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Economic restructuring and demographic growth: demystifying growth and development in Northern Song China, 960-1127

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THE ECONOMIC HISTORY REVIEW

Economic restructuring and demographic growth: demystifying growth and development in Northern Song China, 960–1127

Mainstream scholarship on pre-modern China, as represented by a range of influential works—including those of Robert Hartwell,[1] Shiba Yoshinobu, Mark Elvin, Joel Mokyr and Kenneth Pomeranz[2] — has typically regarded the Northern Song (960–1127) as a period of rapid population growth and 'economic revolution'.[3] Opposite opinions are of a distinct minority.[4] Somewhat conversely, however, Chinese academics have traditionally characterized the Northern Song period as 'administratively weak and militarily incompetent', [5] although there has been a strong undercurrent to re-assess Song performance.[6] There is also a century-long debate (since 1910) known as the 'Tang-Song Transition/Transformation' on cultural, social, political and economic furtherance.[7]

More generally, there is the larger debate on why and how economic growth could have been generated in the pre-modern era. Several influential schools of thought have attempted to consider this issue, including 'cultural determinism', 'institutional

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[1] Hartwell, 'Iron and Coal', 'Economic Change', *Early Industrialism*, and 'Markets'. For the debate; see Wagner 'Iron Industry', p. 176 and his *Science*, pp. 280, 300; Qi, *Songdai*, vol. 2, pp. 559–61; Wang, *Songdai Kuangye*, pp. 159–74; Yoshida, *Chugoku Kagaku*, pp. 364–6.

[2] Shiba, *Commerce*; Elvin, *Pattern*, Pt. 2; Mokyr, *Riches*; Pomeranz, *Divergence*.

[3] On industry, see Hartwell, *Early Industrialism*; Wagner, 'Iron Industry'. On commerce, see Shiba, *Commerce*; Elvin, *Pattern*, Pt. 2. On technology, see Needham, *Science*; Deng, *Maritime Activities*; Mokyr, *Lever*, ch. 8; von Glahn, *Fortune*; Twitchett and Smith, *China, vol. 5, Part One*; Qi, *Songdai*, vol. 2, chs 13, 18, 19, 28. Also, Jones, *European Miracle*, p. 160; Jones, *Growth Recurring*, ch. 4; Jones, 'Real Question'; Hobson, *Eastern Origins*, chs 1–4, and 9.

[4] Landes, *Wealth*, ch. 21.

[5] Deng, *Premodern Economy*, ch. 6; Luo, *Songshi Pieshi*, pp. 3–58; Hua, *Songshi Luji*, p. 142.

[6] Shi, *Beisong Shiqi*; Qi, *Songdai*; Wu, *Songdai Jingjishi*; Liu, *Songjin*; Gao, *Songdai Huobi*; Li, *Songshi*; Zhu and Cheng, *Songshi Yanjiu*. Also, see SYBX, *Songshi*, published in Taiwan from 1958 to 1984.

[7] The debate began in 1910 when Naito Konan (1866–1934) first argued that the Song ushered in a 'modern' society; see his *Chūgoku*, ch. 1; also Fogel, *Politics and Sinology*, p. 170. For the Tang political, economic, artistic and demographic influence; see Hartwell, 'Transformation'; Esherick and Rankin, *Local Elite*; Bol, *Culture*; Smith and von Glahn, *Song-Yuan-Ming*. However, scholars in China see discontinuity of the Tang political and economic institutions; see Deng, 'Songdai Wenhuade'; Deng, 'Tantan Youguan'; Qi, 'Tangsong Zhiji'; Lin, 'Shangpin Jingji'; Zhang, 'Tangsong Biange'; Ge, *Qi Shiji*, pp. 357–60; Huang, *Minnan Wenhua*; Li, *Tangsong*; and Bao, *Songdai Zhidushi*.

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determinism', 'entrepreneurial determinism', and 'freedom determinism'.[8] Due to limited space, this study does not elaborate on such debates.

However, while there is a multitude of contested viewpoints regarding the socioeconomic conditions of the Northern Song, one shared view has been that of Song population growth.[9] Various conceptual frameworks have been advanced to help explain the nature of the population growth. The popular Malthusian explanation has been that the Song population and economy both grew due to the availability of cheap food.[10] Historically, more food often meant more pleasure,[11] despite the notion of 'self-exploitation'.[12] There is the 'involution model': when farmland shrinks in per capita terms, farmers opt for cash crops in exchange for food.[13] There is also the 'city-before-agriculture' paradigm.[14] To satisfy all these models, the supply of land must be inelastic. This, however, was not true in the Northern Song.[15] Therefore, this study uses an alternative model based on the concept of 'diversified income' and argues that responses to external conjunctures (environmental as well as geopolitical) led to a swift restructuring of China's economy which in turn affected significantly the Northern Song demography.[16] Such a conceptualization fits well with 'Say's Law', wherein with which the market clears itself.[17]

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[8] Weber, *Protestant Ethic*; North and Thomas, *Western World*; Gerschenkron, *Backwardness*, pp. 52–71; and Epstein, *Freedom*.

[9] Durand, 'Population Statistics', pp. 227–8; Chao, *Man and Land*; Deng, 'Population Statistics'.

[10] Ho, 'Rice', p. 212; Qi, *Songdai*, vol. 1, chs 1–3; *cf.* Li, 'Xuanjing'; Zeng, 'Songdaide Shuangji'.

[11] Pringle, 'Agriculture'.

[12] Chayanov, *Peasant Economy*.

[13] For Ming-Qing North China, see Huang, *Peasant Economy*. For England, see Campbell, 'Agrarian Problem'.

[14] Jacobs, *Economy of Cities*, ch. 1; Phillips, *City Lights*; Taylor, 'Cities'; Soja, *Postmetropolis*.

[15] Liu, 'Productivity', p. 108.

[16] Lewis, 'Unlimited Supplies'.

[17] Braudel, *Wheels*.

This article is organised as follows: in the wake of this introduction, Section I discusses data availability; Section II examines the nature and impacts of a contemporaneous climate change; Section III considers government policy initiatives and their impacts; Sector IV analyses changes in the economic structure, followed by the final conclusions.

I

Unfortunately, no complete Song archive remains in the historical record. Existing information comes from a relatively narrow band of government documents, as well as private essays, diaries and memoirs, occasionally supplemented by recent archeological discoveries. Even so, the sheer quantity of available information is still considerable — for instance, *Song Shi* (*History of the Song Dynasty*) has 496 volumes, the longest official history hitherto. Another commonly respected work, *Song Huiyao Jigao* (*Edited Administrative Statutes of the Song Dynasty*), has 366 volumes. There are also *Xu Zizhi Tongjian Changbian* (*Enlarged Comprehensive References for State Management*) and *Wenxian Tongkao* (*Comprehensive Study of Historical Records*), each containing 220 and 348 volumes, respectively. These four sources have been heavily depended on by historians, including Needham and Elvin (science and technology),[18] Shiba and Cheng (trade and commerce),[19] Zhang (economic geography),[20] Ho and Li (agriculture),[21] Hartwell and Wagner (proto-industry),[22] Quan (market and taxation), Peng and Gao (monetary systems),[23] Ho and Wu (demography),[24] Lo and Liu (transport),[25] Hymes

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[18] Needham, *Science*; Elvin, *Pattern*.

[19] Shiba, *Commerce*; Cheng, *Songdai Wujia*.

[20] Zhang, *Liangsong Jingji*.

[21] Ho, 'Rice'; Li, *Duoshijiao*.

[22] Hartwell, *Early Industrialism*; Wagner, 'Iron Industry'.

[23] Peng, *Huobi*; Gao, *Songdai Huobi*.

[24] Ho, 'Total Population'; Wu, *Renkoushi*.

[25] Lo, 'Sea Power'; Liu, 'Transport'.

(state governance),[26] Eberhard (social mobility),[27] and Feuerwerker, Qi, Twitchett and Smith (general history),[28] to name but a few.

Private accounts, such as *Qimin Yaoshu* (*Essential Techniques for the Peasantry*), *Chenfu Nongshu* (*Chen Fu's Treatise on Agriculture*), *Mengxi Bitan* (*Notes of Dreams*), and Song poems, may be relevant in particular frameworks but tend to be of limited referential value due to their personal scopes.

Nonetheless, existing Song population data are rarely complete. Government censuses counted households (*hu*) and 'male poll-taxpayers' (*kou*, *dingkou*) only.[29] Hence, Song population numbers have to be reconstructed,[30] with Tang data (Tang: 618–907 AD) commonly used as a proxy.[31] The commonly-circulated figures often disagree with one another. [32] So far, the most reliable information comes from 46 famine-relief observations, indicating that the average Song household had 5.4 persons.[33] As such, the Song population can be calculated as follows:[34]

Year	Households (1,000³)	Persons (1,000³)
989	6,108.6 (100)	32,986.4
1100	19,960.8 (327)	107,788.3

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[26] Hymes, *State and Society*.

[27] Eberhard, *Social Mobility*.

[28] Feuerwerker, *Social and Economic History*; Qi, *Songdai*; Twitchett and Smith, *China, vol. 5, Part One*.

[29] Liang, *Nansongde Nongcun*, p. 54; Zhu and Cheng, *Songshi Yanjiu*, pp. 248–56; Bao, *Songdai Zhidushi*, pp. 295–327. This bias began with Emperor Taizhu (r. 960–76), see Wu, *Zhongguo Jingjishi*, p. 255.

