Debin Ma
Lectures and Readings

Lecture 1: Chinese Historical GDP and International Comparison

Debin Ma, "Economic Growth in the Lower Yangzi Region of China in 1911–1937: A Quantitative and Historical Analysis" *The Journal of Economic History*, Vol. 68, Issue 2, June 2008, pp. 355-392.

Kyoji Fukao, Debin Ma and Tangjun Yuan, "Real GDP in pre-War East Asia: a 1934-36 Benchmark Purchasing Power Parity Comparison with the U.S." *Review of Income and Wealth*, Vol. 53 Issue 3, September 2007

Lecture 2: Historical Chinese Living Standards: a real wage approach

Robert Allen, Jean-Pascal Bassino, Debin Ma, Christine Moll-Murata and Jan Luiten van Zanden, "Wages, Prices, and Living Standards in China, 1738-1925: in Comparison with Europe, Japan and India" *Economic History Review*, Vol. 64, No. S1 2011, pp.8-38

Joerg Baten, Debin Ma, Stephen Morgan and Qing Wang, "Evolution of Living Standards and Human Capital in China in 18-20th Century", *Explorations in Economic History*, Volume 47, Issue 3, pp. 347-359 (July 2010).

Lecture 3: Why England or Japan but not India or China: a factor-price based comparison of historical productivities

Debin Ma, "Why Japan, not China, Was the First to Develop in East Asia, Lessons from Sericulture 1850-1937", *Economic Development and Cultural Change*, January 2004, volume 52, No. 2,.

Broadberry, S. and Gupta, B., "Lancashire, India and Shifting Competitive Advantage in Cotton Textiles, 1700-1850: The Neglected Role of Factor Prices", *Economic History Review*, 62 (2009), 279-305.

Economic Growth in the Lower Yangzi Region of China in 1911-1937: A Quantitative and Historical Analysis
Author(s): Debin Ma
Source: *The Journal of Economic History*, Vol. 68, No. 2 (Jun., 2008), pp. 355-392
Published by: Cambridge University Press on behalf of the Economic History Association
Stable URL: http://www.jstor.org/stable/40056379
Accessed: 02/05/2014 07:44

Economic Growth in the Lower Yangzi Region of China in 1911–1937: A Quantitative and Historical Analysis

DEBIN MA

Through a detailed reconstruction of 1933 GDP for the two provinces in China's most advanced region, the Lower Yangzi, I show that their per capita income was 55 percent higher than China's average, and they had experienced a growth and structural change between 1914–1918 and 1931–1936 comparable to contemporaneous Japan and her East Asian colonies. This article highlights the unique political institution of early-twentieth-century Shanghai as a city state, with its rule of law and secure property rights laying the foundation for economic growth in the Lower Yangzi with long-term impact throughout East Asia.

Chinese economic growth is not a recent phenomenon. Thomas Rawski contends that China's per capita GDP growth had already attained a similar rate to that of Japan in the first three decades of the twentieth century, a period also referred to as the Republican era. In fact, economic growth is a theme as enduring as Chinese economic history. The question raised by Joseph Needham, subsequently referred as the Needham puzzle, asked why, given her scientific, technological, and economic leadership over the rest of the world up until perhaps the fourteenth century, the Scientific Revolution and the Industrial Revolution bypassed China. More recently, a new wave of revisionist scholarship marked by Kenneth Pomeranz's book, *The Great Divergence,* extends this thesis with the provocative claim that levels of development and living standards in the Lower Yangzi region (historically China's most advanced area) may have still been on a par

The Journal of Economic History, Vol. 68, No. 2 (June 2008). ISSN 0022-0507.

Debin Ma is Lecturer, Department of Economic History, London School of Economics, London WC2A 2AE, UK. E-mail: d.ma1@lse.ac.uk.

For encouragement and suggestions, I want to thank Bart van Ark, Loren Brandt, Sherman Cockrane, Huang Han Ming, Paul Kandasamy, Carien Van Mourik, Junya Ma, Angus Maddison, Andrew Mitchell, Ramon Myers, Larry Neal, Patrick O'Brien, Konosuke Odaka, Sonja Opper, Kenneth Pomeranz, Tirthankar Roy, Osamu Saito, Billy So, Jeffrey Williamson, Bin Wong, Pierre van der Eng, Oliver Volckart, and Yuan Weipen. I also thank participants of conferences and seminars organized at FASID Hakone Conference (Japan), LSE, University of Glasgow, Cornell University, University of Pompeu Fabreu, Global Economic History Network (in Istanbul), Economic History Association Meeting (San Jose, CA), International Economic History Congress (Helsinki), and Historical Society (Chapel Hill, NC) for their suggestions. I am indebted to Rawski for sending me his unpublished manuscript, "Economy of the Lower Yangtze Region, 1850–1980," and to Reiko Hayashi and Felipe Fernandes for assisting with the map. My thanks go to the three referees and editors of this JOURNAL, especially to Jeremy Atack. I alone remain responsible for all errors.

with those of Northwestern Europe as late as the eighteenth century. It was accidental factors such as the absence of coal deposits in the Lower Yangzi coupled with the natural resource windfalls from the discovery of the New World for Europe that tilted the balance afterward against China.[1]

This article focuses on Chinese industrialization in the early twentieth century, which was disproportionately concentrated in the Lower Yangzi, a region situated largely within the two administrative provinces of Jiangsu and Zhejiang (hereafter abbreviated as "Jiang-Zhe"). It revisits the debate on Chinese economic growth in the Republican era from 1911 to 1936 with new, regional-level, quantitative evidence. It offers a detailed sectoral reconstruction of the 1930s GDP estimates for Jiang-Zhe within the national GDP framework proposed by Liu Ta-chung and Yeh Kung-chia. The result shows that per capita GDP in Jiang-Zhe in 1930s was about 55 percent higher than China's national average, and 16–29 percent higher than those of Japanese-controlled Korea and Manchuria. It ranked only below Japan and Taiwan. Backward projection based on my 1930s Jiang-Zhe benchmark shows structural change and per-capita income growth comparable to those of Japan and her colonies between the 1910s and 1930s and an economic structure far removed from a traditional agrarian economy.

A striking feature of this distinctively regional economic growth is that it took-off in an era of national disintegration and civil strife. The article offers a narrative to demonstrate that the pattern of industrialization, especially its absence during the latter half of the nineteenth century followed by a surge in the early twentieth century, speak to the importance of ideological and institutional changes in modern China. In particular, during China's tumultuous Warlord era in the 1910s and 1920s, Shanghai transformed from a colonial treaty port to a European style city-state under the rule of Western business elites and provided effective public security and private property rights for both Chinese and foreign business within its jurisdiction. Despite the superior historical conditions of the Lower Yangzi (as recently championed by Kenneth Pomeranz and others), early-twentieth-century economic growth in the Lower Yangzi did not grow out of traditional institutions, but rather grew outside of them. Going beyond resource endowments, I highlight institutions as crucial determinants of long-term economic change.

[1] See Thomas Rawski, *Economic Growth*; and Mark Elvin, *Patterns*. A recent summary of this literature on this theme can be found in Ma, "Growth."

FIGURE 1
MAP OF LOWER YANGZI AND OTHER MACRO-REGIONS IN CHINA

Notes: The bold dark lines mark the provincial boundaries of Jiangsu and Zhejiang.

For Jiangsu province, the Lower Yangzi Macro-Region (in dark shade) includes the following prefectures in Jiangsu province: Suzhou, Songjiang, Jiangnin, Changzhou, Taicang, Zhengjiang, Yangzhou, Tongzhou, Haimen, Haizhou, and the City of Shanghai; and the following prefectures in Zhejiang province: Hangzhou, Jiaxing, Huzhou, Yanzhou, Caoxin, Ningbo, Cuzhou, and Jinhua.

The prefectures outside the Lower Yangzi Macro-Region (in light shade) are Xuzhou and Hua-An for Jiangsu province and Wenzhou and Taizhou for Zhjiang province.

The ten macro-regions that Skinner defined are Manchuria, North China, Northwester China, Upper, Middle and Lower Yangzis, Yungui, Lingna,n and Southeast Coast. For detailed boundaries of macro-regions, see Skinner, "Presidential Addrss," p. 273.

ECONOMIC GROWTH IN THE LOWER YANGZI: A REGIONAL QUANTITATIVE RECORD

Lower Yangzi: The Historical Setting

The Lower Yangzi is one of the ten economic macro-regions defined by William Skinner. Marked in dark shade in the map (Figure 1), it includes eight of the ten prefectures in Zhejiang province and ten of the 12 prefectures in the Jiangsu province plus the city of Shanghai. The Lower Yangzi macro-region constitutes a relatively integrated cultural, economic, and geographic region distinguished from those outlying prefectures in the Jiang-Zhe provinces in levels of development, degrees of commercialization, culture, and dialects.

Due to the nature of the data, my quantitative analysis in this study is largely based on the administrative boundaries of Jiang-Zhe provinces with due references to the somewhat smaller "Lower Yangzi Macro-Region" where necessary, while "Lower Yangzi" will remain a generic term for the area.[2] At 210,741 square kilometers, roughly 86 percent the size of Britain and 56 percent the size of Japan, and with over 60 million residents in the 1930s, Jiang-Zhe is a substantial economic region, albeit only a small part of China.

The Lower Yangzi occupies a central place in recent revisionist literature on eighteenth-century China. While a full evaluation of this literature is beyond the scope of this article, I offer a perspective here with a regional macroeconomic framework.[3] In the absence of any national or regional GDP data for China in the mid-eighteenth century, I make use of the tax revenue records to get a crude approximation of the per capita income difference between the Lower Yangzi and the rest of China. My calculation based on Wang Yeh-chien's study on Qing taxation shows that the per capita tax revenue contributed by the Jiang-Zhe provinces in 1753 was 1.44 times the national average.[4]

[2] Skinner also defines a so-called Lower Yangzi Core which would only include the prefectures of Suzhou, Songjiang, Jiangnin, Changzhou Taicang, and the city of Shanghai in Jiangsu province and the prefectures of Hangzhou, Jiaxing, and Huzhou in Zhejiang province. This small and undoubtedly most advanced and commercialized region, often known as the Jiangnan region, is most often discussed by Pomeranz and Li Bozhong, See Li Bozhong, *Agricultural Development*, chapter 1.

[3] A recent summary of this revisionist scholarship can be found in Ma, "Growth."

[4] Tax data are from Wang, *Land Taxation,* p. 70. Wang's grand total is used. Population is for 1787 from p. 87 (table 5.1). To use per capita tax revenue as a proxy for per capita income carries the strong assumption that tax revenue is proportional to income and that the taxation system was efficient and corruption-free, or at least the degree of corruption varies little by region. For Wang's argument for a relatively efficient tax system in 1753, see chapters 4 and 5. Incidentally, the 1.44 figure derived is nearly identical to the 1.43 ratio equivalent for that of 1910s as shown later in Table 3.

The "guess-estimates" in the global dataset by Angus Maddison show the British, West European, and European (including East Europe but not Russia and Turkey) per-capita income figures are 2, 1.7, and 1.45 times the level of China in 1700, respectively.[5] If the Jiang-Zhe per capita income could be assumed to be 1.44 times of that of China, as implied in the tax records, this would equal 72 percent, 85 percent, and about 100 percent of the per capita income of Britain, Western Europe, and Europe overall, respectively. It would also be slightly higher than Maddison's guess-estimated level for early-nineteenth-century Japan.[6] Clearly, both tax-revenue-based, regional-income-difference estimates and Maddison's guess-estimates are highly speculative. But this exercise is useful to show that a regional perspective could alter our preexisting views on Jiang-Zhe's relative backwardness in the early modern period.[7]

Shanghai-Based Industrialization: The Regional Picture

In the 1930s Shanghai alone produced 41 percent of national manufacturing output (48 percent if excluding Japanese-controlled Manchuria); housed 50 to 60 percent of cotton spindles throughout the 1910s and 1930s; and generated about 50 percent of national electricity in the 1920s, almost twice that of the major British industrial cities of Manchester and Glasgow. In the 1930s, Shanghai alone absorbed 46.4 percent of total foreign direct investment (FDI) in China and 67 percent of FDI in manufacturing and claimed 47.8 percent of China's financial capital. With more than half of China's foreign trade and one-fifth of the Chinese shipping tonnage sailing through its harbor. Shanghai was the commercial, financial, and industrial city of China in the early twen-

[5] Maddison gives China, Eastern Europe, Western Europe, and Britain per capita incomes of 600, 566, 1,024, and 1,250 respectively (in 1990 international $), Maddison, *World Economy*, p. 264, table B-21. Also see Maddison, *Chinese Economic Performance*, p. 25, for the European per capita average.

[6] For Japan, Maddison gives per capita income as 12 percent and 40 percent higher than China's in 1820 and 1870 respectively, see *World Economy*, p. 264. These are below Jiang-Zhe's 44 percent gap over China in the mid-eighteenth century.

[7] For Japanese revisionism, see Akira Hayami, *Kinsei Nihon*; and Hanley and Yamamura, *Economic and Demographic Change*. The absence of a regional perspective often accounts for the so-called Japanese exceptionalism vis-à-vis her Asian neighbors, as found in "Social Structure" by James Nakamura and Matao Miyamoto, where they viewed stagnant population growth in Tokugawa Japan as a precocious demographic transition for a premodern society in contrast to the case of Malthusian population explosion that gripped China during the seventeenth and eighteenth centuries. It is true that population statistics of 1600–1850 seems to confirm a faster Chinese growth rate of 0.37 percent versus that of Japan at 0.21 percent. But annualized population growth in Jiang-Zhe was only 0.14 percent in 1630–1851, even slower than in Japan. For population figures of China and Japan, see Maddison, *World Economy*, p. 40. The Jiang-zhe provincial figures are from Chao Shuji, *Zhongguo*, vol. 4, p. 452, and vol. 5, p. 703.

tieth century.[8] Its population doubled from only half a million in the 1890s, to over a million in the 1910s, and to about 3.5 million in the 1930s, making it the world's seventh largest city.[9] These staggering statistics lead some scholars to refer to China's early-twentieth-century growth as Shanghai-based industrialization.

The Shanghai-based industrialization occurred during China's first major phase of modern industrial expansion dated from the mid-1890s. Du Xuncheng shows that nominal annual industrial investment by Chinese nationals from 1914 to 1925 was 11 times that of the 1840–1911 period.[10] The capital of a modern Chinese banking sector, largely nonexistent before the mid-1890s, multiplied at an annual rate of 10.2 percent between 1897 and 1936. C. F. Remer displays a corresponding growth in foreign investment at annual rates of 8.3 percent, 5 percent, and 4.3 percent respectively for Shanghai, Manchuria, and the rest of China between 1902 and 1931. Railroad mileage built surged from a mere 364 kilometers until 1894 to over 21,000 by 1937. The national industrial output index constructed by John Chang, shows an annual real growth rate of 10 percent for the period of 1912–1936, a phenomenal growth rate by the standard of the time.[11]

John Chang's industrial output index covers the output of modern "factory" employing seven or more workers. It includes 15 products, ten of which are mineral and metallurgical commodities. Overall, these 15 products cover between 40 and 50 percent the total modern factory output.[12] The growth rate implicit in the Chang index turns out to be upward biased due to its over-representation of the fastest-growing mining sectors, part of which was launched in Manchuria of Northeast China under Japanese colonialism from 1931.[13] Recently, Toru Kubo revised Chang's annual series by updating the cotton output series and adding

[8] See the Appendix; Xiong, *Shanghai*, vol. 1, p. 19; Remer, p. 97; and Zhang, Zhong-li, *Jindai Shanghai*, pp. 312–13.

[9] Murphey, *Shanghai*, p. 22.

[10] The calculation is from Cheng Linsun, *Banking*, p. 41. If the mid-1890s rather than 1911 as the cut-off period were used, the contrast of industrial expansion versus stagnation would be even sharper.

[11] See Cheng, Linsun, *Banking*, p. 71; Remer, *Foreign Investment*, p. 73; Yan Zhongpin et al., *Zhongguo*, p. 180; and Chang, *Industrial Investment*, pp. 60–61.

[12] See Chang, *Industrial Development*, p. 36; and Kubo, *Industrial Development*, p. 11.

[13] This bias is noted by Chang himself. To gauge the extent of the bias, Chang shows separately the industrial output series between Manchuria and China proper (which is the rest of China excluding Manchuria) whose real annual growth rates turn out to be 14 percent and 6.4 percent respectively in 1926–1936 (*Industrial Development*, p. 103). In a separate study on the Manchurian economy, Kang Chao gives a real growth rate of 8.8 percent for modern industry during the same period (*Economic Development*, p.84). As Chao's sectoral coverage of modern industry is much larger (therefore a correspondingly smaller share for the mining sector) than Chang's, its slower rate for Manchuria (8.8 percent versus 14 percent) confirms the upward bias inherent in the Chang index due to its large weight assigned to the fast-growing mining sector.

important light industrial products such as silk and flour. The Kubo index as presented in Table 1 raises the total coverage to 72 percent and reduces the real annual growth rates to 8.4 percent for 1912–1936.[14]

We now compare these national indices with the new modern industrial gross output series for Shanghai constructed by Xu Xinwu and Huang Hanming, for the benchmarks of 1895, 1911, 1925, and 1936 based on 1936 prices. The Shanghai index by Xu and Huang, as presented in Table 1, covers nine sectors including textiles (cotton, silk, and wool), flour milling, matches, cigarettes, paper, pharmacy, and machinery repair as well as estimates for other sectors. In the absence of any mining sectors, modern industry in Shanghai attained a real annual growth rate of 9.6 percent, faster than the Chinese national average of 8.4 percent as revealed by the Kubo index. Because the national average included the fast-growing Shanghai and Manchuria, the difference in growth rates between Shanghai and the rest of China outside of these regions would be larger than is shown in Table 1.[15]

Modern industrial growth in Shanghai compares favorably with Japanese industrial performance as measured by those produced by modern factories employing more than five workers. Table 1 shows that Shanghai's growth rate leads Japan both for the 1895–1911 and the 1912-1936 periods, matched possibly only by Korea in the Japanese colonial era of 1912–1936.[16]

Shanghai-based industrialization spilled over to the rest of China but most directly to her immediate hinterland, the Lower Yangzi region. For the Lower Yangzi, Shanghai became a massive draw for labor and a major source of capital and entrepreneurship. Shanghai capital supported the renowned scholar-bureaucrat-entrepreneur Zhang Qian in turning Nantong in Jiangsu province into an industrial city. Capital infusion from Wuxi-born industrial tycoons in Shanghai transformed the market town of Wuxi into China's fifth largest industrial city by the

[14] The new Kubo index also confirms Rawski's crude point estimates of modern industry made for this period. Rawski's point estimates of factory output between 1912 and 1936 (in 1933 prices) had a broader coverage of sectors with a 73 percent share of total output and a real growth rate of 8.1 percent. See Rawski, *Economic Growth*, pp. 353–59.

[15] Assuming Shanghai and Manchuria having a 60 percent share in China's modern industry in the 1930s and a combined growth rate of 9.6 in 1911-36 versus an overall 8.4 percent growth rate for the whole of China, a back-of-the envelope calculation would give a 6.6 percent annual growth rate for the rest of China excluding Shanghai and Manchuria.

[16] See Ohkawa, *Growth Rate*, p. 78. Note that as the growth spurt of modern industry in Japan started well before 1895, Japanese industrial expansion in the twentieth century started from a larger base than did Shanghai's. For industrial growth in Taiwan and Korea during this period, see Mizoguchi and Umemura, *Basic Economic Statistics*, pp. 273 and 276, respectively.

TABLE 1
ANNUALIZED REAL GROWTH RATES OF MODERN INDUSTRY OUTPUT IN CHINA AND JAPAN
(percentages)

	China			
	Chang Index	Kubo Index	Shanghai	Japan
1880–1895				10
1895–1912			9.4	5.7
1912–1925	12.6	10	12	8.6
1925–1936	7.4	5.4	6.5	9.5
1912–1936	10.2	8.4	9.6	8.3

Sources: The Chang index is from Chang, *Industrial Development*, p. 60, table 14. The Kubo index from Kubo, "Industrial Development." The Shanghai series is from Xu and Huang, *Shanghai*, p. 342. Both Chang and Kubo indices are in 1933 prices and the Shanghai index by Xu and Huang is in 1936 prices. The Japanese series of factory manufacture is from Ohkawa, *Growth Rate*, pp. 79–80. The manufacturing price deflator is from Ohkawa et al., *Estimates*, pp. 192–93.

1930s, which was then dubbed "Little Shanghai."[17] Towards the 1930s, industrial production in Shanghai was moving from labor-intensive consumer goods towards more capital-intensive sectors, with low-value-added sectors steadily migrating to other regions, particularly southern Jiangsu. In 1933 the industrial output of Jiangsu province reached about 13 percent of that of China proper (excluding Manchuria), trailing only behind Shanghai and Japanese-controlled Manchuria.[18]

Shanghai-based industrialization also impacted the agriculture sector. Industrial demand brought direct impetus to the improvement of major industrial cash crops such as cotton and silk cocoons through the diffusion of new scientific seeds and practices; and accelerated the adoption of commercial fertilizers and the introduction of power-driven agricultural machines such as water pumps and rice and flour mills.[19]

The Regional Production Accounts

The most comprehensive way to register economic activities is the national income framework. The pioneering research of Ou Baosan et al. and Liu and Yeh provided the first set of Chinese GDP estimates of

[17] For Shanghai investors' financial involvement in the Nantong enterprise, see Elisabeth Koll, *From Cotton Mill*, p. 63 and chapter 6. For Shanghai capital on Wuxi, see Yu Xiaobo, *Bijiao*, pp. 241–48. For the impact of Shanghai industrialization on urbanization in the Lower Yangzi region, see Ma Junya, *Hunghe,* Introductory Chapter.

[18] See the Modern Factory section in the Appendix.

[19] See Ma Junya, *Hunghe*, pp. 67–79.

reasonable quality for the 1930s.[20] I employ their national-level GDP framework to calculate the total net value added (NVA) of all 13 sectors for Jiang-Zhe. I first estimate the ratio of Jiang-Zhe gross value output (GVO) in China's total and then use this ratio to multiply China's NVA for that sector to derive the Jiang-Zhe NVA.[21] Mathematically it is expressed as

$$\text{Jiang-Zhe } NVA_i = \frac{\sum_{R=1}^{3} GVO_R^i}{GVO_{CHINA}^i} \times NVA_{CHINA}^i$$

where i stands for the ith of the 13 sectors and R stands for the Rth provinces or city, namely, Jiangsu, Zhejiang province and the city of Shanghai. The Jiang-Zhe Net Domestic Product (NDP) is the summation of all 13 sectors' net value added. As Liu and Yeh's estimation of Chinese GDP conducted in 1965 is much more consistent in terms of theoretical framework and price and quantity information, I use their national GDP figure and NVAs for all the 13 sectors. My contribution here, as shown in the Appendix, is to derive the GVO ratio of Jiang-Zhe for China. For that, I make use of the rich regional-level data from Ou et al. as well as other available sources as detailed in the Appendix.[22]

Table 2 presents my estimate of the Jiang-Zhe NDP for the 1930s with a detailed breakdown of all 13 sectors. The details of data sources and calculations are reported in the Appendix. Of the 13 sectors estimated, the coverage of products for agriculture in this study is 67 percent of the total, 60 percent for handicrafts, and 100 percent for modern

[20] Ou et al., *Zhongguo Guomin Suode*; and Li and Yeh, *Economy*. There are other GDP estimates for the 1880s, the 1910s, and 1946. They rely heavily on backward or forward projection from the 1933 benchmark estimate. For the 1880s, 1910s, and 1946 GDP estimates, see respectively, Chang Chungli, *Income*, appendix; Yeh, "China's National Income"; and Ou et al., *Zhongguo Guomin Suode*.

[21] This formula implicitly assumes the ratio of GVOs between China and Jiang-Zhe are equal to the ratio of NVD, an assumption that could introduce upward bias in the Jiang-Zhe aggregate NVA estimate given that Jiang-Zhe's NVD to output ratio was likely lower than that of China. However, this bias is likely to be insignificant. We can illustrate with an example of Japanese and Chinese agriculture in the 1930s, whose NVD-output ratios are about 0.84 and 0.9 respectively. See Ohkawa and Shinohara, *Japanese Economic Growth*, p. 290; and Liu and Yeh, *Economy*, p. 140. Applying the Chinese ratio of 0.9 ratio to both countries, only leads to an upward bias of only 0.7 percent for the agricultural NVD for Japan.

[22] Both Liu and Yeh and Ou et al. consistently included the whole of China by adding the regional figures for Japanese-controlled Manchuria where necessary. In cases where regional data other than those Ou et al.'s are used, I have made similar adjustments to ensure geographic consistency. For example, for sectors such as agriculture and modern industry, I have added the Manchuria data into the national total as explained in the Appendix.

TABLE 2
NET DOMESTIC PRODUCT BY SECTOR OF ORIGIN FOR CHINA AND THE JIANG-ZHE PROVINCES IN 1933
(in billion yuans)

	Net Value Added		
	China	Jiang-Zhe Provinces	Jiang-Zhe Share (percent)
Agriculture	18.76	2.81	15
Factories	0.64	0.37	57
Handicrafts	2.04	0.41	20
Mining	0.21	0	Negligible
Utilities	0.13	0.059	45
Construction	0.34	0.1	30
Modern transportation and communication	0.43	0.09	21
Old-fashioned transportation	1.2	0.29	24
Trade	2.71	0.76	28
Government administration	0.82	0.1	12
Finance	0.21	0.14	65
Personal services	0.34	0.082	24
Residential rents	1.03	0.25	24
Net domestic product	28.86	5.45	19
Per capita NNP (yuan)	57.36	88.92	155
Population (millions)	503.1	60.4	12
Land area (million square kms)	966	21	2
Cultivated area (million shi mou)	1,543	143	9.3

Sources: See the Appendix. Population for Jiangsu, Zhejiang, and Shanghai were 34.9, 22, and 3.5 million respectively. See Liu and Yeh, *Economy*, pp. 178–79; and Murphey, *Shanghai*, p. 22. Cultivated acreages for China, Jiangsu, Zhejiang were 1,534, 92 and 51 millions respectively, see Liu and Yeh, *Economy*, p. 129. Land area is from the China State Statistical Bureau cited in Maddison, *Chinese Economic Performance*, p. 181.

industry. As usual, data for service sectors are more problematic. However, except for three sectors (less than 9 percent of the NDP), which were guess-estimated from crude assumptions, all other sectors are supported by some form of regional data.

Table 2 shows that in 1933 the Jiang-Zhe provinces, with a 12 percent share of the Chinese population, contributed 15 percent of agriculture, 20 percent of handicrafts, 57 percent of modern factory output, 65 percent of finance and 45 percent of modern utilities services. Taken together the Jiang-Zhe provinces had 19 percent of China's NDP, with a per capita NDP 1.55 times the national average. Output produced by modern factories had a much larger impact in Jiang-Zhe, reaching 7 percent of NDP versus only 2 percent for China. The share of modern-factory in total manufacturing output (including both factory and traditional handicraft production) was 47 percent for Jiang-Zhe versus only

24 percent for China. This ratio likely puts Jiang-Zhe on about the same level as Japan in the 1900s or the 1910s.[23]

Rawski's unpublished manuscript also offers a GDP estimate for what he defines as the "Lower Yangzi Core" in the 1930s. His per capita income estimate for the core is only 37 percent above the national average, lower than my 55 percent. His "Lower Yangzi Core" has a 7.8 percent share of China's population compared to 12 percent for Jiang-Zhe. As Rawski's manuscript does not present details of geographic definition or data sources, it is hard to pinpoint the sources of discrepancy. My crude guess is that there are differences in geographic coverage and possible underestimation of agricultural and handicraft sectors in his estimates.[24]

Growth and Structural Change

Rawski's 1989 book, *Economic Growth in Prewar China*, provides a most comprehensive reassessment of Chinese economic growth during the Republican era and derives a new estimate of national per capita income growth rate of 1.1–1.2 percent, not much below the Japanese rate of growth of about 1.4 percent between the 1910s and 1930s. This is a remarkably optimistic assessment compared with earlier estimates of annual growth rate of per capita GDP at 0.33 percent for this period.[25] As there is no 1914–1918 benchmark GDP data for China. Rawski, following Yeh Kung-chia, use sectoral series of real growth rates to derive the real GDP growth rates between 1914–1918 and 1931–1936.

Given the small share of the fastest growing modern sectors, Rawski's upward revision of per capita Chinese GDP growth rate between 1914–1918 and 1931–1936 from Yeh's 0.33 percent to 1.1–1.2 percent hinges on a reassessment of the agricultural sector, which accounted for more than 60 percent of GDP. In the absence of reliable agricultural output data for 1914–1918, Rawski uses the growth rate of several scattered series of agricultural real wages to derive his real per capita agricultural output series between the 1910s and 1930s. The annual 1.4–1.7 percent growth in per capita agricultural output thus derived raises his overall 1930s Chinese per-capita income estimate 16 percent above that of Liu

[23] Factory output accounted for only 4 percent and 6 percent of Japanese NDP in 1885 and 1900 respectively. The factory to manufacturing output ratio was 41.2 percent in 1895. Because the Japanese definition of factory (enterprises with five or more employees) is broader than the Chinese definition (enterprises with 30 or more employees), the Japanese ratio should be adjusted downward to be comparable. See Ohkawa and Rosovsky, *Japanese Economic Growth*, pp. 15 and 80–82.

[24] See Rawski, "Economy," p. 68 for his estimate.

[25] See Rawski, *Economic Growth*, p. 330; and Yeh, "China's National Income," p. 120.

and Yeh's original estimate. Without this upward revision in agricultural output, Rawski's revised per-capita income would only be 6 percent higher than the Liu and Yeh estimate and the annual GDP per capita growth rate between the 1910s and 1930s would decrease to 0.5 percent, not that different from the original 0.33 percent rate by Yeh.[26]

Here, I establish a case of regional economic growth without such "aggressive" assumptions about agricultural performance. Given there are no sectoral growth rates for Jiang-Zhe provinces during this period, I use the same rates for China established by Rawski except for agriculture, where I use Yeh's original rate of 0.8 percent. Because Jiang-Zhe is likely to grow faster at the sectoral level than China, the assumption of equal rates for the two establishes a lower-bound estimate for Jiang-Zhe GDP growth rates between the 1910s and 1930s, with differences in growth rates between Jiang-Zhe and China driven entirely by their different sectoral weights.

Table 3 shows that annual per capita NDP growth in both Jiang-Zhe provinces, at 1 percent, were roughly double that of China and almost matched those of Japan and her colonies during this period. So, even in the absence of the "Rawskian" type of upward revision in agricultural output growth, the growth rate in per capita terms in Jiang-Zhe—not China—had already achieved rates comparable to those of her East Asian neighbors. If we apply Rawski's revised agricultural growth rate of 1.55 percent rather than the original 0.8 percent used by Yeh and hold everything else the same, the overall Chinese per capita GDP between 1914–1918 and 1931–1936 is raised to 1 percent per year, and the Jiang-Zhe per capita GDP growth rate attains 1.4 percent, giving the region one of the highest growth records in East Asia for the period.[27] In either scenario, the case for regional growth can be established beyond dispute.

The case for regional growth can be further strengthened if we compare the growth rate in Jiang-Zhe with the rest of China excluding Jiang-Zhe and Manchuria. With an overall Chinese per capita growth rate of 0.53 between the 1910s and 1930s, and assuming a combined annual per capita growth rate of 1 percent for Jiang-Zhe and Manchuria with a total of 25 percent share in overall Chinese GDP, the annual per capita GDP rate of growth for the rest of China (excluding Jiang-Zhe and Manchuria) will be 0.37. This is just about a third of the growth rate of Jiang-Zhe in this Republican era, a finding that confirms Rawski's observation that "regional growth in Manchuria, . . . and probably in the

[26] See Rawski, *Economic Growth*, pp. 280–337.

[27] It is important to note that as population growth rates in Japan and her colonies were higher than that of Jiang-zhe and China for this period, the gap in total output growth remains despite the comparable per capita rates as shown in Table 3.

TABLE 3
PER CAPITA NDP AND NDP COMPOSITION IN EAST ASIA IN 1914–1918 AND 1931–1936
(1930s Chinese Yuan)

	China	Jiang-Zhe Provinces	Lower Yangzi Macro-Region	Japan	Taiwan	Korea	Manchuria
			1914–1918				
Per Capita NDP	52.4	75.2	83.2	161	102	64	
As percentage of China	100	143	159	305	195	122	
NDP Composition (in %)							
Agriculture	71	60	57	29	48	66	
Industry	8	10	11	20	29	7	
Services	21	30	32	51	23	24	
			1931–1936				
Per Capita NDP	57.4	88.9	100	203	132	77	69
As percentage of China	100	155	174	354	230	134	120
NDP Composition (in %)							
Agriculture	65	52	47	19	44	53	36
Industry	10	14	16	28	27	13	20
Services	25	34	37	53	29	34	44
Annual per capita NDP growth rate between 1914–1918 and 1931–1936	0.53	1.0	1.1	1.4	1.5	1.1	
Population (million) in 1931–1936	503.1	60.4	44.7	67.2	5.1	21.2	38.7

Source Notes: The averages of NDP (all in 1934–1936 constant prices) and population in 1914–1918 and 1931–1936 for Japan, Taiwan, and Korea are calculated from Mizoguchi and Umemura, *Basic Economic Statistics*, pp. 228–29, 232–33, and 236–37, respectively.

"Industry" includes factory, handicrafts, and mining. "Services" include sectors other than agriculture and industry.

Growth rates used for the 13 sectors (except for agriculture) to project the 1931–1936 China and Jiang-Zhe series backward to the 1914–1918 are from Rawski, *Economic Growth*, p. 274. They are 0.8, 8.1, 8.1, 8.1, 1.4, 4.6, 3, 1.9, 2.5, 5, 3.4, 0.9, and 0.8 percent respectively for agriculture, modern factory, mining, utilities, handicrafts, construction, modern transportation and communication, traditional transportation and communication, trade, finance, government administration, personal services, and residential rents.

Population figures for China and Jiang-Zhe provinces in 1914–1918 are 440 and 54.1 million, respectively. China's 440 million population in 1914–1918 is from Yeh, "China's National Income," p. 104. The population figures for Jiangsu and Zhejiang provinces are 33.7 and 19.2 million, respectively, from Perkins, *Agricultural Development*, p. 212. Adding the 1.2 million Shanghai population sums to 54.1 million for Jiang-Zhe (Shanghai population is from Murphey, *Shanghai*, p. 23).

The Lower Yangzi Macro-Region per capita income can be calculated as: $Y_{LY} = (Y_{JZ} - Y_C \times P_{EX}) \div P_{LY}$; where Y_{LY}, Y_{JZ} and Y_C stand for the per capita incomes of the Lower Yangzi Macro-Region, Jiang-Zhe, and China respectively, and P_{LY} and P_{EX} denote the respective population shares of the Lower Yangzi Macro-Region and the remaining four prefectures in Jiang-Zhe provinces. The prefectural-level data in 1910 is from Chao Suji, *Zhongguo Renkoushi*, vol. 5, pp. 691–92, which shows that population in the Lower Yangzi Region had a share of 74 percent of the Jiang-Zhe provinces. The same 74 percent is applied to calculate the 1931–1936 population of the Lower Yangzi Macro-Region.

TABLE 3 — continued

Manchuria (for 1934) is from Eckstein, Chao, and Chang, "Economic Development," pp. 254–55. These estimates of per capita income are consistent with more recent work by Yamamoto Yuzou, *Nihon Shokuminchi*, p. 116.

The exchange rate is equal to 1 yuan = 1.1 yen calculated as the average of 1933–1936 from Hsiao, *China's Foreign Trade Statistics*, p. 192.

Lower Yangtze areas of China may have progressed more rapidly than the national average, thus ensuring that other regions experienced below average, and possibly negative, growth."[28]

Table 3 also confirms that the absolute level of per-capita income in Jiang-Zhe based on 1930 exchange-rate conversions was higher than those of Korea and Manchuria, ranking third only after Japan and Taiwan in the 1930s.[29] It shows the economic structures of the Jiang-Zhe in 1914–1918 and 1931–1936 were characterized by shares in industry and service sectors much higher than those that defined the primarily agrarian China. With a population almost the size of Japan's and more than ten times that of Taiwan in the 1930s, Jiang-Zhe was clearly the second largest industrial region in East Asia (perhaps Asia).

Table 3 shows the per capita GDP estimate of the Lower Yangzi Macro-Region (see Figure 1), calculated assuming that the per-capita income of the four prefectures outside the "Macro-Region" but within Jiang-Zhe were equal to China's national average (including that of the Jiang-Zhe Provinces). This calculation shows that the per capita income for the Lower Yangzi Macro-Region in 1933 at 1.74 times the level of China, with an economic structure even further "advanced" than China and Jiang-Zhe.

Any causal statements linking these growth figures to human welfare should hinge on further research on consumption expenditure and income distribution. Existing studies based on household income and consumption surveys conducted during the 1920s and 1930s seem to point to higher household income and consumption standards in Shanghai than in other urban centers outside the Lower Yangzi. Some other surveys conducted for rural households also seem to point to similarly higher levels in Jiang-Zhe than in other parts of China. However, without careful control for differences in sampling methods and regional price effects, these findings only remain very tentative support for the outcome of my production-based study.[30]

[28] See Rawski, *Economic Growth*, p. 271.

[29] For the conversion of per capita incomes based on purchasing power parity (PPP) for China, Japan, Korea, and Taiwan relative to the United States in the 1930s, see Fukao, Ma, and Yuan, "Real GDP."

[30] For the higher household income and consumption levels of Shanghai urban working families, see Yang Ximeng, "Shanghai," pp. 358–59. Yan xinzhe, *Nongcun*, shows that average household income in and around the Lower Yangzi was roughly 1.45 times that of rural households in North China, pp. 146–47.

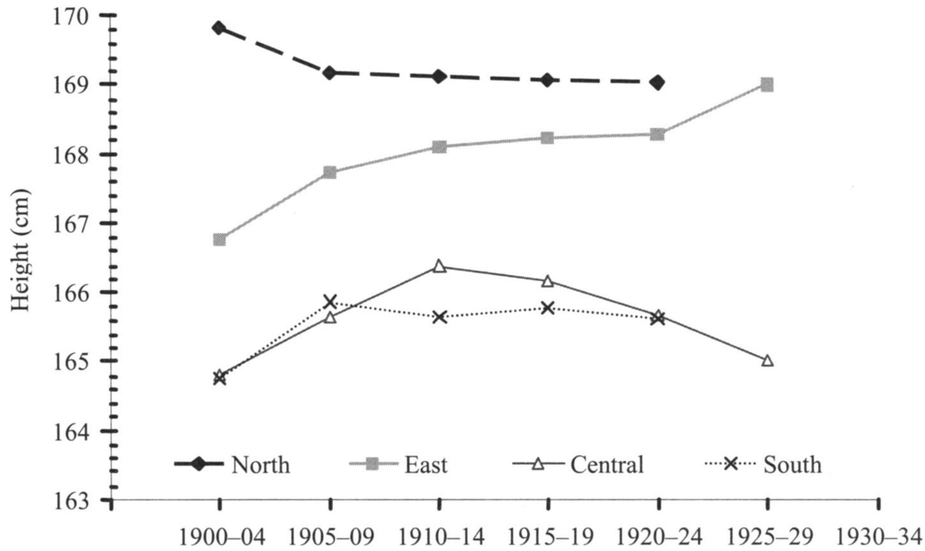

FIGURE 2
ESTIMATE AVERAGE TREND IN ADULT HEIGHT BY REGION, 1900–1929

Source: Adapted from Morgan, "Economic Growth," figure 6. For regional classifications, see ibid., table 3.

Recent anthropometric research by Stephen Morgan seems more definitive. Analyzing thousands of height records of railway employees across China, Morgan concludes that from the last years of the nineteenth century to the second half of the 1920s, the average male stature in China increased 0.25cm per decade but grew by 0.7cm per decade in Jiang-Zhe provinces. This 0.7 cm per decade height increase is only slightly lower than the 0.91 cm per decade increase for Japan between 1892 and 1937. In fact, Morgan's regional figure for railway skilled workers, reproduced here in Figure 2 shows that only the average height of Jiang-Zhe subjects (classified by Morgan as "East" in the figure) shows a consistent upward trend, while average heights in North China, Central China, and South China either stagnated or fluctuated between 1900 and 1929. This evidence leads him to conclude a spatially differentiated and uneven pattern of economic growth, a finding that lends strong support to this study.[31]

[31] See Morgan, "Economic Growth," figure 6 and concluding statement. Morgan's classification of regions roughly corresponds to that of Skinner. I thank Stephen Morgan for providing me the heights data for Figure 2. For Japanese height data, see Ted Shay, "Level." Morgan and Liu, "Was Japanese Colonialism," shows a secular increase of 1.12 cm per decade in Taiwan during the Japanese colonial period. However, Mituhiko Kimura's "Standards of Living" shows that the height increase in Korea remained dubious despite the increase in per capita GDP in the colonial period.

LOWER YANGZI ECONOMIC GROWTH IN HISTORICAL PERSPECTIVE

Political Change and Industrial Development

The distinctively regional nature of economic growth in the early twentieth century raises some large questions germane to the historical origin and pattern of modern economic growth in China and East Asia. In fact, compared with Japan, a growth spurt that came nearly four decades after China's encounter with Western Imperialism around the mid-nineteenth century seems less like a miracle than a puzzle. The contrast is particularly puzzling given the emergence of Chinese mercantile dominance across regions of East and Southeast Asia after the mid-nineteenth century under a free-trade regime imposed by Western imperialism. In particular, Shanghai, as a newly opened treaty port, rapidly emerged as the node of a vast trading network that enveloped, among others, the Japanese treaty ports of Yokohama and Kobe. In fact, the dominance and solidarity of the Chinese merchant network throughout Asia posed a challenge to the young Meiji government as formidable as its agenda of catching-up with the West.[32] To tackle the puzzle of Chinese industrialization in nineteenth-century China, I turn to a brief review of the economic policy contrasts between China and Japan.

In Japan, the new Meiji leaders who came to power in 1868 embarked on a comprehensive reform program to forge a modern nation-state modeled after the West. Although the Meiji government initially engaged in a series of government-sponsored enterprises, their liquidation by the 1880s signaled a decisive switch of its policy away from direct engagements towards indirect support for the private sector. The government engaged in the building-up of critical public infrastructure such as railroads and telegraphs, the establishment of a modern education system, the drafting of the commercial code in the 1880s, and the founding of the Bank of Japan in 1882. The 1880s marked the beginning of Japan's full-scale industrialization.[33]

In comparison, the late-Qing government in China under the era of Tongzhi Restoration (1862–1874) aimed to restore the traditional economy from the Taiping devastation. The limited reform carried out under the banner of the Self-Strengthening Movement (1860–1894) erected a series of government-financed or controlled Western-style, capital-

[32] See Furuta, "Kobe"; and Sugihara, *Japan*, p. 6.

[33] See Smith, *Political Change*, and Ishii, *Nihon*. During the Meiji period, Japanese per capita GDP grew at an annual 2.25 percent between 1887 and 1897, raising her share of manufacturing and mining in total GDP rising from 8.7 percent to 11 percent and 16 percent respectively during the same period, see Ohkawa, *Growth Rate*, p. 278.

intensive industrial and military enterprises in a largely agrarian setting. While these high-profile government-sponsored enterprises were fraught with corruption and inefficiencies, the much more deleterious impact of late-Qing economic structure fell on the development of a modern private sector.[34]

Detailed case studies reveal that attempts to set up modern factories in sectors such as cotton and silk (that were to form the core of early-twentieth-century industrialization) met serious resistance even within the treaty port. Similar obstacles confronted the building of key public infrastructures such as modern railroads and steam shipping in inland waters in the nineteenth century.[35] This critical policy difference towards private sector and public infrastructure held the key to explaining the divergent paths of industrialization between China and Japan.[36]

The 1894–1896 naval confrontation between China and Japan became a turning point when the fruits of these two modernization programs were put to test. The much bigger guns and battleships of the Chinese Northern Fleet built under the Self-Strengthening Movement suffered humiliating loss at the hands of a smaller but more disciplined Japanese navy, supported by a modern economic infrastructure built up during the Meiji era: railroads and steam ships that mobilized troops, a banking system and a bond market that supported war finance.[37]

China's defeat by a nation long regarded as her former student brought a profound mental shock, which spelled the end of the Self-Strengthening Movement and opened the path towards the late-Qing constitutional reform in 1903–1911 modeled directly on Japan's Meiji reform.[38] The constitutional reform recognized the centrality of the private sector to a market economy and paved the way for the introduction of modern public

[34] For the Tongzhi Restoration, see Mary Wright, *Last Stand.* For the Self-Strengthening Movement, see chapters 9 and 10 in Fairbank, ed., *Cambridge History of China,* vol. 10.

[35] The obstacles to Chinese industrialization are multi-fold. One mechanism of these obstacles works through a merchant-bureaucratic power nexus strengthened by the imposition of *likin* tax—a form of domestic transit tax levied in the wake of the Taiping rebellion. The government's need for tax revenue but inability to collect gave rise to tax farming controlled by the merchant guilds. Modern private industrial enterprises faced fierce opposition from both the local guilds and government. These oppositions also threatened modern Chinese enterprises often falsely registered under Western ownership and located within the treaty port, as by treaty regulations, Western business were only allowed to set up commercial establishments but not manufacturing enterprises. See Suzuki, *Yomu Undou*; Motono, *Conflict*; and Debin Ma, "Between Cottage."

[36] This is a point emphatically made by scholars on modern Japan. See Ishii, *Nihon*, chapter 2; Suzuki, *Yomu Undou*, introduction; and Smith, *Political Change*, p. 23.

[37] For the Japanese economic infrastructure for war support, see Ishii, *Nihon*, pp. 99–108.

[38] Military and strategic blunders rather than economic strengths may have accounted for the outcome of the naval warfare. For an argument that China's military defeat led to an excessively negative assessment of the Self-Strengthening Movement and construction of Chinese backwardness, see Benjamin Elman, *On Their Own Terms*, pp. 379–82 and 392–93.

infrastructure.[39] But the immediate economic impact of the defeat was the signing of the treaty of Shimonoseki in 1896 that granted foreigners the right to establish factories in the treaty port, lifting the floodgate of foreign direct investment in China and indirectly legitimizing Chinese modern enterprises. These dramatic turns of events around the turn of the century set off the first major wave of Chinese industrialization.

The Late-Qing constitutional reform was as short-lived as the final years of the empire, which collapsed in 1911. The new Republican regime, following the death of its first dictatorial ruler, Yuan Shikai in 1916, was politically weak and fiscally insolvent. National disintegration and civil strife became the norm in the two decades of warlordism after 1916. According to James Sheridan, warlords often brought terror and exploitation. "[Their] demand for money was insatiable and the militarists wrung an astonishing array of taxes from the population. They printed worthless currency on a large scale. . . . In many areas, the actions of organized crimes were less serious than the hordes of uncontrolled soldiers who roamed the countryside preying on the peasantry."[40]

According to one estimate, there were some 140 wars fought among a total of more than 1,300 rival militarists between 1911 and 1928.[41] In the Lower Yangzi, the least war-torn area, the war between the rival Jiangsu and Zhejiang warlords in 1924 led to massive forced requisitioning of civilian personnel and services, confiscation of private properties, extortion of merchants and businesses, and severe disruptions of production and trade, inflicting total economic losses estimated between four and five hundred million yuan.[42]

The extent of warlord damage to the Chinese economy is disputed by Rawski who points to the limited scale and duration of warfare. Furthermore, there were enlightened and stable warlords such as Yan Xishan and Feng Yuxiang who promoted economic reforms in the territories under their rule. The logic of Chinese warlord politics inspired Mancur Olson's classic distinction between stationary bandits—those with long-tenure rule and thus less predatory—and roving bandits—those with short time horizon and consequently more destructive.[43] Overall, despite the reassessment of the warlord era, Rawski agrees that "political unrest and civil wars made any long-range investment extremely precarious."[44]

[39] See Douglas Reynolds, *China*; and William Kirby "China Unincorporated."
[40] Sheridan, "Warlord Era," p. 318.
[41] Phil Billingsley, *Bandits*, p. 24.
[42] Feng Youcai, *Zaishang*, p. 160.
[43] Olson, "Dictatorship," p. 568.
[44] See Rawski, *Economic Growth*, p. 47 and chapter 1, for his argument about local rulers often promoting economic development. Also see Sheridan, "Warlord Era" (p. 317, footnote 35) for a criticism of Rawski's assessment.

How did and could industrialization take root in an era of widespread abuse of property rights and pervasive political uncertainty during the Republican era? For that, we turn to a new political entity in the Lower Yangzi: the treaty port of Shanghai ruled by Western business elites.

The Rise of the City

Shanghai, once a market town peripheral to the city of Suzhou in the traditional Lower Yangzi, was opened as a designated treaty port in 1842. As a treaty port, Shanghai was under separate jurisdictions of British, French, and American Concessions as well as Chinese quarters. In 1863 the British concession merged with the American quarters to form the International Settlement for all Western (and later Japanese) residents. Following the massive influx of Chinese refugees during the Taiping rebellion, Chinese residents quickly formed the majority of the Settlement residents.

The Settlement operated with its own mini-Constitution: the Shanghai Land Regulations signed in 1854 and subsequently revised and approved in 1866. It organized a Municipal Council whose members were elected by the rate-payers association consisting of tax-paying Western and later Japanese residents in the Settlement. Judicial powers over foreign residents were, under the grant of extraterritoriality, vested in the Consular Courts of the foreigners concerned, or, in the case of unrepresented foreigners or Chinese, in the International Mixed Court. This institutional structure placed the Settlement on a foundation of limited power and rule of law.[45]

The Municipal Council levied land and property taxes and business license fees, ran its own prison and police squad with the additional support of a volunteer army in times of need. In comparison with the Chinese quarter governed by the local Qing government, the business-dominated council was far more efficient in the provision of public goods (or semi-public goods) including the maintenance and improvement of city roads, transportation and communication infrastructures, public utilities, and port facilities.[46]

[45] The Municipal Council had a right to sue in these courts, and could in turn be sued in a court elected from the Consuls of the Treaty Powers, known as the Court of Consuls. As a general rule, the council could make no arrests except on a warrant from the proper court. See Pott, *Short History*, p. 114; and Yang, Xiangjun, *Diguo*, chapter 2.

[46] In 1926 the military warlord governing the Jiangsu province Sun Chuan-fang remarked: ". . . whenever I come to a treaty port I feel thoroughly humiliated, not only because a treaty port is a standing reminder of our loss of sovereignty, but also because whenever we pass from the concessions into Chinese territory we feel that we are crossing into a different world—the former is the upper and the latter is the under-world, for nothing in the Chinese territory—roads,

This governance structure of the Settlement is reminiscent of the Medieval European political tradition where incorporated urban communities practiced self-rule under merchant elites or oligarchies often with charters granted by larger territorial rulers. From its very early days, the Western merchant elites of the Settlement had desired and fought for self-rule. This is an institutional feature that distinguished the Settlement from most other treaty ports in China or even the neighboring French Concession, which had been under the administrative rule of the French consular officials appointed from Paris.[47]

In the wake of the dynastic collapse in China in 1911, the International Settlement and the French Concession realized their greatest territorial expansion to reach 33 square kilometers, 1.5 times the total size of foreign concessions in the other 23 treaty ports in China.[48] When the Qing magistrate in Shanghai absconded—allegedly with public funds—during the 1911 revolution, the International Settlement took over the Mixed Court and began to appoint its own Chinese personnel. By then, the Settlement became a de-facto city-state with full territorial jurisdiction over its residents, Western and Chinese. This is the second institutional feature that set it apart from the rest of foreign concessions in China.

Thomas Stephens's study of the Mixed Court in 1911–1925 led him to emphatically state that "throughout all the political vicissitudes of the Yuan Shikai era . . . , throughout all the marching and countermarching of the armies of the warlords and their murdering marauding hordes, . . . Shanghai became an oasis of peace, order and good government in a China torn into convulsions by revolution, banditry and civil war."[49] The 1911–1925 period saw the transformation of Shanghai into a truly industrial city and ushered in what Marie-Claire Bergere hailed as the golden age of Chinese bourgeoisie.[50]

---

buildings, or public health—can be compared with the concessions. . . ." quoted in Feetham, *Report*, vol. 1, p. 242.

[47] Needless to say, the International Settlement was never officially recognized as an independent political entity by the Chinese government. For a recent exposition of the city-state tradition in Western Europe, see S. R. Epstein, *Freedom*. For the difference between the International Settlement and French Concession political systems, see Marie-Claire Bergere, *Shanghai*, chapter 5.

[48] See Fei Chenkang, *Zhongguo*; and Bergere, *Shanghai*, p. 96.

[49] Stephens, *Order*, pp. 104–06

[50] For the role of the Mixed Court in the 1916 Bank note suspension incident, which was a turning point when Shanghai emerged as China's sole financial center, see Chen, *Banking*, pp. 53–59. For the new generation of Chinese industrial entrepreneurs in cotton textiles, flour milling, matches, tobacco, machinery, and large-scale retail, see Bergere, *Shanghai*. Chinese ownership share of modern industry was consistently higher than that of the foreigners in major sectors in Shanghai throughout the 1910s-1930s. This compares favorably with the share of indigenous entrepreneurship in Taiwan and Korea, or Manchuria under Japanese colonialism. Compare Xu and Huang, *Shanghai*, p. 341; with Mizoguchi and Umemura, *Basic*, p. 77.

But beyond security and order, the institutional model of the International Settlement had exerted a profound and lasting impact on political organization, legal regime of property rights and contract enforcement, fiscal structure, and civil society. It laid the political foundation for a legendary Shanghai style of freewheeling capitalism characterized by free trade, free capital, and banking with a small government but a large civil society.[51] The historical significance of the International Settlement is eloquently captured by Justice Richard Feetham, the judge called upon to review the legal status of the Settlement in the 1930s:

> The great piles of banks, offices and warehouses along the Bund [the financial hub of Shanghai], as seen from the deck of an ocean liner steaming up the river, are at once recognized by the newcomer as evidence of the wealth and enterprise of Shanghai, and of the belief which its merchants and citizens have in its future. But they have a deeper economic significance than this; they are the first conspicuous signs and symbols of the sanctity of the rights of private property, as recognized and safeguarded in the [International] Settlement, and of the far-reaching confidence which this condition of things has inspired.[52]

The political power of the city-state spread beyond the Settlement. In the warlord era, the political structure of Western Shanghai uniquely empowered the Chinese business class to defy the political center and wring concessions of peace from the warlord governments. The Lower Yangzi became the least war-torn region in China—avoiding major battles at least before 1924—partly thanks to the political mobilization of the Shanghai General Chamber of Commerce, the majority of the members of which were Jiang-Zhe natives with a huge stake in the region's peace and order. The Shanghai capitalists also forged an intricate and sometimes treacherous alliance with the new Nationalist regime that founded its capital in Nanjing (Jiangsu province) in 1927. The city, especially its Chinese financial elites, helped shape the new empire—the Nationalist regime—in the formulation of a comprehensive national economic policy which included the restoration of tariff autonomy, modernization of China's public finance and monetary regime.[53]

[51] For a discussion and literature on the institutional influence of the International Settlement on China and Lower Yangzi, see Debin Ma, "Shanghai-based Industrialization." See Ramon Myers, *Chinese Economy*, pp. 138–40, for an argument linking the role of treaty ports (or what he termed as mini-Hong Kongs) as centers of free trade and finance to promote national growth in the Republican era.

[52] Richard Feetham, *Report*, vol. 1, p. 317.

[53] See Feng, *Zaishan*, pp. 136–39 for the role of Shanghai capitalists in the Warlord Era. For the political alliances between the Shanghai capitalists and the Jiang regime and various fiscal extortion and state coercion under the Jiang regime, see Coble, *Shanghai Capitalists*; Bergere, *Shanghai*, pp. 181–82; and Kirby, "China Unincorporated," p. 51. For a recent positive assessment of the National government's tariff policy, see Toru Kubo, *Sankanki Chuugoku*.

The Epilogue

The flowering of a European city-state in the middle of twentieth-century China was fraught with historical irony and institutional contradiction. The Municipal Council's systematic practice of political exclusion and racial discrimination had turned Shanghai into a symbol of national humiliation. The co-existence of three separate jurisdictions in a tight and open space created a fertile ground for political agitation and organized crime.[54] The political autonomy of colonial Shanghai was swept away by the full-scale Japanese invasion in 1941, followed by the arrival of the Communist troops in 1949, which returned China to international isolation.

