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Agricultural productivity and rural incomes in England and the Yangtze Delta, c.1620–c.1820[1]

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The productivity of agriculture in England and the Yangtze Delta are compared *c*.1620 and *c*.1820 in order to gauge the performance of the most advanced part of China vis-à-vis its counterpart in Europe. The value of real output is compared using purchasing power parity exchange rates. Output per hectare was nine times greater in the Yangtze Delta than in England. More surprisingly, output per day worked was about 90 per cent of the English performance. This put Yangtze farmers slightly behind English and Dutch farmers *c*.1820, but ahead of most other farmers in Europe—an impressive achievement. There was little change in Yangtze agricultural productivity between 1620 and 1820. In 1820, the real income of a Yangtze peasant family was also about the same as that of an English agricultural labourer. All was not rosy in the Yangtze, however, for incomes there were on a downward trajectory. Agriculture income per family declined between 1620 and 1820, even though income per day worked changed little since population growth led to smaller farms and fewer days worked per year. The real earnings of women in textile production also declined, since the relative price of cotton cloth dropped—possibly also because a larger population led to greater production. The implication is that the Yangtze family, unlike the English family, had a considerably higher real income *c*.1620, and that period was the Delta's golden age.

I

When did Europe pull ahead of China? Until recently, that was a settled question: Europe was always in the lead. The only question was why.

That was how the classical economists saw the matter. They took Europe's pre-eminence as a fact and explained it using their own theories. Thus, Adam Smith thought that 'rice in China is much cheaper than wheat is any-where in Europe', but wages were lower still. 'The difference between the money price of labour in China and Europe, is still greater than that between the money price of subsistence; because the real recompence of labour is higher in Europe than in China'. As a result, 'the poverty of the lower ranks of people in China far surpasses that of the most beggarly nations in Europe'.[2] Malthus shared this view for characteristically demographic reasons. He believed that early marriage led to high population in China and India with the result that 'the lower classes of people were

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[2] Smith, *Wealth of nations*, pp. 72, 189, 206.

reduced to extreme poverty . . . The population would thus be pressed hard against the limits of the means of subsistence, and the food of the country would be meted out to the major part of the people in the smallest shares that could support life'.[3] Marx and Engels emphasized the mode of production. The hot climate meant that 'artificial irrigation is here the first condition of agriculture'.[4] Large, bureaucratic states emerged in response. They owned the land, and they were the source of prosperity. 'Oriental despotism' stifled individual initiative, and productivity stagnated.

Many subsequent historians have shared these views. Elvin echoes the classical critique in his description of eighteenth-century China. He writes that it had 'a per-acre agricultural productivity that was already the highest in the world'. That did not lead to mass prosperity, however, 'for it was the expansion of the population which produced that combination of high-level farming and transportation technology with a low per capita income which perceptive economists since Adam Smith have recognized as the distinctive characteristic of China in the seventeenth and eighteenth centuries'.[5] In *The European miracle*, Jones traces Europe's lead to a superior natural environment, more restrained fertility, the hydraulic state, and greater rationality. Most recently, Landes argued that the Han outbred other Asians. 'In effect, this pattern of maximum reproduction enhanced political power, in terms both of combat fodder and of material for territorial expansion. In the last analysis, this was the story of Chinese aggrandizement over less prolific societies'. As the Chinese occupied the great river valleys of central and southern China, they organized cultivation to maximize food production and population. Landes endorses Marx's hydraulic argument, as elaborated by Wittfogel: 'the management of water called for supralocal power and promoted imperial authority'. Chinese history was like a 'treadmill' in which more people led to a bigger empire (in geographical terms), which led to more food, which led to more people. The result was always mass poverty.[6]

This interpretation of global history has been called into question in recent decades. The reassessment has several strands. One emphasizes that coastal Asia all the way from the Persian Gulf to Japan was more urbanized and produced higher quality manufactures than Europe throughout the early modern period. Asia was the manufacturing powerhouse of the world economy, and Europe was a backward periphery. Europe's ultimate ascendancy is, then, often traced to the lucky discovery of America with its vast silver resources that financed the European takeover of Asian commerce and finally the governance of much of the continent itself. Another strand consists of critiques of the theories of Smith, Malthus, and Marx as they have been elaborated by later historians. The precariousness of property, the despotic governments, the high fertility demography, and the hydraulic state have all been subjected to withering attack.[7]

While the theoretical explanations of Europe's advance have been called into question, the factual basis of that advance has received less attention. Not that it

[3] Malthus, *Population*, pp. 199, 128–9.
[4] As quoted by Blaut, *Colonizer's model*, p. 83.
[5] Elvin, *Chinese past*, pp. 215, 309.
[6] Landes, *Wealth and poverty*, pp. 22, n. *, 27; Wittfogel, *Oriental despotism*.
[7] Adas, *Machines*; Frank, *ReOrient*; Blaut, *Colonizer's model*; Lee and Wang, *One quarter*; Pomeranz, *Great divergence*; Wong, *China transformed*.

has been ignored: one of the most provocative assertions in Pomeranz's *The great divergence* is his claim that 'it seems likely that average incomes in Japan, China, and parts of southeast Asia were comparable to (or higher than) those in western Europe even in the late eighteenth century'.[8] The opening phrase shows the tentativeness of this reassessment and provides the motivation for the writing of this article.

Pomeranz's generalization is certainly debatable. It conflicts with Maddison's estimates of real GDP per capita in the early modern period, which put Europe far ahead of Asia. But Maddison's figures are based on backward extrapolations from 1990 income levels and are, thus, contaminated by all the errors in the national growth rates as well as reflecting 1990's relative prices which differed considerably from those in early modern Europe and Asia. As Prados de la Escosura has shown, using early nineteenth-century prices as weights can radically change the income levels.[9]

Real wages have also been used to compare European and Asian incomes. Parthasarathai made the first effort at this, and found that Indian textile workers lived as well as their counterparts in England in the mid-eighteenth century—a point for the revisionists. In one study, Allen came to the same conclusion. On the other hand, Bassino and Ma, and Allen et al. have found that the real wages of building workers in Japan and China were at the levels prevailing in the poorest—not the richest—cities of Europe, and Broadberry and Gupta have offered an interpretation of such evidence in terms of international trade theory.[10] Most of the wages used in these comparisons were urban, however; while the economies were predominantly agricultural. Any judgement of overall performance hinges on farming. How did the standard of living of the farm populations of Europe and Asia compare?

This article tackles that question by comparing both agricultural productivity and incomes in agriculture. Agriculture has figured prominently in recent debates about Asian performance—for instance, the exchange in the *Journal of Asian Studies* between Huang, Pomeranz, and Brenner and Isett.[11] These comparisons are typically limited to a few crops—rice and wheat in the Yangtze and wheat in England. While these were important, agriculture in both regions was much more than carbohydrates. Meat, butter, and wool were produced by English farmers, and Chinese farmers also raised pigs and chickens and cultivated mulberry trees and cotton (the last has sometimes been included in intercontinental comparisons). A complete analysis of agriculture requires consideration of all of its products. The task is particularly important since the animal and vegetable activities reinforced each other synergistically in both Europe and China: in China, the pig and the water buffalo produced manure that fertilized the paddy field and, in turn, drew nourishment from the rice and wheat straw; while, in England, sheep grazed the wheat stubble in the fallow fields, manuring them as well. This article attempts

[8] Pomeranz, *Great divergence*, p. 49.

[9] Maddison, *Monitoring*; Prados de la Escosura, 'International comparisons'.

[10] Parthasarathai, 'Rethinking wages'; Allen, 'First look'; Bassino and Ma, 'Unskilled wages'; R. C. Allen, J.-P. Bassino, D. Ma, C. Moll-Murata, and J.-L. van Zanden, 'Wages, prices, and living standards in China, 1739–1925: in comparison with Europe, Japan, and India', Oxford University, Department of Economics working paper 316 (2007); Broadberry and Gupta, 'Great divergence'.

[11] Huang, 'Development or involution?'; Pomeranz, 'Beyond'; Brenner and Isett, 'England's divergence'.

