table 8. As noted above the labor input in agriculture in the years before 1680 is largely speculative. But if I assume that the share of male workers in agriculture in 1500 started at 75%, and then fell linearly to 60% by 1670-9, then it has little effect on the productivity series before 1680. Thus productivity in 1500-39 instead of being 49.2% of that of 1860-9 would be 50.8%. The reason for this is that increasing the number of workers earlier affects the productivity calculation by increasing the weight of labor earlier and reducing that of land. Thus the shares of labor, and land before 1600 become .51 and .26. Since wages were increasing much less than land this reduces the estimated productivity gains of the sixteenth century, but not by very much.

Over the whole period measured productivity increased at an average rate of 0.23% per year. This is very slow by modern standards. As can be seen the period of most productivity

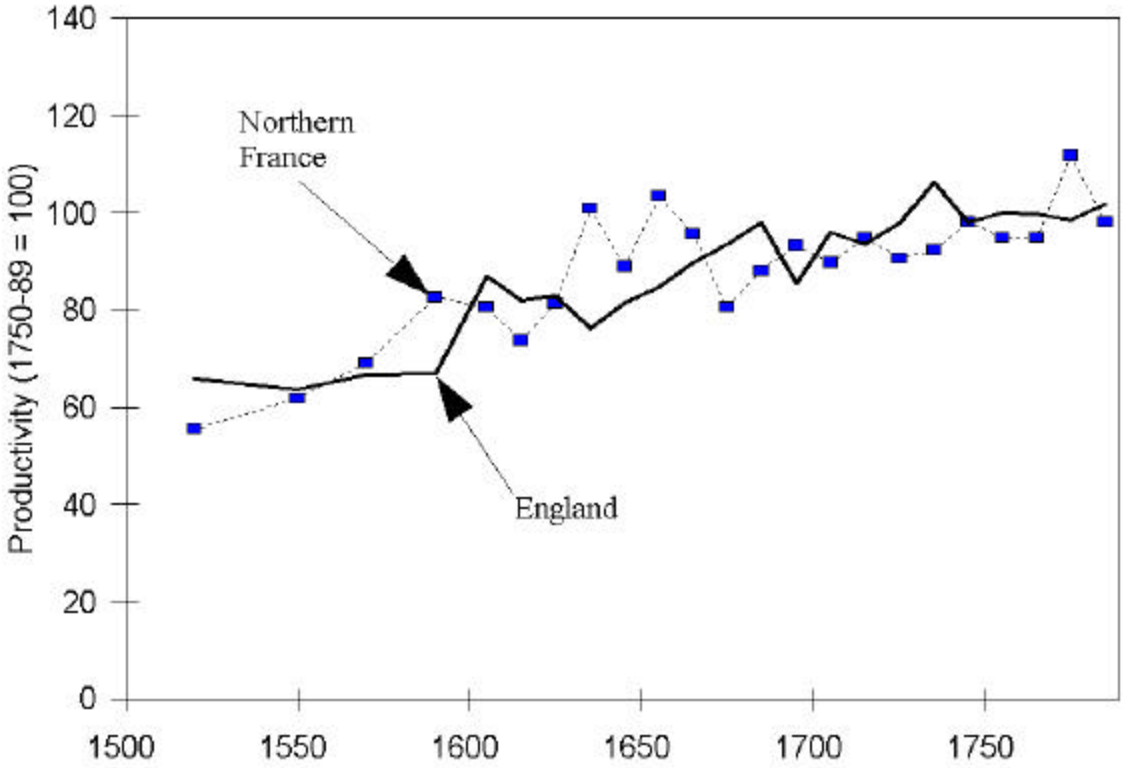
growth is the nineteenth century, where there is a 61% gain between 1790-1809 and 1900-12.[14] That gain comes in two distinct phases, one in the early nineteenth century, followed by a pause from 1825 to 1875, and a second in the last quarter of the nineteenth century. There is a long period from 1600-9 to 1800-9 where there is very little productivity growth. In 200 years productivity increases by no more than 20%. The years 1500-39 to 1600-9 do show a much faster rate of productivity growth, with measured productivity increasing by about 30% over the sixteenth century.

Philip Hoffman has recently published estimates of total factor productivity derived in a similar way for a set of farms in the Paris Basin for the years 1520-1789. Figure 10 shows the productivity movement on these farms compared to productivity movement for England where 1750-89 is set to 100 for each case. Overall these farms in the Paris Basin show as much or more evidence of productivity growth in the years 1500-1789 as does England. Thus the conventional picture that in the eighteenth century France had a stagnating agricultural sector mired in the feudal past, while England had a vibrant agricultural sector forging ahead, simply does not appear in this productivity comparison, at least when we compare Northern France to England. These two agricultural regions both were achieving very modest and incremental productivity gains over a very long course of years. There is nothing in the productivity series to suggest that after 1789 England would go on to triumph in the world of industry and commerce, and France would lag.

---

[14] 1800-9 is not used as a base since there was a measured fall in productivity between 1790-9 and 1800-9 that may be just the result of a lag in rents behind the wartime price rises.

Figure 10: Productivity Growth, England Compared to Northern France



Notes: The average of each series is set to 100 for 1750-89.