Shanghai capitalists' massive exodus to colonial Hong Kong, brought that city capital, industrial skills, entrepreneurial vision, and (as recognized by the Hong Kong government) a 10–15 year head-start in industrialization over many other Asian countries.[55] China's emergence out of isolation in the late 1970s saw the resurgence of Shanghai and the Lower Yangzi. Although economic growth during China's reform era occurred in a different institutional context, a historical shadow of old Shanghai capitalism loomed in contemporary Chinese reform: the increased role of foreign direct investment, the policy experimentation with "special economic zones," and the preservation of Hong Kong's autonomy under the "one country two systems" framework.[56]

Table 4 links my 1910s and 1930s regional per capita GDP to the post–World War II data in a comparative East Asian framework (with the usual caveats against the hazards of cross-country comparison). Note that the relative rankings of per capita income in 1952 largely mirrored those of the 1930s (with Northeast China, formerly Manchuria, being the only exception).[57] While the gap between Jiang-Zhe and China remains unchanged in 1978, China's overall standing in per capita GDP had fallen far behind those market economies of her East Asian neighbors after two decades of isolation and command economies. Two

[54] The property requirement for voting rights ruled out 80 and 90 percent of the Western residents, leaving the Municipal Council in the hands of a tiny and powerful business elite, dubbed as the "Taipan Oligarchy" (see Bergere, *Shanghai*, p. 98). The council refused, until 1928, any representation of Chinese residents, who constituted 96 percent of the population and were the largest tax revenue contributors in 1925, and denied Chinese residents access to Municipal facilities such as "public parks" (see Feetham, *Report*, vol. 1, pp. 138–46). For the presence of labor strikes and violent protests in Shanghai, see Wakeman and Yeh, *Shanghai Sojourners*. See Brian Martin, *Shanghai Green Gang*, on organized mafia.

[55] Wong Siu-lun, *Emigrant Entrepreneurs*, p. 2.

[56] For the resurrection of old Shanghai capitalists in the late 1970s, see Bergere, *Shanghai*, chapter 14.

[57] For the legacy of the pre-Communist industrial sector in Shanghai and Manchuria, see Rawski, "China's Industrial Performance."

TABLE 4
RELATIVE PER-CAPITA GDP IN CHINA AND EAST ASIA
(China = 100)

	Jiang-Zhe Provinces	Japan	Taiwan	Korea (South Korea)	Manchuria (Northeast China Provinces)
1916	143	305	195	122	
1933	155	354	230	134	120
1952	158	436	198	140	192
1978	161	1,285	571	415	149
1999	200	633	483	397	127
2005	206	401	347	313	114

Sources: Data for Japan, Taiwan, and South Korea in 1952–2005 are from Groningen Growth Center website (http://www.ggdc.net/homeggdc.html). The regional per capita income differences for 1999 and 2005 are calculated from relevant annual issues of *China Statistical Yearbook*. The data for China in 1952 and 1978 are from *Xin Zhongguo Wusenian* by the State Statistical Bureau.

decades of opening-up and reform enable a significant catch-up of China and especially Jiang-Zhe with her East Asian neighbors. Meanwhile, with the resurgence of Shanghai along with China's increasing regional inequality, the economic distance between Jiang-Zhe and the rest of the nation attained a ratio of over two by 1999 and 2005, a historical high.

CONCLUSION

Through the reconstruction of a regional prewar GDP estimate and its growth dynamics, this article establishes the case for regional growth concentrated in the Lower Yangzi area and a major reinterpretation of the extent and nature of Chinese economic growth between the 1910s and the 1930s. The narrative structures this growth in the larger historical context and highlights political and institutional changes as the most important determinants to both the timing and pattern of industrialization in China and East Asia during the late nineteenth through early twentieth centuries. In particular, it emphasizes the importance of a new political entity, the International Settlement in Shanghai, that supplied public order and protected private property rights in an era of national disintegration and civil strife. The political structure of a city-state forged a legendary Shanghai style of freewheeling capitalism, a model that stood apart from the acclaimed East Asian model of state-led industrialization in postwar Japan and Korea. Nonetheless, weighed down by its colonial stigma and narrow interest, the city-state model of the Shanghai International Settlement is neither sustainable nor replicable.

The tortuous path of Chinese industrialization in the nineteenth through twentieth centuries questions the fundamental compatibility of its traditional institutions with modern economic growth. While this call forth a larger research agenda, this article draws attention to potential methodological problems inherent in comparative studies that pair economic regions with independent nation states. Situated within the political structure of a centralized empire, economic regions such as the Lower Yangzi encountered constraints to institutional change far more severe than would independent nation-states such as Britain or Japan. As shown above, the rise of Shanghai first as a trading port in the latter half of the nineteenth century and then as an industrial metropolis was largely determined in the large context of political changes in the Chinese empire. Within China's centralized power structure, elements for change from the bottom were perennially short of political space and often survived precariously at the empire's fringe. It is no surprise that institutional breakthroughs in modern East Asia came from new political structures created outside the empire: the rise of a nation-state of Meiji Japan after 1868 and the formation of a breakaway city of Shanghai after the turn of the twentieth century.

The lessons on the diffusion of the Industrial Revolution in East Asia also shed light on the ongoing debate on the origin of the Industrial Revolution. The absence of coal deposits in the Lower Yangzi, as emphasized by Pomeranz for the eighteenth century, did not become a major constraint to Shanghai-based industrialization. Shanghai industrialization, as noted by Rhodes Murphey, was an anomaly by Western standards, characterized by a local absence of most of the essential materials for manufacturing, especially coal. In the mid-nineteenth century when the city was opened as a treaty port, coal arrived from faraway England, then from Japan during the late nineteenth century, and finally from North China in the twentieth century following the completion of railroads.[58]

Similarly, the much-written-about favorable geography of Shanghai—its central position on the coast of East Asia and the Lower Yangzi hinterland—seems more the endogenous outcome of geopolitical changes as acutely observed by one Chinese resident of the International Settlement:

> That this place was chosen as the "Settlement" precisely shows these (Western) barbarians have a vision. It is a global vision. Within the shooting range of (Western) military gunboats on the Huangpu river, the Settlement came under

[58] See Murphey, *Shanghai*, pp. 184–95. For discussion of the lack of coal deposits in the Lower Yangzi, see Pomeranz, *Great Divergence*, pp. 64–65.

effective (Western) naval protection. . . . From a closed perspective, this is a piece of muddy swamp with little value other than some defense against enemies from outside the city wall. But from an open perspective, this is the point of entry to China's richest region and the departure to the world.[59]

Appendix: Net Domestic Product by Sector of Origin for China and the Jiang-Zhe Provinces in 1933

AGRICULTURE

The agricultural share of the Jiang-Zhe province is calculated through two steps. The first step is to use the provincial level data (1931–1937 averages) in the *Crop Reports* published by the National Agricultural Research Bureau (NARB) added with the Manchurian output data to calculate the Jiang-Zhe share in physical units for each commodity. The results are presented in columns A through E of Appendix Table 1. The second step is to multiply the 1933 unit prices of each agricultural commodity by the 1933 agricultural output in physical units to arrive at a total agricultural gross value for China. This Chinese agricultural output value is then multiplied by the Jiang-Zhe share to arrive at the Jiang-Zhe agricultural gross output value in column C. The final share of Jiang-Zhe provinces in agricultural value-added is then calculated as the ratio of Jiang-Zhe gross value to that of China shown as 0.148 in column H.

Note that the Jiang-Zhe share in physical output units is calculated based on the 1931–1937 averages, but the Jiang-zhe share in gross value for 1933 is based on Liu and Yeh price and output data, *Economy*, p. 140. Their gross value for Chinese agriculture in 1933 amounts to 21,170 million yuan (p. 140). Because the gross value of Chinese agricultural products covered in this study sums to 14,110.77 million yuan (column F), this indicates the coverage of products included in this study amounts to 67 percent of the total agricultural gross output for China.

MODERN FACTORY

The coverage of modern factory output is the most complete thanks to the 1933 survey conducted under the able leadership of D. K. Lieu. However, the survey covered only the so-called "China Proper," which is equivalent to the current Chinese territory but without the Japanese-controlled Manchuria, roughly equivalent to today's Northeast provinces of Heilongjiang, Changchun, and Jilin. From Appendix Table 2, I derive the Jiang-Zhe Share of China Proper as 0.663. Then I calculate the Japanese controlled Manchuria share of 0.166 in China Proper from Liu and Yeh's estimate. These two results enable me to calculate the Jiang-Zhe share of China total (including Manchuria) as 0.569.

A new estimate by Kubo and Makino gives a higher Manchuria share of China Proper's industrial output at 0.266 (table 13, p. 41). Using their estimates would have a negligible impact on my result (Jiang-Zhe share of modern industry would be 0.549

[59] Huangpu is the major river that crosses Shanghai. Translated from the quote in Yang Xiangjun, *Diguo*, p. 24. For discussion of the favorable geographic location of Shanghai and Lower Yangzi, see Murphey, *Shanghai*, pp. 2–6; and Rawski, "Economy," pp. 5–6.

APPENDIX TABLE 1
CHINESE AND JIANG-ZHE PROVINCIAL AGRICULTURAL GROSS OUTPUT (IN 1931–1937 AVERAGE) AND GROSS VALUE IN 1933 PRICE

	Jiangsu (1,000 piculs) A	Zhejiang (1,000 piculs) B	Jiang-Zhe Total C = A+B	China Total (1,000 piculs) D	Jiang-Zhe Share in Physical Quantities E = C/D	China Gross Value (million yuan) F	Jiang-Zhe Gross Value G=ExF	Jiang-Zhe Share in Gross Value H=G/F
Rice	132,000	98,000	230,000	1,553,200	0.148	5,436.2	805	
Wheat	59,802	10,579	70,381	447,410	0.157	2,403	378.01	
Barley	27,787	6,953	34,740	159,126	0.218	576.08	125.77	
Millet	3,194	501	3,695	136,090	0.027	916.92	24.90	
Corn	12,926	1,637	14,563	126,278	0.115	539.11	62.17	
Kaoliang	10,887	239	11,126	141,309	0.079	703.64	55.40	
Soybeans	22,651	3,382	26,033	123,395	0.211	921.57	194.43	
Broad beans	6,751	5,290	12,041	60,402	0.199	211.05	42.07	
Peanuts	6,418	521	6,939	53,460	0.130	348.4	45.22	
Sweet potatoes	37,923	14,974	52,897	342,471	0.154	611	94.37	
Rapeseed	3,456	4,006	7,462	49,238	0.152	247.8	37.55	
Sesame	1,864	143	2,007	16,780	0.120	154.4	18.47	
Cotton	3,697	548	4,245	16,316	0.260	596.6	155.22	
Tobacco	158	386	544	12,460	0.044	596.6	14.84	
Cocoons	420	1,200	1,620	4,200	0.386	340	40.50	
Tea	1.55	508.97	511	4,278	0.120	105	15.55	
Total						14,110.77	2,109.47	0.148

Sources: For gross output in physical quantities, rice output is from Liu and Yeh, *Economy,* p. 290; tea is from Ou et al. eds., *Zhongguo Guomin Suode*, (vol. 2), p. 11; cocoons are for the early 1920s from Perkins, *Agricultural Development*, p. 286; and the rest are the 1931–1937 averages (1,000 piculs) from the various issues of *Crop Reports* by NARB summed up in *Shina Nongyou Kisou Tokei Shiryou*, vol. 2 published by Toa Kenkyujyou. Note that the original *Crop Reports* only covered 22 provinces, the *Shina Nongyou Kisou Tokei Shiryou* added the Manchuria agricultural output to make to the China total, which is used here. Although the national agricultural output given by the *Crop Reports*, which I used for calculating the regional GVO ratio, are known to be under-estimates corrected by Perkins (*Agricultural Development*) and Liu and Yeh, *Economy*, this will not affect my regional ratio as long as the national and regional estimates in the *Crop Reports* are both downward biased.

Column F for China gross value is the product of 1933 commodity prices and output. Price and output data are from Liu and Yeh, *Economy*, p. 136 and p. 300, respectively. Cocoon price is from Perkins, *Agricultural Development*, p. 288.

instead of 0.569). In view of the preliminary nature of their revision, I have stayed with the Liu and Yeh figure.

HANDICRAFT

For calculating the share of Jiang-Zhe provinces in Handicraft value added, I use the provincial level handicraft gross output value data in Volume 2 of Ou, Baosan et al.'s book, *Zhongguo Guomin Suode*, to calculate the Jiang-Zhe share for 12 products.

APPENDIX TABLE 2
CHINA'S GROSS OUTPUT VALUE BY MODERN FACTORY
(1,000 yuans)

	Gross Industrial Output in Vol. 3 of Lieu's survey
1. Shanghai	750,869
2. Nanjing	22,938
3. Jiangsu	202,081
4. Zhejiang	70,179
5. Jiang-Zhe (= 1 + 2 + 3 + 4)	1,046,067
6. China Proper (excluding Manchuria)	1,577,590
7. Jiang-Zhe share of China proper (line 5 ÷ line 6)	0.663
	Gross Industrial Output Estimate by Liu and Yeh
8. Manchuria Total •	376,700
9. China Proper Total	2,268,800
10. Manchuria share of China Proper (= line 8 ÷ line 9)	0.166
11. Jiang-Zhe share of China Total (including Manchuria) = Line 5 ÷ [line 6 x (1 + 0.166)]	0.569
Shanghai Share = line 1 / [line 6 x (1 + 0.166)]	0.41

Source: The gross industrial output in vol. 3 of D. K. Lieu's survey is summarized in Kubo and Makino, table 2, p. 29. Makino and Kubo's table also listed provincial level industrial output data from Vol. 2 of Lieu's survey. Vol. 2 data would give the Jiang-Zhe a higher share of 0.596 in China's total (including Manchuria). I have opted for the vol. 3 figure because it had a wider coverage of factories than vol. 2. The gross industrial output estimate by Liu and Yeh is from *Economy*, p. 428, table F-1.

Unfortunately, there is no solid provincial-level data for most other handicraft products including some of the most important items such as flour and rice milling, cotton and silk goods, or oil products. I make rough estimates of these shares based on a variety of sources with different cross-checks. In particular, as most of these handicraft productions are highly localized, agricultural sideline activities, I use provincial shares of agricultural raw materials as proxies for shares of handicraft output. In Appendix Table 3, columns A through E derive the Jiang-Zhe shares of each of these 19 items. Then I multiply this Jiang-Zhe share to the total Chinese Net Value-added (NVD) to derive the Jiang-Zhe NVD in column G. China Net Value-added in column F is from Ou et al, *Zhongguo Guomin Suode*, vol. 1, pp. 65–66. The final Jiang-Zhe share in national handicraft NVD is 0.21. This ratio matches surprisingly well with a government survey in 1936 showing that the Jiang-Zhe share in total agricultural by-products is 0.22 (cited in Wang Jin-yu, *Jindai Zhongguo Zhiben Zhuyi*, p. 101).

Note that as the total net value added of China's handicraft product amounts to 1,340,078 thousand yuan (Ou et al, *Zhongguo Guomin Suode*, vol. 1, p. 66), the 19 products included here (with total net value added summed to 796,823) would constitute about 60 percent of total handicraft NVD in China.

APPENDIX TABLE 3
JIANG-ZHE PROVINCES HANDICRAFT NET VALUE-ADDED FOR THE 1930S

	Gross Output Value (1,000 yuan)				Jiang-Zhe Share	China NVD (1,000 yuan)	Jiang-Zhe NVD
	Jiangsu A	Zhejiang B	Shanghai C	China D			
1. Hemp weaving	189			8,295			
2. Machinery repair	655	205	6,718	11,782	0.64	3,574	2,299
3. Metal products	68	98	1,470	3,417	0.48	342	163.7
4. Electric machinery	30	197	1,394	3,007	0.54	1,013	546
5. Pottery and chinaware	1,200	438		25,063	0.07	15,153	990
6. Lime	2,808	528		16,936	0.20	5,215	1,027
7. Coal product	323	332	1,400	3,059	0.67	1,224	822
8. Stone and clay	247			1,000	0.25	500	123.5
9. Match				6,253	0	1,378	0
10. Paint and dyes	1,500	229		4,346	0.40	1,759	699.8
11. Sugar (1,000 piculs)		269		6,374	0.04	10,313	435.2
12.Paper making	119	20,581		55,800	0.37	27,063	10,039.5
13. Edible oil					0.13	103,231	13,420.03
14. Cotton Spinning					0.26	12,858	3,343.
15. Cotton weaving					0.26	154,346	40,130
16. Silk-reeling					0.23	6,419	1,476.4
17. Silk-weaving					0.35	30,169	10,559
18. Flour milling					0.16	226,680	36,269
19. Rice milling					0.23	192,434	42,336
Total						796,823	163,719
Jiang-Zhe share in handicraft sector							0.21

Source and derivation notes for the 19 handicraft items:
1. Hemp weaving: Ou et al., *Zhongguo Guomin Suode*, vol. 2, pp. 113–14.
2. Machinery repair: ibid., pp. 37–40.
3. Metal products: ibid., p. 36.
4. Electric machinery: ibid., vol. 2, p. 47.
5. Pottery and chinaware: ibid., vol. 2, p. 60.
6. Lime: ibid., pp. 61–63.
7. and 8. Coal products, Stone and clay: ibid., pp. 64–65.
9. Match: ibid., p. 74.

APPENDIX TABLE 3 — continued

10. Paint and dyes: ibid., p. 82.
11. Sugar: ibid., pp. 138–39.
12. Paper making: ibid., pp. 152–55
13. Oil: ibid., p. 145, provides national estimates of seven types of edible oil products but no provincial-level data. As traditional oil processing was highly localized, I use share of raw agricultural materials to gauge Jiang-Zhe's share of edible oil products in national output. The two most important oil items are soybean and peanut oil. Jiang-zhe share in soybeans production in national agricultural output is 0.14. Perkins's book, *Agricultural Development*, provides provincial-level acreage statistics for soybeans, rapeseed, sesame, peanuts, and cotton (for cotton oil) (pp. 258–61). The Jiang-Zhe shares of acreage in these five items are 0.11, 0.13, 0.11, 0.09 and 0.21. I give an overall Jiang-Zhe share of 0.12 for oil products.
14. Cotton-spinning: there is no provincial level hand-spun cotton yarn data. It is however reasonable to assume a close geographical relationship between local cotton cultivation and hand-spun cotton yarn production. So I use 0.26, which is the Jiang-Zhe share of raw cotton production to proxy for its share of hand-spun yarn.
15. Cotton-weaving; there is no provincial level hand-woven cotton cloth data. I the 0.26 Jiang-Zhe share of cotton production in national total as a proxy for its share of hand-woven cloth output with the following two independent cross-checks:

Xu Xinwu, *Jiangnan Tubushi*, p. 215, shows that the Jiangsu share of hand-woven cloth output amount to 27 percent of the national total around 1860.

Yan Zhong-ping, *Zhongguo Miafang Zhi Shigao*, pp. 241–51, provides a survey of regional distribution of hand-weaving production in selected provinces in China. The relative importance across difference provinces in hand-weaving production ranked in his survey matches the ranking in provincial-level cotton acreage statistics for 1931–1937 listed in Perkins's data, *Agricultural Development*, p. 261, with Hebei province having the highest output, followed by Shandong and Jiangsu. This is a confirmation of the relationship between local cotton cultivation and hand-weaving production. Both these two cross-checks are far from perfect, but they offer support that the 0.26 share I chose is possibly within reasonable bounds of accuracy.

16. Silk-reeling: using data compiled by Japanese scholar Shigemi Uehara, Ou et al., *Zhongguo Guomin Suode*, vol. 2, pp. 102–03, shows that total raw silk output figures (both machine and hand-reeled) for Jiangsu, Zhejiang, and China proper (excluding the Japanese occupied Manchuria) were 36,405, 106,230 and 300,788 piculs respectively for 1927. Ou et al., ibid., p. 102, shows the total raw silk output for both China total (including Manchuria) and Manchuria as well as prices for Zhejiang and Manchuria raw silk in 1933. Based on this, I calculate the Manchuria share in China's total gross output value as 18 percent. From this, I derive the Jiang-Zhe share in China's total raw silk output as equal to 0.40 [= (36,405 + 106,230) / (300,788 * 1.18)]. To calculate the Jiang-Zhe share in hand-reeled raw silk, I use the information (Ou et al., ibid., p. 102) that machine-reeled raw silk was about 41 percent of total raw silk output and the Jiang-Zhe share of machine-reeled raw silk output was 65 percent of China (ibid., p. 101, table 5) to derive the ratio of 0.23 [= (0.40 – 0.41 * 0.65) / (1 – 0.41)] for Jiang-Zhe share of hand-reeled raw silk in China's total.
17. Silk-weaving: the Lower Yangzi region has traditionally been the premium producing region. Ou et al, ibid., p. 104, shows that the Jiang-Zhe share of machine-woven silk goods amounts to more than 70 percent of the national total. Clearly, the Jiang-Zhe share of hand-woven silk products would not be as dominant but could be higher than its 0.23 share for hand-reeled raw silk. I choose 0.35 as the final share for Jiang-Zhe share.
18. Flour-milling: I use the Jiang-Zhe share of wheat output, 0.16, for its share of handicraft flouring milling in China.
19. Rice-milling: Ou et al., ibid., p. 126, shows the Jiang-Zhe share in rice milled in modern factories is 0.28 of the national total. However, rice output in Jiang-Zhe is equal to 0.16 of the national total. As Jiang-Zhe provinces have long been rice-deficit region and rice imported from other regions are likely go through additional milling, I give 0.22 for the Jiang-Zhe share.

APPENDIX TABLE 4
TOTAL CAPITAL OF NATIVE BANKS (QIANZHANG AND NINHAO) AND PAWN SHOPS
(in yuan)

	Total Capita of Native Banks (Qianzhang and Ninhao Capital	Total Capital of Pawn Shops
Jiangsu	25,603,000	13,393,749
Zhejiang	8,567,400	19,364,758
China total	121,836,207	63,898,586
Jiang-Zhe share	0.28	0.51

Source: Ou et al., *Zhongguo Guomin Suode*, vol. 2, p. 275, for native banks and p. 276 for pawn shops.

THE SERVICE SECTOR

Finance

For finance, one estimate claims that Shanghai's total capital including deposits, convertible notes and retained earnings of banks, Native Banks (Qiangzhong), Trust Corp. was about 47.8 percent of China in 1936 (Zhang, Zhong-Li, Jindai Shanghai Chengshi Yanjiu, p. 313). Rawski, *Economic Growth*, estimates that deposits of native banks in Shanghai account for 30 percent of the national total in 1935 (p. 390). Ou et al., *Zhongguo Guomin Suode*, also provides some provincial level figures for native banks and pawn shops as follows. It is not very clear whether Ou et al.'s data of native banks and pawn shops included Shanghai. In my estimate, I use a 48 percent share of the national total for Shanghai and add another 17 percent for Jiangsu and Zhejiang provinces to sum up to 0.65 for the Jiang-Zhe share of financial services. See Appendix Table 4.

Utilities

The utilities share of Jiang-Zhe, 0.57, is calculated as the average of water, electricity and gas weighted by the gross value of each sector in China's total output. The steps of calculation are shown in Appendix Table 5.

Modern Transportation and Communication

Appendix Table 6 presents both China's gross value output of transportation and communication services for seven sectors from Liu and Yeh, *Economy*, p. 590. The derivation of Jiang-Zhe share in national total for these seven sectors is presented in the detailed footnotes to Appendix Table 6. Multiplying these individual sectoral shares with the weights derived from the gross value output, I obtain the sectoral share weighted Lower Yangzi share of 21 percent in the national total.

Trade (Commerce)

Ou et al.'s calculation (*Zhongguo Guomin Suode*, vol. 2, pp. 247–58) is based on the total number of retail stores and restaurants and the peddlers. Based on Ou et al.'s data, I calculate that the number of stores (and restaurants) per 1,000 in Jiang-Zhe equal to 2.7

APPENDIX TABLE 5
GROSS OUTPUT VALUES OF UTILITIES
(1,000 yuans)

	Water Supply			
	Chinese Owned	Foreign Owned	Electricity	Gas
Shanghai	2,154	8,324		2,568
Jiangsu	798			
Zhejiang	155			
China	18,740	11,847	214,377	27,697
Jiang-Zhe share in each sector	0.374		0.50	0.093
Aggregated Jiang-Zhe share	0.45			

Source Notes: Gross value of water supply is from Ou et al., *Zhongguo Guomin Suode*, vol. 2, pp. 68–70, gas is from ibid., pp. 65–68. Ou et al.'s book does not have separate provincial level data for electricity. I use his gross value data (ibid., vol. 2, p. 70) and calculate from *Shenbao Nianjian* (p. 569) the share of Jiangsu and Zhejiang in China's total as equal to 0.46. As the *Shenbao* figure does not include electricity generated by factories, I round the figure up to 0.5.

times that of China. Multiplying 2.7 to 0.12 (the L.Y. population share) gives 32 percent for the L.Y. share.

For peddlers, there is no good national survey. Ou et al.'s calculation is based largely on the Jiangsu data (Ou et al., *Zhongguo Guomin Suode*, vol. 1, pp. 107–08). I just assume here the Jiang-Zhe share here is equal to its population share of 0.12. Averaging the two sums by value added weights gives a final Jiang-Zhe share of 28 percent (the value-added weights for stores and peddlers are 0.79 and 0.21 respectively, Ou et al., *Zhongguo Guomin Suode*, vol. 1, pp. 106 and 107).

Government Administration

Appendix 6 in Ou et al., *Zhongguo Guomin Suode*, vol. 2, pp. 277–96, has provincial level government administration expenses for counties, provinces, central government, and foreign concessions. Appendix Table 7 shows that government administration expenses (excluding the central government) in Jiang-Zhe are about 11 percent of the total. With the capital located in Nanjing city, I round the Jiang-Zhe share to be 12 percent. The central government expenses are equal to 484,525,780 with almost three-fourth of it spent on military expenditures (p. 294).

Construction

For Construction, Ou et al. defined it as the building and repair of residential and business housing, factories, canals and rivers, railroads, roads, ports, and transportation infrastructure (*Zhongguo Guomin Suode*, vol. 1, p. 77). Unfortunately, there were no provincial-level data in Ou et al.'s volume. The national data was based on the amount of construction materials used such as stone, cement, lime, bricks, iron and steel, and lumber. Considering the Jiang-Zhe provinces had a share of 57 percent in modern factories and 21 percent in handicraft production, the products of which correlate highly with these construction materials, I assign a rather conservative share of 30 percent for construction in the Jiang-Zhe provinces.

APPENDIX TABLE 6
GROSS VALUE OUTPUT
(million yuans)

	Railroad	Shipping	Trucks, Taxis, and Buses	Trolleys	Air	Communi-cations	Postal Services	Total
China Gross output	369	137	95	13	4	44	46	708
Jiang-Zhe share	0.12	0.25	0.46	0.57	0	0.3	0.33	0.21

Notes: For railroads, Ou et al. (*Zhongguo Guomin Suode*, vol. 2. table 3, p. 189) has gross income for all the railroads. The share of Jiang-Zhe in the national railway income is about 14 percent. However, some of the railroads covered mileage outside Jiang-Zhe. In this case, I give 12 percent for the Jiang-Zhe share to equalize it with its population share.

For shipping, I used the number of junks (Minchuan) in Jiang-Zhe as a proxy for their gross value. Jiang-Zhe had about a 22 percent share (Ou et al, ibid., p.181). For steam ships, I used gross receipts of shipping companies located in the Jiang-Zhe. There were two major shipping companies (Minshen and Zaosanqu) which plied the entire Lower Yangzi river but with a significant share in Jiang-Zhe. Including them in Jiang-Zhe would give a Jiang-Zhe share of 55 percent and excluding them would yield 28 percent, I take the intermediate number 40 percent (Ou et al., ibid., pp. 176–77). Averaging the ships and boats using their weights in total net value added gives a Jiang-Zhe share of 0.25 (weights equal to 0.86 for native boats and 0.14 for modern ships, calculated from Ou et al., vol.2, table 9, p.185).

For trucks, taxis, buses, I used the number of vehicles in the Jiang-Zhe provinces as a proxy for the share which is 46 percent (Ou et al., ibid., p. 202).

For Trolleys in the Jiang-Zhe provinces, they were only operating in Shanghai whose net income was about 57 percent of the national total (Ou et al., ibid., p. 202).

Air was very small. I just assumed it to be zero for Jiang-Zhe.

For modern communication, I calculate the NVD share of the Jiang-Zhe provinces for the two largest items, local phone and wire telegraph. They add up to over 70 percent of the net income for modern communication (Ou et al., ibid., table 18, p. 241). For local phone, the Jiang-Zhe share is 36 percent in gross income (Ou et al., ibid., table 10, p. 235) and for wire telegraph, the share is 24 percent (Ou et al., ibid., table 8, p. 232). The weighted average is 30 percent (weights for phone and telegraph are 0.39 and 0.61 respectively). Ou et al.'s provincial data for phone and telegraph did not include Manchuria. I use Ou et al.'s table 18 (ibid., p. 241) to calculate Manchuria share being 28 percent. So the China total for both phone and telegraph in Ou et al.'s data was multiplied by 1.28.

The Postal Services share for the Jiang-Zhe share in net income is calculated as 33 percent (Ou et al., ibid., table 2, p. 245).

Old-Fashioned Transportation, Personal Services, Residential Rents

There are no regional data on these three sectors, I used 0.24, a number that is about the simple average of Jiang-Zhe shares in trade and modern transportation communication and twice the national per capita average.

APPENDIX TABLE 7
GOVERNMENT EXPENDITURES IN THE JIANG-ZHE PROVINCES
(in yuan)

	County Level	Provincial Level	Foreign Concessions	Total
Jiangsu	23,484,538	11,908,006		
Zhejiang	10,748,913	11,080,321		
Hanzhou	846,816	773,510		
Nanjing		2,426,175		
Shanghai		7,735,110	28,623,516	
Jiang-Zhe	35,080,267	33,149,612	28,623,516	68,229,879
China	210,344,878	407,708,136	47,796,200	618,053,014
Jiang-Zhe share				0.11

Source: County- and provincial-level and foreign concessions data from Ou et al., *Zhongguo Guomin Suode*, vol. 2, pp. 287, 292, and 295, respectively.

REFERENCES

Billingsley, Phil. *Bandits in Republican China.* Stanford, CA: Stanford University Press, 1988.

Chang, John. *Industrial Development in Pre-Communist China.* Stanford, CA: Stanford University Press, 1955.

Chang, Chung-li. *The Income of the Chinese Gentry.* Seattle: University of Washington Press, 1962.

Chao, Kang. "The Sources of Economic Growth in Manchuria: 1920–1941." In *Modern Chinese Economic History,* edited by Hou, Chi-ming, and Yu, Tzong-shian, 255–63. Published by The Institute of Economics, Academia Sinica, Taipei, Taiwan. 1977.

______. *The Development of Cotton Textile Production in China.* Cambridge, MA: Harvard University Press. 1977.

______. *The Economic Development of Manchuria: The Rise of a Frontier Economy.* Ann Arbor: Center for Chinese Studies, University of Michigan, 1982.

Cheng, Linsun. *Banking in Modern China, Entrepreneurs, Professional Managers, and the Development of Chinese Banks, 1897–1937.* Cambridge: Cambridge University Press. 2003.

Coble, Parks, Jr. *The Shanghai Capitalists and the Nationalist Government 1927–1937.* Cambridge, MA: Harvard University Press. 1980.

Eckstein, Alexander, Kang Chao, and John Chang. "The Economic Development of Manchuria: The Rise of a Frontier Economy." This JOURNAL 34, no. 1 (1974): 239–64 .

Elman, Benjamin. *On Their Own Terms: Science in China, 1550–1900.* Cambridge, MA: Harvard University Press, 2005.

Elvin, Mark. *The Pattern of the Chinese Past.* Stanford, CA: Stanford University Press, 1973.

Epstein, S. R. *Freedom and Growth: The Rise of States and Markets in Europe, 1300–1750.* London: Routledge, 2000.

Fairbank, John K., ed. *The Cambridge History of China*, Vol. 10, *Late Ch'ing, 1800–1911*, Part I. Cambridge: Cambridge University Press, 1978.

Fairbank, John K., and Kwang-ching Liu, eds. *The Cambridge History of China,* Vol. 11, *Late Ch'ing, 1800–1911*, Part 2. Cambridge: Cambridge University Press, 1980.

Feetham, Richard *Report of the Hon. Richard Feetham, C.M.G. to the Shanghai Municipal Council.* Shanghai: North-China Daily News and Herald, Ltd. 1931.

Fukao, K., D. Ma, and T. Yuan. "Real GDP in Pre-War East Asia: a 1934–36 Benchmark Purchasing Power Parity Comparison with the U.S." *Review of Income and Wealth*, Series 53, Number 3 (September 2007): 503–37.

Furuta, Kazuko. "Kobe Seen as Part of the Shanghai Trading Network: The Role of Chinese Merchants in the Re-export of Cotton Manufactures to Japan." In *Japan, China, and the Growth of the Asian International Economy, 1850–1949*, edited by K. Sugihara, 23–48. Oxford: Oxford University Press, 2005.

Hanley, S. B., and K. Yamamura. *Economic and Demographic Change in Preindustrial Japan, 1600–1868*. Princeton, NJ: Princeton University Press, 1977.

Hou, Chi-Ming. *Foreign Investment and Economic Development in China, 1840–1937*. Cambridge, MA: Harvard University Press, 1965.

Hou, Chi-ming and Tzong-shian Yu, eds. *Modern Chinese Economic History*, edited by Chi-ming Hou and Tzong-shian Yu. Taipei, Taiwan: The Institute of Economics, Academia Sinica, 1977.

Hsiao, Liang-lin, *China's Foreign Trade Statistics, 1864–1949,* Cambridge, MA: Harvard University Press, 1974.

Hsueh, T., and Q. Li, eds. *China's National Income, 1952–1995*. Boulder, CO: Westview Press, 1999.

Kimura, Mitsuhiko. "Standards of Living in Colonial Korea: Did the Masses Become Worse Off or Better Off under Japanese Rule?" This JOURNAL 53, no. 3 (1993): 629–52.

Kirby, William C. "China Unincorporated: Company Law and Business Enterprise in Twentieth-Century China." *The Journal of Asian Studies* 54, no. 1. (February 1995): 43–64.

Koll, Elisabeth. *From Cotton Mill to Business Empire: The Emergence of Regional Enterprises in Modern China.* Cambridge, MA: Harvard University Press, 2003.

Kubo, Toru. "Industrial Development in Republican China: Newly Revised Index: 1912–1948." Paper presented at the International Economic History Congress at Helsinki, 2006.

Li, Bozhong, *Agricultural Development in Jiangnan, 1620–1850.* New York: St. Martin`s Press, 1998.

Liu, Ta-chung. *China's National Income 1931–36: An Exploratory Study.* Washington, DC: The Brookings Institution, 1946.

Liu, Ta-chung, and Kung-chia Yeh. *The Economy of the Chinese Mainland: National Income and Economic Development, 1933–1959.* Princeton, NJ: Princeton University Press, 1965.

Ma, Debin. "Growth, Institutions and Knowledge: A Review and Reflection on the Historiography of 18th–20th Century China." *Australian Economic History Review* 44, no. 3 (November 2004, Special Issue on the Economic History of Asia): 259–77.

______. "Between Cottage and Factory: The Evolution of Chinese and Japanese Silk-Reeling Industries in the Latter Half of 19th Century." *Journal of The Asia Pacific Economy* 10, no. 2 (May 2005): 195–213.

______. "Shanghai-Based Industrialization in the Early 20th Century: A Quantitative and Institutional Analysis." Global Economic History Network Working Paper No. 18, 2006.

Maddison, Angus, *Chinese Economic Performance in the Long Run*. Paris: Development Center of the OECD, printed in France, 1998.

______. *The World Economy: A Millennial Perspective*. Paris: Development Center of the OECD, 2001.

Martin, Brian G. *The Shanghai Green Gang—Politics and Organized Crime 1919–1939*. Berkeley: University of California Press, 1996.

Montono, Eiichi. *Conflict and Cooperation in Sino-British Business, 1860–1911: The Impact of Pro-British Commercial Network in Shanghai*. New York: St. Martin's Press, 1999.

Morgan, Stephen. "Economic Growth and the Biological Standard of Living in China, 1880–1930." *Economic and Human Biology* 2, no. 2 (2004): 197–218.

Morgan, Stephen, and S. Liu. "Was Japanese Colonialism Good for the Welfare of Taiwanese? Stature and the Standard of Living." forthcoming *China Quarterly*.

Murphey, Rhoads. *Shanghai: Key to Modern China*. Cambridge, MA: Harvard University Press, 1953.

Myers, Ramon H. *The Chinese Economy Past and Present*. Belmont, CA: Wadsworth, Inc., 1980.

Nakamura, James, and Matao Miyamoto. "Social Structure and Population Change: A Comparative Study of Tokugawa Japan and Ch'ing China." *Economic Development and Cultural Change* 30, no. 2 (January 1982): 229–69.

Ohkawa, Kazushi. *The Growth Rate of the Japanese Economy since 1878*. Tokyo: Kinokuniya Bookstore Co., 1957.

Ohkawa, Kazushi, and Henry Rosovsky. *Japanese Economic Growth: Trend Acceleration in the Twentieth Century*. Stanford, CA: Stanford University Press, 1973.

Ohkawa, Kazushi, Tsutomu Noda, Nobukiyo Takamatsu, et al. *Estimates of Long-Term Economic Statistics of Japan, vol. 8, Prices*. Tokyo: Toyo Keizai Shinbunsha, 1967.

Olson, Mancur "Dictatorship, Democracy, and Development." *American Political Science Review* 87, no. 3 (September 1993): 567–76.

Perkins, Dwight. *Agricultural Development in China 1368–1968*. Edinburgh: Edinburgh University Press, 1969.

Pomeranz, Kenneth. *The Great Divergence: Europe, China, and the Making of the Modern World Economy*. Princeton, NJ: Princeton University Press, 2000.

Pott, F. L. Hawks. *A Short History of Shanghai*. Shanghai: Kelly and Walsh, Ltd. 1928.

Rawski, Thomas G. *Economic Growth in Prewar China*. Berkeley: University of California Press. 1989.

______. "China's Industrial Performance, 1949–57." In *Quantitative Measures of China's Economic Output*, edited by Alexander Eckstein, chapter 2. Ann Arbor: The University of Michigan Press, 1980.

______. "Economy of the Lower Yangtze Region, 1850–1980." Unpublished manuscript, 1985.

Remer, C. F. *Foreign Investments in China*. New York: The Macmillan Co., 1933.

Reynolds, Douglas R. *China, 1898–1912: The Xinzheng Revolution and Japan*. Cambridge, MA: Harvard University Press, 1993.

Shay, Ted. "The Level of Living in Japan, 1885–1938." In *Stature, Living Standards, and Economic Development: Essays in Anthropometric History*, edited by John Komlos, 173–201. Chicago: The University of Chicago Press. 1994.

Sheridan, James. "The Warlord Era: Politics and Militarism under the Peking Government, 1916–28." In *The Cambridge History of China*, Vol. 12, *Republican*

China 1912–1949, Part I., edited by Denis Twitchett and John Fairbank, 284–321. Cambridge: Cambridge University Press, 1983.

Skinner, G. William. "Presidential Address: The Structure of Chinese History." *Journal of Asian Studies* 44, no. 2 (February 1985): 271–92.

Smith, Thomas C. *Political Change and Industrial Development in Japan: Government Enterprise, 1868–1880*. Stanford, CA: Stanford University Press, 1955.

Stephens, Thomas B. *Order and Discipline in China.* Seattle and London: University of Washington Press, 1992.

Sugihara, Kaoru, ed. *Japan, China, and the Growth of the Asian International Economy, 1850–1949*. Oxford: Oxford University Press, 2005.

Wakeman, Federick, and Wen-hsin Yeh, eds. *Shanghai Sojourners.* Berkeley: University of California Press.

Wang, Yeh-chien. *Land Taxation in Imperial China, 1750–1911*. Cambridge, MA: Harvard University Press, 1973.

Wong, Siu-lun. *Emigrant Entrepreneurs: Shanghai Industrialists in Hongkong.* Hongkong: Oxford University Press, 1988.

Wright, Mary C. *The Last Stand of Chinese Conservatism: The T'ung-Chih Restoration 1862–1874*. Stanford, CA: Stanford University 1962.

Yeh, K. C. "China's National Income, 1931–1936." In *Modern Chinese Economic History,* edited by Hou, Chi-ming and Yu, Tzong-shian, 95–128. Taipei, Taiwan: The Institute of Economics, Academia Sinica, 1977.

Chinese

Bergere Marie-Claire. *Shanghai Shi* (translated from French with original title: Histoire de la Shanghai). Shanghai: Shanghai Academy of Social Science Press, 2005.

Chao, Shuji, *Zhongguo Renkoushi* (Population History of China), vols. 4 and 5, (the Ming and Qing Dynasties). Shanghai: Fudan University Press, 2000 and 2001.

Du, Xuncheng *Minzu Zhiben Zhuyi yu JiuzhongguoZhengfu* (Chinese Capitalism and the Old Chinese Government: 1840–1937). Shanghai: Shanghai Academy of Social Science, 1991.

Editorial Committee of "Zhongguo Jindai Fangzhishi" *Zhongguo Jindai Fangzhishi* (Modern History of Chinese Textile) (two volumes). Beijing: Zhongguo Fangzhi Publishing. 1997.

Fei, Chengkang. *Zhongguo Zujieshi* (History of Foreign Concessions in China). Shanghai: Shanghai Social Science Academy Press. 1992.

Feng, Youcai. *Zaishang Yanshang, Zhengzhi Bianju zhong de Jiang-zhe Shangren.* (Merchants Only Talk About Business: Jiang-zhe Merchants in Political Turmoil). Shanghai Academy of Social Science Press, 2004.

Ma, Junya, *Hunhe yu Fazhan, Jiangnan Diqu Chuanton Shehui Jinji de Xiandai Yanbian (1900–1950).* (Mixture and Development: The Modern Evolution of the Traditional Social Economy in Jiangnan, 1900–1950). Beijing: Social Science Document Publisher, 2003.

Ou, Baosan, "Zhongguo Guomin Suode 1933, 1936, 1946" (National Income of China, 1933, 1936, 1946), *Sehui Kexue Zazi* (Quarterly Review of Social Sciences) 9, no. 1 (June 1947): 12–155.

Ou, Baosan, Fushen Wang, Jihong Zhang, et al., eds. *Zhongguo Guomin Suode* (National Income of China), vols, 1 and 2. Shanghai: Zhonghua sujui, 1947.

Peng, Zeyi. *Zhongguo Jindai Sougongyeshi Ziliao* (Materials on Modern Chinese Handicraft Industry), vol. 3. Beijing: Zhonghua Sujiu. 1962.

Shenbao Nianjian Press. *Shenbao Nianjian,* No.3. Shanghai: Shenbao Nianjian Press, 1935.

State Statistical Bureau. *Xinzhongguo Wushinian* (Fifty Years of New China). Beijing: China Statistical Publishing House, 1998.

State Statistical Bureau. *China Statistical Yearbook* Beijing: China Statistical Publishing House, 1990 and 1999.

Wang, Jinyu. *Jindai Zhongguo Zhiben Zhuyi de Zhongti Kaocai yu Gean Bianxi* (A General and Case-Study on Modern Chinese Capitalism). Beijing: Chinese Academy of Social Science Press.2004.

Xiong, Yuzi, ed. *Shanghai Tongshi* (The General History of Shanghai), 8 volumes. Shanghai: Shanghai Renmin Chubanshe, 1999.

Xu, Xinwu and Hanming Huang. *Shanghai Jindai Gongyeshi* (History of Modern Industry in Shanghai). 1998.

Xu, Xinwu, ed. *Jiangnan Tubushi* (History of Native Cloth in Jiangnan). Shanghai: Shanghai Academy of Social Science Press. 1989.

Yan, Xinzhe, *Nongcun Jiating Diaocha* (Rural Household Survey). Shanghai: Commercial Press, 1937.

Yan, Zhongpin *Zhongguo Miafang Zhi Shigao* (History of Chinese Cotton Textile 1289–1937). Beijing: Science Press, 1963.

Yan, Zhongpin, Yisheng Xu, Xiangao Yao, et al., eds. *Zhongguo jindai jingjishi tongji ziliao xuanji* (Selected statistical materials on modern Chinese economic history). Beijing: Kexue chubanshe, 1955.

Yang, Xiangju. *Diguo zi Bian yu Guotou zi Lian* (The Imperial Whip and Oligarchic Chain: A Study on the Changing Power Relations of Shanghai Mixed Court). Beijing: Beijing University Press, 2006.

Yang, Ximen. "Shanghai Gongren Shenghuo Chengdu de Yige Yanjiu" (A Research on the Living Standards of Shanghai Workers). In *Minguoshiqi Shehuidiaocha Congbian* (A Compilation of Social Surveys in the Republic Period, the Urban Volume, Vol. 1), edited by Li Wenhai, 243–336. Fuzhou: Fujian Education Press, 2005.

Yu, Xiaobo *Bijiao yu Shenshi – "Nantong Moushi" yu "Wuxi Moushi" Yanjiu* (Comparison and Evluation – a Study on Nantong and Wuxi Models) Anhui Education Press. 2001.

Zhang, Zhong-Li, ed. *Jindai Shanghai Chengsi Yanjiu* (Studies on Modern Shanghai). Shanghai: Shanghai People's Press, 1990.

Japanese

Hayami, Akira. *Kinsei Nihon no Keizai Shakai* (Economic Society in Early Modern Japan). Chiba Prefecture, Japan: Reitaku University Press, 2003.

Ishii, Kanji. *Nihon no Sangyou Kakumei* (Japanese Industrial Revolution: from the Perspective of Japan-China and Japan-Russuo Wars). Tokyo: Asahi News Publishers. 1998.

Kubo, Toru. *Sankanki Chuugoku "Jiritsu e no Mosaku"* (China's Search for Indepdence during the Inter-War Period). Tokyo: University of Tokyo Press, 1999.

Kanemaru Yuichi. "Electric Power Industry and 'The Golden Age of National Industries" in China: A Comparative Study of Shanghai and Jiangsu, 1879–1924." *Ajia Kenkyu* (Asia Studies) 39, no. 4 (August 1993): 29–83.

Kobu, Toru, and F. Makino. "Chinese Industrial Output in 1933." Discussion Paper No. D99-4, Institute of Economic Research, Hitotsubashi University, 1998.

Mizoguchi, Toshiyuki, and Mataji Umemura, eds. *Basic Economic Statistics of Former Japanese Colonies, 1895–1938*. Tokyo: Toyo Keizai Shinposha. 1988.

Suzuki, Tomoo. *Yomu Undou No Kenkyu* (A Study of the Westernization Movement in China in the Latter Half of the Nineteenth Century). Tokyo: Kyuko Shoin, 1992.

Toa Kenkyujyou (Institute of East Asia Research). *Shina Nongyou Kisou Toukei Shiryou* 2. Toa Kenkyuuhyou: 1940.

Yuzou Yamamato. *Nihon Shokuminchi Keizai Shi Kenkyu* (Economic History of Japanese Colonies). Nagoya: Nagoya University Press, 2000.

Review of Income and Wealth
Series 53, Number 3, September 2007

REAL GDP IN PRE-WAR EAST ASIA: A 1934–36 BENCHMARK PURCHASING POWER PARITY COMPARISON WITH THE U.S.

BY KYOJI FUKAO

Institute of Economic Research, Hitotsubashi University

DEBIN MA*

Economic History Department, London School of Economics

AND

TANGJUN YUAN

Institute of Economic Research, Hitotsubashi University

This article provides estimates of purchasing power parity (PPP) converters for expenditure side GDP of Japan/China, Japan/U.S. and China/U.S. in 1934–36 through a detailed matching of prices for more than 50 types of goods and services in private consumption and about 20 items or sectors for investment and government expenditure. Linking with the earlier studies on the price levels of Taiwan and Korea relative to Japan, we derive the mid-1930s benchmark PPP adjusted per capita income of Japan, China, Taiwan and Korea at 32, 11, 23, and 12 percent of the U.S. level respectively. These estimates correct the consistent downward bias in East Asian income levels based on market exchange rate conversions. Compared with Angus Maddison's estimates based on the 1990 benchmark back-projection, our current-price based result are 18 and 44 percent lower for Japan and Korea, and 4 and 10 percent higher for Taiwan and China respectively in the mid-1930s. We develop a preliminary theoretical and empirical framework to examine the possible source of the biases in the back-projection method. The article ends with a discussion on historical implications of our findings on the initial conditions and long-term growth dynamics in East Asia.

INTRODUCTION

In the world history of modern economic growth, the East Asian miracle is a relatively recent phenomenon. The catch-up of Japan, Taiwan and Korea with the world's leading economies is a 20th century, or more precisely, a post-World War II (WWII) affair, while the economic surge of China is only a matter of the last two decades. However, as revealed by the burgeoning literature on economic growth,

Note: We are grateful to Paul Rhode and John Devereux for pointing us to useful data sources. Our special thanks go to Angus Maddison for his careful reading and discussion of our various drafts. Our paper benefited from comments by Stephen Broadberry, Leandro Prados de la Escosura, Riitta Hjerppe, Yumiko Moriyama, Hak Kil Pyo, Jean Pascal Bassino, Prema-Chandra Athukorala, Konosuke Odaka and the two referees and the editor of this Journal; and the participants of the UC Davis workshop, June 1, 2005; the Vice-Presidential Session of the International Economic History Congress at Helsinki, August, 2006; and seminars at the London School of Economics and Oxford University. This paper is partly funded by the NSF Global Prices and Income 1350-1950 project headed by Peter Lindert at UC Davis and the Ministry of Education 21st Century COE Program, Research Unit for Statistical Analysis in Social Sciences, headed by Osamu Saito at Hitotsubashi University. All errors are the responsibility of the authors.

*Correspondence to: Debin Ma, Economic History Department, London School of Economics, Houghton Street, London WC2A 2AE, U.K. (d.ma1@lse.ac.uk or debinma@hotmail.com).

long-term historical factors provide us with crucial insights into both the causal determinants and the mechanism of modern economic growth. What were the initial conditions of East Asian economies prior to their take-off? Were there shared vital historical factors behind their miracles?

These questions cannot be properly answered without long-term series of national accounts. Among the East Asian economies, the most consistent and reliable long-term GDP series going back to the late-19th century are available only for Japan, partly thanks to the efforts of the Long-Term Economic Statistics (LTES) project under the leadership of Kazushi Ohkawa at the Institute of Economic Research of Hitotsubashi University in Japan.[1] The Hitotsubashi group extended this line of research to two former Japanese colonies, Taiwan and Korea, with the 1988 publication of a statistical volume compiled by Mizoguchi and Umemura. The volume provides annual estimates of GDP and its various components for these two economies during the period of Japanese occupation based on the detailed economic statistics of the colonial administrations. Compared with these countries, historical macroeconomic statistics for China remain sketchy. Solid economic statistics for standard national accounts are available only for the 1930s, leading to the pioneering reconstruction of China's GDP for the period 1931–36 carried out by Ou (1947), Liu (1946), and Liu and Yeh (1965).

These pre-war GDP series are all based on their domestic currencies. As is well-known, conversion of per capita incomes based on market exchange rates tends to systematically underestimate the real per capita income level of lower income countries since it fails to incorporate differences in the price level for non-tradable goods (Balassa, 1964; Samuelson, 1964). Yet research on the construction of purchasing power parity (PPP) converters for GDP for the pre-war period, especially for developing countries such as those in East Asia, have barely started. The national accounts datasets based on PPP conversion by the renowned Penn World Table group only cover the post-war period. Angus Maddison is possibly the only scholar to have attempted a systematic reconstruction of long-term national accounts for most countries around the world. To arrive at globally comparable series for the pre-war period, Maddison relied on the use of 1990 benchmark PPPs to project per capita GDP values backward using domestic real per capita GDP growth rates. This methodology, adopted due to the absence of historical PPP converters, has its inherent index number problems associated with factors such as long-term relative shifts in a country's terms of trade and economic structure.

The present paper develops a full-fledged reconstruction of a three-way, bilateral expenditure PPPs for Japan, China and the U.S. for 1934–36. We conduct a detailed matching of the prices of more than 50 types of goods and services for private consumption and about 20 expenditure items for private investment and government expenditure. We find that average consumer prices in China in 1934–36 are 73 percent that of Japan and 32 percent that of the U.S. respectively, while the average GDP price level in Japan is 43 percent that of the U.S. Linking with the

[1]For Japan, there is the 14 volume LTES publication in Japanese. For an abridged English version, see Ohkawa and Shinohara (1979).

Fukao *et al*. study (2006) on the relative price levels of Taiwan and Korea and using Japan as the bridge country, we derive the mid-1930s benchmark PPP-adjusted per capita income of Japan, China, Taiwan, and Korea at 32, 11, 23, and 12 percent of that of the U.S. respectively. These figures are consistently higher than their corresponding per capita GDP estimates based on current market exchange rates, which are 14, 3.6, 9, and 5.2 percent that of the U.S. level respectively. On the other hand, in comparison with Maddison's 1990 benchmark back-projected estimate, our current price values (expressed in 1990 dollars) are 18 and 44 percent lower for Japan and Korea, but 4 and 10 percent higher for Taiwan and China respectively (Maddison, 2003, p. 182).

Our new estimates have considerable implications for both the levels and growth trajectories of these four East Asian economies. In particular, Japanese as well as Korean per capita incomes were lower than previously thought. In fact, comparing our estimate with the data for other countries provided in Maddison (2003) suggests that Japan's per capita income during this period was only marginally higher than that of Malaysia or the Philippines. In other words, Japan launched her full military venture on the Asian continent with a per-capita income roughly comparable to some of the resource-rich Asian countries, most of which were still Western colonies. Our new benchmark PPP estimates, if projected backward and forward, shed new light on the initial GDPs of Japan and East Asia around the mid-19th century and the post-WWII period.

The remainder of this paper is divided into four sections. The first section describes our PPP estimation procedure and reports our current-price PPP estimates in 1934–36. In Section 2 we present our new estimates of per capita incomes in the four East Asian economies and compare them with those based on current market exchange rates as well as the backward projection estimates. Section 3 discusses the index number biases embedded in the back-projection method. Section 4, the summary section, provides a brief reassessment of initial conditions and long-term growth dynamics in East Asia based on our new findings.

1. Current-Price PPP Estimates for 1934–36

We adopt the methodology used by several rounds of the International Comparison Program (ICP) for the post-WWII benchmark periods.[2] We choose the 1934–36 period as our benchmark for several reasons. First, this period has been consistently used as the benchmark in the LTES project. Second, for Japan and her two former colonies, 1934–36 was a period of relative economic and price stability, falling between the severe deflation that lead to Japan's banning of gold exports in 1931–32 and the economic dislocation of the late 1930s brought about by the outbreak of the Sino-Japanese War.[3] In China, there was a major monetary reform by the Nationalist government in 1933 which replaced the traditional silver-based monetary system with a modern unified currency under the control of a Central Bank. More importantly, for the 1931–36 period, we have the first reasonably reliable benchmark GDP estimate. For East Asia in general, it was only during the

[2]For the ICP study, see Heston and Summers (1993) and Maddison (1995).
[3]For the general price level of 1934–36, see Ohkawa and Shinohara (1979, table A50, p. 388).

1930s that urban and rural household surveys became much more plentiful and reliable.

Our computation of relative price levels employs the standard binary matching of two countries. We derived the Fisher geometric mean as follows. For N number of goods and services, the price level in the currency of the numeraire or base country (sub- or superscripted as B here) relative to the price level of country i is calculated as follows:

$$P_{i,B}^{B} = \frac{\sum p_n^i q_n^B}{\sum p_n^B q_n^B} = \frac{\sum \frac{p_n^i}{p_n^B} p_n^B q_n^B}{\sum p_n^B q_n^B} = \sum \frac{p_n^i}{p_n^B} \omega_n^B$$

where p_n^i denotes absolute price level of commodities (or services) n in country i in base country currency and ω_n^B denotes the consumption expenditure weight for the period 1934–36. The summation sign is summed across N types of goods and services. We use the average market exchange rate in 1934–36 for conversion of absolute price levels. The formula using the consumption weight of country i is:

$$P_{i,B}^{i} = \frac{\sum p_n^i q_n^i}{\sum p_n^B q_n^i} = \frac{\sum p_n^i q_n^i}{\sum \frac{p_n^B}{p_n^i} p_n^i q_n^i} = \frac{1}{\sum \frac{p_n^B}{p_n^i} \omega_n^i}.$$

Finally, the geometric average of the two price indices (the Fisher index) $P_{i,B} = \sqrt{P_{i,B}^{i} \times P_{i,B}^{B}}$ gives us country i's absolute price level relative to that of the base country.

PPP Converter for Private Consumption: Japan and China

The information on prices and expenditure weights for Japan is largely drawn from the earlier PPP study of Yuan and Fukao (2002) and Fukao *et al.* (2006). There, prices for each item in Japan in most cases are calculated as the simple average of the retail prices in 12–14 major cities.

For China, we rely on more than 60 volumes of detailed retail price statistics compiled in 1955 by the Communist government (Gongnongye Shangpin Bijia Wenti Diaocha Yanjiu Ziliao Bangongshi, 1956–57). The volumes are entitled "Gongnongye Shangpin Bijia Wenti Diaocha Yanjiu Ziliao Huibian (Archive Materials for Studies of Industrial and Agricultural Commodity Prices)." The retail price information in these volumes is mostly culled from the account books of major stores in urban cities. The price statistics were published and circulated internally within the Chinese government to examine changes in relative prices of agriculture over industry between the 1930s the 1950s. Our retail prices used are the simple averages of 11 cities across China. For some of the services, such as transportation, communication and entertainment and so on, we use a multitude of sources such as local surveys, gazettes, and newspapers in both China and Japan.

