*Online Appendix:
Data Sources and Methods for Time Series, 980–1840*

**APPENDIX 1: AGRICULTURAL OUTPUT**

**A1.1 Cultivated Land**

***Northern Song Dynasty***

The cultivated land area is derived for the years 976, 997, 1021, 1051, 1066, and 1083 from the official literature: *Wenxian tongkao (Tianfu kao; Lidai Tianfu Zhizhi)* and *Songshi (Shihuo Zhi, Nongtian)*, with other years obtained by interpolation. However, the official figures have been adjusted in line with the work of Qi (2009, p. 65), who finds that the actual amount of cultivated land was substantially greater than the officially recorded amount after 1051.

***Ming Dynasty***

The amount of cultivated land after 1400 has been estimated at a ten-year frequency by Liu and Hwang (1979, pp. 81–82). Here, we use the adjusted figures of Shi (2011, p. 97, 2015, p. 21) and Wang (2003, p. 10), which correct for an under-recording of land during the period 1520–1620.

***Qing Dynasty***

The amount of cultivated land is taken from Shi (2011, p. 96, 2015, p. 9) for 1661, 1685, 1724, 1766, 1812, and 1850, with other years obtained by interpolation. As during the Ming period, these estimates include a correction for under-reporting, obtained by comparing independent estimates with official estimates in particular regions.

**A1.2 Crop Yields**

***Northern Song Dynasty***

Grain yield per *mu* is available from the following official literature and private historical works: *Song huiyao jigao (Shihuo) (Shihuo* *zhi buzheng*) and *Wenxian tongkao (Tianfu kao, Tuntian)*. Here, we use the average country level estimates from Qi (2009, p. 154) and Wu (1985, p. 19). Average grain yields for the years around 1020, 1060, and 1100 are based on 286 local observations. Although Perkins (1969, pp. 315–332) worked with 261 observations, they were restricted to Zhejiang and Jiangsu provinces, while Qi (2009) and Wu (1985) provide a more geographically representative sample. Grain yields were generally higher in southern China than in northern China, while eastern China had higher yields than western China. Looking at the entire Northern Song period, the grain yield per *mu* increased gradually.

***Ming Dynasty***

Grain yield per *mu* is derived by Guo (2000, p. 385) from a sample of land rent rate data. Guo (2000, pp. 375–380) added 92 observations to the 87 local grain yields collected by Perkins (1969, pp. 315–32) for the Ming dynasty. He aggregated the local yields on the basis of four different grades of land (highest, high, middle, and low), covering both southern rice areas and northern wheat areas. Country-wide averages for the years around 1402, 1482, 1530, and 1626 are obtained using weights for the different qualities of land (10, 30, 40, and 20 percent, respectively).

***Qing Dynasty***

Grain yield per *mu* for the Qing dynasty is derived by Shi (2015, p. 12) from 3,000 local observations based around the six years 1661, 1685, 1724, 1766, 1812, and 1850. This represents a considerable increase over the 497 observations reported by Perkins (1969, pp. 315–32), as a result of Shi’s (2015) use of additional gazetteers and private historical sources. Average yields are calculated for dry farming and paddy farming in northern China, with weights of 52.7 and 0.5 percent in China’s total cultivated land area. For southern China, dry farming, paddy farming and multiple cropping on both types of land have weights of 23.4, 14.0, and 9.4 percent, respectively.

**A1.3 Agricultural Net Output in 1840**

***Grain Crops***

The total cultivated land area is first adjusted by the share of land devoted to grain crops, derived from Table 1. This is then multiplied by the average grain yield to obtain the volume of grain output. The volume of output is multiplied by the price of grain from *Yiban lu* to obtain gross output. Agricultural inputs are set at 15 percent of gross output, in line with the findings of Fang (1996, p. 94) and Luo (1999, p. 38), and subtracted from gross output to arrive at the value of net output.

***Cash Crops***

The net output of cash crops is set at 25.2 percent of the net output of grain crops, in line with the ratio for the 1880s from Zhang (1987, p. 90).

***Livestock, Forestry and Fishing***

The net output of livestock, forestry, and fishing is set at 10.4 percent of the net output of grain crops, in line with the ratio for the 1880s from Zhang (1987, p. 90).