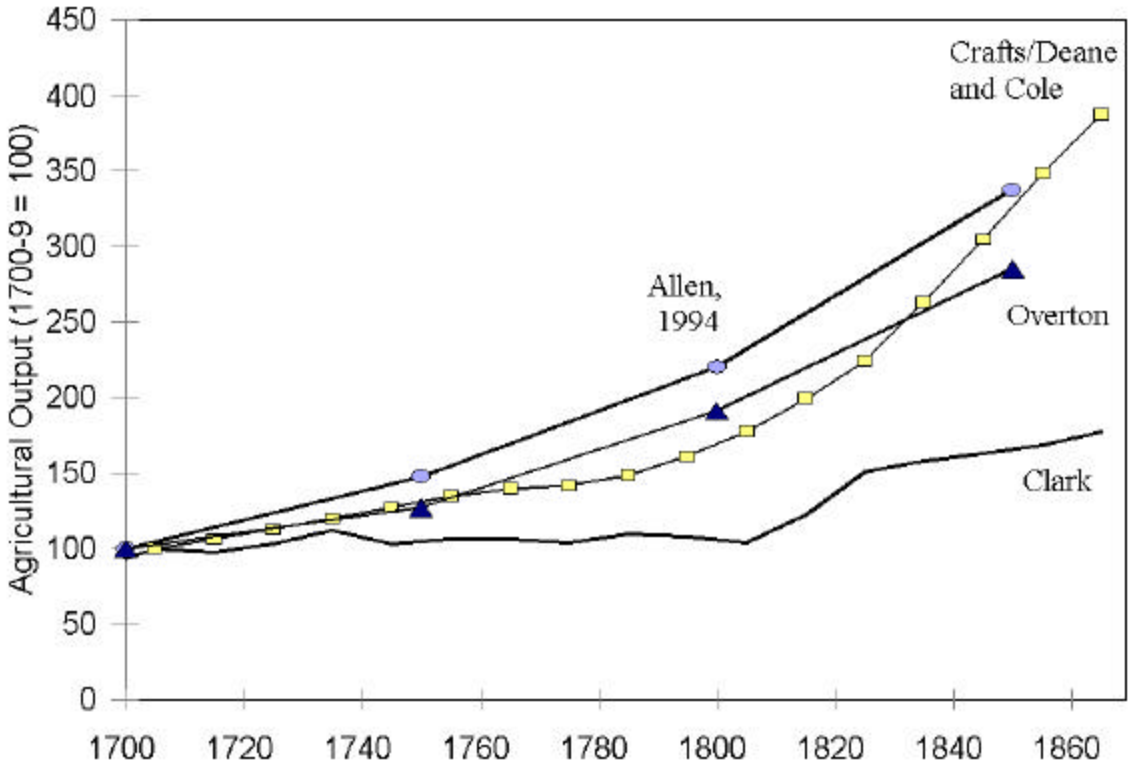
Sources: Table 9. Hoffman (1997), p. 90.

Net Farm Output, Food Demands, and the Industrial Revolution

The real output series produced here shows much slower growth than the conventionally accepted series of output growth for the years 1700-1869. Since these series underlie Crafts' estimates of the overall rate of economic growth in Industrial Revolution Britain if this revision is correct then we need to substantially revise our ideas about the role of agriculture in economic growth in Britain in the Industrial Revolution period, and indeed about the Industrial Revolution itself. Figure 11 shows my estimate of output growth in England with 1700-9 set at 100, compared to the estimate of Crafts for Britain for 1700-1831, and of Deane and Cole for Britain for 1831-1861/71: the series that underpin the standard Crafts account of growth in Industrial Revolution Britain. The estimates of Deane and Cole are derived in the same manner as here from factor payments, but Deane and Cole had not direct evidence of rents in 1831, and the price series they used contained many imported agricultural items. These imported goods – tea, coffee, sugar, tobacco, rum, cinnamon, olive oil, pepper and logwood – were subject to very different price trends, and were also often heavily taxed in earlier years. The estimates of Crafts are derived from consideration of the estimated consumption demand of the population. Figure 11 also shows recent estimates from Bob Allen in 1994 and Mark Overton in 1996 of farm output estimated from partial information on grain yields and animal sizes and stocks. The Crafts/Deane and Cole estimates and those of Bob Allen and Mark Overton from internal evidence on yields in agriculture seemed to match fairly well.

All of these estimates, however, are quite inconsistent with the evidence from farm incomes presented in this paper. Thus farm net output in 1860-9, for example, is less than half as great compared to 1700-9 on my estimates than it is Crafts/Deane and Cole account. This mismatch between the food demands from the British population in the Industrial Revolution

Figure 10: Alternative Estimates of Output Growth in England/Britain, 1700-1860.



Sources: Allen (1994), p. 102, Crafts (1985), p. 42, Deane and Cole (1962), pp. 166-70, Overton (1996), p. 75.