TABLE 1

Consumption Price Levels of China Relative to Japan (1934–36; Japan = 1)

	Chinese Expenditure Weight	Japanese Expenditure Weight	Fisher Average
Total	0.65	0.83	0.73
Food	0.66	0.79	0.72
Lighting and heat	0.58	1.12	0.80
Clothing and bedding	0.63	1.16	0.86
Housing expenses	0.57	0.49	0.53
Miscellaneous	0.75	0.84	0.79

Source: See text.

We employ three levels of consumption weights, denoted as I, II and III in Appendix A, Table A1. The consumption weights at the most aggregate level (level I) are based on Zhang (2001, pp. 375–6) with adjustments in food and miscellaneous categories. Level II weights are based on various local urban and rural surveys with shares weighted by the urban and rural population figures. For level III, the most detailed level, we make use of two consumption surveys for Beijing and Shanghai to represent the different consumption patterns of Northern and Southern China. Our level III weights are derived as the weighted average of these two cities with weights equal to the population shares for China north and south of the Yangzi River.[4]

Table A1 shows a matching of 51 items. Among the five consumption categories as listed in Table 1, Chinese housing expenses are the cheapest followed by food prices, which reflects the differential resource endowment conditions and stages of development. Another notable feature in Table 1 is the large discrepancy between the relative price levels of lighting and heating based on Chinese versus Japanese expenditure weights (0.58 versus 1.12, see also Table A1). The disparity reveals China's very low rates of electrification and relatively high cost of electric power in comparison to that of Japan, a powerful indicator of the differential degree of economic modernization between these two countries for the period.[5] The overall relative price level of China is 73 percent that of Japan.

PPP Converter for Private Consumption: Japan and the United States

Price data for the U.S. in the mid-1930s are fairly abundant and reliable. For most of the food items, we rely on the Bureaus of Labor Statistics Bulletin No. 635 (US Department of Labor, 1938) which provides weighted averages of retail prices in 51 cities. For the retail prices of fuel and utilities as well as wage rates, we use the *Handbook of Labor Statistics* (1941). Other sources include the Statistical Abstract of the United States (1938) (US Department of Commerce, 1939) for items such as clothing and utilities, and micro data from a comprehensive national urban household survey of consumer purchases in 1935–36. This household-based dataset can

[4]Source and methods on these weights are reported in Yuan (2005, chapter 1).

[5]Total electric power generated in Japan is more than 10 times that in China (excluding Japanese-controlled Manchuria) in the 1930s. For total electric power generated in Japan and China in the 1930s, see Minami (1965) and Wang (1988) respectively.

TABLE 2

Consumption Price Levels of Japan Relative to the U.S. (1934–36; U.S. = 1)

	Japanese Expenditure Weight	U.S. Expenditure Weight	Fisher Average
Total	0.34	0.58	0.45
Food	0.37	0.62	0.48
Lighting and heat	1.06	0.89	0.97
Clothing and bedding	0.25	0.49	0.35
Housing expenses	0.59	0.67	0.63
Miscellaneous	0.28	0.48	0.36

Source: See text.

now be accessed through the Inter-university Consortium for Political and Social Research (ICPSR) website hosted by the University of Michigan (http://www.icpsr.umich.edu).

The Historical Statistics of the U.S. (bicentennial edition) provides us with the level I and II consumption expenditure weights. The detailed item weights in the mid-1930s are largely drawn from the cost of living survey in a Bureau of Labor Statistics publication (US Department of Labor, 1941a).

Details of the matching and source notes are presented in Appendix A, Table A2. Table 2 summarizes our U.S.–Japan binary matching of 53 items of goods and services altogether. It shows that around the mid-1930s the average cost of food in Japan was less than half of that in the United States. The average cost of miscellaneous items in Japan, consisting mostly of services such as transportation, communication, education and entertainment, was only 36 percent of the U.S. level. In the case of lighting and heating which mostly consist of energy items, the Japanese price level was nearly identical to the U.S. level. Housing expenses, which include the rent of land—a scarce factor in Japan—were about 63 percent of the U.S. level. Table A2 suggests that Japanese nominal wage rates (for teachers, doctors and unskilled workers) were only about 10 percent the U.S. level based on mid-1930s exchange rates. The low wages and high energy and housing prices in Japan reflect differences in resource endowments and productivity levels during this period.[6] The overall relative price level of Japan relative to the U.S. turns out to be 45 percent for the mid-1930s benchmark.

PPP Converters for Private Consumption in East Asia

As a cross-check, we make a direct PPP comparison between the U.S. and China as shown in Appendix A, Table A3. While the majority of price data for this comparison are derived from those in Tables A1 and A2, we also include additional price data from various sources. Overall, about 50 items of goods and services were matched, showing an overall Chinese price level at 32 percent of the U.S. level. This ratio is nearly identical to the product of the China–Japan and Japan–U.S. relative price levels (73% × 45%), thus satisfying the transitivity conditions of multilateral comparison. Table 3 summarizes the major categories of the China–U.S. comparison, showing most Chinese price categories were only about

[6]For the relatively low Japanese labor productivity levels relative to those of the U.S. in the pre-WWII period based on a production sectoral level PPP comparison, see Pilat (1994).

TABLE 3

Consumption Price Levels of China Relative to the U.S. (1934–36; U.S. = 1)

	Chinese Expenditure Weight	U.S. Expenditure Weight	Fisher Average
Total	0.26	0.38	0.32
Food	0.27	0.35	0.31
Lighting and heat	0.70	0.92	0.80
Clothing and bedding	0.24	0.28	0.26
Housing expenses	0.15	0.24	0.19
Miscellaneous	0.21	0.47	0.32

Source: See text.

TABLE 4

Consumption Price Levels of East Asian Countries Relative to the U.S. (Fisher Average) (1934–36 U.S. = 1)

	China	Taiwan	Korea	Japan
Total	0.32	0.39	0.43	0.45
Food	0.31	0.42	0.45	0.48
Lighting and heat	0.80	0.77	0.80	0.97
Clothing and bedding	0.26	0.33	0.33	0.35
Housing expenses	0.19	0.46	0.55	0.62
Miscellaneous	0.32	0.30	0.26	0.36
Tradable*	0.77	0.88	0.93	*0.55*
Non-tradable*	0.68	0.78	0.71	*0.39*

Notes: *Relative price levels for tradable and non-tradable for Japan are calculated relative to the U.S. For the other three economies, they are computed relative to Japan.

1. Tradable goods for Korea and Taiwan can be found in Fukao *et al*. (2006).

2. Tradable goods for China: food, clothing and bedding, firewood, coal, matches, lamp oil, wooden boards, wash basins, hygiene products, soap, toothbrushes, medical alcohol.

3. Tradable goods for Japan are items marked with "1" in Table A2.

4. The individual weights for tradable and non-tradable items are the same consumption weights used in Tables A1, A2 and A3. For the Japan–China comparison, the aggregate weights used for tradables are 63 percent for Japan and 89 percent for China. For the Japan–U.S. comparison, the weights used for tradables are 47 percent for Japan and 42 percent for the U.S.

20–30 percent of the U.S. level, except that of lighting and heating which was 80 percent. This is consistent with the findings in Tables 1 and 2.

The studies by Yuan and Fukao (2002) and Fukao *et al*. (2006) matched 61 types of goods and services for the Japan–Korea comparison and 58 items for the Japan–Taiwan comparison. We combine the consumption PPPs from that research with our current result to convert the relative price levels of these two economies to the basis of the U.S. by using Japan as the bridge country and applying the Fisher averages across the five upper level consumption weights. The final results for all the four East Asian economies are presented in Table 4 which gives the price levels of China, Taiwan, Korea and Japan relative to the United States at 32, 39, 43, and 45 percent respectively. Overall, price levels in East Asia were far lower in comparison with the U.S. than within the region. Within East Asia, price levels within the Japanese colonial empire were closer to each other than with China, a fact consistent with Japan's colonial policy which forged a "free trade" zone within the empire by the 1930s.[7]

Table 4 also shows that overall price gaps for non-tradables between East Asia and the U.S. are larger than those for tradables. This is a clear confirmation of the theoretical predictions of the productivity and factor proportion differential models that posit lower price levels for non-tradables in relatively underdeveloped countries. As is well known, using market exchange rates ignores the lower prices—particularly of non-tradables—and thus underestimates the per capita income levels of less developed countries. The ranking of relative price levels presented in Table 4 is consistent with their per capita income levels relative to the United States, which we will show later.

PPP Converter for Private Investment and Government Expenditures: Japan and the United States

Expenditure side GDP consists of private consumption, investment, government expenditure, and net exports. In this section, we follow the standard practice of the International Comparison Projects (ICP) to estimate the other two components of GDP, private investment and government expenditure.[8] For China, relevant data for investment and government expenditure are unavailable. Liu and Yeh (1965, p. 68) indicated that private consumption accounted for 91 percent of Chinese GDP during the benchmark period. We therefore feel reasonably comfortable to use our consumption PPP as a proxy for our GDP PPP in this study.

Due to data limitations, our estimates of PPP converters for private investment and government expenditures for Japan–U.S. have to rely on somewhat crude assumptions. For estimation of PPP converter for private investment, we examine relative price levels of two main categories of private investment: equipment and construction in Japan and the United States. In the case of equipment investment, we use the relative price level calculated by Pilat (1994) for machinery and equipment for 1939. In the case of construction investment, we derive the price levels in Japan and the United States as weighted averages of price for construction materials and wages for construction laborers. The results, presented in Table 5, suggest that the price level for private investment is 50 percent of the U.S. level, higher than the price level for private consumption.

For government expenditure for Japan and the U.S., we divide it into two categories: labor and material costs. Labor costs are measured as the ratio of the average income per government employee in Japan and the U.S. Table 6 shows

[7]Taiwan and Korea became Japanese colonies in 1895 and 1910, respectively. By the 1910s, both Korea and Taiwan were set on a de-facto "Japanese yen exchange standard"—the two Central banks, the Bank of Korea and the Bank of Taiwan, issued their bank notes as circulating currency convertible to the Bank of Japan notes which served as the reserve currency. The currencies of Taiwan and Korea were also yen. The currencies of the three countries were convertible at the 1:1 exchange rate. By the 1930s, Taiwan, Korea and Japan had moved towards a free trade bloc protected by a common external tariff (Yamamoto, 2000).

[8]Consistent with ICP and other international comparison studies, we do not separately estimate PPP for net exports, partly because their share is small as a percentage of total GDP (especially for large countries) and partly because prices of traded goods are already included in other GDP components.

TABLE 5

Relative Price Levels for Private Investment for Japan and the U.S. in 1935

	Weight		Japanese Price Level (U.S. = 1)			
	Japan	U.S.	Japan/U.S.	Japanese Weight	U.S. Weight	Fisher Average
Equipment (machinery and equipment)	0.5	0.5	0.88	0.88	0.88	0.88
Construction				0.22	0.51	0.34
Cement	0.0625	0.075	0.68			
Pig iron	0.0625	0.075	0.78			
Nails	0.0625	0.075	0.72			
Tin plate	0.0625	0.075	0.87			
Wages	0.25	0.2	0.13			
Total	1.0	1.0		0.35	0.69	0.50

Source:

1. The Japan/U.S. relative price for equipment is from Pilat (1994, table 2.5, p. 27). Construction wages are from Table A2. Relative prices for the rest are from wholesale price statistics of both the U.S. and Japan.

2. The weights for Japanese equipment and construction investment are based on Emi (1971, p. 10); for the U.S. the weights are based on US Department of Commerce (1975) (Part I, 1947, p. 283). The shares of raw materials and labor for construction investment for the U.S. are from US Department of Commerce (1975) (Part I, p. 282); for Japan, they are from Fukao *et al*. (2006). We use simple average for individual items of raw materials in Construction for lack of better information.

TABLE 6

Relative Price Levels for Government Expenditure for Japan and the U.S. in 1935

	Weights		Japanese Price Level (U.S. = 1)			
	Japan	U.S.	Japan/U.S.	Japanese Weight	U.S. Weight	Fisher Average
Labor costs	0.24	0.45	0.07	0.07	0.07	0.07
Material costs				0.49	0.61	0.55
Food	0.03	0.02	0.48			
Textiles	0.03	0.01	0.35			
Wood products	0.03	0.06	0.95			
Medical costs	0.14	0.06	0.27			
Chemical products	0.11	0.09	1.33			
Metals & machinery	0.06	0.02	0.88			
Construction	0.08	0.24	0.34			
Transportation and communication	0.21	0.04	0.51			
Coal	0.02	0.01	0.89			
Electricity	0.05	0.01	0.96			
Total	1.01	1.00		0.21	0.37	0.28

Source:

1. Labor costs for Japan are based on the salaries of government employees taken from Emi and Shionoya (1966), which includes the additional bonus (see pp. 222–3 and footnote on p. 222 for the bonus part). Labor costs for U.S. are from US Department of Commerce (1975) (Part II, pp. 1100–1). Data on chemical products, metals & machinery, transportation and communication are from Pilat (1994, p. 24). The remaining figures are from Table A2.

2. The weight for labor and material costs for Japan is based on Emi and Shionoya (1966, pp. 31–2); the equivalent weight for the U.S. is based on US Department of Commerce (1975) (pp. 282–3). (The share of material costs is assumed to be equal to the share of total intermediate inputs in government purchases, while value added is assumed to be equal to labor costs. The U.S. shares used are for the 1950s and 60s.) The weights for materials for Japan are based on Fukao *et al*. (2006, table 5). The weights for materials for the U.S. are based on *Historical Statistics* (pp. 282–3).

TABLE 7

East Asian Price Levels Relative to the U.S. (1934–36)

	Expenditure Weight				Relative Price Level (Fisher average, U.S. = 1)		
	Taiwan	Korea	Japan	U.S.	Taiwan	Korea	Japan
Consumption	0.73	0.84	0.70	0.77	0.39	0.43	0.45
Private investment	0.20	0.11	0.18	0.08	0.47	0.49	0.50
Government expenditure	0.07	0.05	0.12	0.15	0.24	0.25	0.28
GDP	1.00	1.00	1.00	1.00	0.38	0.41	0.43

Source: Price levels and weights for Korea and Taiwan are based on Fukao *et al.* (2006). U.S. weights are based on U.S. Department of Commerce (1998, p. 147).

that the average Japanese government employees' compensation was only 7 percent of that of their U.S. counterparts in nominal terms. The second category, material cost, consists of government purchases from various sectors of the economy. Table 6 provides relative price levels and expenditure weights of ten materials. Their relative price level (of Japan over the U.S.) in weighted average turns out to be 55 percent, higher than that for private consumption. This seems plausible as government purchase draws a substantial share from the investment sector of which Japanese price levels were closer to that in the U.S. Overall, thanks to the much lower remuneration paid to employees in Japan, the Japanese government expenditure price level overall was only 28 percent of that of the U.S.

Using the current-price PPP converters for private consumption, private investment, and government expenditures for Korea and Taiwan (relative to Japan) from Fukao *et al.* (2006), and using Japan as the bridge country, we derive a full set of current-price PPP converters for GDP for the four East Asian economies for the mid-1930s, all converted to the base of the U.S., using the Fisher average. Details of the calculation procedures and the results are reported in Table 7.

2. East Asian Real GDPs in 1934–36

PPP and Market Exchange Rates

Table 8 presents the per capita GDP of the four East Asian economies in 1934–36 U.S. dollars. The first data row shows GDP estimates for the different countries in 1934–36 current prices converted to U.S. dollars at market exchange rates. Not surprisingly, GDP at exchange rates gives very low income estimates for East Asia in the mid-1930s: Japan's per capita income was only 13 percent of that of the U.S. and China was a mere 3.5 percent of the U.S. level. The second row of Table 8 presents the price levels of the four East Asian economies relative to the U.S.

Dividing the exchange rate-based per capita income estimates by the relative price levels, we can derive our 1934–36 benchmark PPP adjusted estimates, presented in the third row of Table 8. In comparison with the exchange rate conversion, our PPP converter more than doubles the per capita income of Japan and Korea and triples the per capita income of Taiwan and China. This is a major correction of the downward exchange rate bias.

TABLE 8

1934–36 East Asian Per Capita GDPs in 1934–36 U.S. Dollars and Relative to the U.S.

	U.S.	Japan	Taiwan	Korea	China
1. Exchange rate converted estimate	574.7	77.1	49.2	29.1	20.1
	100%	13.4%	8.6%	5.1%	3.5%
2. Relative GDP price levels	1	0.43	0.38	0.41	0.32
3. PPP adjusted estimate = 1 ÷ 2	574.7	180.8	129.6	70.9	63.6
	100%	31.5%	22.6%	12.3%	11.1%

Source:

1. GDP for China from Liu and Yeh (1965, p. 68, table 10); for Japan from Ohkawa and Shinohara (1979), for Taiwan and Korea from Mizoguchi and Umemura (1988); for the U.S. from the *Historical Statistics of the U.S.* (the Bicentennial Edition, 1975).

2. 1934–36 exchanges rates: 1 U.S. dollar = 3.43 Japanese yen = 3.01 Chinese yuan (Hsiao, 1974, p. 192). Taiwanese and Korean currencies are fixed at 1:1 to the Japanese currency.

Existing studies on PPP for the pre-war East Asia are few and crude. The study by Clark (1940, p. 41) gave Japanese per capita income in 1925–34 at about 26 percent of the U.S. level, closer to our PPP result than that of exchange rate conversion. However, since both the GDP estimates and price levels used by Clark were long outdated, his study should not be viewed as a direct confirmation of our estimates. The more systematic Japan–U.S. PPP study was carried out by Pilat (1994) with 1939 as the benchmark year and using a production side PPP (versus the expenditure side PPP in this study) approach by matching the unit value ratios of comparable goods and services. His study (Pilat, 1994, p. 24) gives a price level for the overall Japanese economy relative to that of the U.S. at 60.7 percent, higher than our 42 percent figure based on the expenditure approach. The discrepancy is not surprising as the production based PPP matching weighs more heavily toward the tradable items whose prices are likely to be closer across countries.

A crude attempt at calculating purchasing power parities for China and the U.S. was done by Liu Ta-chung, a pioneer in the reconstruction of the 1931–36 Chinese per capita GDP. His market exchange rate conversion, similar to ours, gave the 1931–36 Chinese per capita GDP at 3.8 percent of the U.S. level (Liu, 1946, p. 72). To correct downward exchange rate bias, he compared Chinese and American prices for five categories of agricultural crops and arrived at a Chinese price level of 63 percent of the U.S. level (p. 73). Liu's current-price PPP conversion based on these relative price levels gave the 1931–36 Chinese per capita GDP at 5.7 percent of the U.S. level (Liu, 1946, p. 76). But recognizing that the price level differences in agricultural products were possibly the least important cause of the downward bias, Liu went on to adjust for other structural differences between the U.S. and Chinese economies, a concept that was not clearly spelled out in his study. His final adjustment raised the Chinese per capita income to 9 percent of the U.S. level, a level approaching but still lower than our PPP estimate for China relative to the U.S. as shown in Table 8.

Current-Price PPP versus 1990 Backward Projection

It is very instructive to compare our estimates with the massive dataset compiled by Angus Maddison. In Figure 1, we follow Maddison and convert all per

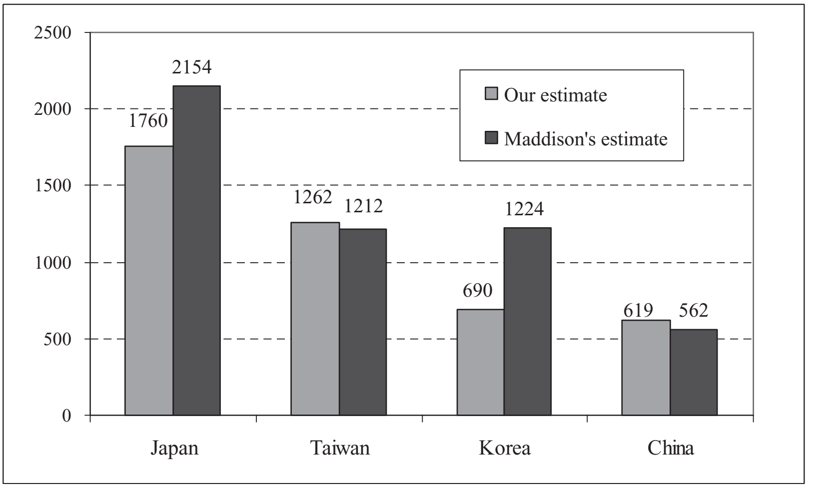

Figure 1. Comparison of Our Current Price PPP Per Capita GDP with Maddison's Back-Projected Estimate (in 1990 U.S. Dollars)

capita GDP estimates into 1990 dollars. Maddison's latest 2003 series provide a back-projected U.S. per capita GDP for 1934–36 at $5,590 in 1990 prices. We use this U.S. figure as the base and apply our relative price levels to derive the per capita incomes of the four East Asian economies in 1990 dollars. Figure 1 compares our 1934–36 benchmark PPP estimates with Maddison's 1990 back-projected estimates, both in 1990 prices.

Figure 1 shows that the deviations between our estimate and Maddison's for Taiwan and China are relatively small. However, his Korean estimate is nearly twice our level and his Japanese figure is 22 percent higher. Maddison's Japanese per capita income of $2,154 (in 1990 dollars) would make the Japanese level at about 39 percent of the U.S. level, higher than our estimate of $1,760, at 32 percent of the U.S. level for 1934–36. Likewise, while the per capita income difference between China and Japan according to Maddison is about 1 to 4, our current price PPP estimate reveals it to be about 1 to 3 for the mid-1930s period. Similar discrepancies in per capita incomes also hold true for Japan versus Taiwan and Korea.

Maddison's upward adjustment of Japanese per capita income from 13 percent (as implied by exchange rate conversion) to 39 percent of the U.S. level would imply a Japanese price level at only about 36 percent of the U.S. level, lower than the 43 percent derived from our study. Similarly, his adjustment of Korean per capita income from 5.1 to 22 percent of the U.S. level would indicate a Korean price level at only 23 percent of the U.S. level, only about half of the 41 percent level derived from our study.

Robustness Checks and Sensitive Test

The discrepancy between our estimates and Maddison's will be explored later. Here we carry out some robustness checks on our PPP estimate. One potential source of error in our PPP comparison is our use of urban price only for these five economies with differential urban–rural shares of population. While urban population shares in the U.S., Japan and Taiwan are roughly comparable, at 56, 54 and 48 percent respectively, the corresponding shares for Korea and China are much lower at 25 percent only.[9] Thus, purely urban-price-based price matching would overestimate the relative price levels of the more rural-based economies of Korea and China. A back-of-the-envelope calculation would show that for two economies with identical urban–rural price gap, national price level (weighted average of urban and rural prices) in a country with 25 percent urbanization would be 4.5 percent lower than a country with 50 percent share of urban population. On the other hand, this downward bias in price levels can also be potentially offset by the relatively lower quality of products and services in poorer and rural-based economies. Thus, our current study makes no adjustment in price level with respect to differential urban–rural population shares.[10]

A second issue is the coverage of our PPP study. With 50–60 items for private consumption and 15–20 items for investment and government expenditure categories, our study is superior to other known PPP research for the pre-WWII period. However, it is still relatively crude by the standard of the large-scale post-WWII ICP exercise that employed 153 categories with hundreds or thousands of individual item prices (Kravis *et al.*, 1982). To test the possible biases of the limited coverage, we match directly the individual categories items of our 1934–36 benchmark with the 153 categories in the 1967 round of ICP study, the earliest year available for Japan–U.S. comparison (see Kravis *et al*., 1975, pp. 257–61). Altogether 46 out of 153 categories in 1967 can be matched.[11] The 1967 shares of these 46 categories amounted to 36 percent with Japanese weight and 47 percent with U.S. weight. Our PPP calculation (using Fisher average) based on these 46 categories alone yields a Japanese price level at 58 percent of the U.S., lower than the 63 percent level derived from the 153 categories in 1967. This 5 percent difference can be easily explained by the fact that most of the unmatched categories are new and modern products that appeared in the post-WWII period, whose relative price levels between Japan and U.S. were smaller than average. In view of the above, we believe that, were a full-scale ICP type of PPP study conducted for the 1934–35 benchmark, the price gap between the ideal ICP study and our study would be limited, certainly below the 5 percent difference.

Finally, we test to see how sensitive our PPP price level to the price of any individual item. We perform an experiment on our China–Japan data sets in Table A2 by dropping an individual item whose weight redistributed to all other items in the data set to re-compute the Fisher-PPP converter. We find that the overall deviation of the recomputed PPPs (with one item excluded each time) from the full-sample based PPP is very small (a standard deviation of 0.0065 for the mean China–Japan relative price level of 0.73). These tests give us some confidence

[9]For urban shares in the U.S., Japan, Taiwan, Korea and China, see US Department of Commerce (1975), *Part I* (p. 11), Bank of Japan (1966, p.14), Mizoguchi and Umemura (1988, pp. 263, 268), and Buck (1937, p. 362).

[10]For the urban–rural price gap in the U.K. and U.S., see Ward and Devereux (2003, p. 831).

[11]The 153 categories for 1967 can be found in Kravis *et al.* (1975, pp. 257–9). The matched 46 categories out of the 153 categories in 1967 are categories 1–3, 7, 9–10, 13–15, 17, 21–23, 28, 30, 33, 37, 38, 40, 48, 52, 54, 55, 58, 72, 75, 83, 85–87, 90, 97–100, 104–106, 125, 136, 137, 149–153.

TABLE 9

Comparison of Relative Price Levels in Pre- and Post-War Periods (U.S. = 100) (numbers in parentheses are PPP adjusted per capita incomes relative to the U.S.)

	Japan	Korea*	Taiwan	China	Sources
1934–36	*35 (39)*	*23 (22)*	*40 (22)*	*35 (10)*	*Maddison back-projection*
	43 (32)	**41 (13)**	**38 (23)**	**32 (11)**	**This study**
Expenditure based PPP					
1952	52 (18)				Watanabe and Komiya, 1958
1967	63 (48)				Kravis *et al*., 1975, pp. 238–9
1970	68 (59)	47 (12)			Kravis *et al*., 1982, pp. 13, 21
1973	95 (64)	43 (15)			Kravis *et al*., 1982, pp. 13, 21
1975	90 (68)	39 (21)			Kravis *et al*., 1982, pp. 13, 21
1985	93 (72)	53 (24)	57 (34)		Yotopulos and Lin, p. 14
1986				23 (8)	Maddison, 1998, pp. 153–4
Production based PPP					
1939	61 (27)				Pilat, 1994, p. 24
1965	55 (46)	38 (8)	33 (18)		Maddison, 1970, p. 295
1975	106 (53)	66 (18)			Pilat, 1994, pp. 118, 121
1985	101 (65)	66 (31)			Pilat, 1994, pp. 152, 154

*South Korea for the post-WWII period.

Source:

1952 is from Watanabe and Komiya 1958. The study did not include, for example, expenditure on energy and housing, the relatively high-priced items in Japan. It did not calculate relative per capita GDP for 1952. We recalculate it with the exchange rate at 1 U.S. dollar = 360 yen and the 52% relative price levels. The per capita GDP estimates for Japan and the U.S. in 1938 and 1952 current prices are from Ohkawa and Shinohara (1979, p. 283) and *Historical Statistics of the United States* (1975, pp. F10–30).

Maddison's PPP converter for China–U.S. in 1986 is based on study by Ren Rouen.

that the margin of errors in our estimate are within reasonable bounds and our PPP result is robust even judged by the stringent post-WWII ICP standard.

Table 9 presents a comprehensive comparison of the relative GDP price levels derived from our study against those in other PPP benchmark studies across different periods as well as Maddison's back-projection. The table shows clearly that the implicit relative price levels in Maddison's back-projected estimates for Japan and Korea—the two countries where our per capita GDP estimates differ most as shown in Figure 1—seemed implausibly low. Surprisingly, even his own production side based PPP studies on Japan and Korea for 1965 showed relative price levels and per capita GDP far closer to our study than his own back-projected estimate.

3. Backward Projection: Theoretical and Empirical Issues

Our finding of a significant discrepancy between GDP figures based on current price PPP and back-projected PPP have long been confirmed by various existing research such as the numerous rounds of post-war ICP studies (Kravis *et al.*, 1982; Heston and Summers, 1993; Maddison, 1998). By comparing past ICP results of every five years from 1970 and backward projected per capita GDP based on 1990 benchmark PPP, their studies reveal substantial gaps between the two values for many countries. Recent studies on long-term historical data of the U.S. and Europe also confirmed similar discrepancies (Ward and Devereux, 2003, 2005). We see two major sources of errors arising out of back-projection from the 1990 benchmark. The first is likely to occur in the linking of a long-term real GDP series which consists of disparate volume series often reconstructed with varying quality, definitions and benchmarks. The second is the index number bias inherent in the back-projection procedure which cast the later period price or quantity weights to the current period ones. Below, we turn to these two issues.

The Making of Real GDP Series in East Asia and the U.S.

Long-term domestic real GDP series used for a period of 60 years between 1930 and 1990 rarely come from a single continuous series. Instead, disparate series with multiple benchmarks or varying definitions, quality and coverage were often "patched together." For example, the coverage and definition of GDP statistics have been revised in the transition from the 1968 SNA to the 1993 SNA. The procedure of using the late-year benchmark to link backward, while useful in updating the past series of real GDP from the old definition to the new definition, could potentially change the original values of the current price nominal GDP in the earlier period and lead to discrepancy between back-projected and current price estimates. Below, we trace Maddison's linking procedure for the five economies under study here.

We first examine Taiwan and China where the discrepancies between current and back-projected estimates are the smallest. The Taiwan real GDP series used by Maddison is the most consistent, based entirely on the 1912–90 series meticulously reconstructed by Mizoguchi and others using 1960 price as the benchmark. Maddison's Taiwan 1990 benchmark PPP came from the Penn World Table, which in turn was based on the 1985 benchmark PPP by Yotopoulos and Lin (1993), updated to 1990 with domestic real GDP growth rates (see Maddison, 2003, p. 153; Fukao *et al.*, 2006). Maddison's Chinese GDP series is presented in detail in his 1998 OECD publication. As is well-known, both the level and trend of Chinese GDP in the post-WWII Communist period are highly controversial due to major differences in definitions and coverage. Maddison's linking of Chinese GDP series between the 1930s and 1950s relied on the careful work of Liu and Yeh (1965) and others. In fact, Maddison used the 1930s GDP to revise the real GDP level for the Communist period (pp. 149–55). Maddison's 1990 benchmark PPP is updated from 1986 benchmark PPP estimated by Ren Ruoen (Maddison, 1998, pp. 153–4).

In contrast, Maddison's linking of Korea real GDP seems the most problematic. There are no consistent GDP series for Korea between 1938 and 1953. Maddison linked the colonial series and post-WWII series by combining a host of disparate independent estimates added with assumptions about the split of territories and population between North and South Korea in the post-war period (Maddison, 2003, p. 153). Although further investigation is necessary, we suspect the large margin of errors inherent in Maddison's linking give rise to the striking discrepancy between the current price and back-projected per capita income estimate for 1934–36 Korea (see Fukao *et al.*, 2006 for details).

Finally, we turn to examine the linking of U.S. and Japanese real GDP series. The U.S. real GDP series is the most straightforward as Maddison's entire series from 1929 onward is from the official Department of Commerce, Bureau of Economic Analysis (BEA) statistics from which we also derive the mid-1930s benchmark current price estimate (Maddison, 2003, pp. 79–80). Discrepancies, if any, between the old and new versions of the BEA series are mostly for the post-war period rather than the 1930s figures and they are usually in the range of 5–6 percent.[12]

For Japan, Maddison used the same Ohkawa and Shinohara GDP series for the pre-war period as we did. However, the series ended in 1940 and the post-war series began only after 1952. Maddison's most recent study filled the war period gap by utilizing an independent study on wartime GDP by Mizoguchi and Nojima (1993). We trace and compare the nominal GDP figures for the three different linking periods at 1940, 1952 and 1960. We find the discrepancies between the nominal figures in different series at each linking periods are relatively minor, and overall the linking procedure by Maddison might lead to a 5.45 percent upward revision of the original Ohkawa and Shinohara series for the pre-war period.[13] Since both the Japanese and U.S. series seem to be raised by about 5–6 percent in this process, updating the real GDP series of both the U.S. and Japan based on the late series is not likely to impact greatly the levels of their nominal GDP in the 1930s.

To sum up, except for Korea, Maddison's linking procedure has been reasonably consistent for the other four economies in this study. Therefore, to explain Maddison's 22 percent upward bias for Japanese per capita income estimate, we look beyond the linking procedure and examine the index number problem bias in back-projection.

Backward Projection Bias: An Index Number Formulation

One difference between our PPP study and the ICP based studies is the use of PPP Fisher average versus the multilateral Geary Khamis (GK) method. It is well-known that the GK method yields lower PPP and thus higher PPP-adjusted real GDP estimates of lower income countries than the Fisher average.[14] According to Maddison's survey (1995, table C-6, p. 172), the Fisher-based PPP only exceeds the GK by about 5–6 percent in 1990, a ratio he used to update the original Fisher-based PPP Taiwan (1985 benchmark) and China (1986 benchmark) into the GK index. For our index number formulation, we present everything in terms of GK international price.

We express the 1990 benchmark backward projected real per capita GDP in benchmark year t (t is 1934–36 in this study) as in equation (1):

[12]See US Department of Commerce (1975), *vol. 1* (p. 224) for the old version and http://www.bea.doc.gov/bea/dn/gdplev.xls for the new version.

[13]The nominal GDP figures for 1940 used by Mizoguchi and Nojima come from Japanese government publications (Keizai Shingi-cho, 1953; Keizai Kikaku-cho, 1963). It is equal to 99 percent of the nominal GDP figures in the Ohkawa and Shinohara series in 1940. Nominal GDP figures used by Maddison to link 1952 and 1960 come from the OECD National Income Statistics (1976, 1999) and are both equal to about 1.03 of the old series. Overall, the linking of the three series in total revised upward the level of real GDP series by 5.45 percent.

[14]The overestimation of per capita GDP in low income countries and thus the underestimation of global inequality due to the use of GK method is explored in detail in Dowrick and Akmal (2005).

(1) $$y_i^E(t,90)=\frac{\mathbf{p}_t^i\mathbf{q}_t^i}{\mathbf{p}_t^i\mathbf{q}_{90}^i}\mathbf{p}_{90}^G\mathbf{q}_{90}^i$$

where $\mathbf{p}_t^i$ denotes a row price vector for commodities (or services) of types *1* through *N* in country *i* at time *t*, and $\mathbf{p}_{90}^G$ denotes the row vector of the reference price (Geary-Khamis (GK) international price), for year 1990. Similarly, $\mathbf{q}_t^i$ and $\mathbf{q}_{90}^i$ are the corresponding column vectors of country *i*'s real per-capita net output.

The first term on the right-hand side of the above equation is the ratio of country *i*'s real per-capita GDP at time *t* over that in 1990 measured in year *t* price. The second term is country *i*'s 1990 real per-capita GDP in 1990 GK price. The product of the two terms gives $y_i^E(t,90)$, the Maddison style 1990 back-projected real per-capita GDP of country *i* at time *t*, with the superscript *E* standing for back-projection or extrapolation. These estimates are equivalent to the "Maddison's estimate" for East Asia in Figure 1.

Our 1934–36 benchmark GDP in current price U.S. dollars as shown in row 3 of Table 8 can be formally written as $y_i^C(t)=\frac{\mathbf{p}_t^G\mathbf{q}_t^i}{\mathbf{p}_t^G\mathbf{q}_t^{US}}\times\mathbf{p}_t^{US}\mathbf{q}_t^{US}$, where superscript *C* stands for current price. This is the ratio of country *i*'s real per-capita GDP to that of the U.S. multiplied by the real per-capita U.S. GDP at time *t* (1934–36 in this study). To derive our 1934–36 East Asian GDP in 1990 dollars (shown as "Our estimate" in Figure 1), we first divide our current price per capita income estimate, $y_i^C(t)$, by that of the U.S., $y_{US}^C(t)=\mathbf{p}_t^{US}\mathbf{q}_t^{US}$ and then multiply Maddison's 1990 back-projected U.S. estimate, $y_{US}^E(t,90)$. With some cancellation and rearranging of terms, we derive equation (2) as follows:

(2) $$y_i^C(t)\div y_{US}^C(t)\times y_{US}^E(t,90)=\frac{\mathbf{p}_t^G\mathbf{q}_t^i}{\mathbf{p}_t^G\mathbf{q}_t^{US}}\times\frac{\mathbf{p}_t^{US}\mathbf{q}_t^{US}}{\mathbf{p}_t^{US}\mathbf{q}_{90}^{US}}\times\mathbf{p}_{90}^G\mathbf{q}_{90}^{US}.$$

Clearly, since equations (1) and (2) are based on different index number formulae, it can only be pure coincidence that the two figures are equal. To analyze the deviation of these two estimates, we conduct a log-decomposition of the ratio of equations (1) over (2). Rearranging the terms, we express the full log-decomposition identity in equation (3) as follows:

(3) $$\begin{aligned}&\left\{\ln\left(y_i^E(t,90)\right)-\ln\left(y_{US}^E(t,90)\right)\right\}-\left\{\ln\left(y_i^C(t)\right)-\ln\left(y_{US}^C(t)\right)\right\}\\&=\underbrace{\left\{\ln\left(\frac{\mathbf{p}_t^G\mathbf{q}_{90}^i}{\mathbf{p}_t^G\mathbf{q}_t^i}\right)-\ln\left(\frac{\mathbf{p}_t^i\mathbf{q}_{90}^i}{\mathbf{p}_t^i\mathbf{q}_t^i}\right)\right\}}_{\text{weight inconsistency effect}}+\underbrace{\left\{\ln\left(\frac{\mathbf{p}_{90}^G\mathbf{q}_{90}^i}{\mathbf{p}_t^G\mathbf{q}_{90}^i}\right)-\ln\left(\frac{\mathbf{p}_{90}^G\mathbf{q}_{90}^{US}}{\mathbf{p}_t^G\mathbf{q}_{90}^{US}}\right)\right\}}_{\text{terms of trade effect}}\\&-\left\{\ln\left(\frac{\mathbf{p}_t^G\mathbf{q}_{90}^{US}}{\mathbf{p}_t^G\mathbf{q}_t^{US}}\right)-\ln\left(\frac{\mathbf{p}_t^{US}\mathbf{q}_{90}^{US}}{\mathbf{p}_t^{US}\mathbf{q}_t^{US}}\right)\right\}.\end{aligned}$$

Equation (3), as cumbersome as it appears, has nice interpretative properties: a positive (or negative) value implies an overestimate (or underestimate) of the *t* period per capita income using the 1990 back-projection method. We summarize the first two terms in equation (3) as "weight inconsistency" effect, also defined by

Szilágyi (1984). It is the log-difference between country *i*'s real GDP growth rates from *t* to 1990 measured using the *t* period GK price and that based on the *t* period domestic price. This weight inconsistency effect, similar to the so-called "Gerschenkron effect," stems from the divergence in domestic real GDP growth rates derived from the use of international price versus domestic price of the *t* period. As partly shown in our matched price items for the mid-1930s, prices in East Asia relative to the U.S. tended to be relatively lower in the primary and service sectors but higher in manufacturing and industrial goods. As international price at time *t* assigns relatively lower weights than domestic price to the expanding manufacturing sector but higher weights to the slow-growing primary sector and service sectors, real GDP growth rate measured using the 1930s international price would be smaller than that using domestic price. Holding other things constant, the weight-inconsistency effect in our case is likely to be negative, implying that back-projection underestimates country *i*'s real GDP at time *t*.

The second component, captured by the next two terms, is bracketed as "terms of trade effect" in equation (3). It is the log-difference of international GK prices between *t* and 1990 for country *i* and the U.S., each weighted by their respective net output in 1990. With certain assumptions, this is equivalent to country *i*'s Paasche terms of trade index relative to the U.S. This "terms of trade" effect, indicates that if country *i*'s Paasche terms of trade improves (or deteriorates) relative to that for the U.S., then backward projection will overestimate (or underestimate) country *i*'s output at time *t*.

Intuitively, this can be understood by the following hypothetical example. Suppose there are two open economies *A* and *B*. Country *A* is a producer of primary goods and country *B* is a producer of manufacturing goods. Assume two countries' total GDP are equal, measured at the international prices in 1930. By 1990, both countries have doubled their output but international prices for primary goods have also doubled, while those for manufacturing goods remain constant. This would imply that country *A*'s GDP is twice that of country *B* based on 1990 prices due to the terms of trade improvement. If we project backward based on the 1990 international price, we will overestimate the relative standing of country *A* over *B* in comparison to that based on the 1930 international price. Since the East Asian economies are more similar to country *A* type than is the U.S., our conjecture is that back-projection leads to overestimation biases of their per capita incomes in the 1930s.

The final two un-bracketed terms in equation (3) are the log-difference between two U.S. quantity indices measured by GK price and U.S. prices respectively at time *t*. Since our PPP study for 1934–36 benchmark is based on the U.S. as the base country, the difference between U.S. and GK prices in 1934–36 is trivial and can be ignored.

Our index number formulation reveals that the bias effects of weight-inconsistency and terms of trade are in fact opposite in direction. Thus both the direction and magnitude of bias are a function of the relative strength of these mutually offsetting factors. This important insight may explain the lack of any systematic direction in biases as revealed in this study as well as the post-WWII ICP. Ideally, one could empirically test the back-projection bias using long-term data on economic structure and terms of trade. Unfortunately, such an empirical test faces several difficulties. As indicated earlier, long-term real GDP series themselves are rarely consistently back-projected from the 1990 benchmark according to our idealized index number formulation. Often, GDP series with multiple benchmarks or varying definitions are linked together, which could compound existing biases, making it extremely complicated, if not impossible, to disentangle.

In Appendix B, we present a preliminary test on the terms of trade (TOT) effect based on our index number formulation and the ICP data for the post-war period. We assume that weight consistency effect is insignificant and small given the much shorter span of 1970 and 1990 covered in the ICP study. Our regression does confirm a statistically significant coefficient with the right sign. We then apply our finding to the case of Japan and U.S. between 1935 and 1990. We find similar confirmation of this relationship between TOT and back-projection biases. However, our preliminary calculation shows that this TOT improvement in Japan relative to the U.S. can only account for 3 percent of the upward biases, clearly a small fraction in relation to the 22 percent overestimate we found in this study. But, this test is far from ideal due to the various data problems illustrated in Appendix B and that the weight consistency effect is likely to be more significant for the 60 year period between the mid-1930s and 1990 than five year period used in ICP data. While much more research is needed, we believe that the reconstruction of current price benchmark PPP study remains as the most important cross-check on back-projected estimates.

4. Implications and Summary

Pre-war GDP estimates for Japan and East Asia based on back-projection have been widely cited in major textbooks and academic publications on economic growth. Our new current-price based estimates thus carry large implications. First, they realigned the 1930s per capita income ranking and gap among the four East Asian economies studied. Chinese per capita income in the 1930s was 35 percent of the Japanese level according to our estimate, compared with Maddison's 26 percent. This ratio for the Japanese colony of Taiwan is 72 percent, much higher than Maddison's 56 percent. Meanwhile, our estimates show that Taiwanese per capita income is 82 percent higher than Korea, whereas Maddison shows they are comparable (see Figure 1). Second, our estimate of 1934–35 Japanese per capita estimate of $1,760 (in 1990 prices) would—if inserted in the Maddison dataset—rank Japan lower than almost all other Western European countries, including Spain, Italy and Greece, only marginally higher that of Malaysia or the Philippines for that period. These intriguing findings seem to point to the need for a more comprehensive research on pre-war PPP for other countries as well.

Back-casting our mid-1930s PPP adjusted income estimate sheds further light on Japan's initial conditions in the early Meiji period. For example, projecting backward from the level of $1,760 (in 1990 prices) in the mid-1930s—rather than Maddison's $2,154—gives an 1880s Japanese per capita income of about $600, only marginally higher than those in China and India but lower than in the Philippines and Thailand (see Maddison, 2003, p. 180). In other words, on the eve of the first wave of industrialization in the 1880s, the Japanese economy was near subsistence, no richer than those of its Asian neighbors, whom Japan was to overtake or even colonize in the following few decades.

This is quite a reassessment of prevailing views on both the initial conditions and the dynamics of long-term economic growth for Japan and Asia in general. We have reason to believe that our result is much more consistent with available information on economic structures, consumption patterns and historical realities. Recent studies based on the comparison of real wages seem to lend tentative support to this reassessment. For example, Bassino and Ma (2005) and Allen *et al.* (2005) show that Japanese real wages in the 18th century were close to those in China and low-income European countries such as Italy. Real wages only consistently rose above the Chinese level after the 1890s and reached more than twice China's level by the 1920s, a result consistent with the per capita GDP differences indicated in this PPP study for the mid-1930s. Studies by Bassino and van der Eng (2002) and Bassino (2005) also reveal that daily nominal wages for unskilled laborers and carpenters in Tokyo in 1935 were not much higher than those in Bangkok, Singapore, or Penang in British Malaya. As consumer price levels, particularly food prices, were much lower in those Southeast Asian cities, their studies suggest that real wages in Tokyo were lower than in those cities.

In this regard, the respectable Japanese economic growth in the pre-WWII period should be deemed as catching up (or overtaking) with the resource rich Southeast Asia in level terms but keeping up with the world income leaders in growth terms. Japanese and subsequently Taiwanese and Korean economic convergence with the world income leaders is truly a post-war phenomenon. This is particularly striking if one compares the pre- and post-war income gaps within East Asia. Income differentials of Japan, Taiwan, and Korea versus China in the 1980s were multiples of those in the 1930s. In this regard, China's rapid economic growth since the 1980s, particularly in some of her coastal regions, is partly a making up for her missed opportunities.

Of course, the big question is: why was it Japan—rather than Malaysia or Thailand—that caught up so quickly in the post-war period despite their possibly common starting points? We can offer some conjectures. Bassino's (2005) wage data shows that the skill premium for carpenters vis-à-vis unskilled laborers in Tokyo was smaller than in any of the Southeast Asian cities, indicating the existence of a large pool of skilled workers in Japan in comparison with Southeast Asia. A recent study by Godo and Hayami (2002) revealed that in the 1930s, average years of schooling in Japan were already over 60 percent of the U.S. level despite the much greater lag in per capita income. Japan then already had some of the world's most dynamic industries, a sizable entrepreneurial class, a competent bureaucracy and, of course, a nation state. Was Japan already on a course of convergence in the pre-war era but was thrown off course by the war? This PPP study provides new answers and raises new questions.

In sum, our study provides a set of pre-war benchmark PPP converters that allow us to carry out comparisons of income, consumption, and other monetary indicators for East Asia in a global context. Our pre-war PPP converters confirm that market exchange rate conversion consistently underestimated per capita incomes of East Asia. They also reveal biases associated with the 1990 backward projection method. Our preliminary theoretical and empirical analysis pointed out the direction of such bias and set out a framework for future research which will enable us to quantify the magnitude of this bias and to eventually "consistentize" our new levels with growth trend in the long-term GDP series for East Asia and beyond.

Our finding that Japanese per capita income in the mid-1930s or the entire pre-war period was lower than widely believed is a major revision of our existing interpretation of long-term economic growth in Japan and East Asia. It may also have further reverberations on our interpretation of the determinants of long-term economic growth. The fact that Japan, or East Asia in general, were historically very poor, is perhaps a message of blessing for developing countries today: initial poverty itself is no curse to a nation's aspirations for prosperity.

Appendix A: Tables

TABLE A1
Chinese Price Level Relative to Japan (1934–36; Japan = 1)

	Items	Chinese Weight I	Chinese Weight II	Chinese Weight III	Japanese Weight I	Japanese Weight II	Japanese Weight III	Unit	Absolute Price: Japan	Absolute Price: China	Absolute Price: China/Japan in PPP	Absolute Price: PPP/ER	Chinese Price Level: Chinese Weight	Chinese Price Level: Japanese Weight	Chinese Price Level: Fisher Average	Sampling Cities of China*
Total	Exchange rate								Yen	Yuan	Yuan/Yen	ER = 0.88 Yuan/yen	**0.65**	**0.83**	**0.73**	
Food		**68.7**			**40.9**								**0.66**	**0.79**	**0.72**	
Grain			68.5	100.0		35.3	100.0						**0.68**	**0.67**	**0.68**	
	Rice			69.9			93.3	1 kg	0.24	0.14	0.59	0.67	1.04	0.62		***1-11***
	Wheat			30.1			6.7	1 kg	0.21	0.13	0.63	0.72	0.42	0.05		***1-11***
Vegetables and fruits			8.8	100.0		8.9	100.0						**0.70**	**0.77**	**0.73**	
	Soybeans			1.7			13.9	1 kg	0.23	0.11	0.45	0.52	0.03	0.07		***1-11***
	Other beans			7.3			9.8	1 kg	0.19	0.06	0.35	0.40	0.18	0.04		*1-3,5-8,10,11*
	Potatoes			5.9			2.9	1 kg	0.07	0.03	0.38	0.43	0.14	0.01		*1,2,4,6,7,9-11*
	Cabbages			63.0			43.7	1 kg	0.08	0.06	0.66	0.75	0.84	0.33		*1,2,4,6,8-11*
	Green onion			2.3			9.9	1 kg	0.08	0.03	0.39	0.44	0.05	0.04		*1,4,6,7,9,11*
	Drying vegetables			9.0			9.9	10 monme (37.5 g)	0.18	0.12	0.66	0.75	0.12	0.07		*1,4,7,10*
	Apples			0.1			2.5	100 monme (375 g)	0.15	0.30	1.99	2.26	0.00	0.06		*1-4,6,9-11*
	Oranges			0.3			2.5	100 monme (375 g)	0.08	0.14	1.78	2.03	0.00	0.05		*1-4,6,9-11*
	Bananas			0.1			2.5	1 kg	0.20	0.40	2.03	2.31	0.00	0.06		*1-4,6,9-11*
	Other fruits			10.1			2.5	100 monme (375 g)	0.10	0.14	1.37	1.56	0.06	0.04		*1,2,4,6,10*
Ingredients			7.4	100.0		8.5	100.0						**0.98**	**1.27**	**1.12**	
	Soysauce			18.0			27.0	1 litter	0.27	0.47	1.74	1.98	0.09	0.53		***1-11***
	Miso			8.0			17.7	1 kg	0.22	0.18	0.82	0.93	0.09	0.17		*2,7,9,11*
	Sugar			11.6			11.5	1 kg	0.40	0.48	1.21	1.38	0.08	0.16		***1-11***
	Salt			8.3			3.5	1 kg	0.07	0.22	3.00	3.41	0.02	0.12		***1-11***
	Oil			54.2			40.4	1 litter	1.03	0.67	0.65	0.74	0.73	0.30		***1-11***
Meat and fish			5.9	100.0		13.5	100.0						**0.36**	**0.80**	**0.54**	
	Pork			38.1			5.3	100 g	0.14	0.04	0.32	0.36	1.06	0.02		***1-11***
	Beef			27.0			12.8	100 g	0.16	0.04	0.23	0.26	1.05	0.03		***1-11***
	Chicken			2.5			2.0	100 g	0.21	0.07	0.34	0.39	0.06	0.01		*1-8,10*
	Fresh fish			14.9			20.5	1 kg	0.71	0.38	0.54	0.61	0.24	0.12		*1-4,6,8-10*
	Salty fish			3.8			20.5	1 kg	1.15	1.85	1.62	1.84	0.02	0.38		*1-4,9,10*
	Other seafood			6.3			20.5	1 kg	0.75	0.20	0.26	0.30	0.21	0.06		*1,2,4,9,10*
	Eggs			5.9			14.3	1 kg	0.62	0.37	0.59	0.67	0.09	0.10		***1-11***
	Milk			1.4			4.3	1 bottle	0.37	0.62	1.67	1.90	0.01	0.08		*1,2,4,8,9*
Others			1.0	100.0		23.8	100.0						**0.77**	**0.80**	**0.79**	
	Sweets			11.7			25.0	1 kg	0.16	0.12	0.76	0.86	0.14	0.22		*1,2,4*

		Preserved vegetables (pickles)			21.6			25.0	1 kg	0.16	0.12	0.76	0.86	0.25	0.22		*1,2*
		Tofu			25.1			25.0	1 cake	0.07	0.03	0.45	0.52	0.49	0.13		*3,4,6,8-10*
		Other processed food			41.6			25.0	100 monme (375 g)	0.07	0.06	0.86	0.97	0.43	0.24		
	Drinks and tobacco			8.4	100.0		9.9	100.0					0.00	**0.59**	**0.71**	**0.65**	
		Tobacco			51.4			39.1	1 package	0.15	0.16	1.06	1.20	0.43	0.47		***1-11***
		Alcohol			20.9			48.7	1 litter	0.85	0.15	0.18	0.21	1.02	0.10		***1-11***
		Tea			27.7			12.1	100 g	0.19	0.19	1.03	1.17	0.24	0.14		***1-11***
Lighting and Heating			**8.3**			**4.8**								**0.58**	**1.12**	**0.80**	
	Electricity a)			0.3	100.0		47.6	100.0	1 kwh	0.14	0.16	1.16	1.31	**1.31**	**1.31**		
	Fuel			97.0	100.0		48.9	100.0						**0.57**	**0.94**	**0.73**	
		Coal			6.0			11.8	10 kg	0.27	0.11	0.41	0.46	0.13	0.05		***1-11***
		Firewood			77.0			38.8	10 kg	0.26	0.12	0.45	0.52	1.49	0.20		*1,4,6,8-11*
		Charcoal			1.7			40.8	10 kg	0.81	1.00	1.24	1.41	0.01	0.57		*3,4,6,8-11*
		Lamp oil			15.3			8.6	1 kg	0.26	0.28	1.09	1.24	0.12	0.11		***1-11***
	Others	Matches		2.7	100.0		3.5	100.0	1 packet (10 boxes)	0.06	0.05	0.82	0.94	**0.94**	**0.94**	**0.94**	***1-11***
Clothing and Bedding			**8.5**			**10.7**								**0.63**	**1.16**	**0.86**	
	Clothing			80.3	100.0		72.8	100.0						**0.63**	**1.23**	**0.88**	
		Cotton weaver's wage (female) *b)*			79.4			49.8	daily	0.65	0.32	0.49	0.56	1.42			
		Sweatshirt			11.3			49.7	1 piece	0.88	1.48	1.68	1.91	0.06	0.95		***1-11***
		Cotton			9.2			0.5	1 kg	0.98	0.71	0.72	0.82	0.11	0.00		***1-11***
	Personal items			19.7	100.0		27.2	100.0						**0.66**	**0.95**	**0.79**	
		Sports shoes			25.0			34.9	1 pair	0.70	1.07	1.53	1.74	0.14	0.61		***1-11***
		Shoemaker's wage *b)*			25.0			34.9	daily	1.77	0.73	0.41	0.47	0.53	0.16		***1-11***
		Umbrella			50.0			30.3	1 piece	0.89	0.47	0.53	0.60	0.84	0.18		*1-4,8-10*
Housing			**5.3**			**10.7**								**0.57**	**0.49**	**0.53**	
	Rent			61.6	100.0		97.3	100.0						**0.46**	**0.47**	**0.46**	
		Monthly housing rent *c)*			33.4			33.4	1 room (7.43 sq.	5.09	1.72	0.34	0.38	0.87	0.13		*9,11*
		Carpenter's wage *b)*			33.3			33.3	daily	1.97	0.96	0.49	0.55	0.60	0.18		
		Brick d)			33.3			33.3	1000 pieces	22.18	9.11	0.41	0.47	0.71	0.16		***1-11***
	Furniture			38.4	100.0		2.7	100.0						**0.97**	**1.13**	**1.05**	
		Wooden board			33.4			33.4	3.3 sq. m.	1.98	1.68	0.85	0.96	0.35	0.32		
		Sawer's wage *b)*			33.3			33.3	daily	1.55	0.91	0.59	0.67	0.50			
		Wash basin			33.3			33.3	1 piece	0.31	0.49	1.56	1.77	0.19	0.59		***1-11***
Miscellaneous Expenses			**9.2**			**32.9**								**0.75**	**0.84**	**0.79**	
	Trans.			4.9	100.0		**6.2**	100.0						**0.40**	**0.85**	**0.58**	
		Rickshaw pullers' wage *b)*			50.0			50.0	daily	2.67	0.54	0.20	0.23	2.18	0.11		

TABLE A1 (*continued*)

	Items	Chinese Weight I	Chinese Weight II	Chinese Weight III	Japanese Weight I	Japanese Weight II	Japanese Weight III	Unit	Absolute Price: Japan	Absolute Price: China	Absolute Price: China/Japan in PPP	Absolute Price: PPP/ER	Chinese Price Level: Chinese Weight	Chinese Price Level: Japanese Weight	Chinese Price Level: Fisher Average	Sampling Cities of China*
	Average railroad fares per passenger km *e)*			50.0			50.0		0.01	0.02	1.30	1.47	0.34	0.74		
Education			1.5	100.0		5.8	100.0						**0.37**	**0.81**	**0.55**	
	Teachers' wage *b)*			50.0			50.0	monthly	65.91	12.50	0.19	0.22	2.32	0.11		
	Pencil			50.0			50.0		0.03	0.04	1.23	1.40	0.36	0.70		***1-11***
Hygience			9.9	100.0		10.4	100.0						**1.17**	**1.39**	**1.28**	
	Soap			25.0			25.0	1 piece	0.10	0.20	2.00	2.27	0.11	0.57		***1-11***
	Toothbrush (Tokyo)			25.0			25.0	1 piece	0.15	0.21	1.40	1.59	0.16	0.40		***1-11***
	Haircut *f)*			50.0			50.0	once	0.40	0.30	0.75	0.85	0.59	0.43		
Medicine	*Liushenwan (Chinese medicine) g)*		5.8	100.0		12.8	100.0	1 tablet	0.05	0.01	0.26	0.30	**0.30**	**0.30**	**0.30**	1
Entertainment	Movie *h)*		19.2	100.0		21.3	100.0	once	0.30	0.20	0.67	0.76	**0.76**	**0.76**	**0.76**	
Other	Newspapers *h)*		58.7	100.0		43.5	100.0	1 set	0.05	0.04	0.80	0.91	**0.91**	**0.91**		

Notes on PPP calculation: The column under "China/Japan in PPP" is the ratio of Chinese price over Japanese price in the previous two columns. In the case of rice, it is equal to 0.14 ÷ 0.24 = 0.59. The column under "PPP/ER" is the number in the "China/Japan in PPP" column divided by the exchange rate which is equal to 0.88. The numbers under the columns of "Chinese weight," "Japanese weight" and "Fisher Average" are calculated based on the index number formulae given in the introduction to Section 1.