[30] Li, 'Songmo', p. 33; Wu, *Renkoushi*, p. 580; Jiang, *Renkou*, p. 60; Duan, *Zhongguo Renkou*, p. 335; Ge, *Zhongguo Renkou*, p. 308; Wu, *Zhongguo Jingjishi*, pp. 253–63; Wang, *Jindai*, pp. 174–8; McEvedy and Jones, *Atlas*, pp. 166–74; Chao, *Man and Land*, p. 41; Maddison, *Economic Performance*, p. 267.

[31] The legal ages for marriages; see Jiang, *Renkou*, p. 272; PCOIG, *Population Atlas*, pp. 70–1.

[32] The highest estimate is 7.5 people/household; the lowest, 5.0; the medium, 5.4–6.0; see Li, 'Songmo', p. 33; Wu, *Renkoushi*, p. 580; Jiang, *Renkou*, p. 60; Duan, *Zhongguo Renkou*, p. 335; Ge, *Zhongguo Renkou*, p. 308; Wu, *Zhongguo Jingjishi*, pp. 253–63. For regional differences; see Wang, *Jindai Zhongguo*, pp. 174–8.

[33] Wu, *Renkoushi*, pp. 156, 159.

[34] Ibid., pp. 346–8.

Annual growth %	1.07

Song cadastres were complicated by their use of 'acreage conversion' (*zhemu*), a system in which as much as 10 *mu* of inferior land could be counted as one *mu* of good land.[35] Song data would make better sense if one imagines that all the recorded acreage had identical medium fertility. Unfortunately, recorded Song agricultural yields were anecdotal, often with no independent verification.[36]

Some production magnitudes, such as iron outputs, can only be detected from the mandatory 20-80 output-sharing (*erba choufen*) by the state.[37] Data on the volume and value of trade come mainly from commercial revenues and taxes. Tax information used in this project is extracted from *Zhongguo Lidai Hukou Tiandi Tianfu Tongji* (*Chinese Historical Survey of Households, Farmland and Land Tax*);[38] and tax rates from *Song Shi*,[39] *Liangsong Caizheng Shi* (*A Fiscal History of the Northern and Southern Songs*),[40] and *Liansong Chengxiang Shangpin Huobi Jingji Kaolue* (*The Rural and Urban Commercial and Cash Economy of the Northern and Southern Song Periods*).[41] Note that due to tax evasion, taxation-based accounts are likely to under-report, but they should serve the current purpose of sizing up China's economy of the time.

Finally, the issue of currency must be considered, since silver was not a common market medium during the Northern Song Period.[42] All prices cited are in bronze coins.

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[35] Xu, *Jigao*, 'Shihuo 70/120', in RT, vol. 7, p. 6416; Toutuo, *Song*, 'Shihuozhi 126', in *ESWS*, vol. 7, p. 5712; Wu, *Zhongguo Jingjishi*, p. 172.

[36] E.g. Skinner, 'Sichuan's Population'. It remains unclear the extent of the problem across all 18 provinces.

[37] Wang, *Songdai Kuangye*, pp. 191–5; Qi, *Songdai*, vol. 2, pp. 586–92; Hu, *Zhongguo Shougongye,* pp. 149–50. Note: the Song mandatory output-sharing took the form of state procurement of a share at fixed prices. It was a type of command economy. On top of that, there were government taxes.

[38] Liang, *Lidai*, pp. 288–9, 297, 302.

[39] Tuotuo, *Song*, 'Shihuozhi 126', and 'Shihuozhi 139', in *ESWS*, vol. 7, pp. 5712, 5757.

[40] Wang, *Liangsong Caizheng*, pp. 52, 678–86.

[41] Guo, *Liangsong*, pp. 238–41.

[42] Wang, *Songdai Baiyin*, pp. 474–5; Peng, *Huobi*, pp. 420, 502.

This article takes into account the three debasements in 1063, 1125 and 1162.[43] Iron currency was pegged to the bronze; and the paper currencies, to the iron.[44] Iron coins and paper notes were geographically confined by law.[45] The market share of iron coins was quite small: 400 million iron coins maximum were issued per year in Chengdu Fu,[46] worth just 40 million bronze coins, compared with the 3.9 billion bronze coins produced by 10 mints in South China.[47] Conversion between bronze and iron currencies is based on official rates set at 1:10 for taxation purposes.[48]

II

The Northern Song territory can be divided into five main zones, based on economic activities (Figure 1). These zones correspond to prefectures (*fu*).[49]

Figure 1 is here

Towards the end of the eleventhtenth century, the shares of farmland in each of these zones were as follows (as of 1078): Zone A accounted for 22 percent of China's total farmland area; Zone B–B'–B", 46 percent; Zone C, 21 percent; Zones D and E combined,

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[43] Long, 'Songdai Liangjia', p. 159.

[44] Yan et al., *Liangsong*, pp. 407–8.

[45] Tuotuo, *Song*, 'Shihuozhi 2', in *ESWS*, vol. 7, pp. 5737, 5739, 5741; Peng, *Huobi*, p. 453; An archaeological 'iron-currency sphere' covers just three provinces; Yan et al., *Liangsong*, pp. 1–251.

[46] Yan et al., *Liangsong*, p. 403; for the historical context, see von Glahn, *Fortune*.

[47] Tuotuo, *Song*, 'Shihuozhi 2', in *ESWS*, vol. 7, p. 5740.

[48] Ibid., 'Shihuozhi 2', in *ESWS*, vol. 7, pp. 5737, 5738.

[49] Ibid., 'Dilizhi', in *ESWS*, vol. 7, pp. 5458–88.

11 percent.[50] Zone C remained peripheral;[51] (this is underscored by the fact that both C and D served as locales to exile criminals and dissidents).[52]

As a result of a significant climatic change, Zones A and E faced a major challenge, one traditionally referred to as the 'Cold Period of the Song' (CPS).[53] From 1000–1120, the frequency of warm weather in these zones was reduced by 90 percent compared to the period immediately proceeding or following the CPS;[54] average temperatures dropped 1–2° C,[55] delaying the harvest seasons by about a month,[56] and causing a 10–20 percent drop in agricultural yields in northern China.[57] The CPS thus moved the East Asian pasture-farming dividing line to the south of the Great Wall,[58] and likewise pushed China's rice-orange belt further southwards.[59] A local gazetteers-based study (*fangzhi*) confirmed that Henan (the location of the Song capital) had ~~hitherto~~ the highest cold current attacks on record (Figure 2).

Figure 2 is here

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[50] Liang, *Lidai*, pp. 164, 290–1; Cheng, *Songdai Diyu*, p. 87; also Perkins, *Agricultural Development*, p. 342.

[51] Gao, 'Zhongguo Chuantong', p. 73.

[52] Exiling criminals in Zones C and D, see Xu, *Jigao*, 'Xingfa, 4/1–4/4, 4/15, 4/25, 4/68', 'Xingfa 5/12, 5/25', 'Xingfa 6/34', in RT, vol. 7, pp. 6608–9, 6615, 6620, 6641, 6661, 6668, 6696.

[53] For the debate, see Zhang, *Qihou Bianhua*, pp. 305–6. For 'temperatures swinging', see Zhang, *Qihou Bianhua*, p. 439; Zhang, *Qihou Bianhua*, p. 297; He et al., 'Lishi Shiqi', p. 2290; Zhang, 'Kaifeng'. For 'temperature increases', see Ge et al., 'Guoqu 2000 Nian', pp. 166–73; He et al., 'Lishi Shiqi'; Man, *Qihou Bianhua*, ch. 8. For a 'warm middle age', see Ge et al., 'Wendu Bianhua'.

[54] Song et al., *Zhongguo Gudai*, p. 343.

[55] Flohn, *Climatology*, p. 236; Loehle, 'Global Temperature'; Schneider and Mass, 'Volcanic Dust'; Zhu, 'Woguo', p. 36; Zhang, *Qihou Bianhua*, p. 415; Shi, *Heshan*.

[56] Tuotuo, *Song*, 'Shihuozhi 127', in *ESWS*, vol. 7, p. 5716.

[57] Zheng, *Gudai Jingji*, pp. 39–43; Song et al., *Zhongguo Gudai,* p. 187; Zhang, *Qihou Yu Renlei*, pp. 123–4.

[58] Zhang, *Qihou Bianhua*, pp. 399–403.

[59] Zhao and Yin, 'Gongyuan', p. 71; Cheng, *Songdai Diyu*, pp. 13–14; Zhang, *Qihou Bianhua*, p. 415.

Song China also suffered from the most serious episodes of droughts and floods since 500 AD (despite the usual difficulty for modern researchers to verify those records).[60] Of all provinces, Henan reported the highest numbers of droughts and floods during 960–1279:[61]

Region	Drought	Flood
North China		
Shandong	15	51
Hebei	10	41
Henan	82	115
South China		
Anhui	2	15
Jiangsu	8	39
Hubei	1	16

This major climate change caused significant uncertainty in crop yields throughout Zones A and E, where resultant disengagement from farming became an issue. In 996, the court official Chen Jing (948–1026) reported that '[a]cross 30 prefectures of 1,000 *li* surrounding Kaifeng, only 20–30 percent of arable land is actually cultivated.'[62] Officials complained in 1007 that land tax revenue declined by 718,000 piculs.[63] Decades later in 1069, Hou Shuxian, an official in charge of farming, reported that '[i]n the capital [Kaifeng] region, over 10,000 *qing*, or half of total arable land, is not farmed.'[64] It was documented in 1067 that 70 percent of households did not farm all their registered land,[65]

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[60] Song et al., *Zhongguo Gudai,* p. 123.