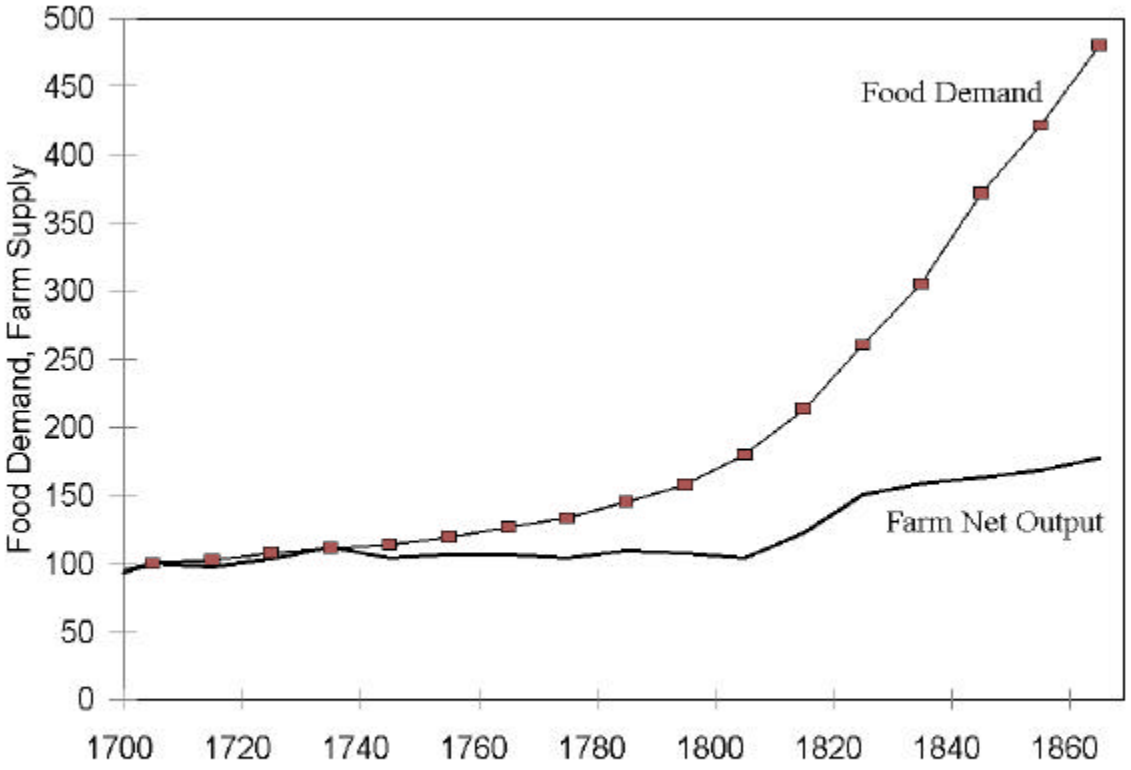
period, and the evidence on food supply from domestic agriculture has already been explored in Clark, Huberman and Lindert (1995). But the apparent contradiction between supply based estimates and demand estimates of agricultural output needs to be addressed before we can have any confidence that the agricultural output and productivities series have any validity. Figure 12 shows the seeming contradiction in its most stark form. Total demand for agricultural produce in England is estimated from the equation

$$D ? aNy^{0.6}$$

where N is the population of England and y is an estimate of real income per capita, and a is a constant. Bob Allen has recently pointed out that to correctly estimate food demand we should also take into account changes in the relatives prices of agriculture and other products (Allen (1999)). For this period, however, food prices do not move particularly differently from a general consumption price index in England, so that the distortion induced by only considering income will be modest. Figure 12 seemingly implies that by the 1860s domestic farm output would supply only 37% of the food demanded by an English population that had grown nearly fourfold, and whose income per person had increased by 44% since 1700.

If the output series derived in this paper is to be plausible then we have to bridge the gap between farm output in the lower curve and food demand in the upper curve. The first important element is food imports. Unfortunately from 1830 on we only have trade statistics for the United Kingdom, constituting in addition to England, Wales, Scotland and Ireland. And Ireland was a net exporter of food to England. We thus have to make some assumption about how food imports to the United Kingdom were allocated. What I assume here is that Wales, Scotland and Ireland were on balance self-sufficient in food, and that all imports of food to the United Kingdom went to England. In the 1860s food imports were on average £75 m. so that they

Figure 12: English Food Demand and Farm Output, 1700-1869



Note

Source: Real output per person from Clark (2000).

were 67% of domestic net farm output. In 1700-9 food imports were on balance £2.2 m. in 1860-9 prices (see table 11).[15] But this still means that based on the output per person in 1700-9 food availability per person in 1860-9 was only 76% of what it was per capita in 1700-9, and only 62% of the expected demand per person once we take into account rising incomes per person.

Clark (1999a) suggests that this apparent puzzle is generated mainly by the mistaken assumption that the output of English agriculture was almost entirely food for human consumption. The assumption that English agriculture produced only food is close to true by the 1860s, when at least 90% of English agricultural output went for human food consumption. But that was possible in the 1860s and later because the demands of the population for heat, light, building materials, clothing fiber, bedding fiber, dyestuffs, and transport were largely met either by imports or through mined coal. In the pre-industrial period domestic agriculture could not specialize on food production because it also had to supply all these other needs. Wood, turf and furze was needed for fuel and construction, wool and flax were required for clothing, oats and hay were needed to feed horses for transport.

