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Chinese agricultural output and TFP: 1661–2019☆

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ABSTRACT

In a pioneering effort, we construct annual frequency series of labour input, sown area, machinery, fertiliser and output for Chinese agriculture from 1661 to 2019. With the new dataset, we examine agricultural output and TFP over the past four centuries.

1. Introduction

Since the beginning of the first literate civilisation, agriculture has been the most important sector in China for nearly three thousand years. Agriculture runs through all the memories of the Chinese people, nurturing a population of about 60 million from the early AD to today's 1.4 billion. However, due to a lack of data, qualitative stories have long been known, while quantitative evidence such as agricultural output, productivity or TFP has been poorly understood. Once we could not even indicate what the long-term agricultural performance was like. Perkins (2013/1969) and Liu and Hwang (1977) conducted some pioneering preliminary studies on this issue decades ago, establishing population and land data to discuss the long-term agriculture economy in China. However, some new evidence suggests that their estimates need to be significantly updated to accommodate recent findings (Broadberry et al., 2018, 2021; Cao, 2000, 2001; Perkins, 2013/1969; Shi, 2017, etc.). Based on the new results of Chinese economic history in the recent decades, we construct four centuries of annual level agricultural data for the first time, including population, labour input, land, machinery, fertiliser, etc. With the new dataset, we can demystify agricultural growth from the early Qing Dynasty to the present era (1661–2019).

2. Data

Agricultural output data in different periods has been well established (Broadberry et al., 2018, 2021; Ma and De Jong, 2019; Wu, 2014; Xu et al., 2017). In the absence of reliable statistics prior to 1949, output-based methods of estimation are the dominant option, thanks to the widely accepted information on land and grain yields generated by the detailed records of Chinese historical materials. The direct method of estimating agricultural output is available in the pre-modern period almost exclusively in China, the Netherlands and England. However, with the exception of annual estimation of Ma and De Jong (2019) for 1840–1912, data currently available prior to 1949 have only the highest 10-year resolution. To obtain annual variation, along with Ma and De Jong (2019), we refer to the so-called subjective harvest index compiled from a large number of Qing government reports. Combined with the benchmark data previously constructed, we can get the annual agricultural output series.

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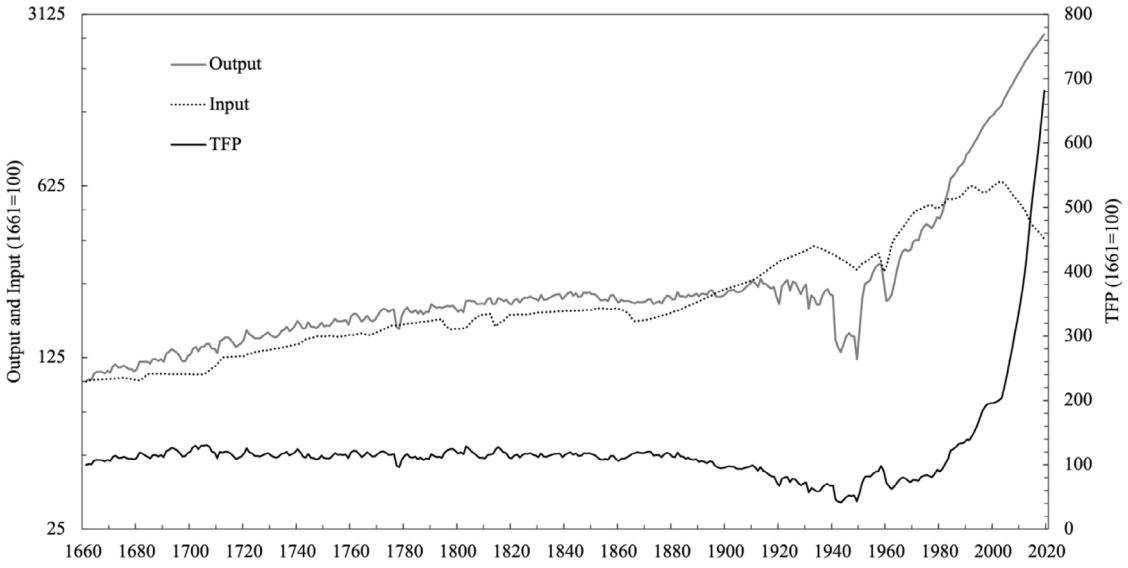

Fig. 1. Agricultural output, inputs, and total factor productivity, 1661–2019 (1661 = 100).
Source: See the text.