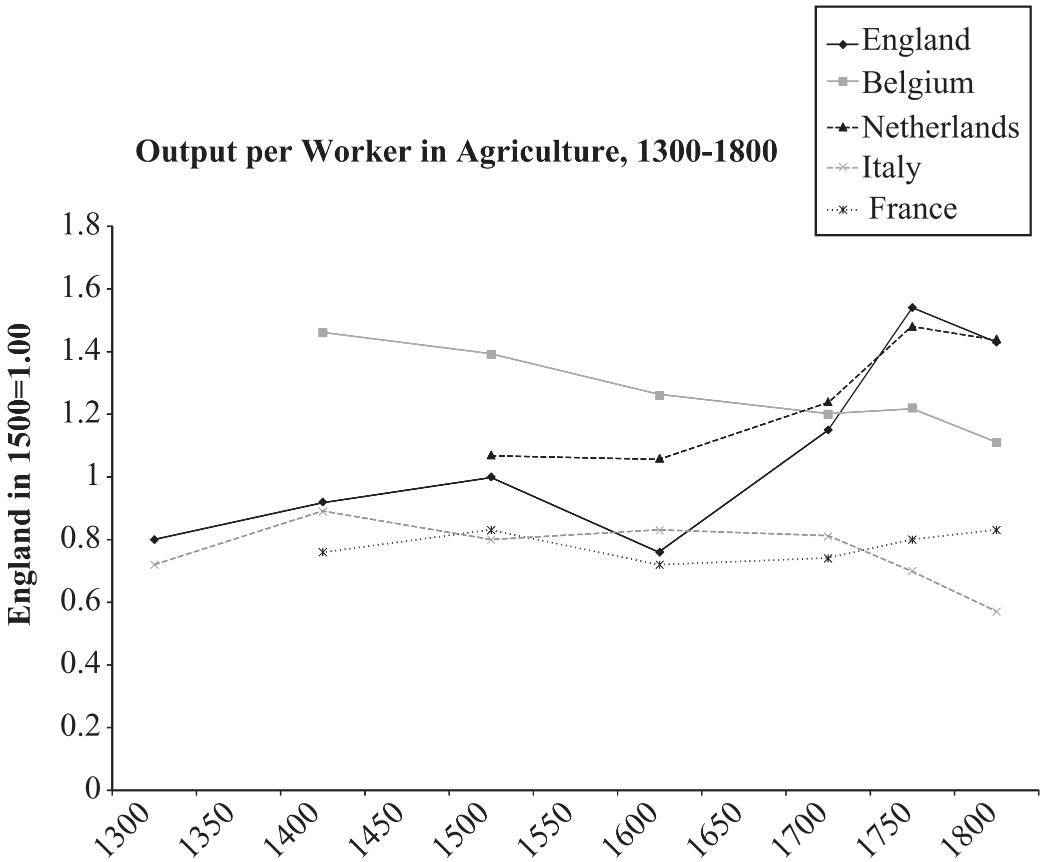

Figure 1. *Agricultural labour productivity: Europe, 1300–1800*
Source: Allen, 'Economic structure', p. 20.

a comprehensive analysis of agriculture at the regional level including all aspects of farm production. In addition, it addresses the complex index number problems that arise in intercontinental comparisons by using purchasing power parity exchange rates to convert Chinese money to English money.

The history of labour productivity in European agriculture provides a standard for judging Chinese performance. The literature on the comparative study of European agricultural productivity is very large. Figure 1 is an attempt to delineate its broad patterns from 1300 to 1800.[12] One can always debate the details and the methods underlying that figure, but the results are consistent with widely held views on the subject. The key question is which countries had agricultural revolutions.

Figure 1 distinguishes three trajectories of productivity growth. First, most of the continent exhibited low productivity modulated by population movements.

[12] Allen, 'Economic structure'.

The Italian series is representative.[13] It shows a rise in output per worker following the Black Death, and then a persistent decline as population grew in subsequent centuries. There is no evidence of an 'agricultural revolution' before the nineteenth century. Second, in contrast, present-day Belgium had high labour productivity in the middle ages, and that advantage continued throughout the period, although productivity sagged under the weight of population growth. Medieval Flanders was renowned for the efficiency of its farms and the density of its cities, and those leads are reflected in the Belgian figures. Third, two countries—England and the Netherlands—had agricultural revolutions in the early modern period. In 1500, their productivity was not markedly higher than elsewhere, but by 1750 they had closed the gap with Belgium. The economies of north-western Europe led the continent, and their high agricultural labour productivity was an essential ingredient of their success, since it meant that each farm worker could feed and clothe several workers in commerce and manufacturing.

Where would China fit in figure 1? Like Europe, China was diverse. Ideally, one would ascertain the distribution of good and bad regions in both continents and compute a weighted average of overall efficiency, but that is too ambitious a programme for the moment. Instead, this article concentrates on the Yangtze Delta. It was the most advanced region and was, thus, the counterpart of England or the Netherlands.[14] There were about seven million acres of cultivated land in the Yangtze—one-fifth of England's 34 million acres of arable, pasture, and meadow. On the other hand, the population of the Yangtze Delta (perhaps 26 million in 1750) was more than four times that of England (about six million). The Yangtze's land–labour ratio was one-twentieth of England's.

The comparison of England and the Yangtze Delta raises two questions—one of levels and one of trends. As to the first, in 1800, was output per farm worker in the Yangtze like that in England or in Italy or somewhere not featured in figure 1? As to the second, did Yangtze agriculture experience an agricultural revolution like England or the Netherlands, or did productivity fall under the impact of population growth as in Italy? The only way to answer these questions is through a careful comparison of productivity levels at the two ends of Eurasia, and that is an objective of this article.

Historians' views on the Yangtze's performance span a broad spectrum. Involution is the most widely held view of Chinese agriculture, and its roots run back to the classical economists.[15] In this view, technology is seen as essentially static. Over time, the population grew and farms were subdivided. Farmers worked more days on each hectare and, as a result, output per hectare rose. Perkins estimated that yields grew by almost half between 1400 and 1770, and that increase is consistent with involution.[16] But the obverse of that growth was a fall in output per day of work as labour ran into diminishing returns. Lower labour productivity, in turn, implied a lower real income from farming. By the same token, falling farm income induced a redeployment of labour out of agriculture into cotton spinning

[13] See Federico and Malanima, 'Italian agriculture', for an additional measure of productivity that shows a similar pattern.

[14] In this article, 'England' refers to England and Wales.

[15] This was argued most recently by Brenner and Isett, 'England's divergence'; Huang, *Peasant family*; and idem, 'Development or involution?'.

[16] Perkins, *Agricultural development*, pp. 14–29.

and weaving. This was a sign of desperation rather than progress, and the flood of textiles lowered their price, so rural industry made scant contribution to family income. Population growth in China led to immiseration.

A spectrum of revisionist views challenge the hypothesis of immiseration. The most contrary is B. Li's thesis that the Yangtze Delta experienced an English- or Dutch-style agricultural revolution between 1620 and 1850. According to B. Li, there was little change in the amount of land under cultivation in the Yangtze Delta throughout the period: farmed land remained constant at about 45 million mu (three million hectares). Population was about 20 million in 1620; it dropped mid-century due to war and famine, and rebounded to 20 million *c*.1690. From then until 1850, there was steady growth to 36 million. Land per farm family fell from 15 mu in 1620 to nine mu in 1850. B. Li defends the peasant family farm as a mode of production well suited to raising productivity. He estimated that rice yields jumped from 1.7 shi per mu to 2.5 over the period (a shi was 100 litres and is presumed to weigh 65 kg), and that the double cropping of wheat, soy beans, and rapeseed expanded from 40 per cent of the rice area to 70 per cent. Family labour was redeployed in cotton spinning and weaving. All of this is grist for the Involutionists' mill. Where B. Li parts company with them is in his treatment of farm labour. The increase in output per hectare was accomplished with only a minor increase in days worked, so the rise in output per mu translated into a rise in output per day worked—contrary to the Involutionists: 'My conclusion is the opposite of the conventional view that "heavy population pressure" reduced labour productivity in farming in early and mid-Qing Jiangnan. The reduced size of Qing farms did not reduce per worker labour productivity on the farm. On the contrary, labour productivity rose'. While progressively more of the labour of Yangtze farm families was allocated to cotton spinning and weaving, B. Li maintains that these were well-remunerated activities. Higher agricultural labour productivity and expanded incomes from textile production implied a rise in peasant living standards between 1620 and 1850—not a fall.[17]

None of the other revisionists are as optimistic as B. Li. While Goldstone, Pomeranz, and Wong deny that output per worker was falling as the population was growing, they do not follow B. Li in claiming that labour productivity actually rose.[18] Instead, the more widely held view is that Yangtze farmers improved their methods enough to offset the depressing effects of population growth on productivity, but not enough to reverse them. Output per worker, in this view, remained constant in Yangtze farming over the seventeenth and eighteenth centuries.

Careful measurement is the only way to discriminate between these contending views. This article attempts that task by comparing land and labour productivity in the English midlands and the Yangtze Delta around 1620 and 1820. In that way, it is possible to see whether the Yangtze Delta went through an agricultural revolution like that in north-western Europe, and how its income and productivity levels compared to those in England.

[17] B. Li, *Agricultural development*, especially pp. 19–27, 139–40, 152–3; quotation pp. 40–1.

[18] J. Goldstone, 'Missing the forest for the trees: a comparison of productivity in preindustrial England and imperial China', paper presented at the Center for Social Theory and Comparative History, UCLA (2002); idem, 'Feeding the people, starving the state: China's agricultural revolution of the 17th/18th centuries', paper presented at the Global Economic History Network conference, London School of Economics, 18–20 Sept. 2003; Pomeranz, *Great divergence*, pp. 94–106; idem, 'Beyond'; Wong, *China transformed*, p. 19.

The calculations are quite detailed. Before plunging into them, it is important to highlight their overall structure. For each region, the land-use pattern and number of farm animals is first specified. The gross output of each crop and animal product is calculated by multiplying area or number by yield. Costs of production are deducted to compute net output. Dividing total net production by land area gives output per hectare.