Domestic agricultural production of energy was replaced almost entirely by the coal industry. Thus coal used for domestic consumption is estimated for Britain in 1700 at as low as 0.2 tons per capita (Hatcher (1983, p. 68, p. 409)). By 1855, coal consumption for domestic purposes had climbed to 0.73 tons per capita (Church (1983, p. 19)). How many cubic feet of wood an acre of woodland would produce in a year is not known. Modern sources note that

---

15 There were exports of wheat and barley, but these were very modest relative to agricultural output, and were counterbalanced by imports of sugar, wine, coffee and tea.

woodland in England can produce "up to 100 cubic feet per year."[16] Assuming that woodland produced at this upper limit of 100 cubic feet per year, if woodland supplied enough energy for domestic purposes to bring energy consumption in 1700 up to the equivalent of .73 tons of coal then there would have to have been 1.6 m. acres of woodland in England in 1700, 6% of the farm area.[17] A sign that coal was substituting for other fuel sources, which must have been wood from the domestic agricultural sector, comes from the experience of the London coal market. Coal consumption per capita in London exhibited the following pattern in terms of tons per capita: 1700, 0.8; 1750, 1.0; 1800, 1.3; 1830, 1.3. Thus either energy consumption per capita rose by 60% between 1700 and 1800 in London, at a time when there is little sign of income increases, or Londoner's were still using significant quantities of billets and faggots from the agricultural sector even in 1700.[18]

Coal further replaced wood as the energy source in such energy intensive activities as iron and steel, brick and pottery making. Iron production in England in the early eighteenth century was a very modest 17,000 tons annually. Yet each ton seems to have required about 1,800 cubic feet of wood. At the upper estimate of timber growth rates iron production in England in the early eighteenth century would have required an additional 300,000 acres of woodland to sustain

---

16 See Hammersley (1973, pp. 604-5). The French National Forest Service estimates its average growth rate as only 23.5 cubic feet of timber per acre in the 1990s. But the national forests would include much mountainous and marginal land.

17 This may just have taken the form of thicker fences. I noted above that in 1845 fences were estimated to occupy 7% of the land in Devon.

18 Tons consumed is from Flinn (1984, p. 274). The population of London is from Wrigley (1985) for 1700, 1750 and 1801, and thereafter from the census.

it.[19] There would be additional calls on wood in 1700 for energy for brick and pottery production.

The construction timber imported annually into England in the 1860s was the equivalent of 6.9 cubic feet per person per year.[20] If the same amount of timber per person were homegrown in 1700 that would add another 360,000 acres of woodland. In total for heating, construction and iron production alone the lower bound estimate, assuming woodland produced the maximum estimated 100 cubic feet per acre per year, is that 8.5% more of the farmland area had to be devoted to wood production in 1700 than in 1860.

Agriculture in 1700 also had to produce most of the fiber used to clothe people and provide bedding in the form of wool or flax. By 1860 almost all of this fiber was imported in the form of cotton, wool, flax, hemp, jute and silk.

Table 11 shows estimated farm output per capita for 1700-9 and 1860-9 for England in the prices of the 1860s. Also shown in 1860s prices are supplies of domestically consumed coal, and imports of food and raw materials. Counting all of these sources of supply of food, raw materials and energy, despite the decline in domestic farm output per person to about half its level of the 1700s there is a nearly 20% increase in the consumption of food, raw materials and energy per capita. The rise in consumption per capita is about what we would expect if the income elasticity of demand for food, raw

---

[19] Wrigley (1988), p. 80, quotes the conventional figure that one ton or iron required felling 10 acres of wood. If this number is correct, and if woodland was felled every 15 years, then iron consumption would require 2.55 m. acres of woodland in the early eighteenth century.

[20] This is assuming that UK imports were distributed according to population except that the Irish consumed half as much per head because of lower incomes.

Table 11: Agricultural Consumption per Person in England, 1700s to 1860s.

	1700-9	1860-9
Population (millions)	5.16	19.97
English Farm net output (£ m.)	63.1	111.7
Net Food Imports (£ m.)	2.2	75.2
Net Raw Material Imports (£ m.)	-1.3	62.7
Domestic Coal Consumption (£ m.)	1.7	50.3
Total Food, Energy and Raw Material Consumption (£ m.)	65.7	309.9
Consumption per Person (£)	12.7	15.5
Predicted Consumption (£)	12.7	15.8

Notes: Cotton, wool, flax, and silk retained for home consumption are estimated by subtracting the raw material content of textile exports estimated using figures given in Deane and Cole (1962).

Coal prices were taken as the average of export prices for coal free on board and the price of best coals in London.

Sources: Coal production: Flynn (1984, p. 26) and Church (1986, pp. 19, 53, 85-97). Imports 1860-9: Mitchell (1988). Imports 1700-9: Schumpeter (1960, tables XV, XVII). Exports 1700-9: Schumpeter (1960, tables VII, IX, X, XII, XIII), Mitchell (1988), pp. 221-2).

materials and energy is about 0.6. Now the 0.6 figure comes from budget studies on food demand for working class families in the 1860s in England (see Clark, Huberman and Lindert (1995)). This elasticity may well be higher once we include demand for energy and raw materials. On the other hand richer consumers had a lower demand elasticity for food. But the elasticity assumption is not crucial here since I estimate an increase in income per person in England between 1700-9 and 1860-9 of only 33%, so that whatever the figure is in the range .5-1.0 will make a relatively small difference to estimated total demand for food, energy and raw materials in 1860-9 relative to 1700-9.