Source notes:

*The number of cities in our sample is ordered as follows: 1. Shanghai, 2. Shijiazhuang, 3. Chongqing, 4. Guangzhou, 5. Zhengzhou, 6. Nanjing, 7. Lanzhou, 8. Hangzhou, 9. Tianjin, 10. Wuhan, 11. Beijing.

1. The original price data are mainly from "Archival Materials for Studies of Industrial and Agricultural Commodity Prices." For some cities where prices are missing for some items in our sample, we use the average prices of their neighboring cities as follows: for Chongqing, we use the average prices of Nanchong, Jianyang, Lizhuang; for Wuhan, we use the average of Shashi, Shuanggou, Shadaoguan, Ziqiu; for Guangzhou, we use Shantou; for Beijing, we use Zhangjiakou; for Nanjing, we use the average of Wuxi, Erjiazheng, Suqian, Xuzhou; for Lanzhou, we use the average of Xining and Huangyuan; for Shijiazhuang, we use the average of Baoding, Dingxian, Tangshan; for Zhengzhou, we use the average of Zhengping and Linbao; for Hangzhou, we use the average of Pinghu and Yiwu. Prices for Beijing are the average of 1934–35 from *China Economic Statistics Annals*.

2. For weights, see the text. For Housing and Miscellaneous, we use simple average for the lower level weights.

(a) Average of Chongqing and Wuxi. Chongqing from *Sichaun Economic Reference Materials* for 1935 (Zhang, 1939), Wuxi is the average of 1934–35 from *China Economic Statistics Annals*. Japan is for Tokyo only.

(b) Teachers' wages in China are estimated from Hao Jinhua (2005), "Income of Private School Teachers in 1920–30s" in *Fujian luntan* (Fujian Tribune). The Monthly wages converged from annual salaries. Japan is from *Statistical Annals of Japanese Empire*. Ricksaw Pullers' daily wages in China from Shanghai Local Gazette Office (at http://www.shtong.gov.cn/). Other Chinese wages from *China Economic Statistics Annals* with daily wages converted into monthly income by multiplying 25 days. Japanese wages from Ohkawa *et al*., *LTES, Vol. 8*.

(c) Average of Tianjin and Beijing. Tianjin from *Nankai Economic Indices*, Beijing from *China Economic Statistics Annals*. Japan is for Tokyo.

(d) Wholesale prices.

(e) The railroad fares per passenger-km is the average of Jing-han line (1936), Bei-ning line (1935) and Jingpu line (1935) reported in *World Rail Statistics.* Japan is from *Ministry of Railroad.*

(f) Chinese price from Wuhan Local Gazette Office (http://www.whfz.gov.cn/. Japanese price is for Tokyo.

(g) Japan is from *Asahi News* for 1934–36.

(h) *Dagong Daily* for 1934–36.

(i) Price of gasoline is from 'Newspaper Article in digital version' at Kobe University (http://www.lib.kobe-u.ac.jp/sinbun/e-index.html); the original source is *Chugai shogyo simpo* 1935.9.26.

3. Source information on prices and weights for Japan can be found in Yuan and Fukao (2002) and Fukao *et al.* (2006).

TABLE A2

Japanese Price Level Relative to U.S. (1934–36; U.S. = 1)

	Items	Japanese Weight I	Japanese Weight II	Japanese Weight III	U.S. Weight I	U.S. Weight II	U.S. Weight III	U.S. Units	Japanese Units	Prices: U.S.	Prices: Japan	Prices: Japan/U.S. in PPP	Prices: PPP/ER	Japanese Price Level: Japanese Weight	Japanese Price Level: U.S. Weight	Japanese Price Level: Fisher Average	Sample Size of the U.S. ICPSR Data	Tradables
Total	Exchange rate									dollars	yen		ER = 3.43 Yen/US$	**0.34**	**0.60**	**0.45**		
Food		**41.3**			**33.2**									**0.37**	**0.62**	**0.48**		
Grain and bread			39.7	100.0		12.0	100.0	Unit	Unit					**0.39**	**0.60**	**0.48**		**1**
	Rice			92.9			3.1	1 lb	1 kg	0.08	0.24	1.30	0.38					
	Wheat flour			5.8			16.7	1 lb	1 kg	0.05	0.23	2.11	0.62					
	Bread *1*, *a*			1.2			80.6	1 lb	1 lb	0.08	0.17	2.05	0.60					
Meat			2.7	100.0		19.8	100.0							**0.91**	**0.94**	**0.93**		**1**
	Beef			63.9			51.7	1 lb	1 kg	0.14	1.28	4.04	1.18					
	Pork			26.8			34.1	1 lb	1 kg	0.32	1.40	2.01	0.59					
	Chicken			9.4			14.2	1 lb	1 kg	0.29	2.08	3.21	0.94					
Fish			8.3	100.0		1.3	100.0							**0.26**	**0.25**	**0.26**		**0**
	Flounder/halibut			54.4			52.3	1 lb	100 monme	0.24	0.15	0.77	0.22				43	
	Mackerel *a*			43.0			16.5	1 lb	100 monme	0.12	0.11	1.19	0.35				24	
	Salmon *1*, *a*			2.5			31.1	1 lb	100 monme	0.24	0.17	0.85	0.25				24	
Milk and eggs			2.5	100.0		18.9	100.0							**0.36**	**0.86**	**0.56**		**0**
	Milk			23.0			77.6	1 qt.	1 go (180cc)	0.12	0.08	3.52	1.02					
	Eggs			77.0			22.4	1 doz	1 kg	0.36	0.62	1.03	0.30					
Ingredients			8.5	100.0		3.0	100.0							**0.73**	**0.81**	**0.77**		**1**
	Salt *a*			10.3			10.3	1 lb	1 kg	0.05	0.12	1.01	0.29					
	Sugar			89.7			89.7	1 lb	1 kg	0.06	0.37	3.00	0.87					
Vegetables and fruits			9.2	100.0		12.7	100.0							**0.29**	**0.36**	**0.32**		**1**
	Cabbage			6.7			7.2	1 lb	1 kg	0.04	0.08	0.90	0.26					
	Onion *1*			5.4			11.3	1 lb	1 kg	0.04	0.10	1.06	0.31					
	Sweet potato			20.4			4.1	1 lb	1 kg	0.04	0.08	0.87	0.25					
	Potato			18.5			33.0	1 lb	1 kg	0.02	0.08	1.47	0.43					
	Spinach			12.1			8.2	1 lb	1 kan	0.08	0.30	0.48	0.14					
	Bananas			18.5			14.4	1 lb	1 kg	0.06	0.20	1.41	0.41					
	Apples *1*, *a*			18.5			21.6	1 lb	1 kg	0.05	0.15	1.26	0.37				545	
Processed food			19.1	100.0		7.0	100.0							**0.34**	**0.35**	**0.35**		**1**
	Peanut oil and			50.0			50.0	1 lb	1 kg	0.20	0.62	1.38	0.40					
	Canned pink			50.0			50.0	1 lb	1 can (235 g)	0.15	0.08	1.03	0.30				120	
Alcohol			4.8	100.0		14.5	100.0							**0.48**	**0.48**	**0.48**		**1**
	Beer *a*			100.0			100.0	1 quart	1 bottle (720)	0.27	0.33	1.63	0.48				3	
Tea and drinks			1.2	100.0		2.6	100.0							**0.36**	**0.36**	**0.36**		**1**
	Tea			100.0			100.0	1 lb	1 kg	0.68	1.86	1.24	0.36					
Tobacco	Cigarettes *a*		3.9	100.0		8.1	100.0	1 package	1 package	0.14	0.15	1.11	0.32	**0.32**	**0.32**	**0.32**	704	**1**
Household Utilities		**4.8**			**5.8**									**1.06**	**0.89**	**0.97**		
Fuel expenses			52.4	100.0		75.6	100.0							**1.21**	**0.88**	**1.03**		**1**
	Coal			12.9			97.1	10 kg	1 kg	0.00	0.03	2.96	0.86					
	Firewood *a*			87.1			2.9	10 kg	10 kg	0.06	0.27	4.40	1.28				6	
Electricity	Electricity		47.6	100.0		24.4	100.0	1 kwh	1 kwh	0.05	0.16	3.20	0.93	**0.93**	**0.93**	**0.93**		**0**

TABLE A2 (*continued*)

Items		Japanese Weight I	Japanese Weight II	Japanese Weight III	U.S. Weight I	U.S. Weight II	U.S. Weight III	U.S. Units	Japanese Units	Prices U.S.	Prices Japan	Prices Japan/U.S. in PPP	Prices PPP/ER	Japanese Price Level Japanese Weight	Japanese Price Level U.S. Weight	Japanese Price Level Fisher Average	Sample Size of the U.S. ICPSR Data	Tradables
Clothing and Bedding		**10.6**			**13.3**									**0.25**	**0.49**	**0.35**		**1**
Cloth			33.3	100.0		33.3	100.0							**0.65**	**0.72**	**0.69**		
	Raw silk *2*, *b*			20.0			20.0	1 lb	1 kg	1.50	11.23	3.40	0.99					
	Cotton yarn *2*, *b*			20.0			20.0	1 lb	1 kg	0.30	1.19	1.78	0.52					
	Muslin *2*, *b*			20.0			20.0	1 yard	1 yard	0.15	0.49	3.22	0.94					
	Woolen yarn *2*, *b*			20.0			20.0	1 lb	500 g	1.64	2.71	1.48	0.43					
	Serge *2*, *b*			20.0			20.0	1 yard	I m	1.08	3.01	2.55	0.74					
Wages for			33.3	100.0		33.3	100.0							**0.11**	**0.11**	**0.11**		
	Tailors and			100.0			100.0	daily	daily	0.60	1.80	0.38	0.11					
Personal items			33.3	100.0		33.3	100.0							**0.65**	**0.65**	**0.65**		
	Men's leather			100.0			100.0	1 pair	1 pair	3.73	8.25	2.21	0.65					
Housing and Furniture		**10.2**			**21.0**									**0.59**	**0.75**	**0.66**		
Monthly housing rent			85.3	100.0		69.5	100.0	1 room	1.65 sq. m.	4.77	1.06	2.69	0.79	**0.79**	**0.79**	**0.79**	664	**0**
Furniture, equipment and supplies			14.7	100.0		30.5	100.0							**0.24**	**0.68**	**0.40**		**1**
	Furniture makers'			50.0			50.0	hourly	daily	0.50	1.80	0.45	0.13					
	Wooden boards			50.0			50.0						1.23					
Miscellaneous Expenses		**33.2**			**26.7**									**0.28**	**0.51**	**0.37**		
Transp. & communication			6.2	100.0		43.8	100.0							**0.39**	**0.61**	**0.49**		
	Subway (New			20.2			22.9	1 ride	1 ride	0.05	0.10	2.00	0.58					**0**
	Gasoline *i*			20.2			22.9	yen per	gallon	66.50	43.50		0.65					**1**
	Bus drivers' or			20.2			22.9	hourly	daily	0.58	2.70	0.54	0.16					**0**
	Automobile			20.2			22.9	unit	unit values	2587.9	601.96	4.30	1.12					**1**
	Postage for a			19.4			8.3	1 piece	1 piece	0.01	0.02	1.50	0.44					**0**
Health and hygiene			23.2	100.0		23.3	100.0							**0.21**	**0.58**	**0.35**		
	Doctors' salaries			28.0			37.1	annual	annual	2196.5	633.00	0.29	0.08					**0**
	Aspirin and cold			28.0			37.1	100 pills	10 pills	0.59	0.25	4.24	1.24					**1**
	Men's haircut *1*,			21.6			14.0	once	once	0.39	0.40	1.04	0.30				2886	**0**
	Toilet soap *1*, *a*			22.4			11.8	1 piece	1 piece	0.07	0.09	1.42	0.41				2838	**1**
Education, books, and newspapers			11.3	100.0		8.8	100.0							**0.29**	**0.39**	**0.34**		**0**
	Tuition and fees			23.6			22.8	annual	monthly	2.19	0.40	2.19	0.64				1828	
	Tuition and fees			23.5			22.7	annual	monthly	138.50	12.48	1.08	0.32				137	
	Wood pulp			5.3			5.5	100 lbs	1 kg	2.00	0.18	4.04	1.18					
	Teachers' salary			5.3			5.4	annual	monthly	1974.5	65.91	0.40	0.12					
	Newspapers *1*, *a*			42.3			43.6	1 issue	1 issue	0.06	0.05	0.79	0.23				74	
Entertainment, religious and welfare																		**0**
	Movies *1*, *a*		59.3	100.0		24.1	100.0	per show	per show	0.29	0.30	1.03	0.30	**0.30**	**0.30**	**0.30**		

Notes:

1. For Japan, items marked with 1 are the average value for Tokyo in 1934–36, while items marked with 2 are the Tokyo wholesale prices in 1935. All other prices are the 1934–36 averages of consumer prices.
2. For the U. S., items marked with "a" are based on micro-data from the Study of Consumer Purchases in the United States (ICPSR 8908), while items marked with "b" are the wholesale prices for the U.S. in 1935.
3. Gasoline prices for the U.S. and Japan are from *Chugai shogyo simpo* 1935.9.26, at http://www.lib.kobe-u.ac.jp/sinbun/e-index.html. Prices are all in Japanese yen.
4. Bus drivers' wages are from the HLS, vol. I, p. 980. In the case of Japan we used rickshaw wages.
5. For automobiles, unit values with values and quantities in the U.S. and Japan are from the 1939 Census of Manufactures and Factory Statistics (Bureau of the Census, 1939).
6. Doctors' salaries for the U.S. are the average of those of dentists and chiropodists (HLS, vol. II, pp. 298–300).
7. Teachers' salaries for the U.S. are from table 12, p. 311 in HLS, vol. II, p. 311.
8. Electricity prices for the U.S. are from the HLS, vol. I, pp. 666–7.
9. Embroiderers' wages for the U.S. are from the HLS, vol. II, p. 94.
10. 1 lb = 453.6 grams; 1 momme = 375 grams.
11. Wholesale prices for the U.S. are from the Statistical Abstract 1938. Wholesale prices for Japan are for Tokyo and are from the Historical Statistics of Japan (CD-ROM).
12. U.S. rent data are based on the micro-data of households in two metropolises (New York and Chicago) and six big cities (Providence, RI; Columbus, OH; Atlanta, GA; Omaha–Council Bluffs, NE–IA; Denver, CO; and Portland, OR). The rent includes neither heating nor furnishing.
13. Rent data for Japan are the weighted average of rents in Tokyo and six other big cities (Osaka, Kyoto, Nagoya, Kyoto, Kobe, and Yokohama). As weights, we used the number of households in each city in 1935 (taken from Nihon Teikoku Toukei Nenkan (Statistical Annals of the Japanese Empire, 1938).
14. The average rent per 1.65 sq.m. in Tokyo is from Toukei Shiryou Dai 78 Go (Pre-War Standard Consumption Level—Method of Calculation for Tokyo (1), Statistical Materials No. 78) by Keizai Shingi-cho Chosabu Tokeika (Statistical Survey Department of the Economic Council) (Keizai Shingi-cho, 1953). We calculated rent in other cities using information of rent per house (apartment) in Tokyo and the other six cities reported in Clark (1940).
15. For price of wooden boards for making furniture, we use the average of prices for firewood and wood pulp.
16. For medicine pills, prices are for aspirin and cold medicines respectively.

TABLE A3

Chinese Price Level Relative to U.S. (1934–36; U.S. = 1)

		Items	Chinese Weight I	Chinese Weight II	Chinese Weight III	U.S. Weight I	U.S. Weight II	U.S. Weight III	U.S. Units	Chinese Units	Absolute Price U.S.	Absolute Price China	Absolute Price China/U.S. in PPP	Absolute Price PPP/ER	Chinese Price Level Chinese Weight	Chinese Price Level U.S. Weight	Chinese Price Level Fisher Average
	Total	**Exchange rate**									Dollar	Yuan	ER = 3.01 Yuan/US$		**0.26**	**0.38**	**0.32**
Food			**68.7**			**33.2**									**0.27**	**0.35**	**0.31**
	Grain			68.5			12.1								**0.29**	**0.40**	**0.34**
		Rice			69.9			3.1	1 lb	1 kg	0.08	0.14	0.77	0.26	2.73	0.01	
		Wheat			30.1			96.9	1 lb	1 kg	0.05	0.13	1.22	0.40	0.74	0.39	
	Vegetables and fruits			8.8			12.7								**0.15**	**0.25**	**0.20**
		Potatoes			14.9			37.1	1 lb	1 kg	0.02	0.03	0.48	0.16	0.93	0.06	
		Cabbages			36.0			7.2	1 lb	1 kg	0.04	0.06	0.65	0.21	1.73	0.02	
		Spinach *a)*			36.0			8.3	1 lb	1 kg	0.08	0.05	0.32	0,11	3.42	0.01	
		Onion			2.3			11.3	1 lb	1 kg	0.04	0.03	0.32	0.11	0.22	0.01	
		Apples			5.3			7.2	1 lb	1 kg	0.06	0.58	4.10	1.36	0.04	0.10	
		Oranges *b)*			5.3			7.2	1 lb	1 kg	0.25	0.38	0.69	0.23	0.23	0.02	
		Bananas			0.1			21.6	1 doz (2 kg)	1 kg	0.33	0.40	0,55	0.18	0.00	0.04	
	Ingredients			7.4			3.0								**0.67**	**1.23**	**0.91**
		Sugar			11.6			90.0	1 lb	1 kg	0.06	0.48	3.90	1.29	0.09	1.16	
		Salt			88.4			10.0	1 lb	1 kg	0.05	0.22	1,90	0.63	1.40	0.06	
	Meat and fish			5.9			40.0								**0.26**	**0.32**	**0.29**
		Park			38.1			5.6	1 lb	100 g	0.32	0.04	0.64	0.21	1.80	0.01	
		Beef			27.0			8.5	1 lb	100 g	0.14	0.04	1.17	0.39	0.70	0.03	
		Chicken			2.5			2.3	1 lb	100 g	0.29	0.07	1.09	0.36	0.07	0.01	
		Eggs			5.9			3.5	1 doz	1 kg	0.36	0.34	0.94	0.31	0.19	0.01	
		Milk			1.4			12.2	1 qt.	1 bottle	0.12	0.62	2.42	0.80	0.02	0.10	
		fish			25.1			67.9	1 lb	1 kg	0.24	0.38	0.71	0,24	1.06	0.16	
	Others			1.0			7.0								**0.09**	**0.09**	**0.09**
		Preserved vegetables (pickles)			100.0			100.0	1 lb	1 kg	0.20	0.12	0.27	0.09	11.29	0.09	
	Drinks and tobacco			8.4			25.2								**0.25**	**0.39**	**0.32**
		Cigarettes			51.4			32.12	1 package	1 package	0.14	0.16	0.54	0.18	2.89	0.06	
		Beer *c)*			20.9			57.50	1 quart	*1 bottle*	0.27	0.54	1.53	0.51	0.41	0.29	
		Tea			27.7			10.38	1 lb	100 g	0.68	0.19	1.28	0.43	0.65	0.04	
Lighting and heating			**8.3**			**5.8**									**0.70**	**0.92**	**0.80**
	Electricity			0.3	100.0		24.4	100.0	1 kwh	1 kwh	0.05	0.16	3,20	1.06	**1.09**	**1.09**	**1.09**
	Fuel			99.7			75.6								**0.70**	**0.86**	**0.78**
		Coal			23.0			97.10	10 kg	10 kg	0.04	0.11	2.62	0.87	0.26	0.84	
		Firewood			77.0			2.90	10 kg	10 kg	0.06	0.12	1.99	0.66	1.17	0.02	
	Clothing and bedding		8.5			13.3									**0.24**	**0.28**	**0.26**
	Clothing			80.3			66.7								**0.23**	**0.25**	**0.24**

		Sweatshirt			50.0			50.0	each	each	1.50	1.48	0.99	0.33	1.53	0.16	
		Tailors and embroiderers			50.0			50.0	daily	daily	0.60	0.32	0.53	0.18	2.82	0.09	
	Personal items			19.7			33.3								**0.32**	**0.32**	**0.32**
		Men's leather shoes *d)*			100.0			100.0	1 pair	1 pair	2.73	2.63	0.96	0.32	3.12	0.32	
Housing			**5.3**			**21.0**									**0.15**	**0.24**	**0.19**
	Rent			61.6			69.5								**0.16**	**0.19**	**0.18**
		Monthly housing rent *i)*			50.0			50.0	1 room	1 room	4.77	1.72	0.36	0.12	4.17	0.06	
		Brick *b)*			50.0			50.0	1000 pieces	1000 pieces	11.84	9.11	0.77	0.26	1.96	0.13	
	Furniture			38.4			30.5								**0.14**	**0.37**	**0.22**
		Furniture makers' wage			50.0			50.0	hourly	daily	0.50	0.91	0.23	0.08	6.62	0.04	
		Wooden board *h)*			50.0			50.0						0.66	0.76	0.33	
Miscellaneous Expenses			**9.2**			**26.7**									**0.21**	**0.47**	**0.32**
	Trans.			4.9			43.8								**0.10**	**0.52**	**0.23**
		Bus driver and rickshaw puller's wage			33.3			50.0	hourly	daily	0.58	0.54	0.12	0.04	8.61	0.02	
		Average railroad fares per passenger-km			33.3			30.0			0.01	0.02	1.31	0.45	0.75	0.13	
		gasoline			33.3			20.0	gallon	gallon	66.50	122.50		1.84	0.18	0.37	
	Educ.			1.5			5.0				0.00				**0.05**	**0.13**	**0.08**
		Teachers' wage			50.0			50.0	annual	annual	1974.50	150.00	0.08	0.03	19.81	0.01	
		college and university *e)*			50.0			50.0	annual	annual	138.50	100.00	0.72	0.24	2.08	0.12	
	Hygiene			9.9			6.0								**0.31**	**0.43**	**0.37**
		Soap			25.0			22.8	1 piece	1 piece	0.07	0.20	3.04	1.01	0.25	0.23	
		Toothbrush			25.0			22.7	each	each	0.28	0.21	0.75	0.25	1.00	0.06	
		Haircut *g)*			50.0			54.5	once	once	0.39	0.30	0.78	0.26	1.93	0.14	
	Medicine	Aspirin *f)*		5.8	100.0		17.3	100.0	1 bottle	1 bottle	0.59	1.46	2.47	0.82	**0.84**	**0.84**	**0.84**
	Entertainment	Movie		19.2	100.0		24.1	100.0	per show	once	0.29	0.20	0.69	0.23	**0.24**	**0.24**	**0.24**
	Other	Newspapers		58.7	100.0		3.9	100.0	1 issue	1 set	0.06	0.04	0.63	0.21	**0.22**	**0.22**	**0.22**

Source: See Tables Al and A2 except as noted below.
(a) The average price of Beijing, Shanghai, Nanjing from *China Economic Statistics Annals* 1934–1935.
(b) Prices of bricks and orange in the U.S. are from Statistical Abstract of the United States 1938.
(c) The average price of Wuhan, Chongqing and Shanghai. The units are 1 quart = 946 milliliters in the U.S. and 1 bottle = 720 milliliters in China.
(d) Price is for Chongqing.
(e) College tuition is the median value of private colleges reported in ″College Tuitions in the 1930s″ by Cheng Mingyuan in *Nanfang Zhoumuo*, Dec. 4, 2003.
(f) Price is for Morris County, New Jersey 1935 (http://www.gti.net/mocolib1/prices/193s.html); price for China is for Wuhan. Each bottle is 100 pills.
(g) Haircut is calculated as the product of the U.S—Japan and Japan—China prices.
(h) Wooden board uses the price of firewood.
(i) One room is 20 square meters in China.

Appendix B: An Empirical Analysis of the Relationship between Terms of Trade Change and Back-Projection Bias

We empirically test the implication of our theoretical analysis using the data in Heston and Summers (1993). Table 3 of Heston and Summers (1993) reports

$$\ln\left(\frac{y_i^E(t,90)}{y_{EU}^E(t,90)}\right)-\ln\left(\frac{y_i^C(t)}{y_{EU}^C(t)}\right) \tag{B1}$$

for $t = 1970$, 75, 80, and 85 and i = each of 23 OECD countries. The variables with EU denote values for three European countries (the U.K., West Germany and Italy).

The weight consistency effect is only significant for countries experiencing substantial structural change. Since the OECD countries in 1970–90 were already quite developed and relatively homogenous, our statistical test will focus on the terms of trade effect, treating the weight consistency effect as a random error. By taking first differences of equation (B1) over time, we derive the following:

(B2)

$$\left\{\ln\left(\frac{y_i^E(t+5,90)}{y_{EU}^E(t+5,90)}\right)-\ln\left(\frac{y_i^C(t+5)}{y_{EU}^C(t+5)}\right)\right\}-\left\{\ln\left(\frac{y_i^E(t,90)}{y_{EU}^E(t,90)}\right)-\ln\left(\frac{y_i^C(t)}{y_{EU}^C(t)}\right)\right\}$$
$$=\left\{-\ln\left(\frac{\sum_{n=1}^{N}p_n^G(t+5)q_n^i(t+5)}{\sum_{n=1}^{N}p_n^G(t)q_n^i(t+5)}\right)+\ln\left(\frac{\sum_{n=1}^{N}p_n^G(t+5)q_n^{EU}(t+5)}{\sum_{n=1}^{N}p_n^G(t)q_n^{EU}(t+5)}\right)\right\}$$

+ error term (composed of weight inconsistency effect and other observation errors).

The first term on the right-hand side of the equation denotes the terms of trade effect.

To simplify the terms of trade effect we make the following additional assumptions: (i) each country's balance of goods and services trade is close to zero; (ii) each country has a similar demand structure; and (iii) the GK price vector is close to the domestic price vector of each country and the international price vector. Denoting $x_n^i(t)$ as net exports of commodity n in country i in year t, the first term on the right-hand side of equation (B2) can be approximated by

$$-\sum_{n=1}^{N}\left(\frac{p_n^*(t)x_n^i(t+5)}{\sum_{n=1}^{N}p_n^*(t)q_n^i(t+5)}\frac{p_n^*(t+5)-p_n^*(t)}{p_n^*(t)}\right)+\sum_{n=1}^{N}\left(\frac{p_n^*(t)x_n^{EU}(t+5)}{\sum_{n=1}^{N}p_n^*(t)q_n^{EU}(t+5)}\frac{p_n^*(t+5)-p_n^*(t)}{p_n^*(t)}\right)$$

and, given our assumptions, could be further simplified as follows:

$$-m^i(t+5)\left\{\ln\left(T^i(t+5)\right)-\ln\left(T^i(t)\right)\right\}+m^{EU}(t+5)\left\{\ln\left(T^{EU}(t+5)\right)-\ln\left(T^{EU}(t)\right)\right\}$$

where $m^i(t + 5)$ denotes the simple average of country i's export–GDP ratio and import–GDP ratio. We call m the trade dependence ratio. $T^i(t)$ denotes country i's terms of trade at time t. As the terms of trade effect of the three European countries will affect the PPP gap in the same way, we use time dummies to control for this.

From the above analysis we obtain the following model for our econometric test.

$$\left\{\ln\left(\frac{y_i^E(t+5,90)}{y_{EU}^E(t+5,90)}\right)-\ln\left(\frac{y_i^C(t+5)}{y_{EU}^C(t+5)}\right)\right\}-\left\{\ln\left(\frac{y_i^E(t,90)}{y_{EU}^E(t,90)}\right)-\ln\left(\frac{y_i^C(t)}{y_{EU}^C(t)}\right)\right\}$$
$$=\alpha-\beta m^i(t+5)\left\{\ln\left(T^i(t+5)\right)-\ln\left(T^i(t)\right)\right\}+\sum_T \gamma^T DUM^T(t)+\varepsilon^i(t)$$

where $DUM_T(t)$ is the time dummy. Since Heston and Summers (1993) report that the current benchmark comparison of 1970 is not fully reliable, we used data for $t = 1975$, 80, and 85.

The regression using the above equation with the data from Heston and Summers (1993) is tabulated in Table B1; β, the coefficient of the cross-term of the change in the terms of trade and the trade dependence ratio, is the key variable. Based on our theoretical considerations, we expect β to be close to −1. When a country's terms of trade deteriorate, the extrapolation bias will increase. This effect will be larger for countries with a high trade dependence. Table B1, reporting the results of our regression, shows that the β coefficient is close to −1 and statistically significant, thus confirming our theory.

TABLE B1
The Estimation Result on the Terms-of-Trade Effect

	Coefficients	Standard Error	t
α	−0.0147	0.019	−0.763
β	−0.651	0.156	−4.167
Γ^{80}	3.46E-05	0.025	0.001
Γ^{85}	0.0943	0.025	3.751

R square = 0.49. Sample size is 31.

Based on these findings, we turn to the terms of trade (TOT) effect for Japan and the U.S. between 1935 and 1990 as studied in our paper. Figure B1 presents our terms of trade indices for Japan and the U.S. linked from 1935 to 1990. It shows that the U.S. terms of trade deteriorated by 54 percent compared with those of Japan. This would imply, according to our decomposition, an upward bias in the 1930s Japanese per capita income based on the 1990 back-projection, a result consistent with our earlier empirical findings. We quantify the upward bias based on the following formula derived above:

$$m^{\text{Japan}}(1990)\left\{\ln\left(T^{\text{Japan}}(1990)\right)-\ln\left(T^{\text{Japan}}(1935)\right)\right\}-$$
$$m^{\text{US}}(1990)\left\{\ln\left(T^{\text{US}}(1990)\right)-\ln\left(T^{\text{US}}(1935)\right)\right\}.$$

Since trade dependency ratio (the average of exports and imports over GDP) was 10 percent for Japan and only 8 percent for the U.S. respectively in 1990, the terms of trade improvement for Japan between 1935 and 1990 would only account for about 3 percent upward bias in the 1990 backward projection method, clearly a small fraction in relation to the 22 percent overestimate we found in this study.

However, the limited impact of the terms of effect in our empirical test should be carefully interpreted. A major problem is that our long-term TOT indices are constructed by linking disparate series where both quantity weights and quality of products (also the number of new products) have changed quite substantially at each linking period. In the case of Japan, there was a hyperinflation and a corresponding huge depreciation of yen after WWII. Our Japan series is based on Yamazawa and Yamamoto's link ratio of TOT between 1934–36 and 1952–54. But due to the change in Japan's trade structure, the number of goods they could match was limited: altogether 163 goods for exports and 135 goods for imports, but only 3 and 12 for export and imports respectively in the case of machinery. The figure also reveals the highly volatile TOT fluctuation in the short run. All these affect the reliability of our empirical test.

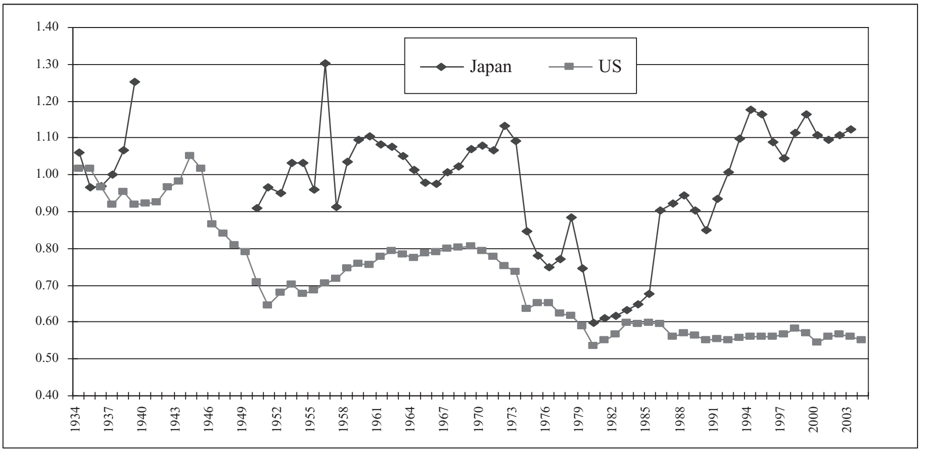

Figure B1. Terms of Trade Indices for the U.S. and Japan (unit value index of total exports/unit value index of total imports), 1934–36 = 1

Source:

Japan:

1934–54: *Estimates of Long-Term Economic Statistics of Japan Since 1868*, Vol. 14 : Foreign Trade and Balance of Payments, edited by Ippei Yamazawa and Yuzo Yamamoto, Toyo Keizai Shinposha, 1979;

1954–60: *Historical Statistics of Japan*, Vol. 3, 1985, Editorial Supervision: Statistics Bureau, Management and Coordination Agency, Japan Statistical Association, Tokyo, Japan;

1960–2000: *Nihon Kanzei Kyokai* (Japan Tariff Association) "Gaikoku Boeki Gaikyo (General Situation of Japan's International Trade).

U.S.:

1934–55: *Historical Statistics of the United States*, Bicentennial Edition, Colonial Time to 1970, Part 2, 1975, U.S. Department of Commerce, Bureau of the Census (1975);

1955–84: International Monetary Fund, *International Financial Statistics*, Yearbook, 1985, International Monetary Fund;

1984–2000: Downloaded from the website of Bureau of Labor Statistics, http://www.bls.gov/data/home.htm.

References

Allen, Bob, Jean-Pascal Bassino, Debin Ma, Christine Moll-Murata, and Jan Luiten van Zanden, "Wages, Prices and Living Standards in China, Japan and Europe," http://gpih.ucdavis.edu/Papers.htm, 2005.

Balassa, Bela, "The Purchasing Power Parity Doctrine: A Reappraisal," *Journal of Political Economy*, 72, 584–96, 1964.

Bank of Japan, *Hundred-Year Statistics of the Japanese Economy*, Tokyo, 1966.

Bassino, Jean-Pascal, "How Poor was Asia Before the Industrialization?" unpublished manuscript, Maison Franco-Japonaise, Tokyo, 2005.

Bassino, Jean-Pascal and Debin Ma, "Japanese Wages for Unskilled Laborers in 1730–1910: An International Perspective," *Research in Economic History*, 53, 229–48, 2005.

Bassino, Jean-Pascal and Pierre van der Eng, "Economic Divergence in East Asia: New Benchmark Estimates of Levels of Wages and GDP, 1913–1970," paper presented at the XIII Economic History Congress, Buenos Aires, July 22–26, 2002.

Buck, John, *Land Utilization in China: A Study of 16,786 Farms in 168 Localities, and 38,256 Farm Families in Twenty-two Provinces in China, 1929–1933*, University of Nanking, Nanking, 1937.

Bureau of the Census, *Census of Manufactures*, 1939, Bureau of the Census, Washington DC, 1939.

Clark, Conlin, *Conditions of Economic Progress*, St Martin's Press, London, 1940.

Dowrick, S. and M. Akmal, "Contradictory Trends in Global Income Inequality: A Tale of Two Biases," *Review of Income and Wealth*, 51(2), 201–29, 2005.

Emi, Koichi and Yuichi Shionoya, *Estimates of Long-Term Economic Statistics of Japan since 1868 (LTES) vol. 7, Government Expenditure*, Toyo Keizai Shinposha, Tokyo, 1966.

Emi, Koichi, *Estimates of Long-Term Economic Statistics of Japan since 1868 (LTES) vol. 4, Capital Formation*, Toyo Keizai Shinposha, Tokyo, 1971.

Fukao, K., D. Ma, and T. Yuan, "International Comparison in Historical Perspective: Reconstructing the 1934–36 Benchmark Purchasing Power Parity for Japan, Korea and Taiwan," *Explorations in Economic History*, 43(2), 280–308, 2006.

Godo, Yoshihisa, and Yujiro Hayami, "Catching Up in Education in the Economic Catch-up of Japan with the United States, 1890–1990," *Economic Development and Cultural Change*, 50(4), 961–78, 2002.

Gongnongye Shangpin Bijia Wenti Diaocha Yanjiu Ziliao Bangongshi, *Gongnongye Shangpin Bijia Wenti Diaocha Yanjiu Ziliao Huibian (Archive Materials for Studies of Industrial and Agricultural Commodity Prices)*, versions of Shanghai (1956), Hebei (1956), Sichuan (1956), Guangdong (1957), Henan (1956), Jiangsu (1956), Gansu (1957), Zhejiang (1956), Tianjin (1956), Hubei (1956).

Heston, Alan and Robert Summers, "What Can Be Learned from Successive ICP Benchmark Estimates?" in A. Szirmai, B. Van Ark, and D. Pilat (eds), *Explaining Economic Growth*, North Holland, Amsterdam, 1993.

Hsiao, Liang-lin, *China's Foreign Trade Statistics*, 1864–1949, Harvard University Press, Cambridge, 1974.

Keizai Kikaku-cho (Economic Planning Agency), Japanese Government, *Showa 37 Nendo Kokumin Shotoku Hakusho (White Paper on National Income 1962 C.Y.)*, Printing Office, Ministry of Finance, Tokyo, 1963.

Keizai Shingi-cho (Economic Counsel Board), Japanese Government, *Showa 27 Rekinen Kokumin Shotoku Hokoku (Report on National Income Statistics 1952 C.Y.)*, Keizai Shingi-cho (Economic Counsel Board), Tokyo, 1953.

Keizai Shingi-cho, Chosabu Tokeika (Statistical Division, Economic Counsel Board), Japanese Government, *Senzen Kijun Shohi Suijun—Tokyo SanSyutsu Hoho 1, Tukei Siryo No. 78 (pre-war Standard Consumption Level—Method of Calculation for Tokyo (1), Statistical Materials No. 78),* Keizai Shingi-cho (Economic Counsel Board), Tokyo, 1953.

Kravis, Irving B., Alan Heston, and Robert Summers, A *System of International Comparisons of Gross Product and Purchasing Power*, Johns Hopkins University Press, Baltimore, MD, 1975.

———, *World Product and Income, International Comparisons of Real Gross Product*, Johns Hopkins University Press, Baltimore, 1982.

Liu, Ta-chung, *China's National Income 1931–36, An Exploratory Study*, The Brookings Institution, Washington DC, 1946.

Liu, Ta-chung and Kung-chia Yeh, *The Economy of the Chinese Mainland: National Income and Economic Development, 1933–1959*, Princeton University Press, Princeton, NJ, 1965.

Maddison, Angus, *Economic Progress and Policy in Developing Countries*, Allen & Unwin, London, 1970.

———, *Monitoring the World Economy 1820–1992*, OECD, Paris, 1995.

———, *Chinese Economic Performance in the Long Run*, OECD, Paris, 1998.

———, *The World Economy: A Millennial Perspective*, OECD, Paris, 2001.
———, *The World Economy: Historical Statistics*, OECD, Paris, 2003.
Minami, Ryoshin, "Railroads and Electric Utilities," in Kazushi Ohkawa *et al.* (eds), *Estimates of Long-Term Economic Statistics of Japan since 1868 (LTES) vol. 12*, Toyo Keizai Shinposha, Tokyo, 1965.
Ministry of Commerce and Industry, Statistics Department, Japanese Government, *Koujyou Toukei (Factory Statistics)*, 1938.
Ministry of Industry, National Government, *Zhongguo Jinji Nianjian (China Economic Annals)*, Commercial Press, Shanghai, 1934–36.
Ministry of Railroad, Transportation Bureau, International Department, *Sekai Katsukoku Tetsudo Tokei (Rail Statistics of the World)*, Tokyo, 1937.
Ministry of Railroad, *Tetsudo Tokei (Rail Statistics)*, Tokyo, 1975.
Mizoguchi, Toshiyuki, *Taiwan, Chosen no Keizai Seicho: Bukka Tokei wo Chushin to shite (Economic Growth of Taiwan and Korea: a Study of Prices)*, Iwanami Shoten, Tokyo, 1975.
Mizoguchi, Toshiyuki and Noriyuki Nojima, "1940–55 Nen ni Okeru Kokumin Keizai Keisan no Ginmi (Nominal and Real GDP of Japan: 1940–55)," *Nippon Tokei Gakkaishi (Journal of the Japan Statistical Society)*, 23(1), 91–107, 1993.
———, "Taiwan, Kankoku no Kokumin Keizai Keisan Choki Keiretsu no Suikei" (Estimation of the Long Term National Accounts of Taiwan and Korea), Asian Historical Economic Statistics Project Discussion Paper: R96-6, Institute of Economic Research, Hitotsubashi University, Tokyo, 1996.
Mizoguchi, Toshiyuki and Mataji Umemura (eds), *Kyu Nihon Shokuminchi Keizai Tokei: Suikei to Bunseki (Basic Economic Statistics of Former Japanese Colonies 1895–1938)*, Toyo Keizai Shinposha, Tokyo, 1988.
OECD, Department of Economics and Statistics, *National Accounts of OECD Countries*, OECD, 1976.
———, Department of Economics and Statistics, *National Accounts of OECD Countries*, OECD, 1999.
Ohkawa, Kiyoshi and Miyohei Shinohara, *Patterns of Japanese Development: A Quantitative Appraisal*, Yale University Press, New Haven, CT, 1979.
Ou, Baosan (ed.), *Zhongguo Guomin Soude (National Income of China), vols. 1 and 2*, Zhonghua sujui, Shanghai, 1947.
Pilat, Dirk, *The Economics of Rapid Growth: The Experience of Japan and Korea*, Edward Elgar, Aldershot, U.K. and Brookfield, U.S., 1994.
Samuelson, Paul, "Theoretical Notes on Trade Problems," *Review of Economics and Statistics*, 46, 145–54, 1964.
Szilágyi, Gyorgy, "Updating Procedures of International Comparisons Results," *Review of Income and Wealth*, 30, 153–65, 1984.
U.S. Department of Labor, Bureau of Labor Statistics, Department of Agriculture, Bureau of Home Economics Micro data of *Study of Consumer Purchases in the United States*, 1935–1936, ICPSR 8908, http://www.icpsr.umich.edu/.
U.S. Department of Labor, Bureau of Labor Statistics, *Retail Prices of Food 1923–36*, Bulletin No. 635, Bureau of Labor Statistics, Washington, DC, 1938.
———, *Changes in Cost of Living in Large Cities in the United States, 1914–41*, Bulletin No. 699, Bureau of Labor Statistics, Washington, DC, 1941a.
———, *Handbook of Labor Statistics*, Bulletin No. 694, vols. I and II, Bureau of Labor Statistics, Washington, DC, 1941b.
U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States 1938*, Government Printing Office, Washington, DC, 1939.
———, *Historical Statistics of the United States, Parts 1 and 2* (Bicentennial Edition), Bureau of the Census, Washington, DC, 1975.
U.S. Department of Commerce, Bureau of Economic Analysis, "GDP and other Major NIPA Series, 1929–97" *Survey of Current Business*, 78(8), 1998.
Wang, Qingyi, *Zhongguo Nenyuan (Chinese Energy)*, China Metallic Industry Press, Beijing, 1988.
Ward, Marianne and John Devereux, "Measuring British Decline: Direct Versus Long-Span Income Measures," *Journal of Economic History*, 63(3), 826–51, 2003.
———, "International Comparisons of Incomes, Labor Productivity and Capital Stocks for Developed Economies: 1870–1950," paper presented at UC Davis workshop, *Estimating Production and Income Across Nations and over Time*, UC Davis, Institute of Governmental Affairs, Davis, CA, May 31–June 1, 2005.
Watanabe, Tsunehiko and Ryutaro Komiya, "Findings from Price Comparisons Principally Japan vs. the United States," *Zeitschrift des Instituts für Weltwirtschaft an der Universität Kiel*, 81(1), 81–96, 1958.
Yamamoto, Yuzou, *Nihon Shokuminchi Keizai Shi Kenkyu (Studies on the Economic History of Japanese Colonies)*, Nagoya University Publishing House, Nagoya, 2000.

Yotopoulos, P. A. and J. Lin, "Purchasing Power Parities for Taiwan," *Journal of Economic Development*, 18(1), 7–51, 1993.

Yuan, Tangjun, "Cyugoku no Keizai Hatten no Shoki Jokyo: 1930 Nendai Niokeru Jissitsu Shohi Suijun no Kokusai Hikaku (The Initial Condition of China's Economic Growth: An International Comparison of Per Capita Real Consumption Level in the 1930s)," Chapter 1 in T. Yuan, *Chugoku no Keizai Hatten to Bumonkan Shigen Haibun (China's Economic Growth and the Resource Reallocation among Sectors)*, Ph.D. Dissertation, Graduate School of Economics, Hitotsubashi University, 2005.

Yuan, Tangjun and Kyoji Fukao, "1930 Nendai Niokeru Nippon, Chosen, Taiwan Kanno Kobairyoku Heika: Jissitsu Shohi Suijun no Kokusai Hikaku (The Purchasing Power Parity of Japan, Korea and Taiwan in the 1930s: An International Comparison of Real Consumption)," *Keizai Kenkyu (The Economic Review)*, 53(3), 322–36, 2002.

Zhang, Donggang, *Xiaofei Xuqiu de Biandong yu Jindai Zhongri Jingji Zengzhang (Aggregate Consumption Demand and Economic Growth in Modern China and Japan)*, People's Press, Beijing, 2001.

Zhang, Xiaomei, *Sichuan Jingji Cankao Ziliao (Reference Materials on Sichuan Economy)*, Institute of Chinese National Economy, Shanghai, 1939.

THE
ECONOMIC HISTORY REVIEW

Economic History Review, 64, S1 (2011), pp. 8–38

Wages, prices, and living standards in China, 1738–1925: in comparison with Europe, Japan, and India[1]

By ROBERT C. ALLEN, JEAN-PASCAL BASSINO, DEBIN MA, CHRISTINE MOLL-MURATA, and JAN LUITEN VAN ZANDEN

This article develops data on the history of wages and prices in Beijing, Canton, and Suzhou/Shanghai in China from the eighteenth century to the twentieth, and compares them with leading cities in Europe, Japan, and India in terms of nominal wages, the cost of living, and the standard of living. In the eighteenth century, the real income of building workers in Asia was similar to that of workers in the backward parts of Europe but far behind that in the leading economies in north-western Europe. Real wages stagnated in China in the eighteenth and early nineteenth centuries and rose slowly in the late nineteenth and early twentieth, with little cumulative change for 200 years. The income disparities of the early twentieth century were due to long-run stagnation in China combined with industrialization in Japan and Europe.

> 'The difference between the money price of labour in China and Europe is still greater than that between the money price of subsistence; because the real recompence of labour is higher in Europe than in China'.
>
> Adam Smith, *Wealth of nations*[2]

The comparative standard of living of Asians and Europeans on the eve of the industrial revolution has become a controversial issue in economic history. The classical economists and many modern scholars have claimed that European living standards exceeded those in Asia long before the industrial revolution. Recently, this consensus has been questioned by revisionists, who have suggested that Asian living standards were on a par with those of Europe in the eighteenth

[1] This article is part of the National Science Foundation grant funded project 'Global prices and income 1350–1950' headed by Peter Lindert, the Spinoza premium project on Global Economic History funded by Nederlandse Organisatie voor Wetenschappelijk Onderzoek (the Netherlands), and the Team for Advanced Research on Globalization, Education, and Technology funded by the Social Sciences and Humanities Research Council of Canada. We wish to express our thanks to Peter Lindert for suggestions and encouragement at every stage of this article, as well as to Kariin Sundsback for collecting the Dutch East Indies Company data. This article also benefited from the lively discussion at the 43rd Cliometrics Conference in June 2005, the Global Economic History Network (GEHN) Conference at Utrecht in June 2005, seminars at the University of Warwick, Paris School of Economics, Tsinghua University, University of Tuebinger, University of Tokyo, and Yale University, and in particular comments from Jörg Baten, Steve Broadberry, Kent Deng, Bishnupriya Gupta, Timothy Guinnane, Patrick O'Brien, Kenneth Pomeranz, Jean-Laurent Rosenthal, Tirthankar Roy, Osamu Saito, and R. Bin Wong. Our thanks also go to three anonymous referees of this journal and to the editor, Jane Humphries. The underlying price and wage data in this study are available in Excel format at http://www.iisg.nl/hpw/data.php#china and http://gpih.ucdavis.edu/Datafilelist.htm.

[2] Smith, *Wealth of nations*, p. 189.

century and who have disputed the demographic and agrarian assumptions that underpin the traditional view.[3] The revisionists have not convinced everyone, however.[4]

One thing is clear about this debate, and that is the fragility of the evidence that has been brought to the issue. Most of the comparative studies relied on indirect comparisons based on scattered output, consumption, or demographic data. The few that attempted comparisons of direct income were largely based on scattered information about wages and prices in Asia.[5] Our knowledge of real incomes in Europe is broad and deep because since the mid-nineteenth century scholars have been compiling databases of wages and prices for European cities from the late middle ages into the nineteenth century when official statistics begin.

This article, by assembling and constructing systematic data on wages and prices from Imperial ministry records, merchant account books, and local gazetteers, is an attempt to fill that gap for China in the eighteenth and nineteenth centuries. These wage series, deflated by appropriate cost of living indices using reconstructed consumption baskets, are then compared to the Japanese, Indian, and European evidence to assess the relative levels of wage earners' real income at the two ends of Eurasia. The comparisons paint a less optimistic picture of Asian performance than the revisionists suggest.

Taking the hypothesis of Adam Smith at the head of this article as a point of departure, the present study compares the 'money price' of labour in China and Europe. For this purpose, wage rates are expressed in grams of silver earned per day in the two regions. Unminted silver measured in taels (one tael equalled 37 grams)[6] was a universal medium of exchange in China in this period. The terms on which silver coins exchanged defined the market exchange rate of European and Asian moneys. Next, the 'money price of subsistence' is compared. This is a more complicated problem since the subsistence foods were different in China and Europe. Fortunately, the different methods adopted to tackle this problem turn out to imply similar relative price levels. Once they are measured, the differences between European and Chinese money wages and costs of subsistence and the implications of those differences for the 'real recompence of labour' can be perceived.

The rest of the article is divided into six sections with a conclusion. The first two sections review a variety of Chinese wage data to establish the history of nominal wages from the eighteenth to the twentieth centuries. The focus is set on the histories of Canton, Beijing, and the nearby cities of Suzhou and Shanghai in the Yangzi Delta, because more information is available for these cities, and because they are comparable to the large cities in Europe and Japan for which we have similar information. In section III, nominal wages in China and Europe are compared to see if Smith was correct about the 'money price of labour'. Section IV

[3] For instance, Pomeranz, *Great divergence*; Parthasarathi, 'Rethinking wages'; Wong, *China transformed*; Lee and Wang, *One quarter of humanity*; Li, *Agricultural development*; Allen, 'Agricultural productivity'; idem (2004) 'Mr Lockyer meets the index number problem: the standard of living in Canton and London in 1704' [WWW document]. URL http://www.economics.ox.ac.uk/Members/robert.allen/Papers/Lockyer.pdf [accessed on 10 June 2009]; idem, 'Real wages in Europe and Asia'; Allen, Bengtsson, and Dribe, eds., *Living standards in the past*.

[4] For instance, Broadberry and Gupta, 'Early modern great divergence'; Allen, 'India in the great divergence'.

[5] Pomeranz, *Great divergence*; Lee and Wang, *One quarter of humanity*.

[6] The present study applies this average value; variation for the four most important varieties ranged between 36.54 and 37.58 grams. See Peng, *Zhongguo huobi shi*, p. 669, nn. 4–7.

turns to the 'price of subsistence' and develops consumer price indices to compare the cost of living across Eurasia. In section V, the authors compare Smithian price indices to Fisher Ideal Indices for broader consumer bundles and show that they yield similar results in a comparison of London and Beijing. In section VI, the real wage income in Canton, Beijing, and Suzhou/Shanghai from the mid-eighteenth century to the 1920s is estimated. Smith's belief about the 'real recompence of labour' is tested by comparing real wage income in these Chinese cities to their counterparts in other countries. For Japan, Chinese urban incomes are compared to a composite picture of Kyoto and Edo (modern Tokyo) in the eighteenth and early nineteenth centuries, and Tokyo for the late nineteenth and early twentieth centuries, based on Bassino and Ma's study 'Japanese unskilled wages'. Real wages in China are compared to those in India using the results in Allen's 'India in the great divergence'. The perspective on Asian performance is broadened by contrasting living standards there with those in London, Amsterdam, Leipzig, and Milan, as worked out by Allen in 'Great divergence'. The study concludes with a discussion of the significance of its findings for Adam Smith and the great divergence debate.

I

Before comparing living standards, the level and trend of nominal wages in China must be established. Since most European wages are recorded for urban labourers in the building industry, the present study concentrates on unskilled male workers in three large Chinese cities. No single source covers the whole period from the eighteenth century to the twentieth, so the wage history of China must be pieced together by combining disparate information.[7]

For Beijing, some wages for labourers on eighteenth-century government building projects are known, and wages for similar workers from the 1860s to the 1920s can be found. For Canton, wage data of unskilled port labour hired by European trading companies in the eighteenth century are available. For Suzhou, the daily earnings of men engaged as calenderers pressing cloth in the textile industry can be estimated. This series can be linked to the wages of spinners in cotton textile mills in Shanghai in the twentieth century. Indeed, a more complete picture of labour incomes in the Yangzi Delta can be developed by also assessing the earnings of male farm labourers, rural women spinning and weaving cotton cloth, and peasant households as a whole. By matching eighteenth-century wages for specific unskilled occupations in China with corresponding wages for the early twentieth century, the long-term history of Chinese wages can be reconstructed for comparison with European wages.

This wage survey begins with three sets of wage data for the eighteenth century that are reasonably continuous and well defined. The first set is the piece wage rates of the cotton calenderers inscribed on steles for crafts and commerce in Suzhou, the largest industrial and trading city in the Yangzi Delta during the eighteenth and nineteenth centuries. The case of cotton calenderers and their wage disputes has been the subject of numerous studies.[8] The calenderers' job was 'to

[7] For a survey of existing studies on wages and prices, see Kishimoto, *Shindai chūgoku*, pp. 11–46.

[8] Quan, 'Qingdai Suzhou de chuaibuye'; Terada, 'Sōshū tampogyō'; Santangelo, 'Urban society'; Xu, ed., *Jiangnan tubu shi*.

soften and polish cotton cloth after it had been pressed and rubbed'.[9] The inscribed data give us the guild-negotiated piece wage rates for the years of 1670, 1693, 1701, 1715, 1730, 1772, and 1795. As these are piece wages quoted in silver taels, there are no ambiguities about copper–silver exchange rates or additional food allowances. The major issue is the conversion of piece rates into daily wages, for which Xu's study on the early twentieth century was used, as explained in appendix I A. Overall, the daily wages thus derived come to 0.09944 and 0.1144 silver taels in 1730 and 1772 respectively.

In the eighteenth century, the calenderers were mostly migrants to Suzhou from the impoverished provinces of northern Jiangsu and Anhui. They 'had to be strong men, considering the especially tiring nature of their job: using their arms as levers on wooden supports while balancing, they had to rock a huge forked stone with a ground base onto cotton cloth wrapped around a wooden roller which rotated in a groove in the base of the stone'.[10] Calenderers were only a little above unskilled building labourers but probably below a fully skilled worker in the pay scale.

Our second source for private sector wages is the archives of the Dutch East Indies Company (VOC). Many VOC ships docked at Canton, which was the city where Europeans were allowed to trade with China in the eighteenth century. The VOC hired many Chinese workers to repair ships and move cargo. A recent study by van Dyke offers a detailed description of the workings of the provisioning system in Canton. From the VOC archives, 63 wage quotations spanning the eighteenth century can be obtained.[11] The wages fluctuated, but they clustered between 0.08 and 0.1 taels per day with no additional food allowances.

The third set of wage data comes from diverse sources. We begin with two government regulations. The first is the *Wuliao jiazhi zeli* (*Regulations and precedents on the prices of materials*) of 1769, which is a very detailed and systematic government report on the prices of building materials and the wages paid at construction projects, and an attempt to set these prices and wages for the future. According to the editorial introduction, it contained information about 1,557 administrative units described in a compilation of 220 chapters. The original compilation has not been preserved, but the editions for 15 provinces covering 945 districts are extant. Most of them contain the daily wages of unskilled and skilled craftsmen for each district; a few are more detailed and present wages for occupations such as master sawyers, carpenters, stonemasons, paint-makers and painters, tailors, plasterers, canopy makers, paperhangers, and cleaners (in Zhili). Occasionally additional food provisions and their monetary value are recorded, so that the total wage value can be calculated. Where no food provisions are mentioned, probably no food allowance was given, as these wage regulations were supposed to cover the entire labour cost of these public building projects.[12]

[9] Santangelo, 'Urban society', p. 109.