Output per worker is also computed, and this requires estimates of employment. These are based on the land-use patterns, animal numbers, and production estimates. Employment is analysed on a task-by-task basis. The labour for most tasks is specified on a per hectare basis, so the total days required for harvesting, for instance, equals the hectares to be harvested multiplied by the number of days per hectare required. Employment in threshing and husking labour, however, are functions of the gross production rather than the area planted. Adding up the days of labour gives the total used in agriculture. Dividing total net production by total days of farm labour gives output per day.

The employment estimates developed here do not include labour outside of the farm sector that might, from a very broad point of view, be tallied as agricultural labour. Thus, the labour used to enclose land, plant hedges, maintain rural roads, scour water courses, and clean and maintain sluices are excluded from the English estimates, as is the labour embodied in purchased farm machinery. Likewise, the Chinese estimates do not include labour to build dykes or public infrastructure.[19] In both cases, the labour deployed by farmers in the course of their own operations to drain or irrigate their own land is included in the reckoning. It would be desirable to estimate the labour implicit in all of the related and supportive activities, but the task would be very difficult. As a first step, I concentrate on the work of farmers, their spouses and children, and their employees.

II

The measurement of English productivity is based on a detailed analysis of agriculture in the south midlands around 1800. This region consisted of about 2.3 million acres of farm land—about 8 per cent of the English total.[20] Particularly detailed information is available for this region, and that facilitates the international comparisons undertaken here. In addition, the overall character of farming in the south midlands—the mix of crops and livestock, for instance—was similar to that of English agriculture in general. The average rent of farm land in the south midlands, however, was about 20 per cent above the national average in 1810–11, and this suggests that total factor productivity in the south midlands exceeded the national average by about 7 per cent.[21] An adjustment for this difference is made when the Yangtze record is juxtaposed with that of England in figure 2.

[19] Wagner, *Landwirtschaft*, pp. 155–8, 189–99, 282–931; Perkins, *Agricultural development*; Elvin, *Elephants*, pp. 115–64.

[20] The south midlands, as defined here, contained 2.85 million acres (Allen, *Enclosure*, p. 34) of which about 80% were arable, pasture, and meadow. The corresponding figure for England in 1800 was 29.1 million acres (idem, 'Agriculture', p. 104).

[21] McCulloch, *Statistical account*, vol. I, p. 551. If rent was one-third of costs, a 20% rent premium implies a 7% (the cube root of 1.2) advantage.

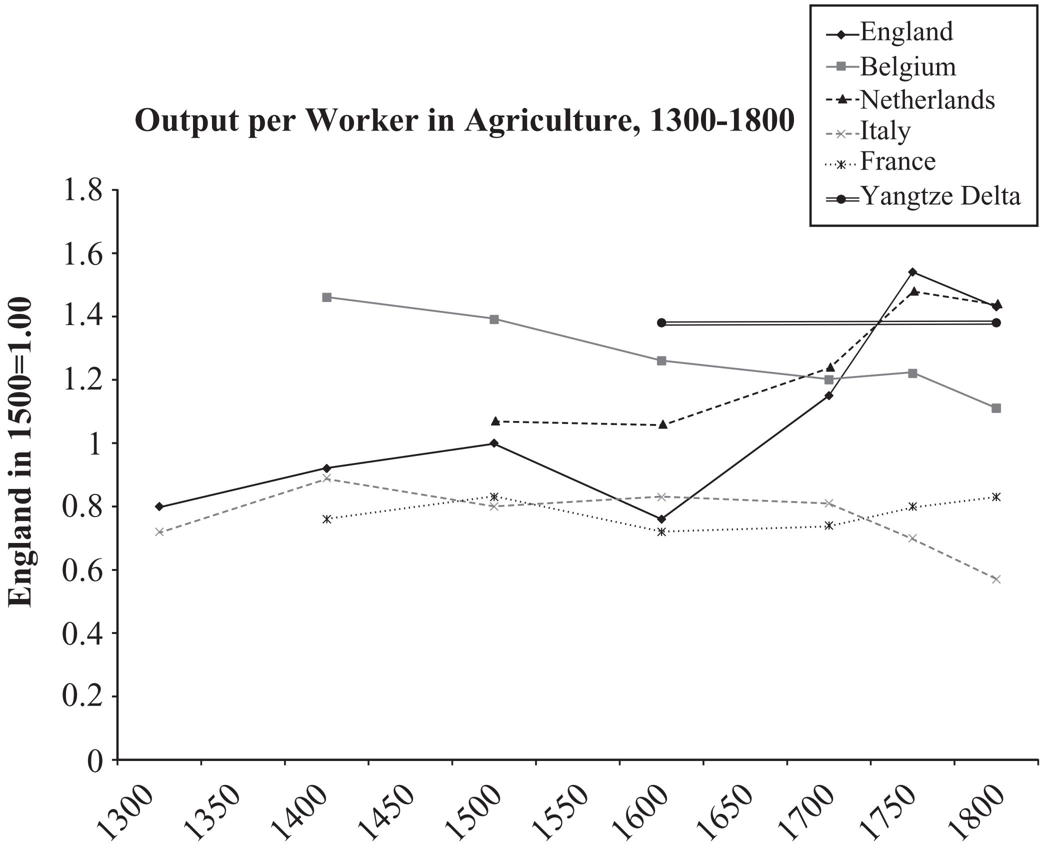

Figure 2. *Agricultural labour productivity: Europe and the Yangtze Delta, 1300–1800*
Source: Allen, 'Economic structure', p. 20, and calculations explained in the text.

Table 1 is an overview of farming in the south midlands early in the nineteenth century. The information on land use, livestock numbers, and crop yields derives from Parkinson's *General view of the agriculture of Huntingdon* and *General view of the agriculture of Rutland*, as well as a more limited survey for Buckinghamshire.[22] These reports were commissioned by the Board of Agriculture and had great authority, although the authors approached their task in individual ways. Parkinson was a social surveyor, who conducted an agricultural census of his counties. He reported critical variables like land use, yields, and livestock numbers on a parish-by-parish basis. Cross-classifying this information by soil type and enclosure status is the basis for the regional farming portraits.[23]

The estimate of net output involved a sequence of calculations. Each subdivision of the south midlands contained arable, pasture, and meadow, and the arable was broken down into acres of fallow, wheat, barley, oats, beans, clover, and turnips. Clover and turnips, as well as the hay from the meadow, were consumed by animals on the farm and so contributed nothing to net output. The production of

[22] Parkinson, *Huntingdon*; idem, *Rutland*; Priest, *Buckingham*.
[23] Allen, *Enclosure*, pp. 107–87.

Table 1. *Agriculture in the south midlands, c.1806*

	Acres or number	Gross Yield	Gross Product	Gross Price	Gross value (million d.)
Land use					
Arable	944,877				
Pasture	1,032,913				
Meadow	302,902				
Total	2,280,693				
Arable use					
Fallow	190,631				
Wheat	208,324	20.5 bushels	4,265,086	105.12	448.35
Barley	147,500	29.8 bushels	4,401,479	51.12	225.00
Beans/peas	155,253	20.7 bushels	3,208,943	60.48	194.08
Oats	54,388	30.7 bushels	1,671,894	36.00	60.19
Turnips	84,486				
Clover	104,296				
Animal products					
Butter			8,356,137	13.5	112.82
Veal			1,081,095	9.0	9.73
Mutton			65,317,628	7.5	489.88
Beef			36,073,092	7.5	270.55
Pork			5,228,893	8.0	41.83
Wool			18,189,510	12.0	218.27
Animals					
Horses	51,577				
Cows	64,722				
Calves	27,418				
Sucklers	11,161				
Sheeps	1,719,026				
Lambs	678,161				
Fatting	124,730				
Foals	8,165				
Hogs	161,198				
Gross output (million d.)					2,070.69
Seed and fodder					263.99
Net output					1,806.70
Days worked (millions)					29.66

Source: See text.

wheat, barley, oats, and beans is calculated by multiplying the acreage of each by the yield.[24] Net output was then determined by deducting the volume retained for seeds and fed to animals as fodder. The farms also supported horses, cows, calves, beef cattle, pigs, and sheep. Horses produced no net output, but the other animals produced butter, beef, veal, pork, mutton, and wool, the production of which was determined by multiplying livestock numbers by yields. In most cases, livestock were bred on the farm, but in the cases where animals were purchased for fattening, output is defined as the value added on the farm—that is, the cost of the animal to be fattened was subtracted from the value of its products.

[24] The English farms never grew enough oats to feed the horses. Consequently, the net output of oats was negative. This is entirely appropriate: feed grains are treated in the same way as animals purchased for fattening. Farm output is net of intermediate inputs. (It may be that beans or other feed grown on the farm was given to the horses. Deducting the notional value of purchased oats has the same effect as estimating the utilization of beans as feed and subtracting it from the gross output of beans.)

Total output of the farm is the value of the net output of each of its nine products. Parkinson reports the average prices received by farmers for all of these products, and his prices are used to aggregate output.