The most important inputs data comes from population and land. Although there is much consensus on long-run population estimates, annual variation is still insufficient. Therefore, based on the original registration in the Qing government, we obtain the annual frequency population data following the methods of Liu and Hwang (1977) and Zhao and Xie (1988). Correspondingly, labour force data can be obtained from the occupational structure study (Guo et al., 2019). Land benchmark data is derived from Shi (2017), where annual variation is constructed similarly to population. Other inputs such as machinery and fertiliser are assumed to have grown in line with population prior to 1949 according to Perkins (2013/1969). These other inputs were not dominant in the pre-industrial era, so the setting does not introduce much bias. Details are furnished in the online appendix. Fig. 1 shows our estimated series of agricultural output, weighted inputs, and TFP over four centuries. Factor elasticity settings are described in the following section. Both series are set to 100 in 1661.

Overall, trends in the growth of agricultural output and inputs did not diverge until the 1980s, which means that the real change in TFP should have started in the 1980s. But it was not a picture of complete stagnation before that. For example, there was a slight increase in TFP before the 19th century and a slow decline after that. The first part of the 20th century saw TFP enter a period of significant contraction. It is only that all of the above is overshadowed by the dazzle of the post-1980s period.

3. Labour productivity and agricultural TFP growth

More specifically, Fig. 2 presents agricultural output per worker and TFP growth rates. From the 17th century to the early 19th century, there was limited change in labour productivity, similar to Allen's (2009) discussion for the Yangzi Delta. Given that population continues to grow, it could be called a Malthusian stagnation to some extent. Productivity then fell steadily from the mid-19th century to the early 1930s. Although it is still debatable whether agriculture declined during the period, at least from productivity perspectives, it is consistent with the decline of grain yields and continuous deterioration of agricultural harvests seen by observers at the time (Chao et al., 1995; Zhang, 1996). Buck's retrospective investigation of agricultural wages in the 1930s reached similar conclusions (Buck, 1937). The nadir for several centuries occurred during the Japanese Invasion and only in the early years of the New China did labour productivity rise significantly for the first time. However, this seemingly promising growth was soon interrupted by the Famine (1959–1961). Labour productivity dropped steeply from 98.1 in 1958 to 62.6 in 1962, by 36 percent. In the five years after 1961, productivity rebounded significantly, in line with the central government's new policy of encouraging agriculture after the famine. The recovery was short-lived, however, halting in 1966 and slipping back into recession until 1971. This was the period of the so-called Cultural Revolution. Was institutional deterioration the main reason for the decline? This however is beyond the ambit of this article. More evidence is needed to ascertain whether the continuing chaos of rural politics was destroying production. Labour productivity resumed a slow growth after 1971. It was not until the 1980s that a new phase of sustained and vigorous growth emerged. In 1985, productivity finally surpassed the peak of the Qing Dynasty and entered an unprecedentedly high level.

Though there are many ways to calculate TFP, for simplicity's sake, we still refer to the classic Solow residual approach. For consistency, we use the factor elasticity set by Perkins (2013/1969) and Liu and Hwang (1977). Labour elasticity is set to 0.6, with 0.2 for sown area and 0.2 for other inputs. The ratio of machinery to fertiliser is considered equal. Although there are possibilities for improvement, we do not intend to enter a technical discussion, but rather a preliminary exploration of long-term trends in TFP. Table 1 depicts the contribution of various factors to agricultural growth. Before the 1950s, positive contribution of TFP was not significantly greater than that of other factors, but its negative effect could be fatal. Although the slow growth of various factors was the reason for the decline of agriculture in the late Qing Dynasty, the negative contribution of TFP was particularly obvious. It is highly doubtful that there was some kind of Boserupian growth in China during this period due to population pressure. However, it is worth noting that TFP before the 1760s had an annual growth rate of around 0.25 percent, which is not a bad performance for a pre-modern economy. This means that Qing agriculture had two distinct phases, namely benign growth before the 19th century and a marked decline after that.