[10] Ibid., p. 109.

[11] See van Dyke, *Canton trade*, and Jörg, *Porcelain*, pp. 21–73, for the details of the organization of the VOC in Canton. We specifically used the files in the National Archives of the Netherlands, The Hague, Archives VOC, nos. 4373, 4376, 4378, 4381, 4382, 4386, 4388, 4390, 4392, 4395–4401, 4403, 4405, 4408, 4409.

[12] The introductory memorial to these regulations by the compiler Chen Hongmou, 'Wuliao jiazhi zonglue' ['General remarks on the prices of materials'], states that market prices and wages were investigated in the regions, and that the prices and wages quoted in these volumes were near to market prices at low market activity; see *Wuliao jiazhi zeli*, ch. 1, fol. 4b, available as WWW document, URL [http://www.uni-tuebingen.de/uni/ans/project/shp/zeli/zonglue.htm] [accessed on 10 Jan. 2010]. The provincial editions for Zhili, Henan, Shandong,

Table 1. *Nominal wages of workers in public construction, 1769–95, and in arms manufacture, 1813 (in taels per day)*

	Construction (unskilled)	*Construction (skilled)*	N =	*Arms manufacture (unskilled)*	*Population (millions in 1787)*
Manchuria and the north-western frontier					
Heilongjiang	0.100	0.191	2/6 (unskilled/skilled)		
Jilin	0.095	0.160	6		1.0***
Shengjing	0.057	0.100	13		
Xinjiang	0.097	0.110	3		0.5
North					
Rehe*	0.066	0.120	7		
Beijing*	0.077	0.141	24		
Tianjin/Baoding*	0.071	0.112	34		23.0****
Residual Zhili*	0.054	0.081	82	0.060****	
Gansu	0.044	0.054	48		15.2
Shanxi	0.054	0.073	85	0.040	13.2
Shaanxi	0.044	0.050	74	0.040	8.4
Shandong	0.045	0.061	50	0.040	22.6
Middle					
Henan	0.037	0.039	106	0.040	21.0
Jiangsu**	0.040	0.051	63	0.040	31.4
Zhejiang**	0.040	0.060	63	0.040	21.7
Hunan	0.039	0.050	10	0.040	16.2
Hubei				0.040	
Jiangxi				0.030	
Guizhou				0.040	
Sichuan	0.048	0.062	47	0.040	8.6
Yunnan	0.048	0.068	84	0.030	3.5
South					
Fujian (including Taiwan)	0.030	0.050	9	0.040	12.0
Guangdong	0.040	0.050	89	0.040	16.0
Guangxi				0.040	
Average (unweighted)	0.053	0.081			
Average (weighted by N)	0.047	0.065	901/905 (unskilled/skilled)		
Average (weighted by population)	0.044	0.060			214.5

Notes: *Part of the province of Zhili; **Yangzi Delta; ***whole of Manchuria; ****whole of Zhili. N: number of districts for which data are available.
Sources: For wages, see app. I; for population data: Wang, *Land taxation*, p. 87.

A virtue of the *Wuliao jiazhi zeli* is its comprehensive regional coverage of Chinese wages. For each province we calculated the unweighted average of the wage norms for labourers in all districts. Table 1 presents the results of these calculations for 21 regions. Zhili is divided into a number of sub-regions because of the large wage differences within this province. The total population of these

Shanxi, Shaanxi, Gansu, Jiangsu, Zhejiang, Guangdong, and Yunnan all carry the same introductory memorial dated 1769. Other editions have no preface, such as those for Hunan, which is a fragment, and 'Manchuria' (Shengjing/Jilin/Heilongjiang). The 1791 Sichuan and the 1795 Rehe editions are later compilations. No special edition was ever compiled for Xinjiang, but a few Xinjiang data are mentioned in the Gansu, Sichuan, and Rehe editions. Digitized datasets for the provinces Gansu, Zhili, Yunnan, Hunan, and Shanxi are available online in the 'Databases on materials, wages, and transport costs in public construction in the Qianlong era' [http://www.uni-tuebingen.de/sinologie/project/shp/databases.html]. See also Song and Moll-Murata, 'Notes', pp. 93–9.

regions in 1776 was about 214.5 million, or 73 per cent of the total population of China of about 293 million.[13]

The pattern that emerges from the *Wuliao jiazhi zeli* is that daily wages in parts of Manchuria (Heilongjiang and Jilin), the home territory of the ruling Manchu Dynasty, and the sparsely populated north-western frontier of Xinjiang, stand out as the highest, followed by areas in and near the capital city of Beijing. Average daily wages in the rest of China seem to have been fairly uniform, with the coastal Fujian province fetching the lowest, 0.030 taels for unskilled labourers.

A second government source is the so-called *Gongbu junqi zeli* (*Regulations and precedents on weapons and military equipment by the Ministry of Public Works*) of 1813, which contains more government wage regulations on an empire-wide scale. The *Gongbu junqi zeli* contains wages for master artisans and unskilled labour that produced military equipment. This dataset includes information for skilled and unskilled labourers.[14] This source shows again that, with the exception of Zhili where Beijing is situated, the norm for average daily wages of unskilled labourers in most provinces in 1813 was about 0.04 taels, very close to that in the 1769 regulations.

Extreme caution should be exercised in the interpretation of these government data. The *Wuliao jiazhi zeli* wage data collected at the county level often show identical wages across a vast number of counties within one province, with little distinction between the more and less urbanized ones. This poses the question whether these data reflect actual market conditions or rather government policies, which tended to favour the capital region as well as Manchuria, the home territory of the Qing rulers.[15]

To tackle the question of how accurately these government regulated wages approximate wages in the private sector of the economy, we place these wage series against a broader dataset of 264 scattered wage quotations from many sources and for different parts of China. The problem with these disparate wages from the private sector is a lack of the kind of detailed information available for the Suzhou calenderers and Canton VOC labourers. Also, there is a general lack of comparability due to the multiplicity of labour contracts, payment systems, and currency units. Employment contracts could last for a day, a month, or a year, and careful attention must be given to the number of days worked in a month or a year to reduce the payment information to a consistent daily rate. There are many cases for which food allowances were given in addition to cash payments. Possibly the most difficult issue of all is the quotation of wages in different currency units (copper coins, silver taels) with exchange values that were both highly localized and fluctuating over time. Studies not taking full cognizance of these problems can be very misleading.[16]

[13] Wang, *Land taxation*, p. 87.

[14] See You, 'Lun junqi zeli', p. 314. Wages of skilled craftsmen were 0.020 or 0.010 taels higher than those of unskilled labourers.

[15] The Qing government restricted the migration of Han Chinese to the land and resource rich, but labour-scarce region of Manchuria until the mid-nineteenth century.

[16] Vogel, 'Chinese central monetary policy', contains the most comprehensive collection of market exchange rates for various provinces in China for the seventeenth to nineteenth centuries, but these exchange rates do not apply to the case of the co-circulation of multiple versions of silver and copper cash within the same locality, an issue pointed out in Kuroda's recent study, 'Copper coins'. For a case of neglecting these complicated currency problems in the study of nominal and grain wages, see Chao, *Man and land*, pp. 218–20.

The most important official source for private wages consulted in the present study is the records of the imperial Ministry of Justice, which summarized judicial cases dealing with wage payment. A sample of 188 manufacturing and handicraft wages was obtained from Peng's compilation on craft history, which is based on judicial records from *c.* 1740 to 1820.[17] They are contained in the archival documents of the Ministry of Justice, *Qingdai xingbu chao'an* (*Copies of archival materials from the Qing Ministry of Justice*).[18] This represents a widespread sample which includes scattered wage data for different occupations, in different regions, using different means of payment (silver taels or copper coins), covering different time periods (per day, month, or year), and spread over a long period. The Ministry of Justice records also contain samples of agricultural wages. These are available in the work of Wei and Wu.[19]

The resulting large, if disparate, sample of wages covers many provinces, industries, and types of employment in eighteenth-century China. To extract basic patterns from this information, a wage function was estimated using all of the collected wages, including the VOC and government regulation wages. All wages were converted to daily wages in silver taels by means of Vogel's regional dataset of silver–copper conversion ratios.[20]

The following independent variables were defined: (1) regions: Manchuria, Zhili, the north (Shanxi, Shaanxi, Gansu, Shandong), the Yangzi Delta (Jiangsu and Zhejiang), the 'middle', and the south (see table 1 for the exact specification of the regions; Canton is also distinguished separately); (2) branches (agriculture, coal mining, the iron industry, construction, textiles, and other industries); (3) a time-trend with 1700 as the base year; (4) skill (a dummy for skilled labour was used; unskilled labourers were all agricultural workers, the unskilled labourers in construction and the 'helpers' in other industries); (5) regulation (data drawn from the two government documents *Wuliao jiazhi zeli* (1769) and *Gongbu junqi zeli* (1813) were identified by a dummy for 'regulation'). We also include a few additional government regulation data from *Suzhou zizhao ju zhi* (1686) and *Da Qing huidian shili* (for 1723 and 1736).[21]

The total number of observations was 327, relatively equally spread over the different regions and branches. There are only four observations for the late seventeenth century. Most observations cluster between the 1740s and the 1810s; no observations after 1820 were included.

[17] Peng, *Zhongguo jindai shougongye*, vol. 1, pp. 396–414.

[18] Ibid., vol. 1, p. 397, n. 2.

[19] Wei, 'Ming-Qing'; Wu, 'Qing'.

[20] Vogel, 'Chinese central monetary policy'. Another problem was how to convert monthly and annual wages into daily wages; a few observations of both daily and monthly or annual wages suggests conversion factors of about 15 (days/month) and 60 (days/year). The next step was to use these conversion factors and estimate dummies for monthly and annual wages in the wage regression. The dummies became close to zero when somewhat different conversion factors were used, namely 13 and 90. We used these conversion factors in the estimation of wage levels in the wage regressions shown in tab. 1; therefore, the dummies for monthly and annual wages have not been included.

[21] Wage data from *Suzhou zizhao ju zhi* (*Treatise on the Suzhou weaving offices*) for 1686, included in Peng, *Zhongguo jindai shougongye*, vol. 1, pp. 90–2, were also consulted, as well as wage data from *Da Qing huidian shili*, ch. 952, fos. 4b–5a, pp. 16,640–1. The complete wage dataset used in this study can be found at http://www.iisg.nl/hpw/data.php#china; it presents an overview of the different datasets, their compilers (Christine Moll-Murata, Debin Ma, and Paul van Dyke), and the linked Excel files.

Table 2. *Wage regressions for eighteenth-century China, standardized on the daily wage of an unskilled construction labourer in the Yangzi Delta in 1769 (in taels)*

	Coefficient	T-*value*
Constant	0.0456	4.00
Trend	−0.0000351	−0.348
Manchuria	0.0902	6.73
Zhili (including Beijing)	0.0441	4.36
North	0.0132	1.397
Middle	−0.0022	−0.026
South	−0.000593	−0.056
Canton	0.0379	3.55
Skilled	0.0295	4.79
Regulated	−0.0171	−2.21
Iron industry	0.0092	1.12
Coal mining	−0.0093	−0.83
Agriculture	−0.0072	−0.744
Textiles	0.0403	3.22
Other	−0.0147	−1.93
R^2	0.408	
F (14,312)	15.34*	
N	327	

Note: *Significant at the 1% level.

Table 2 presents the results of the wage regression. All independent variables except the time trend are dummies for regions, branches, and so on; the standard for comparison is the market wage of a construction labourer in the Yangzi Delta in 1700. The constant in the equation is his wage, which is estimated as 0.0456 taels. The regional pattern mirrors the results from the analysis of the *Wuliao jiazhi zeli*: wages in Manchuria and Zhili were (much) higher than in the rest of the country, whereas the differences between the Yangzi Delta and the rest of the rice region were very small. Most industry dummies were insignificant. Finally, the dummy for skill premium is significant; its level in regression is 63 per cent of the wage of an unskilled labourer in the Yangzi Delta.

To get a perspective on our wage regression, we plotted in figure 1 the wage rates of Suzhou and Canton against the predicted wages from our regression. Figure 1 shows that the baseline predicted wages, set as the constant plus the time trend in the wage regression (the rate equivalent to that of an unskilled labourer in the Yangzi Delta), is about half the level of Suzhou and Canton wages. While VOC and calenderers' wages were rising gently, wages in China in general were declining slowly, as indicated by the wage equation. This difference in trend is not significant for our purpose. Figure 1 also plots the predicted wages of Beijing which uses the dummy coefficients for Zhili from the wage regression.

These results make sense: large cities in Europe, the counterparts of Canton, Suzhou, and Beijing, had higher wages than small towns and rural districts in part because the cost of living was higher in the large cities and also because they had to recruit population from the countryside. This conjecture is in agreement with Pomeranz's description of the earnings of a Yangzi Delta farm worker employed by the year in the mid-eighteenth century. Pomeranz reckoned that the cash component of these earnings was two to five taels, and that the food allowance over a full

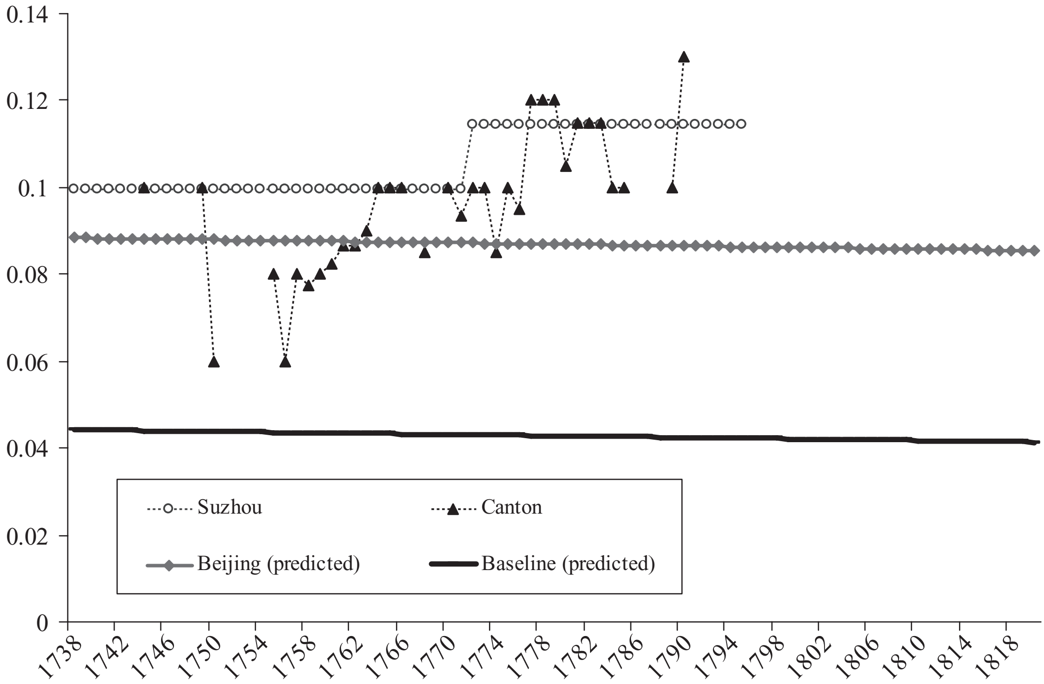

Figure 1. *Nominal wages in Beijing, Suzhou, and Canton (in silver taels)*
Source: See section I.

year was perhaps five *shi* of rice worth 8.4 taels, so the total earnings over the year were 10.4 to 13.4 taels. Dividing by 360 implies daily earnings of 0.035 to 0.045 taels per day, very close to the baseline wage level from our regression result.[22]

As the wage regression contains some wage data that might include additional food allowances, we have experimented with alternative regressions by adding 0.024 taels—roughly the cost of one kilogram of rice in Canton or millet in Beijing in the middle of the eighteenth century—to the daily earnings of those workers earning less than six taels per year (0.5 taels per month). The alternative regression leads to changes of little significance to the coefficients of most significance for this study.

The level of our baseline wage in figure 1 matches the empire-wide averages in the *Wuliao jiazhi zeli* and *Gongbu junqi zeli* in the official regulation data. This leads us to

[22] Pomeranz, *Great divergence*, pp. 319–20. The average of agricultural wages on daily contracts collected in our sample was 0.045 taels. Wages on daily contract were likely to be higher, as usually day labourers were more often employed during the planting and harvest seasons. It is unclear whether additional food was provided. A national level survey conducted by Chen in the 1930s, *Gesheng nonggong*, reveals the existence of both types of payment arrangements for daily wages, either with or without food payment, the latter being higher. However, in cases where there was food payment, the portion amounted to about 33 per cent of the total cash wage, much less than for the eighteenth- and nineteenth-century agricultural wages on annual contracts (Chen, *Gesheng nonggong*, p. 9). Li, *Agricultural development*, p. 94, also seems to indicate that seventeenth-century nominal wage levels may not be far apart from those of the eighteenth to nineteenth centuries. He discusses wage levels in agriculture and silk production in the Yangzi Delta, and estimates the average wage in rice cultivation at 0.06 taels per day, adding 'the official standard was 0.04 taels a day which is a bit low compared to the wages in some farms in Huzhou, Zhejiang province'.

believe that the government regulation wages may have been set as a wage floor for the market wages, which the government used for the purpose of cost-accounting. Both these sources also reveal higher wage levels for the capital region than the national average, which may be a reflection of possible governmental discrimination. If carefully interpreted, the regulated wage is more useful as a benchmark for a national wage floor than as an indication of regional wage patterns. For the subsequent analysis, the wage level for Beijing and Canton was set in 1700, based on the predicted values in the regression of 0.0897 and 0.0835 taels respectively, equal to the constant coefficients plus dummy coefficients for Zhili and Canton respectively. For Suzhou, 0.09 taels for 1700 were used, very close to the 0.0968 taels for the calenderers' wages. The national trend level was used for all these three series in the international comparison. Clearly, we view our wage series as more reliable in indicating long-term trends than short-term fluctuations.

Somewhat contrary to the claims that Lower Yangzi had the highest living standards, our dataset collected at this stage do not reveal a higher nominal wage for unskilled laborers in that region. While the implications of possible regional wage difference will be discussed later (in particular, see footnote 54), the rest of this study focuses on cross-national comparison of average wage income for unskilled labourers between China and Europe. On the assumption that these wages are complete payments for unskilled labourers in the three major urban centres, they most likely represent the upper bound estimates of our larger dataset. Thus, if the average level turns out to be lower than our nominal wages, then actual Chinese living standards would be even lower.

II

Jumping forward in time, the best available information on wages in Beijing, Canton, and Shanghai is for the early twentieth century. Our wage series for Beijing is anchored in the work of Sidney Gamble (1890–1968). Gamble was an American sociologist who lived in China in the 1920s and 1930s. He conducted a survey of workers in Beijing in 1921. This provided the weights for a consumer price index for Chinese capital for 1900–24, and that index, in turn, was used in a study of real wages for the period. Gamble and his associates also recorded wage series for unskilled construction workers in Beijing for the period 1862–1925 using the records of the Beijing guilds for construction workers. This is our source for unskilled wages in the capital.[23]

Gamble carried out another important study based on the account books of a fuel store in the rural area of Beijing. The information runs from 1807 to 1902 and is possibly the only consistent wage series for nineteenth-century China. The nineteenth-century wage payments were recorded in copper cash and were broken around the mid-nineteenth century due to the monetary debasement in the period of the Taiping Rebellion. Gamble does provide vital information on copper–silver rates in that area from which we derive a silver-based wage series for 1807–1902,

[23] This series is composed of two parts. The first part is the 1870–1900 copper cash wages (inclusive of food money) in Gamble, 'Daily wages', p. 66, which we converted to silver wages using copper–silver rates from Peng (*Zhongguo huobi shi*, p. 548). The second series is the 1900–24 series by Meng and Gamble, 'Wages, prices, and the standard of living', p. 100.

as shown in appendix I B. The level of the wage rates seems very low and is difficult to interpret in its own right, as Gamble indicated that workers received unrecorded food allowances.[24] We apply the trend (not the levels) of these silver wages to fill in the 1820–62 gap for the light it throws on the Taiping Rebellion and its aftermath.

Information on Cantonese wages is less comprehensive than that for Beijing. As noted above, estimates of wages in the eighteenth century have been derived mainly from VOC records and summarized in the wage regression. For the early twentieth century, the simple average of six series of union-regulated shows wage rates for unskilled labourers in the construction sector from 1912 to 1927 is used.[25] For the nineteenth century, various plausible wage data exist, but were not included in the analysis as they were incomplete and scattered.

Similarly, no systematic wage series for Suzhou in the nineteenth century was available. From the middle of the nineteenth century, Shanghai was emerging as China's predominant trading and industrial city under the treaty port system imposed by western imperialism. Setting out from wage notations for female cotton spinners in Shanghai between 1910 and 1934, we have calculated the wage levels of male unskilled labourers based on a wage survey of the 1930s.[26]

III

Adam Smith thought that the 'money price of labour' was higher in Europe than in China. To test that, Chinese and European wages must be compared. Building on our earlier studies of European daily wage rates earned by labourers in the building industry,[27] we have been careful to exclude wage quotations where the earnings included food or other payment in kind that could not be valued and added to the money wage. As with China, we have converted the European wages to grams of silver per day by using the market price (in units of account) at which silver coins of known weight and fineness could be purchased.

Figures 2 and 3 show the daily wage rates of unskilled workers in London, Amsterdam, Leipzig, Milan, Beijing, and Kyoto/Tokyo from the eighteenth century to the twentieth. Figure 2 shows the series from 1738 to 1870. For this period, Adam Smith was half right. Wages were, indeed, highest in London and lowest in Beijing, but the other series show that the world was more complex than Smith thought. The silver wage in Milan or Leipzig was not appreciably higher than the wage in Beijing, Canton, or Suzhou throughout the eighteenth century.[28] The statistics of other European and Chinese cities show that this similarity was general.

[24] Gamble, 'Daily wages', p. 41.

[25] Department of Peasantry and Labour, *Reports of statistics*, vol. 3, 'Wage tables in the construction sector'. Our wage series is the simple average of five types of unskilled labourers in the construction sector.

[26] We make use of the series by Rawski, *Economic growth*, p. 301, and the Bureau of Social Affairs, *Cost of living index*, pp. iii–iv. According to Yang, 'Shanghai gongren shenghuo', p. 250, female workers in 1927–8 were paid about 80% of the level of male workers.

[27] van Zanden, 'Wages and the standards of living'; Allen, 'Great divergence'.

[28] As indicated earlier in section I and in fig. 1, the silver wages we used for Beijing, Canton, and Suzhou/Shanghai are broadly equal. For reasons of easy visibility, we only plot the silver wage for the Beijing series on figs. 2 and 3. Complete price and wage series for figs. 2–6 can be downloaded from the websites at http://www.iisg.nl/hpw/data.php and http://gpih.ucdavis.edu/Datafilelist.htm.

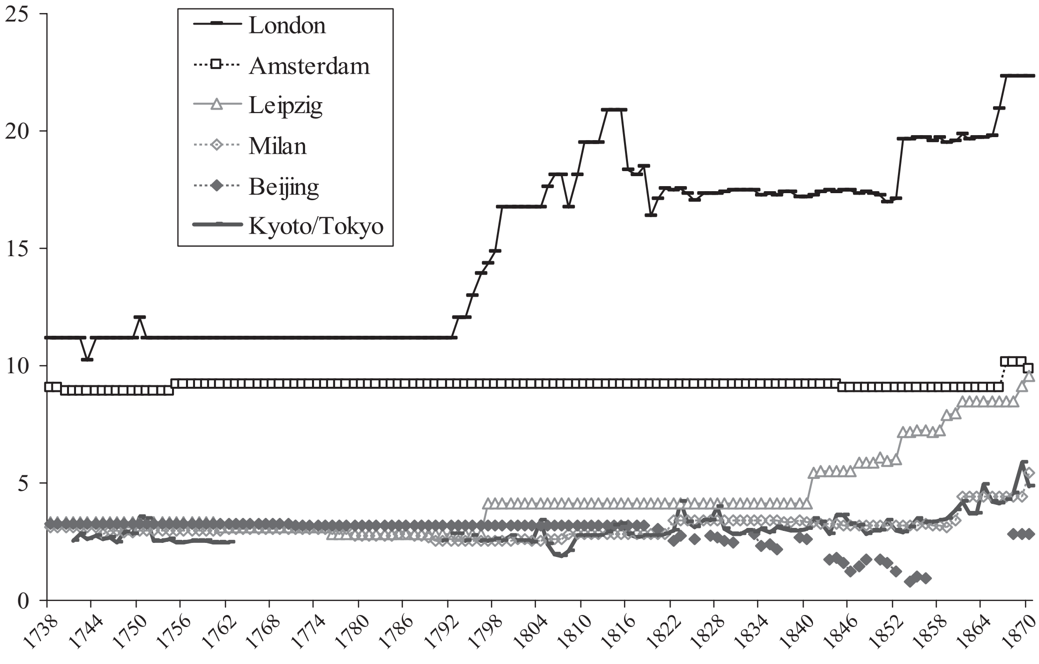

Figure 2. *Daily wages in grams of silver, 1738–1870*

Sources: For wages in Kyoto/Tokyo, see Bassino and Ma, 'Japanese unskilled wages'; for the rest, see section III, n. 31.

Amsterdam occupies a peculiar position in figure 2. Nominal wages there were remarkably constant for a century and a half. At the outset the Amsterdam wage was similar to the London wage. The same was true of Antwerp. Indeed, the Low Countries and the London region stand out from the rest of Europe for their high wages in the seventeenth and eighteenth centuries. These high wages were probably due to the active involvement of these regions in intercontinental commerce. However, this pattern changed as the nineteenth century advanced. The industrial revolution raised British wages above Dutch levels. Indeed, the early industrialization of Germany is seen in figure 2 as a rise in the Leipzig wage.

These developments intensified after 1870, as shown in figure 3. British wages continued to increase. By the First World War, German wages had caught up with the British level, and Dutch wages closed the gap as well. Italian wages were also growing, but the increase was muted compared to the industrial core of Europe. Outside Europe, Japanese wages before 1870 stayed largely flat, in keeping with the low Italian level. After 1890, Japanese wages, spurred by the industrialization drive in the Meiji era, began to rise, but continued to stay substantially below the rising trend of early twentieth-century European wages.

Chinese wages, in contrast, changed little over the entire period. There was some increase in the silver wage after 1870, but figure 3 emphasizes that the gain was of little importance from a global perspective. By the First World War, nominal wages in China were very much lower than wages in Europe generally.

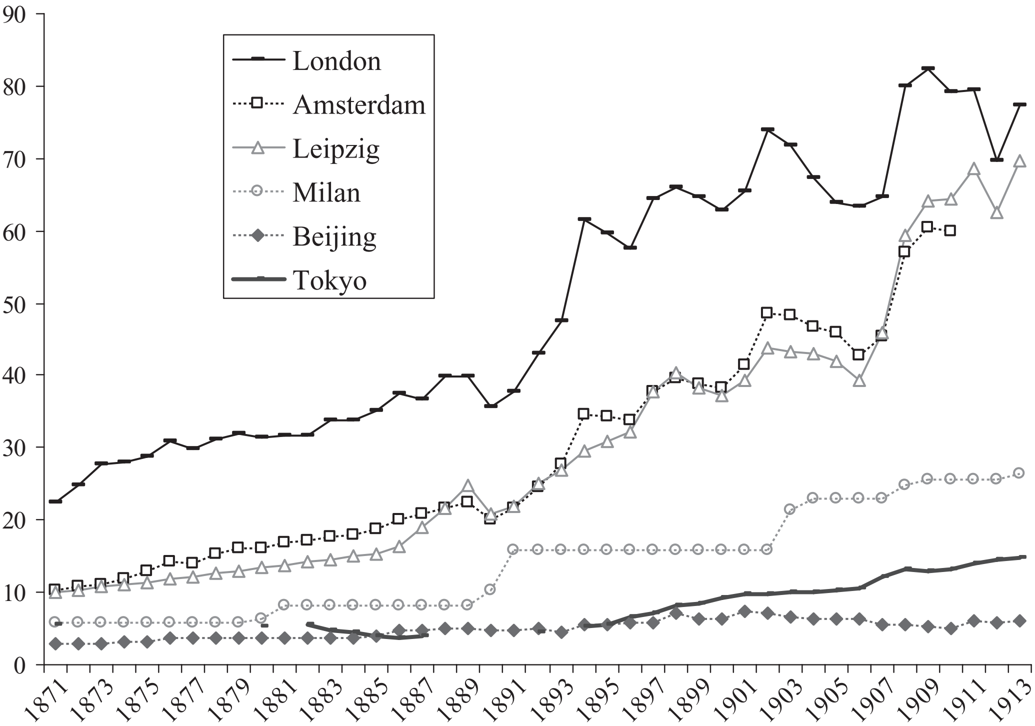

Figure 3. *Daily wages in grams of silver, 1870–1914*

Sources: For wages in Kyoto, see Bassino and Ma, 'Japanese unskilled wages', pp. 231–3; for the rest, see section III, n. 31.

Taken at face value, Adam Smith's generalization about Chinese and European wages was more accurate at the time of the First World War than when he penned it in 1776.

IV

What of Adam Smith's second generalization? He remarked that 'the difference between the price of subsistence in China and in Europe is very great'.[29] This generalization can be tested by computing price indices. We have tried many formulae and sets of weights, and the reassuring result is that our conclusions about relative real wages do not depend in any important way on the choice of price index.

The index number problem is a difficult one, since diet and lifestyle were radically different in different parts of Eurasia. How precisely does the real income of an English worker who consumed beef, bread, and beer compare to that of a Chinese labourer who ate rice and fish?

The approach considered in this section takes Adam Smith's comment as its point of departure. His generalization about price levels is expressed in terms of the 'price of subsistence'. We operationalize that by defining consumption baskets that represent the 'bare bones' minimum for survival (see tables 3–4). The baskets

[29] Smith, *Wealth of nations*, p. 189.

Table 3. *Subsistence lifestyle: baskets of goods in China*

	Suzhou/Canton			*Beijing*		
		Nutrients/day			*Nutrients/day*	
	Quantity per person per year	*Calories*	*Grams of protein*	*Quantity per person per annum*	*Calories*	*Grams of protein*
Rice	171 kg	1,677	47			
Sorghum				179 kg	1,667	55
Polenta						
Beans/peas	20 kg	187	14	20 kg	187	14
Meat/fish	3 kg	8	2	3 kg	21	2
Butter						
Oil	3 kg	67	0	3 kg	67	0
Soap	1.3 kg			1.3 kg		
Cotton	3 m			3 m		
Candles	1.3 kg			1.3 kg		
Lamp oil	1.3 kg			1.3 kg		
Fuel	3 M BTU			3 M BTU		
Total		1939	63		1,942	71

Note: For conversion of calories and proteins, see tab. A2. M: metres. M BTU: million BTU.
Sources: As explained in section IV.

Table 4. *Subsistence incomes: baskets of goods in Europe*

	Northern Europe			*Milan*		
		Nutrients/day			*Nutrients/day*	
	Quantity per person per year	*Calories*	*Grams of protein*	*Quantity per person per annum*	*Calories*	*Grams of protein*
Oats	155 kg	1,657	72			
Sorghum						
Polenta				165 kg	1,655	43
Beans/peas	20 kg	187	14	20 kg	187	14
Meat/fish	5 kg	34	3	5 kg	34	3
Butter	3 kg	60	0	3 kg	60	0
Oil						
Soap	1.3 kg			1.3 kg		
Cotton	3 m			3 m		
Candles	1.3 kg			1.3 kg		
Lamp oil	1.3 kg			1.3 kg		
Fuel	3 M BTU			3 M BTU		
Total		1,938	89		1,936	60

Notes: M: metres. M BTU: million BTU.
Sources: As explained in section IV.

provide 1,940 calories per day mainly from the cheapest available carbohydrate. In Shanghai, Canton, Japan, and Bengal that was rice; in Beijing it was sorghum; in Milan it was polenta; and in north-western Europe it was oats. The diet includes some beans and small quantities of meat or fish and butter or oil. Their quantities were suggested by Japanese consumption surveys of the 1920s and by the Chinese rural consumption survey in the 1930s carried out by the National Agricultural

Research Bureau (NARB).[30] Despite relying on the cheapest carbohydrates, these baskets provide at least the recommended daily intake of protein, although the amount varies from basket to basket. Polenta (closely followed by rice) is the least nutritious source of calories in this regard. Non-food items include some cloth and fuel. The magnitudes of the non-food items were also suggested by the Japanese and Chinese consumption surveys of the interwar period. It would have been hard for a person to survive on less than the cost of one of these baskets.

Having specified the consumption 'baskets' in tables 3–4, time series of the prices of the items shown are necessary, so that the cost of the baskets can be calculated across the eighteenth, nineteenth, and twentieth centuries. For Europe, the prices described in Allen's 'Great divergence' can be applied.[31] New databases were compiled for the Chinese cities under observation. For Beijing, we extended Gamble's retail prices for 1900–24 back to 1738.[32] Food prices were extended using wholesale agricultural prices for Zhili province compiled by Li.[33] The implicit assumption in these extrapolations was that the ratio of retail to wholesale prices remained constant. The details and the procedures for cloth and fuel are explained in appendix II. For Shanghai and Canton, twentieth-century retail prices were extracted from official sources.[34] For the eighteenth century, Wang's Yangzi Delta rice price series was used for Suzhou and Chen's series for Guangdong.[35] These are probably wholesale rather than retail prices. No allowance was made for retail mark-ups—a procedure which is again biased against our conclusions, for if rice prices in China were higher then living standards would have been even lower. The prices of other foods and fuel were taken from the costs incurred by European trading companies in provisioning their ships in Canton. These prices have been compared to the estimated prices for Beijing, and the agreement is close. For most of the eighteenth century, competition was intense in supplying these ships.[36]

The cost of the basket is Adam Smith's 'money price of subsistence', and its history is plotted in figure 4 for leading cities in China and Europe in the eighteenth and nineteenth centuries. The findings would have surprised Smith, for it contradicts his claim that China had cheaper subsistence than Europe. The silver cost of a 'bare bones' basket in Beijing or Suzhou was in the middle of the European range. A corollary is that the silver prices of grains, which dominate the cost of these indices, were similar across Eurasia. Another casualty of figure 4 is

[30] Department of Crop Reporting, Division of Agricultural Economics, The National Agricultural Research Bureau (NARB), China, Crop reports, vol. 5, issues 7 and 8; Rōdō undō shiryō iinkai, *Nihon rōdō*, p. 568. Alternative baskets constructed on the basis of these surveys can also be found in our earlier working paper, R. C. Allen, J.-P. Bassino, D. Ma, C. Moll-Murata, and J. L. van Zanden, 'Wages, prices, and living standards in China, Japan, and Europe, 1738–1925', Global Price and Income History Group working paper no. 1 (2005) [WWW document]. URL [http://gpih.ucdavis.edu/Papers.htm#1].

[31] The data are available on-line at http://www.nuffield.ox.ac.uk.

[32] Meng and Gamble, 'Wages'.

[33] Li, 'Integration'.

[34] The Canton data are based on *Reports of statistics* compiled by the Department of Peasantry and Labour, Kwangtung Government, China, in 1928; it covers the period 1912 to 1927. The Shanghai price is from Bureau of Social Affairs, *Cost of living index*, pp. 35–44.

[35] Wang, 'Secular trend', pp. 40–7; Chen, *Sichang jizhi*, pp. 147–9.

[36] See van Dyke, *Canton trade*.

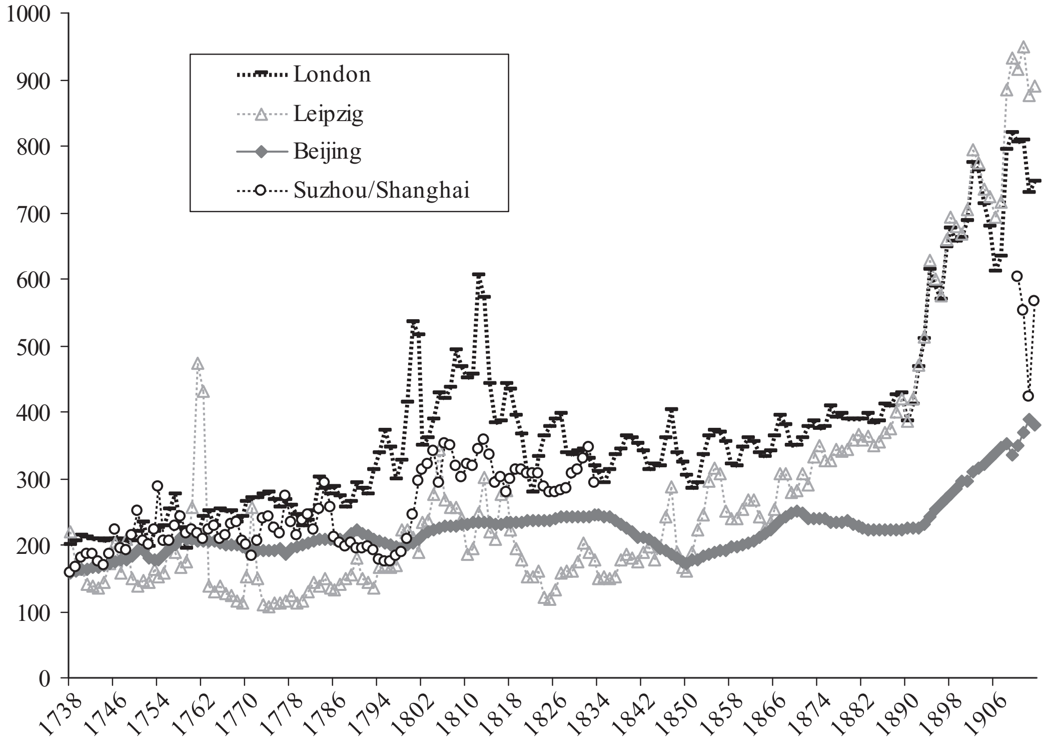

Figure 4. *Costs of the baskets in grams of silver per person per annum*
Source: As described in section IV.

Smith's generalization that 'rice in China is much cheaper than wheat is anywhere in Europe'.[37]

Another feature of figure 4 is worth highlighting. The figure shows very little difference between the two consumer price indices for both Beijing and Suzhou/Shanghai (or Canton, not shown in the figure) for the eighteenth century. These two cities represent the two agrarian halves of China—the northern small grain region and the southern rice region. However, from the beginning of the eighteenth century, rice prices began a secular rise over those of sorghum, which led to a somewhat more expensive basket for the unskilled labourers in the south than in the north. While the implication of this finding needs further research, this difference matters little for our purpose of international comparison. Overall, as seen in figure 4, price gaps between Europe and China really opened up from about the mid-nineteenth century.

V

Before considering the implications of the cost of the baskets for comparative living standards, the results of indexing prices in other ways can be briefly summarized.

[37] Smith, *Wealth of nations*, p. 189.

In modern theory, the index number problem unfolds thus. Suppose an individual or family receives a particular income and faces particular prices. The income and prices determine the maximum level of utility (highest indifference curve) that the individual can reach. Now suppose that prices change. What proportional change in income would allow the individual to reach the original indifference curve in the new price situation? The price index is supposed to answer that question. Comparing the actual change in income to the index shows whether consumer welfare has risen or fallen.

There are no insuperable difficulties in applying the theory to real income changes over time in either Europe or Asia, provided full information about wages, consumer prices, and spending patterns is available. Yet how can living standards between Europe and Asia be compared? The pattern of goods—particularly foods—consumed in the two regions was radically different. The standard theory of consumer welfare assumes that all the goods are available in both regions and that there is a 'representative agent' who would voluntarily choose to consume rice, fish, and sake when confronted with Asian prices and bread, beef, and beer when confronted with English prices. In fact, all goods were not available everywhere, and, moreover, it is unlikely that there were people flexible enough to shift their consumption voluntarily between the European and the Asian patterns in response to the difference in prices. This is the reason why we approached the problem in terms of Adam Smith's 'cost of subsistence'. By building on the results of these calculations, the outcome of a more orthodox approach can be approximated. During the comparative process, the associated data problems come sharply into focus. We concentrate on a comparison of Beijing and London because the Beijing diet was based on small grains that were more comparable than rice to English grains.

We first approach the question from the point of view of a Beijing resident and ask how much it would have cost to live the 'bare bones' Beijing lifestyle in London. This is the pertinent question, for the typical labourer could not afford to buy anything more. The difficulty is that we cannot cost out the Beijing basket in London, for sorghum was not sold in London. However, oats were the counterpart of sorghum in Britain—it was the least costly, most inferior grain—and if we take oats and sorghum to be equivalent, we realize that we have already answered the question by comparing the cost of the 'bare bones' baskets.

We can also ask how much the London lifestyle would have cost in Beijing. That lifestyle is represented by the 'respectable' consumption basket in table 5, which summarizes spending in north-western Europe.[38] The diet is late medieval in inspiration, in that it does not contain new commodities like sugar and potatoes introduced into Europe after the voyages of discovery.

The basket in table 5 contains important items for which we lack prices in China. Bread is the most important, and we have estimated what bread would have sold for, had it been produced commercially, from Allen's 'bread equation'.[39] This is a statistical relationship between bread prices, wheat prices, and wage rates prevailing in many cities in Europe. Since we have time series of wages and wheat prices for Zhili province, which includes Beijing, the price at which bread would

[38] Allen, 'Great divergence', pp. 420–1.
[39] Ibid., p. 418.

Table 5. *Comparison of different basket costs around 1750*

	'Bare bones' basket		*'Respectable' basket*		*London prices (in grams of silver)*	*Beijing prices (in grams of silver)*
	Europe	*North China*	*Europe*	*North China*		
Oats/sorghum	155 kg	179 kg			0.76	0.48
Bread			182 kg	182 kg	1.28	0.95
Beans			40 kg	40 kg	0.5	0.84
Meat/fish	5 kg	3 kg	26 kg	31 kg	3.19	2.04
Cheese			5.2 kg		2.07	
Eggs			52 pieces	52 pieces	0.37	0.074
Butter	3 kg		5.2 kg		6.45	
Beer/rice wine			182 l	49 l	0.39	1.98
Oil/cooking		3 kg		5.2 kg		4
Soap	1.3 kg	1.3 kg	2.6 kg	2.6 kg	6.36	1.65
Linen/cotton	3 m	3 m	5 m	5 m	4.87	6.14
Candles	1.3 kg	1.3 kg	2.6 kg	2.6 kg	5.4	3.3
Lamp oil	1.3 kg	1.3 kg	2.6 kg	2.6 kg	2.8	3.3
Fuel	3 M BTU	3 M BTU	5 M BTU	5 M BTU	5.59	11.2
Total basket cost (grams of silver)	213	182.6	558.6	499.3		
Europe/Beijing ratio	'Bare bones' basket 1.17		'Respectable' basket 1.12		Geometric average 1.14	

Notes: M: metres. M BTU: million BTU.
Sources: See sections IV and V, and app. II.

have been supplied had it been produced in the European manner can be calculated. Likewise, the price of beer is unknown. For it, we substituted the quantity of rice wine (*sake*) that contained the same quantity of alcohol.[40] We estimated the price of rice wine using the Japanese relationship between the retail price of sake and the wholesale price of rice. In this way we proxied the missing prices needed to cost out a European basket in Beijing.

The European and Beijing baskets define Paasche and Laspeyres price indices. The final step in comparing the cost of living in London and Beijing is to compute the geometric average of the two, which is a Fisher Ideal Price index. This is a 'superlative' price index, which corresponds to a generalized Leontief expenditure function.[41] That representation of consumer preferences has the property that indifference curves are tangent to prices at both consumption patterns. In other words, the representative consumer whose behaviour is summarized by the price index would shift from an English to a Chinese spending pattern as prices shifted from the London to the Chinese configuration. Using this index number imposes the assumptions of modern theory on the reality of eighteenth-century behaviour—certainly a debatable procedure.

How does the Fisher Ideal Price index compare to the 'bare bones' indices? In fact, they are very similar. The relative cost of the European basket in London and Beijing was always close to the relative cost of the 'bare bones' baskets, which are equal to ratios of 1.12 and 1.17 respectively in table 5. Hence, their geometric average is also similar. Consequently, a superlative index number, in this case, gives

[40] 182 litres of beer at 4.5% alcohol contain as much alcohol as 41 litres of sake at 20%.

[41] Diewert, 'Exact and superlative index numbers'. The use of alternative consumption baskets for Canton and Japan based on comparable calories and protein contents also confirm the findings here; see Allen et al., 'Wages, prices, and living standards' (see above, n. 30).

the same result as a comparison of Smith's 'cost of subsistence'. Since the latter has so many intuitive interpretations, we use it as the axis of our discussion in the confidence that it is not misleading us when the index number problem is considered from other perspectives.

VI

The purchasing power of wages is usually measured by the ratio of the wage to the consumer price index. Our procedure elaborates that approach. In constructing the consumer price index, a notional budget was specified that represented the least costly way to survive (tables 3 and 4, however, do not include housing costs, so we increase them now by 5 per cent, which is a minimal allowance for rent). The budget was an annual budget for an adult male. If the man supported a family, the expenditures would have been higher, so that the cost of the budget (augmented by 5 per cent for rent) was multiplied by three to represent the annual budget of a family. This increase is roughly in line with the calorie norms for a man, a woman, and two young children.[42] On the income side, our income measure is the annual earnings that a worker could have gained if he worked full time for a year. We assume that one year's work consisted of 250 days—roughly full-time work allowing for holidays, illness, and slack periods. The earnings from full-time work provide a useful benchmark for comparing Europe and Asia and for defining the economic strategies of families. The ratio of estimated full-time earnings to the annual cost of the family budget is a real wage index.

Our real wage index has a particular interpretation since it answers a specific question, namely, whether a man working full time could support a family at the 'bare bones' level of consumption. Real wage indices of this sort are called 'welfare ratios'. When the welfare ratio equalled one, an unskilled labourer working full time could earn just enough to support his family at subsistence level. Higher values indicate some surplus, while values below one mean either that the family size had to be reduced or work effort had to be increased since there was little scope for reducing expenditure.

Figures 5 and 6 show welfare ratios for unskilled male workers from 1738 to 1923 in the European cities we discussed and the Chinese cities. Several features stand out. Firstly, as shown in figure 6, the Yangzi Delta is reputed to have had the most advanced economy of any Chinese province, but the real wage there was not noticeably higher than the real wage in Beijing or Canton, as we will see. Secondly, the Chinese cities were in a tie for last place with the Italian cities, which had the lowest standard of living in Europe, so an optimistic assessment of China's performance is difficult. Thirdly, the existing information about Beijing wages in the nineteenth century indicates that the real wage continued to slide until the Taiping Rebellion in mid-century, when it reached a life-threateningly low level. After authority was restored, living standards improved slowly into the early twentieth century. Fourthly, the most striking feature of figures 5 and 6 is the great lead in living standards enjoyed by workers in the rapidly growing parts of western Europe. The standard of living of workers in London was always much higher than

[42] Precisely, two children aged 1–3 and 4–6 respectively. For a discussion of food requirements for a notional family of four, see Allen, 'Great divergence', p. 426.

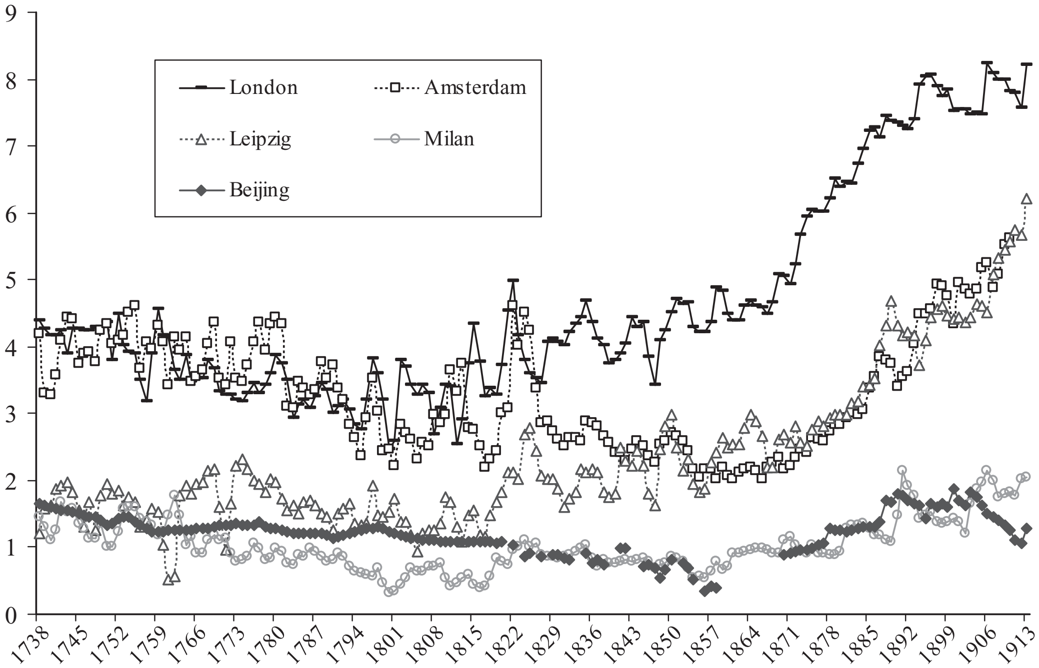

Figure 5. *Welfare ratios*
Source: As described in section VI.

that of workers in Beijing or the Yangzi Delta. After the middle of the nineteenth century, London living standards began an upward trajectory and increased their lead over China. While workers in Amsterdam in the eighteenth century also lived better than their counterparts in Beijing, the Dutch economy faltered in the early nineteenth century.[43] By mid-century, however, growth resumed and real wages were climbing to new heights. At the same time, the rapid growth of the German economy was translating into rising real wages for workers in Leipzig. By the First World War, the standard of living of workers in the industrial core of western Europe had greatly increased over their counterparts in Beijing and Suzhou. The standard of living in China remained low and on a par with the regions of Europe untouched by the industrial revolution. Fifthly, the workers in north-western Europe with welfare ratios of four or more did not eat four times as much oatmeal as their 'bare bones' diet presupposes. Instead, they ate higher-quality food—beef, beer, and bread—that was a more expensive source of calories. In addition, they bought a wide range of non-food items. In the eighteenth century, these included the Asian imports and novel manufactures that comprised the 'consumer revolution' of that era. By the same token, workers in north-western Europe could afford the basket of goods shown in table 5, while workers in Asia could not, and had to subsist on the 'bare bones' baskets. After all, in regions of settled agriculture, the

[43] van Zanden and van Riel, *Strictures*, pp. 121–30, pp. 188–91.

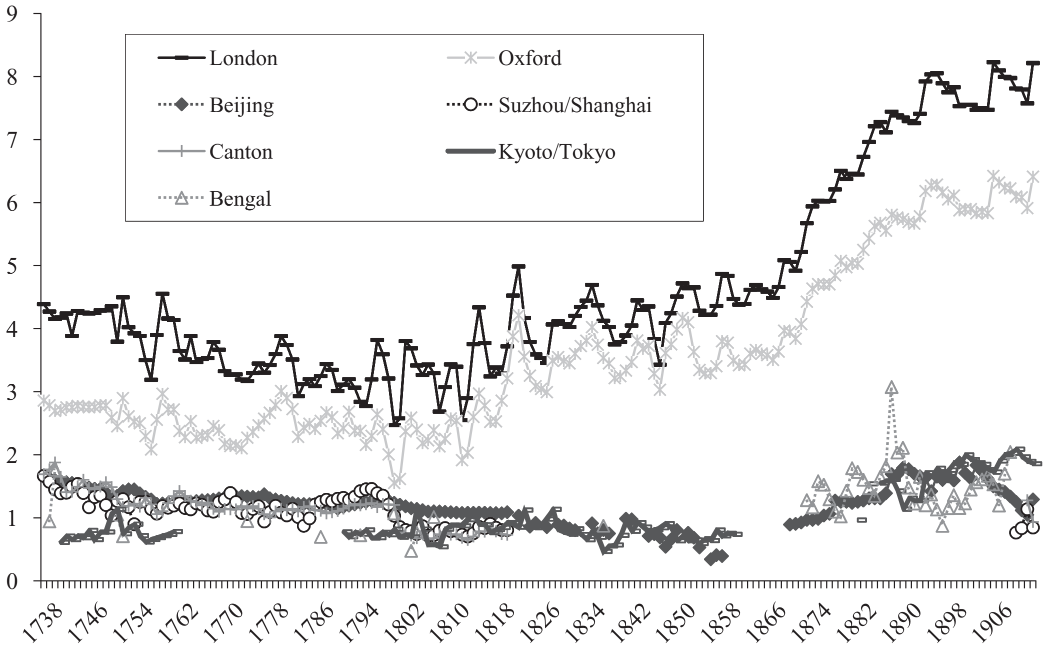

Figure 6. *Welfare ratios in Asia*

Sources: For Bengal welfare ratio, see Allen, 'India in the great divergence'. Kyoto/Tokyo welfare ratio is based on Bassino and Ma, 'Japanese unskilled wages'. As the 'Japan B' consumption basket constructed in Bassino and Ma article is roughly equivalent to the 'bare bones basket', we use real wages deflated by the cost of the 'Japan B' basket.

least expensive way to get calories is to boil the cheapest grain into a gruel or porridge. In northern Britain, the poorest people ate oat porridge; in the Yangzi Delta, they ate wheat gruel.[44]

Figure 6 tests the generality of these conclusions by including all of the Asian welfare ratios for comparison. There was variation in experience, but that variety does not qualify the conclusion that Asian living standards were at the low end of the European range. The history of living standards in Japan, India, and Canton was very similar to that of Beijing or Suzhou. Real wages in Istanbul, as shown by Özmucur and Pamuk, were at a level as low as China's, so it may have characterized much of the non-industrializing world in the eighteenth century.[45] There is evidence of rising living standards across Asia after 1870, but the gains were not enough to catch up to the standard of mid-eighteenth-century London or Amsterdam, let alone the much higher standard of living enjoyed by workers in those cities in the early twentieth century.

Figure 6 broadens our comparison by inserting the welfare ratio of Oxford, with the view that London may be exceptional in terms of real wages among English towns. Indeed, real wages in Oxford were always lower than in London, although the gap narrowed from the late eighteenth century.[46] Nonetheless, at a welfare ratio between 2.5 and 3.0 during the eighteenth century, Oxford still seemed far more

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

[45] Özmucur and Pamuk, 'Real wages'.

[46] For welfare ratios in Oxford and other towns in England, see Allen, 'Great divergence', pp. 415–16.

prosperous than Beijing. London (the capital and a major port) and other big cities were chosen because they are comparable to Beijing (the capital) and Canton (a major port), which are likely to be at the top of the wage scale in their country or region. Oxford, meanwhile, ranked much lower on the urban hierarchies compared with the cities in our study. Thus, the inclusion of Oxford as a robustness check assured us that our finding is not driven by the relative position of London.

A more important question is how representative wages are of labour incomes in China in general. Our knowledge of labour market conditions and the extent of regional migration seem to substantiate the view that wage rates may serve as a reasonable proxy for the average earnings of a particular socio-economic group as well as the marginal productivity of labour in the economy as a whole. The existence of a vibrant and active labour market, particularly for short-term or day labour, in early modern China (and Japan) is well documented, although the precise proportion remains elusive.[47] For the early twentieth century, which shared much of the institutional and economic continuities of the eighteenth and nineteenth centuries, large-scale household surveys reveal, for example, that between 30 and 50 per cent of rural households in the 1930s Wuxi county in the Yangzi Delta region hired day labourers during peak season, whereas the long-term labour market was extremely thin. Furthermore, those households whose main income derived from farm labour fetched an average income 20 per cent below the mean per capita income of all the Wuxi households. This income distance of 20 per cent from the mean shows that agricultural day labourers were at the lower end—but not a marginal fringe—of the income ladder.[48]

Secondly, at least for the commercialized regions near the major urban centres, evidence of a relatively high degree of integration of labour markets between urban and rural areas can be perceived. As noted earlier, most calenderers in Suzhou were migrant workers from the relatively impoverished rural Northern Jiangsu. Similarly for the Beijing wage series, Gamble's detailed study reminds us of the close linkage between urban and rural wages in the nineteenth century. Indeed, if labour market and regional labour migration in eighteenth-century China were as flexible as claimed by the revisionists, there is all the more reason to believe that the wage rates for unskilled labourers we measure are representative of labour earnings for a substantial part of the population at the relatively low end of income distribution.[49]

Our notional wage income can be directly compared with the labour income data cited by Pomeranz and Li when they in fact argue the reverse case, namely, that labouring people in the Yangzi Delta had a high standard of living. Pomeranz,

[47] The literature on the prevalence of labour employment and contracts in Ming and Qing China is voluminous. Examples of this literature can be seen in Pomeranz, *Great divergence*, pp. 81–2, and Huang, *Peasant family*, pp. 58–62. Wei, 'Ming-Qing', documents in detail the improved legal status of labourers towards the eighteenth century.