An implication of the reconciliation here between food demand and farm net output is that about one third of English farm output in 1700-9 had to be for food for horses, energy and raw materials.[21] This implication is not at present directly testable, but farm accounts from this period should show a larger share of income from sales of faggots, hay, oats, and timber if the output series derived here for English agriculture is to be correct.

Sources of Productivity Growth

Figure 9 suggests that productivity growth in the years 1500-1869 was driven mainly by growth in output per acre, while productivity growth in the late nineteenth century was dominated by growth in output per worker. That is 1860-9 in England marks the break between a pre-mechanization era where labor productivity was largely stagnant because labor inputs on many tasks such as threshing and harvesting were heavily dependent on outputs, and little influenced by

---

21 Indeed that is why in the price index for agricultural output in the years before 1775 wood, tallow, hay, and wool is given a weight of 0.18 in forming the price index (compared to a weight of 0.06 in 1860-9).

yields, and a mechanization era where labor productivity could rise even though yields improved little. Thus already by 1700 labor productivity is at 80% of its level in 1860-9.

The relative unimportance of labor productivity gains in the years before 1860-9 is a puzzling. For what is unusual about English agriculture compared to other European economies in 1860 was precisely the very high labor productivity of England. Thus in the mid nineteenth century output per acre in England was similar to output per acre in the Netherlands and Belgium, and only about 20% greater than output per acre in France and Ireland. But output per worker in England was double or more output per worker in all these other countries.[22] In particular output per worker in France is estimated at only 44% of its level in England in 1851. But this implies real output per male worker in England in 1700 already far exceeded output per worker in any other European economy in the 1850s. And even if 75% of the male labor force was in agriculture in the years before 1680 real output per worker in England in 1600 would be greater than in France in 1850.

High English labor productivity in 1850 compared to other Western European countries has been taken to imply that there must have been substantial labor productivity growth in England sometime before 1860-9. Indeed there is a long history, starting with Marx, that emphasizes how in England the development of capitalist agriculture led to the expropriation of the independent peasantry, and the creation of a landless rural proletariat that were easily moved into the industrial sector. Thus there have been a series of articles recently estimating when labor productivity in English agriculture rose and seeking to explain its causes. Wrigley (1985) uses urbanization as a way to measure this (assuming constant food consumption per person) and finds

---

22 See Clark (1991), Wrigley (1985), Allen (1988)

that labor productivity in England nearly doubled between 1500 and 1800. Allen (1988) explores the role of larger British farm sizes in explaining this labor productivity growth and finds that farm size growth predicts a more than doubling of labor productivity in the south Midlands from 1600 to 1800. Patrick O'Brien concludes that "British families left the countryside, partly in response to better opportunities in towns or abroad, but essentially because the institutions of capitalist agriculture will not retain as much redundant labour" and that "the institutions and culture of peasant agriculture in France operated to restrain the outflow of people from countryside to towns and from agriculture to industry" (O'Brien (1996), p. 226, p. 228). Allen recently in this journal applies a more sophisticated variant of Wrigley's method over the years 1300, 1400, 1500, 1600, 1700, 1750 and 1800 which takes into account changes in food demand per capita also (Allen (2000)). This refined method still finds that labor productivity in agriculture roughly doubles from 1600 to 1800, while French labor productivity hardly increases at all, and that these were the years when the two economies diverged into a progressive England and stagnant France.

My evidence on farm output estimated from factor payments suggests, however, that the institutional changes in English agriculture between 1600 and 1800 – enclosure and the growth of the wage labor force in the countryside - had little effect on labor productivity. If England and France started out with the same agricultural labor productivity in 1600, and ended up with England at more than twice the level of France, then France must have seen a substantial decline in labor productivity over these years.

Further the observed gains in labor productivity between 1500 and 1860 may themselves be explained mainly as a consequence of yield growth. As Clark (1991) explores, a rise in grain yields will itself lead to some increase in labor productivity. Indeed based on the estimates there the yield gains from 1500 to 1860 would easily explain any labor productivity gains. Even if these

hypothetic calculations are incorrect it is clear that much of the observed gain in labor productivity between 1500 and 1860 would have to be attributed to yield gains, rather than to factors such as farm size, enclosure, or the creation of a landless rural proletariat.

Yield growth then seems to be the driving force in agricultural change between 1500 and 1860-9. The yields estimated per acre for 1500-39 are indeed low: the equivalent of 3.3 bushels of wheat per acre as net output. Clark (1991) estimates for southern England in 1300-49 from manorial account records that net output per acre was the equivalent of 4.1 bushels per acre. Thus there is no sign of any gain in yields in this 200 years, and indeed signs of some potential decline. Thereafter measured yields grow most rapidly in the late sixteenth century and early nineteenth century with a long period of stasis in between. The cause of these yield gains remains unclear. But the new information presented here on the timing of the gains may rule out some explanations and support others.