The measurement of labour also presents practical and conceptual difficulties. Most English farming was done by large-scale, capitalist enterprises exclusively devoted to agriculture. They did not produce manufactures, so these farms present no problems in separating proto-industrial activity from agricultural. In the case of the English farms, it is possible to compute the total number of days worked in each task from information collected by Batchelor's *General view of the agriculture of the County of Bedford*.[25]

While Parkinson was a social statistician, Batchelor was an accountant. He devoted about 100 pages of his *General view* to working out the costs of farm operations. This was not an unusual exercise for the time. Young produced volumes of farm costs and notional income statements in order to analyse all manner of farm improvements.[26] Batchelor, however, was exceptionally single-minded in his endeavour. He paid great attention to detail and showed care in estimating the more variable elements of costs. He estimated the cost of shoeing horses and repairing their harness, for instance, 'by reference to some old blacksmiths' bills'.[27] This thoroughness suggests that his discussion deserves careful attention.

There are two other reasons for relying on Batchelor and Parkinson. First, the costs implied by their figures agree with other sources; namely, Young's survey of farms *c*.1770.[28] In his tours of England, Young reported the details of several hundred farms, including their size and permanent workforce.[29] By estimating the labour supplied by the farmer and his family and adding on the additional labour employed at the harvest, employment per acre can be computed. The result agrees with Batchelor's figures collected a generation later. The employment figures are plausible in terms of the size of a farm workforce. Thus, arable farms used 1,600–1,700 days of labour per 100 acres. If 300 days equal one year, then the average workforce of a 100-acre farm was between five and six. There was a harvest peak, of course, and allowing for that would imply a somewhat smaller number of workers employed on a full-time, continuous basis. These workers included the farmer and his family as well as hired employees.

Second, the Batchelor–Parkinson data imply an internally consistent representation of farming in financial terms. Ricardian surplus—the difference between revenue and non-land costs—can be calculated and compared to rent and taxes. In general, rent plus taxes were of the same order as surplus, although there were discrepancies, particularly for pastoral farms with large amounts of farmer-supplied capital (livestock).[30] Either Batchelor's costing is less exact in these cases or farmers had a poor idea of their costs since most of them were implicit interest and depreciation rather than explicit payments as in arable farming. Probably both issues were involved.

[25] Batchelor, *Bedford*, pp. 70–160.
[26] Young, *Farmer's guide*.
[27] Batchelor, *Bedford*, p. 89.
[28] Allen, *Enclosure*, p. 162.
[29] Young, *Six weeks tour*; idem, *Six months tour*; idem, *Farmer's tour*.
[30] Allen, *Enclosure*, pp. 176–9.

Table 2. *Agriculture in the Yangtze, 1620*

	Area (mu) or number (million)	*Yield*	*Product (million)*	*Price (1820 cash)*	*Value of gross output (million 1820 cash)*
Primary land use					
Paddy	42.4	1.7 shi	72.08	3,494	251,812
Cotton	1.9	80 catty	152	80	12,160
Mulberry	0.7	6 catty	4.2	4,110	17,262
Total	45.0				
Double cropping (at 40%)					
Wheat	12.6	1.0 shi	12.6	2,446	30,817
Beans	3.6	1.0 shi	3.6	2,446	8,805
Rape	1.8	1.0 shi	1.8	4,000	7,200
Animals					
Sows	1.2				
Pigs	3.6	90 catty	324	80.0	5,920
Chickens	6.3	9 catty	56.7	80.0	4,536
Draught	0.0				
Gross output					358,548
Seed and fodder					9,378
Net output					349,170
Days worked (millions)					842.07

Notes and sources: Land use: B. Li, *Agricultural development*, pp. 26–35, which also reports yields. See text for rice yield. The land was divided into three million farms (ibid., p. 23).
Price of rice is the average of the 1810–20 price in Wang, 'Rice prices', pp. 40–7. Wheat and beans set at 70% of the rice price, based on B. Li, *Agricultural development*, pp. 208 n.6, and 212, nn. 9 and 13; idem; and L. Li, 'Grain prices', p. 80. There is approximate agreement among these sources.
Animal numbers and meat production from assumptions in tab. 3. Perkins, *Agricultural development*, pp. 73, 307, argued for a constant ratio of pigs to people from the early Ming period onwards, and I calculate accordingly.

III

Tables 2 and 3 summarize land use and animal numbers in the 1820s (mid-Qing) and 1620s (late Ming) for the Yangtze Delta.[31] The former is better documented—although many parameters are poorly established, as will become apparent—and is the comparator for the English midlands *c.*1806. Many figures used here are derived from B. Li's *Agricultural development in Jiangnan, 1620–1850* and subsequent papers.[32] These figures can be cross-checked against other sources, and those comparisons confirm the reconstruction.

The Yangtze Delta was intensively cultivated. About 95 per cent of its 45 million mu of farm land were divided into rice paddies in both 1620 and 1820. The remaining land was planted with cotton or mulberries. Some of the surface was double cropped with wheat, soy beans, and rapeseed. Many farmers kept chickens and pigs. Their pork was a useful addition to the mainly vegetarian diet, but manure was their most valuable product. Batchelor referred to sheep as 'living

[31] For the purposes of this article, the Yangtze Delta is defined as the prefectures of Suzhou, Songjiang, Taicang, Changzhou, Zhenjiang, Jiangning, Hangzhou, Jiaxing, and Huzhou. This is the region that B. Li, *Agricultural development*, p. 69, refers to as Jiangnan.

[32] B. Li, *Agricultural development*; idem, 'Involution or not: a case study of farm economy in Songjiang, 1823–34', paper presented at the All-U.C. Group in Economic History conference, 'Convergence and divergence in historical perspective: the origins of wealth and persistence of poverty in the modern world', Univ. of California, Irvine, 8–10 Nov. 2002.

Table 3. *Agriculture in the Yangtze, 1820*

	Area (mu) or number (million)	*Yield*	*Product (million)*	*Price (1820 cash)*	*Value of gross output (million 1820 cash)*
Primary land use					
Paddy	40.4	2.3 shi	92.92	3,494	324,663
Cotton	3.1	100 catty	310	80	24,800
Mulberry	1.5	6 catty	9	4,110	36,990
Total	45.0				
Double cropping (at 70%)					
Wheat	22.1	1.0 shi	22.1	2,446	54,052
Beans	6.3	1.0 shi	6.3	2,446	15,409
Rape	3.2	1.0 shi	3.2	4,000	12,800
Animals					
Sows	2.0				
Pigs	6.0	90 catty	540	80.0	43,200
Chickens	10.5	9 catty	94.5	80.0	7,560
Draught	1.25				
Gross output					519,473
Seed and fodder					147,202
Net output					372,271
Days worked (millions)					919.3104

Notes and sources: As in tab. 2. The land was divided into five million farms (B. Li, *Agricultural development*, p. 23). The animal numbers were conjectured on the basis of Buck, *Land utilization*, vol. 3, pp. 122, 124 (sows: one each on 40% of the farms; pigs: three per sow, 100% annual slaughter rate; chickens: three per farm on 70% of the farms, 100% annual slaughter rate; draught: one each on 25% of the farms). The implied annual production of pork is 15 kg per person in the Yangtze, which agrees with Buck's (ibid., vol. 3, p. 77) budgets showing per capita meat consumption of 14.6 kg in the Yangtze rice–wheat region.

dung carts', and Perkins characterized Chinese water buffaloes and pigs in almost identical terms.[33]

The principal innovation transforming Yangtze agriculture between 1620 and 1820 was the increasing availability of bean cake.[34] It was the by-product of pressing soy beans to extract oil. The fibrous residue was rich in nutrients and served as fertilizer and fodder. The residue from pressing cotton seeds to extract their oil was a close substitute and had been available as long as cotton was grown. Imports of bean cake into the Yangtze were modest in the sixteenth century, but rose dramatically in the seventeenth with the opening of trade with Manchuria. That province exported wheat and bean cake to the Yangtze in exchange for cotton cloth and tea.[35] In the early eighteenth century, production of soy beans increased in northern China and a growing volume was shipped to the Yangtze by the Grand Canal. Imports from north-eastern China continued to grow after 1750.[36]

Northern and north-eastern China were the 'ghost acres' that transformed Yangtze agriculture in several ways. First, bean cake was used as fertilizer and was responsible for a rise in the yield of rice. Throughout the Ming and Qing, farmers spread traditional fertilizers—human and animal manure, grass, mud, and green manure—on their fields before planting rice. The innovation of the seventeenth

[33] Batchelor, *Bedford*, p. 106; Perkins, *Agricultural development*, p. 72.
[34] Perkins, *Agricultural development*, p. 71.
[35] Elvin, *Chinese past*, p. 214.
[36] B. Li, *Agricultural development*, pp. 113–14. See Xue, 'Critical response,' for a sceptical view.

century was to apply a second dressing of oil cake as the rice was growing.[37] Oil cake was much more efficacious, kilogram for kilogram, than the traditional fertilizers. Farmers exploited this by shifting from early- to late-maturing strains of rice, which were more responsive to fertilizer. While the traditional fertilizers were labour-intensive, oil cake required little labour to cart and spread on the fields. On the other hand, oil cake had to be purchased for cash, whereas the traditional fertilizers were largely made on the farm.

