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China's Population Expansion and Its Causes during the Qing Period, 1644–1911

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Abstract[1]

The Qing Period (1644–1911) has been recognised as one of the most important eras in China's demographic history. However, factors that determined and contributed to the rise in the Qing population have remained unclear. Most works so far have only speculated at what might have caused the population to increase so significantly during the Qing Period. This study uses substantial amounts of quantitative evidence to investigate the impact of changes in China's resource base (farmland), farming technology (rice yield level and spread of maize-farming), social welfare (disaster relief), peasant wealth (rice prices), cost of living (silver's purchasing power), as well as exogenous shocks (wars and natural disasters) on the Qing population.

Keywords: Economic Growth, Demography, Household Incomes, Market Prices, Tax Burden, Proto-Welfare, Sectoral Differences

JEL Codes: E2, J1, N5.

[1] 1 I wish to thank Dr. Shengmin Sun (Economics Department of Shandong University and 2015 Visiting Fellow of ARC at LSE) and my current PhD student Mr. Jae Harris for their invaluable inputs.

Introduction, motivation and data

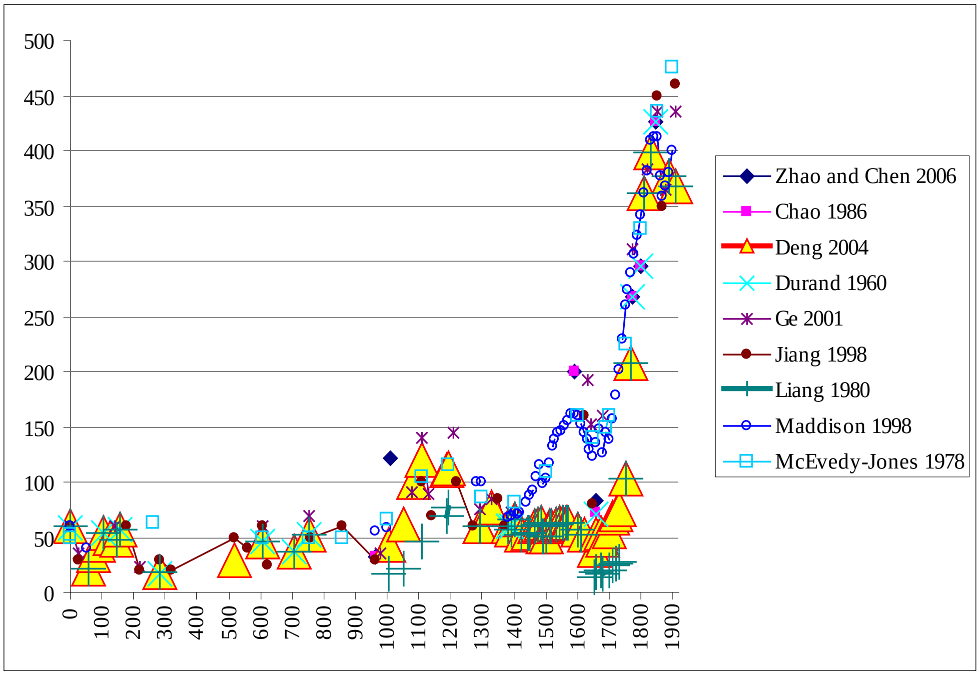
It is commonly agreed that pre-modern China's population experienced two growth spurts: one in the tenth to eleventh centuries (Northern Song: 960–1127), and other during *c*. 1700–1830 (Qing: 1644–1911).[1] During the first growth spurt, China's population jumped from about 50 to 120 million before declining; during the second population rose dramatically from about 56 to 400 million before again declining.[2] Taken together, these two growth spurts accounted for only about 10 percent of the total lifespan of the Chinese empire (2,132 years, 221 BC–1911). Thus, they were exceptions rather than the rule in China's long-term historiography.

During the Song spurt, the annual population growth rate was 1.07 percent; under the Qing, it was substantially higher, at 1.50 percent. Not only was the Qing population growth rate 40 percent greater than that of the Song, but the growth also proved to be more sustainable, decisively changing China's demographic trajectory for good (Figure 1).

[1] Many scholars have backdated the second spurt *c*. 1500; e.g. D. H. Perkins, *Agricultural Development in China, 1368–1968* (Edinburgh: Edinburgh University Press, 1969), Appendix A; Mark Elvin, *The Pattern of the Chinese Past* (Stanford: Stanford University Press, 1973), pp. 129, 310; Colin McEvedy and Richard Jones (eds), *Atlas of World Population History* (Harmondsworth: Penguin Books, 1978), pp. 166–74. However, this assertion lacks support by any historical record or evidence. Although doubts on China's official statistics have been raised, (see G. W. Skinner, 'Sichuan's Population in the Nineteenth Century', *Late Imperial China*, 8/1 (1987), pp. 1–79), there appears to be no technical nor institutional reason for the government not to count people correctly.

[2] See Kent Deng, 'Unveiling China's True Population Statistics for the Pre-Modern Era with Official Census Data', *Population Review* 43/2 (2004), Appendix 3. Note that it has been agreed that between the 1860s and 1920s China's annual population growth rate was still 1.4 percent; see J. K. Fairbank and Kwang-ching Liu (eds), *Cambridge History of China, Late Ch'ing, 1800–1911, Part II* (Cambridge: Cambridge University Press, 1980), pp. 3–4.

Figure 1. China's Demographic Pattern (in Million), 1–1900 AD



Source: (1) Official censuses as the base-line: Liang Fangzhong, *Zhongguo Lidai Hukou Tiandi Tianfu Tongji* (*Dynastic Data for China's Households, Cultivated Land and Land Taxation*) (Shanghai: Shanghai People's Press, 1980), pp. 4–11; adjusted official population data are based on Kent Deng, 'Unveiling China's True Population Statistics for the Pre-Modern Era with Official Census Data', *Population Review* 43/2 (2004), pp. 1–38. (2) Estimates for comparison: J. D. Durand, 'The Population Statistics of China, A.D. 2–1953'. *Population Studies*, 13 (1960), pp. 209–57; Colin McEvedy and Richard Jones (eds), *Atlas of World Population History* (Harmondsworth: Penguin Books, 1978), pp. 166–74; Kang Chao, *Man and Land in Chinese History: An Economic Analysis* (Stanford: Stanford University Press, 1986), p. 41; Angus Maddison, *Chinese Economic Performance in the Long Run* (Paris: OECD, 1998), p. 267; Jiang Tao, *Lishi Yu Renkou – Zhongguo Chuantong Renkou Jieguo Yanjiu* (*History and Demography – China's Traditional Demographic Pattern*) (Beijing: People's Press, 1998), p. 84; Ge Jianxiong, *Zhongguo Renkou Shi – Qing Shiqi* (*A Demographic History of China, Vol. 5, the Qing Period*) (Shanghai: Fudan University Press, 2000), pp. 831–2; Zhao Gang and Chen

Zhongyi, *Zhongguo Tudi Zhidu Shi* (*A History of Land Ownership in China*) (Beijing: New Star Press, 2006), p. 110.

Many scholars – mainly historical demographers and archivists – have adopted a strictly descriptive mode when dealing with such significant fluctuations of the Qing population, as if there were no particular need for an explanation.[3] Similarly, some have taken the Qing population size for granted in so far as to use it as a proxy for the size and health of the economy.[4] Yet such an approach leads to circular argumentation: a large population was fed by a large economy, and a large economy supported a large population.

Some recent works have tried to turn the problem on its head by looking for evidence that would indicate there was a much smaller population increase than previously suggested. These studies have argued that the change in the Qing family size was only marginal, suggesting that by the mid-eighteenth century, only one extra person had been added to an average household.[5] If so, the implication is that China's population may have only experienced 20–25 percent net growth overall. Moreover, it has been proposed that preventive checks, both *ex ante* (herbal contraception) and *ex post* (infanticide), were extensively practised at the household level, meaning that the Qing population may have been consciously controlled.[6] On its own, however, the preventative argument is

[3] J. D. Durand, 'The Population Statistics of China, A.D. 2–1953'. *Population Studies*, 13 (1960), pp. 209–57; McEvedy and Jones, *Atlas of World Population History*, pp. 166–74; Liang Fangzhong, *Zhongguo Lidai Hukou Tiandi Tianfu Tongji* (*Dynastic Data for China's Households, Cultivated Land and Land Taxation*) (Shanghai: Shanghai People's Press, 1980), pp. 4–11; Jiang Tao, *Lishi Yu Renkou – Zhongguo Chuantong Renkou Jieguo Yanjiu* (*History and Demography – China's Traditional Demographic Pattern*) (Beijing: People's Press, 1998), p. 84; Ge Jianxiong, *Zhongguo Renkou Shi – Qing Shiqi* (*A Demographic History of China, Vol. 5, the Qing Period*) (Shanghai: Fudan University Press, 2000), pp. 831–2.

[4] E.g. Maddison, *Chinese Economic Performance*, p. 267; Zhao Gang and Chen Zhongyi, *Zhongguo Tudi Zhidu Shi* (*A History of Land Ownership in China*) (Beijing: New Star Press, 2006), p. 110.

[5] Lee and Wang, *One Quarter of Humanity*, pp. 34–5, 38.

[6] Feng Wang, James Lee and Cameron Campbell, 'Marital Fertility Control among the Qing Nobility', *Population Studies* 49/3 (1995), pp. 383–400; Li Bozhong, 'Qingdai Qianzhongqi Jiangnan Renkode Disu Zengzhang Jiqi Yuanyin' ('The Low Population Growth in the Yangzi Delta and its Reason during Early and Mid-Qing Times'), *Qingshi Yanjiu* (*Study of Qing History*), 2 (1996): 10–19; Li Bozhong, *Duoshijiao Kan Jiangnan Jingjishi, 1250–1850*

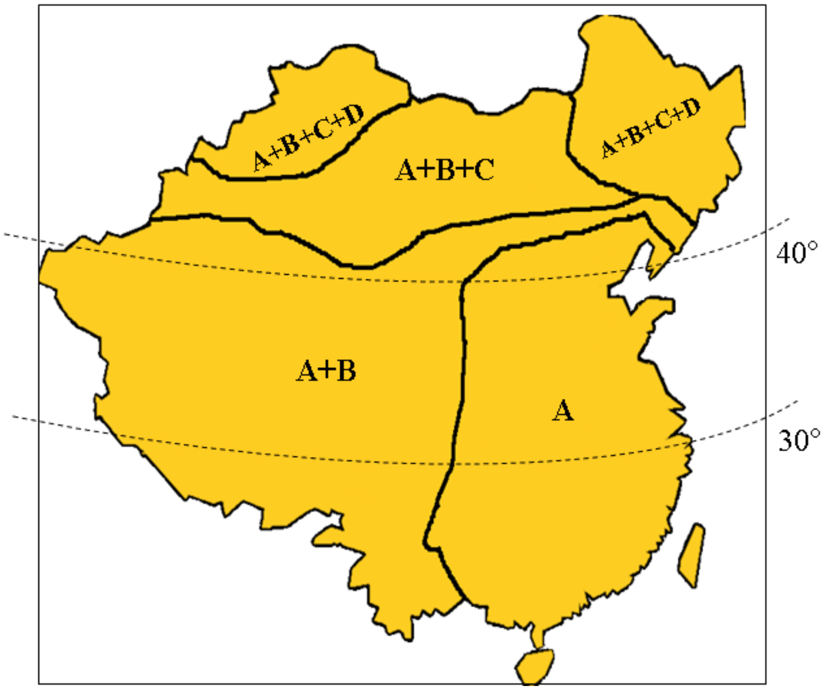
incompatible with the weight of evidence indicating that China's population quadrupled over the period. Such preventative checks, therefore, would had to either occurred very late in the period, and/or on very small scale, such that their effect was not significant enough to impact the overall population growth dynamics.

Meanwhile, why and how the remarkable Qing population growth occurred has remained open to debate. Implicitly or explicitly, a Malthusian paradigm is often used when the doubling of China's territory under the Qing is considered.[7] Intuitively, territorial expansion could lead to more resource endowments and then to more population growth. However, China's territorial increases did not automatically warrant a larger population. By the Tang Period (618–907), China's population had remained below 60 million, regardless of two major increases in the empire's territory during the Western Han (206 BC – 25 AD) and the Tang. During the Northern Song (960–1127), China shrank back to the size under the Qin (221 BC – 207 BC), but its population exceeded 100 million, the largest *hitherto* in China's history. Under the Mongol colonisation, China's territory expanded to its historical peak, but China's population stagnated at the 50–60 million level. Under the Qing, China's territory fell to a size between that of the Tang and Yuan, but the population rocketed (Figure 2). So, more territory can be viewed at best as a necessary but not sufficient condition for China's population increases.

Figure 2. Fluctuations in China's Territory,* 221 BC – 1911 AD

(*Multiple Dimensional View on Economic History of the Jiangnan Region, 1250–1850*) (Beijing: Sanlian Books, 2003), pp. 137–212.

[7] E.g. J. K. Fairbank and Merle Goldman, *China: A New History* (Harvard University Press, 2005), pp. 143–62; J. D. Spence, *The Search for Modern China*, third edition (New York: Norton, 2012), chs 2, 4 and 5; G. D. Rawnsley and M. T. Rawnsley (eds.), *Political Communications in Greater China* (London: RoutledgeCurzon, 2003), pp. 10–38.



Source: Based on Tan Qixiang, *Jianming Zhongguo Lishi Dituji* (*Concise Maps of Chinese History*) (Beijing: China's Map Press, 1991), pp. 15–18, 39–40, 57–8, 67–8.

Note: * Here, the Qing (1644–1911) boundaries are used as a template. A = the Qin territory (*c.* 207 BC) and roughly the Northern Song territory (960–1127); A+B = the Western Han territory (*c.* 24 AD); A+B+C = the Tang territory (*c.* 907); A+B+C+D = the Qing territory (*c.* 1911) and roughly the Yuan territory (1279–1368).