[61] Tuotuo, *Song*, 'Wuxing Zhi', in *ESWS*, vol. 7, pp. 5339–57. Counting prefectures, based on Tan, *Jianming*, pp. 51–2.

[62] Tuotuo, *Song*, 'Shihuozhi 126', in *ESWS*, vol. 7, p. 5711. 1,000 Song *li* ≈ 500 km.

[63] Ibid., vol. 174, 'Shihuozhi 127', in *ESWS*, vol. 7, p. 5717. Note: One Song picul (*shi*) = 46.2 kg.

[64] Xu, *Jigao*, 'Shihuo 7/19', in RT, vol. 5, p. 4901. Note: One *qing* = 100 *mu*.

[65] Toutuo, *Song*, 'Shihuozhi 126', in *ESWS*, vol. 7, p. 5712.

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and 11 percent of registered farmland in the region was simply 'abandoned' (*feitian*).[66] Southward migration became accelerated.[67]

The conventional wisdom argues that these Song agricultural difficulties were overcome through the adoption of Champa rice, introduced from what is now central Vietnam; this quicker-maturing variety allowed for double cropping farming methodology.[68] However, this conventional wisdom story is doubtful. First, the alleged double-cropping of rice has traditionally been based on a dubious logic of 'early-ripening rice' ≡ 'fast-ripening rice' ≡ 'rice double cropping'.[69] The earliest recorded double-cropping of rice was in 1178, well after the end of the Northern Song Period.[70] Double-cropping of rice became modestly common 200 years thereafter during the Ming Period (1368–1644).[71] The widely quoted 'second harvest of rice' (*zaishu dao*) during the Song referred to the re-tilling of old stems; the output of which was never guaranteed.[72] According to known Song sources, a single rice crop per year was *the* norm across all regions.[73]

Second, rice-farming is water-intensive. Given that only five percent of rice paddies are rain-fed in modern China,[74] compared with 40 and 29 percent in South-Southeast Asia and the world, respectively,[75] irrigation is the *sine qua non* for rice-farming. Certainly, the Song state promoted irrigation.[76] But only 7 to 8 percent of all Song

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[66] Ibid., vol. 7, p. 5712.

[67] Liang, *Lidai*, pp. 126–9.

[68] Ho, 'Rice', p. 212.

[69] In Ho's vocabulary, 'early-ripening' and 'fast-ripening' are worryingly interchangeable. Long before the Song, the Chinese differentiated 'early-sowing' from 'early-ripening'; see Xia, *Cihai*, p. 97.

[70] Zhou, *Lingwai*, vol. 8.

[71] Li, *Tangdai*, pp. 119–20; and his 'Songmo'; Cheng, *Songdai Diyu*, pp. 98–101; Chao, *Man and Land*, p. 199; Lin, 'Changjiang'; Liu, 'Productivity', p. 106.

[72] Cheng, *Songdai Diyu*, p. 97.

[73] Cheng, *Songdai Diyu*, pp. 87, 96; Wu, *Renkoushi*, pp. 122–35; Liang, *Nansongde Nongcun*, p. 117.

[74] For annual rainfall, see www.britannica.com/EBchecked/topic/11803/China/70982/Precipitation.

[75] Neue, 'Methane Emission', p. 467, Table 4.

[76] Tuotuo, *Song*, 'Hequzhi 49', in *ESWS*, vol. 7, p. 5503.

farmland was irrigated. [77] Of state-owned land, the irrigated share was merely 0.5 percent.[78] Hence, even if double cropping of rice did take place, given the paucity of irrigated farmlands, the limited scale would have had little change to the overall food supply.

Third, a sudden increase in food supply ahead of population growth would have inevitably pushed food prices downward. But studies show that after 970, the price of rice *increased* about five-fold (coins/picul rice, current prices):[79]

A. China in general[80]

Year	Price
970	190 (100)
1080	1,125 (592)
Annual % change	1.6

B. Densely populated regions[81]

Kaifeng (Zone A)		Hedong (Zone A)		Liangzhe (Zone B)	
Year	Price	Year	Price	Year	Price
989	300 (100)	979	100 (100)	970	200 (100)
1074	1,500 (500)	1086	500 (500)	1098	1,000 (500)
Annual % change	1.9		1.5		1.3

The same trend in rice prices appeared when priced in silver (silver *taels*/picul rice, current prices):[82]

Year	Price

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[77] Ibid., 'Shihuozhi 126', in *ESWS*, vol. 7, p. 5712; Liang, *Lidai*, pp. 290–1; Cheng, *Songdai Diyu*, p. 87.

[78] Shiba, *Songdai Jiangnan*, p. 203.

[79] Peng, *Huobi*, p. 487; Liang, *Lidai*, p. 45; Cheng, *Songdai Wujia*, pp. 125, 132–4, 139–41.

[80] Peng, *Huobi*, p. 487.

[81] Cheng, *Songdai Wujia*, pp. 125, 132–4, 139–41.

[82] Peng, *Huobi*, p. 505.

970	0.33 (100)
1080	1.46 (444)
Annual % change	1.4

As a check to avoid currency inflation and heterogeneity,[83] one can look at rice prices relative to home-made plain silk cloth (*juan*), a common commodity of the time. Rice prices increased under such a comparative analysis, as well:

	Set A[84]		Set B[85]
Year	Bolts silk cloth/*picul* rice	Year	Bolts silk cloth/*picul* rice
970	0.27 (100)	997	0.24 (100)
1080	1.12 (415)	1108	0.95 (396)
Annual % change	1.3		1.2

Another question of key importance is whether a single food crop a year could have supported the population, something that has not been investigated before. There are three known facts here: first, the Song total registered farmland was 312.5 million *mu* in 997 AD; second, the commonly cited yield level from the medium fertile land during this time was approximately one picul per *mu* in Zones A and E, and about twice that in Zone B;[86] and third, the Song daily adult food-grain requirement *per diem* cost of living was 0.02 piculs per day, or 7.3 piculs a year, as given by the Song famine relief standard.[87] Zones C and D were described at the time as 'Rice fields are half tilled and half deserted with only 70 to 80 percent of plants standing. Local farmers never fertilise and weeds

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[83] See Quan, *Zhongguo Jingjishi*, vol. 1, pp. 143–208, vol. 2, pp. 179–208; Peng, *Huobi*, p. 505; Guo, *Liangsong*, pp. 287–321, 331.

[84] Peng, *Huobi*, p. 505–7.

[85] Yu, *Zhongguo Jiage*, pp. 602, 610. Also see Guo, 'Wujia Biandong', p. 72. Qi, *Songdai*, vol. 2, pp. 1104–7.

[86] Wu, *Zhongguo Jingjishi*, p. 115; Hua, *Shongshi*, pp. 4–5; Qi, 'Songdai', pp. 38–9.

[87] Tuotuo, *Song*, 'Shihuozhi 128' and 'Bingzhi 144', in *ESWS*, vol. 7, pp. 5723, 5776.

abound.'[88] It is thusly reasonable to treat them in a similar manner as Zones A and E. With these stylised facts, an output along the Song 'production possibility frontier for food' (PPF) can be calculated as follows:[89]

Zone	~~106~~ Million registered *mu*	Main grain type	Picul/*mu*
A + E	±100	Millet/wheat	1.0
C + D	±70	Rice	1.0
B	±140	Rice	2.0
Total	±310		
PPF (piculs)		±450 million	
Margin of error[90]	±25% (piculs)	338–563 million	

This PPF would feed 60 million people.[91] China had only about 33 million people at the time.[92] Cheap food would have been expected, despite land abandonment and the margin of error.

Note that such calculations represent the Song PPF *prior* to the onset of the CPS climatic event. Now let us reconsider the scenario once CPS entered the picture. Zone B fared better in CPS, as seen in Jiangsu (Figure 3).

Figure 3 is here

Crop yields noticeably declined from the Tang level.[93] Farmers in Jiangsu grew an extra crop a year: not rice but winter-wheat (*sumai*).[94] Winter-wheat (*sumai*) emerged as the

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[88] Cited in Gao, 'Zhongguo Chuantong', p. 73.

[89] Geelan and Twitchett, *China* p. 13; Cheng, *Songdai Diyu*, pp. 87, 96; also see Qi, 'Songdai', pp. 43–5. Note: PPF represents the 'best practice'.

[90] Referring to errors in the Song registration; see Zhao, 'Jishu Wucha'.

[91] This approach differs from that of Perkins; see his *Agricultural Development*, pp. 14, 17.

[92] Liang, *Lidai*, p. 122; Wu, *Renkoushi*, p. 346.

[93] Liu, 'Productivity', pp. 104, 106.

farmers' choice due to its tolerance of low temperatures and irradiance.[95] Winter-wheat had been available previously, as revealed by the Tang poet Bai Juyi (772–846):[96]

> *When it is rainless and windy in the Third Month,*
> *Wheat ears wither and die.*
> *When it is frosty and cold in the Ninth Month,*
> *Rice ears go empty and dry.*

It was confirmed in 1037 that 'the Lower Yangzi region nowadays has a rice crop after a wheat crop, two crops a year.'[97] The practice was also reported by the court official Ouyang Xiu (1007–72): 'People raise debts in winter and repay their debts with their winter-wheat harvest in early summer.'[98] The 'Green-shoots Loan' (*qingmiao fa*) of 1069 was designed to help those whose winter-wheat crop failed.[99]

The gain of this extra crop from the medium fertile land was about 0.8 piculs per *mu*.[100] Taking this into consideration, the Song PPF would look as follows (as in 1111):[101]

Zone	Million registered *mu*	Main grain type	Picul/*mu*
A + E	±180	Millet/wheat	1.0
C + D	±120	Rice	1.0[102]

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[94] Numerous references; e.g. Ge, *Song Liao*, pp. 103–13; Li, 'Changjiang Xiayou', p. 7; Kong, 'Jianlun Zhongtang'.