The impact of bean cake on rice yields has been the subject of considerable debate, but most of the discussion centres on the early seventeenth century.[38] There is surprisingly little disagreement among scholars as to the average yield of rice in the first half of the nineteenth. B. Li has offered figures between 2.3 and 2.5 shi per mu, while Brenner and Isett suggest a range of 2.0 to 2.5 shi per mu and settle for the middle—2.25 shi, a figure that Huang also accepts. These figures apply to husked rice. I use a figure of 2.3, which is in the middle.[39]

The situation is far murkier *c.*1620. B. Li suggests an average yield of 1.7 shi per mu—implying as much as a 47 per cent increase to 2.5 *c.*1800. This suggestion is based on a calculation of the consumption needs of the population rather than direct evidence. Brenner and Isett suggest a yield of 2.35 shi in 1600, implying a 6 per cent increase, which is in line with the work of Zhao, Liu, and Wu.[40]

I have chosen to follow B. Li in this regard and work with a yield of 1.7 shi per mu *c.*1620, implying a yield increase of 0.6 shi per mu in the following two centuries. This choice is based on consistency with other figures when they are evaluated in terms of the farm accounting model developed subsequently: in particular, a smaller yield increase (that is, a higher yield in 1620) would not generate enough extra revenue to cover the cost of the additional fertilizer applied to the land in the mid-Qing period. This calculation includes changes in double cropping, labour use, livestock numbers, and so forth. One advantage of an explicit farm accounting model is that it helps to narrow the options by imposing consistency among the elements of the calculation in this way.

Second, the greater use of bean cake led to more extensive double cropping. Both B. Li and Brenner and Isett presume that 40 per cent of the land was planted with wheat, beans, or rapeseed *c.*1600, and 70 per cent *c.*1800.[41] The increase in double cropping raised output per hectare for the farm as a whole. There is no evidence that the yields of these crops rose in this period. In the absence of much information, all scholars assume that wheat, for instance, yielded 1 shi per mu and required 0.1 shi of seed. I do the same.

The third aspect ofYangtze agriculture to be transformed by bean cake was animal husbandry. Few draught animals were used in 1620—almost all of the work of

[37] Indeed, Brenner and Isett, 'England's divergence', pp. 621–4, emphasize that many farmers were applying a second coating of bean cake by the end of the eighteenth century. I suggest later that this was done by feeding the bean cake to farm animals and then applying their manure to the land.

[38] The poor quality of the data is striking: Perkins, *Agricultural development*, pp. 309, 318–19, and B. Li, *Agricultural development*, p. 214, n. 29, cannot even agree as to whether their early modern sources are reporting the yield of unhusked paddy or husked rice. Since a litre of unhusked paddy gave roughly half a litre of husked rice, the difference is of some consequence!

[39] B. Li, *Agricultural development*, p. 125; Brenner and Isett, 'England's divergence', p. 652; Huang, 'Development or involution?', p. 509.

[40] B. Li, *Agricultural development*, p. 125; Brenner and Isett, 'England's divergence', p. 625; Zhao, Liu, and Wu, *Qingdai*.

[41] B. Li, *Agricultural development*, p. 33; Brenner and Isett, 'England's divergence', p. 625.

ploughing, harrowing, and land preparation was done by human labour. By the 1730s, draught animals were used on wet fields in the Yangtze but not on dry fields.[42] A century later, oxen and water buffalo were widespread.[43] The numbers shown in table 3 are estimated from Buck's survey data for the 1930s of farms of roughly nine mu in area.[44] On the face of it, the greater use of animals is surprising in view of the decline in farm size from 15 to nine mu. The explanation is the increase in double cropping, which led to peaks in labour demand in late May, June, and late October. Draught animals alleviated the peaks.[45] The greater availability—and presumably lower price—of bean cake in 1820 compared to 1620 was the underlying cause, since it was responsible for the increase in double cropping.

The value of farm production is the sum of the net output of rice, wheat, beans, rapeseed, pork, raw cotton, and raw silk. Prices from the 1820s are used for both the late Ming and mid-Qing periods to measure changes in the volume of production. The value of seed and purchased bean cake are deducted to compute net output. There is debate about these costs. At one extreme is B. Li, who maintains that 'production costs per mu of rice were equivalent to about 1 shi of rice in both periods'; that is, the late-Ming and the mid-Qing.[46] These costs were predominantly fertilizer costs, although they presumably also included other costs, which are hard to detect in historical documents, such as the occasional renting of draught animals. These costs are high compared to those of other writers, and their magnitude is an essential ingredient for B. Li's agricultural revolution, as will be seen. Brenner and Isett rely on W. Li's assertion that production costs were 15 per cent of gross output, which comes to 0.36 shi per mu with a yield of 2.4.[47] B. Li also maintained that 'costs for wheat were about 1/4 of those of rice, or 0.25 shi of rice/mu, in the latter period'.[48] Brenner and Isett accept this figure.

B. Li's fertilizer costs look too high, especially before the bean cake revolution: the fertilizer applied in the early seventeenth century was largely produced on the farm; in which case, the cash cost was zero. The work involved was included in the labour input. The bean cake applied in the late eighteenth century cost about 0.6 tael (0.35 shi of rice) per mu. This is consistent with W. Li's estimate that rice production costs amounted to 15 per cent of output, with a yield of 2.4 shi per mu. For these reasons, I part company with B. Li and set fertilizer costs at zero *c.*1620 and 0.6 taels per mu *c.*1820.

In order to compute output per day worked, it is necessary to estimate the number of days worked in agriculture in the Yangtze in *c.*1620 and *c.*1820. Several approaches have been taken to this problem. In the case of wheat and rice, B. Li, Brenner, and Huang have estimated the days required to cultivate a mu and harvest and husk its output. B. Li claims that 'rice cultivation in Ming-Qing Jiangnan, from preparing the soil through to harvesting, required about 10 work days/mu. If we add the labour for pumping water and collecting and transporting

[42] Perkins, *Agricultural development*, p. 306.
[43] B. Li, *Agricultural development*, pp. 43–6.
[44] Buck, *Land utilisation*, vol. 3, pp. 133–4.
[45] B. Li, *Agricultural development*, p. 45.
[46] Ibid., p. 139.
[47] Brenner and Isett, 'England's divergence', app. B, pp. 652–3.
[48] 0.25 shi of rice corresponds to 0.357 = 0.25/0.7 shi of wheat. This includes seed, which B. Li, *Agricultural development*, p. 111, reckons at 0.1 shi per mu, so the fertilizer and other costs amounted to 0.257 shi of wheat per mu.

fertilizer the total is 15 workdays/mu'. Transporting fertilizer amounted to about two days, so water pumping came to three days.[49] B. Li thought that wheat required much less labour—only three days per mu. In addition, B. Li's analysis of family labour utilization indicates that further labour was required 'for husking and braning'. B. Li computes this at the rate of one day per shi of rice or wheat expressed as rice equivalents (by multiplying a shi of wheat by 0.7).[50] Brenner and Isett presume that rice required 11 days per mu, while Huang chooses 10 days.[51] On the other hand, these authors tally the labour required for wheat production at 7–13 days per mu. Since much of the land was double cropped, especially in the eighteenth century, the higher rating for wheat compensates for the lower rating for rice, implying similar totals *c.*1800. These estimates apply to cultivation without draught animals. According to B. Li, their use cut the labour time for rice by several days per mu.[52]

A second approach to measuring labour requirements is demonstrated in Buck's survey in the 1930s.[53] He endeavoured to measure the number of days per acre required to cultivate all of the crops analysed in this article. These data reflect the use of draught animals as they were employed in the early nineteenth century; indeed, the technology appears to have changed little, so early twentieth-century data may give an accurate description of earlier employment. Buck's labour requirements are similar to those of Brenner and Issett, and Huang, once allowance is made, along the lines suggested by B. Li, for the economies in employment due to the use of water buffalo. My calculations use Buck's survey results since they encompass all of the crops, but the results for wheat and rice do not differ materially from those suggested by the work of other scholars.

While the crops are dealt with in this way, it should be noted that there is very little information about the labour devoted to pigs, chickens, and water buffaloes. I have estimated these requirements arbitrarily based on European information and common sense: for instance, Batchelor's data imply that the care of a horse required about 45 minutes a day, and I have applied the same requirement to Chinese draught animals.[54] In the absence of any information, I posit that each Chinese farm family that kept chickens had three, and spent 18 minutes per day feeding them and gathering their eggs.

IV

In order to compare productivity in England and the Yangtze Delta, land, labour, and output must be measured commensurably. Land and labour can be measured in acres (or mu) and days. There is some uncertainty as to the length of the day—but little can be done about that—and measuring land by extent ignores differences in environmental capability. These are captured in the productivity

[49] B. Li, *Agricultural development*, p. 95, reports that the cost of transportation in rice cultivation was 0.125 taels per mu, which equalled about two days' labour.

[50] Ibid., pp. 152, 217, n. 13.

[51] Brenner and Isett, 'England's divergence', p. 652; Huang, 'Development or involution?', pp. 509, 512.

[52] B. Li, *Agricultural development*, pp. 72–3.

[53] Buck, *Land utilisation*, vol. 3, pp. 314–19.

[54] Batchelor, *Bedford*, p. 87.