[48] For information on the labour market in north China and the Yangzi Delta, see Huang, *Peasant family*, p. 110. The Wuxi survey summary can be found in Kung, Lee, and Bai, 'Human capital', tabs. 1 and 2. For a nationwide survey of the labour market in the 1930s, see Chen, *Gesheng nonggong*. Similar labour market and income distribution can also be found in Tokugawa Japan. Bassino, Ma, and Saito, 'Level of real wages', calculate that the welfare ratios of the wage earnings of farm labourers were roughly equivalent to those of tenant cultivators who, in turn, were about 20% below those of the median class.

[49] For linkage between urban and rural wages, see Gamble, 'Daily wages', p. 67. See Pomeranz, *Great divergence*, ch. 2, for an argument on the flexibility of product and factor markets and labour migration in early modern China.

for instance, estimates that a male agricultural labourer employed full time over the course of a year would have realized about 12 taels. Using average prices for 1745–54, the 'bare bones' cost of maintaining a family was 22.59 taels, so the labourer was only earning 53 per cent of subsistence; in other words, the welfare ratio was 0.53. He could barely support himself, let alone a wife and children. A woman spinning and weaving cotton for 200 days per annum, which Li and Pomeranz both reckon was about the maximum possible, could earn 14.61 taels, a bit more than a man.[50] Again, this was less than the cost of maintaining a family. Husband and wife together, however, would have earned 26.61 taels, which was 1.18 times the cost of maintaining a family. A family could survive on that, so long as nothing went wrong, but the standard of living was far behind that in London or Amsterdam where the labourers earned four times the cost of a 'bare bones' standard of living in the middle of the eighteenth century.

So far, this comparison has focused on the wage income of unskilled labourers. However, the wage regression and the twentieth-century wages summarized by Gamble for Beijing all indicate that the ratio of skilled to unskilled wages was about the same in China as in north-western Europe. While future research is needed, this evidence suggests that our conclusions about comparative living standards could still hold true if the comparison were broadened to include all kinds of wage earners.[51]

VII

Our investigation of Asian and European wages and prices shows that the situation differed somewhat from Adam Smith's impressions. Money wages were in accord with his view: in China, they were certainly lower than wages in the advanced parts of western Europe in the eighteenth century and similar to those in the lagging parts of Europe. By the twentieth century, however, wages in all parts of Europe were higher than in China. Contrary to Smith, the cost of living was similar in China and in Europe in the eighteenth century.

The upshot of the wage and price comparisons is that living standards were low in China. In the eighteenth century, advanced cities like London and Amsterdam had a higher standard of living than Suzhou, Beijing, or Canton. The standard of living in the Chinese cities we have studied was on a par with the lagging parts of Europe, the Ottoman Empire, India, and Japan. By the twentieth century, enough progress had occurred in even the backward parts of Europe that their standards of living were beginning to creep above those in China. Wages seemed to have slipped in China in the eighteenth century. Still, most of the difference between Europe and China in 1913 was due to European advance rather than Chinese decline.

In spite of the above, a major surprise is our finding that unskilled labourers in major cities of China and Japan—poor as they were—had roughly the same standard of living as their counterparts in central and southern Europe for the

[50] Li, *Agricultural development*, pp. 149, 152. Pomeranz, *Great divergence*, pp. 318–19, offers two calculations pointing to slightly lower earnings. Li's calculation assumes women received 0.19 shi per bolt of cloth; Pomeranz's is slightly higher. They do not use precisely the same prices. We use average values for 1745–54.

[51] J. L. van Zanden, 'The skill premium and the "great divergence" ', paper presented at the conference 'Towards a global history of prices and wages' (Utrecht, 19–21 Aug. 2004) [WWW document]. URL http://www.iisg.nl/hpw/papers/vanzanden.pdf [accessed on 10 June 2009].

greater part of the eighteenth century. This calls into question the fundamental tenet of the large 'rise of the west' literature that sees western Europe—as a whole—surpassing the rest of the world in the early modern era. Our article suggests that it was only England and the Low Countries that pulled ahead of the rest. The rest, in this context, includes not only Asia but also much of Europe.[52]

In this regard, Adam Smith neglected regional variation and thereby over-generalized the comparison of Europe and China. But our findings also dispute the revisionists' claim that the advanced parts of China, such as the Yangzi Delta, were on a par with England on the eve of the industrial revolution, for we find real wages for unskilled labourers in the Yangzi Delta to have been no higher than those in Beijing or Canton. Clearly, our database on China could be greatly improved and we do not claim to have given the final answer to this question. Nevertheless, any newly discovered data would have to be very different from what is currently available in order to convince us that pre-industrial Chinese living standards were similar to those in the leading regions of Europe.[53] In this regard, Adam Smith's pessimism looks closer to the truth than the revisionists' optimism. Of course, establishing the existence of an income gap between north-western Europe and China in the early modern era only takes us halfway towards the resolution of the great divergence debate. The search for a causal explanation of the great divergence still looms large as a future research agenda.

University of Oxford; University of Montpellier; London School of Economics; Bochum University; Utrecht University

Date submitted	*4 June 2008*
Revised version submitted	*15 June 2009*
Accepted	*8 September 2009*

DOI: 10.1111/j.1468-0289.2010.00515.x

[52] For a coverage of welfare ratios of unskilled workers across 16 major urban centres of continental Europe in the early modern period, see Allen, 'Great divergence'.

[53] For the discussion of higher living standards in the Yangzi Delta, see Pomeranz, *Great divergence*, and Li, *Agricultural development*. Huang's comparative regional study, *Peasant family*, also makes a strong case that the Yangzi Delta overall had higher productivity levels and income than north China. Our findings of roughly comparable nominal and real wage levels in the three major Chinese urban centres do not necessarily preclude the possibility that broader measures of per capita income and living standards could still be higher in the Yangzi Delta. A recent study by Ma, 'Economic growth', shows that the per capita income of the two provinces in the Yangzi Delta in the 1930s were 55% higher than the Chinese national average. There is good reason to believe the regional income gap in China in the 1930s would have been larger than in the eighteenth century. While future empirical research is needed to construct a comprehensive regional wage profile for eighteenth- and nineteenth-century China, the magnitude of regional variation within China as discussed in these other studies pales in comparison with the gaps in average real wages in urban centres between China and England.

Footnote references

Allen, R. C., 'The great divergence in European wages and prices from the middle ages to the First World War', *Explorations in Economic History*, 38 (2001), pp. 411–47.

Allen, R. C., 'Agricultural productivity and rural incomes in England and the Yangtze Delta, *c.* 1620–*c.* 1820', *Economic History Review*, 62 (2009), pp. 525–50.

Allen, R. C., 'Real wages in Europe and Asia: a first look at the long-term patterns', in R. C. Allen, T. Bengtsson, and M. Dribe, eds., *Living standards in the past: new perspectives on well-being in Asia and Europe* (Oxford, 2005), pp. 111–31.

Allen, R. C., 'India in the great divergence', in T. J. Hatton, K. H. O'Rourke, and A. M. Taylor, eds., *The new comparative economic history: essays in honor of Jeffrey G. Williamson* (Cambridge, Mass., 2007), pp. 9–32.
Allen, R. C., Bengtsson, T., and Dribe, M., eds., *Living standards in the past: new perspectives on well-being in Asia and Europe* (Oxford, 2005).
Bassino, J.-P. and Ma, D., 'Japanese unskilled wages in international perspective, 1741–1913', *Research in Economic History*, 23 (2005), pp. 229–48.
Bassino, J.-P., Ma, D., and Saito, O., 'Level of real wages in historic China, Japan and Southern Europe, 1700–1920: a review of evidence', *Economic Research [Keizai Kenkyu]*, 56, 4 (2005), pp. 348–69.
Broadberry, S. and Gupta, B., 'The early modern great divergence: wages, prices and economic development in Europe and Asia, 1500–1800', *Economic History Review*, LIX (2006), pp. 2–31.
Bunko, M., ed., *Kinsei Nihon goki ni okeru jūyō bukka no dōtai [Trends of major prices in early modern Japan]* (Tokyo, 1989).
Bureau of Social Affairs, City Government of Greater Shanghai, *The cost of living index numbers of laborers, Greater Shanghai, January 1926–December 1931* (1932).
Chao, K., *Man and land in Chinese history: an economic analysis* (Stanford, 1986).
Chen, C., *Shichang jizhi yu shehui bianqian: shiba shiji Guangdong mijia fenxi [Market mechanism and social change—an analysis of rice prices in eighteenth-century Guangdong]* (Guangzhou, 1992).
Chen, Z., *Gesheng nonggong guyong xiguan ji xugong zhuangkuang [Employment practice and conditions of supply and demand for agricultural labourers in various provinces]* (Nanjing, 1935).
Da Qing huidian shili [Collected statutes of the great Qing Dynasty, with factual precedents] (Taibei, 1963, repr. from 1899).
Department of Crop Reporting, Division of Agricultural Economics, The National Agricultural Research Bureau (NARB), China, *Crop reports*, vol. 5, issues 7 and 8 (Nanjing, 1937).
Department of Peasantry and Labour, Kwangtung Government, China, *The reports of statistics*, vol. 3: *The wage indexes of labourers in Canton, China, 1912–1927* (1928).
Diewert, W. E., 'Exact and superlative index numbers', *Journal of Econometrics*, 4, 2 (1976), pp. 115–45.
van Dyke, P. A., *The Canton trade. Life and enterprise on the China coast, 1700–1845* (Hong Kong, 2005).
Feuerwerker, A., 'Handicraft and manufactured cotton textiles in China, 1871–1910', *Journal of Economic History*, 30 (1970), pp. 338–78.
Gamble, S. D., 'Daily wages of unskilled Chinese laborers, 1807–1902', *Far Eastern Quarterly*, 3, 1, (1943), pp. 41–73.
Gongbu junqi zeli [Regulations and precedents on weapons and military equipment by the Ministry of Public Works], comp. by Q. Liu et al., Qing official printing (Beijing, 1813–16).
Huang, P., *The peasant family and rural development in the Yangzi Delta, 1350–1988* (Stanford, 1990).
Jörg, C. J. A., *Porcelain and the Dutch China trade* (The Hague, 1982).
Kishimoto, M., *Shindai chūgoku no bukka to keizai hendō [Prices and economic change in Qing Dynasty China]* (Tokyo, 1997).
Korthals Altes, W. L., 'Prices (non-rice)', in P. Creutzeberg *et al.*, *Changing economy in Indonesia*, vol. XV (The Hague, 1994).
Kung, J., Lee, Y. -F., and Bai, N., 'Human capital, migration, and "vent" for surplus rural labor in 1930s' China: the case of the Lower Yangzi', *Economic History Review* (forthcoming).
Kuroda, A., 'Copper coins chosen and silver differentiated: another aspect of the "silver century" in East Asia', *Acta Asiatica* (2005), pp. 65–86.
Lee, J. Z. and Wang, F., *One quarter of humanity: Malthusian mythology and Chinese realities, 1700–2000* (Cambridge, Mass., 1999).
Li, B., *Agricultural development in Jiangnan, 1620–1850* (New York, 1998).
Li, L. M., 'Grain prices in Zhili province, 1736–1911: a preliminary study', in T. G. Rawski and L. M. Li, eds., *Chinese history in economic perspective* (Berkeley, 1992), pp. 70–100.
Li, L. M., 'Integration and disintegration in north China's grain markets, 1738–1911', *Journal of Economic History*, 60 (2000), pp. 665–99.
Ma, D., 'Economic growth in the lower Yangzi region of China in 1911–1937: a quantitative and historical perspective', *Journal of Economic History*, 68, (2008), pp. 385–92.
Meng, T. -P. and Gamble, S. D., 'Wages, prices, and the standard of living in Peking, 1900–1924', *Chinese Social and Political Science Review*, 20 (1926), pp. 1–113.
Özmucur, S. and Pamuk, Ş., 'Real wages and standards of living in the Ottoman Empire, 1489–1914', *Journal of Economic History*, 62 (2002), pp. 293–321.
Parthasarathi, P., 'Rethinking wages and competitiveness in the eighteenth century: Britain and south India', *Past & Present*, 158 (1998), pp. 79–109.
Peng, X., *Zhongguo huobi shi [A monetary history of China]* (Shanghai, 1954), trans. as *A monetary history of China*, E. H. Kaplan, trans. (Bellingham, 1993).
Peng, Z., *Zhongguo jindai shougongye shi ziliao 1840–1949 [Materials for early modern Chinese craft history, 1840–1949]*, 4 vols. (Beijing, repr. 1984).
Pomeranz, K., *The great divergence: China, Europe, and the making of the modern world economy* (Princeton, 2000).

Quan, H., 'Qingdai Suzhou de chuaibuye' ['Cotton calendering in Qing Suzhou'], *Xin Ya xuebao [New Asia Journal]*, 13 (1975), pp. 424–6.
Rawski, T., *Economic growth in pre-war China* (Berkeley, 1989).
Rōdō undō shiryō iinkai [Commission for Historical Documentation of the Labour Movement], *Nihon rōdō undō shiryō [Historical documents on the Japanese labour movement]*, vol. 10 (Tokyo, 1959).
Santangelo, P., 'Urban society in late imperial Suzhou', in L. Cooke Johnson, ed., *Cities of Jiangnan in late imperial China* (New York, 1993), pp. 81–116.
Smith, A., *An inquiry into the nature and causes of the wealth of nations*, E. Cannan, ed. (New York, 1937).
Song, J. and Moll-Murata, C., 'Notes on Qing Dynasty handicraft regulations and precedents *(jiangzuo zeli)*, with special focus on regulations on materials, working time, prices, and wages', *Late Imperial China*, 23, 2 (2002), pp. 87–126.
Terada, T., 'Sōshū tampogyō no kei'ei keitai' ['Management systems in Suzhou calendering'], *Tōhōku daigaku bungakubu kenkyū nenpō [Research Annals of the Humanities Department of Northeast University]*, 18 (1967), pp. 121–73.
Timkovski, G., *Voyage à Péking* (Paris, 1827).
Vogel, H. U., 'Chinese central monetary policy, 1644–1800', *Late Imperial China*, 8, 2 (1987), pp. 1–52.
Wang, Y. -C., *Land taxation in imperial China, 1750–1911* (Cambridge, Mass., 1973).
Wang, Y. -C., 'Secular trends of rice prices in the Yangzi Delta, 1638–1935', in T. G. Rawski and L. M. Li, eds., *Chinese history in economic perspective* (Berkeley, 1992), pp. 35–68.
Wei, J., 'Ming-Qing shidai nongye zhong dengjixing guyong laodong xiang feidengjixing guyong laodong de guodu' ['The transition from hierarchical to non-hierarchical agricultural labour employment during the Ming and Qing periods'], in W. Li, J. Wei, and J. Jing, eds., *Ming Qing shidai de nongye ziben zhuyi mengya wenti* (Beijing, 1983).
Wong, R. B., *China transformed: historical change and the limits of European experience* (Ithaca, 1997).
Wu, L., 'Qing qianqi nongye gugong de gongzi' ['Wages of hired agricultural labourers in the early Qing'], *Zhongguo shehui jingjishi yanjiu [Journal of Chinese Social and Economic History]*, 2 (1983), pp. 17–30.
Wuliao jiazhi zeli [Regulations and precedents on the prices of materials], comp. by H. Chen et al., Qing official printing (1769–95).
Xu, X., ed., *Jiangnan tubu shi [History of native cloth in Jiangnan]* (Shanghai, 1989).
Yan, Z. *et al.*, eds., *Zhongguo jindai jingjishi tongji ziliao xuanji [Selected statistical materials on modern Chinese economic history]* (Beijing, 1955).
Yang, X., 'Shanghai gongren shenghuo chengdu de yige yanjiu' ['A study on the living standards of Shanghai workers'], in W. Li, ed., *Minguo shiqi shehui diaocha congbian. Chengshi (laogong) shenghuo bian [A collection of survey research in Republican China. Volume on the living conditions of the urban working class]*, 1 (Fuzhou, 2005), pp. 243–336.
You, Z., 'Lun junqi zeli' ['A study of regulations and precedents on weapons and military equipment'], in C. Moll-Murata, J. Song, and H. U. Vogel, eds., *Chinese handicraft regulations of the Qing Dynasty* (Munich, 2005), pp. 307–24.
van Zanden, J. L., 'Wages and the standards of living in Europe, 1500–1800', *European Review of Economic History*, 3 (1999), pp. 175–98.
van Zanden, J. L. and Van Riel, A., *The strictures of inheritance. The Dutch economy in the nineteenth century* (Princeton, 2004).

APPENDIX I: NOTES ON THE SOURCES FOR CHINESE WAGES, 1686–1902

A. Cotton calenderers' wages

In the seventeenth to nineteenth centuries, most calenderers in Suzhou were migrant workers from impoverished regions in Northern Jiangsu or Anhui. They usually worked under a contract system, renting capital and place of work from cotton cloth merchants. Although forbidden by the government to form their own guilds, they often went on strike for higher wages, hence the documentation of these negotiated wage rates in the stele records.

Information on the daily productivity quoted in Xu's study can be applied for converting the piece rates into daily wages. According to Xu, a calenderer could press one bolt of cloth in about 40 minutes.[54] In a day of about 11 working hours, he could press about 12 bolts of cloth. For conversion, we use 11 bolts of cloth pressed per day to adjust it roughly to a 10-hour working day. However, the calenderers would have to hand in 20 per cent as payment for rental and other expenses. Deducting the 20 per cent from the final wage, we converted the piece wage of 0.0113 taels (in 1730) and 0.013 taels (in 1772 and 1795) per bolt of cloth into 0.0994 and 0.1144 taels per day respectively. The daily productivity data in Xu's study are based on suburban Shanghai in the early twentieth century, but Xu explicitly states that both technology and organization then had changed little from the early modern period.[55]

B. Gamble's nineteenth-century wage series

The wage series in Gamble's 'Daily wages', which spans almost the entire nineteenth century, was derived from detailed account books of a fuel store in rural Beijing. Gamble presented three series of average wages for the months of May to August, April to September, and January to December respectively.[56] His careful study reveals the highly seasonal nature of the annual wage patterns which corresponds with the agricultural harvest season. We chose the annual average wage series (January to December), which is the lowest of the three, as it includes the rates for the slack winter period. This wage series in copper cash is shown in the first column of appendix table 1 below.

The original wage series are all quoted in copper cash. Since Gamble was mainly interested in constructing wage indices, he presented nominal and copper wage indices in table 6 of his article without explicitly giving the copper–silver conversion rates.[57] Moreover, due to a major debasement around 1860 and a corresponding change of monetary account in the fuel store account books, Gamble broke his silver and copper wage indices at 1860, setting 1845 as a base 100 for the pre- and post-1860 periods respectively. Thus, it is possible to derive the index—not the actual rate—of copper–silver exchange from his copper and silver wage indices.

Gamble did mention the actual silver–copper conversion rates in numbers of *tiao* (strings of copper cash) per silver tael for selected years of 1807, 1827, 1862, 1884, and so on.[58] Our procedure for arriving at a consistent series of copper–silver exchange rates for the nineteenth century is to combine these benchmark rates with the derived copper–silver exchange indices.

However, interpreting the value of one *tiao*, which usually contained 1,000 copper coins but could vary by region, is a major hurdle. Gamble remarked that one *tiao* in rural Beijing was equal to 500 copper cash before 1860 and 100 copper cash after 1860.[59] In other words, the copper cash before 1860 circulated in that locality was only half of the value of the official cash. This seems to be corroborated by Yan et al.'s study of prices and exchange rates.[60] They derived the exchange rate series (1807–50) from the account books of a merchant store located in Daliu zhen of Ningjin County in Hebei province, about 300 kilometres from Beijing. In a footnote to their exchange rate table, the authors pointed out that the value of two copper cash was counted as one.[61] A comparison of their copper–silver exchange series and our implicit Gamble series shows that their trends are nearly identical.

[54] Xu, ed., *Jiangnan tubu shi*, p. 378.
[55] Ibid., p. 375.
[56] Gamble, 'Daily wages, p. 61.
[57] Ibid., p. 60.
[58] Ibid., pp. 44, 69.
[59] Ibid., p. 44.
[60] Yan et al., eds., *Zhongguo jindai jingjishi*, p. 428.
[61] Ibid., tab. 31, p. 38.

Despite their footnote, Yan et al. derived their copper–silver series based on the standard rate of one *tiao* being equal to 1,000 cash. Our copper–silver exchange rate series in the second column is similarly derived, with the standard of one *tiao* equal to 1,000 cash. In order to derive the accurate wage rate in silver tael, the third column of table A1 is the silver wage converted from the first two volumes further divided by two. The wage rate thus derived seems extraordinarily low. However, as indicated by Gamble, workers were also given additional food.[62] As shown in section II, we use only the trend (not the level) for this study.

Table A1. *Gamble's rural Beijing wage series in copper cash and silver taels, 1807–1902*

Year	Copper wages in cash (wen)	Copper cash per silver tael	Silver wages in taels (= col.1/(col.2x2)	Year	Copper wages in cash (wen)	Copper cash per silver tael	Silver wages in taels (= col. 1/(col. 2x2)
1807	81	979	0.041	1860	255		
1808	83	1,020	0.041	1865	265	5,180	0.026
1812	81	1,078	0.038	1870	287	5,576	0.026
1813	80	1,067	0.037	1871	333	5,892	0.028
1816	87	1,129	0.039	1872	355	6,170	0.029
1817	80	1,123	0.036	1873	382	6,383	0.03
1818	89	1,106	0.04	1874	388	6,611	0.029
1819	87	1,183	0.037	1875	389	6,681	0.029
1820	95	1,159	0.041	1876	370	7,446	0.025
1822	99	1,203	0.041	1877	368	8,325	0.022
1824	83	1,208	0.034	1878	348	8,314	0.021
1825	88	1,192	0.037	1879	375	8,342	0.022
1827	88	1,265	0.035	1880	410	8,510	0.024
1829	95	1,294	0.037	1881	401	8,341	0.024
1830	96	1,329	0.036	1883	387	7,154	0.027
1831	92	1,346	0.034	1884	356	6,722	0.026
1832	89	1,347	0.033	1885	395	7,573	0.026
1835	94	1,251	0.038	1886	402	6,950	0.029
1836	85	1,378	0.031	1887	395	7,024	0.028
1837	96	1,488	0.032	1888	361	7,883	0.023
1838	91	1,553	0.029	1889	421	7,314	0.029
1841	98	1,382	0.035	1890	393	7,254	0.027
1842	100	1,439	0.035	1891	390	7,627	0.026
1845	86	1,823	0.024	1892	372	7,651	0.024
1846	96	2,010	0.024	1893	410	7,212	0.028
1847	87	2,013	0.022	1894	443	6,722	0.033
1848	68	2,049	0.017	1896	448	6,501	0.034
1849	80	2,046	0.02	1900	422	5,312	0.04
1850	94	1,997	0.024	1901	462	5,758	0.04
1852	93	2,018	0.023	1902	470	6,079	0.039
1853	93	2,205	0.021				
1854	90	2,723	0.017				
1856	110	4,970	0.011				
1857	105	3,935	0.013				
1858	130	4,970	0.013				

[62] Gamble, 'Daily wages', p. 41.

APPENDIX II: NOTES ON THE SOURCES FOR CHINESE PRICES

Our series of prices for Beijing begins with Meng and Gamble's study of wages and prices in Beijing between 1900 and 1924.[63] For that period they collected the retail prices of most elements of the basket detailed in table 4. We abstracted the following series: wheat flour, *lao mi* (old, blackened rice), bean flour, millet, corn flour, pork, sweet oil, peanut oil, foreign cloth, and coal balls. 'Sweet oil' was treated as 'edible oil' in our scheme and 'peanut oil' as 'lamp oil'. Coal balls were two-thirds coal dust and one-third earth, and the price was converted to an energy basis by rating one kilogram of coal balls at two-thirds of the energy content of coal, which was itself rated at 27,533 BTU per kilogram.

To estimate the price of soybeans for 1900–8, we increased the wholesale price per kilogram of black beans by 50 per cent to allow for trade mark-ups and quality differences. The wholesale price was derived from Li, 'Grain prices'.[64] For 1909 onwards, when the Li series ends, the 1908 price was extrapolated on the basis of Meng and Gamble's price series for bean flour.[65]

Since no information on the price of candles was available, we assumed their price per kilogram to be the same as that of one litre of lamp oil. Based on European precedents, we estimated the price of soap at half of the price of lamp oil.

The next problem was to extend these series back to the pre-industrial period. It should be noted that in several important respects Meng and Gamble's data were ideal: they were retail prices of goods that consumers actually bought. In contrast, many historical price series are wholesale prices of intermediate goods. For instance, Meng and Gamble recorded the price of wheat flour in a shop, while historians must usually make do with the price of unprocessed wheat in wholesale markets.

Taking advantage of these ideal features of Meng and Gamble's data, we applied Li's study of wholesale grain prices in Zhili province, which includes Beijing. From the graphs in her paper, we could read off the prices of wheat, millet, and sorghum from 1738 to 1908, as well as the relative price of black beans to wheat. These are five-year moving averages, so annual fluctuations are suppressed, but that is of little consequence for the present study.[66] On the basis of these series, the retail prices of wheat flour, millet, corn flour, bean flour, and soybeans were extrapolated back to 1738. The resulting extrapolated series are linked using the average of 1901–4 as the base period. This procedure assumes that the ratio of the retail price of the consumer good to the wholesale price of the unprocessed good remained constant.

The retail prices of other products were extrapolated back to 1738 as follows: for meat, edible oil, lamp oil, and candles, the price of wheat flour was applied, based on the benchmark period of 1901–4 for meat (the average price of pork and mutton), and 1902 for the rest. For corn flour, the price of sorghum based on the 1901–4 benchmark was used, and for rice (*lao mi*, old or blackened rice), the price of rice in the Yangzi Delta, based on the 1901–4 benchmark.[67]

[63] Meng and Gamble, 'Wages, prices, and the standard of living', pp. 28, 38–9, 51, 59.
[64] Li, 'Grain prices', pp. 69–100.
[65] Meng and Gamble, *Prices*, p. 28.
[66] Professor L. M. Li kindly supplied us with some of the underlying series for her paper, 'Integration'.
[67] Wang, 'Secular trends', pp. 40–7.

Two things can be said in favour of these extrapolations. First, most of the long-term agricultural time series inflate at the same rate, so the values projected back into the eighteenth century do not depend critically on which price series is used for the extrapolation. Second, the extrapolations can be checked by comparing the values we obtain in the eighteenth century for prices listed in the VOC records for Canton. Since the extrapolated prices are similar to prices paid then, this gives us some confidence in the procedure.

The price series of cotton cloth is based on several sources. First, the Beijing retail price of foreign cloth was projected back to 1871 using Feuerwerker's series of the price of cotton cloth imported into China.[68] Imported cloth was measured in pieces which were usually 40 yards long by one yard wide (360 square feet). Meng and Gamble's price was the price per 100 feet. We interpret that to mean 100 linear feet from a bolt of cloth, which we assume was three feet wide—a typical width. On those assumptions, the retail price per square foot of foreign cloth in Beijing was about 50 per cent more than the price at which it was landed. This is not an unreasonable mark-up.

In his detailed discussion of eighteenth-century cloth prices and weaving incomes, Pomeranz estimated the price of cloth in a low price scenario at 0.5 taels per bolt.[69] On this assumption, 300 square feet of cloth were worth 4.59 taels, and we interpret this as the eighteenth-century counterpart to Meng and Gamble's price for a 100-foot length of a piece of cloth three feet wide. Following Pomeranz, we assume that cloth prices remained constant over the eighteenth century.[70]

For the years between 1800 and 1870, we were guided by the history of cloth prices in Indonesia. A series of the price paid for cotton cloth in Java from 1815 to 1871 shows that from 1815 to 1824, the price was 4.89 grams of silver per square metre, which compares to a Chinese price of 5.12 grams per square metre for the eighteenth century. This correspondence is reassuring since cotton cloth was traded across Asia, so we would not expect extreme differences in its price. Starting in the 1830s, the price in Java dropped fairly quickly to a value of about 2.5 grams of silver per square metre and stayed at that level until 1871.[71] That low price is similar to the value of cloth imported into China—2.36 grams of silver per square metre in 1871. On the assumption that cloth prices in China followed the same temporal pattern as those in Java, the eighteenth-century price derived from Pomeranz was continued to 1830, and then interpolated linearly between 1830 and 1871.

The price of energy was also combined from diverse sources. For 1739–69, we used the data implied by charcoal prices in Zhili province in the 1769 *Wuliao jiazhi zeli*, and for 1816, the price implied by the price of coal in Beijing given by Timkovski.[72] From 1900 onwards, the cost of energy was based on the price of coal balls. One of the striking features of this scattered information is that it gives a fairly constant price for energy. In view of that constancy, the values for the missing years were interpolated.

[68] Feuerwerker, 'Handicraft', p. 344.

[69] Pomeranz, *Great divergence*, p. 319, decided that a cloth of 16 *chi* in length cost 0.4 taels. According to Li, *Agricultural development*, p. xvii, a bolt of 20 *chi* had 3.63 square yards. Hence, the price of cloth was 0.5 taels per bolt.

[70] Pomeranz, *Great divergence*, p. 323.

[71] See Korthals Altes, 'Prices', for cloth prices in Java.

[72] Timkovski, *Voyage*, p. 200.

Since no Chinese alcohol prices were available, the present study used the Japanese data, which show that one litre of sake equalled 1.31 kg of rice.[73] This ratio is applied to Beijing and Canton, assuming that the technology for processing rice wine was similar in China and Japan.

Table A2. *Caloric and protein contents*

	Unit (metric)	*Calories per unit*	*Grams of protein per unit*
Bread	kg	2,450	100
Beans/peas (Europe)	litre	1,125	71
Beans (Asia)	kg	3,383	213
Meat	kg	2,500	200
Butter	kg	7,268	7
Cheese	kg	3,750	214
Eggs	pieces	79	6.25
Beer	litre	426	3
Soy beans	kg	4,460	365
Rice	kg	3,620	75
Wheat flour	kg	3,390	137
Barley	kg	3,450	105
Millet	kg	3,780	110
Buckwheat	kg	3,430	133
Corn flour	kg	3,610	69
Fresh fish	kg	1,301	192
Edible oil	litre	8,840	1
Alcohol (20°)	litre	1,340	5

Sources: The caloric and protein content are based on Allen, 'Great divergence', p. 421, for bread, beans/peas consumed in Europe (fresh with pods, measured in litres), meat, butter, cheese, eggs, and beer. For other items, we relied on US Department of Agriculture (USDA) National Nutrient Database for Standard Reference [http://www.nal.usda.gov/fnic/foodcomp/search/] [accessed 11 Jan. 2010].

[73] On the basis of sake and glutinous rice price data in Osaka in the period in 1824–54 reported in Bunko, ed., *Kinsei Nihon*, tab. 8, pp. 113–17.

Explorations in Economic History 47 (2010) 347–359

Contents lists available at ScienceDirect

Explorations in Economic History

journal homepage: www.elsevier.com/locate/eeh

Evolution of living standards and human capital in China in the 18–20th centuries: Evidences from real wages, age-heaping, and anthropometrics

Joerg Baten [a], Debin Ma [b,*], Stephen Morgan [c,d], Qing Wang [a]

[a] Dept. of Economics, University of Tuebingen, Mohlstr. 36, 72074, Tuebingen, Germany
[b] Economic History Dept., London School of Economics, Houghton Street, London WC2A 2AE, UK
[c] School of Contemporary Chinese Studies, University of Nottingham, Nottingham, NG8 1BB, UK
[d] School of Historical Studies, University of Melbourne, Melbourne 3010, Australia

ARTICLE INFO

Article history:
Received 10 November 2008
Available online 19 September 2009

Keywords:
China
Standard of living
Human capital
Real wages
Height
Numeracy

ABSTRACT

This article mobilizes and integrates both existing and new time series data on real wages, physical heights and age-heaping to examine the long-term trend of living standards and human capital for China during the eighteenth to twentieth centuries. Our findings confirm the existence of a substantial gap in living standards between China and North-western Europe in the eighteenth and nineteenth centuries. They also reveal a sustained decline in living standards and human capital at least in South China from the mid-nineteenth century followed by a recovery in the early twentieth century. However, comparative examination of age-heaping data shows that the level of Chinese human capital was relatively high by world standard during this period. We make a preliminary exploration of the historical implication of our findings.

1. Introduction

One prominent feature that underpins the phenomenal catch-up of East Asia from very low levels of per capita incomes after World War II is the rapid accumulation of physical and human capital. Godo and Hayami (2002) compiled data on average years of schooling to show that the Japanese catch-up in average years of schooling preceded that of per capita income relative to the US in the pre-War period. Unfortunately, works with such a long-term perspective are relatively scarce given the paucity of systematic and comparable data, especially for China.[1] Similarly, despite the voluminous literature on China's long and tumultuous nineteenth century, which saw social and economic dislocation from the onslaught of Western imperialism and the devastating domestic rebellions, quantitative indications of a systematic kind are sorely lacking for long-term trend in welfare and living standards.

Our paper represents the first attempt to construct a more comprehensive profile of the evolution of Chinese living standards and human capital in the nineteenth and twentieth centuries based on the integration of large-sample based real wage and anthropometric evidences. Our data series confirm a general decline in living standards and human capital after the mid-nineteenth century followed by a recovery only at the turn of the century. Our real wage data also reveal Chinese living stan-

* Corresponding author. Fax: +81 3 3341 0220.
E-mail address: d.ma1@lse.ac.uk (D. Ma).

[1] Godo (2006) extended the average years of schooling data to colonial Taiwan and Korea. For physical capital accumulation in East Asia, see the controversial summary article by Paul Krugman (1994). For a summary of the East Asian path of labor-intensive industrialisation based on quality human capital formed in the traditional sector, see Sugihara (2007), "The Second Noel Butlin Lecture."

0014-4983/$ - see front matter
doi:10.1016/j.eeh.2009.09.003

dards were probably closer to the relatively backward parts of Europe but lower than North-western Europe in the eighteenth and nineteenth centuries. So contrary to recent revisionism (Pomeranz, 2000; Lee and Wang, 1999), our studies confirm the traditional view that the divergence in living standards and per capita incomes between Europe and China already existed before the industrial revolution and only widened from the nineteenth century and afterward. However, in contrast to the findings based on real wages and heights, our age-heaping index – a measure of Chinese numerical abilities – reveals a relatively high level of Chinese human capital, which was closer to that of North-western Europe for eighteenth and nineteenth centuries than countries with a comparable low level of living standards.

We explore the historical implication of this intriguing combination of relatively low living standards but high human capital in China at the time. The concluding section makes some preliminary discussion on the unique institutional features in traditional China, such as the Civil-Service Examination, a unified character-based language and a precocious government bureaucracy, as factors that contributed to relatively higher level of literacy and numeracy without necessarily generating sustained economic growth to support a higher living standard in the early modern era. We posit that this large reservoir of human capital in early modern China and East Asia formed important strategic factors to underpin the region's rapid economic catch-up in the modern era once the institutional and ideological changes were accomplished.

The rest of the paper is divided into three sections to discuss the findings derived from real wage, heights and age-heaping, followed by a concluding section.

2. Real wages

In the debate on the comparative standard of living of Asians and Europeans on the eve of the Industrial Revolution, a recent wave of revisionist scholarship has claimed Asian living standards were on a par with those of Europe in the eighteenth century. However, the evidence brought to this debate is fragile, using indirect comparison of scattered output, consumption or demographic data. This contrasts with our knowledge of real incomes in Europe where scholars since the mid-nineteenth century have been compiling databases of wages and prices for European cities from the late Middle Ages into the nineteenth century when official statistics begin.[2]

The ideal measure for comparison would be per capita GDP, which has the advantage of being the most acceptable measure of the overall economy and productive capacity, despite the long-held caveats that it was not able to capture non-market income often crucially important for developing economies, and distributional dimensions. Unfortunately, there are no meaningful GDP series for China before the twentieth century.[3] The influential estimates by Maddison are largely guess-work based on backward projection from twentieth century estimates. While highly questionable, they might still be useful as a guide for rough comparisons across benchmark years, but they give little indication of fluctuations between the benchmarks.

Recent studies by Allen et al. (2007, 2009) represent the most ambitious attempt to use real wages to fill this gap for China in the eighteenth and nineteenth centuries. The wage series in these studies are constructed from data obtained from Chinese imperial ministry records, merchant account books and local gazetteers, which have been deflated using appropriate cost of living indices reconstructed from consumption baskets. The Allen et al. paper concentrates on the wage histories of Canton (south China), Beijing (north China), and Suzhou and Shanghai in the lower Yangzi (east China), because they are comparable to the large cities in Europe and Japan for which we have similar information.

While the Allen et al. study is the most comprehensive so far in terms of data coverage and methodology, their comparison concentrates only on the real wage of urban unskilled workers in major cities of Europe and China. This raises questions of the representativeness and comparability of their findings.[4] Despite these qualifications, which were extensively discussed in the Allen et al. paper, we have reason to believe their finding represent a better approximation of the relative levels of real income at the two ends of Eurasia for the eighteenth and nineteenth centuries than any available alternative estimates. Clearly, future research is needed to produce more definitive findings in this area. Fig. 1 reproduces one of their real wage comparisons, which paint a less optimistic picture of Chinese or Asian performance than the revisionists suggest.

Fig. 1 confirms the traditional view that the divergence in living standards between major urban centers of China and those of the Netherlands and England was already present in the eighteenth century. The standard of living of workers in London and Amsterdam was much higher than that of workers in Beijing or Suzhou in the eighteenth century. But a major surprise is that unskilled laborers in major cities of China – poor as they maybe – had roughly the same standard of living as their counterparts in central and southern Europe, the Ottoman Empire, India, and Japan for the larger part of the eighteenth century.[5]

Secondly, from the mid-nineteenth century, real wages in the industrial core of Western Europe such as Leipzig began to overtake those of China. In contrast, Milan remained at a similarly low level as China during this period. By the twentieth century, enough progress had occurred in even the backward parts of Europe (as shown in Milan) and Japan that their stan-

[2] See Allen et al. (2007) and (2009) for a review of the data issues and Ma (2004) for a general review of the revisionist scholarship.

[3] See Fukao et al. (2007) for a review of GDP data in East Asia.

[4] One obvious question is the representativeness of the largest and fastest growing cities in Europe. Allen (2001) has shown that in smaller English cities such as Oxford, real wages were much lower than those in London, but they were still higher than in China (also see Bassino and Ma, 2005).

[5] See Allen et al. (2009), Fig. 6 for other Asian cities. As their paper finds no major differences in levels of real wages among the three cities of Beijing, Canton and Suzhou/Shanghai, the real wage series for Canton is omitted in Fig. 1.

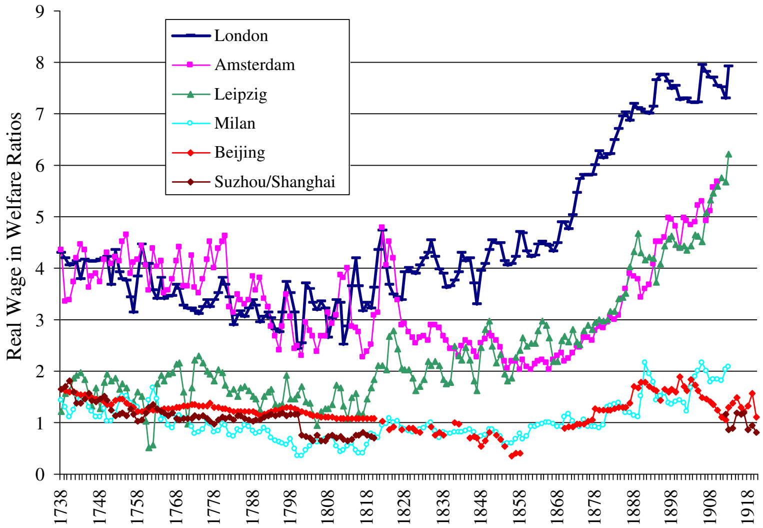

Fig. 1. Real wage trends in China and Europe. Source: Allen et al., 2009. *Notes:* All real wages are converted to welfare ratios. A welfare ratio of one indicates subsistence. For details on welfare ratios, see Allen et al., 2009.

dards of living were beginning to creep above those in China, while London increased the lead over Beijing. This is what we term as the second divergence in the modern era.

Thirdly, and most relevant for our perspective, is the trend in the real wage series for Beijing (Fig. 1). This series is composed of three series linked together: the first one for the eighteenth century based on the average of large number of scattered wage information; the second series based on Sidney Gamble (1943), which runs from 1807 to 1903, and the third series is for 1900–1925 from Meng and Gamble (1926). Among these series, the Gamble (1943) series most importantly spans the entire nineteenth century. As seen in Fig. 1, it points to a clear and sharp drop in real wages during the mid-nineteenth century, a period known for the severe economic dislocation caused by Taiping Rebellion that devastated large swathes of southern and eastern China.

3. Heights

Historical data on heights have long been an important complementary measure of living standard (Fogel, 1994; Komlos, 1994; Steckel, 1995, 2009; Komlos and Baten, 1998; Komlos and Cuff, 1998). While heights do not measure the purchasing power aspect of living standard, they are better at capturing the 'biological' component of welfare such as health, life expectancy and the quality of nutrition. Compared with GDP, height is particularly sensitive to the economic inequalities and the welfare development of the lower income strata, which corresponds more closely to the groups of unskilled workers in the real wage study.[6]

Care needs to be taken about interpretation of heights in international comparison due to differences in intergenerational height transmission and nutritional habits, which might not be directly related to economic scarcities, at least in the short run. For example, the Dutch and Scandinavians today still consume far more milk than Southern Italians and Japanese, possibly a legacy of economic scarcity of the past.[7] Even within China, there exist regional differences with Northerners far taller than people in the South. Nonetheless, with rapidly changing nutritional and economic conditions, there has been a narrowing of regional differences in heights as well as a convergence of Chinese heights to the European and North American level more recently.[8]

For this research, we mobilize several large data sets of heights of Chinese who migrated from South China to the United States, Australia and Indonesia during the nineteenth and twentieth centuries, or who worked in modern organisations in

[6] Height is closely correlated with income; the poorer strata of a population on average are shorter than those in the better off strata. In a low income economy, an increase in income will raise average height, other things being equal. Average height will also increase if income distribution improves such that the lower income strata are better able to acquire the inputs necessary for human growth. Conversely, where inequality worsens average height might decline even in the presence of increasing GDP. See Steckel (1995).

[7] Lactose intolerance, the inability to drink milk without diarrhoea, may have played a limited role in genetically predisposing some populations to shorter stature. East Asians, Native Americans and some African people suffer from lactose intolerance (see Mace et al., 2003).

[8] In the early twentieth century the difference between north and south China was in the order of 6 cm, compared with about 3 cm in 2000 for populations of roughly the same socioeconomic status (Morgan, 2009, Table 7). Also, contemporary educated young male adults in Beijing are not much shorter than white American males. The average height of the birth cohort of 1978–81 in urban Northern China was 173.0 cm (ranged from 171.2 to 175.8 cm) for the pooled ages age 19–22 years, which is only 2.2 cm shorter than the United States average in the 1980s (175.8 cm); Beijing urban males were 175.5 cm on average (China, Ministry of Education, 2002). Large-scale anthropometric surveys of children 7–22 years have been conducted in China since the late 1970s about every five years. Analysis of the 1979–1995 surveys and survey methodologies is reported in Morgan (2000).

China. We believe that the reported height trend and – with certain qualifications – their levels during the nineteenth–twentieth century is likely to be a robust long-term indicator for nutritional quality and *ceteris paribus* the living standards at least for the Southern Chinese. Below we explain our data sets in six different categories.

(1) *Immigrants to Indonesia:* Baten and Hira (2008) made use of a large data set of Chinese migrants to Indonesia originally measured by the anthropologist Bernhard Hagen in the 1880s. Most of the observations were made in 1885 and 1886, with some perhaps in 1887.[9] The occupations of the Chinese were described as "mainly agricultural." Fortunately, Hagen reported the ages so that the approximate birth years can be calculated. Overall, Hagen measured no less than 15,722 Chinese males who had migrated to Indonesia. Our data set made use of 12,678 subjects, aged from 23 to 50 years. We discarded all those above 50 and below 23 years of age to exclude the effects of residual growth in our data set. We also collected a much smaller data set of migrants to Suriname (159 cases) for the birth cohort of 1830–1834 to 1845–1849. As explained later, they reveal similar height features to migrants to Indonesia.

(2) *Prisoners in the United States:* Carson (2006) collected a sample of 1472 Chinese male immigrant workers who were incarcerated in the United States mostly for petty crimes.

(3) *Prisoners in Australia:* Morgan (2009) compiled a data set of 1492 Chinese imprisoned in Australia between the 1850s and 1920s, who were from South China and who were mostly born between the 1810s and 1880s. Many arrived during the "Gold Rush" period of the 1850s. When the alluvial gold petered out, those who remained in Australia mostly turned to rural occupations and were generally in a lower socioeconomic group than Chinese migrants who arrived from the 1880s.

(4) *Migrants to Australia:* In the later decades of the nineteenth century another wave of Chinese migrants, also mainly from South China, arrived in Australia. Somewhat different from the prisoners' sample, they included many small merchants, market gardeners and tradesmen who went to destinations such as Melbourne and Sydney (Morgan, 2006a). Those who settled in northern Australia, such as Queensland or the Northern Territory, were engaged in mining and agriculture and they were more typical of the earlier gold-rush period migrants; they were also shorter than those residing in Melbourne or Sydney. The current dataset numbers 3692 subjects.[10]

(5) *Migrants to the US:* From the *National Archives and Records Administration* (NARA) archive of the Pacific Region, we obtained a small data set of heights ($N = 360$) from the ship lists of Chinese migrants to the US or returning to China. Moreover, this archive also holds the National Archives microfilm publications of passenger manifests for ships arriving at San Francisco, 1893–1957. The manifests list the height and age of each passenger from 1907 to 1948, and the same is true for most of the immigration files.

(6) *Employees of Government Organisations in China:* The last data set discussed comes from government enterprises and agencies, who measured their employees in the 1930s and 1940s as part of a medical examination system. Most of them were born between the 1890s and the 1920s, with some teenagers from the early 1930s (Morgan, 2004). The largest group was railway workers, but there were also employees of government, financial or other institutions.

The region of birth is relatively homogenous: the south, and the province Guangdong in particular.[11] Only in the case of the government employees (sample 6) was the regional spread larger, but we took care to extract a regionally homogenous series – unskilled railway workers from South China. We can therefore assume that the estimates approximate trends in Southern China.

Fig. 2 gives a plot of the trend level of different time series of Chinese heights as described in the sample. Two features stand out. Firstly, the shortest Chinese were those who went to Indonesia as contract worker as well as those that went to Suriname.[12] The heights of prisoners in both Australia and the United States were the second shortest. Clearly, among the tallest are the migrants to the US and Australia. Interestingly, migrants to the Australian Northern territory were shorter than those that resided in Melbourne and Queensland. Finally, the railroad employee data set for South China had relatively high values.

We believe the observed differences in our samples seem a reasonable reflection of the selectivity biases among the migrants who comprise the samples used here. It is likely that those who went to more attractive locations had to incur higher costs of migration and thus might have been slightly positively selected. This might have been the case for Chinese migrants to the United States and Australia, many of whom funded their passage through debts securitised against property or other family assets (summarized in Morgan, 2009). Those in Northern Territory, who were the shortest of the later migrants to Australia, are a case in point: they could reach Port Darwin more cheaply via Singapore than the eastern seaboard cities of Melbourne or Sydney, and they were mostly engaged in mining or remote area agriculture rather than in urban commer-

[9] Murray (1994) found a citation to the study in another anthropological study of the 1920s, and we were able to locate the original text (in German) at the University Library Hamburg.

[10] The data are from the National Archives of Australia (NAA) series B13/0, B78/1, J2482, and E752/0, which comprise 'Certificate Exempting from Dictation Test' (CEDT) and a 'Statutory Declaration' for Chinese resident in Australia after 1901 who wish to leave Australia and return. Detailed description of these series can be obtained from the NAA online search facility at www.naa.gov.au and the use of the Australian immigration records for anthropometric research is discussed in Morgan (2006b).

[11] All measured Chinese immigrants were reported to have come from the South (usually Canton) or simply "China". Our statistical *t*-test reveals that the differences in mean heights for migrants identified as Canton or another place in South China and "China" groups as indistinguishable at the 1 per cent level. For the predominance of Guangdong and Fujian origin of overseas Chinese migrants in the nineteenth century, see Ge et al. (1999), pp. 191–201.

[12] The Surinam sample not shown in the figure confirms a similar height levels with a clear downward trend from the 1840s, see Baten and Hira (2008).

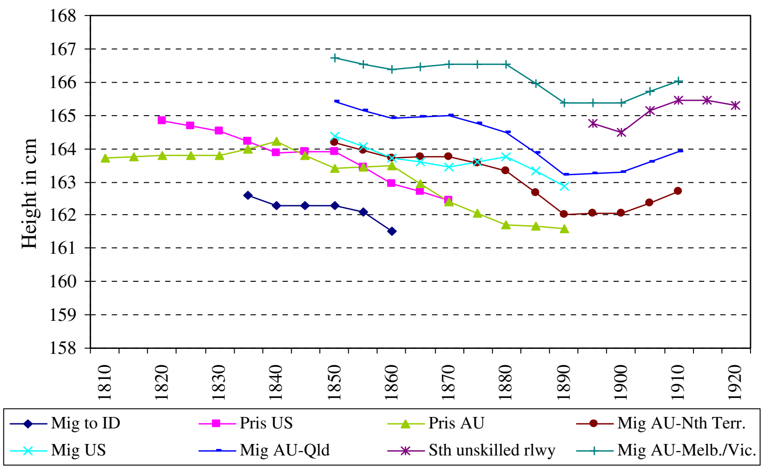

Fig. 2. Trends of Chinese height samples by Birth Cohort. Source: See text. *Notes:* Mig to ID, Migrants to Indonesia; Pris US, Chinese prisoners in the United States; Pris AU, Chinese Prisoners in Australia; Mig US, Migrants to the United States; Sth unskilled rlwy, unskilled railway workers from south China; Mig AU-Nth Terr, Migrants to Australia's Northern Territory; Mig AU-Melb./Vic., Migrants to Melbourne/Victoria; Mig AU-Qld, Migrants to Queensland; The reported height of the Chinese to Australia for both prisoners and migrants were adjusted for age-related shrinkage as explained in Morgan (2009).

cial activities. Finally, the relatively high value of the unskilled railroad workers in South China can be explained by the fact that these government employees were often regarded as a kind of elite workers with literacy level higher than the average working population (Morgan, 2004).

Secondly, despite this heterogeneity, we can discern clearly a broad common trend among these different series. While the height trend seems to have been stable up until the 1830–1840s, all series started to decline from the mid-nineteenth century, which coincided with the devastating Taiping rebellion. Moreover, an unexpected finding is that most of the series, following what seems like a stagnation – at best a mild recovery – in heights during the 1860s and 1870s, revert back into a fairly substantial and sustained decline all the way into the 1880s and even 1890s. This decline seems to have bottomed out towards the turn of the last century with a rebound and recovery in the first two decades of the twentieth century. The co-movement of these series is remarkably consistent.

We believe that systematic selection biases in any one direction are less likely as our data sets consist of large numbers of South Chinese migrants who went to different locations in both developed and developing regions with varying entry dates and measured by different authorities.[13] We also make a cross-check against the only independent height series for non-overseas migrant available during the nineteenth century: Chinese residents (largely of Cantonese and Fujianese origin) in Taiwan still under Qing rule (Olds, 2003). Measured by Japanese colonial authority in the early twentieth century, the height trend for male and female reveal nearly identical patterns of decline from the mid-nineteenth century, followed by stagnation during the 1860s and 1870s, and a renewed and sustained decline in the 1880s and 1890s.[14]

In Fig. 3, we summarize these disparate sample series into a single continuous but notional series that we believe is representative of the height trend of the lower and working class Southern Chinese male in 1810–1920, but with sufficient human capital and wealth to move to Australia. The series splices together the Australia prisoner series for 1810–1840 with the migrant series estimated for migrants in the Northern Territory, whose occupation backgrounds is similar to the prisoners, and the gap 1840–1850 is filled by simple linear interpolation.[15] We also plot this trend line against other height series for international comparison. These series were adult males of broadly comparable social class to our Southern Chinese series and regionally representative for their country population as a whole (see Baten, 2006).

Fig. 3 clearly indicates that the northern Europeans (Netherlands) were taller and became even taller after the mid-century. The southern Europeans (Italy) were shorter than the Chinese with little upward movement in stature until the 1860s, after which their heights began to rise above the Southern Chinese. Fig. 3 thus confirms the so-called second divergence where both Dutch and Italian heights starting an upward trend from the mid-nineteenth century following rapid industrialization, while Chinese height stagnated or declined thereafter.[16]

[13] See Fig. 8 in Morgan, 2006a for the year of arrival for some of Chinese immigrants in Australia.

[14] See Olds (2003), Figs. 2 and 3, which are partly reproduced in Fig. 3 in this article.

[15] The original series were estimated in decadal units. Linear interpolation between the decal mid-points have been used to create a five-year series.

[16] We can place our Southern Chinese height data in a larger sample of the heights in all European countries. An appendix to Baten (2006) presents the height estimates for all European countries with 500,000 and more inhabitants for the birth cohorts 1850, 1890, and 1920 (available from: http://www.wiwi.uni-tuebingen.de/cms/fileadmin/Uploads/Schulung/Schulung5/Paper/eurohgt.pdf accessed May 7th, 2009). In 1850, the Southern Chinese height of around 164 cm, is shorter than the average height of 168–169 cm in those European countries with tall inhabitants (Scandinavia, Ireland, some parts of later Yugoslavia) but surpasses the 160–162 cm average attained in those countries with short populations (Portugal, Spain, Italy). Overall, seven out of 36 countries or about one fifth of European countries had lower heights than those of Southern China. By 1890, however, all European populations except Portugal were taller than Southern China, and by 1920, Southern China stood at the bottom of the European height distribution.

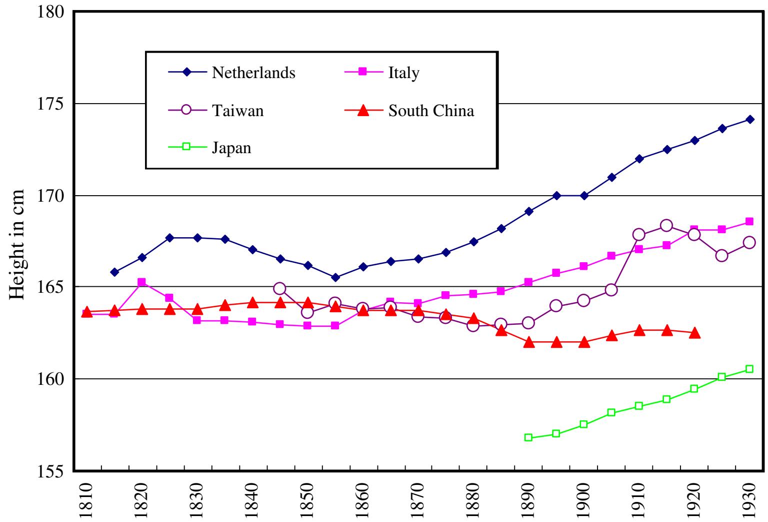

Fig. 3. A notional trend of secular height of Southern Chinese in 1810s–1920s in comparative perspective. *Notes:* Italy – calculated from A'Hearn (2003), Netherlands – calculated from Drukker and Tassenaar (1997), For Taiwan, 1845–1900 from Olds (2007 Model 2 for Male in Table 3. 1900–1930 from Morgan and Liu (2007); South China see text and Fig 2; Japan is calculated from Bassino (2006) and Shay (1994).

Perhaps more interesting is that the Southern Chinese seemed to perform poorly in the East Asian context. As shown in the data, although the Japanese started as unusually short, they managed to grow at a rate of about 1.0 cm a decade from the late nineteenth century. More strikingly, heights of Chinese in Taiwan (largely of South China origin) are almost non-distinguishable both in trend and level during the nineteenth century but grew rapidly from the early decades of Japanese colonialism from the beginning of the twentieth century (Olds, 2003; Morgan and Liu, 2007). Overall, we see a case of China lagging behind the better performers during the nineteenth–twentieth centuries.[17]

4. Age-Heaping

Recently, new research based on the use of age-heaping measurement has made it possible to quantify numeracy in comparative and long-term perspectives. This line of research was pioneered by Mokyr (1983) in the modern economic history context, and by Duncan-Jones (1990) for the study of ancient economies (after some earlier demographic studies, see Bachi, 1951). But recently, Crayen and Baten (forthcoming-a,b) have compiled large international data sets that allow global comparisons. The age-heaping strategy is based on the tendency of poorly educated people in the past to round their age. For example, when asked their age they answer more often "40", when their actual age may in fact be 39 or 41 years. Conversely, better educated people are more likely to report their exact age. The age-heaping index (also called a Whipple index) is a measure of the concentration or degree of age-heaping between 23 and 62 years inclusive and is represented as follows:

$$\mathrm{WI} = \frac{5 * \text{number of ages ending in a 0 or a 5}}{\text{number of all ages}} * 100 \qquad (1)$$

Therefore, an index equal to 100 indicates the absence of age-heaping and magnitude of the index being above 100 indicates the degree of age-heaping.