**APPENDIX 2: INDUSTRIAL OUTPUT**

**A2.1 Metal and Mining Industries**

***A2.1.1 Iron***

***Northern Song Dynasty***

We use the estimates of Liu (1993, p. 90), which show a much lower peak level of iron production in 1078 than Hartwell (1962, pp. 153–62).

***Ming Dynasty***

The production of the state-run iron industry, which was based mainly in Zunhua City, can be derived from the official records. The production of the private iron industry can be calculated from the tax revenue, which can be found in *Ming shilu*; *Da Ming huidian, Vol. 194*; and *Guangdong tongzhi chugao in the reign of the Jiajing Emperor* (Huang 1989, pp. 2–18).

***Qing Dynasty***

Data from Li (1979, pp. 116–26) are used to estimate the output of iron in Guangdong, the center of the iron mining and metallurgical industry. Output is also estimated for other provinces to derive the total volume of iron production.

***A2.1.2 Copper***

***Northern Song Dynasty***

The volume of copper output is estimated from the *ke e(r)*, or tax quota, following the research of Wang (2005, pp. 59–60) and Wang (1995b, pp. 726), based on the original data from *Xu zizhi tongjian changbian*, *Wenxian tongkao*, *Song huiyao jigao*. Because of the government’s strict regulation of the production of copper, which was used for minting, few adjustments to the *ke e(r)* were needed. For the period 1078–1125, the original data show too steep a decline because they cover only the southern area of Northern Song China, so output has been held constant after 1078.

***Ming Dynasty***

Tax data on the private copper industry and production data on the state-run copper industry are available at infrequent intervals, and must be interpolated for other years.

***Qing Dynasty***

Copper output data come from Xu and Wu (1985, pp. 491–93). During the Qing dynasty, the government gave up the right to monopolize the mining of minerals. In some provinces, there are thus gaps in the data on copper production. Abundant data exist for Yunnan province, which was an important center of copper mining, and to which estimates for other provinces are added, based on more fragmentary information.

***A2.1.3 Salt***

***Northern Song Dynasty***

Guo (1997, p. 647) collected data on salt production in different regions and then aggregated them to arrive at national salt output.

***Ming Dynasty***

Salt tax data were recorded in *Ming shilu*, but have been supplemented with information from the demand side, making use of estimates of consumption per head, multiplied by population.

***Qing Dynasty***

Salt output during the Qing dynasty is also taken from the research of Guo (1997, p. 727).

**A2.2 Food Processing**

Following Broadberry et al. (2015), we assume other food processing industries grew in line with agricultural output.

**A2.3 Textiles**

Output is assumed to grow in line with population, which is consistent with the absence of a trend in cloth consumption per head (Li 2005, pp. 57–58; Xu 1992, pp. 215–16).

**A2.4 Building**

Building is assumed to grow in line with population, but with an allowance for urbanization. This follows the procedure of Broadberry et al. (2015) in the estimation of English economic growth, 1270–1700. The urbanization data are taken from Rozman (1973), as presented by Maddison (1998, p. 35).

**APPENDIX 3: SERVICE SECTOR OUTPUT**

**A3.1 Commerce**

The output of the commercial sector is estimated indirectly from data on the volume of agricultural and industrial output. The 1840 weights of 58 percent for agricultural goods and 42 percent for industrial goods reflect the much lower share of agricultural output that was marketed. Wu (1998, p. 21) finds a commercialization rate of 17 percent for agriculture, whereas all industrial output was assumed to be marketed. The value of distributed output is thus derived as 17 percent of agricultural GDP plus 100 percent of industrial GDP in 1840 from Table 2.

**A3.2 Government**

Output of government services is derived from the number of civil servants and soldiers multiplied by their salaries. The number of soldiers and civil servants and their pay are taken from **Li (1988, pp. 78–103) and** Wang (1995a, pp. 774, 778) for the Northern Song dynasty. For the Ming dynasty, data for all parts of government can be obtained from *Ming shilu* and *Wanli kuaiji lu*. For the Qing dynasty, data are taken from Chen (2008, pp. 405–37) and from Shi and Xu (2008, p. 50). The nominal value of these services is converted to real terms by deflating with a price index. Details of the GDP deflator used for this purpose are given in Appendix A4.