Table 4. *PPP exchange rate: England and the Yangtze Delta*

	Yangtze cash/kg	*England pence/kg*	*Yangtze/ English*	*Yangtze share*	*English share*	*Average share*
Rice	53.7	14.6	3.69	0.62	0	0.31
Wheat	32.2	3.9	8.20	0.10	0.35	0.23
Beans	26.3	2.3	11.66	0.06	0.09	0.07
Pork	160	17.6	9.08	0.09	0.45	0.27
Fibre	480	26.4	18.16	0.13	0.11	0.12
Price indices (copper cash per pence):						
arithmetic with Yangtze shares	6.98					
arithmetic with English shares	9.97					
Fisher Ideal	8.34					
Törnqvist (Divisia)	7.42					

Notes and sources:
Rice
China: the price is taken to be 2.55 taels per shi and 1,370 copper cash per tael. (B. Li, *Agricultural development*, p. xvii).
England: Beveridge, *Prices and wages*, vol. 1, p. 433.
Wheat
China: the price was about 70% of the price per shi of rice according to B. Li, *Agricultural development*, pp. 208, n. 6; 21, nn. 9 and 13. It is assumed that one shi of wheat weighed 76 kg.
England: wheat cost 105.12d. per bushel. Each bushel weighed 60 lbs.
Beans
China: price per shi is taken to be 70% of the price of wheat, based on the Zhili prices graphed by L. Li, 'Grain prices', p. 80.
Pork
Yangtze: 80 cash per catty = 160 cash per kg.
England: 8d. per pound = 17.64d. per kg.
Fibre
Yangtze: ginned cotton cost 240 cash per jin (catty) or 480 cash per kg, since three catties of unginned cotton made one catty of ginned cotton (Pomeranz, *Great divergence*, p. 317).
England: raw wool cost 12d. per pound or 26.46d. per kg.
Price indices: see text.

measures with the result that they do not indicate which country had the better farmers. Output, however, presents special problems in view of the use of prices to aggregate the products.

The agricultural output of each country was computed by valuing the net output of every product using the money of that country—pence for England and copper cash for China. A conversion factor is necessary to make these monetary valuations commensurable. The exchange rate is an obvious candidate: in terms of the price of silver in each country, one penny was worth 20.29 copper cash.[55] This ratio, however, is a misleading indicator of the value of money, since 20.29 copper cash purchased much more in China than did one penny in England: for instance, one penny bought 259 grams of wheat in England, while 20.29 cash got 539 grams in the Yangtze (table 4). This kind of problem frequently arises with exchange rates, so economists resort to 'purchasing power parity' (PPP) exchange rates for international comparisons of productivity and living standards. These exchange rates are indices of the relative prices of a basket of commodities in the two countries.[56]

[55] This is the exchange rate implied by the weight of one tael (31.066667 grams of silver), one penny (0.46 grams of silver), and the exchange rate of 1,370 cash per tael (B. Li, 'Involution or not', p. 16, n. 25; see above, n. 33). 20.29 = 0.46/(1370/31.066667).

[56] Summers and Heston, 'New set'; idem, 'Penn World Table'; Maddison, *Monitoring*; O'Brien and Keyder, *Economic growth*.

Table 5. *Agricultural productivity comparisons*

	English midlands c.*1806*	*Yangtze Delta* c.*1620*	*Yangtze Delta* c.*1820*
Output (£)/acre	3.30	24.5	26.18
Days per acre	13.0	112.3	122.6
Output (d.)/day	60.9	52.5	51.3

Note: Yangtze output values were all in *c.*1820 cash prices and were converted to pence by dividing by the PPP exchange rate in tab. 4.

In the case at hand, a PPP exchange rate has been computed using the prices of rice, wheat, beans, pork, and fibre. Wheat, beans, and pork were produced in both countries. Rice, of course, was not grown in England, but it was imported, so its price is observable. Farmers had the option of producing it, but chose not to, since its cultivation would not have been profitable at that price under English conditions. For fibre, I use the price of raw wool in England and raw cotton in the Yangtze. As with rice, the calculations could be made using the price of raw cotton in England since so much was imported, but the results would scarcely change since the prices of wool and cotton were similar.

Table 4 shows the prices of these items in English and Chinese money. Rice was very expensive in England (and is still not produced there). For the three foods produced at both ends of Eurasia, the Chinese price in cash was 9–13 times the English price in pence. Only in the case of textile fibres was the ratio of the Chinese to the English price of the same order as the exchange rate, a point emphasized by Broadberry and Gupta.[57]

Table 4 also matches the price relative to shares suggested by the structure of gross agricultural output shown in the Yangtze and English midlands in 1820 (tables 1 and 2). Many index numbers can be computed with these shares, and they do not entirely concur. Table 4 shows weighted arithmetic averages of the price relatives using both south midlands and Yangtze shares. These Laspayres and Paasche indices are 7.0 and 10.0. The geometric average of these indices is the Fisher Ideal with a value of 8.3. The Fisher Ideal index has many desirable properties compared to the Laspayres and Paasche, and for that reason has been dubbed a 'superlative' index by Diewert.[58] Another superlative index is the Törnqvist or Divisia index, which is a weighted geometric average of the price relatives where the weights are average shares. This index is also shown in table 4 and has a value of 7.4. The Fisher Ideal and the Törnqvist indices are the best choices and are closer to each other than the Laspayres and Paasche, but still leave a range of values for the PPP exchange rate. Since a choice between the Fisher Ideal and the Törnqvist indices is arbitrary, I use an average of the two (a value of 7.9 copper cash per penny) in the comparisons that follow.

Using this exchange rate, table 5 compares agricultural inputs and outputs for the English midlands and Yangtze Delta in the early nineteenth century. Days worked per acre were about eight times higher in China than in England, and output per acre was nine times higher. These disproportions would not have surprised Smith, Malthus, or Marx. What is perhaps surprising is how well China

[57] Broadberry and Gupta, 'Great divergence', pp. 24–8.
[58] Diewert, 'Index numbers'.

does when labour productivity is the standard of performance. Output per worker in the Yangtze was 84 per cent of output per worker in the English midlands.

Table 5 also includes measures of agricultural output and inputs for the Yangtze in the early seventeenth century. Output is measured in prices of the 1820s to facilitate comparison. Population growth led to only a small increase in employment per acre over these two centuries. Evidently, there was little change in land or labour productivity.

The introduction of this article raised the question of how the Yangtze Delta mapped into the European experience summarized in figure 1. Land in the south midlands rented for 20 per cent more than land in England as a whole, implying a 7 per cent productivity advantage for the region compared to the country.[59] Allowing for this implies that labour productivity in the Yangtze Delta was 90 per cent of that in England in 1800. As figure 2 shows, the Netherlands and England had a small lead on the Yangtze in 1800, but in 1600, the Delta was ahead of them and, indeed, of present-day Belgium. Throughout the seventeenth and eighteenth centuries, labour productivity in the Yangtze Delta exceeded that in France, Germany, Spain, Italy, and the other continental economies. The constancy of labour productivity in the Yangtze Delta over the seventeenth and eighteenth centuries confirms the views of the moderate revisionists like Pomeranz, Goldstone, and Wong. The finding contradicts the expectations of both the Involutionists, who expect falling labour productivity, and of B. Li, who expects rising productivity.

It is instructive to see why B. Li's agricultural revolution does not appear in figure 2. Both his data and the data in this article show gross production per mu rising from 1620 to 1820 as the yield of rice increased and double cropping expanded. Also, in both cases, there is little change in days worked per mu over the two centuries. Both sets of data show, therefore, that there was an increase in gross output per day worked. What is relevant, however, is net output per day, and, in order to determine that, costs, in particular fertilizer costs, must be subtracted from gross output. In the calculations in this article, nothing is deducted for fertilizer *c.*1620, while a large deduction is made in 1820 due to the large volume of bean cake applied at that date. The cost of the bean cake offsets the rise in gross output producing constant labour productivity. B. Li, however, subtracted the same expense for fertilizer in both 1620 and 1820. Subtracting the same number from gross output in both years means that net output rises by B. Li's reckoning; hence, his agricultural revolution. But, as argued earlier, little fertilizer was purchased in 1620, so there is no fertilizer cost to deduct in that year. Hence, B. Li's increase in net output per day cannot be accepted.

V

Agricultural productivity is important for understanding economic development, but it is only indirectly relevant to Pomeranz's contention that incomes in China *c.*1800 were at least as high as those in Europe. In order to address that issue,

[59] The average rental in Bedfordshire, Berkshire, Buckinghamshire, Cambridgeshire, Huntingtonshire, Leicestershire, Northamptonshire, Oxfordshire, Rutland, and Warwickshire exceeded that of England as a whole by 7% in 1814/15. See McCulloch, *Statistical account*, vol. I, p. 551, for the rents.