A wide range of research has confirmed a strong relationship between illiteracy and age-heaping especially for Less Developed Countries (LDCs) after 1950. For example, a correlation coefficient of 0.63 has been found for a sample of about 270,000 individuals, organized by 416 regions, ranging from Latin America to Oceania. The data from the PISA (Programme for International Student Assessment) results for numerical skills yielded an even higher correlation coefficient (A'Hearn et al., 2009, Appendix). This correlation has also been confirmed for the nineteenth century data (A'Hearn et al., 2009; Crayen and Baten, forthcoming-b). Age-heaping index reflects numerical skills even more than literacy skills, which could be more important for technical, commercial and craftsmen activities than literacy.

The appeal of age-heaping methods is the ready availability of age-information for countries such as China where systematic sources of historical numeracy or literacy information are largely absent. Before we present our findings, it is important to clarify some specific issues related to the use of age-heaping measures in the context of traditional China. We perform a test to examine the linkage between literacy and numeracy using an exceptional sample of Chinese migrants in the US,

[17] The unusually short level of Japanese heights in the nineteenth and twentieth centuries has been much noted and may be associated with a lack of protein in a largely vegetarian diet until quite recently. Here our comparative analysis focuses on its trend, which is unequivocally from the 1880s.

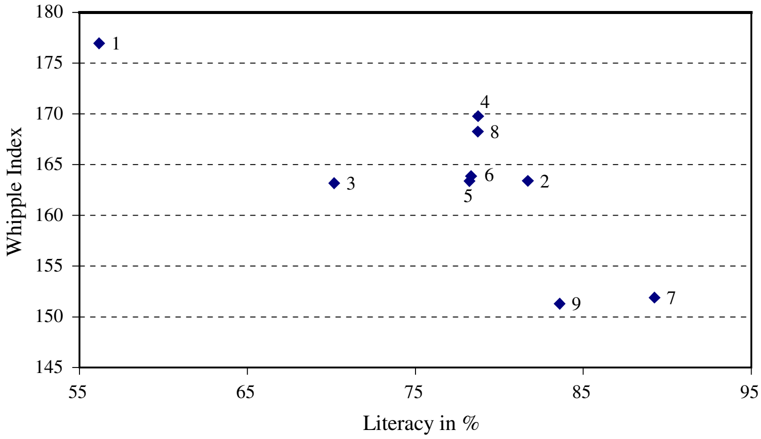

Fig. 4. Literacy and Age-heaping (Whipple Index) by nine different occupational classes among Chinese immigrants to the U.S. *Notes:* See the text. The sample size for the nine occupational categories (from one to nine) is: 178, 153, 239, 268, 202, 415, 158, 627, and 195. The nine occupational categories contain all together 150 different specific categories with category 1 having the lowest average income and group 9 the highest.

which provide not only age-information but also literacy (which includes both Chinese as well as English reading and writing skills) and occupational categories. This is a data set of 2435 Chinese males in the United States, 220 of whom were US born. The data, extracted from the Individual Public Use Microdata Set (IPUMS) data set of 1850–1910, are a representative sample based on the US censuses (Ruggles et al., 2004). We exclude the females (their number was too small for reliable analysis) before calculating age-heaping for those of the birth decades of the 1830s–1880s.

For our purpose, we use the standard occupational classification used by the US Census to create nine categories for the 2435 Chinese males between 23 and 72. The occupations ranged from income level of 600 dollars per year in 1950 prices (group 1) to between 1500 and 2000 (group 5), and to more than 2500 (group 9). The distribution of incomes was not linear, and some occupations accounted for a large share of the Chinese population, so we took care that sufficient numbers of observations fell in each group.

Fig. 4 reveals a high negative relationship (with a correlation coefficient of −0.8) between literacy rates and Whipple Index for these nine occupation categories.[18] More interestingly, this correlation seems actually tighter than the correspondence between income categories and literacy rates. While the higher income groups 7 and 9 had the highest literacy rates, and the poorest group 1 has the lowest rate, occupation categories 4 (mainly launderers) and 8 (mainly miners) or group 2 (domestic servants) in fact have similar levels of literacy rates. Thus, we are reasonably assured that age-heaping index is good predicator for literacy rates and human capital in China.[19]

Below we describe six different data sets for our age-heaping series:

(1) The Qing archives of the Imperial Board of Punishment contain a record of criminal cases of Chinese farmers and peasants involved in various property crimes, rental conflicts, usury or domestic conflicts during the late seventeenth and eighteenth centuries. The court files as published covered a large number of Chinese regions. Overall, we have 602 reported ages between 23 and 72, which allows some point estimates for the late seventeenth and early eighteenth century.[20]
(2) The data file for immigrants to Indonesia is the same as those for the height series.
(3) We collected a smaller data set of 193 Beijing Chinese soldiers born in mid-nineteenth century. Although a small sample, these data are particularly valuable as other nineteenth century data consisted mostly of overseas migrants. The sources are from the Qing archive and consisted of soldier lists from the Chinese army (partially Manchu), which were taken by Chinese officers between 1902 and 1911.[21]

[18] Without using the classification of occupational categories, we can also confirm this negative relationship with a logit regression, which regresses a dummy variable of people who reported their ages in the multiples of 0s and 5s on a dummy variable of literacy. Our result shows that people who reported ages in 0s and 5s are 3% less likely to be literate than those who did not, which is statistically significant at 10% level. The small marginal effects (3%) are expected given that this is a fairly literate sample and that not all people who reported their ages in round numbers are illiterate.

[19] We also checked whether the Chinese use of animal cycles for their birth years may lead to age-heaping of a different sort rather than on multiples of 5s or 0s. We checked the age-heaping around the dragon year of birth – the most popular and auspicious animal sign for a birth year – for Chinese migrants to the US and found they were far less marked than heaping on multiples of 5s.

[20] The censorial section of the board of punishment (*Xingke tiben*) is an important archival source for a number of reasons, not only the age statements. The memorial documents contain information on land prices, land rents, interest rates ('usury'), among other personal and household data, covering all Chinese administrative regions. A small part of these memorials, especially from the Qianlong period (1735–95) have been published (Historical Archive No. 1 1981). Allen et al. 2007 also made use of wage information from these sources. Ages we used in those sources only include self-reported ones by "criminals" still living at the time.

[21] The No. 1 Historical Archive, Beijing, Shuntian Fu archive, microfilm reel No. 254. We thank Hans-Ulrich Vogel for helping with the access to this valuable source.

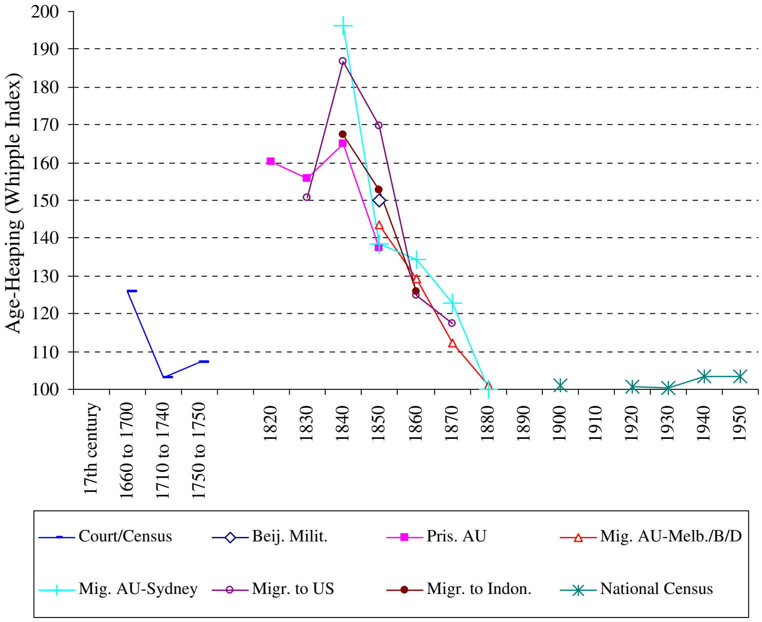

Fig. 5. Trends of age-heaping among a variety of Chinese samples by Birth Cohort. *Note:* see the text. "Mig. AU-Melb./B/D" were there migrants recorded in the archives of Melbourne, Brisbane, and Darwin. Age-heaping samples below 50 were discarded.

(4) Two data series for Chinese immigrants to Australia are used to estimate age-heaping. The first is the same as the height series discussed above for migrants to Melbourne, Brisbane and Darwin. The second series is a recently compiled dataset of 8209 Southern Chinese immigrants who lived in Sydney, or elsewhere in the state of New South Wales in Australia, from the ST84/1 series at the NAA, Sydney Office. This series has only been used to estimate age-heaping and is independent of the first series used to report heights.[22]
(5) The data set of 2435 Chinese males in the United States as described earlier.
(6) We use the first Chinese nationwide census undertaken in 1953 to calculate Whipple Index for those born in the 1900s and 1910s, in order to complement the eighteenth and nineteenth century data with an endpoint in the early twentieth century.

Fig. 5 plots the Whipple indices of the different data series.[23] The late seventeenth and early eighteenth century data from the Board of Punishment files reveal a rather modest level of age-heaping of about 110. It is important to note that most European countries reached such a low level not before the late eighteenth century, whereas the early eighteenth century levels of France and Germany were much higher (in the range of 160–220).[24] We do not have data for the period between the early eighteenth century and the 1820s. But for series starting from the 1820s, the picture that emerged in Fig. 5 is that for almost all series of age-heaping indices as organized by birth-decades rose and peaked around the 1840s, with that of the US migrants rising to as high as 170–190.[25] A similar spike in age-heaping is also confirmed for the Beijing soldiers in the period 1840–60, with a value at 150. But from the 1860s (birth cohorts) onward, Fig. 5 reveals a huge improvement in age-heaping almost

[22] The Sydney ST84/1 series only contains the CEDT (also known as a Form 21) and does not include the Statutory Declaration (Form 22), which shows data related to occupations, residences, and other information useful for analysing height trend.

[23] For calculating age-heaping, we aggregate all age statements into the age groups such as 23–32, 33–42, and 53–62, and denote those born mostly in the 1850s as "1850" in the graph (even if this sometimes refers to those born actually 1847–56). This methodology is common in the age-heaping literature to ensure that age-heaping is estimated more conservatively than the obvious alternative to estimate age brackets 20–29, 30–39, 50–59 and so on. The problem with the alternative method is a strong age-heaping on, for example, age 50, in societies with low life expectancies leaving fewer survivors past age 53. Similarly, there will be more survivors at age 55 rather than age 59. Thus, taking age brackets 23–32 etc. places the most strongly preferred age 30 and 25 to the middle of the distribution, hence minimizing this bias.

[24] We also located a very small data set of about 50 seamen who found shelter in Japan during a storm. Their Whipple Index turned out to be as high as 213. The sample size is too small to be meaningfully included here. But it is plausible that levels of literacy and numeracy were very low among the class of seamen or pirates who were usually social outcasts barred, for example, from taking part in the Civil-Service Examination system, see Wakeman (1997), chapter 1. Data on Chinese seamen are from Ryūkyū ōkoku hyōjōsho monjo henshū iinkai (1988).

[25] For the US migrant sample, average age by birth decade is relatively constant at 30–36 (except for the middle cohort of those born in the 1860s, with an average age of 41), so we believe that our result is not biased by possible differences in the age composition of the various samples.

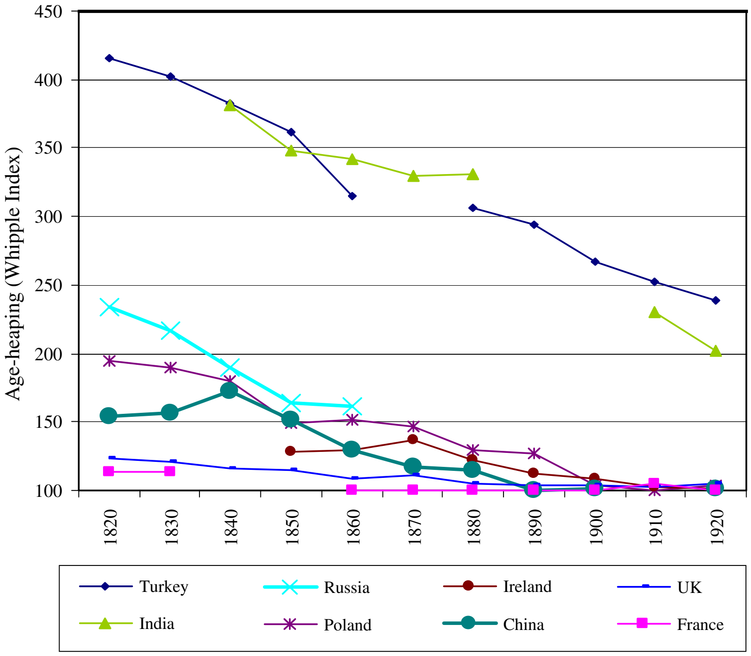

Fig. 6. Age-heaping in China in international comparison. Sources: China is an average from the data reported in the text. The sources for the other countries are provided in Crayen and Baten (2009). For India, this includes only the part of the country included in the late-nineteenth C censuses (age-heaping might have been higher for other regions). Poland refers to a weighted average of Russian, Habsburg, and Prussian Poland. Russia reflects the provinces which form today's Russia. Ireland excludes North Ireland. The Turkish values reflect the whole country after the 1880s, and the province of Kars before that (which Crayen and Baten, 2009 judge as broadly representative for the Turkish average). We thank Dorothee Crayen for assisting us with relevant data and information.

across all the data series.[26] By the early twentieth century, age-heaping seems to have largely disappeared based on the National census data of the 1950s.[27]

Fig. 6 organizes the various age-heaping measures for China into one single notional series to cast it in international context. Taking an average of the Chinese age-heaping values reported above yields values around 160 during the 1820s, rising to 170 during the mid-century crisis period, and declining afterwards until full age numeracy is reached among the birth cohort of the 1890s (with a Whipple Index of 100). Despite the mid-nineteenth century surge, the Chinese degree of age numeracy thus measured were impressive by international comparison, being among the highest in the world along with Western and Eastern Europe in the nineteenth century (see Crayen and Baten, forthcoming-b). In fact, we could make a general case for East Asia. The earliest source on Japanese age-heaping in 1879 (published 1882 for the region which is now Yamanashi) that could be located so far did not show any age-heaping for the birth cohorts of the early nineteenth century, nor did the Taiwan list from 1905, taken by the Japanese colonial government.[28] Fig. 6 shows that while UK and France were achieving better values already in the early nineteenth century, Poland, Russia (European part) and Ireland were actually doing worse than China, with India or Turkey (with per capita income possibly comparable to that of China) faring far worse.

The anthropometric, age-heaping, and real wage evidences presented in this article now allow us to piece together a quantitative profile of Chinese welfare and human capital for the eighteenth to twentieth centuries when historical evidences presented so far have been descriptive, indirect and scattered. Our findings confirm and revise traditional historiography as well as reveal new insights.

Firstly, our study quantitatively confirms the large and sustained decline in living standards and human capital during the mid-nineteenth century, an era of political and economic crises brought by the Opium War and the devastating Taiping Rebellion. The Taiping rebels originated in the southern province of Guangxi in 1850 and spread north into east China and beyond. By the time of their military defeat in 1864, the entire rebellion and its suppression led to a halving of the population of the lower Yangzi provinces of Jiangsu and Zhejiang and possibly 30 million deaths nationwide. For Guangdong province and the city of Canton, the rebellion of Red Turbans associated with Taiping movement caused large-scale destruc-

[26] Although not sufficient in numbers, we also calculated the level of United States born Chinese for the 1870s and 1880s. Interestingly, their age-heaping is not lower than those Chinese born, but rather higher, with values of 167 of those born in the 1870s, and 136 in the 1880s.

[27] We also calculated Whipple Index for the data series of the railway and other modern organisations for the early twentieth century and also confirmed that there was no age-heaping. This is not surprising given that the average literacy level for the Chinese national railways was about 70%, and 100% for the professional staff. More importantly, these data also recorded birth dates and years, making the calculation of age-heaping index highly problematic.

[28] We thank Osamu Saito for providing those lists on Japan and Taiwan.

tion of lives and properties during the mid-1850s (Spence, 1999; Wakeman, 1966). Our data reveals the severe negative impact of mid-nineteenth century crisis on the 1840s Chinese birth cohort's capacity to acquire numerical and literacy skills possibly due to malnutrition and breakdown of social order and traditional school system during their formative decades of the 1850s and 1860s. Such an experience is not peculiar to China as witnessed by the surge in age-heaping among the Irish inflicted by the famine crisis of the 1840s and also for Spain on a milder scale (Manzel, 2008).

Secondly, the different patterns of the three data series as revealed in our study contribute new historical insights. Among the three series, real wage and age-heaping indices bounced back from the 1860s, but the fall in height trend seems to have sustained throughout the latter half of the nineteenth century. The rapid recovery of the first two series seems to confirm the traditional historiography that emphasized the relative success of the so-called 1862–1874 Tong-Zhi restoration in returning the post-Taiping China to peace and normalcy (Wright, 1962). A hallmark of the Restoration was the rejuvenation of traditional governmental bureaucracy as severely compromised by the massive sale of official titles in the war era for revenue purpose and reinstatement of the millennium-old national Civil-Service Examination system as suspended during the War era (Wright, 1962, chapter 5). It is likely that these policies have restructured incentives for human capital accumulation and contributed to the drastic improvement in age-heaping indices.

The somewhat surprising finding of a sustained decline in heights into the 1880s and 1890s seems to stand in contrast to the rapid recovery of age-heaping (and the real wage series) in the post-Taiping Rebellion era. While it is plausible this decline may be more region-specific to South China (including Taiwan) with Canton losing her eminent trading port status to Shanghai or other treaty ports in the post-Opium War era, we believe that our empirical finding merits serious future academic research, which may well lead to a more pessimistic profile of living standards during the latter half of the nineteenth century. [29] In fact, despite the high-profile attempts to modernize her military and other limited industrial sectors, the general outlook and policy of Qing under the so-called late-nineteenth century self-strengthening movement remained conservative, especially in contrast to contemporaneous Meiji Japan. Not only did they resist any fundamental institutional reform, but also obstructed the construction of modern infrastructures such as railroads. Modern public infrastructures constructed mostly after the beginning of the twentieth century, as emphasized recently by Ge et al. (1999), would have allowed effective relief efforts to avert the kind of massive human and material losses incurred by disaster and famine in the latter half of the nineteenth century.[30] In this context, the recovery in heights from the beginning of the twentieth century – an era marked by the imminent dynastic collapse and national disintegration – does not come as total surprise. Recent scholarship has emphatically shown that the first three decades of the twentieth century – despite the political and civil strife – were marked by the onset of a region-based spurt of industrialization and modernization (Rawski, 1989; Ma, 2008).

5. Conclusion: towards an integrated narrative of living standards and human capital

By placing our new time series data in an international context, our article reveals a rather intriguing combination of relatively low living standards with high human capital in traditional China. While our finding of a relatively low standard of living counters the argument of recent revisionism, the case for a relatively high level of human capital seems to echo other historical studies. For example, Ronald P. Dore's landmark study in 1965 offered a remarkably optimistic reassessment of Japanese education in the Tokugawa period (1603–1868). The school enrolment data in 1868 led him to conclude something like 43% literacy rate for male and 19% for girls, a remarkably high level by early modern standards (Hayami and Kito, 2004). Other studies have also pointed to the existence of a dynamic book publishing industry and book rental market as well as near ubiquitous presence of book-keeping and accounting practise among business and domestic households, and the widespread use of farm manuals (Hayami and Kito, 2004; Smith, 1988).

Evelyn Rawski's 1979 study in many ways echoed the Japanese assessment for the case of China. Based on admittedly fragmentary and circumstantial evidence, Rawski put the basic literacy level of Chinese males at 30–45 percent and females at 2–10 percent for China as a whole (Rawski, 1979, p. 22–23). According to her, both opportunities for education and schooling had expanded during the Ming (1368–1644) and Qing (1644–1911) period. More importantly, education went way beyond the elites in preparation for the prestigious civil-service examinations and spilled over to a wide spectrum of the society to fulfill demand for commerce, local administration or even agricultural production (Rawski, 1979, chapter 1, Li, 2004). In comparison with Japan, Rawski argued that "if a stratified, status-fixed society such as Japan's experienced this great demand for basic skills in reading, writing, and arithmetic among townsmen and farmers (in the Tokugawa period), a relatively open society such as China's, where education was the key to upward social mobility, should have stimulated a similar if not greater effective demand for literacy" (p. 5). In other studies, both Rawski (1985) and Li (2004) detailed

[29] For regional differences in height trend in the first three decades of the twentieth century, see Morgan (2004)).

[30] Ge et al. (1999), noted the importance of modern health facilities and public infrastructure in the early twentieth century for disaster and famine relief. For wars and disasters occurring during the period of 1870–1890, see Cao (2001), chapters 13–15, on the prolonged Muslim rebellions in South- and North-western parts of China and severe drought leading to famine in five provinces of Northern China in the late 1870s which claimed tens of millions of lives. Finally, cross-national factors could be at work as well: waves of rinderpest (cattle plague) seemed to have swept across parts of Asia and Africa where we observed similar decline in heights in the 1880s and 1890s period (Spinage, 2003). Rinderpest was enzootic to hooved animals in China's central plains and the Mongolian steppes. Its presence was first observed in outbreaks in Hong Kong and Shanghai in the 1860–70s, and transmitted to Japan through imported cattle with epizootic effect, though there were earlier suspected outbreaks (Spinage, 2003; MacPherson, 1987; Kishi, 1976). A foreign medical missionary (Bliss, 1922) described rinderpest as having a more debilitating affect on Chinese agriculture than floods and drought, primarily by depriving farmers of ox and buffalo for ploughing fields and pumping water, which could reduce grain yield.

the development of a thriving private and commercial publishing industry to satisfy the demand of a large reading public forged by the homogeneity of the Chinese written character. Book publishing was highly differentiated, from scholarly encyclopedias, histories and philosophical treatises to morality plays, romance novels, Buddhist sutra and primers for all sorts of trades. In addition, cities and towns "had an abundance of posted regulations, shops signs, advertisements, and other material to read for profit and amusement" (Naquin and Rawski, 1987, pp. 58–59) and publishing was further aided by the relatively low cost of paper and Chinese style of woodblock printing (Rawski, 1985). Commercial publishing in the Yangzi region, for example, catered not only for the literate elite, but also for merchants, artisans and other non-elite readers (Li, 2001).[31]

Besides literacy, scholars have also presented direct historical evidence of numeracy. Li (2004), in particular, noted the widespread diffusion of popular arithmetic textbooks, the spread of abacus, and the adoption of various special numerals for book-keeping and accounting during the late Ming and Qing. A series of new research have now begun to utilize long-ignored surviving account books, which meticulously recorded transactions and various summary accounts with sophisticated traditional accounting techniques (Guo, 1982, 1988; Gardella, 1992, for China; Jun and Lewis, 2006, for Korea). The important role of a lunar calendar in daily lives and in fact, the numerology and number-mysticism, for whatever its dubious claim to prediction, predisposed Chinese thinking to a numerical framework for scientific inquiry (Ronan and Needham, 1978).

In fact, the combination of high human capital and low income level is not merely a historical phenomenon. Drawing on the results of standardized international tests, Hanushek and Woessmann (2008) show that the average test scores of Chinese students today ranked among the top end of those from OECD countries whose per capita income are several fold higher than in China. Further research should explore the possible historical root of this relatively high level of human capital accumulation, in particular its linkage with long-lasting institutions in traditional China, such as a relatively open Civil-Service Examination, a unified written character and a precocious government bureaucracy. The rise of an independent small-holding peasantry under this institutional framework turned each household into a self-contained producing and marketing unit in direct interaction with both the market and state (for taxation).

It is important to note that these institutional features in traditional China had been largely designed for social control and discipline for an agrarian empire. But its unintended legacy – a relatively large reservoir of human capital in early modern China and East Asia – may have facilitated their rapid economic catch-up of in the modern era once required institutional and ideological changes were accomplished. In fact, the lags and differential pace of economic catch-up within East Asia over the past two centuries may well be an outcome of the differential timing of the institutional and ideological change. This intricate relationship between human capital and institutions for China and East Asia is a confirmation of recent theoretical and empirical insights as expounded in Glaeser et al. (2004). It serves as a fresh reminder that by focusing exclusively on the comparison of national income per capita, we may be missing the most crucial and essential factor that accounts for both the early modern great divergence and the recent convergence between the two ends of Eurasia.

Acknowledgments

We want to thank Dorothee Crayen, Hans Ulrich Vogel, and Osamu Saito for help on data sources and the comments from participants of the Chorus workshop in Nice, France in 2006 and the Conference on "Economic Change around the India Ocean" in July 2008, LSE economic history department seminar and Economic History Society meeting in Warwick, UK in 2009. In addition, we thank comments from Latika Chaudhary, Chris Minns, Patrick O'Brian, Evelyn Rawski and the co-editor of this Journal, Tim Leunig. Joerg Baten thanks for mobility support from ESF GlobalEuroNet, the EU HIPOD project, research assistance from Valeria Prayon, Sonja Rabus and others. Debin Ma acknowledges support of the NSF funded "Global Price and Income Project" headed by Peter Lindert. Stephen Morgan acknowledges several funding grants from the Australian Research Council Small Grants and the University of Melbourne Research Grants schemes, and thanks Fiona Herron and Indah Morgan for research assistance. We are responsible for all the errors.

References

A'Hearn, B., 2003. Anthropometric evidence on living standards in northern Italy, 1730–1860. Journal of Economic History 63, 351–381.

A'Hearn, B., Baten, J., Crayen, D., 2009. Quantifying quantitative literacy: age-heaping and the history of human capital. Journal of Economic History 69 (3), 783–808.

Allen, R.C., 2001. The great divergence in European wages and prices from the middle ages to the first world war. Explorations in Economic History 38, 411–447.

Allen, R.C., Bassino, J.-P., Ma, D., Moll-Murata, C., van Zanden, J.L., 2007. Wages, prices and living standards in China, Japan and Europe, global prices and income project. Available from: <http://gpih.ucdavis.edu/Papers.htm>.

Allen, R.C., Bassino, J.-P., Ma, D., Moll-Murata, C., van Zanden, J.L., 2009. Wages, Prices, and Living Standards in China, 1738–1925: in Comparison with Europe, Japan and India" LSE Economic History Department Working Paper No. 123/09. Available from: <http://www.lse.ac.uk/collections/economicHistory/pdf/WP123.pdf>.

Bachi, R., 1951. The tendency to round off age returns: measurement and correction. Bulletin of the International Statistical Institute 33, 195–221.

Bassino, J.-P., Ma, D., 2005. Wages and living standards of Japanese unskilled laborers in 1720–1913: an international comparison. Research in Economic History 23 (Chapter 7).

[31] A large literature on the Chinese book, publishing and reading has emerged in recent years in both Chinese and English, but is beyond the scope of this article to summarise. Recent English-language studies include Brokaw (2007), Brokaw and Chow (2005), Chia (2002) and McDermott (2006).

Bassino, J.-P., 2006. Inequality in Japan (1892–1941). Physical stature, income and health. Economics and Human Biology 4 (1), 62–88.
Baten, J., 2006. Global Height Trends in Industrial and Developing Countries, 1810–1984: An Overview. Working Paper, Tuebingen.
Baten, J., Hira, S., 2008. Anthropometric trends in Southern China, 1830–1864. Australian Economic History Review 48 (3), 209–226.
Bliss, E., 1922. Rinderpest and its prevention. China Medical Journal 36, 153–170.
Brokaw, C.J., 2007. Commerce in Culture: The Sibao Book Trade in the Qing and Republican Periods. Harvard University Asian Centre, Cambridge.
Brokaw, C.J., Chow, K.-W. (Eds.), 2005. Printing and Book Culture in Late Imperial China. University of California Press, Berkeley.
Cao, S., 2001. Zhongguo Renkou Shi (Population History of China) vol. 5, Qing shiqi (Qing Period). Fudan University Press, Shanghai.
Chia, L., 2002. Printing for Profit: The Commercial Publishers of Jianyang, Fujian (11th–17th Centuries). Harvard University Asian Centre, Cambridge.
China, Ministry of Education, et. al. 2002. 2000-nian Zhongguo xuesheng tizhi yu jiankang diaoyan baogao (Report on the physical fitness and health surveillance of Chinese school students, 2000), Gaodeng jiaoyu chubanshe, Beijing.
Crayen, D., Baten, J., forthcoming. New evidence and new methods to measure human capital inequality before and during the industrial revolution: France and the U.S. in the seventeenth to nineteenth centuries). Economic History Review. doi: 10.1111/j.1468-0289.2009.00499.x.
Crayen, D., Baten, J., forthcoming. Global trends in numeracy 1820–1949 and its implications for long-run growth, Explorations in Economic History.
Dore, R.P., 1965. Education in Tokugawa Japan. Routledge & Kegan Paul, London.
Drukker, J.W., Tassenaar, V., 1997. Paradoxes of modernization and material well-being in the Netherlands during the nineteenth century. In: Steckel, R.H., Floud, R. (Eds.), Health and Welfare during Industrialization. University of Chicago Press, Chicago, pp. 331–377.
Duncan-Jones, R., 1990. Structure and Scale in the Roman Economy. Cambridge University Press, Cambridge.
Fogel, R.W., 1994. Economic growth, population theory, and physiology: the bearing of long-term processes on the making of economic policy. American Economic Review 84 (3), 369–394.
Fukao, K., Ma, D., Yuan, T., 2007. Real GDP in pre-war East Asia: a 1934–36 benchmark purchasing power parity comparison with the U.S. Review of Income and Wealth 53 (3), 503–537.
Gamble, S.D., 1943. Daily wages of unskilled chinese laborers, 1807–1902. The Far Eastern Quarterly 3 (1), 41–73.
Gardella, R., 1992. Squaring accounts: commercial bookkeeping methods and capitalist rationalism in late Qing and Republican China. The Journal of Asian Studies 51 (2), 317–339.
Ge, J.X., Hou, Y.F., Zhang, G.F., 1999. Renkou yu Zhongguo de Xiandaihua (Population and Modernization of China). Xuelin Press, Shanghai.
Glaeser, E.R., La Porta, F., Lopez-de-Silanes, Shleifer, A., 2004. Do institutions cause growth. Journal of Economic Growth 9 (3), 271–303.
Godo, Y., Hayami, Y., 2002. Catching up in education in the economic catch-up of Japan with the United States, 1890–1990. Economic Development and Cultural Change 50 (4), 961–978.
Godo, Y., 2006. The role of education in the economic catch-up: comparative growth experience from Japan, Korea, Taiwan, and the United States. Unpublished paper.
Guo, D., 1982. Zhongguo kuaiji shigao (a draft history of Chinese accounting) vol. 1. Chinese Finance and Economic Press, Wuhan, 1982.
Guo, D., 1988. Zhongguo kuaiji shigao (a draft history of Chinese accounting) vol. 2. Chinese Finance and Economic Press, Beijing.
Hanushek, E., Woessmann, L., 2008. The role of cognitive skill in economic development. Journal of Economic Literature 46 (3), 607–668.
Hayami, A., Kito, H., 2004. Demography and living standards. In: Hayami, A., Saito, O., Toby, R.P. (Eds.), Emergence of Economic Society in Japan, 1600–1859 – The Economic History of Japan: 1600–1990, vol. 1. Oxford University Press, Oxford., pp. 211–246.
Historical Archive No. 1 and History Institute of the Chinese Academy of Social Sciences (Eds.), 1982. Qingdai dizu boxue xingtai (the forms of exploitation of land rent during the Qing). 2 vols. Zhonghua shuju, Beijing.
Jun, S.H., Lewis, J.B., 2006. Accounting techniques in Korea: 18th-century archival samples from a non-profit association in the Sinitic world. Accounting Historians Journals 33 (1), 53–87.
Kishi, H., 1976. A historical study of the outbreaks of rinderpest during the Yedo era in Japan. Yamaguchi Journal of Veterinary Medicine 3, 33–40.
Komlos, J. (Ed.), 1994. Stature, Living Standards and Economic Development: Essays in Anthropometric History. University of Chicago Press, Chicago.
Komlos, J., Baten, J. (Eds.), 1998. Studies on the Biological Standard of Living in Comparative Perspective. Franz Steiner Verlag, Stuttgart.
Komlos, J., Cuff, T. (Eds.), 1998. Classics in Anthropometric History–A Selected Anthology. Scripta Mercaturae Verlag, St. Katharinen.
Krugman, P., 1994. The myth of Asia's miracle. Foreign Affairs 73 (6), 62–79.
Lee, J., Wang, F., 1999. One Quarter of Humanity: Malthusian Mythology and Chinese Realities, 1700–2000. Harvard University Press, Cambridge.
Li, B., 2001. Ming-Qing Jiangnan de chuban yinshua ye (the publishing and printing industry of Jiangnan during the Ming and Qing dynasties), Zhongguo jingjishi yanjiu. Research in Chinese Economic History 3, 94–107, 146.
Li, B., 2004. Bagu zhi wai: Ming Qing Jingnan de jiaoyu ji qi dui jingji de yingxiang (beyond the eight-legged essay: education and its impact on Jiangnan economy in Ming and Qing). Qing shi yanjiu. Research in Qing History 1, 1–14.
Ma, D., 2004. Growth, institutions and knowledge: a review and reflection on the historiography of 18th–20th century China. Australian Economic History Review 44 (3), 259–277.
Ma, D., 2008. Economic growth in the lower Yangzi region of China in 1911–1937: a quantitative and historical perspective. The Journal of Economic History 68 (2), 385–392.
Mace, R. et al, 2003. Testing evolutionary hypotheses about human biological adaption using cross-cultural comparison. Comparative Biochemistry and Physiology, Part A 136, 85–94.
MacPherson, K.L., 1987. A Wilderness of Marshes: The Origins of Public Health in Shanghai, 1843–1893. Oxford University Press, Hong Kong.
Manzel, K., 2008. Subsistence Crises, Education and Economic Development: the Impact of Subsistence Crises on Human Capital Formation. Working Paper University, Tuebingen.
McDermott, J.P., 2006. A Social History of the Chinese Book: Books and Literati Culture in Late Imperial China. Hong Kong University Press, Hong Kong.
Meng, T.P., Gamble, S.D., 1926. Wages, prices, and the standard of living in Peking, 1900–1924. The Chinese Social and Political Science Review 20, 1–113.
Mokyr, J., 1983. Why Ireland Starved: A Quantitative and Analytical History of the Irish Economy. Allen & Unwin, London. pp. 1800–1850.
Morgan, S.L., 2000. Richer and Taller – stature and the standard of living in China, 1979–1995. The China Journal 44, 1–39.
Morgan, S.L., 2004. Economic growth and the biological standard of living in China, 1880–1930. Economics and Human Biology 2 (2), 197–218.
Morgan, S.L., 2006a, The Biological Standard of Living in South China during the 19th century: Estimates Using Data from Australian Immigration and Prison Records. Asia-Pacific Economic and Business History Conference, 16–18 February. Queensland University of Technology, Brisbane. Available from: <http://www.uow.edu.au/commerce/econ/ehsanz/pdfs/Morgan1.pdf>.
Morgan, S.L., 2006b. Australian Immigration archives as sources for business and economic history. Australian Economic History Review 46 (3), 268–282.
Morgan, S.L., 2009. Stature and economic growth in china during the nineteenth century. Explorations in Economic History 46 (1), 53–69.
Morgan, S.L., Liu, S.Y., 2007. Was Japanese colonialism good for the welfare of the Taiwanese? Stature and the standard of living. China Quarterly 192, 990–1017.
Murray, J.E., 1994. Stature and body-mass index among mid-nineteenth century south Chinese immigrants. Annals of Human Biology 21 (6), 617–620.
Naquin, S., Rawski, E.S., 1987. Chinese Society in the Eighteenth Century. Yale University Press, New Haven.
Olds, K., 2003. The biological standard of living in Taiwan under Japanese occupation. Economic and Human Biology 1 (2), 187–206.
Pomeranz, K., 2000. The Great Divergence. Princeton University Press, Princeton.
Rawski, E.S., 1979. Education and Popular Literacy. The University of Michigan Press, Ann Arbor.
Rawski, E.S., 1985. Economy and social foundation of late imperial culture. In: Johnson, D., Nathan, A.J., Rawski, E.S. (Eds.), Popular Culture in Late Imperial China. University of California Press, Berkeley, pp. 3–33.
Rawski, T.G., 1989. Economic Growth in PreWar China. University of California Press, Berkeley.

Ronan, C.A., Needham, J., 1978. The Shorter Science and Civilisation in China: An Abridgement of Joseph Needham's Original Text, vol 1. Cambridge University Press, Cambridge.
Ruggles, S., Sobek, M., Alexander, T., et al., 2004. Integrated Public Use Microdata Series: Version 3.0 (Machine-readable database). Minnesota Population Center, Minneapolis, MN (producer and distributor).
Ryūkyū ōkoku hyōjōsho monjo henshū iinkai (Ed.), 1988. Ryūkyū ōkoku hyōjōsho monjo (Documents of the Ryūkyūan State Council). Minami nishi insatsu, Naha.
Shay, T., 1994. The level of living in Japan, 1885–1938: new evidence. In: Komlos, J. (Ed.), Stature, Living Standards, and Economic Development: Essays in Anthropometric History. The University of Chicago Press, Chicago, pp. 173–201.
Smith, T.C., 1988. Native sources of Japanese industrialization, 1750-1920. University of California Press, Berkeley.
Spence, J.D., 1999. The Search for Modern China, second ed. W.W. Norton, New York.
Spinage, C.A., 2003. Cattle Plague: A History. Kluwer Academic, New York/Dordrecht.
Steckel, R.H., 1995. Stature and the standard of living. Journal of Economic Literature XXXIII 1903, 1940.
Steckel, R.H., 2009. Height and human development: recent developments and new directions. Explorations in Economic History 46 (1), 1–23.
Sugihara, K., 2007. The second noel butlin lecture: labour-intensive industrialisation in global history. Australian Economic History Review 47 (2), 121–154.
Wakeman, F.E., 1997. Strangers at the Gate: Social disorder in South China, 1839–1861. University of California Press, Berkeley.
Wright, M.C., 1962. The Last Stand of Chinese Conservatism: The T'ung-Chih Restoration, 1862–1874. Stanford University Press, Stanford.

Why Japan, Not China, Was the First to Develop in East Asia: Lessons from Sericulture, 1850–1937*

Debin Ma
Foundation for Advanced Studies on International Development, Tokyo, and National Graduate Institute for Policy Studies, Tokyo

Although Japan and China are geographically and culturally close, today their levels of economic development are worlds apart. The origin of this gap is relatively recent. As late as the nineteenth and early twentieth centuries, Japanese exports competed directly with Chinese in the international market in such low value-added, labor-intensive products as raw silk. Between 1850 and 1930, raw silk ranked as the leading export for both countries, accounting for 20%–40% of Japan's total exports and 20%–30% of China's.[1]

Raw silk consists of bundles of long, continuous silk threads used for silk weaving. Its production starts with sericulture that involves the cultivation of mulberry trees and the harvesting of the leaves to feed the silkworms that develop into self-spun cocoons. Traditionally, cocoons were hand-reeled into raw silk within rural households. However, by the latter part of the nineteenth century, the spread of mechanization was steadily shifting the reeling process to modern factories.

The performance of the Japanese raw silk exports contrasted sharply with that of China. In 1873 China exported three times as much raw silk as Japan, but by 1905, Japanese raw silk exports exceeded the Chinese, and in 1930, Japanese raw silk exports tripled those of China, gaining a dominant 80% share in the global market.[2] This contrast is puzzling given that as late as the sixteenth and seventeenth centuries, Chinese raw silk dominated the Japanese market, and even in the mid-nineteenth century, Chinese silk enjoyed a more favorable global reputation than that of Japan.

This article presents a comparative analysis of this dramatic contrast by focusing on the cocoon sector that contributes between 60% and 80% in the value added of raw silk, leaving the reeling sector to future study.[3] It also adopts a regional approach by comparing Japan with the Lower Yangzi, the most advanced region of China. They are comparable in size, population, and

0013-0079/2004/5202-0004$10.00

climate and are part of the wet-rice economies characterized by intensive agriculture, high population density, and small-scale farming. The broad similarities in initial conditions, factor endowment ratios, crop choice, and geographic environment offer us a rare case study of a relatively controlled experiment.[4]

I argue that the Japanese success in silk export largely derived from the capacity of its sericultural sector to develop appropriate technology and institutions through a creative combination of traditional technology and modern science to overcome its resource constraints. These accord well with the so-called induced innovation hypothesis advocated by Yujiro Hayami to explain the overall success of Japanese agriculture for the same period.[5] Thus, the absence of the Japanese style of innovation was the cause of the stagnancy of the Lower Yangzi sericulture.

Why did broadly similar conditions induce innovations in one place and not the other? I argue that important physical and social infrastructure built up after the Meiji reform in Japan but largely ignored by the Qing bureaucrats of the conservative Self-Strengthening Movement in the Lower Yangzi during the latter part of the nineteenth century are the key to understanding this contrast. This article shows further that the Japanese success in turn profoundly affected the Lower Yangzi and elicited a dynamic technological and institutional response in the 1930s when a minimal set of necessary conditions was gradually being put into place since the Meiji-inspired Late-Qing reform in 1903–11.

This article mobilizes a multitude of independent sources of information, including the voluminous survey reports on the Chinese silk sector written by Japanese specialists between the 1890s and the 1930s, and offers various technical and productivity indices, including a price dual total factor productivity (TFP) index. The quantitative analysis is further supported by a careful examination of the institutional and technological developments in the cocoon production and distribution sectors in these two regions.

The rest of the article is divided into three sections followed by a conclusion. Section I presents comparative data on output, input, and prices and estimates of partial and total factor productivities. Section II, consisting of three parts, offers a comparative narrative of technology and commercialization and a summary of growth accounting results. Section III describes the 1930s catch-up in the Lower Yangzi.

I. Output, Prices, and Productivity

Annual Japanese cocoon output (for both domestic consumption and export) almost quintupled from the 1890s to the 1930s to about 300,000 tons. Comparable data were not available for the Lower Yangzi. Robert Eng's collection of various French and Japanese scholars' cocoon output estimates gave a range of between 70,000 and 100,000 metric tons, with growth rates largely stagnant for the Lower Yangzi between 1875 and 1930. Despite the data problem, it seems plausible that the cocoon output performance largely mirrors the regions' contrasting performance in raw silk exports, that is, that circa 1930, Japan was producing three to four times more cocoons than the Lower Yangzi.[6]

Various household and land productivity data seem to confirm a similar story of contrasting performance between 1890 and 1929. Annual cocoon output per household in the late 1920s Lower Yangzi was about 50–65 kilograms, about a third of the Japanese level during the same period, but roughly equivalent to its 1900 level. Annual cocoon output per acre of land in the Lower Yangzi was estimated to be about 150 and 142 kilograms in 1897 and 1932, respectively, about 70% of the Japanese level in the 1920s but equal to the Japanese level around 1910. The actual cocoon productivities in the Lower Yangzi would be even lower in comparison to Japan if cocoon quality deterioration in the 1910s and 1920s were taken into account.[7]

These partial productivity indices suffer various shortcomings. For the Lower Yangzi, most estimates were based on scattered individual observations. For Japan, as will be shown later, land and labor productivity improvements were exaggerated by the rapid intensification in Japanese sericulture that occurred between 1900 and 1920. These problems posed formidable obstacles to the construction of TFP based on the primal input-output approach.

In this context, the cost (or price) based TFP approach is more viable as time series data of input and output prices were relatively consistent and reliable. The dual equivalence of production and cost side TFP based on a Cobb-Douglas production function requires the assumption of constant returns to scale and long run competitive market assumptions (with cost side TFP expressed as $A_t^d = \prod_{i=1}^{4} w_{it}^{\alpha_i} / AC_t$, w_{it} and α_i being price and weight, respectively, for the ith input at time t, AC_t as average cost of production and $\Sigma\alpha_i = 1$). Both these assumptions are reasonably satisfied for the small-scale and scattered rural sericultural production taking raw silk and cocoon prices as given by the global market.

To calculate the dual TFP, I have used cocoon price for AC and four price series of input, namely, labor, land, sericultural inputs (fertilizer, silkworm egg seeds, etc.), and capital (silkworm rearing room, tools) for the period between 1903 and 1928. Their summary statistics are presented in the appendix.

Figure 1 shows the annual cocoon (as well as raw silk) prices for Japan and the Lower Yangzi all converted into Japanese yen. The cocoon price of the Lower Yangzi is from Wuxi, the most important cocoon-marketing center in the region. Notice that the Wuxi cocoon price, which roughly paralleled that of the Japanese cocoon price until the mid-1910s, began to dip consistently below the Japanese level thereafter.

The abrupt but sustained lowering of the level of cocoon prices after the mid-1910s reflected a systematic deterioration of cocoon quality in the Lower Yangzi as captured by the rising silk yield ratio—the amount of cocoons needed to produce a certain unit of raw silk. Shigema Uehara, the most authoritative specialist on Chinese silk industry at the time, presented data

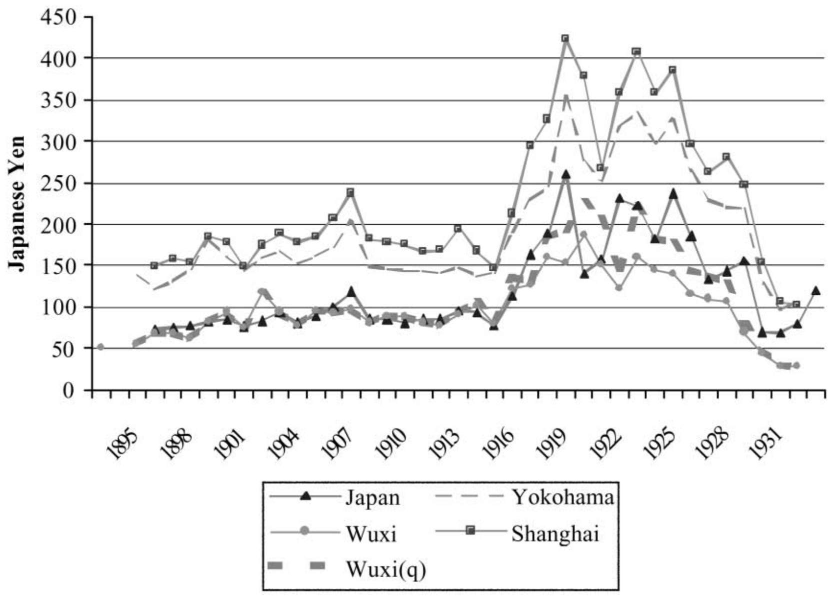

FIG. 1.—Cocoon and raw silk prices in Japan and the Lower Yangzi. The "Japan" and "Wuxi" series are for Japanese and the Lower Yangzi cocoon prices in 100 kilograms. *Wuxi(q)* stands for the quality adjusted price series. The "Yokohama" and "Shanghai" series are for raw silk export prices in 10 kilograms from Japan and the Lower Yangzi. Sources: For sources, see the data appendix. The Shanghai series for 1896–1917 is from Ziyu Chen, *Jindai Zhongguo de Zisi Saosi Gongye, 1860–1945* (The silk industry of modern China, 1860–1945) (Taipei: Institute of Modern History, Academia Sinica, 1989), p. 62; and that for 1917–32 is from Xin-wu Xu, ed., *Zhongguo Jindai Saosi Gongyeshi* (Modern history of Chinese silk-reeling industry) (Shanghai: People's Publishing House, 1990), pp. 692, 698. The Yokohama series is from Shozaburo Fujino, Shiro Fujino, and Akira Ono, *Estimates of Long-Term Economic Statistics of Japan since 1868* (Tokyo: Toyo Keizai Shinposha, 1979), 11:296–97. Exchange rates are from Liang-lin Hsiao, *China's Foreign Trade Statistics, 1864–1949* (Cambridge, Mass.: Harvard University Press, 1974), pp. 190–93.

showing that the amount of dried cocoon required for producing 100 kilograms of raw silk increased from 500 in 1915 to more than 600 kilograms in 1924—a decline of more than 20%.[8]

Adjusting the cocoon price by the quality change is essential for an accurate calculation of TFP changes for the Lower Yangzi. The quality-adjusted cocoon price in Wuxi (obtained by multiplying the cocoon price by the standardized silk-yield ratios) is displayed in figure 1 as Wuxi(q). The price dual TFP adjusted by cocoon quality (A_t^q) can be written as $A_t^q = \prod_{i=1}^{4} w_{it}^{\alpha_i} / S_t p_t$, with S_t and p_t denoting the standardized silk-yield and market cocoon price, respectively. For the Lower Yangzi, $S_t p_t$ is equivalent to Wuxi(q). The results for both regions are presented in table 1. Japanese TFP growth accelerated during these 3 decades. The Lower Yangzi showed very promising

TABLE 1

Quality-Adjusted TFP Index for Japan and the Lower Yangzi

Japan		Lower Yangzi	
1903–9	105	1904–9	68
1910–19	119 (1.3%)	1910–19	86 (2.35%)
1920–28	157 (3.2%)	1920–28	79 (−.9%)
Average annual growth rate 1903–28	2.05%	Average annual growth rate 1904–28	.52%

Sources.—For sources of input and output prices and Chinese silk yield data, see the data appendix. Japanese silk yield data are from Shozaburo Fujino, Shiro Fujino, and Akira Ono, *Estimates of Long-Term Economic Statistics of Japan since 1868* (Tokyo: Toyo Keizai Shinposha, 1979), vol. 11, table 49, col. 4. The shares of labor, land, capital, and input (fertilizer being the major item) used for Japan are .5, .12, .2, .18, respectively, and .5, .17, .15, and .18 for the Lower Yangzi, respectively. The Japanese factor share information is from Central Committee of Japanese Sericultural Association, *Souen oyobi yousan keieihi no kenkyu* (Studies on the cost of mulberry cultivation and silkworm rearing), nos. 1, 2, 3 (1924 and 1925), report no. 1, p. 11; report no. 2, p. 19. For the Lower Yangzi, I have used information from Shigemi Uehara, *Shina Sanshigyo Taikan* (Overview of the Chinese silk sector) (Tokyo, 1929), pp. 83–84, 160; and also Ziyu Chen, *Jindai Zhongguo de Zisi Saosi Gongye, 1860–1945* (The silk industry of modern China, 1860–1945) (Taipei: Institute of Modern History, Academia Sinica, 1989), pp. 60–70.

Note.—Numbers in parentheses are growth rates compared with the earlier period. For the Lower Yangzi TFP, I used 1904 as the starting year because 1901–3 corresponded to an extraordinary period of cocoon market speculation in Wuxi due to a sudden surge of silk-reeling factories in Shanghai. This is explained in Sec. II*B* above. If I use 1901 or 1903 as the starting year, annual TFP growth rates in 1901–28 would be 1.5% and 1.1%, respectively. To test for the robustness of my TFP calculation, I have performed a sensitive test by applying alternative weights. Applying Chinese share weights on the Japanese data gives an average annual growth rate of 2.1% for Japan in 1903–28. Using Japanese share weights on Chinese data gives an annual TFP growth rate of 0.67% for the Lower Yangzi in 1904–28. Neither of these two rates was significantly different from those in this table.

TFP growth from about the 1900s to the 1910s, but this then turned negative in the 1920s as the silk yield decline took its toll. Overall, the Lower Yangzi TFP growth rate of 0.52% was only about a quarter of Japan's 2.05% in the first 3 decades of the twentieth century.[9]

II. Accounting for Growth: Technology and Commercialization

The leaders that came to power through the 1868 Meiji Restoration made no pretense of "restoring" Japan to its old days but, instead, proclaimed, in the new imperial "Charter Oath," that "knowledge shall be sought throughout the world" and subsequently embarked on a reform program to forge a modern nation-state modeled after the West.[10] Japan's decisiveness in turning outward in the face of the Western Imperialist challenge was matched by contemporaneous Qing's determination to reinstate an orthodox neo-Confucian ruling ideology to an empire that had been brought to the brink of collapse by the devastating 1860s Taiping rebellion.

The Qing bureaucrats did recognize the superiority of Western military technology and, under the so-called Self-Strengthening Movement (1860–94), attempted to modernize the Chinese military through a series of either government-financed or government-controlled Western style industrial enterprises. The attitude of the Self-Strengthening Movement toward private initiatives in the modern sector ranged from indifference to hostility and displayed little interest in supplying modern public goods; in most cases, this movement was even opposed to private efforts to build public infrastructure such as railroads and inland steam shipping.

In comparison, Meiji's sell-off of its limited number of government enterprises in the 1880s gave a powerful signal that the private sector was the mainstay of Japan's industrialization. The government concentrated on building crucial social and physical infrastructures such as a legal system, public education, research and technological diffusion, a modern monetary and banking system, modern transportation, and modern communication.

China's shocking naval military defeat by Japan in 1895 was soon to spell the end of the Self-Strengthening Movement and subsequently set off a process of intellectual awakening that questioned the fundamentals of the traditional system. The Qing constitutional reform in 1903–11, itself inspired and modeled after the Meiji reform, recognized the importance of the private sector and the government's role in public goods provision. But the imperial Qing collapsed in 1911, leaving an unfinished reform agenda to a China in disarray.[11]

The following three sections will show that these crucial changes in the late nineteenth and early twentieth centuries set the production and commercialization in Chinese and Japanese sericulture along increasingly divergent paths of technology and institutions despite similar starting points. This divergent path directly affected the productivities and competitiveness of the two sectors.

A. Technology

Japan was a latecomer in the global silk market. The rise of a domestic Japanese raw silk sector, originated in Tokugawa shoguns' 1685 restrictions against Chinese silk imports, was a case of import substitution based on the borrowing of the Chinese, particularly the Lower Yangzi sericulture technology. In the 1860s and 1870s, Japan became the most important supplier of quality silkworm eggs for Europe. Japan's comparative advantage in the export of silkworm eggs, a product lower in value added than raw silk, seems to corroborate other evidence that pointed to a level of late-Tokugawa Japanese technology, while possibly converging to or even overtaking that of the Lower Yangzi in the area of silkworm rearing, still lagging behind in mulberry cultivation and hand-reeling technique.[12]

Meiji reform opened Japanese sericulture to the world of European science and technology. The Iwakura mission that sent Meiji ministers on a 2-year study tour of Europe and America in 1871–73 enlightened Japanese sericulturalists as well. Following the official Iwakura mission to Italy was a group of Japanese sericultural experts headed by Nagaatsu Sasaki, who visited northern Italy in 1873.

At the time of Sasaki's visit, northern Italy represented the frontier of

Europe's sericultural technology, being transformed by the application of modern science, particularly the discovery and diffusion of Louis Pasteur's microscopic examination method of pebrine disease. The sericultural institute that Sasaki visited and studied for one full month in Gorizia (in northern Italy) was the first of its kind set up in 1869. Sasaki returned to Japan with the most up-to-date silkworm-rearing tools, such as microscopes and hygrometers, and actively advocated the establishment of modern sericultural research and education in Japan. The visit heralded the beginning of Japan's own national system of technological innovation, diffusion, and education. In the period between the 1890s and 1940s, Japanese sericultural specialists produced a steady stream of survey reports on foreign sericultural technology and commercial practices, with a total of about 40 volumes just on China.[13]

Such keen awareness of the ongoing technological revolution in European sericulture could not be found in the Lower Yangzi before the twentieth century.[14] Preparation for the grueling, pyramid-structured Civil Service Examination system based on the memorization of Confucian classics continued to engross the intellectual energies of the Chinese elites. Among the limited efforts by the Self-Strengthening bureaucrats to diffuse Western science and technology was the translation of a series of Western texts by the translating department of the Jiangnan Arsenal, a government industrial venture established to build Western-style military ships. One of these texts translated in 1899 is a classic Italian sericulture book, published originally in the late 1810s. The Chinese translation, itself possibly based on a late English translation, involved the work of three nonspecialists in sericulture—an Englishman by the name of John Fryer provided the oral interpretation of the text and two Chinese writers converted Fryer's verbal explanation into classical Chinese. This Chinese style of acquiring a classic but outdated Italian technology through a multiple of indirect media forms a direct contrast to the Japanese style of learning as displayed in Sasaki's 1873 study tour in Italy.[15]

By the turn of the century, Japanese surveys on Lower Yangzi sericulture had already shown important traces of technological divergence. These reports often criticized silkworm-rearing practices in the Lower Yangzi as backward, naïve, and superstitious, and most interestingly, "very much like our practices in the pre-Meiji era."[16] It confirms that Japanese sericultural technology began decisively to forge ahead of the Lower Yangzi only around the turn of the last century. The following comparative narrative illustrates two of Japan's most important technological breakthroughs in the early twentieth century that laid the foundation for its global dominance.[17]

Silkworm improvement: Developing the F_1 variety. Silkworm eggs are an essential input to cocoon production. While there were numerous technical innovations in the prevention of silkworm disease and improvement of silkworm varieties, the fundamental breakthrough came with the discovery of the so-called first filial (F_1) hybrid silkworm in the early 1910s. The performance of the F_1 variety surpassed the previous types in almost all technical indices.[18]

The concept of hybrid vigor behind the F_1 variety is ancient in East Asia.

However, previous studies and experiments with silkworm crossbreeding, including those done in the early Meiji era, were not supported by the theory of heterosis as expounded by Mendel's genetic principle. The key element of Mendel's discovery was that the superior traits of the two pure strain parent varieties were stable in their first generation of crossbreeds but not in the succeeding generations derived from this cross. This important theoretical recognition led to the rise of modern experimental labs that specialized in the selection and breeding of pure strain varieties and the mass production of the crossed F_1 variety silkworm eggs for cocoon production.