Despite widespread criticism of the planned economy from the 1950s to the 1980s, agricultural growth was perceptible in

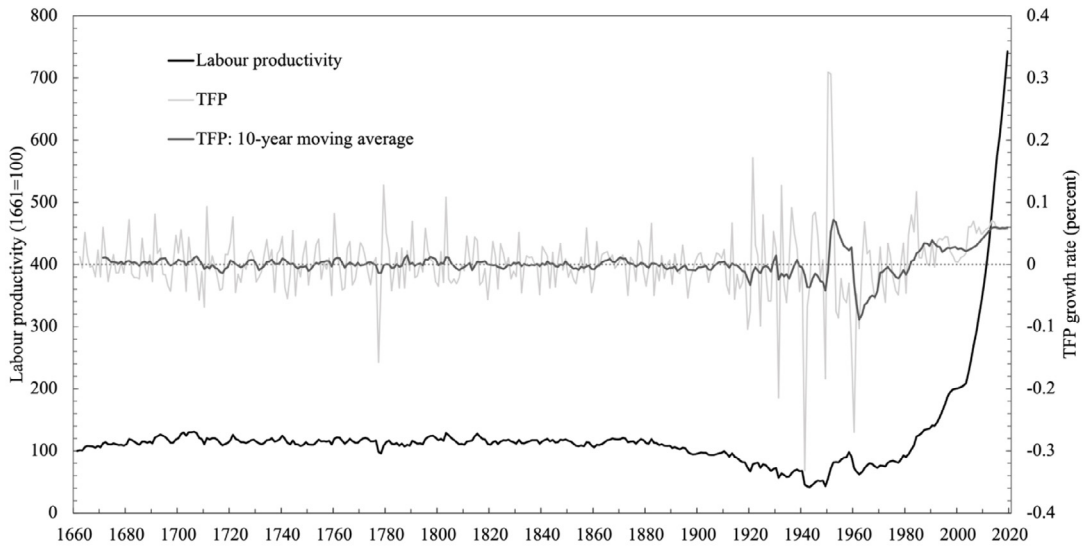

Fig. 2. Agricultural output per worker (1661 = 100) and TFP growth rates per annum, 1661–2019.
Source: See the text.

Table 1
Growth rates of output, inputs, and TFP in Chinese agriculture, 1660–2019 (percent).

Period	Output	Labour	Sown	Machinery	Fertiliser	TFP
1661–1710	0.583	0.201	0.103	0.030	0.030	0.219
1711–1760	0.758	0.332	0.051	0.052	0.052	0.271
1761–1810	0.306	0.235	0.048	0.060	0.060	−0.097
1811–1860	0.066	0.069	0.051	0.022	0.022	−0.098
1861–1910	0.436	0.325	0.033	0.010	0.010	0.058
1911–1950	−0.541	0.202	0.024	0.057	0.057	−0.881
1951–1958	8.388	0.367	0.358	3.466	2.925	1.272
1959–1970	2.165	2.393	−0.085	2.409	1.938	−4.490
1971–1980	2.258	0.306	0.041	2.137	1.422	−1.648
1981–1990	6.298	0.966	0.027	0.691	0.744	3.870
1991–2000	3.809	0.129	0.105	0.626	0.485	2.464
2001–2010	4.229	−1.137	0.040	0.585	0.298	4.443
2011–2019	3.812	−2.378	0.102	0.129	−0.029	5.988

Notes: The contribution of each variable growth is shown in the table, calculated by multiplying the annual average growth rate of the variables by the share set in the text (0.6, 0.2, 0.1, 0.1).

the early 1950s. Contribution of factors other than labour during collectivisation is obvious. Even before the 1959's famine, TFP was rising at a pace not seen in centuries. If we accept the narrative of Lin (1990) that the stagnation of agriculture during 1959–1978 resulted from the loss of exit rights in forced collectivisation, it is reasonable to believe that the roots of structural growth after the 1980s may have been buried in voluntary collectivisation in the early 1950s. In fact, although agricultural growth was rapid between 1959 and 1978, the negative effects of TFP were far ahead of the pre-modern period, and capital investment was the main source of growth during the period. This means that forced collectivisation was essentially a trade-off between positive capital accumulation and negative institutions. In other words, the shift from pre-modern small-scale farming to collectivisation, combined with the guarantee of participants' right of exit, may be the key to the real take-off of Chinese agriculture after the 1980s.

4. Conclusion

We construct nearly four centuries of Chinese agricultural data and find no significant structural changes in agricultural growth before the 1980s. Yet previous agriculture, despite its slow growth, did not have the same face. The Qing and Republican Dynasties showed a distinctly pre-19th century benign performance and a subsequent decline. The pattern of agriculture in the first three decades of the New China, under collectivisation, was also quite different from that of the previous centuries. But the final turnaround in everything happened after the 1980s.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.econlet.2022.110415.

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