**A3.3 Housing** **and Domestic Service**

Following Broadberry et al. (2015), it is assumed that housing and domestic service grew in line with population, with an allowance for urbanization from Rozman (1973), as detailed in Section A2.4 on building.

**APPENDIX 4: POPULATION**

***Northern Song Dynasty***

The Northern Song population data for benchmark years 980, 1003, 1021, 1063, 1066, 1083, 1100, 1102, and 1109 are taken from Wu (2000, pp. 346–48) with decadal estimates obtained by interpolation.

***Ming Dynasty***

The Ming population data are available at decadal frequency in Maddison (1998, p. 169), based on a series produced by Liu and Hwang (1979, pp. 81–82) by interpolation between benchmark estimates for 1393, 1600, and 1650 from Perkins (1969, p. 216). Maddison (1998, p. 167) adjusted Liu and Hwang’s estimates to remove implausibly high decadal population growth rates, but allowed a large unexplained population decline between 1480 and 1490. We have log-linearly interpolated between 1480 and 1510 because there is no qualitative historical material to support a sharp drop of more than 15 percent in the population at this time.

***Qing Dynasty***

The Qing population data are available at decadal frequency in Maddison (1998, p. 169), based on a series produced by Liu and Hwang (1979, pp. 81–82) by interpolation between benchmark estimates for 1650, 1750, and 1850 from Perkins (1969, p. 216). Maddison (1998, p. 167) adjusted Liu and Hwang’s estimates to remove implausibly high decadal population growth rates.

**APPENDIX 5: PRICES**

**A5.1 Agriculture**

***Northern Song Dynasty***

The price series of grain crops are taken from Qi (2009, pp. 1103–105) and Quan(**1991, pp. 29–87, 235–65**), both of whom estimate the prices of rice and wheat, and argue that the prices of other crops (such as millet and beans) moved in similar ways. Qi provides observations for 14 years between 1007 and 1117, with seven observations drawn from *Xu zizhi tongjian changbian*, two observations from *Shihuo of Song huiyao jigao,* and the other five observations from private historical sources. Quan draws his observations from the same sources as Qi, but provides more historical analysis of the price changes during this period. The price series for grain is an unweighted average of the price of wheat and rice.

***Ming Dynasty***

Peng (**1965, p. 704**) records the price series of rice measured in silver throughout the Ming dynasty based on a 10-year frequency. Data on the price of wheat are more limited for this period, but suggest a price of around 80 percent of the price of rice. Ninety percent of Peng’s prices are drawn from *Ming shilu*, with the other 10 percent coming from private historical sources.

***Qing Dynasty***

Rice prices during the Qing dynasty are taken mainly from the work of Peng (1965, p. 850), drawn from *Qing shilu* and *Qingshi gao*. Other crop prices are taken from Luo (1999, pp. 32–33), based on Zheng Guangzu’s *Yiban lu*.

**A5.2 Non-Agriculture**

***Northern Song Dynasty***

The price series for cloth is an unweighted average of silk and hemp cloth prices from Yu (2000), recorded in copper coin and converted to silver tael per pi. The silk cloth price is assumed to move in line with the price of raw silk taken from Yu (2000, p. 615) while the hemp cloth price data are from Yu (2000, p. 606). Additional prices for hemp cloth were collected by Cheng (2008, pp. 251–54) from *Shihuo of Song huiyao jigao, Wenxian tongkao (Vol. 5, Tianfu Kao),* and other private historical sources, recorded in iron coin. Additional data on the price of silk cloth were collected by Qi (2009, p. 1106) from *Song huiyao jigao* and *Xu zizhi tongjian changbian*.