A fuller understanding is obtained by recognising that institutions played a vital part in determining the nature of population growth under different resource constraints. For instance, under the Mongol colonisation of China, genocide against the Han Chinese took place under a mindset described as, 'the Chinese are useless to our cause, and should be killed off so that their land can be converted to grazing land'.[8] Among those Han Chinese who survived, millions were enslaved (*quding*); horses belonging to the Chinese were confiscated; vast agrarian areas were enclosed as grazing land; a second crop after the summer harvest was forbidden in order to make space for horses; taxation burden

[8] Song Lian, *Yuan Shi* (*History of the Yuan Dynasty*) (1371), vol. 153: no. 146 'Yeluchucai Zhuan' ('Biography of Yeluchucai'), in *Er-shi-wu Shi* (*Twenty-Five Official Histories*) (Shanghai: Shanghai Classics Press, 1986), vol. 9, p. 7635; see also A. F. Wright and Denis Twitchett (eds), *Confucian Personalities* (Stanford: Stanford University Press, 1962), pp. 19–20, 189–216.

multiplied.[9] All such policies effectively counteracted any possible resource windfall that would allow for more population growth.

In sharp contrast to the Mongol policies, the Qing territorial expansion was coupled with the government physiocratic commitment. Private land ownership was granted to the Han Chinese. Government schemes deliberately proliferated owner-tiller farms into new frontiers including Manchuria and South Mongolia. Efforts were also made to open up the north-western region of Gansu and Xinjiang and the south-western region of Sichuan, Guizhou and Yunnan, also for farming.[10] These schemes left only Tibet and neighbouring Qinghai untouched.

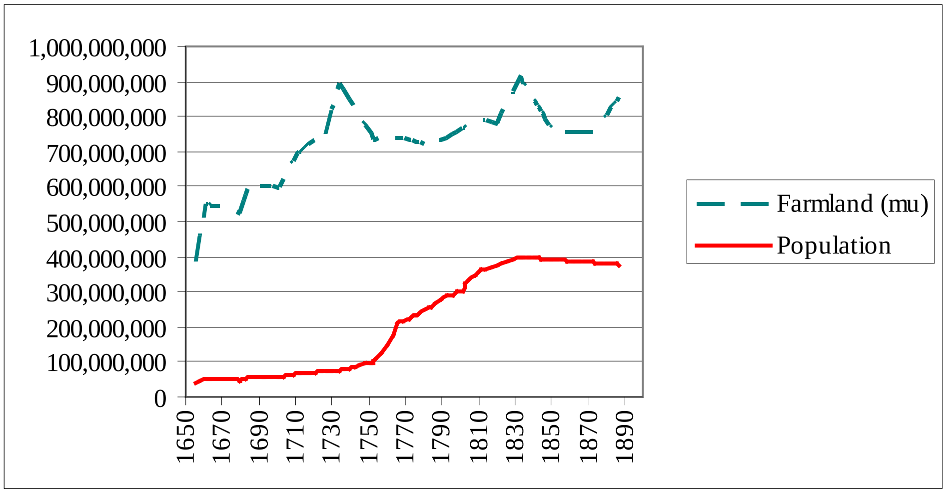
The supply of farmland under the Qing became without doubt more elastic. The additional farmland supply in Manchuria and South Mongolia alone was equivalent to about one-sixth of China's total. China's farmland more than doubled in the first 100 years of the Qing rule (Figure 3). Thus, we consider the first factor in relation to the Qing population growth to be supply of farmland. The current research examines the impact of such a supply on the Qing population.[11]

Figure 3. Supply of Farmland versus Population Growth, 1650–1900

[9] Wang Qi, *Xu Wenxian Tongkao* (*Imperially Commissioned Continuation of the Comprehensive Study of Literature*) (publisher unknown, 1586), vol. 1; Perkins, *Agricultural Development in China*, pp. 23–4, 197–9; Zheng Xuemeng, Jiang Zhaocheng and Zhang Wenqi, *Jianming Zhongguo Jingji Tongshi* (*A Brief Panorama of Chinese Economic History*) (Harbin: Heilongjiang People's Press, 1984), pp. 242–4, 254–5.

[10] By the 1820s, the new farmland in the Balikun and Yili regions of Xinjiang (also known as 'Chinese Turkistan') alone totalled 908,500 *mu* or 121,735 hectares; see Chen Hua, *Qingdai Quyu Shehui Jingji Yanjiu* (*Regional Socio-Economic Conditions during the Qing Period*) (Beijing: People's University Press, 1996), p. 265; J. K. Leonard and J. R. Watt (eds.), *To Achieve Security and Wealth* (Ithaca: Cornell University East Asia Program, 1992), pp. 21–46.

[11] The elastic supply of farmland contradicts the well-circulated notion — known as the 'man-land ratio argument' — that arable land under the Qing was fixed and thus its workforce had to farm more intensively to keep up with an increasing population; see Kang Chao, *Man and Land in Chinese History: An Economic Analysis* (Stanford: Stanford University Press, 1986).

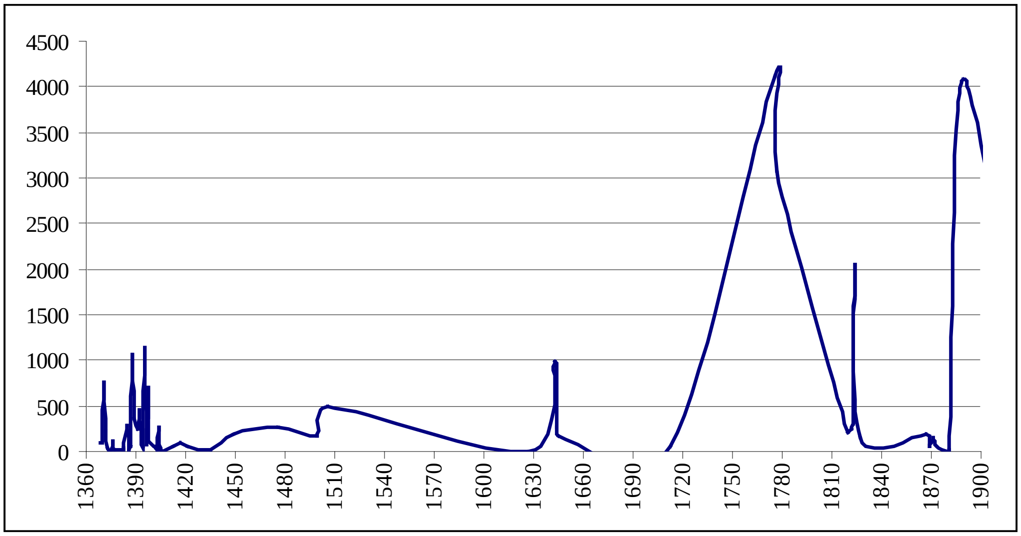


Source: Farmland is based on Liang, *Dynastic Data*, pp. 10, 380, 384, 396, 400, 401. Population is based on Deng, 'Unveiling China's True Population Statistics'.

Note: Farmland in *mu*. Population in persons.

Concomitant with the impact of farmland supply providing support for the Qing population growth was labour mobility. During the Qing, the scale of internal migration was greater than that of the previous Ming Period (Figure 4). The impetus for such increased migration level was the Qing policy of 'farming by invitation' (*quannong*), which actively encouraged farmers to occupy newly available farmland, including old core farming regions such as Shanxi, Zhejiang, Hunan, Fujian and Guangdong.

Figure 4. Internal Migration Index (1369=100), 1369–1900



Source: Ge Jianxiong (ed.), *Zhongguo Yimin Shi* (*A History of Migration in China*) (Fuzhou: Fujian People's Press, 1997), vol. 1, pp. 342–40.

Note: Ordinate – persons. Abscissa – Calendar years.

The concern behind the Qing migration policy was an explicit economy-wide resource re-allocation policy called 'filling regions with land abundance with population from regions of high population density' ('*yi zhai bu kuan*').[12] Often, the Qing state provided migrants with free passage, working capital (seed and tools) and tax holidays for a number of years. Overall, the policy proved effective (Table 1).

Table 1. Internal Economic Migration during the Qing Period

Donor Region	Recipient Region
Shanxi	Sichuan
Hunan	Guangdong, Fujian
Anhui, Hubei	Shanxi
Henan, Jiangxi	Shanxi
Hunan, Guangdong	Sichuan
Jiangxi	Fujian

12 Anon., *Qing Gaozong Shilu* (*Veritable Records of Emperor Gaozong of the Qing Dynasty*) (1799. Reprint. Taipei: Hualian Press, 1964), vol. 311, Entry 'Shisannian Sanyue'.

Fujian, Guangdong	Hunan
Fujian	Zhejiang, Taiwan
Shandong	Manchuria
Shanxi	Mongolia

Source: Ge Jianxiong (ed.), *Zhongguo Yimin Shi* (*A History of Migration in China*) (Fuzhou: Fujian People's Press, 1997), vol. 1, pp. 169–402.
Note: The actual numbers of migrants are difficult to assess. Often, only vague amounts are mentioned in reference to a migration scheme, such as, 'several tens thousand persons/households', or '60 to 70 percent of the locals migrated'.

Large numbers of migrants from the old core regions (such as Shandong, Shanxi, Shaanxi, Hebei, and Henan) resettled elsewhere for a better life.[13] By 1668, the frontier region of Manchuria had absorbed 14 million immigrants from China proper.[14] In the nineteenth century, the annual immigrants to that region were 600,000. By the very end of the Qing (at 1907), the government immigration quota for Heilongjiang, the northern tip of Manchuria, was two million per year.[15] Large-scale immigration also took place into Mongolia. In 1712, the number of immigrants from Shandong counted for over 100,000.[16] As a result, modern-day Manchuria, Mongolia and Sichuan are lineage enclaves of clans from Shandong, Hebei, Hubei and Hunan.[17]

[13] For the eighteenth century, see Pierre-Etienne Will, *Bureaucracy and Famine in Eighteenth-Century China* (Stanford: Stanford University Press, 1990), pt. 2.

[14] Anon., *Veritable Records of Emperor Gaozong of the Qing Dynasty*, vol. 311, Entry 'Shisannian Sanyue' (The Third Month of the Thirteenth Year under the Gaozong Reign).

[15] Tian and Chen, *Brief History of Migration*, pp. 110–12.

[16] The Qing state eventually imposed a ban on permanent immigration to Manchuria (1668–1860) and Mongolia (1740–1897). But there was little control over seasonal migrants to both regions. Moreover, by the time when the restriction was introduced in 1740–2 , a large number of immigrants had already settled in; see Zhao Erxun, *Qingshi Gao* (*Draft of the History of the Qing Dynasty*) (1927), vol. 120 'Shihuo Zhi' (Economy), in *Twenty-Five Official Histories*, vol. 11, pp. 9252–9.

[17] Yuan Yida and Zhang Cheng, *Zhongguo Xingshi Qunti Yichuan He Renko Fenbu* (*Chinese Surnames, Group Genetics and Demographic Distribution*) (Shanghai: East China Normal University Press, 2002), pp. 6–57.

Likewise in Sichuan near the upper reaches of the Yangtze River, a surge of immigration began in 1713 under Emperor Kangxi's edict of 'filling up Sichuan with the population from Hubei' (*huguang tian sichuan*).[18] In 1743–8 alone, a quarter of a million migrants re-settled there.[19] Minor waves of migration also occurred elsewhere.[20]

Such vigorous economic-driven migration and farming resettlement significantly altered China's resource allocation regarding labour, capital and land. However, the actual impact of this economic migration on Qing population growth has thus far remained unclear. This study regards internal migration as inherently related to the increase in farmland. In other words, new gains in farmland became an effective factor in the economy only because new immigrants settled and farmed the new land. We thus consider internal migration attached to the factor of farmland.

The second factor we find central to explaining Qing population dynamics is food production. Some scholars see the Qing population growth as subject to technological determinism. Mark Elvin's heuristic 'High Level Equilibrium Trap' hypothesises a mutually-reinforcing mechanism between labour-intensive agriculture and population density until the Qing economy reached equilibrium. Under his argument, China's technology was fixed indefinitely and only imported new technology could unlock China's equilibrium.[21] Elvin's approach has been modified by Francesca Bray who, inspired by Ester Boserup,[22] argued specifically that rice-farming was the determinant for China's (as well as the whole of Monsoon Asia's) demographic pattern. She presented a notion that rice production suffers little diminishing returns and hence eliminates the

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[18] Tian Fang and Chen Yijun, *Zhongguo Yimin Shilue* (*Brief History of Migration in China*) (Beijing: Knowledge Press, 1986), pp. 113–14; Chen, *Regional Socio-Economic Conditions*, ch. 8; Jiang Tao, *Renko Yu Lishi, Zhongguo Chuantong Renko Jiego Yanjiu* (*Population and History, A Study of Chinese Traditional Demographic Structure*) (Beijing: People's Press, 1998), p. 96.

[19] Anon., *Veritable Records of Emperor Gaozong of the Qing Dynasty*, vol. 311, Entry 'Shisannian Sanyue' (The Third Month of the Thirteenth Year under the Gaozong Reign).

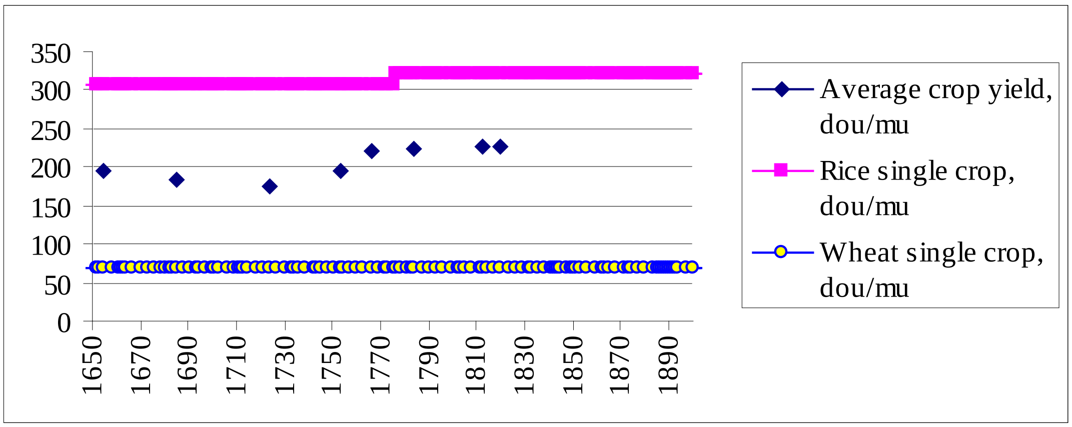
[20] James Lee, 'Population Growth in Southwest China, 1250–1850', *The Journal of Asian Studies*, 41/4 (1982), pp. 711–46.

[21] Elvin, *The Pattern of the Chinese Past*, ch. 9.