Conclusion: The Agricultural Revolution

The concept of that an agricultural revolution as a counterpart to the Industrial Revolution occurred in Britain sometime in the years 1560 to 1870 has long been the crucial organizing principle of English agrarian history. Thus at least eleven books have been written about English agriculture in these years which include "agricultural revolution" in their title. Most of the debate among agricultural historians has been about when in the long period 1560 to 1850 the agricultural revolution occurred, with the years 1550-1650, 1650-1750, and 1750-1850 each having their supporters.[23]

---

23 See, for example, Overton (1996) and Allen (1999).

Yet if the rent and associated real output series derived above are correct it is not clear if we can usefully think of developments in English agriculture in the years 1500 to 1869 as representing any revolutionary change in technique. It is true that over these years English agricultural output seems to have quadrupled, and the measured total factor productivity of the system doubled. But this was achieved over a very long period with few abrupt changes so that the rate of growth of productivity per years was on average 0.21%. This would mean that even in any twenty year period farmers would be unable to discern given the noise of year to year fluctuations that productivity was actually increasing.

Further the measured doubling of productivity between 1500-39 and 1860-9 certainly overstates the true productivity gain - as opposed to gains from more investment of capital in farmland. For this measure assumes that each acre of farmland was the same in 1860-9 as in 1500-39. All farmland, however, was a bundle of raw land and various capital investments: housing, barns, fences, drainage, roads, soil amendments. But we see above in figure 8 that after 1600 land became much more valuable relative to labor than before, and the rise in the value of land relative to labor continued until the early nineteenth century. If the cost of the capital invested in the land was proportionate to labor costs this would mean that after 1600 landowners would have an enhanced incentive to drain, reclaim, recycle animal waste, and build buildings. Thus, for example, about 10% of the rise in real rents from 1500-39 to 1860-9 was the result of common land being enclosed. Hence enclosure explains about 4% of the measured productivity increase. But I argue in Clark (1998b) that enclosure was mainly a capital investment induced by higher land rents relative to wages, with very little pure productivity gain. If the various other measures which resulted in higher land yields – increases in the pasture area, reduced fallow on the arable, higher arable crop yields – resulted in part from investing more capital in the form of

maintaining increased stocks of organic matter in soil and returning more animal waste to the soil, then again my productivity measure based on rents will mismeasure some of these gains from intensified use of land as pure productivity gains. The only way we could test to see how powerful these effects are would be to measure productivity using as a measure of land rents the site value of agricultural land. But no such measure is available.

Thus the extent to which the "agricultural revolution" of the years 1500 to 1869 was a revolution, in the sense of getting something for nothing through getting more output from the same set of inputs, or was just an intensification in the use of land, getting more output by using more inputs, is a matter still to be settled.

Appendix 1: Agricultural Prices, 1500-1912

Table 12 shows the prices used for each commodity in the base years 1860-9, and the share of output allocated to each commodity in each period. The weights for 1860 on were derived from Fletcher (1961). Those for before 1859 are from Clark (1991). For the years before 1830 the weights for all other commodities were reduced to allow the addition of tallow and wood as significant agricultural outputs based on the discussion in the text above. Prices for the index were derived from Beveridge (1939), Thorold Rogers (1888), Bowden (1985) and John (1989).

Table 12: Output Shares of Different Commodities

Commodity	Price 1860-9	Weights 1500-1774	Weights 1775-1805	Weights 1805-29	Weights 1830-59	Weights 1860-84	Weights 1885-1912
Arable		.46	.48	.49	.50	.40	.27
Wheat	6.269 s./bu.	.23	.24	.24	.25	.25	.11
Barley	4.379 s./bu.	.14	.14	.15	.15	.11	.10
Oats	2.892 s./bu.	.09	.10	.10	.10	.04	.06
Pasture		.46	.48	.49	.50	.60	.73
Beef	5.431 d./lb.	.13	.14	.15	.15	.19	.25
Mutton	6.346 d./lb.	.13	.14	.15	.15	.19	.19
Tallow	-	.02	.02	.00	.00	.00	.00
Butter	12.004 d./lb.	.05	.05	.05	.06	.08	.12
Cheese	7.020 d./lb.	.05	.05	.06	.06	.08	.12
Hay	97.3 s./ton	.02	.02	.02	.02	.02	.02
Wool	21.388 d./lb.	.06	.06	.06	.06	.04	.03
Wood	-	.08	.04	.02	.00	.00	.00
All		1.00	1.00	1.00	1.00	1.00	1.00

Appendix 2: Taxes on Land Occupiers, 1500-1912

In addition to national taxes such as the Land Tax of 1692 and later which were typically paid by the landlord, land occupiers in England were subject to a variety of taxes for local purposes. Thus there were Poor Rates, Church Rates, Highway Rates, County Rates, Police Rates, and later in the nineteenth century Sanitary Rates. Since the Poor Rate was the majority of local taxation in early years often all these rates were lumped together and included under the title Poor Rates in the years before 1860. A benchmark for the incidence of land taxes on land occupiers was established for rural parishes in England for the years 1841-2 using the ratio of poor rates in 1841 in parishes where at least 75% of property rental value was from land to the total rental value of property in 1842 under the Income and Property Tax. The counties used were Bedford, Berkshire, Buckingham, Cambridge, Cheshire, Cornwall, Cumberland, Derby, Devon, Dorset, Durham, and Essex. The rural parishes in these counties suggested that poor rates were 5.5% of rents in the North, 9.3% in the Midlands, 9.4% in the South-East and 10.1% in the South-West.