***Ming Dynasty***

The price series for cloth is an unweighted average of silk and cotton cloth prices from Yu (2000), recorded in silver tael per pi. The silk cloth price is assumed to move in line with the price of raw silk taken from Yu (2000, pp. 800–806) while the cotton cloth price data are from Yu (2000, pp. 801–802). Peng (**1965, p. 711**) also collected silk prices from the second half of the fourteenth century to the second half of the sixteenth century. Peng (1965, p. 712) also provided cotton cloth prices for nine years between 1368 (the first year of the Hongwu Emperor) and 1643 (the sixteenth year of the Chongzhen Emperor). The primary sources for both silk prices and cotton cloth prices are *Ming shilu* and *Da Ming huidian.*

***Qing Dynasty***

The price series for cloth is an unweighted average of silk and cotton cloth prices, recorded in silver tael per pi. The primary sources for cotton cloth prices are ***Qufu kongfu dangan ziliao xuanbian* and other** private price history books. The cotton cloth price data collected by Yu (2000, pp. 926–27) show the same trend as the series produced by Huang (2008, pp. 112–14) so the two studies are combined here to arrive at a single series for cotton cloth prices during the Qing dynasty. Huang (2008, pp. 109–11) provides an average price of silk cloth in China as a whole, derived from the prices of different kinds of silk cloth in different regions.

Table A1

Summary information on data series

|  |  |  |
| --- | --- | --- |
|  |  | Coefficient of Variation |
|  | Range | Northern Song | Ming | Qing |
| **Agriculture** |  |  |  |  |
| Cultivated land | 21.1–100.0 | 0.32 | 0.22 | 0.11 |
| Crop yields | 62.4–101.2 | 0.05 | 0.05 | 0.07 |
| **Industry** |  |  |  |  |
| Iron | 2.7–100.0 | 0.65 | 0.46 | 0.22 |
| Copper | 1.3–123.0 | 0.65 | 0.43 | 0.52 |
| Salt | 4.8–100.0 | 0.21 | 0.40 | 0.31 |
| Food processing | 13.2–100.0 | 0.35 | 0.27 | 0.18 |
| Textiles | 9.0–100.0 | 0.43 | 0.27 | 0.34 |
| Building | 7.9–100.0 | 0.43 | 0.27 | 0.31 |
| **Services** |  |  |  |  |
| Commerce | 11.2–100.0 | 0.37 | 0.25 | 0.23 |
| Government | 22.3–286.9 | 0.86 | 0.14 | 0.23 |
| Housing and domestic service | 7.9–100.0 | 0.43 | 0.27 | 0.31 |
| **Real aggregates** |  |  |  |  |
| GDP | 12.6–100.0 | 0.40 | 0.22 | 0.17 |
| Population | 9.0–100.0 | 0.43 | 0.27 | 0.34 |
| GDP per capita | 99.6–181.7 | 0.06 | 0.08 | 0.20 |
| **Nominal aggregates** |  |  |  |  |
| GDP deflator | 17.2–100.0 | 0.37 | 0.24 | 0.30 |
| Nominal GDP | 2.9–100.0 | 0.75 | 0.42 | 0.44 |

*Sources*: See Appendices A1 to A4.

Table A2

Recorded observations, benchmarks and methods of interpolation for independent component series

|  |  |  |  |
| --- | --- | --- | --- |
|  | Northern Song, 980–1120 | Ming, 1400–1620  | Qing, 1690–1840 |
| Number of decades covered | 15 | 23 | 16 |
| **Agriculture** |  |  |  |
| Cultivated land | 6 annual observations  | 23 recorded annual observations used to interpolate between 3 corrected benchmark years | 6 annual observations |
| Crop yields | National average grain yields for 2 periods  | National average grain yields for 4 years | National average grain yields for 6 years  |
| **Industry** |  |  |  |
| Iron | 6 observations | 7 observations | 3 observations  |
| Copper | 6 observations  | 6 observations  | 16 observations for Yunnan and additional estimates for other provinces  |
| Salt | 7 observations  | 23 observations  | 14 observations  |
| **Services** |  |  |  |
| Urbanization | 1 observation | 1 observation | 2 observations  |
| Government | 11 observations  | 23 observations  | 16 observations  |
| **Real aggregates** |  |  |  |
| Population | 9 observations  | 23 recorded observations used to interpolate between 3 corrected benchmark years | 16 recorded observations used to interpolate between 3 corrected benchmark years |
| **Nominal aggregates** |  |  |  |
| Grain price | 14 observations  | 23 observations  | 16 observations  |
| Cloth price | 19 observations covering 15 decades  | 8 observations  | 54 annual observations covering 16 decades  |

*Notes*: Simple log-linear interpolation used except where stated otherwise.

*Sources*: See text of Appendices A1 to A4.

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