[22] Ester Boserup, *The Conditions of Agricultural Growth: The Economies of Agrarian Change under Population Pressure* (London: Allen and Unwin, 1965).

ceiling for population growth.[23] In other words, under rice farming, population growth becomes unlimited. Evidence suggests, however, that the average wheat yield level remained largely unchanged while the average rice yield level increased but modestly (Figure 5). This suggests that the Qing crop yield levels remained very stable over time.[24]

Figure 5. Crop Yield Levels, 1640–1910



Source: Shi Zhihong, 'Shijiu Shiji Shangbanqide Zhongguo Liangshi Muchanliang Ji Zongchanliang Zai Guji' (Re-Estimation of Yields per *Mu* and the Aggregate Food Output in Early Nineteenth Century China), *Zhongguo Jingjishi Yanjiu* (*Research into Chinese Economic History*) 3 (2012), pp. 52–66.
Note: Rice and wheat crops only. (1) Average rice yields from 12 southern provinces (Anhui, Jiangsu, Zhejiang, Hubei, Hunan, Jiangxi, Fujian, Guangdong, Guangxi, Sichuan, Guizhou, Yunnan), (2) average wheat yields from 8 northern provinces (Zhili, Shandong, Shanxi, Henan, Shaanxi, Gansu, Manchuria, Xinjiang), counting one crop only.

Similarly, Kang Chao has argued that, with China's arable land being fixed, the Qing peasantry had to farm more, and more intensively, to increase food provision.[25] However, the reality was that in Shandong, Jiangnan, Fujian and Guangdong — places

[23] Bray, *The Rice Economies*.

[24] According to Wu Hui, there was mere a 1.7 percent increase in China's crop yield level from the Ming to the Qing; see Wu Hui, *Zhongguo Jingjishi Rugan Wentide Jiliang Yanjiu* (*Quantitative Studies of Chinese Economic History*) (Fuzhou: Fujian People's Press, 2009), p. 147.

[25] Chao, *Man and Land in Chinese History*, ch. 1.

where food shortage perpetuated during the Qing — local farmers did *not* necessarily farm more intensively and with more varieties for staple food.[26] Instead, they often grew more cash crops, especially cotton, tea and, later tobacco, in exchange for rice imported from food-surplus regions.[27] This was rural 'involution' in full swing.[28] There were as many as ten shipping routes running from rice-surplus provinces to cash crop producing provinces, transporting as much as 36–57 million *piculs* (*shi*) of rice per annum.[29] Since one *picul* contained 75 kilograms, this makes the total shipment 2.7–4.3 million tonnes. Given it takes 180 kilograms of cereal to maintain an adult at the subsistence level, approximately 15–24 million adults were able to live entirely on imported rice in the four food-deficit provinces.

Other scholars see new crop species from outside the empire as a driver of the Qing population growth. These were the 'New World crops' – maize (*Zea mays*), white potatoes (*Solanum tuberosum*) and sweet potatoes (*Ipomoea batatas*).[30] Anecdotal

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[26] Contemporary scholars such as Li Bozhong and Pomeranz mention little about the New World crops in the Ming–Qing Jiangnan region. See Li Bozhong, *Duoshijiao Kan Jiangnan Jingjishi, 1250–1850* (*Multiple Dimensional View on Economic History of the Jiangnan Region, 1250–1850*) (Beijing: Sanlian Books, 2003); Kenneth Pomeranz, *The Great Divergence, Europe, China and the Making of the Modern World Economy* (Princeton: Princeton University Press, 2000).

[27] Chen Hua, *Qingdai Quyu Shehui Jingji Yanjiu* (*Regional Socio-Economic Conditions during the Qing Period*) (Beijing: People's University Press, 1996), pp. 106–7; K. L. So, *Prosperity, Region, and Institutions in Maritime China, the Fukien Pattern, 946–1368* (Cambridge [MA]: Harvard University Asia Center, 2000), pp. 95–6.

[28] Philip Huang, *The Peasant Economy and Social Change in North China* (Stanford: Stanford University Press, 1985); Chen Chunsheng and Liu Zhiwei, 'Qingdai Jingji Yunzuode Liangge Tedian' (Two Characteristics of Qing Economic Operation), *Zhongguo Jingjishi Yanjiu* (*Research into Chinese Economic History*), 3 (1990), pp. 84–9.

[29] Wu Chengming, *Zhongguode Xiandaihua: Shichang Yu Shehui* (*China's Modernisation: the Market and Society*) (Beijing: Sanlian Books, 2001), pp. 152–7; Zhang Haiying, *Mingqing Jiangnan Shangpin Liutong Yu Shichang Tixi* (*Commodity Flows and Market Structure in the Jiangnan Region during the Ming-Qing Period*) (Shanghai: East China Normal University Press, 2001), pp. 198–203; Wu, *Quantitative Studies of Chinese Economic History*, p. 376.

[30] These crops were introduced in the following sequence: Sweet potato vines (*fanshu, Ipomoea batatas*) were smuggled to China from Luzon in 1593. Maize (*yumi*, *Zea mays*) was first mentioned in Li Shizhen's *Compendium of Materia Medica* (*Bencao Gangmu*) written in 1578 (Reprint. Beijing: People's Press, 1977), vol. 23; and then in Xu Guangqi's *Nongzheng Quanshu* (*Complete Treatise on Agricultural Administration* of 1628 (Reprint. Shanghai: Shanghai Classics Press, 1979), p. 629. The white potato (*malingshu, Solanum tuberosum*) was first introduced to Taiwan around 1650. See Guo Wentao, *Zhongguo Nongyie Keji Fazhan Shilue* (*A Brief History of Development of Agricultural Science and Technology in China*) (Beijing: Chinese Science and Technology Press, 1988), pp. 383–4. Yet

evidence suggests that in the early seventeenth century, sweet potatoes were able to yield ten times (gross weight) that of rice;[31] similarly, maize allegedly increased the land yield by 30 percent.[32] A common assumption has thus been made that there was a close link between these crops and the fast growth in China's population.[33] In this study, we attempt to clarify the role of the New World crops in regard to the Qing population growth. The spread of new crops is our third factor.

A complicating issue, however, is that not until the first comprehensive survey of China's agrarian economy in the 1920s[34] was the geographic spread of New World crops ever systematically mapped. Therefore, due to data availability, we use maize as a representative for New World crops. Official records for the spread of sweet potatoes are limited to the provincial level (18 provinces under the Qing rule).[35] Official records for maize are much better: at the county level (over 1,300 counties).[36] However, there is no

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until the 1630s, their spread was very limited. According to Song Yingxing's *Exploitation of the Works of Nature* (*Tiangong Kaiwu*) of 1637, seventy percent of the Chinese lived on rice and thirty percent on wheat, barley, sorghum and millet. The New World crops were excluded; see Song Yingxing, *Tiangong Kaiwu* (*Exploitation of the Works of Nature*) (1637. Reprint. Guangzhou: Guangdong People's Press, 1976), p. 11. These crops became better known during the Qing Period.

[31] Shi Shenghan, *Nongzheng Quanshu Jiaozhu* (*Annotated Edition of the* '*Complete Treatise on Agricultural Administration*') (Shanghai: Shanghai Classics Publisher, 1979), p. 692.

[32] See J. K. Fairbank and Kwang-ching Liu (eds), *Cambridge History of China, Late Ch'ing, 1800–1911, Part II* (Cambridge: Cambridge University Press, 1980), p. 11. Also see R. H. Myers, *The Chinese Peasant Economy: Agricultural Development in Hopei and Shangtung, 1890-1949* (Cambridge [MA]: Harvard University Press, 1970), Appendix.

[33] E.g. Mark Elvin, *The Pattern of the Chinese Past* (Stanford: Stanford University Press, 1973), p. 298; F. W. Mote, *Imperial China, 900-1800* **(**Cambridge [MA]: Harvard University Press, 1999), p. 750; L. E. Stover and T. K. Stover, *China: an Anthropological Perspective* (Pacific Palisades [CA]: Goodyear Publishing Co., 1976), p. 115. See also, Lee James, 'Population Growth in Southwest China, 1250–1850' *The Journal of Asian Studies*, 41/4 (1982), pp. 711–46; L. E. Stover and T. K. Stover, *China: an Anthropological Perspective* (Pacific Palisades [CA]: Goodyear Publishing Co., 1976), p. 115. See also, Lee James, 'Population Growth in Southwest China, 1250–1850' *The Journal of Asian Studies*, 41/4 (1982), pp. 711–46.

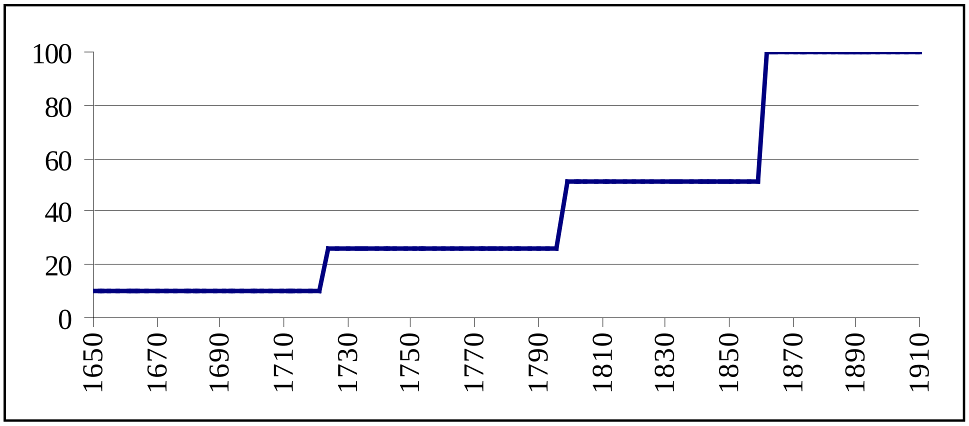
[34] J. L. Buck, *Land Utilization in China: Atlas* (London: Oxford University Press, 1937).

[35] Jia, Ruixue, 'Weather Shocks, Sweet Potatoes and Peasant Revolts in Historical China', *The Economic Journal*, 124/575 (2014), pp. 92–118.

[36] Xian Jinshan, 'Cong Fangzhi Jizai Kan Yumi Zai Woguode Yinjin He Chuanbo' (Adoption and Spread of Maize Seen from Local Gazetteers), *Gujin Nongye* (*Agriculture, Past and Present*), 1 (1988), pp. 99–111.

record on the actual sown area for sweet potato or maize. Thus, we use the geographic spread of maize as a proxy for the new farming technology of the time (Figure 6).

Figure 6. Spread of Maize-farming (% of All Counties), 1650–1910



Source: Xian Jinshan, 'Cong Fangzhi Jizai Kan Yumi Zai Woguode Yinjin He Chuanbo' (Adoption and Spread of Maize Seen from Local Gazetteers), *Gujin Nongye* (*Agriculture, Past and Present*), 1 (1988), pp. 99–111.

The fourth factor we consider is degree of tax burden imposed on the citizenry. In the beginning of the Qing rule, the heavy taxes of the previous Ming Period were abandoned, a policy known as 'abolishment of the Ming practice' (*fei mingfa*).[37] Until 1840 when fiscal crises occurred, the Qing bureaucracy maintained strong distaste for tax increases.[38] In 1712, the total revenue of the Land-Poll (*diding*) was frozen for good to allow surpluses to be retained by ordinary households.[39] As a result, the highest annual tax revenue collected in grain under the Qing (as of 1820) was 29 percent of its Ming counterpart (as of 1502). The Qing tax burden per unit of land (as of 1661) was 17

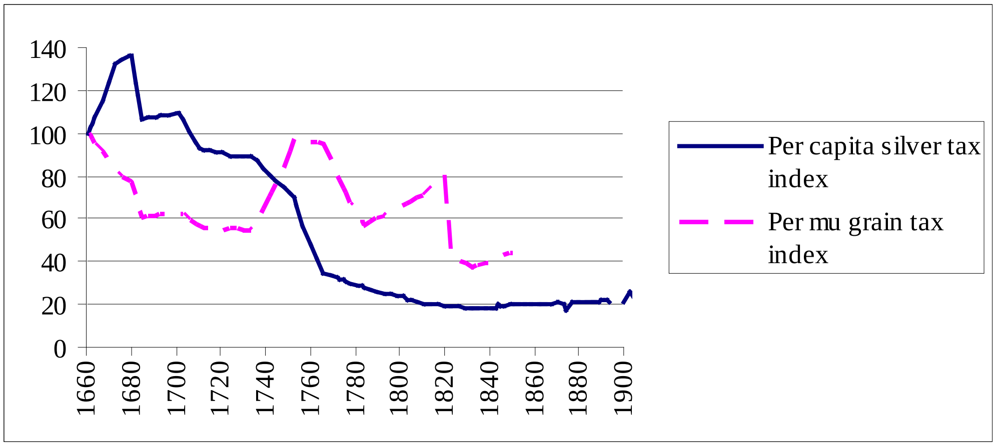
[37] Zhao, *Draft of the History of the Qing Dynasty*, vol. 14 'Shizuji Yuannian' (Biography of Emperor Shizu, the First Year of His Reign).

[38] W. J. Peterson (ed.), *The Cambridge History of China* (Cambridge: Cambridge University Press, 2002), vol. 9. pp. 604–5.

[39] Deng, *China's Political Economy*, pp. 16–18.

percent of the peak of the Ming (as of 1542).[40] The Qing tax burden per capita (as of 1766) was 8 percent of the Ming (as of 1381).[41] Conceptually, a significantly declining tax burden would be beneficial to population growth (Figure 7).

Figure 7. Tax Burden Indices (1660 = 100), 1660–1900



Source: Population is based on Deng, 'Unveiling China's True Population Statistics'. Farmland is based on Liang, *Dynastic Data*, pp. 396, 400, 401. Taxes are based on Liang, *Dynastic Data*, pp. 10, 380, 384; Xiang Huaicheng, *Zhongguo Caizheng Tongshi* (*A General History of Government Finance in China*), 2006, vol. 8, pp. 78, 222.

Exogenous shocks can also impact population levels. During the first 100 years of the Qing rule, while the number of natural disasters increased, the total number of all disasters (natural and man made) declined (Figure 8).