[95] Cheng, *Songdai Diyu*, pp. 98–100.

[96] Cited in Tang, *Tangsong*, p. 863.

[97] Zhu, *Wujun Tujing*, vol. 1, 'Wuchan'.

[98] Cited in Hua, *Songshi Lunji*, p. 23.

[99] Tuotuo, *Song*, 'Shihuozhi 129', in *ESWS*, vol. 7, p. 5726.

[100] Wu, *Zhongguo Jingjishi*, p. 115; Ge and Gu, 'Songdai Jiangnan' pp. 78–9; Qi, 'Songdai', pp. 38–9.

[101] Tuotuo, *Song*, 'Shihuozhi 126', in *ESWS*, vol. 7, p. 5712.

[102] Due to a lack of information, it is safe to keep the numbers low. Zones C and D were too warm for winter wheat; see Kong, 'Jianlun Zhongtang'.

B	±250	Rice + winter-wheat	2.8
Total	±550		
PPF (piculs)		±1,000 million	
Margin of error ±25% (piculs)		750–1,250 million	

The new PPF would feed 137 million people. By 1111, China had about 108 million people.[103] Here, growth in PPF was a mere 0.7 percent a year over 114 years. If we consider the possibility that a proportion of land could have been used for cash crops, the margin of food surplus would narrow further. A minus 25 percent error would mean insufficient food supply to part of the population. Higher food prices over this period would be logical.

However, high food prices did not lead to more farming; nor did the government strategies to promote food production (including the promotion of land ownership, low taxes and technical assistance) yield any visible success.[104] In 1074, the official Shen Kuo (1031–95) reported vast idle lands in Zone B.[105] What was the reason for such lack of growth in farming?

III

From the early Song, another challenge loomed large: prolonged government budget deficits (Table 1).

Table 1 is here

The reason for the government to incur such budget deficit was due to external threats. After the Tang Dynasty (618–907) was toppled by General An Lushan (703–57), China

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[103] Liang, *Lidai*, p. 124; Wu, *Renkoushi*, pp. 347.

[104] For private ownership, see Xu, *Jigao*, 'Shihuo 69/36', in RT, vol. 7, p. 6333. For taxes, see Tuotuo, *Song*, 'Shihuozhi 126', in *ESWS*, vol. 7, pp. 5710–11. For technical provision, see Xu, *Jigao*, 'Shihuo 6/11 – 7/57', in RT, vol. 5, pp. 4870–4920.

[105] Xu, *Jigao*, 'Shihuo 7/28', in RT, vol. 5, p. 4905.

broke up into ten kingdoms. Although the Northern Song managed to rebuild the empire, China's northern borders faced constant pressure from Khitan Liao (916–1125), Tangut Xixia (1038–1227) and Jurchen Jin (1115–1234). In a classic case of Toynbee's 'challenge-response' situation,[106] the size of the Song military increased:[107]

Year	Soldiers
976	378,000 (100)
1048	1,259,000 (333)
Annual % change	1.7

The previous Tang army had about 600,000 men to guard an empire twice as vast in size.[108] Moreover, unlike the Tang compulsory military service, the Song army was comprised of well-paid professional soldiers (*mubing*). The 'stipend rice' for the army amounted to six million piculs (277,200 metric tons) per year.[109] It took a fleet of 6,000 200-tonners to send food and fodder across the extensive Yangtze and Yellow river systems to the northern frontiers.[110] The government regularly purchased large quantities of grain from the market with a special fund worth about one billion bronze coins.[111] The amount of silk cloth bought by the government increased five-fold from 600,000 bolts (in 1004) to 3,000,000 bolts (in 1041), mainly to pay the military as wage goods.[112] Weapons represented another demanding expenditure to the government, the costs of which are listed below in current prices, [113]

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[106] Somervell, *History*; Kearny, 'Challenge'.

[107] Tuotuo, *Song*, 'Bingzhi 141', in *ESWS*, vol. 6, p. 5762.

[108] Ouyang, *Xin Tangshu*, 'Zhi 40', in *ESWS*, vol. 6, p. 4271.

[109] Tuotuo, *Song*, 'Shihuozhi 128', in *ESWS*, vol. 7, p. 5723. Six million piculs fed about 820,000 adults for a year (0.02 *piculs* per day).

[110] Deng, *Maritime Activities*, pp. 62, 66, 82; Quan, *Zhongguo Jingjishi*, vol. 1, p. 371.

[111] Quan, *Zhongguo Jingjishi*, vol. 1, pp. 367, 369.

[112] Li, *Songchao*, p. 466.

[113] Wang, *Liangsong Caizheng*, p. 437.

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Item (x 1)	Bronze coins
War horse	35,000–60,000
Body armor	17,300–38,200
Sword	3,300
Crossbow	1,500
Arrow	60

Around the mid-eleventh century, eEach soldier cost 37,000–70,000 bronze coins a year, excluding food, clothing and shelter; an officer cost 3–5 times more.[114] Thus, the military budget took 70 to 80 percent of the government's total annual revenue, attracting repeated complaints from government officials.[115]

Despite its size and costs, the Song army proved ineffective. Two campaigns to retake 16 prefectures from the Khitans in 979 and 986 both ended in defeat.[116] This led to a strategy of appeasement.[117] The '1004 Chanyuan Treaty' with the Khitans specified that the Song government would pay annual tributes of 200,000 bolts of silk cloth and 100,000 taels of silver (3.7 metric tons, as one *Song* tael = 37.3 grams3.7 metric tons). After the 1004 settlements, the Song army kept growing, with the government deliberately using the army to absorb unemployed men in order to ease popular discontent. As a result, military budget cuts became politically unfeasible.

As the Song economy grew, the size of the tributes increased to 300,000 bolts and 200,000 taels (7.4 metric tons) under the new '1042 Guannan Treaty'.[118] The Tanguts demanded 130,000 bolts of silk, 500,000 taels of silver, and 200,000 *catties* of tea as their price for peace.[119] More wealth was transferred to the Jurchens: in 1126 alone, the Song government paid 5 million taels of gold, 50 million taels of silver, 2 million bolts of silk, and 11,000 draft animals. Another 378,000 taels of gold, 7,140,000 taels of silver, and

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[114] Tuotuo, *Song*, 'Bingzhi 147', in *ESWS*, vol. 7, p 5787; Wang, *Liangsong Caizheng*, p. 406.

[115] Wang, *Liangsong Caizheng*, pp. 25–8, 771–3.

[116] Zeng, *Yuyan*.

[117] Tsang, *War and Peace*; Cheng, 'Songchu'; Bao, *Songdai Zhidushi*, pp. 5, 34, 187–209.

[118] Mao, *Songchaode Duiwai*, pp. 166, 176.

[119] Ibid., p. 177.

1,040,000 bolts of silk went to the Jurchens a year later.[120] By then, the Song Treasury had been emptied.[121]

The mounting fiscal burden (see Table 1) led the government to employ a two-pronged strategy: (1) to increase the money supply to meet the government's payment obligations, and (2) to raise revenues to finance the budgets. These were desperate measures for desperate times to compensate the Song state failure and military incompetence. A range of policies were implemented which in turn produced forward and backward linkages in the economy. First, there was an increase in liquidity to pay for the costs of running the state (annual total, in million coins):[122]

Year	Bronze coins issued (10^6)	Iron coins issued (10^6)
980	500 (100)	500 (100)
1030	1000 (200)	210 (42)
1045	3000 (600)	430 (86)
1077	3730 (746)	986 (197)
1080	5060 (1012)	889 (178)
Annual % change	2.8	0.6

Likewise, from 1023 to 1107, the amount of paper currency issuance increased 40 times.[123]

Second, the state increased revenues through increased seigniorage, direct marketeering, and taxation. In 1041–8, seigniorage gains increased five to 24-fold.[124] Such gains attracted widespread counterfeits.[125] Taxes collected in cash also swelled drastically (Figure 4).[126]

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[120] Ibid., pp. 50, 227.

[121] The Peloponnesian War (431–404 BC) was won by the less wealthy Sparta. During the thirteenth century, the Mongols conquered about 40 nations of which many were more affluent than the invaders.

[122] Peng, *Huobi*, p. 451; Wang, *Liangsong Caizheng*, pp. 750–3; Qi, *Songdai*, vol. 2, pp. 609–10.

[123] Qi, *Songdai*, vol. 2, p. 1087.

[124] Tuotuo, *Song*, 'Shihuozhi 132' in *ESWS*, vol. 7, p. 5738; Peng, *Huobi*, p. 448.

[125] Tuotuo, *Song*, 'Shihuozhi 132' in *ESWS*, vol. 7, pp. 5738–9.