Table 6. *CPI exchange rate: England and the Yangtze Delta*

	Yangtze cash/kg	*England pence/kg*	*Yangtze/ English*	*Yangtze share*	*English share*	*Average share*
Rice	53.7	14.6	3.69	0.62	0	0.31
Wheat	32.2	3.9	8.20	0.10	0	0.05
Bread	35.6	5.5	7.64	0	0.35	0.18
Beans	26.3	2.3	11.66	0.06	0.09	0.07
Pork	160	17.6	9.08	0.09	0.45	0.27
Cloth	176	12.0	14.67	0.13	0.11	0.12
Price indices (copper cash per pence):						
Linear with Yangtze shares	6.53					
Linear with English shares	8.99					
Fisher Ideal	7.66					
Törnqvist (Divisia)	6.94					

Notes and sources: Prices as in tab. 4 except for:
Bread
China: estimated from bread equation in Allen, 'Great divergence', p. 418.
England: 10d. for a four-pound loaf in the 1820s (Mitchell and Deane, *British historical statistics*, p. 498).
Cloth per square yard
Yangtze: one bolt of cloth required three catties of unginned cotton worth 240 cash. Domestic workers received one dou (0.1 shi) of rice for spinning and weaving which came to 400 cash in the early nineteenth century. One bolt of cloth (3.63 square yards) cost 640 cash or 176 cash per square yard. Alternative scenarios have been explored by Pomeranz, *Great divergence*, pp. 316–26.
England: one piece of Neild cloth was 29 yards by 28 inches (22.6 square yards) and cost 22.6s. in 1812 or 12d. per square yard (Harley, 'Cotton textile prices', p. 80).

it is possible to use the data for measuring agricultural productivity to compare incomes in the Yangtze Delta to those in the English midlands. There are two objectives: to compare income *levels* at the start of the nineteenth century and to compare income *trends* in the seventeenth and eighteenth centuries.

An important question is whose income should be compared to whose. There are four possibilities. In both the midlands and the Yangtze, men did most of the agricultural work, and their earnings comprised most of the family income. The options are as follows. (1) We can compare the wages of male farm workers in both regions. (2) Most of the farm land in England had passed from small-scale family farms to large-scale farms operated by wage labourers, and those labourers were far more numerous than the remaining small-scale farmers. The situation was very different in the Yangtze where most of the population were peasant cultivators. If we want to compare the 'bulk of the rural population', we should concentrate on English agricultural labourers and Yangtze peasants. (3) Women contributed to the family income in both regions through the domestic production of textiles, and their earnings can be compared. (4) Overall family incomes can be compared by summing the earnings of men and women.

To effect any of these comparisons, we must convert Chinese copper cash prices to English pence. The same issues arise here as arose in the context of productivity comparisons. The solution is to construct an international consumer price index. Table 6 shows details. Six commodities are distinguished: rice, wheat, bread, beans, pork, and cotton cloth. Beans, pork, and cotton cloth were consumed in each country; however, there were marked differences in the carbohydrate portion of the diet. In the Yangtze, it consisted of rice and wheat porridge.[60] In contrast,

[60] B. Li, *Agricultural development*, p. 207, n. 25.

bread was the staple in England. Prices are needed for all goods in both regions even if they were not consumed.[61]

Table 6 also shows Paasche, Laspayres, Fisher Ideal, and Törnqvist indices. The average of the last two was 7.3 copper cash per penny, and that will be used to compare the purchasing power of earnings. This exchange rate is similar to the value of 7.9 worked out for the productivity comparisons.[62]

The four income comparisons will now be considered.

1. *Wages of Male Farm Workers*

English farm labourers were hired by the day. The wage fluctuated with the seasons. In the early nineteenth century, a man in Bedfordshire who was employed in agriculture for 52 weeks at six days per week earned an average of 23 pence per day, taking account of seasonal variations and including the value of food and drink supplied by the farmer as well as the cash payments.[63]

Chinese farm labourers were generally hired on annual contracts and paid in money and food. A database of their earnings has been analysed by Allen et al.[64] According to their estimated wage equation, farm workers in the Yangtze *c.*1820 received 0.038 taels per day. This equalled 52 cash or 7.1 pence in purchasing power. This is about one-third of the wage of the English farm worker. This difference in real wages is consistent with estimates for other occupations made by Allen et al. The Yangtze labourers were hired for a year, while the English labourers could only expect about 275 days of work, so the purchasing power of the English wage ought to be reduced by 275/365 to 17 pence per day. Even with this adjustment, Yangtze incomes were much lower than English and similar to those in the poorest parts of Europe.

The differentials were probably smaller 200 years earlier. Between the mid-seventeenth century and 1820, real English farm wages were essentially unchanged. While we do not have a consumer price index for the Yangtze Delta for this period, we do know that the price (in silver taels) of rice in the late seventeenth century was about 40 per cent of the price in 1820 and nominal wages in silver were slightly higher. Using the price of rice as the deflator implies that the real farm wage in the Yangtze Delta was around 18 pence per day in 1820 English prices. It looks like the mid-seventeenth century was the time when Yangtze and English wages had similar purchasing power.

2. *Yangtze Peasants Versus English Farm Workers*

The wage comparison is not the most pertinent, however, since most Yangtze residents were peasant farmers rather than wage earners. Peasant incomes were

[61] No bread price was available for the Yangtze Delta. I estimated a value using the 'bread equation' in Allen, 'Great divergence', p. 418. This equation shows how bread prices in European cities depended on the price of wheat and the wage rate. Yangtze values were substituted into the equation to determine what bread would have cost had it been produced in the European way.

[62] The exchange rate can also be calculated from the data used in Allen et al., 'Living standards'. Comparing the cost of achieving the nutritional standard in Allen, 'Great divergence', with a Chinese-style diet valued with a Yangtze rice price implies an exchange rate of 7.93 cash per penny in 1820.

[63] Batchelor, *Bedford*, pp. 80–1. Nominal wages were similar in 1820.

[64] Allen et al., 'Living standards'.

earnings from business operations. By subtracting rent from net farm income, agricultural earnings per day can be derived from the estimate of output per day. Most Yangtze peasants in the early nineteenth century paid a rent equal to half of the rice crop. Peasant farmers produced 405 copper cash from each day's work, but only received 228 cash. The difference was rent.

Peasant incomes compared favourably with English wages. The purchasing power of 228 copper cash was 31.2 (=228/7.3) pence per day. As we have just seen, the English farm worker averaged 23 pence per day over the year. This calculation puts the Yangtze peasant considerably ahead of the English labourer.

The matter, however, is slightly more complex. The Yangtze peasant cultivating nine mu only worked 184 days per year. This short work year was the result of the subdivision of farms. In contrast, a fully employed farm labour in England could expect to work about 275 days per year. If we compare average daily earnings over the course of 365 days, the Yangtze peasant made 16 pence per day ($31.2 \times 184/365$), while the English labourer earned 17 pence ($23 \times 275/365$) per day. The Englishman had a small lead. No doubt, the Yangtze peasant did not spend half his year in idleness, but whether he could earn much money outside of agriculture or textile production (to be considered later in this article) is open to doubt. The incomes of English farm labourers and Yangtze peasants look similar in the early nineteenth century.

Why was the income earned for a day's work greater for a Yangtze peasant than for an English labourer? There are several possible explanations. The first is that the labourers were young, single men who were not in a position to lease farms, while the peasants had families and the resources to operate a farm. The second is that rents in the Yangtze Delta were less than the commercial value of the land. According to Brenner and Isett, the peasants gained 'fixed rents, exemptions from rent procurements against second crops, and a variety of favourable terms that reduced the weight of rents'.[65] Rent, they say, was 'politically fixed' rather than determined by the supply and demand for land. Population decline in the seventeenth century was the initial cause of low rents. The peasants consolidated their gains through bargaining and rent strikes. The result was a low level of rent and a high net income per day worked for the peasants in the early nineteenth century. The situation might have been more complicated if the peasants who gained fixed, low rents sublet their holdings at commercial rents to people who actually cultivated the soil.[66] In that case, the cultivators themselves may not have realized an income greater than that of labourers, and the value of the land may have been distributed across a hierarchy of individuals, including peasants, who were leasing out land. The extent of subletting is unknown, and further research is warranted to explore why peasants were so successful and who was getting the income.

What about two centuries earlier? Larger farm size meant that peasants could work 281 days per year on the land instead of 184 (table 7). In addition, net earnings per day were 16 per cent greater as well. (While there were important limitations on rent increases, as Brenner and Isett have argued, rent still did go up as rice yields grew, and those increases cut into peasant incomes.) These calculations suggest that real peasant incomes from agricultural production (averaging

[65] Brenner and Isett, 'England's divergence', p. 615.
[66] I am indebted to Debin Ma for suggesting this interpretation.

Table 7. *Real family income in the Yangtze, 1620–1820*

	1620	*1820*
Agricultural (male) days worked	280.7	183.9
Real agricultural income/day worked	265.1	228.4
Textile (female) days worked	118.2	124.0
Real textile income per day worked	131.4	66.7
Real family income per day worked	225.5	163.2
Real family income over 365 days	246.4	137.7

Note: Incomes are measured in copper cash prices, *c*.1820.
Source: See text.

over 365 days in a year) were 77 per cent greater in 1620 than they became two centuries later. With little trend in English real agricultural wages, Yangtze peasants were much more prosperous than English farm workers in 1620.

3. *Women's Earnings*

In the early nineteenth century, many English women worked in domestic textile industries. Typically, they realized half or two-thirds of the income of men (that is, 11–14 pence per day) in the early nineteenth century.