Figure 8. Qing Disaster Index (1646 = 100), 1646–1910

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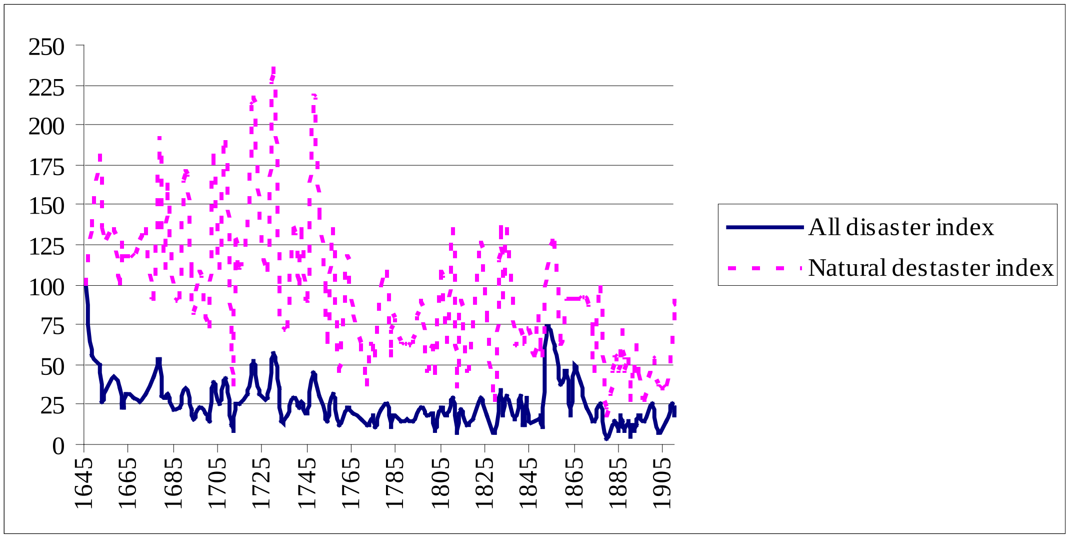
[40] Gang Deng, *The Premodern Chinese Economy – Structural Equilibrium and Capitalist Sterility* (London and New York: Routledge, 1999), p. 124.

[41] Liang, *Dynastic Data*, p. 428.



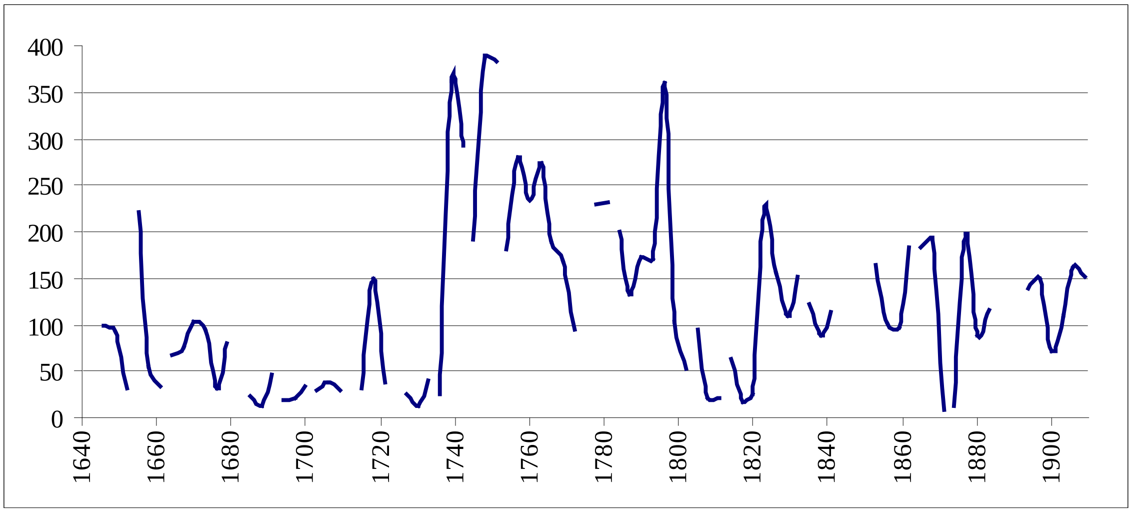
Source: Chen Gaoyong, *Zhongguo Lidai Tianzai Renhuo Biao* (*Chronological Tables of Chinese Natural and Man-made Disasters*) (Shanghai: Jinan University Press, 1937).

We consider government spending on disaster relief as the fifth factor. Ever since the early Qing, the state provided the population with a safety net against famine (Figure 9).[42] Relief aid during a bad year sometimes exceeded the state annual tax revenue by several times.[43]

Figure 9. Qing Disaster Relief Recipient Index (1646 = 100), 1646–1910

42 Pierre-Etienne Will, *Bureaucracy and Famine in Eighteenth-Century China* (Stanford: Stanford University Press, 1990); Pierre-Etienne Will and R. B. Wong, *Nourish the People:_the State Civilian Granary System in China, 1650-1850* (Ann Arbor: University of Michigan Center for Chinese Studies, 1991); Kent Deng, *China's Political Economy in Modern Times* (London: Routledge, 2011), pp, 19–24.

43 W. J. Peterson (ed.), *The Cambridge History of China* (Cambridge: Cambridge University Press, 2002), vol. 9, pt. 1, p. 307.



Source: Zhao Erxun, *Qingshi Gao* (*Draft of the History of the Qing Dynasty*) (1927), vols 4–25 'Benji' (Biographies of the Qing Emperors), in *Er-shi-wu Shi* (*Twenty-Five Official Histories*) (Shanghai: Shanghai Classics Press, 1986), vol. 11, pp. 8827–8937.

Note: Recipient county as the basic accounting unit.

Over the course of its reign, the Qing state governed from 1,672 to 1,704 counties.[44] As indicated in Table 2, therefore, our preliminary observations indicate that the empire was covered 29 times by aid schemes. Densely populated core farming zones received more aid than the periphery (Table 3).

Table 2. Disaster Relief Coverage, 1674–1911

Year	Tax exemptions*	Aid hand-outs*	Total (A) *	A/B† index
1674–1723	3,281	–	3,281	2.0
1724–73	9,784	6,082	15,866	9.5
1774–1823	8,850	1,889	10,739	6.4
1824–73	7,295	3,004	10,299	6.2
1874–1911	6,278	2,465	8,743	5.2
Total	35,443	13,440	48,883	29.2

44 Zhao, *History of the Qing Dynasty*, vols 54–81 'Dili Zhi' (Administrative Geography), in *Twenty-Five Official Histories*, vol. 11, pp. 9071–9131.

Annual average	149.5	56.7	206.3

Source: Zhao, *History of the Qing Dynasty*, vols 4–25 'Benji' (Biographies of the Qing Emperors), in *Twenty-Five Official Histories*, vol. 11, pp. 8827–8937.

Note: * Total recipient counties. † Calculated based on 1,672 counties.

Table 3. Provincial Aggregate Disaster-Aid Entries, 1644–1911

	Provincial entries	% in China's total
Northern core farming provinces	693	40.7
Southern core farming provinces	677	39.7
Northern periphery farming provinces	148	8.7
Southern periphery farming provinces	170	10.0
Non-farming provinces	16	0.9
Total entries	1,704*	
Total shares		100.00

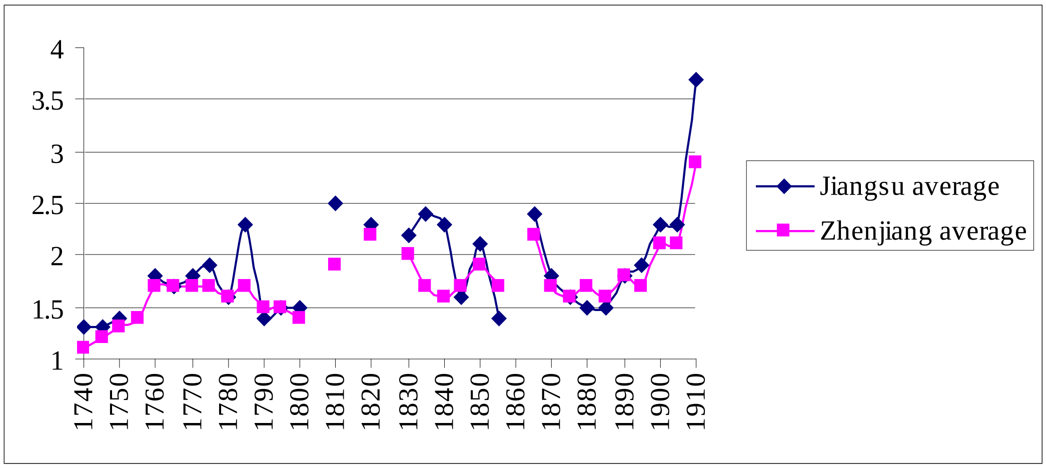
Source: Zhao, *Draft of the History of the Qing Dynasty*, vols 4–25 'Benji' (Biographies of the Qing Emperors) and vols 54–81 'Dili Zhi' (Administrative Geography), in *Twenty-Five Official Histories*), vol. 11, pp. 8827–8937, 9071–9131.[45]

Note: Northern core farming provinces: Zhili, Henan, Shandong, Shanxi, Shaanxi, and Gansu. Southern core farming provinces: Anhui, Jiangsu, Zhejiang, Hubei, Hunan, Jiangxi, Fujian, Guangdong. Northern periphery farming provinces: Fengtian, Jilin, Heilongjiang, and Xinjiang. Southern periphery farming provinces: Sichuan, Guizhou, Guangxi, Yunnan, and Taiwan. Non-farming provinces: Tibet, Qinghai, Chahar, and Mongolia. * Including country-equivalent units.

[45] Zhao's history is commonly recognised authoritative for the Qing dynasty, ranked equally with all the official histories of the other dynasties.

The cost of living represents the sixth major factor influencing growth of the Qing population. Studies by scholars like Pomeranz, Fang Xing, Bozhong Li, Fan Jinmin, and Gao Wangling have indicated that until *circa* 1850 ordinary rural people lived rather well in the Qing period.[46] We use food prices and currency purchasing power as proxies for the cost of living. The most complete records of prices are those from China's rice farming regions, especially the urban market of the Lower Yangtze Valley (Figure 10).

Figure 10. Average Urban Rice Prices in Jiangsu and Zhejiang, 1740–1910



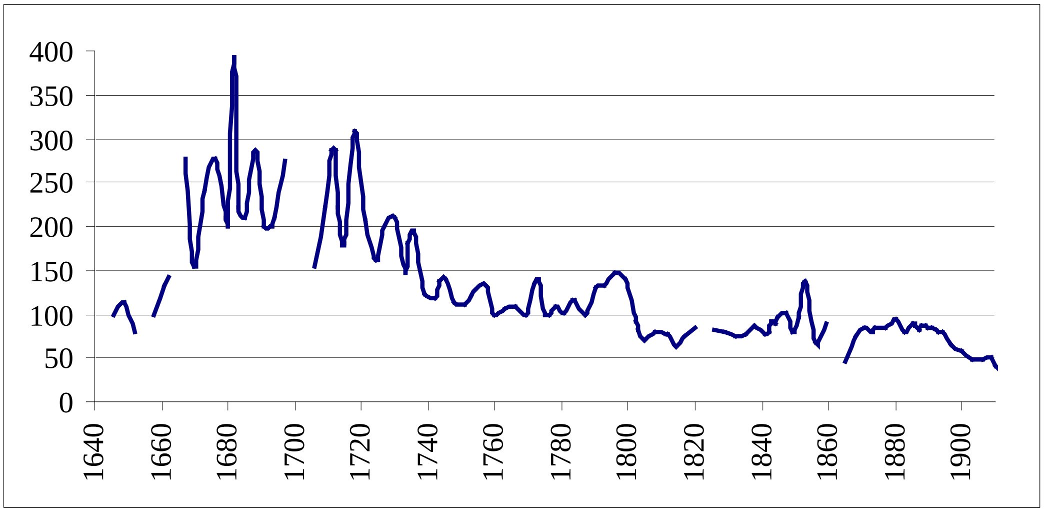
Source: Yejian Wang, *The Database of Grain Prices in the Qing Dynasty*. Institute of Modern History, *Academia Sinica*, 2013, http://140.109.152.38/DBIntro.asp.
Note: * In amount of silver (taels) per *shi* of rice. Prices of the Ninth Month when supply was plenty. Locations were the seats of governments of the named prefectures.

Given its use throughout the Qing era as currency, we also construct a silver purchasing power index —measured by amount of rice one tael of silver purchased — to gauge the

46 Pomeranz, Kenneth, *The Great Divergence, Europe, China and the Making of the Modern World Economy* (Princeton: Princeton University Press, 2000), ch. 1; Fang Xing, 'Qingdai Diannongde Zhongnonghua' (Tenants Joining the Middle-Income Group during the Qing Period), *Zhongguo Xueshu* (*Chinese Academics*) 2 (2000), pp. 44–61; Li Bozhong, 'Rengen Shimu Yu Mingqing Jiangnan Nongminde Jingying Guimo' (The Practice of 'Ten *Mu* per Farmer' and the Scale of the Traditional Peasant Economy), *Zhongguo Nongshi* (*Agricultural History of China*), 1 (1996), pp. 1–14; Fan Jinmin, *Guoji Minsheng, Mingqing Shehui Jingji Yanjiu* (*National Economy and People's Livelihood in the Ming-Qing Period*) (Fuzhou: Fujian People's Press, 2008); Gao Wangling, *Zudian Guanxi Xinlun: Dizhu, Nongmin He Dizu* (*New Theory of Tenancy: Landlords, Tenants and Rents*) (Shanghai: Shanghai Books, 2005).

cost of living (Figure 11). At first glance, the silver purchasing power index seems to move in the opposite direction of rice prices. This would suggest that the increase in prices of rice might have been dictated more by inflations of the silver currency, as opposed to population pressure.