Figure 4 is here

Government direct marketeering was prominent in the early eleventh century in the form of non-tax revenues (in 10⁸ million bronze coins, current prices):[127]

Year	All revenues	Taxes	Non-tax Revenue
1021/2	140.3-00	53.0-70 (38%)	87.2-30 (62%)
1064/5	116.1-40	76.0-90 (65%)	40.0-50 (35%)

The government proved able to bring in 32.2 billion bronze coins by selling 'certificates for monks or nuns' (*dudie*) in 1068–1109.[128] Various monopolistic dealerships were set up. By law, tea-growers sold their outputs exclusively to government agents. The government tea collection system involved 6 bureaus with 13 branches. It routinely handled 23–29 million *catties* (13,730–17,300 metric tons) of tea a year, earning the government annually 100–300 million bronze coins.[129] Salt fields were state-run. Salt license fees grew from 2.8 billion bronze coins in 1049 to 23 billion in 1078.[130] The wine monopoly began with the yeast production, with as much as 2,220,000 *catties* of yeast per year being sold to breweries by government agents.[131] Further, it was mandatory for breweries' wine output, annually 100 million *sheng*, to be sold through a government channel.[132] Eventually, revenues from the wine monopoly matched the entire trade duties of the empire (*shangshui*).[133] The table below lists the revenue growth from these non-tax items (in 10⁶ million bronze coins, current prices):[134]

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[126] Ibid., 'Zhiguanzhi 115', in *ESWS*, vol. 7, p. 5664.

[127] Wang, *Liangsong Caizheng*, pp. 678–86; Liang, *Lidai*, p. 297; Quan, *Zhongguo Jingjishi*, vol. 1, p. 234.

[128] Qi, *Songdai*, vol. 2, chs 22–5, 29; Guo, *Liangsong*, pp. 259–68. Wang, *Liangsong Caizheng*, pp. 741–3.

[129] Hua, *Songshi*, pp. 76, 109; Zhu, 'Songdai Chazhi'.

[130] Qi, *Songdai*, vol. 2, p. 850; Li, *Songchao*, p. 222.

[131] Wei, *Songdai Guanying*, pp. 356, 361.

[132] Hu, *Zhongguo Shougongye*, p. 353.

[133] Wei, *Songdai Guanying*, p. 351.

Year	Tea-salt revenue	Wine revenue
998	3,750 (100)	4,280 (100)
1046	7,150 (191)	17,100 (396)
1078	22,300 (595)	–
Annual % change	2.3	2.9

State monopoly was also imposed on pharmaceuticals and spices that came to Canton from as far away as Baghdad. [135] The Bureau for Maritime Trade procured and transported imported pharmaceuticals through coastal and river routes and marketed them *via* 2,000 bureaus (*wu*) and local fairs (*chang*).[136] During 1076–78, 1.5 billion bronze coins' worth of frankincense was sold through the system.[137] The arbitrage yielded 20 to 100 percent profits.[138]

Meanwhile, China exported more than ever before. It was documented that '[m]ost out-going ships are loaded with ceramics, smaller pieces packed inside larger ones, no space being wasted.'[139] Metal cooking utensils were routinely exported to Southeast Asia;[140] and lacquer-wares and printed books to Korea.[141] Archeological findings have mapped Song 'porcelain routes' all the way to East Africa.[142] Song coins have been unearthed as widely as its porcelain.[143] Infrastructure in sea ports was upgraded. In Quanzhou (Zone

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[134] Quan, *Zhongguo Jingjishi*, vol. 1, pp. 242, 244–8.

[135] Guo, *Liangsong*, p. 233; Liu 'Transport'; Lin, *Songdai Xiangyao*, pp. 92–103.

[136] Lin, *Songdai Xiangyao*, pp. 106–111, 270–93; Song, 'Songdaide Shangshui'.

[137] Deng, *Guangzhou*, p. 100.

[138] Tuotuo, *Song*, 'Shihuozhi 137', in *ESWS*, vol. 7, pp. 5751, 5752.

[139] See Zhu, *Pingzhou*, vol. 2. For archaeological findings; see Ma and Meng, *Zhongguo Guci*; Huang, 'Songchao'; Xu, 'Songdai'.

[140] Chen and Wu, *Songyuan*, pp. 55–6.

[141] Ibid., pp. 60–1.

[142] Chen and Wu, *Songyuan*, pp. 54–5.

[143] Peng, *Huobi*, pp. 495–6.

B"), about 290 stone bridges were constructed during the Northern Song,[144] sponsored mainly by the private sector.[145]

In this context, maritime trade received special attention partly because the economy produced only 200,000 taels of silver a year (as per 1078).[146] To finance the tribute payments owed to the northern nomads, additional silver had to come from outside of China. The nomads also demanded luxury goods which often had to be transported by sea.[147] Thus, the development of the shipping industry was encouraged in order to bring in both goods and revenues. At its peak, Song China had 3,000 sea-goers of 500 to 1,000 tons each.[148] These were long-range 'Fuzhou ships' (*fuchuan*),[149] equipped with magnetic compasses.[150] Sea charts became common;[151] new routes were added, including those to the Arabian Peninsular (Tazi) and the East African coast (Zanj).[152] Arab merchants also operated Song ports.[153] The Bureau for Maritime Trade (*shibosi*) monitored the east coast and taxed imports. Maritime tax revenues grew rapidly during this period (annual, current prices):[154]

Year	Maritime tax, ~~10⁶~~ in million bronze coins
1087	416 (100)
1106	1,110 (267)
Annual % change	5.3

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[144] Deng, *Maritime Sector*, p. 27.

[145] Fang, 'Songdai Sengtu'.

[146] Tuotuo, *Song*, 'Shihuozhi 138', in *ESWS*, vol. 7, p. 5756. One Song tael = 37.5 grams.

[147] The Jurchens imported from China lychee, sappan wood, rhinoceros horns, elephant tusks, and cinnabar; see Tuotuo, *Jin*, 'Shihuo 5', in *ESWS*, vol. 9, p. 7039.

[148] Deng, *Maritime Activities*, pp. 68, 80; Deng, *Maritime Sector*, p. 12.

[149] Deng, *Maritime Activities*, ch. 2.

[150] Zhu, *Pingzhou*.

[151] Li, *Tongjian* vol. 54.

[152] Zhou, *Lingwai*; Shen, 'Zhenghe'.

[153] Zhao, *Zhufan*; Lin, *Songdai Xiangyao*, pp. 417–9.

[154] Wang, *Liangsong Caizheng*, pp. 723–4.

Soon, maritime duties contributed approximately 15 percent of total government revenue.[155] Meanwhile, the cash share in the total revenue increased steadily (Figure 5).[156]

Figure 5 is here

The changes in government monetary and fiscal policies were widely felt throughout the economy.[157] First of all, government spending enlarged overall aggregate demand (Table 2).

Table 2 is here

Part of the government budget — especially expenditures associated with salaries paid to military personnel — re-entered the economy through the multiplier effect.[158] Conservatively, if a third of the extra payments received by the army were spent on investment and/or domestic goods and services (bearing a 5 percent tax), it would generate 40 percent of new income in the economy.[159]

Moreover, the demand from government mints fuelled the growth in mining, metallurgy, and metal processing industries (Table 3).

Table 3 is here

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[155] Chen and Wu, *Songyuan*, pp. 180–2.

[156] Quan, 'Tang Song Zhengfu', p. 202.

[157] Growth generated by a fiscal state has been well studied in European history, see Yun-Casalilla and O'Brien, *Fiscal States*; 't Hart, *Dutch Wars*.

[158] Hegeland, *Multiplier*.

[159] Multiplier = 1 / (Δsaving/Δincome + Δtax/Δpurchase + Δimport/Δ purchase); hence, 1 / (0.7 + 0.015 + 0) = 1.4.

Iron was used to produce copper and steel.[160] Iron was also a common material for weapons, production tools, and cooking utensils, musical instruments and statues.[161] Moreover, large quantities of iron were used in shipbuilding.[162]

In a nutshell, the two-pronged strategy shifted the money supply curve ($LM_0 \rightarrow LM_1$), while the government fiscal expansionary policies shifted the aggregate demand curve ($D_0 \rightarrow D_1$). Now, more goods and services were available at higher prices (Figure 6).[163]

Figure 6 is here

Changes in the economy were accompanied by extensive changes in Song society. The merchant class became more respected. Concomitantly, numerous changes in government policies benefited merchants. Government grain procurement was commissioned to merchants with a guaranteed price mark-up of 220 to 370 percent.[164] Other government privileges, such as salt permits (*yanyin*) and tea permits (*chayin*), also targeted merchant-investors. In 1078, salt permits were sold for 23 billion coins.[165] A preferential tax rate for the non-farming production sectors was set at half the rate imposed on agriculture.[166]

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[160] Copper through a chemical agent (i.e. $CuSO_4 \cdot 5H_2O$), see Qi, *Songdai*, vol. 2, pp. 567–8. For steel, see Hu, *Zhongguo Shougongye*, pp. 205–7.

[161] Ebrey, *Illustrated History*, p. 144.

[162] Deng, *Maritime Sector*, pp. 29, 31, 47–8; Qi, *Songdai*, vol. 2, pp. 681–8.

[163] Maintaining conservative assumptions, we fix the money velocity constant. Velocity means the number of times per year the same unit of money changing hands, formulated as $M = PT/V$, where M is the actual money needed for all transactions a year; PT, the total value traded a year; and V, the velocity of money in circulation a year. $M = PT/V$ is derived from the so-called 'monetarist equation' $MV = PT$; see Irving Fisher, *The Purchasing Power of Money*. If the velocity increases, as very likely to have happened in a commercial boom during the Northern Song, the same amount of money facilitates more trade in both volume and value. If so, the aggregate demand and supply, and the size of the market will all be considerably greater if velocity is not constant.

[164] Wei, *Songdai Guanying*, pp. 281, 287.