Total payments for poor rates in rural areas were then calculated for the years 1812-14, 1829-33, 1838-1841, 1851 and 1855 using parish level data in the Parliamentary Papers. This series on rural poor rate payments was extended to the years 1570-1824 by use of archival data on poor rate payments in 25 rural parishes in Bedford, Cambridge, Dorset, Essex and Warwick. This series divided by the estimated total land rent and tithe of England gives the estimates for the ratio of local taxes to rents shown in table 7. The parishes supplying data (with the number of years in parenthesis) were Eaton Socon (46), Flitwick (57), Kempston (76), Northill (53), Potton (92), Southill (31), and Tempsford (39) from Bedford, Foulmere (68), Kirtling (102), and Over (97) from Cambridge, Abbotsbury (86), Askerwell (33), Beer Hackett (98), Bere Regis (89), and

Buckland Newton (100) from Dorset, Alphamstone (53), Bobbingworth (85), Boreham (45), Debden (93), Fairstead (118), Gosfield (128), Great Easton (44), and Writtle (25) from Essex, and Tysoe (95) from Warwick.

For the years 1870-1893 local tax payments relative to rents were estimated from accounting data for 92 farms printed by the Royal Commission on Agriculture (Parliamentary Papers (1896)).

Manuscript Sources

Bedford Record Office, Overseers Accounts. Eaton Socon, Flitwick P59/12, Kempston, Northill, Potton P64/12/1-3, Southill, Tempsford P20/12/1.

Cambridge Record Office, Overseers Accounts. Foulmere, P72/8/1-3. Kirtling, P101/12/3-5. Over, P129/5/1-2, P129/12/1.

Dorest Record Office, Overseers Accounts. Abbotsbury, PE/ABB/OV1-2. Askerwell, PE/ASK/OV1. Beer Hackett, PE/BEH/OV1. Bere Regis, PE/BER/OV1-7. Buckland Newton.

Essex Record Office, Overseers Accounts. Alphamstone, . Bobbingworth, . Boreham, . Debden, . Fairstead, D/P 310/12/1-5. Gosfield. Great Easton. Writtle.

References

Allen, Robert C. 1988a. "The Price of Freehold Land and the Interest Rate in the Seventeenth and Eighteenth Centuries," Economic History Review 41(1): 33-50.

Allen, Robert C. 1988b. "The Growth of Labor Productivity in Early Modern English Agriculture," Explorations in Economic History, 25(2), 117-146.

Allen, Robert C. 1992. Enclosure and the Yeoman. Oxford: Clarendon Press.

Allen, Robert C. 1994. "Agriculture during the Industrial Revolution." In Roderick Floud and Donald McCloskey, The Economic History of Britain since 1700, Vol. 1, 96-122.

Allen, Robert C. 1999. "Tracking the Agricultural Revolution in England," Economic History Review, 52 (2), May, 209-235.

Allen, Robert C. 2000. "Economic Structure and Agricultural Productivity in Europe, 1300-1800." European Review of Economic History, 4 (1), 1-26.

Beveridge, Lord. 1939. Prices and Wages in England, Vol 1: The Mercantilist Era.

Bowden, Peter J. 1985. "Statistical Appendix," in Joan Thirsk (ed.), The Agrarian History of England and Wales, Vol. V.II, 827-902. Cambridge: Cambridge University Press.

Church, Roy. 1986. The History of the British Coal Industry. Vol. 3, 1830-1913. Oxford: Clarendon Press.

Clark, Gregory. 1991. "Labour Productivity in English Agriculture, 1300-1860," in B.M.S. Campbell and Mark Overton, Agricultural Productivity in the European Past. Manchester: Manchester University Press, 211-235.

Clark, Gregory. 1998a. "The Charity Commission as a Source in Economic History," Research in Economic History, 18, 1-52.

Clark, Gregory. 1998b. "Commons Sense: Common Property Rights, Efficiency, and Institutional Change." Journal of Economic History 58(1): 73-102.

Clark, Gregory. 1998c. "Land Hunger: Land as a Commodity and as a Status Good in England, 1500-1914." Explorations in Economic History 35(1): 59-82.

Clark, Gregory. 1998d. "Renting the Revolution" Journal of Economic History, 58(1)**:** 206-210.

Clark, Gregory. 1999a. "Too Much Revolution: Agriculture and the Industrial Revolution, 1700-1860" in Joel Mokyr (ed.), The British Industrial Revolution: An Economic Assessment. 2nd Edition. Boulder, Colorado: Westview Press.

Clark, Gregory. 1999b. "The Long March of History: Farm Laborers' Wages in England, 1208-1850" (manuscript, University of California, Davis, available at **http://www.econ.ucdavis.edu/faculty/gclark/**).