Figure 11. Silver Purchasing Power Index (1646=100),* 1640–1910

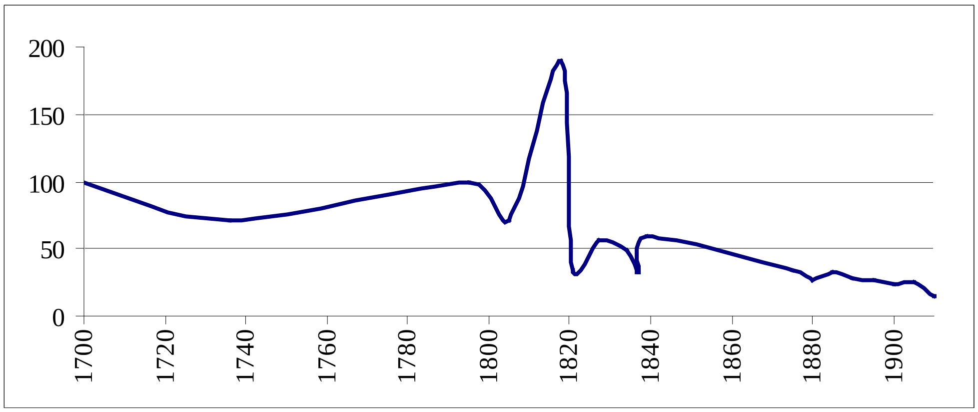


Source: (1) Before 1693, based on Ye Mengzhu, *Yueshi Bian* (*Record of Life-time Experience in Songjiang*) (c. 1688. Reprint. Shanghai: Shanghai Classics Press, 1981), vol.7, pp. 153–4; Yao Tinglin, *Linian Ji* (*Personal Annals*) (c. 1698. Reprint. Shanghai: Shanghai People's Press, 1982), pp. 43–156. (2) During 1693–1722, based on Department of Archives, Palace Museum (ed.), *Li Xu Zouzhe* (*Li Xu's Memorials to the Throne*) (Beijing: Zhonghua Books, 1976), pp. 1–293. (3) During 1723–35, based on H. S. Chuan and R. A. Kraus, *Mid-Ch'ing Rice Markets and Trade: An Essay in Price History* (East Asian Research Center, Harvard University, 1975), pp. 145–8. (4) After 1736, based on Wang, *The Database of Grain Prices.*

Note: * The index represents the amount of rice one silver tael was able to buy. Data are from Jiangsu Province of the Lower Yangtze.

To isolate silver's impact on rice prices, we use the terms of trade between cotton cloth and rice. The cotton cloth price relative to per unit of rice shows a downward trend similar to silver purchasing power index (Figure 12). There exists no evidence indicating any significant technical progress in cotton farming and cotton textile production of the time that would drive relative cotton prices lower.[47] Hence, it is apparent that food became substantively more expensive during the Qing.

Figure 12. Rice-Cloth Terms of Trade Index (1700=100),* 1700–1910



Sources: Huang Miantang, *Zhongguo Lidai Wujia Wenti Kaoshu* (*Study of Prices in China's History over the Long Term*) (Jinan: Qilu Books, 2007), pp. 10, 11–12, 47–9, 52–7, 61–5, 101–7, 109–14, 314, 318–21, 330–3, 336–9 ; Xu Xinwu, *Jiangnan Tubu Shi* (*A History of Homemade Cotton Cloth in the Lower Yangzi Delta*) (Shanghai: Shanghai Academy of Social Science Press, 1989), pp. 176, 201; Yu Yaohua, *Zhongguo Jiage Shi* (*A History of Prices in China*) (Beijing: China's Prices Press, 2000), pp. 805, 921–2, 929.[48]

Note: * Amount of rice (urban prices) per bolt of cotton cloth was able to buy. Cloth here is measured in three *zhang* per bolt, a common unit for tax payment and domestic trade. Rice means white rice, husked and ready to cook.

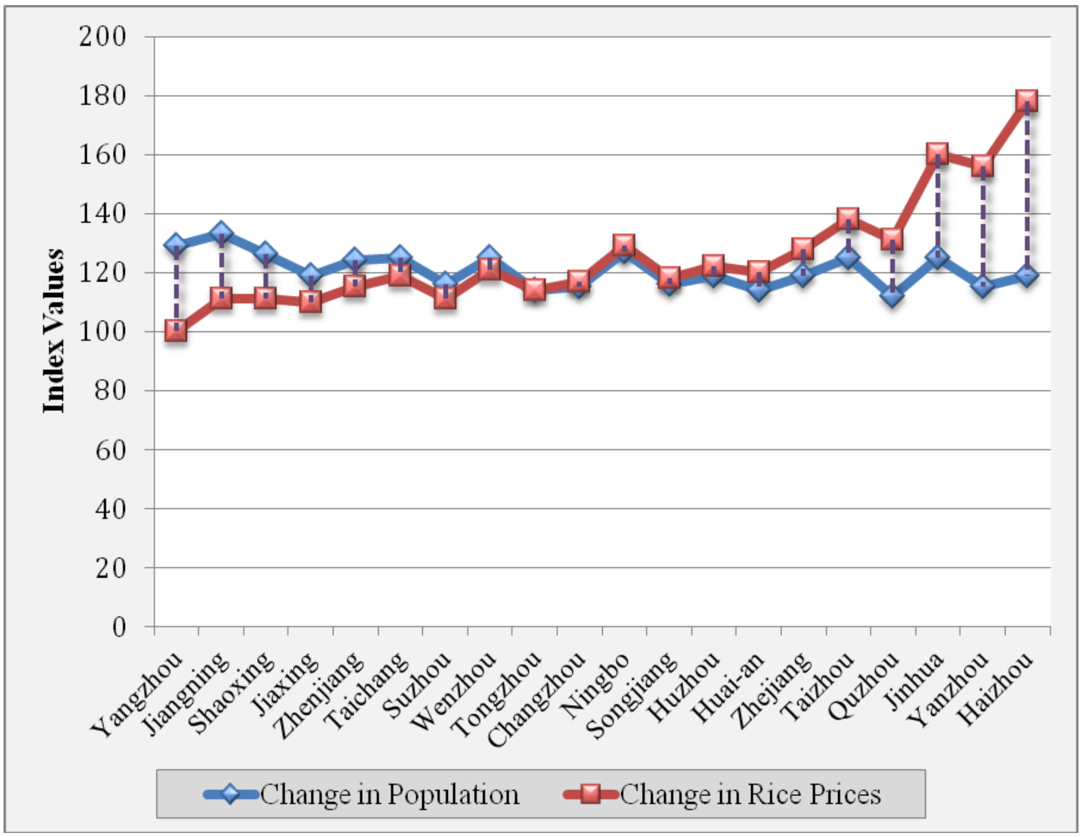
Meanwhile, rice prices and population growth moved at the different rates (Figure 13). Case by case, in some locales, relative population growth outstripped increases in rice prices (those provinces to the left of Tongzhou), whereas in other provinces rice prices

47 Xu Xinwu, *Jiangnan Tubu Shi* (*A History of Homemade Cotton Cloth in the Lower Yangzi Delta*) (Shanghai: Shanghai Social Sciences Press, 1989).

48 For much lower cotton cloth pries, see Xu Xinwu, *Jiangnan Tubu Shi* (*A History of Homemade Cotton Cloth in the Lower Yangzi Delta*) (Shanghai: Shanghai Academy of Social Science Press, 1989), pp. 92, 94.

increased more than population (those to the right of Tongzhou). As such, a more in depth analysis is necessary in order to understand the independent impact of cost of living on the population.

Figure 13. Index Values for Changes in Local Total Population and Rice Prices, 1775/6 – 1820, by Prefectures in the Lower Yangtze



Source: See Table 4.

Table 4. Changes in Local Total Population (Both Rural and Urban) and Rice Prices

Prefecture	1775/6 (A)	1820 (B)	Index (B/A x 100)
A. Jiangsu Province			
1. Changzhou			
Population*	311.5	389.6	115
Rice prices†	1.8	2.1	117
2. Haizhou			

Population*	103.3	122.6	119
Rice prices†	1.8	3.2	178
3. Huai-an			
Population*	263.0	300.0	114
Rice prices†	2.0	2.4	120
4. Jiangning			
Population*	394.1	525.2	133
Rice prices†	1.9	2.1	111
5. Songjiang			
Population*	227.7	263.2	116
Rice prices†	1.7	2.0	118
6. Suzhou			
Population*	511.1	590.8	116
Rice prices†	1.9	2.1	111
7. Taichang			
Population*	142.3	177.2	125
Rice prices†	2.1	2.5	119
8. Tongzhou			
Population*	245.5	280.1	114
Rice prices†	2.1	2.4	114
9. Yangzhou			
Population*	515.7	666.3	129
Rice prices†	2.1	2.1	100
10. Zhenjiang			
Population*	177.0	219.5	124
Rice prices†	2.0	2.3	115
B. Zhejiang Province			
11. Hangzhou			
Population*	268.2	319.7	119
Rice prices†	1.8	2.3	128
12. Huzhou			

Population*	215.3	256.8	119
Rice prices†	1.8	2.2	122
13. Jiaxing			
Population*	235.3	280.5	119
Rice prices†	1.9	2.1	110
14. Jinhua			
Population*	204.8	255.0	125
Rice prices†	1.5	2.4	160
15. Ningbo			
Population*	186.1	235.6	127
Rice prices†	1.7	2.2	129
16. Quzhou			
Population*	102.0	114.1	112
Rice prices†	1.6	2.1	131
17. Shaoxing			
Population*	426.5	539.2	126
Rice prices†	1.9	2.1	111
18. Taizhou			
Population*	222.7	277.4	125
Rice prices†	1.6	2.2	138
19. Wenzhou			
Population*	162.0	201.7	125
Rice prices†	1.4	1.7	121
20. Yanzhou			
Population*	127.4	146.1	115
Rice prices†	1.6	2.5	156

Source: Population data are based on Ge, *A Demographic History of China, Vol. 5*, pp. 87–8, 113.

Note: * Population in 10,000 persons. † Silver taels per *picul*.

Overall, most explanations thus far presented were based on rough back-of-the-envelope style of calculations. The present research seeks to address this issue more comprehensively by employing a quantitative approach that allows for the independent and simultaneous effects of the identified factors to be estimated and analysed.

To conduct our analysis, we have developed an extensive dataset. The data are drawn from Qing sources. The key data of population, farmland, tax regimes and burden, government revenues and expenditures, food prices, China's territorial borders, and disasters and disaster relief, are extracted from the following authoritative works: Zhao Erxun's *Qingshi Gao* (*Draft of the History of the Qing Dynasty*), Liang Fangzhong's *Zhongguo Lidai Hukou Tiandi Tianfu Tongji* (*Dynastic Data for China's Households, Cultivated Land and Land Taxation*), Xiang Huaicheng's *Zhongguo Caizheng Tongshi* (*A General History of Government Finance in China*), Peng Xinwei, *Zhongguo Houbishi* (*A History of Currencies in China*), H. S. Chuan and R. A. Kraus, *Mid-Ch'ing Rice Markets and Trade: An Essay in Price History*, Yeh-chien Wang's 'Secular Trends of Rice Prices in the Yangzi Delta, 1638–1935', Yejian Wang's *The Database of Grain Prices in the Qing Dynasty*, *Zhongguo Houbishi* (*A History of Currencies in China*), Tan Qixiang's *Jianming Zhongguo Lishi Dituji* (*Concise Maps of Chinese History*), Chen Gaoyong's *Zhongguo Lidai Tianzai Renhuo Biao* (*Chronological Tables of Chinese Natural and Man-made Disasters*), and Fu Zhongxia, Zhang Xing, Tian Zhaolin, and Yang Boshi's *Zhongguo Junshi Shi* (*A Military History of China*). All of these works are based on confirmed government records and represent the best available data sources.

Information regarding silver as currency and its purchasing power comes from local accounts in the Lower Yangtze River: Ye Mengzhu's *Yueshi Bian* (*Record of Life-time Experience in Songjiang*), Yao Tinglin's *Linian Ji* (*Personal Annals*), and Department of Archives' *Li Xu Zouzhe* (*Li Xu's Memorials to the Throne*), H. S. Chuan and R. A. Kraus, *Mid-Ch'ing Rice Markets and Trade: An Essay in Price History*, Yeh-chien Wang's 'Secular Trends of Rice Prices in the Yangzi Delta, 1638–1935', Yejian Wang's *The Database of Grain Prices in the Qing Dynasty*, *Zhongguo Houbishi* (*A History of Currencies in China*).

Internal migration figures are based on Ge Jianxiong's *Zhongguo Yimin Shi* (*A History of Migration in China*), a comprehensive five-volume study based heavily on local government records.

Information on the spread of maize-farming comes from detailed accounts of the adoption of the new crops as recorded in Qing local gazetteers (*fangzhi*), presented in Xian Jinshan's 'Cong Fangzhi Jizai Kan Yumi Zai Woguode Yinjin He Chuanbo' (Adoption and Spread of Maize Seen from Local Gazetteers). The information contained in local gazetteers is commonly regarded as among the most reliable in premodern China.

Qing crop yield levels are based on Shi Zhihong's 'Shijiu Shiji Shangbanqide Zhongguo Liangshi Muchanliang Ji Zongchanliang Zai Guji' (Re-Estimation of Yields per *Mu* and the Aggregate Food Output in Early Nineteenth Century China), a work that systematically tests all the main estimates *hitherto*. Shi's analysis covers twelve southern provinces (Anhui, Jiangsu, Zhejiang, Hubei, Hunan, Jiangxi, Fujian, Guangdong, Guangxi, Sichuan, Guizhou, Yunnan). This is large enough to serve as a proxy for the improvement in the existing technology in food production.[49] Shi's yield range is similar to John Buck's comprehensive survey of China's food yields in the 1920s.[50] We decide to use Shi's information not only due to its economy-wide vision, but also because of its realistically modest approach compared with many regional 'anecdotes-based' or 'best practice-based' claims.

Due to the lack of data, goods for trade in the economy have to come from estimates. To strike a balance, we compared four major works, two in Chinese and two in English: (1) Wu Chengming's *Zhongguode Xiandaihua: Shichang Yu Shehui* (*China's Modernization: Market and Society*), (2) Liu Foding, Wang Yuru and Zhao Jin's *Zhongguo Jindai Jingji Fazhan Shi* (*A History of Economic Development in Early Modern China*), (3) Chung-li Chang's *The Income of the Chinese Gentry*, and (4) Albert Feuerwerker's *The Chinese Economy, 1870–1949*. However, given that the market share of the Qing economy plays no part in our modelling, any inaccuracy in this respect has no bearing on our analysis.

[49] Note: the average wheat yield level in eight provinces in North China (Zhili, Shandong, Shanxi, Henan, Shaanxi, Gansu, Manchuria, and Xinjiang) did not have much change and is thus unsuited for our purpose.

[50] Buck, *Land Utilization in China: Atlas*, pp. 4, 49.

The complete list of data sources are presented in Table5.