[165] Li, *Songchao*, p. 222.

[166] Tuotuo, *Song*, 'Shihuozhi 126' and 'Shihuozhi 139', in *ESWS*, vol. 7, pp. 5712, 5757; Guo, *Liangsong*, pp. 238–41.

Buying and selling became Song China's national pastime.[167] Eight prefectures became specialised in paper-making.[168] Xinan Prefecture (Zone A) and Huizhou Prefecture (Zone B) alone annually produced 1.4 and 1.5 million sheets, respectively.[169] Paper production fuelled the book market, partly because of the Imperial examinations.[170] There were also official newspapers (*chaobao*).[171] The Song imperial library added 73,877 new volumes to its collections.[172] A total of 300 million characters were carved in Fujian to print the *Tripitaka*.[173]

In terms of agriculture, cash-crops competed with food production within the same growth season (see Table 4).

Table 4 is here

Vegetable farms generated 10 times the income than farms producing grain food crops.[174] Silk was produced in 123 prefectures.[175] Tea production spread across 374 prefectures.[176] In Zone C, up to 70 percent of farms were involved in the growing and processing of sugarcane.[177] Commercialization now ran its own course.[178]

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[167] Wu, 'Shilu Songdai'.

[168] Zheng, *Tang Wudai*, pp. 206–7. For an unearthed workshop of 22,000 m^2, see http://xbh.zjol.com.cn/05xbh/system/2010/01/20.

[169] Needham, *Science*, vol. 5, pt 1, p. 47; Hu, *Zhongguo Shougongye*, p. 51.

[170] The Song Imperial degree-holders were five times of the previous Tang; Yang, *Songdai Chuban*, p. 47.

[171] Kang, *Beisong*, pp. 108–31.

[172] Tuotuo, *Song*, 'Yiwenzhi 155', in *ESWS*, vol. 7, pp. 5808–12.

[173] Kang, *Beisong*, p. 157.

[174] Cited in Qi, *Songdai*, vol. 1, p. 162.

[175] Zhao, 'Songdai Cansiyede', pp. 587, 595. Some households lived on silkworms, see Chen, *Nongshu*.

[176] Zhu, 'Songdai Chazhi'; Hua, *Songshi*, pp. 56, 58.

[177] Wang, *Tangshuang*.

[178] Similar to England in 1680–1820, see Wrigley, 'Population Growth'.

23

Meanwhile, more citizens became urban dwellers.[179] Growth was particularly strong in the south (in 1,000 households):[180]

	Zone	980 (=100)	1102
Kaifeng	A	178.6	261.1 (146)
Fuzhou	B"	94.5	211.6 (224)
Tanzhou[181]	C	52.9	440.0 (832)

If one takes the population growth as a benchmark and compares it with growth rates in commercialization and manufacturing, different growth trajectories emerged:

Growth area	Annual growth %
Population	1.07
Food (PPF)	0.7
Food prices (China-wide)	1.6
Manufacturing outputs	
Iron	2.0
Copper	2.1
Lead	2.9
Tin	4.0
Commercialisation	
Bronze currency supply	2.8
Tea-salt revenue	2.3
Wine revenue	2.9
Maritime tax	5.3

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[179] Qi, *Songdai*, vol. 2, pp. 933, 948; Zhao, *Zhongguo Chengshi*, p. 76; Wu, *Renkoushi*, p. 681.

[180] Liang, *Lidai*, pp. 132–60; Hu and Zhang, *Renkou*, vol. 1, p. 249; Wu, *Renkoushi*, pp. 574, 584.

[181] Tanzhou' was located in current day Hunan Province. The place name was unchanged under the Mongol Yuan. It became 'Changsha Fu' under the Ming (1368–1644).

Figure 7 recapitulates the mechanism. Through policies favouring non-farming sectors, the government shifted F to F' with a smaller increase in relatively low value farming output ($r_1 \rightarrow r_2$) and a larger increase in high value outputs ($\delta_1 \rightarrow \delta_2$). This activated a high return curve 0-Y'. As agriculture became less attractive and food supply turned less elastic, S shifted counter-clockwise to S'. At the new equilibrium f, food prices increased ($p_1 \rightarrow p_2$) faster than the food quantity ($q_1 \rightarrow q_2$), meaning that the 'total food bill' increased (area $q_2\, f\, p_2\, 0$). The economy now *diversified* across different sectors (at b, $\delta_2 > \delta_1$; $r_2 > r_1$). The gain in income therefore over-compensated for the extra food bill (Area $p_1\, p_2\, d\, c'$). Population increased from g to h with enough food (at q_2) albeit at higher prices (at p_2).

Figure 7 is here

IV

To conclude, a strong growth in population during the Northern Song Period coincided with significant economic restructuring. The main engine for this economic transformation was the monetary and fiscal policies the state implemented out of desperation of the political centre. In the process, labour, capital and land were channeled to non-food sectors where returns were higher. Thus we have a story similar in kind to Arthur Lewis's dualism. The importance of climate change was secondary. Champa Rice had no significant role to play.

After demystifying changes during the Northern Song, further steps may be considered regarding real wages and living standards.[182] Comparisons with the Ming-Qing periods, when China's population rose again, may be fruitful. The results presented in this article have enabled the door for the study of the Northern Song case to be opened wider than ever before.

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[182] E.g. Allen et al., *Living Standards*; Broadberry and Burhop, 'Real Wages'; Broadberry et al., 'China, Europe'.
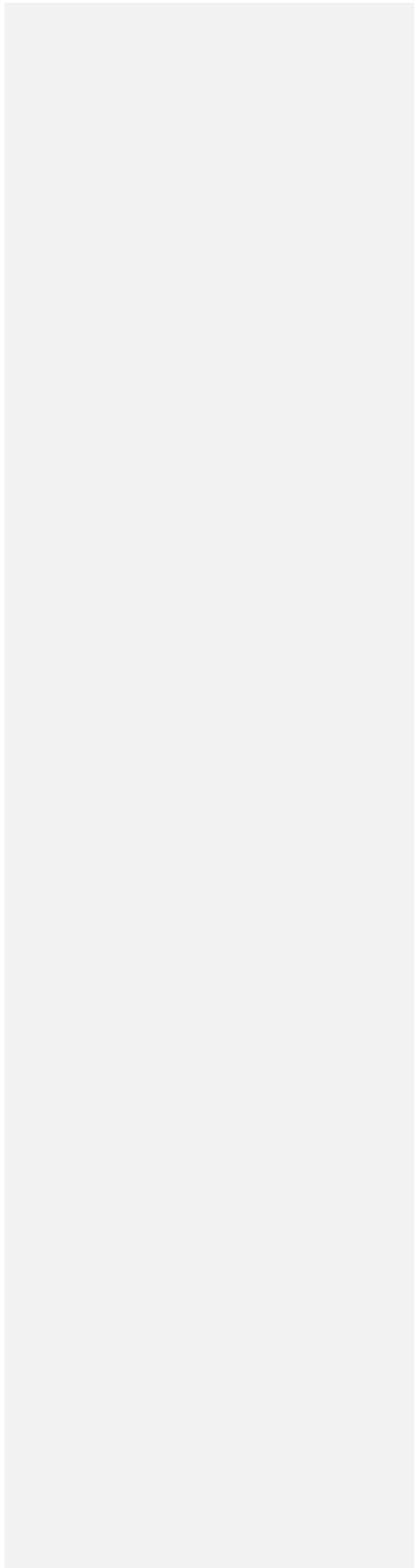
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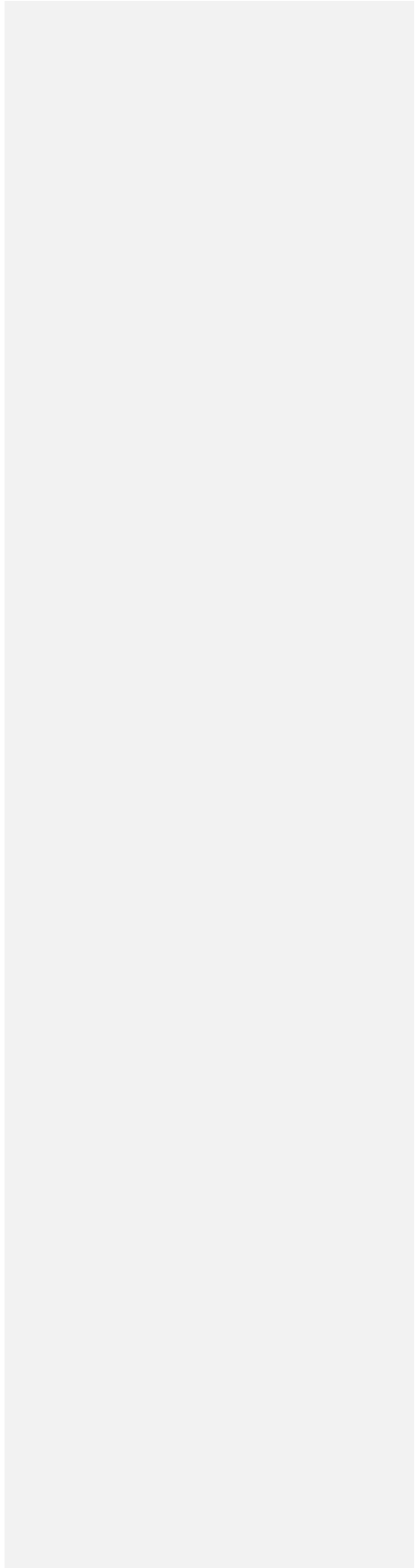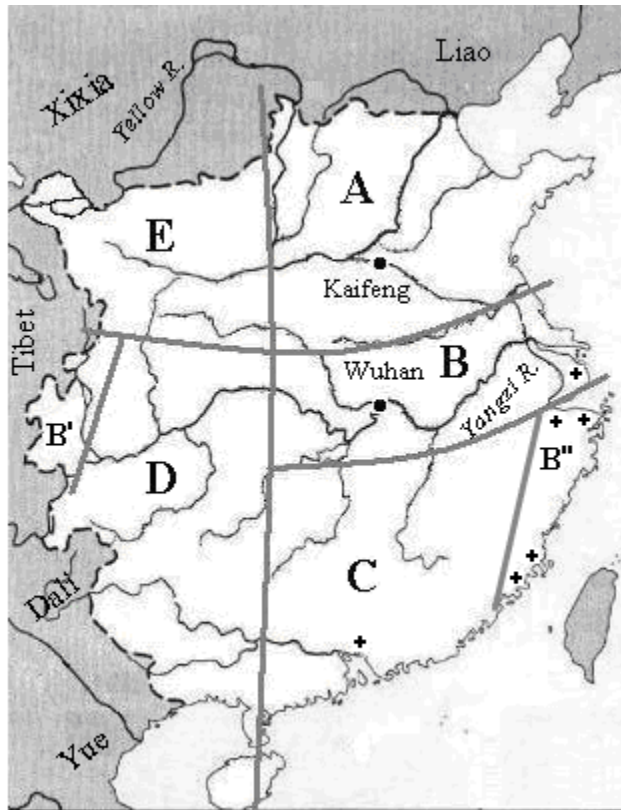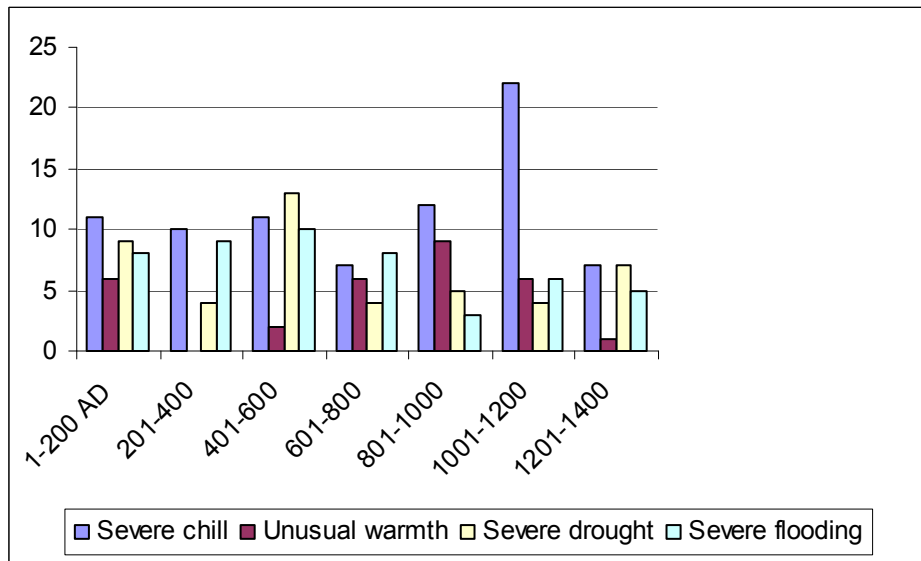58
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Figure 1. Northern Song: Zones, River Systems, and Sea Ports