The opportunities were similar for women in rural villages in the Yangtze Delta who spun and wove cloth in their homes. The total labour devoted to these tasks can be calculated from the production of cotton (as shown in table 1) in the Delta on the assumption that there was no net importation of raw cotton into the region *c*.1820.[67] Three catties of unginned cotton gave one catty of ginned cotton, which, in turn, yielded one bolt of cloth.[68] Each bolt of cloth required six days of labour *c*.1820 (but seven days in 1620) and generated a labour income equal to one-tenth of a shi of rice, worth about 0.246 taels or 337 copper cash.[69] With these ratios, cloth production, manufacturing employment, and income can be calculated from raw cotton production. Yangtze women made about 56 cash per day on these assumptions; that is, a bit less than eight pence per day at 7.3 cash per penny. This is only between half and two-thirds of the wage earned by English women.

The available evidence suggests that Yangtze women were probably better off (relative to English women) in the middle of the seventeenth century. English wages were generally constant in real terms over this period. The course of

[67] This estimating procedure, which is based on Li's aggregate calculations, implies less output and employment than B. Li, *Agricultural development*, pp. 151–5, estimated when he analysed family income. In that exercise, he subtracted the labour used in agriculture from his estimate of the family labour supply (300 days of male labour and 200 days of female). These calculations, which assume full employment in the Yangtze and the allocation of all labour to textiles that was not used in agriculture, imply much greater production than was feasible given the estimates of cotton production in the Delta. Pomeranz's discussion of trade flows (*Great divergence*, pp. 330–3) suggests that net imports of raw cotton into the Yangtze were probably negligible; indeed, the region may have been an exporter.

[68] The ratios are plausible since they imply that cloth weighed 0.3 pounds per square yard. See also B. Li, *Agricultural development*, p. 33. Pomeranz, *Great divergence*, pp. 317, 322, 330–3, also analysed cotton production and employment in the Yangtze.

[69] B. Li, *Agricultural development*, p. 149. The price of rice is the average for 1809–28 from Wang, 'Rice prices', p. 44.

earnings in Yangtze textiles is an issue that has divided involutionists from more optimistic historians.[70] According to the involutionist view, the growth of the population reduced farm size and pushed more and more people into textile by-employments. Cloth production increased proportionately. As the supply grew, the price of cloth was forced down, rendering textiles an increasingly unremunerative activity. The optimists, on the other hand, see the market for textiles as buoyant and highly remunerative, and thus see the expansion in employment as the response to growing demand for cloth rather than the increasing supply of spinners and weavers. Price history seems to favour the involutionists. B. Li, a proponent of rising incomes in this period, observed that 'the net income from a bolt of cloth was worth 2.3 dou of rice in the late seventeenth century, 1.4 dou in the early eighteenth century, and 1.9 dou in the mid eighteenth century. In the early and mid-nineteenth century of very low prices it was still 1 dou . . . '.[71] There was some fluctuation, but the overall trend was downward. Furthermore, the fall in real terms was so large that the real earnings of Yangtze women probably exceeded those of their English counterparts in the mid-seventeenth century. As in the case of male farm workers, that was their golden age.

How 'adequate' was the remuneration? The issue turns both on the time of the assessment and on the standard chosen. One day's work in the late seventeenth century produced 7,684 calories (7,684 = 23 litres/bolt × 0.65 kg/litre × 3,598 cal/kg/7 days per bolt) which was already low by world standards but adequate to support a family. On the other hand, one dou per bolt in the early nineteenth century produced only 3,898 calories (4,498 = 10 litres/bolt × 0.65 kg/litre × 3,598 cal/kg/6 days per bolt), which might have sustained the weaver and a couple of young children but not a whole family. The downward trend toward immiseration is stark.

4. *Family Incomes in the Yangtze and England*

The production of cotton cloth must be valued and added to agricultural income in order to establish the well-being of families. Table 7 shows the income per day of the average Yangtze peasant family *c.*1620 and *c.*1820. Income is calculated using copper cash prices *c.*1820 in both cases, so the table shows 'real' income. It dropped by 42 per cent over those two centuries.

The table also identifies the causes of the decline in terms of earnings per day and days worked. Family income equals income per day earned in agriculture multiplied by the number of days of agricultural work, plus income per day earned in textiles multiplied by the number of days of textile work. Two elements accounted for most of the decline—earnings per day in textiles, and the number of days worked in agriculture. The first reduction is due to the falling price of textiles, and the second reflects the reduction in farm size. Population growth (and a lack of job expansion outside of agriculture) led to the decline in farm size and probably the drop in textile prices. There was a less important slump in earnings per day in agriculture as rents

[70] The debate between Huang, 'Development or involution?', and Pomeranz, 'Beyond', on the trend in textile earnings has been intense, and it would be rash to claim that B. Li's prices are unobjectionable. I have chosen these since they come from a proponent of rising incomes but contradict that claim.

[71] B. Li, *Agricultural development*, p. 149.

rose with the growth in rice yields. The smallness of the decline in farm earnings per day reflects the constant labour productivity in farming.

How did overall family incomes compare in the Yangtze Delta and the English midlands? If we combine average earnings from an average-size farm with average employment in weaving and spinning cotton, family income (over 365 days) amounts to 137.7 copper cash, or 19 pence per day, at the exchange rate of 7.3 cash per penny.[72] In the south midlands, agricultural labourers earned 17 pence per day averaged over the whole year. Horrell and Humphries have used contemporary budget surveys to measure family incomes and expenditure patterns, and they find that the earnings of women and children increased family income 20 per cent above the earnings of the labourer.[73] Allowing for these earnings raises the family income to 20 pence per day—about 5 per cent more than the earnings of the Yangtze peasant family. This is virtually a dead heat, and such a small differential supports Pomeranz's revisionism.

VI

The evidence on income and productivity surveyed here supports a nuanced assessment of Yangtze economic performance. Some aspects of the situation support the optimistic views of historians like Pomeranz, while others point to more pessimistic conclusions.

Agricultural productivity in the Yangtze Delta was impressive. Output per hectare was an enormous nine times higher than in England. This great lead in land productivity was not counterbalanced by correspondingly low labour productivity, since output per worker in Yangtze agriculture was 90 per cent of the English level in the early nineteenth century. As figure 2 showed, the Yangtze Delta was ahead of most countries in Europe.

The other impressive achievement of Yangtze agriculture was the level of peasant family income that it supplied. In the early nineteenth century, real income per day (averaged over the whole year) of Yangtze peasant families was almost on a par with that of English agricultural labourers. The basis for this achievement was high farm labour productivity in conjunction with limitations on the rise in rent. These two factors resulted in high earnings for each day worked in agriculture. The rent 'stickiness' is consistent with the class conflict model advanced by Brenner and Isett, while the resulting high peasant income is consistent with Pomeranz's belief in the prosperity of Yangtze cultivators.

While these two characteristics of the Yangtze Delta are consistent with optimistic assessments, there were also reasons for concern. Not all of the income comparisons showed the Yangtze Delta to be as prosperous as England. Real male wages and female textile earnings were significantly lower in the Yangtze than in England in the early nineteenth century, although the Delta was probably in the lead in the middle of the seventeenth century. The real wage comparisons push the start of the 'great divergence' back from the nineteenth century to the seventeenth.

[72] Some processing of silk was also carried out on the farm, although much of this work was done in cities (B. Li, *Agricultural development*, p. 141; Xu and Wu, *Chinese capitalism*, p. 203). If *all* silk processing income (including that from work done in cities) were added to farm income, it would raise peasant family income by about one penny per day averaged over 365 days.

[73] Horrell and Humphries, 'Living standards', pp. 855–9; Horrell, 'Home demand', pp. 568–70.

Moreover, if the high incomes of Yangtze peasant cultivators were due to their political success in preventing rent increases rather than to the equilibrating effects of the market, then those high incomes were hostages to politics. A shift of power towards landlords would have put paid to Yangtze prosperity.

In addition, all of the income measures in the Yangtze Delta were trending downward from the mid-seventeenth century onwards. The rising population is the obvious explanation. In the case of farming, output per worker was maintained through the bean cake revolution (although productivity failed to advance as B. Li maintains). Even though output per day worked showed little trend, the rise in population cut the size of farms, so each cultivator worked fewer days per year. The resulting drop in agricultural earnings averaged over the year was, thus, directly attributable to the fragmentation of farms under the pressure of rising population. It is impossible to be as definitive in the case of textile earnings or labourers' wages, but population pressure must be the prime suspect for the decline. The Yangtze Delta looks more like an economy becoming increasingly involuted rather than one on the brink of take-off.

This analysis suggests that the Yangtze's golden age was in the seventeenth century and that its future prospects were poor. High agricultural labour productivity was not an expandable feature of the economy. There were limits as to how many days of work could fruitfully be applied to the soil. In the calculations of this article, that number is rigidly fixed with the result that men were devoting only 184 days of work per year to their small farms. Further population growth would reduce farm size and cut income per family. In reality, the opportunities for increasing the labour applied to the land may have been greater than the present model allows, but the prospects nonetheless look grim. The suggestion is that China was becoming a 'surplus labour economy' where a fertile soil sustained a large population without absorbing all of its labour, and where, consequently, people spent much of their time struggling to raise their incomes in unproductive activities. Only capital accumulation and industrialization would solve that problem.

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