Table 5. Sources of Variables

Variable	Sources
Population (LP) (Dependant)	Qing official figures: Liang, *Dynastic Data*, p. 10; Deng, 'Unveiling China's True Population Statistics', Appendix 2.
Farmland, *mu* (LLAND) (Predictor)	Qing official figures: Liang, *Dynastic Data*, pp. 10, 380, 384, 396, 400, 401.
Rice output (counting single crop), *dou*/*mu* (LOUTPUT) (Predictor)	Crop yield levels (*dou*/*mu*): Shi Zhihong, 'Re-Estimation of Yields per *Mu* and the Aggregate Food Output in Early Nineteenth Century China', pp. 52–66.
Adoption of maize-farming (counting recipient counties) (LMAIZE) (Predictor)	Xian, 'Adoption and Spread of Maize Seen from Local Gazetteers'.
Agricultural tax (Land-Poll and Stipend Rice) (LTAX) (Predictor)	Qing official figures: Liang, *Dynastic Data*, pp. 10, 380, 384, 396, 400, 401, 414–16, 482; also Xiang, *A General History of Government Finance*, vol. 8, pp. 78, 222.
Number of disasters and wars (LWARDI) (Control)	Disasters: Chen, *Chronological Tables of Chinese Natural and Man-Made Disasters*. Wars: Fu *et al.*, *A Military History of China*, pp. 65–85.
Disaster relief (counting recipient counties) (LRELIEF) (Control)	Qing official records: Zhao, *History of the Qing Dynasty*, vols 4–25 'Benji' (Biographies of the Qing Emperors), in *Twenty-Five Official Histories*, vol. 11, pp. 8827–8937.

Prices of rice, taels/*shi* (LPRICE) (Control)	Official figures: Wang, 'Secular Trends of Rice Prices in the Yangzi Delta, 1638–1935'; Wang, *The Database of Grain Prices in the Qing Dynasty*; Peng, *A History of Currencies in China*, pp. 824–5, 837, 844, 850–1.
Silver's purchasing power index (LINDEX) (Control)	Period information: Ye, *Record of Life-time Experience in Songjiang*; Yao, *Personal Annals*; Department of Archives, Palace Museum (ed.), *Li Xu's Memorials to the Throne*); Wang, *Database of Grain*.

II. Hypothesis and Modelling

Our hypothesis is that the sustained population growth during the Qing period was the result of a range of factors: (i) farmland availability, the main resource base of the economy, (ii) crop yield level, which determined the food stock for the population to live on, (iii) maize adoption and adaptation, which serves as a proxy for new farming technology, and (iv) direct taxes imposed on land and population, a financial burden which deducted wealth from the population. Hence, our dependent variable is the growth in population (P), with our four predictor variable being farmland availability (LAND), crop yield (OUTPUT), maize adoption and adaptation (MAIZE), and agricultural taxes (TAX).

Moreover, we include four control variables within our estimation model. The first control is the combined number of wars and natural disasters to account for shocks on the standing population. The second control is the number of counties receiving government disaster-relief designed to assist the standing population. The third control is the price of rice (the primary staple food), which intends to indicate cost of living. Our fourth control is the purchasing power index of silver, to provide a robust check on food prices. In the model these four controls are given as WARDI, RELIEF, PRICE, and INDEX, respectively.

Our population figures are numbers of persons counted by the state. While the accuracy of the official data has been questioned,[51] there has been no independent information to verify either the official data or the modern doubts. In terms of farmland, the practice of land acreage conversion (*zhe mu*) is well understood, a system under which all farmland was commonly converted into a bench-mark *mu* for taxation purposes.[52] Note that the *mu* figures cited in Qing official documents only make sense if one imagines that all the Qing farmland had the identical medium fertility. Figures after conversion still reflected the size of the Qing resource basis for food production.

Regarding the burden of direct taxes, we incorporate two types of agricultural taxes: (1) the main type of Land-Poll Tax (*diding*) collected in silver from all 18 provinces, and (2) the auxiliary Stipend Rice Tax (*cao mi*, *cao liang*) collected in grain from 8 provinces along the Grand Canal and other rivers.[53] Both were direct taxes and claimed the lion's share of the Qing government's revenue. Given that the cash for the Land-Poll Tax payment was in one way or another a result of peasant grain sales at market for the sake of tax payment, both taxes came as grain, either originally or ultimately, from the farming sector. Thus, we convert all the monetary tax payments to grain (*shi*) according to the current prices. Our tax burden is measured by tax revenue per *mu* of farmland to make it more agriculture-specific.

Now, there is a paradox regarding tax payment in food. On the one hand, such taxes constituted a deduction of households' income which would have otherwise been used to support more children in the faming sector. On the other hand, food surrendered by the peasantry to the state may not have all been wasted. Rather, it could be consumed by

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[51] E.g. G. W. Skinner, 'Sichuan's Population in the Nineteenth Century', *Late Imperial China*, 8/1 (1987), pp. 1–79. Noted, Sichuan during the Qing was one of the 18 provinces. It remains unclear the extent of the problem.

[52] Liang, *Dynastic Data*, p. 528, and Zhao Yun, 'Jishu Wucha, Zhemu Jiqi Juli Shuaijian Guilü Yanjiu' (Technical Errors: Land Unit Conversion and the Law of Diminishing Distance), *Zhongguo Shehui Jingjishi Yanjiu* (*Research into Chinese Social and Economic History*), 3 (2007), pp. 1–13; Shi Zhihong, 'Shijiu Shiji Shangbanqide Zhongguo Liangshi Muchanliang Jiqi Zongchanliang Zai Guji' (Re-Estimation of Yields per *Mu* and the Aggregate Food Output in Early Nineteenth Century China), *Zhongguo Jingjishi Yanjiu* (*Research into Chinese Economic History*) 3 (2012), p. 55.

[53] Zai Ling, *Caoyun Quanshu* (*Complete Records of Stipend Rice Shipping*) (N.d. Reprint. Beijing: Beijing Library Press, no date); Li Wenzhi and Jiang Taixin, *Qingdai Caoyun* (*Stipend Rice during the Qing Period*) (Beijing: Zhonghua Books, 1995).

someone else in the economy, be they officials, soldiers and artisans. Non-farming families would have babies, too. Therefore, in theory, taxes merely redistributed food instead of destroying it. In reality, however, food was perishable and there was regular spoilage in relation to transport and storage, not to mention food used in state-run alcohol production and for state-own herds of working animals.

In addition, tax regimes affected farmers' future production perspectives and incentives if they saw a cash cower in cash cropping and handicrafts. It channeled resources to non-food production, and reduced food for potentially more population growth. So, even if the cash for tax payment did not come from food farming through conversion, it represented opportunity costs for the food stock that would otherwise be produced.

Aside from land taxes, a few minor taxes such as the Salt Tax (*yanke*) and Customs Duties (*guanshui*) were imposed. But these were indirect taxes and hence linked to consumers' choices, and as such, less stable. There was also the notorious 'Transit Levy' (*lijin* or *likin*). But this new tax began very late in the 1850s, and is therefore unsuited for our analysis.

Based upon the sources listed in Table 5, our time series dataset covers the period 1646 to 1911 with 77 observations. Due to data availability, there are inevitable gaps in our time series. That said, most of our data are relatively evenly spread out across the time period under consideration. Where applicable, missing data are linearly interpolated, no estimation is used. Table 6 summarises the descriptive statistics of the variables without conversion to natural logarithm.

Table 6. Descriptive Statistics of Variables

Variables	Mean	S.D.	Min	Max	Obs.	Period
Population (P)	237000000	146000000	38600000	399000000	118	1655-1911
Farmland, *mu* (LAND)	727000000	106000000	388000000	912000000	104	1655-1877
Rice output, *dou*/*mu* (OUTPUT)	313.008	7.515	306	321	122	1646-1911

Adoption of maize-farming (counties) (MAIZE)	709.287	691.037	113	1944	122	1646-1911
Disasters and wars (WARDI)	13.672	8.102	2	56	122	1646-1911
Disaster relief (counties) (RELIEF)	592	454.675	0	1929	90	1646-1911
Rice Prices taels/*shi* (PRICE)	1.919	0.906	0.6	6.2	121	1646-1911
Silver's purchasing power index (INDEX)	126.486	67.384	37	392.2	112	1646-1911
Agricultural direct taxes, *shi* of grain (TAX)	0.034	0.016	0.01	0.099	102	1661-1906

Source: See Table 5.

III. Estimation Strategy and Empirical Results

As a first step, we conduct an analysis of correlation coefficients of the logged values of our dependent, four explanatory, and four control variables. Doing so suggests potentially high levels of collinearity between LLAND, LTAX, and LPRICE: i.e. the correlation coefficients between LLAND and LTAX, between LTAX and LPRICE, between LLAND and LPRICE are -0.7318, -0.9380 and 0.4861, respectively. This is well expected, considering (1) the deliberate policy of the Qing state of 'embedding the Poll Tax in farmland' (*tanding rumu*) and (2) the conversion of tax revenue in silver to tax revenue in kind (grain). As a result, we choose not to include LTAX within the subsequent multivariate analysis.

The next step in our analysis is to examine the determinants of Qing population growth by employing Ordinary Least Squares (OLS). Our model in the log-linear version is structured as follows (Model 1):

$$LP_t = \alpha + \beta_1 LLAND_t + \beta_2 LOUTPUT_t + \beta_3 LMAIZE_t + \beta_4 LWARDI_t + \beta_5 LRELIEF_t + \beta_6 LPRICE_t + error \quad (1)$$

It is expected that farmland ($LLAND_t$), rice output ($LOUTPUT_t$), adoption of maize-farming ($LMAIZE_t$) and disaster relief ($LRELIEF_t$) are positively related to population growth (LP_t); and disasters and wars ($LWARDI_t$) to be negatively related to population growth, *ceteris paribus*. Note that while there exists a strong positive theoretical relationship between standard of living and population growth, the expected direction of $LPRICE_t$ is nonetheless indeterminate due to the complexity of the relationship between rice prices and Qing period living standards, as will be discussed in further detail below.

Our methodology is to run multiple versions of the model, adding each of the explanatory and control variables with each iteration run, in order to obtain a complete set of regression results. The results are displayed in Table 7.

Table 7. OLS Empirical Results with Standard Error

	Model iteration				
	(1)	(2)	(3)	(4)	(5)
Farmland	1.958	1.053	0.924	0.926	0.910
($LLAND_t$)	(0.284)***	(0.311)***	(0.305)***	(0.327)***	(0.314)***
Rice output	23.024	13.411	13.583	15.758	14.602
($LOUTPUT_t$)	(1.912)***	(2.553)***	(2.477)***	(2.883)***	(2.792)***
Adoption of maize-farming		0.398	0.382	0.306	0.235
($LMAIZE_t$)		(0.078)***	(0.076)***	(0.090)***	(0.090)**

Disasters and wars			-0.184	-0.217	-0.226
($LWARDI_t$)			(0.068)***	(0.077)***	(0.074)***
Disaster relief				0.133	0.100
($LRELIEF_t$)				(0.040)***	(0.040)**
Prices of rice					0.327
($LPRICE_t$)					(0.120)***
Obs	104	104	104	77	77
Adj R-sq	0.796	0.836	0.846	0.858	0.870

Note: 1. The dependent variable for all iterations is Population (LP). 2. Standard errors are in parentheses. 3.***, ** and * are coefficients significant at the 1%, 5% and 10% levels, respectively.

The generated results are for the most part consistent with our prior expectations. In particular, all of the estimated coefficients for all of the included variables in each of the model iterations are significant at the 95 percent significance level or higher. Importantly, the model itself seems stable, with the scales of the coefficients remain relatively consistent as additional variables are successively included. Likewise, the signs on the coefficients are all in line with our *a priori* expectations.

The one exception is in regard to the sign of the coefficient on rice prices ($LPRICE_t$). Earlier, we suggested that the expected direction of this variable was ambiguous; here, we explain our reasoning in greater detail. Our results find a positive relationship between rice prices and population growth. In some sense, this might be regarded as counter-intuitive — intuitively, a high price of food implies a high cost of living, and a high cost of living discourages population growth, suggesting an expected negative relationship between rice prices and population growth. Correctly interpreting this situation however requires a deeper understanding of the dualistic nature of the Chinese economy, and the equally dualistic nature of China’s food markets under the Qing. There are four main components of this analysis. Firstly, although some studies have implicitly linked Qing commercial growth to population growth,[54] Qing China was not known for an unusual growth in trade and capitalism. Throughout most of the Qing era, the share of trade as a percentage of GDP remained small, as did the share of food, up until the eve of the 1840 Opium War (Table 8). It has been estimated that only 5.5 percent of the grain produced during this period ever entered intra-regional trade.[55] This made the Qing period very different from the Song period, when population growth was fuelled by an unprecedented degree of commercialisation and proto-industrialisation.[56]

Table 8. China's Annual Trade in Value, 1830s

	Value, in tonnes of silver	% in total
1. Rural sector		
Grain[57]	6,123.8	41.0
Cotton fibre and cotton cloth	4027.5	27.0
Tea	1,196.3	8.0
Raw silk and silk textiles	997.5	6.7
2. Urban sector		
Salt	2,197.5	14.7
Porcelain	168.8	1.1
Metals	225.0	1.5
Total	14,936.3	100.0
3. Trade in GDP		

[54] Li Bozhong, *Duoshijiao Kan Jiangnan Jingjishi, 1250–1850* (*Multiple Dimensional View on Economic History of the Jiangnan Region, 1250–1850*) (Beijing: Sanlian Books, 2003); Li Bozhong and J. L. van Zanden, 'Before the Great Divergence? Comparing the Yangzi Delta at the Beginning of the Nineteenth Century', *Journal of Economic History* 72 (2012), pp. 956–90.

[55] Wu, *Quantitative Studies of Chinese Economic History*, pp. 374, 376

[56] K. Deng and L. Zheng, 'Economic Restructuring and Demographic Growth, Demystifying Growth and Development in Northern Song China, 960–1127', *Economic History Review*, (2015), forthcoming.

[57] The figures for grain represent some of the more optimistic estimates; see Yeh-chien Wang, 'Evolution of the Chinese Monetary System, 1644–1850', in Hou Chi-ming, ed., *Modern Chinese Economic History* (Taipei: The Institute of Economics, *Academia* Sinica, 1979), pp. 425–56.