Note: B, B' and B" shared similar farming patterns. Crosses = sea ports.

Source: Tan, *Jianming*, pp. 41–2, 51–4; Qi, 'Songdai Shehui', pp. 43–5; Liang, *Lidai,* p. 164.
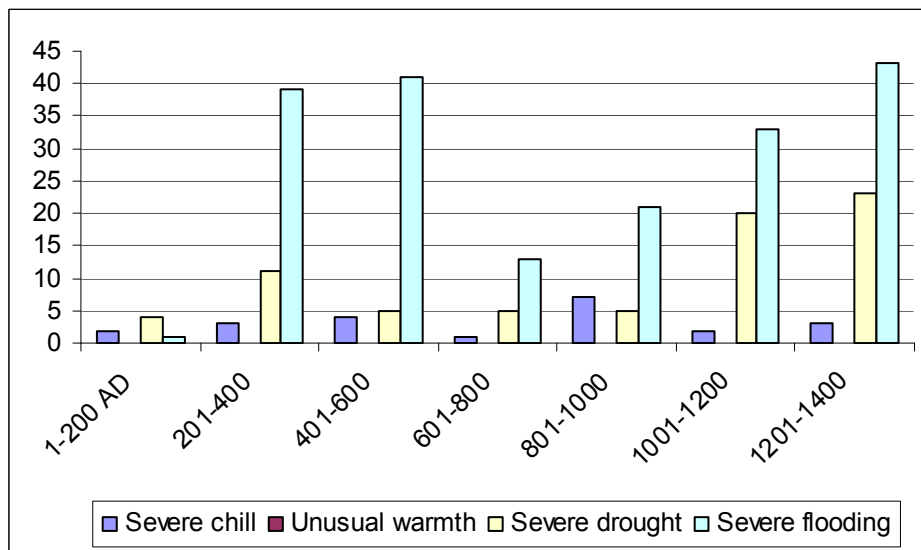
Figure 2. Major Disasters in Henan, 1–1400 AD

Source: Sheng, *Henan Lishi*, pp. 40–55, 84–8.

Note: Cases counted are 'severe chill' (*da han*), 'severe flooding' (*da shui*), 'severe drought' (*da han*), and 'unusual warmth' (*da nuan*).

Figure 3. Major Disasters in Jiangsu, 1–1400 AD

Source : Shi et al., *Jiangsu Nongye*, pp. 2–102.

Figure 4. Changes in Money Supply and Revenues, 970–1087
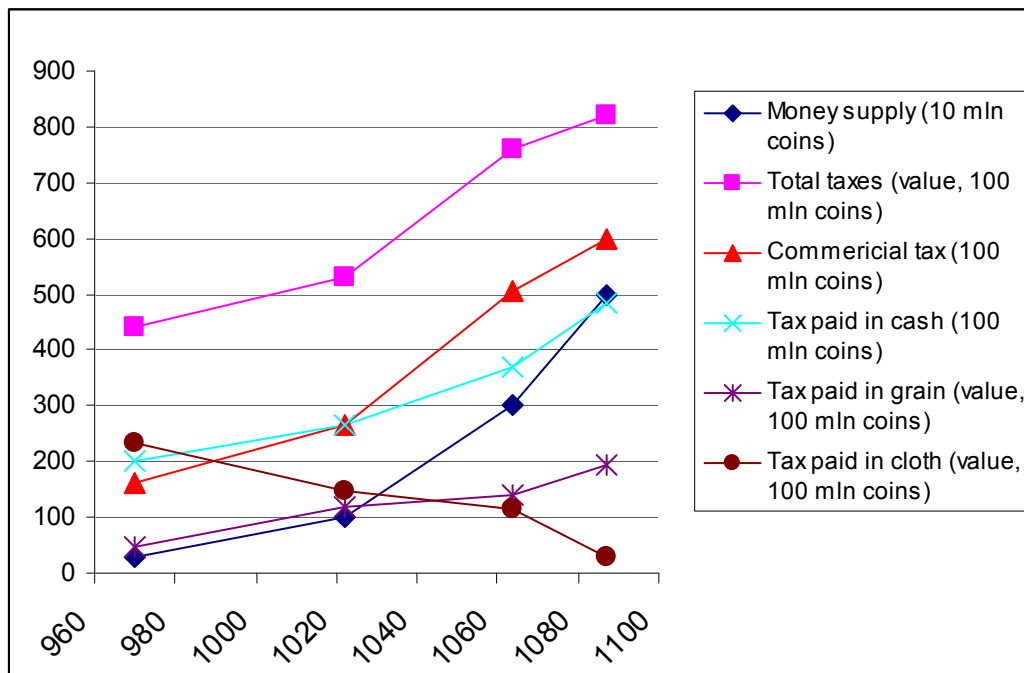
Note: Current prices in bronze coins. The supply of iron coins and paper currencies are not included. Large quantities of Song coins also flowed overseas.[1] Thus, the money supply grew faster than tax revenues.
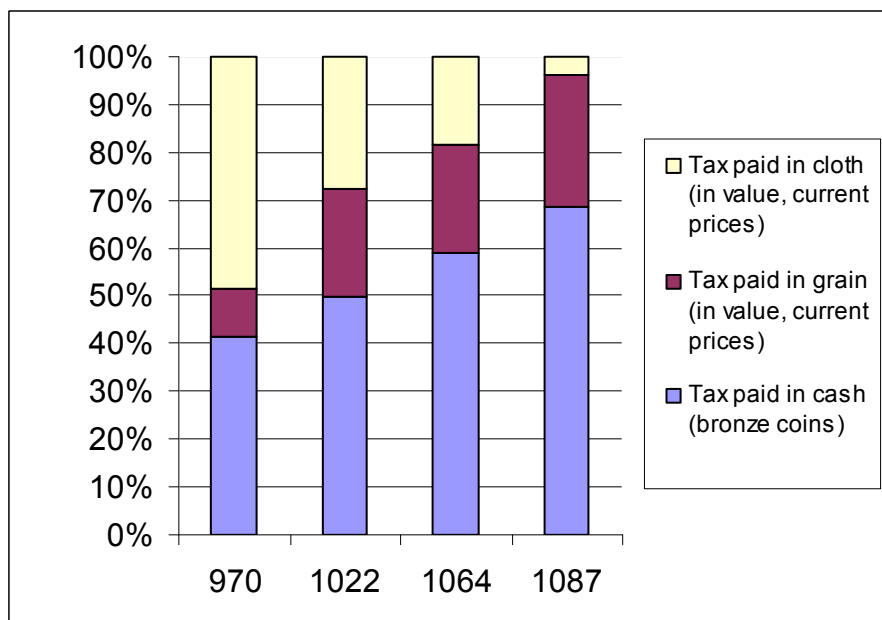
Source: Liang, *Lidai*, p. 297; Quan, 'Tang Song', p. 234; Gao, *Songdai Huobi*, p. 103; Li, 'Luexi Songdai'; Yu, *Zhongguo Jiage*, pp. 602, 610.