Clark, Gregory. 2000b. "Shelter from the Storm: Housing in the Industrial Revolution." Working Paper, University of California, Davis.

Clark, Gregory. 2000b. "The Meaning of the Industrial Revolution." Working Paper, University of California, Davis.

Clark, Gregory. 2001. "Farm Wages and Living Standards in the Industrial Revolution: England, 1670-1869" Forthcoming, Economic History Review.

Clark, Gregory, Michael Huberman and Peter Lindert. 1995. "A British Food Puzzle," Economic History Review, 68 (May), 215-237.

Crafts, Nick. 1985. British Economic Growth during the Industrial Revolution. Oxford: Clarendon Press.

Fletcher, T. W. 1961. "The Great Depression of English Agriculture, 1873-1896" Economic History Review, 13, 417-32.

Deane, Phyllis and W. A. Cole. 1962. British Economic Growth, 1688-1959. Cambridge: Cambridge University Press.

Flinn, Michael W. 1984. The History of the British Coal Industry. Vol. 2,1700-1830. Oxford. Clarendon Press.

Fox, A. Wilson. 1903. "Agricultural Wages in England and Wales During the Last Half Century," Journal of the Royal Statistical Society, 66, 273-348.

Grant, John. 1845. "A Few Remarks on the Large Hedges and Small Enclosures of Devonshire and the Adjoining Counties" Journal of the Agricultural Society of England, 5, 420-429.

Hatcher, John. 1993. The History of the British Coal Industry, Vol. 1, Before 1700: Towards the Age of Coal. Oxford: Clarendon Press.

Hammersley, G. 1973. "The Charcoal Iron Industry and its Fuel, 1540-1750." Economic History Review, 24: 593-613.

Hoffman, Phillip. 1996. Growth in a Traditional Society: The French Countryside, 1450-1815. Princeton: Princeton University Press.

John, A. H. 1989. "Statistical Appendix" in G. E. Mingay (ed.), The Agrarian History of England and Wales, Vol. VI, 1750-1850, 1089-1177. Cambridge: Cambridge University Press.

Kerridge, Eric. 1953. "The Movement of Rent, 1540-1640." Economic History Review, 6 (-), 208-226.

Lindert, Peter H. "English Occupations, 1670-1811." Journal of Economic History, Vol. 40, No. 4. (Dec., 1980), pp. 685-712.

Lindert, Peter H. and Jeffrey Williamson. 1982. "……" Explorations in Economic History.

Mingay, G. E. 1956. "The Agricultural Depression, 1730-1750." Economic History Review, 8 (-), 323-338.

Mitchell, B. R. 1988. British Historical Statistics. Cambridge: Cambridge University Press.

O'Brien, Karl Patrick. 1996. "Path Dependency, or Why Britain Became an Industrialized and Urbanized Economy Long Before France." Economic History Review, 49 (2), 213-248.

Overton, Mark. 1996. Agricultural Revolution in England: The Transformation of the Agrarian Economy 1500-1850. Cambridge: Cambridge University Press.

Parliamentary Papers. 1852-3a. Number of Inhabitants, 1801-51. Volume 1 with Census Report. Vol. LXXXV.

Parliamentary Papers. 1852-3b. Number of Inhabitants, 1801-51. Volume 2. Vol. LXXXVI.

Parliamentary Papers. 1888. Agricultural Returns of Great Britain. Vol. CVI.

Parliamentary Papers. 1896. Royal Commission on Agriculture. Particulars of the Expenditures and Outgoings on Certain Estates in Great Britain and Farm Accounts. Vol. XVI.

Schumpeter, Elizabeth. 1960. English Overseas Trade Statistics, 1697-1808. Oxford: Oxford University Press.

Squarey, Elias P. 1878. "Farm Capital" Journal of the Royal Agricultural Society of England, Second Series, 14, 425-444.

Stamp, Josiah. 1920. British Incomes and Property. London: King and Son.

Thorold Rogers, J. E. 1888. A History of Agriculture and Prices in England. Volume 6. Oxford: Clarendon Press.

Tomson, James. 1847. "Account of Hall Farm, near Sevenoaks, Kent." Journal of the Royal Agricultural Society of England, 8, 33-46.

Turner, Michael E., J. V. Beckett and B. Afton. 1997. Agricultural Rent in England, 1690-1914. Cambridge: Cambridge University Press.

Turner, Michael E., J. V. Beckett and B. Afton. 1998. "Renting the Revolution: A Reply to Clark," Journal of Economic History, 58(1)**:** 211-214.

Wratislaw, Charles. 1861. "The Amount of Capital Required for the Profitable Operation of a Mixed Arable and Pasture Farm in a Midland County." Journal of the Royal Agricultural Society of England, Second Series, 14, 425-444.

Wrigley, E. A. 1985. "Urban Growth and Agricultural Change: England and the Continent in the Early Modern Period," Journal of Interdisciplinary History, 15, 683-728.

Wrigley, E. A. 1988. Continuity, Chance and Change. Cambridge: Cambridge University Press.

Wrigley, E. A., R. S. Davies, J. E. Oeppen, and R. S. Schofield. 1997. English Population History from Family Reconstitution, 1580-1837. Cambridge: Cambridge University Press.