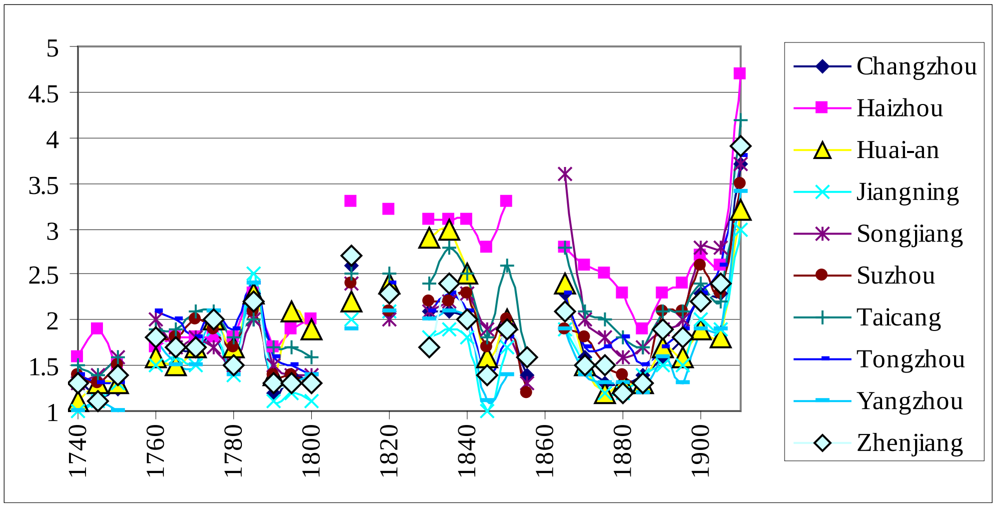
China's total GDP	104,298.8–131,568.8	
Trade in total GDP		11.4–14.3
Of which grain in total GDP		4.7–5.9

Source: Market values, based on Wu Cengming, *Zhongguode Xiandaihua: Shichang Yu Shehui* (*China's Modernization: Market and Society*) (Beijing: Sanlian Books, 2001), pp. 148–9. China's total GDP, based on Chung-li Chang, *The Income of the Chinese Gentry* (Seattle: University of Washington Press, 1962), p. 296; Albert Feuerwerker, *The Chinese Economy*, *1870–1949* (Ann Arbor: Center for Chinese Studies of the University of Michigan, 1995), p. 16; Liu Foding, Wang Yuru and Zhao Jin, *Zhongguo Jindai Jingji Fazhan Shi* (*A History of Economic Development in Early Modern China*) (Beijing: Tertiary Education Press, 1999), p. 66.
Note: Values reflect current prices.

Secondly, the vast majority of cited rice prices were urban ones. Rural and village prices have remained largely unknown. Moreover, to treat the Qing economy as an integrated market can be misleading. The Qing urban markets were not highly integrated even in the advanced Lower Yangtze Delta during the eighteenth and nineteenth centuries, let alone cross-regional markets (Figures 14 and 15).[58]

Figure 14. Urban Prices of Rice per *Picul* (*Shi*) in Jiangsu Province, 1740–1910

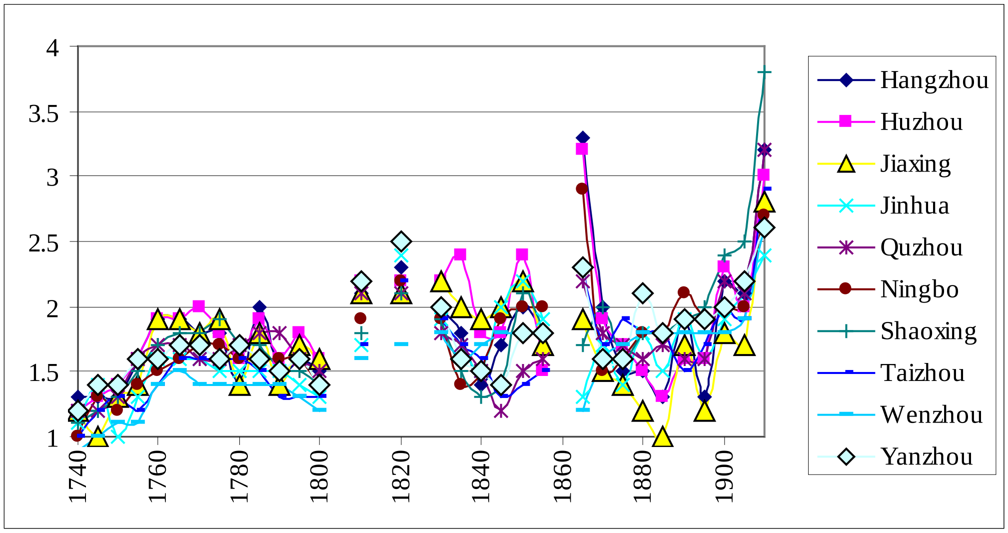
58 For similar plural markets for food during the Qing, see Luo Chang, 'Liangtao Qingdai Liangjia Shuju Ziliaode Bijiao Yu Shiyong' (Comparison and Application of Two Sets of Food Price Data for the Qing Period), *Jindaishi Yanjiu* (*Study of Modern History*), 5 (2012), pp. 142–56.



Source: Yejian Wang, *The Database of Grain Prices in the Qing Dynasty*. Institute of Modern History, *Academia Sinica*, 2013, http://140.109.152.38/DBIntro.asp.

Note: Prices of the Ninth Month, in silver tael. Rice in picul (*shi*). Locations are seats of governments of named prefectures.

Figure 15. Urban Prices of Rice per *Picul* (*Shi*) in Zhejiang Province, 1740–1910



Source: the same as Figure 14.

Note: the same as Figure 14.

Thirdly, on the demand side, the amount of market-dependent food consumers, mainly the urban dwellers, accounted for only about 6–7 percent of the total population.[59] Even in the economically-advanced Jiangsu and Zhenjiang Provinces of the Lower Yangtze, urbanisation rates were only at 13.6 percent and 10 percent, respectively (*circa* 1790).[60] Note these figures include urban absentee landlords who received their rent in the form of either cash payment or food. By the end of the Qing, throughout 16 provinces, landlords accounted for just two percent all households.[61] Thus, even if all landlords had been absentees, their impact on the urban food market would be trivial.

Within the urban sector, there were state-run annual stipends of four million *piculs* (*shi*) of rice (300,000 tonnes) for all officials and military personnel. This stipend rice was extracted from eight provinces as a tax in kind. At the aforementioned minimal food consumption level, this four million *piculs* was estimated to be able to feed 1.7 million adults, sufficient for both 800,000 Qing military troops, and 24,150 (*c.* 1700) to 26,355 (1850) salaried Qing officials.[62] These urban consumers therefore did not depend on the staple food market for their *per diem*. Hence, the Qing urban market was smaller than the urban population figures might suggest.

Additionally, there was the food exported to the four food-deficient provinces to feed 15–24 million adults. Given that the total population in Shandong, Jiangnan, Fujian and Guangdong was about 91.7 million (as of 1776), the beneficiaries counted merely for one-sixth to a quarter of the locals, let alone in China's total.

Thus, on the demand side, it was non-military and non-government official urban dwellers, and import-dependent communities in the coastal food-deficit provinces, who were the primary users of the food markets. These consumers were likely to be price-takers on the grounds that (a) they were unable to alter the supply of food and, (b) food

[59] Ge, *A Demographic History of China, Vol. 5*, pp. 774, 828–9.

[60] Ibid., pp. 757, 762.

[61] Fairbank, *Cambridge History of China*, vol. 12, p. 84.

[62] The total number of the Qing troops included 120,000 Eight Banners (*baqi*) and 660,000 Green Standards (*lüying*, literarily 'Green Corps'); see Zhao, *History of the Qing Dynasty*, vol. 131, 'Military', in *Twenty-Five Official Histories*, vol. 11, pp. 9305, 9307. For the number of salaried officials, see Yang Zhimei, *Xhongguo Gudai Guanzhi Jiangzuo* (*Bureaucracy of Premodern China*) (Beijing: Zhonghua Books, 1992), pp. 420–1. According to Chung-li Chang's, the officials were at one time only 12,000 and no more than 22,830; see Chang, *Income*, pp. 42, 197, 329–30.

consumption is both relatively price and income inelastic. On the supply side, marketed food was only about 4.7–5.9 of China's total GDP (Table 8). This implies that the vast majority of the Qing population did not live on marketed food. Conceptually, we call the functional food market (the source for our rice prices) the 'urban real food market'.

Fourthly, although the lion's share of food in the economy did not enter the market, due to the taxation linkage, farmers were aware of food prices in the market sector as a reliable reference to real tax burden. Inevitably, urban real food market prices had real meaning for the rural population, even in the absence of substantial physical trading of rice. Conceptually, the rural non-market sector can be referred to as a 'rural virtue food market'. Because of the legally required cash payment for the Land-Poll, a rise in urban rice prices is equivalent to a tax cut. The non-market sector is also made better off due to a virtue gain in farmers' food value. Such a mechanism affected over 90 percent of the Qing population.

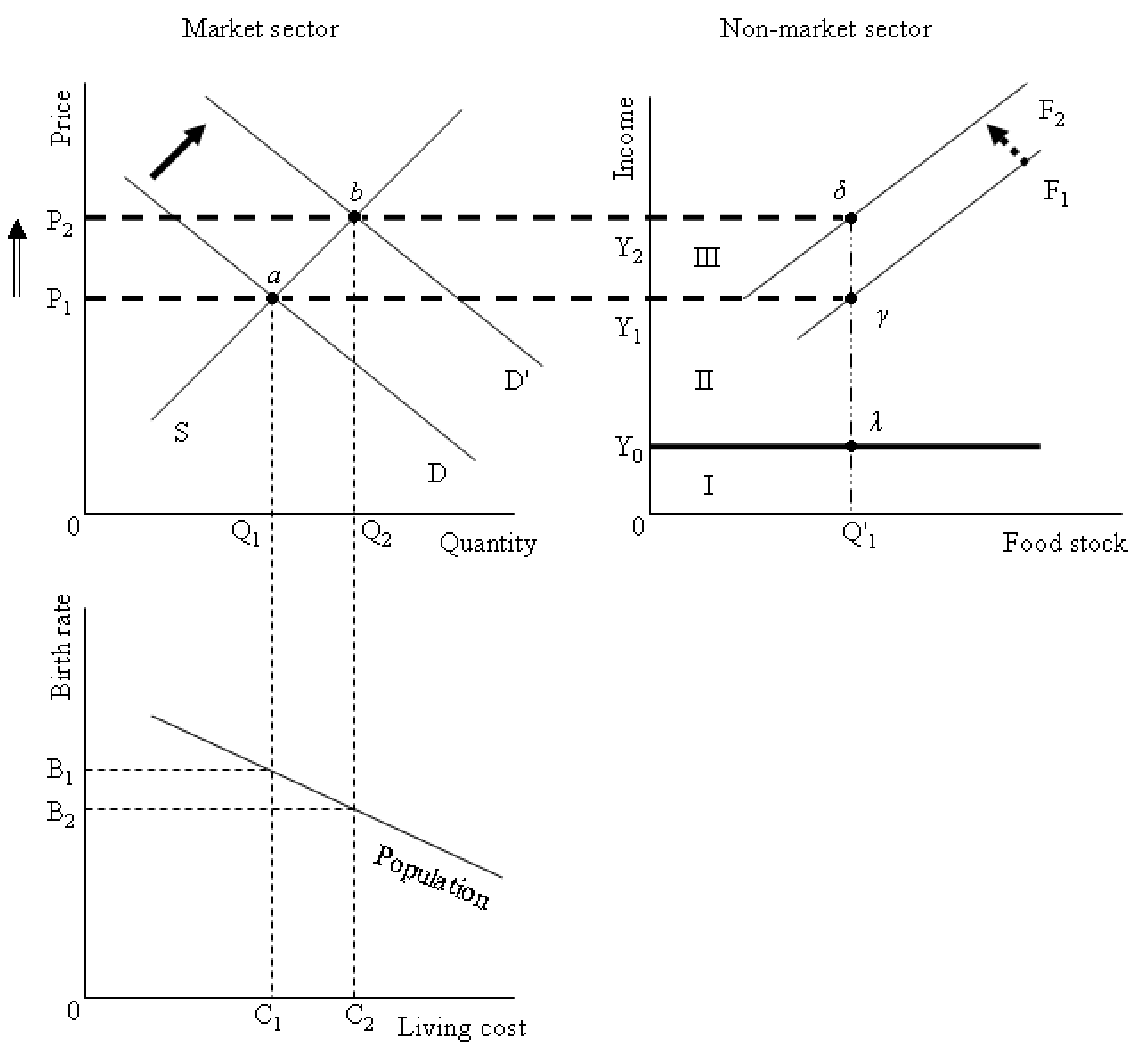
Thus, the key mechanism between rice prices, standard of living, and population growth is illuminated. The relationship between living standards and population growth is clear — lower living standards puts downward pressure on population growth, while higher living standards supports population growth. But the dualistic nature of Qing China's rice markets meant that increases in food prices saw rural living standards rise (leading to an increase in births in the non-market sector), while urban living standards fell (leading to birth declines in the market sector). Given the highly unequal population distribution between urban and rural China under the Qing, the net effect of a rise in rice prices was an increase in the aggregate population.

This process is expressed in Figure 16. Note that the economy is divided into the market and non-market sectors. The initial move comes from an increase in food demand in the market sector (including all the people who depend the market for food) with a shift from D to D'. The resultant food price increase from P_1 to P_2 subsequently attracts more food to the market (Q_1 to Q_2). The increase in the food price likewise increases costs of living in the market sector (C_1 to C_2) which in turn discourages births (B_1 to B_2). At the same time, an increase in the market food price has an income effect, making non-market (mainly rural) households' existing food stock more valuable than before (Y_1 to Y_2), with the initial income gain represented by the area $Y_1\ Y_2\ \delta\ \gamma$. With the Qing direct tax revenue (the Land-Poll Tax) being frozen at 0 Y_0 λ Q'_1, there is also a tax saving. Given the increase value in food, the new tax obligation accounts for a smaller share in the gross households' income as follows:

II + III (0 Y_2 δ Q'_1) > II (0 Y_1 γ Q'_1);

Hence, I (0 Y_0 λ Q'_1) : II + III < I : II.