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[1] The Song government 'rewarded' the Bohai Kingdom (in what is now Korea) 100 million bronze coins in 984, Samboja (in Sumatra) 64 million in 1018, and Coromandel (now India) 81.8 million in 1077; see Tuotuo, *Song*, 'Waiguo 5', in *ESWS*, vol. 8, pp. 6767, 6769, 6772. Such large outflows of coins caused money shortages at home; see Luo, 'Nansong Qianhuang'.

Figure 5. Per Household Tax-payment Structure, 970–1087

Note: Current prices.

Source: Quan, 'Tang Song', p. 234; Liang, *Lidai*, p. 297; Gao, *Songdai Huobi*, p. 103; Li, 'Luexi Songdai'; Yu, *Zhongguo Jiage*, pp. 602, 610.

Figure 6. Impact of the Song Monetary-Fiscal Policies
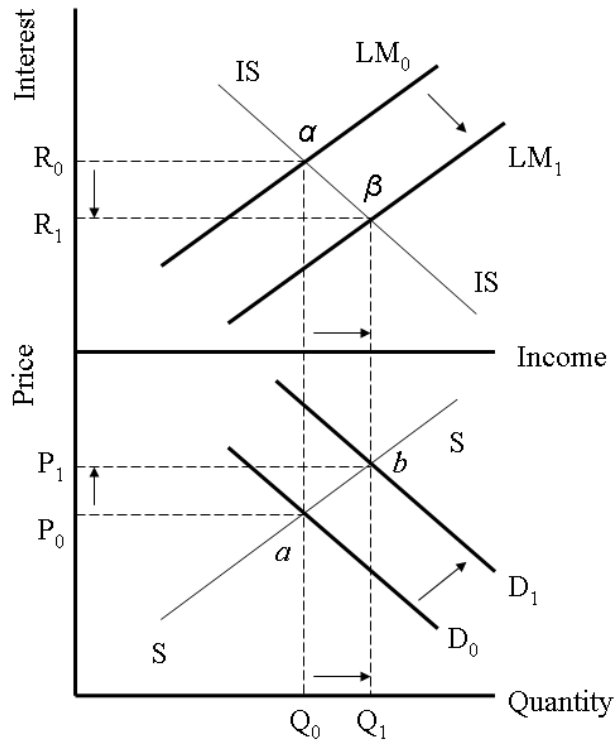
Note: Upper part: the monetary market. Lower part: the goods-services market. R_0, R_1 – real interest rates. P_0, P_1 – prices. Q_0, Q_1 – real income, or quantity of goods and services. Points β and b – new equilibriums.

Figure 7. Economic Restructuring during the Northern Song
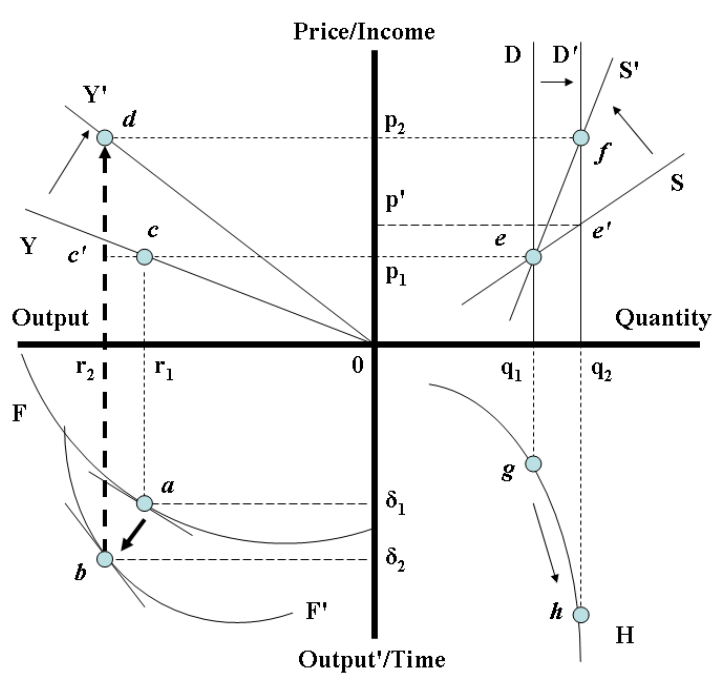
Note: The thick solid arrow represents the prime mover. The thick broken arrow starts a chain reaction. Quadrant III shows production; F and F' are production curves; tangent slopes at *a* and *b* show production bias. Quadrant IV represents returns; 0-Y and 0-Y' are return curves. Quadrant I is the food market; D and D' (income and price inelastic), S and S' are demand and supply curves. Quadrant II demonstrates households; H is population growth curve.

Table 1. Government Budget Deficits, 997–1086

	Revenue	Expenditure	Balance
997	708.9	869.5	−160.6
1021	1403.0	1680.4	−277.4
1065	1161.4	1203.4	−42.0
1086	824.9	919.1	−94.2

Note: 100 million bronze coins, current prices.

Source: Wang, *Liangsong Caizheng*, pp. 678–86.

Table 2. Government Spending and Aggregate Demand, 1021–1087

	(Y + I)*	T	(X – M)¶	G	AD	G/AD
1021/2	(a) 265.7/0.1†	530.7	0	1680.4	9,112.7	18.4%
	(b) 265.3/0.05§					
	(a)+(b) = 7,963					
1064/5	(a) 254.9/0.1†	760.9	0	1203.4	13,111.5	9.2%
	(b) 506.0/0.05§					
	(a)+(b) = 12,669					
1086/7	(a) 220.6/0.1†	820.6	0	919.1	14,304.5	6.4%
	(b) 600.0/0.05§					
	(a)+(b) = 14,206					

Note: Current prices, in 100 million bronze coins. (a) = Farming sector. (b) = Non-farming sector. Aggregate demand (AD) = consumer incomes (Y) – taxes (T) + investment (I) + exports (X) – imports (M) + government spending (G). *All investment for $Period_1$ appears as part of incomes in $Period_0$. Savings are embedded in post-tax Y. †Conversion based on 10 percent tax rates on agriculture. §Based on 5 percent tax rates on industry and services. ¶Assuming X = M.

Source: Tuotuo, *Song*, 'Shihuozhi 126' and 'Shihuozhi 139', in *ESWS*, vol. 7, p. 5712, 5757; Wang, *Liangsong Caizheng*, pp. 678–86; Liang, *Lidai*, p. 297; Quan, 'Tang Song', p. 234; Gao, *Songdai Huobi*, p. 103; Li, 'Luexi Songdai'; Yu, *Zhongguo Jiage*, pp. 602, 610.

Table 3. Government Procurement, 997–1077 (in *Catties*)

Year	Copper	Tin	Lead	Iron
997	4,122,000	269,000	793,000	5,748,000
1077/8	21,744,750	6,159,300	7,943,350	28,500,000
Annual % change	2.1	4.0	2.9	2.0

Note: One Song *catty* = 0.6 kg.

Source: Ma, *Wenxian*, vol. 18, Entry 'Mining'; see also, Du, 'Tang Song', p. 44; Wei, *Songdai Guanying*, p. 436.

Table 4. Crop Choices during Song Times

	Lunar Month	Growth cycle (days)
Food crops		
Winter-wheat*	$9^{th} - 3^{rd}$ (the following year)	175
Millet	$2^{nd} - 7^{th}$	145
Rice α†	$3^{rd} - 5^{th}$	58
Rice β†	$3^{rd} - 7^{th}$	116
Rice γ†/Buckwheat§	$4^{th} - 9^{th}$	145
Cash crops		
Hemp	$1^{st} - 6^{th}$	145
Sugarcane§	$2^{nd} - 10^{th}$	230
Early sesame	$3^{rd} - 7^{th}$	116
Vegetables, tea	$3^{rd} - 10^{th}$	201
Fruits, mulberry trees	$3^{rd} - 10^{th}$	201
Early legume	$4^{th} - 7^{th}$	87
Late sesame	$5^{th} - 9^{th}$	116

Note: A Chinese lunar calendar month has 29 days. Rice α–γ = rice choices; their sowing timing did not allow two rice crops within the same calendar year. *Suited for Zones A, B (including B' and B") and E. †Suited for Zones B, C and D. §Sugarcane is perennial and requires re-planting once every three years.

Source: Chen, *Nongshu*, pp. 2–5; Wang, *Tangshuang*; Guo, *Chengxiang*, pp. 258, 264–8; Liang, *Nansongde Nongcun*, p. 117; Cheng, *Songdai Diyu*, pp. 98–100.

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