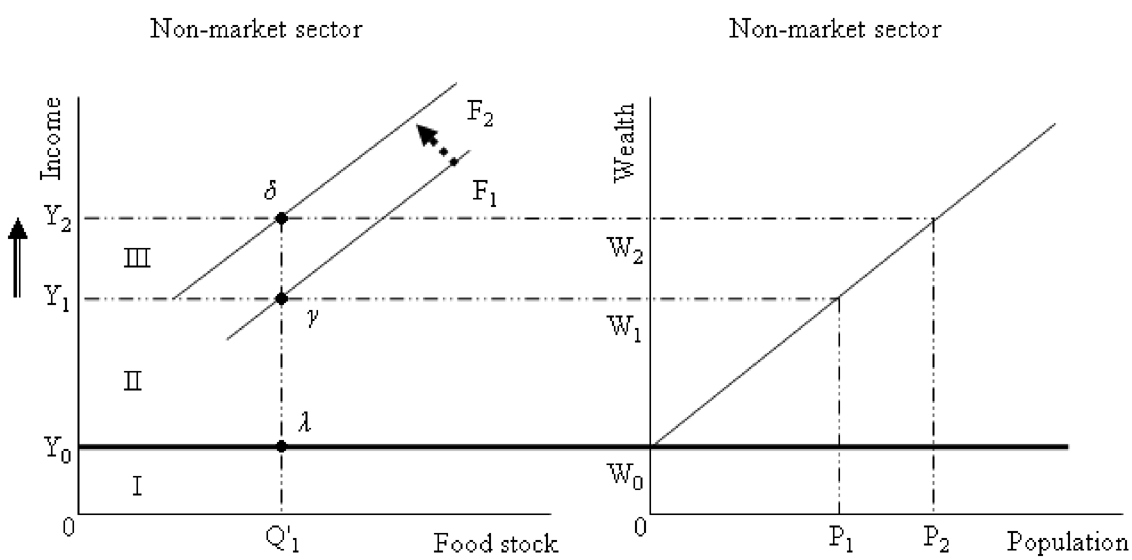
Figure 15. Dual Sectors of the Qing Economy



Note: Points *a*, *b*, *γ*, *δ*, *λ* are equilibria. The solid arrow represents the initial move of the market demand curve, the hollow arrow represents a subsequent change in market food prices, the dash arrow represents 'income effect of changed food prices' in the non-market sector, thick dash lines represent key linkages between the two sectors, and the thick line represents a reduction in income from direct taxes. Areas I, II, and III represent different components of households' gross income.

Rural households' net wealth moves from W_0-W_1 to W_0-W_2, a condition which encourages births (P_1 to P_2), as shown in Figure 16.

Figure 16. Impact on the Non-Market Sector



Note: Points *a*, *b*, *γ*, *δ*, *λ* are equilibria. 0-Y_0 and 0-W_0 show income deduction due to taxes. The hollow arrow represents a subsequent change in market food prices, and the dash arrow represents 'income effect of changed food prices' in the non-market sector, Areas I, II, and III represent different components of households' gross income.

Our quantitative analysis indicates the existence of a time lag between a rise in food price, and a subsequent increase in population (Columns 13 and 14 in Table 10). Our discovery unveils the complexity of the Qing economy. By correctly identifying in our analysis that two sectors, two markets, and two human reproduction regimes must be decoupled from one another, the appropriate logic behind the positive relationship between urban rice prices and overall population growth is illuminated.

We subjected our output to White's Test, which confirmed the presence of heteroskedasticity.[63] Therefore, we conduct several robustness checks, performing OLS using robust standard errors. First, we re-run Model 1 utilizing robust standard error. Second, we create a new variant of the model, labeled Model 2, in which we substitute silver's purchasing power index ($LINDEX_t$) for the variable representing rice prices ($LPRICE_t$):

$$LP_t = \alpha + \beta_1 LLAND_t + \beta_2 LOUTPUT_t + \beta_3 LMAIZE_t + \beta_4 LWARDI_t + \beta_5 LRELIEF_t + \beta_6 LINDEX_t + \text{error} \quad (2)$$

Finally, we construct Model 3, in which we include agricultural direct taxes ($LTAX_t$) but drop farmland ($LLAND_t$) and rice prices ($LPRICE_t$) in order to reveal the impact of $LTAX_t$ on population (LP_t):

$$LP_t = \alpha + \beta_1 LOUTPUT_t + \beta_2 LMAIZE_t + \beta_3 LWARDI_t + \beta_4 LRELIEF_t + \beta_5 LTAX_t + \text{error} \quad (3)$$

The results of our robustness checks are displayed in Table 9, with Columns (6), (7) and (8) displaying the regression results of Models 1, 2 and 3, respectively.

Table 9. OLS Empirical Results with Robust Standard Error

	Population		
	(6)	(7)	(8)
Farmland ($LLAND_t$)	0.910	0.676	

[63] Due to the nature of our finite and non-contiguous data with irregular gaps in the time series, we are unable to carry out tests for autocorrelation, or an HAC (Heteroskedasticity and Autocorrelation Consistent Standard Error) and cointegration analysis.

	(0.340)***	(0.364)*	
Rice output ($LOUTPUT_t$)	14.602	13.699	14.449
	(2.873)***	(2.791)***	(2.779)***
Adoption of maize ($LMAIZE_t$)	0.235	0.173	0.259
	(0.060)***	(0.067)**	(0.068)***
Disasters and wars ($LWARDI_t$)	-0.226	-0.216	-0.265
	(0.086)**	(0.086)**	(0.091)***
Disaster relief ($LRELIEF_t$)	0.100	0.097	0.131
	(0.034)***	(0.032)***	(0.032)***
Prices of rice ($LPRICE_t$)	0.327		
	(0.110)***		
Silver's purchasing power index ($LINDEX_t$)		-0.498	
		(0.134)***	
Total direct taxes ($LTAX_t$)			-0.431
			(0.119)***
Obs	77	71	75
Adj R-sq	0.880	0.875	0.868

Note: 1. Robust Standard errors are in parentheses. 2. ***, ** and * are coefficients significant at the 1%, 5% and 10% levels, respectively.

The high values of adjusted R-squared indicate that our three model formulations are well-specified, with the independent variables able to capture most of the variation in the dependent variable. Note that for Model 1, the results from OLS using robust standard error are not different from those presented in Table 7. For the Model 2 and 3 specifications, we find that $LINDEX_t$ and $LTAX_t$ are negatively related to LP_t. Their coefficients are significant at 1% level.

Note that while, like $LPRICE_t$, $LINDEX_t$ is measured in the silver currency (taels), we must be careful in its interpretation. $LPRICE_t$ represents market prices, which are positively related to population growth; the coefficients on LPRICE in our regression results in all model specifications are positive, as expected. Conversely, for $LINDEX_t$, the purchasing power of silver is negatively related to the population growth, since the stronger the currency's purchasing power, the lower the general price level, which lowers the cost of living. This contrasts with higher food prices, which translate into higher living costs. Thus, with respect to the cost of living, market prices and silver's purchasing power move in opposite directions.

Given that there exists the possibility that causation could also run from the dependent variable to the independent variables, we run additional variants of the Models with lagged values of the independent variables of farmland ($LLAND_{t-1}$), rice output ($LOUTPUT_{t-1}$), adoption of maize ($LMAIZE_{t-1}$), disaster relief ($LRELIEF_{t-1}$), prices of rice ($LPRICE_{t-1}$), as well as silver's purchasing power index ($LINDEX_{t-1}$) in Model 2, and agricultural direct taxes ($LTAX_{t-1}$) in Model 3. Since wars and disasters usually had their impact on population in real time, we do not include a variable for lagged values of LWARDI.

We repeat our methodology as before with Model 1, successively adding lagged versions of the independent variables one at a time; these results are shown in Columns (9)–(14) in Table 10. Column (15) in Table 10 indicates the results of using the lagged variable $LINDEX_{t-1}$ in Model 2. Similarly, the results with lagged variables in Model 3 are shown in Table 11.

Table 10. OLS Empirical Results of Model 2 with Lagged Variables and Robust Standard Error

	Population						
	(9)	(10)	(11)	(12)	(13)	(14)	(15)
LLAND		0.874	0.877	0.865	1.003		
		(0.349)**	(0.353)**	(0.323)***	(0.332)***		
$LLAND_{t-1}$	0.565					0.943	0.783
	(0.271)**					(0.297)***	(0.368)**
LOUTPUT	14.526		14.732	13.414	14.436		
	(2.729)***		(2.752)***	(2.860)***	(2.879)***		

LOUTPUT $_{t-1}$		13.776				12.716	11.745
		(2.951)***				(2.992)***	(2.889)***
LMAIZE	0.232	0.275		0.240	0.237		
	(0.059)***	(0.068)***		(0.063)***	(0.061)***		
LMAIZE$_{t-1}$			0.243			0.257	0.193
			(0.059)***			(0.064)***	(0.068)***
LWARDI	-0.233	-0.224	-0.217	-0.234	-0.200	-0.162	-0.152
	(0 .086)***	(0.088)**	(0.085)**	(0.077)***	(0.083)**	(0.077)**	(0.078)*
LRELIEF	0.102	0.113	0.104		0.097		
	(0.032)***	(0.038)***	(0.034)***		(0.033)***		
LRELIEF $_{t-1}$				0.098		0.090	0.083
				(0.034)***		(0.037)**	(0.036)**
LPRICE	0.415	0.278	0.330	0.318			
	(0.110)***	(0.122)**	(0.109)***	(0.103)***			
LPRICE$_{t-1}$					0.332	0.322	
					(0.102)***	(0.105)***	
LINDEX$_{t-1}$							-0.503
							(0.126)***
Obs	76	77	77	77	77	77	71
Adj R-sq	0.884	0.874	0.881	0.883	0.882	0.872	0.868

Note: 1. Robust Standard errors are in parentheses. 2. ***, ** and * are coefficients significant at the 1%, 5% and 10% levels, respectively.

Table 11. OLS Empirical Results of Model 3 with Lagged Variables and Robust Standard Error

	Population				
	(16)	(17)	(18)	(19)	(20)
		14.361	12.898	14.261	
LOUTPUT		(2.683)***	(2.839)***	(2.766)***	

$LOUTPUT_{t-1}$	13.770 (2.844)***				12.342 (2.980)***
LMAIZE	0.303 (0.074)***		0.299 (0.075)***	0.253 (0.076)***	
$LMAIZE_{t-1}$		0.273 (0.067)***			0.329 (0.075)***
LWARDI	-0.258 (0.093)***	-0.250 (0.090)***	-0.254 (0.080)***	-0.229 (0.088)**	-0.174 (0.084)**
LRELIEF	0.143 (0.034)***	0.135 (0.031)***		0.122 (0.030)***	
$LRELIEF_{t-1}$			0.120 (0.032)***		0.118 (0.035)***
LTAX	-0.361 (0.138)**	-0.430 (0.109)***	-0.358 (0.121)***		
$LTAX_{t-1}$				-0.473 (0.131)***	-0.345 (0.139)**
Obs	75	75	76	74	75
Adj R-sq	0.862	0.871	0.868	0.868	0.851

Note: 1. Robust Standard errors are in parentheses. 2. ***, ** and * are coefficients significant at the 1%, 5% and 10% levels, respectively.

We can observe that the results of running our model specifications 1, 2 and 3 with lagged variables generate results that are highly similar to our model specifications without lagged variables. This indicates there is a low risk of bi-directional causality in our model specifications between the dependent and independent variables. Therefore, we focus our remaining discussion in regard to the results listed in Table 7.

The empirical results generated from Models 1, 2 and 3 (listed in Table 7) indicate that all eight predictor variables (Table 6) were important for the population growth (LP) experienced under the Qing. Farmland ($LLAND_t$), rice output ($LOUTPUT_t$), adoption of maize-farming ($LMAIZE_t$) and disaster relief ($LRELIEF_t$) all had positive and significant impact on population growth.

Given the size of the coefficient, the effect of rice output on population growth was substantial. Second in importance was the amount of farmland, followed by the impact of rice prices, adoption of maize-farming, and then disaster relief. This result reveals that improvements in the then-existing technology (an increased rice yield level) and availability of new technology (adoption of maize) were the main driving forces behind Qing population growth. In this context, a significant amount of 'free lunches' still existed in the Qing economy.[64]

On the institutional front, the Qing proto-welfare state that expanded farmland (migration embedded) and minimised population losses played a positive role in population growth.[65]

In addition, wars and disasters (LWARDI) had a significant but negative influence on population growth, as did direct taxes (LTAX). The negative impact of the tax burden was greater than that of wars and disasters, despite the fact that the Qing tax burden was the lightest *hitherto* in China's history, and perhaps because disaster relief buffered shocks from calamities.

It is worth noting that both farmland (LLAND) and agricultural direct taxes (LTAX) had impact on the Qing population growth. However, during the Qing, there was a capping of agricultural direct taxes. As such, the positive impact of the expansion of farmland on the population stood out more prominently. On the other hand, in per unit of farmland terms, agricultural direct taxes became progressively lighter as the tax revenue was diluted in the increasing farmland. So, the impact of the tax burden per *mu* was negative but weak on population growth.

Finally, in terms of cost of living, the prices of rice (LPRICE) had positive and significant impact while the silver's purchasing power index (LINDEX) had negative and significant impact on population growth.

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64 Joel Mokyr, *The Lever of Riches* (New York and Oxford: Oxford University Press, 1990), ch. 1.

65 Will, *Bureaucracy and Famine*; Will and Wong, *Nourish the People*; Deng, *The Premodern Chinese Economy*, chs 1–3.

IV. Conclusions

In this study, we used a historical time series dataset to model China's unprecedented population expansion during the Qing Period. Ordinary Least Squares (OLS) with robust standard errors, as well as more dynamic models with lagged variables, were used to model the impact on population growth from a variety of explanatory variables. Our results prove to be robust, and the lagged variable tests indicate a low risk of bi-directional causality.

Our findings reveal that the extraordinary growth in China's population during the Qing Period was supported by, in the order of weight and importance, a synergy of (1) farming technology (rice yield and maize adoption), (2) farmland, and (3) disaster relief. These three factors are all positively related to population growth. Wars and disasters, and the degree of tax burden had a negative impact on Qing population growth. Further, the unique combination of increased farmland and capped agricultural direct taxes led to a steady decline in the tax burden on per unit of land, which in turn reduced the negative impact of taxation on population growth. It is clear that to a very large extent, the extraordinary population growth experienced in China under the Qing was mainly propelled by the non-market sector, which responded to changes in food prices very differently from its market counterpart.

Admittedly, out research is on the macro-level using an economy-wide approach, which makes sense only when we deal with the Qing economy as one entity. It would be ideal to have more available variables on both macro- and micro-levels to facilitate more empirical studies of the premodern economy of China.

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