It is important to note that the success of the F_1 variety was founded on a series of cumulative research on embryology and cellular biology. Unlike other minor innovations, government-sponsored research labs and university departments were responsible for most of the basic scientific research and biological experiments at the core of the F_1 technology.[19]

Aided by a diffusion network of experimental stations, specialized silkworm-egg dealers, industrial silk reelers, and associations, the F_1 variety diffused rapidly among sericultural farmers. The diffusion started in the early 1910s, and by 1923, the F_1 variety's share in the spring crop reached 100%; by 1929, 100% of the summer and fall crop used the F_1 breed.[20]

The diffusion of the F_1 variety had a direct impact on both the productivity and quality of cocoons in Japan. The most commonly used indicator for the performance of silkworm varieties and rearing was the so-called cocoon-egg yield—the weight of cocoons obtained from a certain amount of hatched silkworm eggs. Table 2 shows clearly that the improvement of cocoon yield accelerated from 1900–1909 to 1910–19, which corresponded well with the timing and rate of diffusion of the F_1 variety. This also matched the acceleration of my TFP index for Japan. By the late 1920s, when the diffusion of the F_1 variety was complete, Japanese egg yields surpassed the level of Italy.

In contrast, silkworm eggs used in the Lower Yangzi before 1925 were almost entirely produced by traditional breeding methods, with little use of the microscopic method of disease prevention. Based on various Japanese survey reports, the final column of table 2 presents a direct comparison of the cocoon yield for these two regions. This contrast is compelling. Around 1900, the cocoon-egg ratios in Japan and the Lower Yangzi were roughly equal, but for the next 2 decades, the Japanese cocoon-egg ratio surged, as opposed to a largely immobile cocoon yield index in the Lower Yangzi.

Intensification: Rearing a second crop. The next major Japanese innovation was the rearing of a second crop of silkworms in the fall in addition to the main spring crop. Again, like so many other Japanese innovations, this one has its roots in East Asia.[21] However, instability in hatching and other technical problems constrained its growth. The great merit of the fall crop was that the timing of its rearing fell in the period when rice cultivation required the least labor, thus enabling cocoon growth without the sacrifice of cereal production.[22] In Japan, studies of artificial hatching started in the late 1880s, and Japanese farmers had also experimented with various crude meth-

TABLE 2

Yield of Silkworm Eggs (Kilograms of Cocoons per Gram of Silkworm Eggs Hatched)

	Italy	France	Japan (All Crops)	The Lower Yangzi as a Percentage of the Japanese Level in That Year
1878–87	1.02	.94		
1888–1902	1.48	1.43	.86 (1899)	
1903–13	1.76	1.55	.80 (1900–1909)	100% (1900)
1910–19			1.06 (3.8%)	74% (1917)
1920–29	1.74		1.75 (5.2%)	50% (1927)

Sources.—Italian and French data are from Giovanni Federico, *An Economic History of the Silk Industry* (Cambridge: Cambridge University Press, 1997), appendix, table 15. I choose the *c* column for the Italian yield, which is the more consistent but also higher than the other estimate. Japanese data are from Shozaburo Fujino, Shiro Fujino, and Akira Ono, *Estimates of Long-Term Economic Statistics of Japan since 1868* (Tokyo: Toyo Keizai Shinposha, 1979), vol. 11, table 62. For Chinese data, the 1904 yield is from Kizo Minemura, *Shinkoku Sansigyou Sisatu Fukumeisho* (Survey report on the Chinese silk sector) (Tokyo: Ministry of Agriculture and Commerce, 1900), pp. 105–8. The yield for 1917 is for Zhejiang province given by Akaishi quoted in Katsuhiko Ikawa, *Kindai Nihon Seishigyo to Mayu Seisan* (Modern Japanese silk-reeling industry and cocoon production) (Tokyo: Tokyo Economic Information, 1998), p. 223. The 1927 data are from Shigemi Uehara, *Shina Sanshigyo Taikan* (Overview of the Chinese silk sector) (Tokyo, 1929), p. 30. Various estimates by Chinese scholars put the average cocoon yields in Jiangsu province of the late 1920s and early 1930s at roughly less than 1 kilogram per gram of eggs. See Su-Ping Yue, *Zhongguo Cansi* (Chinese silk) (Shanghai: World Press, 1935), p. 78; and Zhuang-Mu Wang, ed., *Minguo Sichou Shi* (History of silk in the Republic Era) (Beijing: China Textile Publishing House, 1995), p. 50.

ods of preserving and hatching the silkworm eggs in autumn. But it was not until Japanese scientists' discovery of hydrochloric acid processing in 1911–12 that the timing and outcome of artificial hatching stabilized.

Innovation in silkworm egg preservation and hatching was only half of the tale. The more binding constraint on the fall crop was the supply of mulberry leaves in the fall season when mulberry trees were no longer yielding fresh leaves. Technical innovation in this area had gone through several phases of search and experimentation and eventually converged to a set of three complementary technologies: the introduction and adaptation of a fertilizer-responsive tree variety, known as "Lu" from the Lower Yangzi; a new tree-pruning technique called "stem pruning"; and the adoption of new types of commercial fertilizer.

Japan had learned of the superior Lu mulberry trees through Chinese sericultural texts in the Tokugawa era but only started widespread introduction after Meiji through the advocacy of the energetic Sasaki. Stem pruning applied to the Lu types of trees reduced the tree trunks to bushes that matured faster, carried a higher yield, and could bloom multiple times within a year but that had a shorter life span.[23]

In China, the stem-pruning technique and bush type of mulberry trees (not the Lu type) were widespread in the subtropical Guangdong province.[24] Japan's success in transferring a subtropical technique to the temperate zone was complementary with the diffusion of new commercial fertilizers in 1900–1930. Among the types of commercial fertilizer used, soybean cake imported from Manchuria in northeast China was the most important.[25] The commercial adoption of the soybean cake from Northern China was a major historical achievement of Lower Yangzi agriculture in the eighteenth and nineteenth centuries. But by the twentieth century, Japan's colonial economic activities in Manchuria as well as significant improvements in internal distribution and transportation effectively diverted this trade flow toward Japan.[26]

This combination of technological innovation led to the rise of the ratio of the summer and fall crop to total output from just over 20% in the 1880–1900 period to 34% in 1900–1909, and, after 1920, the summer and fall crops consistently made up about half of the total output, rivaling the spring crop.[27]

By contrast, the early twentieth-century mulberry cultivation in the Lower Yangzi displayed an ecosystem formed since the late Ming (about the late sixteenth century). Mulberry trees, mostly of the Lu type, trunk-pruned, clustered along the banks of the canal system, fertilized by the canal sediments, with mulberry leaves transported to markets through the canal network.[28] Scattered estimates show that 1910–30 average Lower Yangzi mulberry yields per acre, while still higher than those for Gunma and Nagano prefectures for the period of 1880–90, the two most important sericultural regions in Japan, became only half of Japan's national average yield in 1927. Consequently, the share of summer and fall crops in the late 1920s Lower Yangzi remained at about the level of Japan before the 1880s.[29]

B. Commercialization

Japan: Breaking the resource constraint. In the 1880s the Suwa district of Nagano prefecture became the center of mechanized reeling factories. As Suwa was in the heart of the sericultural regions in eastern Japan, initially silk-reeling factories acquired cocoons directly from the rural households in neighboring areas. With the phenomenal growth of modern reeling factories over the next 2 decades however, silk reelers began to reach into other prefectures for additional supplies of cocoons at cheaper prices. Nationwide cocoon procurement by silk reelers induced the growth of cocoon collection and marketing centers in all of the major sericultural regions from the 1880s to the 1910s. These collection and marketing centers usually consisted of cocoon merchant houses as well as individual merchants, some equipped with cocoon drying and storage facilities.

The mountain-locked Suwa district was a harsh environment for commercialization. Therefore, the rapid extension of the radius of the cocoon supply region was a feat of man's triumph over geography. Nakabayashi has carefully documented how the adoption of modern insurance and transportation methods, the building of railroads, and the cooperation of silk reelers and railroad authorities had managed to break, one by one, the bottlenecks that would have otherwise constrained the enormous expansion of the cocoon supply. The building of railroads, starting in the early 1880s, instantly opened up new cocoon supply regions for the Suwa silk reelers, turning more and more traditionally integrated producers of silk-reeling and silkworm rearing into specialized cocoon farmers.

From the 1910s, the development of direct purchase arrangements between reelers and farmers expanded at the expense of intermediary markets or middlemen. After World War I, the direct exchange between reelers and farmers or farmers' cooperatives markedly increased. Statistics show that, by 1923, cocoons sold directly to the reelers were 46.6% of total sales, higher than the 23.9% and 29.5% sold through the cocoon market and merchants, respectively.[30] Out of the direct exchange system evolved another institutional innovation that brought reelers and rearers even closer, the so-called subcontractual direct purchase system. This system, which probably originated in 1905, entailed a long-term exchange contract between farmers and reelers. From 1926 to 1933, the share of cocoons sold through this system grew from 12.5% to 40.1% in Japan.[31]

The Lower Yangzi contrast: Growth and constraints. Compared with the almost linear progression of Japanese cocoon commercialization, the process for the Lower Yangzi was far more twisted. The period before the mid-1890s saw much activity but little real spread of modern silk-reeling factories. The exports of machine-reeled raw silk from Shanghai before 1894 were so insignificant that they were counted as hand-reeled raw silk in the customs statistics.

This is no surprise, as private modern industry, distinguished from those supported by the Self-Strengthening bureaucrats, had no legal status before the twentieth century. The few mechanized silk-reeling factories that did survive under the dubious extraterritorial protection in the treaty port of Shanghai were repeatedly harassed by the local officials representing the interests of the traditional silk weavers, who feared for their source of raw silk supply.[32] The issue was swept away by the treaty of Shimonoseki in 1895 signed after China's defeat by Japan granting legality to private enterprises in the treaty ports.

In Shanghai, the number of modern silk-reeling factories more than doubled between 1895 and 1896.[33] But the take-off of the Shanghai reeling industry, itself located about 200–300 kilometers from sericultural regions, soon ran into the constraint set by the nascent cocoon marketing and distribution infrastructure in rural Lower Yangzi, sending the cocoon price in Wuxi as presented in figure 1 to surge 70% between 1902 and 1903.

In the nineteenth century, the Lower Yangzi lowlands relied on its intricate waterways for cocoon transportation, thus barely surviving Qing's prohibition of railroads in China. Attempts by Shanghai silk reelers and merchants to introduce steamships into inner rivers were thwarted by local officials who were protecting the interests of traditional shippers. It was after 1896 with the signing of the Shimonoseki treaty that steamship and, later, regular steamer routes in the inner river and canal system began.[34] In 1908 and 1912, two railroads linking Shanghai to the sericultural heartlands of Jiangsu and Zhejiang provinces were also completed.

Lower Yangzi cocoon distribution was largely in the hands of the cocoon *hang*s. The *hang*s received fresh cocoons from farmers, dried them in their ovens, and then shipped them to Shanghai. Cocoon *hang*s belonged to the traditional Ya-hang system, in which the Ya-hang obtained local trading privileges by its purchase of government-issued licenses and payment of commercial taxes.[35]

The rising demand in the twentieth century induced a steady increase of cocoon *hang*s. In Wuxi, the number of cocoon *hang*s increased from fewer than 50 in 1895 to 140 in 1910. By 1917, Jiangsu and Zhejiang provinces had over 700 cocoon *hang*s scattered in major sericultural regions.[36] In 1902, Wuxi *hang* merchants, whose organizing activities to regulate market practices and coordinate collective action could be traced back to the 1880s, founded their official Cocoon Guild. This was absorbed in 1909 into a joint guild organization representing both the Lower Yangzi cocoon merchants and Shanghai silk reelers.[37]

Still, cocoon commercialization in twentieth-century Lower Yangzi was no smooth sailing. In the mid-1910s, at the peak of the Lower Yangzi cocoon commercialization, the traditional silk weavers' guild succeeded in pressuring the provincial governments to promulgate legislation to place a ceiling on the number of cocoon *hang*s allowed within a certain geographical area in the Lower Yangzi. Subsequently, the pace of growth of cocoon *hang*s and shipments to Shanghai noticeably slackened during the 1920s.[38]

Commercial organization in twentieth-century Republican China as characterized by guilds and *hang*s was a legacy of the traditional imperial system. In the Late Qing, strained by its deteriorating fiscal condition, the government increasingly resorted to commercial taxes in place of the rigid land tax. But the collection of commercial tax, particularly the infamous Lijing tax levied on goods in domestic transit, was in the hands of local governments whose revenue-extracting measures were often arbitrary and extortionary. It was the organized guilds, taking advantage of local governments' limited informational capacity on commercial activities, that acted as tax collection agents. Through the practice and spread of commercial tax farming, merchant guilds wielded additional leverage over rural cocoon distribution in the Lower Yangzi.[39]

Throughout this period, the Cocoon Guild, like the other guilds, resorted to all means to protect their trading privileges by shutting out independent cocoon intermediaries. Their efforts to collectively bargain down the purchase price for cocoons alienated cocoon farmers, who were constantly attempting to circumvent the *hang* system.[40]

A potential information problem emerged in the process of cocoon commercialization that created a division of labor between silkworm rearing and silk reeling. In scattered rural households where silkworms were reared, cocoon farmers had private information about their rearing process and the quality of their products. By the 1910s and 1920s, the fraudulent and dishonest practices of selling low-quality cocoons had turned the cocoon market into something like Akerlof's lemon market.[41]

Interestingly, Tokugawa Japan, especially in the eighteenth century, may have been no less guild-oriented than the Lower Yangzi. Official chartered merchant guilds paid license fees and contributed tax revenue to the Bakufu in exchange for trading privileges. It was Meiji reform that abolished the merchant guild system and upheld the legality of free commercial transactions.[42]

The absence of a government-sanctioned monopoly gave rise to the diversity of institutional arrangements of cocoon transactions in Japan and created possibilities for institutional innovation, as seen in the case of the "subcontractual direct purchase" system. Through the long-term direct purchase contract, industrial silk reelers, by providing scientifically bred silkworm eggs and detailed technical guidance, acquired a monitoring capacity of farmers' silkworm-rearing process. In Japan, large-scale, high-quality raw silk manufacturers such as Katakura and Gunze were the main users of this system.[43] The asymmetric information problem that had plagued the Lower Yangzi in the 1910s and 1920s, possibly causing the regions' silk yield decline, was eased by a system of semivertical integration in Japan.

C. A Summary Growth Accounting

The differential pace and sequence of cocoon commercialization in the two regions have productivity implications. Both visual observation and the standard statistical cointegration test on the price series in figure 1 reveal the much higher degree of market integration between Japanese cocoon markets and the Yokohama raw silk market than that between Wuxi and Shanghai in the first 2 decades of the twentieth century. Sericulture in the twentieth-century Lower Yangzi, possibly at a similar stage of commercialization as that in Japan in the latter half of the nineteenth century, might have realized significant productivity gains from new infrastructures and greater specialization. Such gains, however, may have been relatively insignificant for Japan in the twentieth century, as major infrastructures and a cocoon-marketing network were already well established. If we could assign the 0.52% annual Lower Yangzi TFP growth in 1904–28 in table 1 to possible efficiency gains from commercialization, we have to explain the 2.05% Japanese rate of TFP growth in 1903–28 in the context of the momentous technological and institutional innovations within its sericultural sector.[44]

Table 3 presents the growth accounting to calculate separately the contributions of input expansion (extensive growth) and TFP growth (intensive growth) to cocoon output growth for Japan. It shows that TFP growth (from table 1) made up 37% of the total growth in cocoon output, leaving the

TABLE 3

AVERAGE ANNUAL GROWTH RATES OF INPUT, OUTPUT, AND TFP IN 1903–27

	Japan	Lower Yangzi
Input expansion:		
Input (excluding summer and fall)	2 (42)	...
Intensification (summer and fall)	1.15 (21%)	0
Total factor productivity	2.05 (37%)	.52
Cocoon output	5.5	...
Raw silk exports	7.9	2.8

SOURCE.—For Japan, cocoon and raw silk data are from Shozaburo Fujino, Shiro Fujino, and Akira Ono, *Estimates of Long-Term Economic Statistics of Japan since 1868* (Tokyo: Toyo Keizai Shinposha, 1979), vol. 11, tables 57, 61, 63. For the Lower Yangzi, raw silk data are from Xin-wu Xu, ed., *Zhongguo Jindai Saosi Gongyeshi* (Modern history of Chinese silk-reeling industry) (Shanghai: People's Publishing House, 1990), pp. 690–92.

NOTE.—Numbers in parentheses indicate percentage contribution to growth rate of cocoon output. The 5.5% number is the Japanese cocoon growth rate adjusted by the silk yield. The growth rate without the quality adjustment is 5.2%.

remaining 63% to input expansion in 1903–28. Out of this 63% input expansion, I calculate the pure intensification effects from summer and fall crops using the following counterfactual calculation:

$$\text{Annual growth rate from intensification}$$
$$= \exp[\log(Q1927) - \log(Q_h 1927)]/24 - 1.$$

The expression $Q1927$ = total spring, summer, and fall cocoon output in 1927; $Q_h 1927$ = 1927 spring cocoon output + ($Q1927 \times$ 1903 summer and fall ratio).

This calculation, as presented in table 3, shows that intensification through the summer and fall crop (as a part of the input expansion) was equivalent to an annual 1.15% input growth (about 21% of the total growth in cocoon output). Altogether, TFP growth and intensification accounted for 58% of the annual growth in Japanese cocoon output, leaving the remaining 42% to pure expansion in land and labor.

I showed earlier that the TFP growth was directly related to the discovery and diffusion of the F_1 variety, while intensification was achieved through the application of artificial hatching in combination with the set of complementary technologies in mulberry cultivation. These constituted the core of the induced innovation in Japanese sericulture. Had such innovation not occurred, that is if we remove the 58% contribution of the induced innovation from the 5.5% annual cocoon growth rate in 1903–27, Japanese growth would have been only 2.3%. This is roughly equivalent to the 2.8% growth rate of the raw silk exports in the Lower Yangzi in the same period. Clearly, what ultimately made the difference between these regions is the race-seed-fertilizer transformation.[45]

III. An Epilogue: The Lower Yangzi Catch-up in the 1930s

The lackluster sericultural performance in twentieth-century Lower Yangzi has to be placed in the larger context of China's political disintegration and social and economic dislocation that occurred after the Qing collapse in 1911. Under a series of weak governments or sometimes no government in the Republican period, real reforms made little headway. Yet the legacy of reform and the fundamental ideological switch proved to be far more enduring.

In 1897, a local magistrate founded China's first modern sericultural institute in Hanzhou, Zhejiang province. Sericultural manuals with titles using the newly introduced term "experiment" appeared after 1900. The Late Qing reform, which abolished the Civil Service Examination, paved the way for a modern educational system with a new curriculum. Slowly but steadily, experimental stations, research institutes, schools of various levels, departments in universities, and a scientific community grew, actively promoting sericultural reform, popularizing scientific principles, and diffusing new technology.[46]

The first 2 decades of the century also heralded the so-called golden age of Chinese capitalism in the treaty port of Shanghai. Rapid industrial and financial growth in Shanghai was spilling over to the Lower Yangzi, especially along the recently completed Shanghai-Nanjing railroad on which Wuxi was located. By the mid-1920s, Wuxi, with its cheap labor and proximity to raw materials, had emerged as a second center of modern silk-reeling production in the Lower Yangzi.

The scattered mosaics of economic growth seemed to really come together with the founding of the new Nationalist government in Nanjing, Jiangsu province, in 1927. The restoration of general peace and stability was an invaluable public good that a government could offer. By 1933, for the first time the number of modern silk-reeling machines in Wuxi exceeded those in Shanghai.[47] Most notable was the rise of a giant silk-reeling conglomerate, the Yongtai Company, which moved from Shanghai in 1926. It soon emerged as the industry leader in pushing for sericultural improvement and technological diffusion in the 1930s.

In 1928, the Nationalist government abolished the trading privileges of the Cocoon Merchant Guild, lifted the restrictions on the opening of cocoon *hang*s, and started reforms in commercial taxation and tax farming. Between 1928 and 1929, the number of cocoon *hang*s in Wuxi county jumped by about 30%.[48] The government encouraged the establishment of silkworm-rearing cooperatives to sell cocoons directly to reeling factories. In 1932, the Yongtai Reeling Company began to set up long-term exclusive contracts with farmers or cooperatives in the Lower Yangzi, a system very similar to the subcontractual direct purchase system pioneered by the large silk reelers in Japan.[49]

Starting in 1932, the provincial governments of both Jiangsu and Zhejiang began to take a direct role in promoting sericultural improvement and tech-

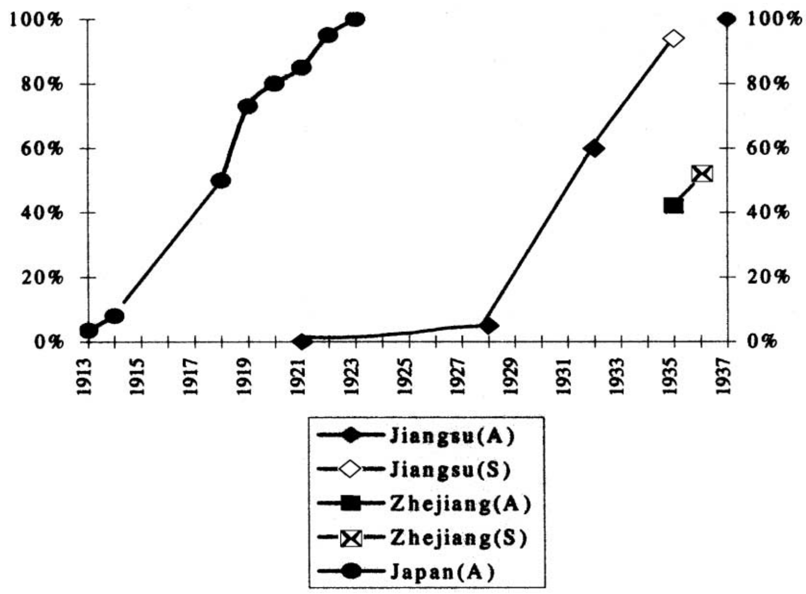

FIG. 2.—Diffusion of scientifically produced silkworm varieties in Japan and the Lower Yangzi. Sources: Diffusion figures for Japan were adapted from Yukihiko Kiyokawa, "The Diffusion of New Technologies in the Japanese Sericulture Industry: The Case of the Hybrid Silkworm," *Hitotsubashi Journal of Economics* 25 (1984): 31–59, esp. p. 41, fig. 1. *A* includes all crops, while *S* includes only spring crops. For China, see Saiichi Benno, "Chugoku No Nogyo Kindaika Ni Taisuru Teiko" (Resistence toward Chinese agricultural modernization), *Shakai Keizai Shigaku* 59, no. 2 (1993): 30–59, esp. p. 43; Zhuang-Mu Wang, ed., *Minguo Sichou Shi* (History of silk in the Republic Era) (Beijing: China Textile Publishing House, 1995), pp. 10, 49; and Y. Robert Eng, *Economic Imperialism in China: Silk Production and Exports, 1861–1932* (Berkeley: University of California Press, 1986), p. 136.

nological diffusion by designating model districts across the region. In 1934, the government founded a national level sericultural research and improvement organization.[50]

The outcome was a 1930s Lower Yangzi catch-up with Japan that was nothing short of remarkable. Figure 2 plots the Lower Yangzi diffusion curve for the scientifically improved variety, mostly of the F_1 types. For Jiangsu province, the percentage of scientifically produced silkworm eggs increased from 5% to almost 100% within only 5–7 years. Diffusion lagged somewhat in Zhejiang, but the overall rate of diffusion in the Lower Yangzi in the 1930s was comparable to the Japanese diffusion of the F_1 hybrids in the 1910s and 1920s.

Following the Japanese method of artificial hatching, Jiangsu province took the leadership in rearing fall silkworms. In 1935, the ratio of fall crops to total crops was 42% for Jiangsu and 18% for Zhejiang province.[51]

The distinctive imprint of Japanese technology and institutions on the

Lower Yangzi path of catch-up was unmistakable. This came about by no accident but was the outcome of 2 decades of conscious Japanese learning on the part of Chinese sericulturalists and later the Wuxi entrepreneurs. Lower Yangzi's success in a near full-scale transplantation of the Japanese sericultural model attests to the binding power of comparable conditions of factor endowments and a common cultural and technological heritage between the two regions. It also bears witness to the early twentieth-century momentous reversal of the historical direction of knowledge transfer between these regions from the premodern era.[52]

Cocoon output and raw silk exports from the Lower Yangzi increased in 1935 and 1936. Equipped with the newly imported Japanese reeling technology, raw silk by Yongtai conglomerate cut into the U.S. silk stockings market, formerly the exclusive territory of the giant Japanese high-quality raw silk producers such as Katakura and Gunze.

The positive developments centered around Wuxi sent alarms to the Japanese competitors. Despite its global dominance in the 1930s, Japanese competitiveness in this labor-intensive product was rapidly eroding due to rising labor costs brought about by decades of economic growth. The massive outflow of Japanese technology was only chipping away at its last line of defense.[53] Therefore, the 1930s Lower Yangzi catch-up was riding the historical shifting tides of dynamic comparative advantage, only to be abruptly brought to a halt by Japan's full-scale invasion of China in 1937.

IV. Conclusion

Around the middle of the nineteenth century when Western imperialism opened up East Asia, China, by all measures of comparative advantage, seemed set on a course of regaining its historical supremacy in the global silk market. Instead, the 6 decades to follow were to witness the rise of Japan against all odds.

This article demonstrates that induced technological and institutional innovation brought Japanese sericulture decisive productivity advantages over that of the Lower Yangzi, the key to its dominance in the twentieth-century global raw silk market. It further argues that the rise of induced innovation in Japan and its absence in the Lower Yangzi during this period has to be analyzed in the context of the two countries' contrasting ideological and political responses to the mid-nineteenth-century Western imperialist challenge, leading to economic policies drastically different in the provisioning of public goods, the structuring of economic incentives, and the alignment of interest groups. Therefore, the case of the Lower Yangzi's remarkable convergence to Japan in the 1930s was as much in the areas of technology and commercialization as in ideology.

This, however, begs the larger question: why, when confronted with the same Western challenge, had Japan's ideological or cognitive switch been earlier and more decisive? This is a question of enormous import to our understanding of economic development that would call upon a much more comprehensive and multidisciplinary approach than the scope of this article allows.

This comparative analysis contributes both a historical and an East Asian perspective to the theory of induced innovation. In Japan and the Lower Yangzi, the development of technology biased toward using labor and saving capital and land as a response to the rising labor-land ratio had been a long-standing tradition traceable to Tokugawa Japan and Southern Song China (1127–1279).[54] Even in the twentieth century, the two Japanese epochal technical innovations in crossbreeding and summer and fall crops were ancient in origin but achieved fundamental breakthroughs with the infusion of modern science, the establishment of a national diffusion network, the build-up of modern physical and social infrastructure, and the rise of new systems of production and distribution.

Clearly, what set the Japanese induced innovation in the modern era apart from that of the premodern is not its direction of technical bias but, rather, its sharply accelerated pace of technical progress due to the availability of the newly supplied public or social capital to create economy-wide externalities. While some of these externalities, as shown by the Japanese experience, can be partially internalized by the large and integrated reeling firms that acted as powerful agents of change, such a possibility was stymied in the Lower Yangzi—the growth of its mechanized reeling industry was both belated and geographically removed from the rural sector as a consequence of China's fragile legal environment for the private sector.

Judged in this light, the late nineteenth-century and early twentieth-century growth record of the Lower Yangzi sericulture was quite impressive and historically unprecedented if measured by the standards of the sixteenth and seventeenth centuries, when Chinese raw silk still reigned supreme globally. It pales in comparison to Japan only in its fast track of modern economic growth.

Finally, this article also sheds light on the ongoing historical debate on China related to the so-called Needham puzzle—why China, with its significant scientific achievements and relatively flexible economic institutions, failed to become the first country to industrialize. The related grand hypotheses ranging from "high level equilibrium trap" to "involution" and to the recent California school's resource constraint argument, all grounded in some form of resource and factor endowment explanation seem to have neglected the important lesson from Japan's rapid industrialization in the twentieth century in the face of overpopulation, labor abundance, and resource scarcity.[55] Openness, by which I mean not only opening the country to trade, but also opening the minds of its populace, clearly matters.

Data Appendix

I. Averages of Nominal Input and Cocoon Price Indices for Japan and the Lower Yangzi

	The Lower Yangzi					Japan				
	Labor	Land	Capital (Draft Animal)	Input (Bean Cake)	Cocoon	Labor	Land	Capital	Input (Fertilizer)	Cocoon
1901–9	100	100	100 (1906)	100	100	100	100 (1903)	100	100	100
1910–19	169	152	149	109	98	173	200	140	127	118
1920–28	220	197	202	130	119	369	369	261	173	215

Sources.—For the Lower Yangzi, the cocoon price in Wuxi: for 1901–20 it is from Katsuhiko Ikawa, *Kindai Nihon Seishigyo to Mayu Seisan* (Modern Japanese silk-reeling industry and cocoon production) (Tokyo: Tokyo Economic Information, 1998), table 2, pp. 304–5; for 1920–24, it is converted from Shigemi Uehara, *Shina Sanshigyo Taikan* (Overview of the Chinese silk sector) (Tokyo, 1929), p. 225. Data for 1925–27 are unavailable; I projected them from the 1924 cocoon price level using the 1925–27 market price of raw silk. The 1927–29 cocoon price is from Jing-Yu Gao and Xue-xi Yan, *Jindai Wuxi Cansi Ye Ziliao Xuanji* (Selected materials on the modern silk industry and sericulture) (Jiangsu People's Press and Jiangsu Classics Press, 1987), pp. 88–89. The market price of raw silk in Shanghai is from D. K. Lieu, *The Silk Industry of China* (Shanghai, Hongkong, and Singapore: Kelly & Walsh), appendix, table 4. The original 1912 price for fresh cocoons in Ikawa is 24, which seems implausibly low. I adjusted it to 28.5 using the cocoon price in Ziyu Chen, *Jindai Zhongguo de Zisi Saosi Gongye, 1860–1945* (The silk industry of modern China, 1860–1945) (Taipei: Institute of Modern History, Academia Sinica, 1989), p. 62. The farm wage index, land price index, and farm animal price index in the Lower Yangzi are from John Buck, *Land Utilization in China* (Nanjing: University of Nanking, 1937), vol. 3, table 5, pp. 151–52, table 10–1, p. 168, and table 6, p. 153. The soybean cake price is from Liang-lin Hsiao, *China's Foreign Trade Statistics, 1864–1949* (Cambridge, Mass.: Harvard University Press, 1974), pp. 80–81. There were no consistent long-term price series data for fertilizer and capital stock in the Lower Yangzi; I used the prices of bean cake and draft animals as proxy prices. None of these two inputs were used on a large scale in the Lower Yangzi, and their inclusion could lead to possible biases in TFP. Considering that their share is relatively small (12% and 18%), the biases may not be so serious and could potentially offset each other. Japanese cocoon price, land price, current input, and capital prices are from M. Umemura, S. Yamada, Y. Hayami, N. Takamatsu, and M. Kumazaki, *Agriculture and Forestry*, vol. 9, *Estimates of Long-Term Economic Statistics of Japan since 1868* (Tokyo: Toyo Keizai Shinposha, 1966), col. 11 of table 7, cols. 3 and 13 of table 34, and col. 6 of table 31.

Note.—Numbers in parentheses indicate the earliest available data.

II. Lower Yangzi Silk Yield Data

The following table from Shigemi Uehara, *Shina Sanshigyo Taikan* (Overview of the Chinese silk sector) (Tokyo, 1929), p. 225, is the Wuxi silk yield data in kilograms of dried cocoons required to produce 100 kilograms of raw silk.

Year	Before 1916	1916	1917	1918	1919	1920	1921	1922	1923	1924
Wuxi	520	550	510	560	620	600	670	590	680	620

Uehara also listed silk yields of three other sericultural districts in the Lower Yangzi. They all showed a declining trend similar to that in Wuxi.

Silk yield in the 1900s and the early 1910s was around 500. For 1903, see Kizo Minemura, *Shinkoku Sansigyou Sisatu Fukumeisho* (Survey report on the Chinese silk sector) (Tokyo: Ministry of Agriculture and Commerce, 1900), p. 148; and for 1910, see Kouhisa Ootori, *Shina Seijyou no Kenkyuu* (Tokyo: Houbunsha, 1919), pp. 177–78. Various reports confirm that by the late 1920s and early 1930s, it had become a standard practice in the Lower Yangzi to use 620–50 for cocoon silk conversion; Jing-Yu Gao and Xue-xi Yan, *Jindai Wuxi Cansi Ye Ziliao Xuanji* (Selected materials on the modern silk industry and sericulture) (Jiangsu People's Press and Jiangsu Classics Press, 1987), p. 75; Saiichi Benno, "Chugoku No Nogyo Kindaika Ni Taisuru Teiko" (Resistence toward Chinese agricultural modernization), *Shakai Keizai Shigaku* 59, no. 2 (1993): 30–59, esp. pp. 32, 43.

For computing the TFP, I used the Wuxi silk yield. For 1903 and 1910, I used the silk yield of 500. Linear interpolation is applied for the interval years between 1903 and 1916. For silk yields after 1924, the averages of 1920 through 1924 are used.

Notes

* For comments and suggestions, I thank Robert Gallman, Paul Rhode, Miles Fletcher, Takeshi Abe, Loren Brandt, Yoshihisa Godo, Yujiro Hayami, Ryou Kambayashi, Paul Kandasamy, Christopher Isett, Akinobu Kuroda, Yukihiko Kiyokawa, Angus Maddison, Ramon Meyers, Konosuke Odaka, Keijiro Otsuka, Jan Pieter Smits, Osamu Saito, Bart van Ark, and Claudio Zanier as well as the participants of seminars at Hitotsubashi University, Tokyo University, University of Groningen in the Netherlands, Washington University, and University of Toronto. My thanks also go to D. Gale Johnson and to a referee of this journal. Research grants from the Japan Society for the Promotion of Science, University of Missouri at St. Louis, and Foundation for Advanced Studies on International Development are gratefully acknowledged. I alone am responsible for all errors.

1. Lillian Li, *China's Silk Trade: Traditional Industry in the Modern World, 1842–1937* (Cambridge, Mass.: Harvard University, Council on East Asian Studies, 1981), p. 77; Ippei Yamazawa and Yuzo Yamamoto, *Estimates of Long-Term Economic Statistics of Japan since 1868* (Tokyo: Toyo Kiezai Shinposha, 1979), 14:5. Globally, the combined exports of China, Japan, and Italy consistently accounted for more than three-fourths of world raw silk trade.

2. See Giovanni Federico, *An Economic History of the Silk Industry* (Cambridge: Cambridge University Press, 1997), chap. 3, p. 36, table 3.4; p. 200, table AIII.

3. Except for Lillian Li's "Silks by Sea, Trade, Technology and Enterprise in China and Japan," *Business History Review* 56 (1982): 192–217, and Yukihiko Kiyokawa's "Senzen Chugoku No Sanshi-gyo Ni Kansuru Jyakkan No Kousatsu" (A few observations on the prewar Chinese silk sector), *Keizai Kenkyu* 26, no. 3 (July 1975): 240–55, most studies as seen in the references usually focus either on China or Japan. Federico's work covers the global raw silk industries.

4. The Lower Yangzi region, located in the central eastern part of China, consists of the provinces of Jiangsu, Zhejiang, and Anhui. The average size of a sericultural farm in Japan was about 0.5 acre in the 1900s and 0.7 acre in the 1920s. For the Lower Yangzi, the average size was a little less than 0.5 acre in the early 1930s. For Japan, see Shozaburo Fujino, Shiro Fujino, and Akira Ono, *Estimates of Long-Term Economic Statistics of Japan since 1868* (Tokyo: Toyo Keizai Shinposha, 1979), 11: 151. For the Lower Yangzi, see Toua Kenkyujyo, *Keizai ni Kansuru Shina Kanko*

Chosa Houkokusho (Investigative report on Chinese customs related to economic activity) (Tokyo: Toa Kenkyuu Jyo, 1944), pp. 26–28. In this study, I did not specifically include another major export-oriented silk-producing region, the Guangdong province in southern China. The subtropical Guangdong reared the multivoltine type of silkworms that could hatch and spin cocoons five or six times a year. The quality of Guangdong raw silk was inferior, and possibilities for technological transferability from the temperate zones were also more limited.

5. Yujiro Hayami and Vernon Ruttan, *Agricultural Development: An International Perspective* (Baltimore: Johns Hopkins University Press, 1985).

6. For Japanese cocoon output data, see Fujino, Fujino, and Ono, table 57, col. 5. For the Lower Yangzi, see Y. Robert Eng, *Economic Imperialism in China: Silk Production and Exports, 1861–1932* (Berkeley: University of California Press, 1986), table 2.7, p. 35.

7. The Japanese data are from Fujino, Fujino, and Ono, pp. 306–7. Data for the Lower Yangzi delta in the late 1920s were based on the following sources: Toua Kenkyujyo, pp. 27–28; Shigemi Uehara, *Shina Sanshigyo Taikan* (Overview of the Chinese silk sector) (Tokyo: Ogada Nichieido, 1929), pp. 132–33; Su-Ping Yue, *Zhongguo Cansi* (Chinese silk) (Shanghai: World Press, 1935), pp. 169–70; and Ziyu Chen, *Jindai Zhongguo de Zisi Saosi Gongye, 1860–1945* (The silk industry of modern China, 1860–1945) (Taipei: Institute of Modern History, Academia Sinica, 1989), pp. 68–69.

8. Uehara's book, totaling over 1,000 pages, was an encyclopedic coverage of the Chinese silk sector, based on 5 years of travel through 18 provinces. For details on silk yield data by Uehara, see the data appendix.

9. Federico did a primal input-output-based TFP calculation for Japanese sericulture from about 1890 to 1929 using only land and labor as inputs. His estimate of annual TFP growth of 2.6% (for the spring crop only), ignoring other inputs such as fertilizer and equipment that grew much faster than land and labor, represents an overestimate (Federico, p. 85). This lends further support to my 2.05% price dual TFP estimate based on a more complete coverage of inputs.

10. See Marius B. Jansen, *The Making of Modern Japan* (Cambridge, Mass.: Harvard University Press, 2000), p. 355.

11. For the Tongji Restoration, see Mary Wright, *The Last Stand of Chinese Conservatism: The T'ung-Chih Restoration, 1862–1887* (Stanford, Calif.: Stanford University Press, 1962). For the Self-Strengthening Movement, see chaps. 9 and 10 in John K. Fairbank, ed., *The Cambridge History of China*, vol. 10, *Late Ch'ing, 1800–1911*, pt. 1 (Cambridge: Cambridge University Press, 1978). For the Late Qing reform, see chaps. 5 and 7 in John K. Fairbank and Kwang-ching Liu, *The Cambridge History of China*, vol. 11, *Late Ch'ing, 1800–1911*, pt. 2 (Cambridge: Cambridge University Press, 1980). Tomoo Suzuki, *Yo Mu Undou No Kenkyu* (A study of the westernization movement in China) (Tokyo: Kyuko Shoin, 1992). For Japan, see Thomas Smith, *Political Changes and Industrial Development in Japan: Government Enterprise, 1868–1880* (Stanford, Calif.: Stanford University Press, 1955.

12. For Chinese influence on Japanese sericultural technology, see Tosio Furushima, *Furushima Tosio Cyosakusyu* (Collected works of Tosio Furushima) (Tokyo: University of Tokyo Press, 1975), 5:384; 6:630. Zenjirou Inoue, "Yousan Gijutus no Tenkai to Sansho" (Sericultural technique and manuals), in *Nihon Nousho Zenshuu*, ed. Nousan Gyouson Bunka Kyoukai (Tokyo: Nousan Gyosan Bunkka Kyoka, 1976), 35:465–70. For pre-Meiji Japan's relative position in sericultural technology, see L. Li (n. 3 above); and Kanji Ishii, *Nihon SanshiGyo Shi BunSeki* (Analysis of Japanese silk industry) (Tokyo: Toyo Keizai Shinpousha, 1972), p. 374.

13. Editorial Committee of Japanese Silk History, *Nihon Sanshigyousi* (History of Japanese sericulture and reeling) (Tokyo: Japanese Sericulture and Silk Association, 1935), 4:282; 3:503, and 3:219. For Sasaki's visit, see Istituto Bacologico Sperimentale

di Gorizia, *Annuario dell' Istituto Bacologico Sperimentale di Gorizia, Seitz* (Gorizia, 1874), p. vi.

14. In the 1880s, Paul Brunat, the French silk-reeling expert and entrepreneur who had helped found Japan's large-scale government-run Tomioka Silk Reeling plant in the 1870s, was the manager of an American-funded silk-reeling plant in Shanghai. In 1886, when Li Hongzhang, the leader of the Self-Strengthening Movement, visited his factory, Brunat made a direct appeal for the need of introducing microscopic examination in China. Brunat's appeal, reported in the Shanghai newspapers but clearly ignored by Li and others, caught the attention of Japanese bureaucrats at the Ministry of Agriculture and Commerce, who translated this news piece into Japanese. Alarmed by the potential possibility of silkworm disease in Japan, technicians at the ministry conducted microscopic examinations on silkworm eggs in Japan, only to be shocked by the prevalence of disease already in Japan. This finding, according to these bureaucrats, was one important reason behind the promulgation of the Silkworm Disease Prevention Law in Japan in that year. See *Dai Nippon Sanshi Kaihou* (Report of the Sericultural Association of Japan), no. 178, March 20, 1907, p. 39. Also see Kazuko Furuta, "Kindai Seishigyou No Douryu to Kounan Shakai no Taiou" (The introduction of modern sericulture and the response of Jiangnan society), in *Kindai Nihon to Ajia* (Modern Japan and Asia), ed. Hirano Keniichirou (Tokyo: University of Tokyo Press, 2000), p. 96.

15. This Chinese translation of this Italian sericulture book by Vincenzo Dandolo can be found at the East Asia Library of the Hoover Institute at Stanford University. I thank Claudio Zanier for the information on Dandolo. For John Fryer, see Fairbank (n. 11 above), 10, pt. 1: 536. For the tradition of Japanese directly translating Chinese and Western works (especially in the Dutch Studies period in Tokugawa) and the contrasting tradition of Chinese intellectuals dependent on Western scholars' oral interpretation of Western works in Ming and Qing, see chap. 8 of Tingjiu Li and Atsushi Yoshida, *Zhongre Wenhua Jaoliu Shi Dashi: Keji Juan* (History of Sino-Japan cultural exchange: Science) (Hangzhou: Zhejiang People's Publishing, 1996).

16. See Nakajiro Takatsu, *Shinkoku Sanshigyo Shisatsu Houkokushou* (Reports on China's sericultural sector) (Tokyo: Ministry of Agriculture and Commerce, 1898), p. 16; Zenshino Oishi, *Shinkoku Kouso Sekko Ryoushou Sanseishi Chousahoukokusho* (Survey reports on the silk sectors of Jiangsu and Zhejiang provinces) (Tokyo: Tokyo High School of Commerce, 1908), p. 8. Hitosi Matunaga, *Shinkoku SanGyo Sisatsu Fukumeisho* (Survey report on Chinese sericulture) (Tokyo: Ministry of Agriculture and Commerce, 1898), pp. 3–5.

17. It is worthwhile to note that Europe had for long sought East Asian sericultural technology, whose global leadership may have been maintained as late as the eighteenth century. This European quest culminated in the publication of two translated works of Chinese and Japanese sericultural texts in 1837 and 1848. See Claudio Zanier, *Where the Roads Met: East and West in the Silk Production Processes (17th–19th Century)* (Kyoto: Italian School of East Asian Studies, 1994), pp. 71–94.

18. Lab tests confirmed that the F_1 variety shortened the rearing period, produced longer fibers, yielded fewer defective cocoons, and was better suited to the demands of machine reeling. See Yukihiko Kiyokawa, *Nihon No Keizai Hatten To Gijutsu Fukyu* (Japanese economic development and technological diffusion) (Tokyo: Toyo Keizai Shinpousha, 1995), pp. 91–92.

19. Yukihiko Kiyokawa, "The Diffusion of New Technologies in the Japanese Sericulture Industry: The Case of the Hybrid Silkworm," *Hitotsubashi Journal of Economics* 25 (1984): 31–59, pp. 37–38.

20. For a diffusion curve, see Kiyokawa, "The Diffusion of New Technologies in the Japanese Sericulture Industry." The diffusion of the F_1 variety led to the standardization of silkworm egg varieties used nationally and thus to more uniform types of raw silk, a feature highly favored by the increasingly mechanized U.S. market. For

the growing importance and eventual dominance of the U.S. market for raw silk in the twentieth century, see Debin Ma, "The Modern Silk Road: The Global Raw-Silk Market, 1850–1930," *Journal of Economic History* 56, no. 2 (1996): 330–55.

21. Zhu Xin-yu pointed out a method of artificially prolonging the silkworm egg hibernation period in low temperature recorded in a Chinese sericultural manual dated 1273 A.D.; see Xin-yu Zhu, *Zhong Guo Si Chou Shi* (History of Chinese silk) (Beijing: Textile Publishing, 1992).

22. For a linear-programming-based study analyzing the gains of allocative efficiency from summer and fall crops, see the work by Le Thanh Nghiep and Yujiro Hayami included as chap. 6, "The Tradeoff between Food and Industrial Crops: Summer-Fall Rearing of Cocoons," in *The Agricultural Development in Modern Japan: A Century's Perspective*, ed. Yujiro Hayami and Saburo Yamada (Tokyo: University of Tokyo Press, 1991), pp. 175–98.

23. For the cumulative improvements of the Lu mulberry trees in the Lower Yangzi over almost a millennium, see chap. 4 of Fagen Ji, ed., *Shichou zi Fu Huzhou yu Sichou Wenhua* (Silk city Huzhou and silk culture) (Beijing: China International Broadcasting Publishing House, 1994). As European sericulturalists had long learned about and experimented with the Lu variety in Europe (which they named the "Philippine variety"); see Zanier, p. 74. Sasaki himself recalled that he owed his knowledge of the Lu tree to the works of Kaibara Ekiken (1630–1714), Tokugawa Japan's foremost scholar on the philosophy of Confucius and on Chinese botany. See *Dai Nippon Sanshi Kaihou* (Reports of the Sericultural Association of Japan), no. 176 (1907), pp. 24–26; Editorial Committee (n. 13 above), 4:80; and Zanier, p. 74. For the advantages of the stem-pruning technique, see Katsuhiko Ikawa, *Kindai Nihon Seishigyo to Mayu Seisan* (Modern Japanese silk-reeling industry and cocoon production) (Tokyo: Tokyo Economic Information, 1998), chap. 3.

24. For the stem-pruning method in China, see Jiamian Liang, ed., *Zhongguo Nonye Kexue Jishu Sigao* (History of Chinese agricultural science and technology) (Beijing: Agricultural Publishing, 1989), pp. 219–20. For the bush type of mulberry trees in Guangdong province, see C. P. Howard and K. P. Buswell, *A Survey of the Silk Industry of South China* (Canton, 1925), chap. 3.

25. Other commercial fertilizers used were fish cakes and, later, modern chemical fertilizer; see Ikawa, chap. 8; and Hayami and Yamada, eds., chap. 4.

26. For soybean in the Lower Yangzi, see Keiji Adachi, "Daizukasu Ryutsuu to Shindai no Shougyouteki Nougyo" (Distribution of soybean cake and the commercialization of Qing agriculture), *Touyoushi Kenkyu* 37, no. 3 (1978): 35–63. For Japan's internal transportation and distribution improvements and the activities of large Japanese shipping companies and trading houses, such as Mitsui and Mitsubishi in Manchuria, see Ikawa, chap. 8.

27. Data on the ratio of the summer and fall crops in 1880–89 are from Kiyokawa, *Nihon No Keizai Hatten To Gijutsu Fukyu* (Japanese economic development and technological diffusion), pp. 60–62. The rest is from Fujino, Fujino, and Ono (n. 4 above), vol. 11, table 57, cols. 6, 7. The Lu type and its close relatives represented the single most important variety, accounting for one-fifth of mulberry acreage in Japan by 1920. Lu trees also crossed with other varieties and could use different names. Besides Lu, Meiji Japan introduced other varieties of mulberry from other sericultural regions in China as well as other parts of the world, including Italy, India, and South America. By the 1910s and 1920s, the stem-pruned type of mulberry tree formed about 60% of all mulberry trees in Japan. By the 1920s, almost 70% of the mulberry fields in Japan could supply leaves for both the spring and fall crops in a year. See Editorial Committee, 4:14, and 4:105–13; Ikawa, chap. 3; and Fujino, Fujino, and Ono, 11:155.

28. Ikawa, pp. 227–31.

29. For Chinese mulberry yield, see ibid., p. 231; Yue (n. 7 above), pp. 19, 71;

Jing-Yu Gao and Xue-xi Yan, *Jindai Wuxi Cansi Ye Ziliao Xuanji* (Selected materials on the modern silk industry and sericulture) (Jiangsu People's Press and Jiangsu Classics Press, 1987), pp. 10–11; Shanghai International Testing House, *A Survey of the Silk Industry of Central China* (Shanghai, 1925), pp. 88, 92. The Gunma and Nagano yield are from Ikawa, pp. 230–31. Japanese national average yield in the 1920s is from Editorial Committee (n. 13 above), 4:319–20. For the Lower Yangzi share of summer and fall crops in the 1910s and 1920s, see Ikawa, p. 225; and Toua Dobun Kai, *Shina Nen Kan* (China annals) (Tokyo: Toua Dobun Kai, 1917 and 1919).

30. The narrative so far is based on Ishii (n. 12 above), pp. 397–405; and Masaki Nakabayashi, "Seishi Gyo no Hattatsu to Kansen Tetsudo" (Development of silk reeling and main rail lines), in *Meiji no Sangyo Hatten to Shakai Shihon*, ed. Naosuke Takamura, Meiji Industrial Development and Social Capital (Tokyo: Minerva, 1997).

31. Ishii (n. 12 above), pp. 423–29.

32. For the troubles of modern silk-reeling factories in Shanghai, see Suzuki (n. 11 above), pp. 325–33. The fragility of private enterprise in nineteenth-century China can best be illustrated by the fate of an indigeneous modern private silk-reeling industry in rural Guangdong. The mechanized silk-reeling factories, set up by an overseas Chinese merchant in 1872, grew rapidly within a few years but were faced with riots from traditional silk weavers and subsequently ordered to close by the local magistrate. See Debin Ma, "Europe, China and Japan: Transfer of Silk Reeling Technology in 1860–95," in *Asia Pacific Dynamism, 1550–2000,* ed. A. J. H. Latham and Heita Kawakatsu (London: Routledge, 1998).

33. Xin-wu Xu, ed., *Zhongguo Jindai Saosi Gongyeshi* (Modern history of Chinese silk-reeling industry) (Shanghai: People's Publishing House, 1990), p. 615.

34. Under the treaty system, steamship companies were allowed to ply the Yangzi river and the coast but not the inner rivers or canals. The government did compromise in 1889 to grant the use of steamers in towing traditional boats in 1889; Suzuki (n. 11 above), p. 347.

35. For commercial organization in Qing China, see Susan Mann, *Local Merchants and the Chinese Bureaucracy, 1750–1950*, (Stanford, Calif.: Stanford University Press, 1987); for cocoon hangs, see L. Li (n. 1 above), pp. 176–85; Saburo Soda, *Chugoku Kindai Seishi Gyo Shi No Kenkyu* (Study on the modern Chinese silk industry) (Tokyo: Kyuko Shoin, 1994), pp. 389–404; Gao and Yan, pp. 18–19.

36. Soda, p. 417.

37. See chap. 4 of Lynda Bell's *One Industry, Two Chinas: Silk Filatures and Peasant-Family Production in Wuxi County, 1865–1937* (Stanford, Calif.: Stanford University Press, 1999); Suzuki, p. 406; Soda, pp. 416–22.

38. Soda, pp. 423–44; and Bell, pp. 79–80. The average metric tons of annual cocoons shipped from the sericultural regions in the Lower Yangzi to Shanghai in the period of 1900–1909 were 9,767. This number increased to 21,303 tons for 1910–19 but only to 27,152 tons for 1920–28. See Uehara (n. 7 above), pp. 227–28 for 1913–28; and Akira Sitou, *Shinkoku Sansigyou Ippan* (An examination of the Chinese silk sector) (Tokyo: Raw Silk Inspection Bureau of Ministry of Agriculture and Commerce, 1911), pp. 120–22 for 1898–1911.

39. For Qing's fiscal system, see Yeh-chien Wang, *Land Tax in Imperial China, 1750–1911* (Cambridge, Mass.: Harvard University Press, 1993); Bell, pp. 83–87; Mann.

40. Bell, p. 82; and Soda, p. 427. The cocoon hang system had a control of about 40%–60% of all total cocoons sold in the Lower Yangtze. Federico (n. 2 above), pp. 148–49.

41. There were systematic efforts by the farmers to mix inferior quality cocoons with better quality cocoons; see L. Li (n. 1 above), p. 185; and Soda, pp. 433–44.

42. For an English-language account of the rise, fall, and revival of the merchant guild system (Kabu Nakama) in the Tokugawa period, see Charles Sheldon, *The Rise*

of the Merchant Class in Japan, 1600–1868 (New York: Augustin, 1958). For the Meiji abolishment of guilds, see Ryousuke Ishii, *Houseishi* (Legal history) (Tokyo: Yamagawa Publishing, 1965), p. 261.

43. Ishii (n. 12 above), pp. 57–83, 429. Among the eight variables used in Kiyokawa's probit regression, the subcontractual direct purchase system was the leading variable in explaining the rapid diffusion of the F_1 variety (Kiyokawa, "The Diffusion of New Technologies in the Japanese Sericulture Industry" [n. 19 above], p. 47).

44. For efficiency gains from commercialization in twentieth-century China, see Earnest Liang, "Market Accessibility and Agricultural Development in Prewar China," *Economic Development and Cultural Change* 30, no. 1 (October 1981): 77–105; and Loren Brandt, *Commercialization and Agricultural Development: Central and Eastern China 1870–1937* (Cambridge: Cambridge University Press, 1989).

45. Hayami and Yamada ([n. 22 above], chaps. 5 and 6) conducted counterfactual statistical analysis on what the performance of Japanese agriculture would have been like had developments in commercial fertilizer and summer and fall crop not occurred. Had Hayami conducted a comparative study of China and Japan, he would have felt less need for his counterfactual exercise. The Lower Yangzi sericulture unfortunately supplied exactly the factual side of Hayami's counterfactual of Japanese agriculture in the early twentieth century.

46. Zhuang-Mu Wang, ed., *Minguo Sichou Shi* (History of silk in the Republic Era) (Beijing: China Textile Publishing House, 1995), pp. 45–46, 87. For a list of sericultural texts, see Zhu (n. 21 above), app. 1. For the growth of modern academic communities and institutions after the twentieth century, see chap. 8 of John Fairbank and Albert Feuerwerker, *The Cambridge History of China*, vol. 13, *Republican China, 1912–1942*, pt. 2 (Cambridge: Cambridge University Press, 1986).

47. It is important to note that the emergence of the Suwa district as Japan's premium silk-reeling production center was the spread of modern banking and other service facilities throughout Japan in the nineteenth century. See Ishii (n. 12 above), chap. 2. For banking and service developments in Wuxi, see Chen (n. 7 above), chap. 2; and Gao and Yan (n. 29 above).

48. Mann argued that tax-farming practices did not disappear but were taken over by specialized tax-farming agents (Mann, n. 35 above), chap. 9.

49. See Toua Kenkyujyo (n. 4 above), pp. 63–69; Gao and Yan, pp. 305–8.

50. Tetsu Okumura, "Kyoko Ka Kosetsu Sanshigyo no Saihen" (Restructuring of the Jiangsu and Zhejiang silk industry under the Great Depression), *Toyoshi Kenkyu* 37, no. 2 (1979): 80–116; Saiichi Benno, "Chugoku No Nogyo Kindaika Ni Taisuru Teiko" (Resistence toward Chinese agricultural modernization), *Shakai Keizai Shigaku* 59, no. 2 (1993): 30–59; Zhuang-Mu Wang (n. 46 above), pp. 64–86.

51. For a penetrating analysis of factors accounting for the lag in diffusion of the improved variety in Zhejiang, see Benno. The ratio of fall crops is calculated from Toua Kenkyujyo (n. 4 above), p. 298.

52. Although European and American individuals and organizations also made positive contributions to sericultural improvements, the Japanese model eventually took dominance in the Lower Yangzi, as confirmed by the large number of sericultural reformers holding Japanese degrees, direct participation of Japanese specialists in Lower Yangzi sericultural schools, and extensive introductions of Japanese sericultural technology in journals and books in the 1920s and 1930s. See Kazuko Furuta, "Technology Transfer and Local Adaptation: The Case of Silk-Reeling in Modern East Asia" (Ph.D. diss., Princeton University, 1988), pp. 117–82; and Zhuang-Mu Wang (n. 46 above). For a description of Chinese copying the Japanese model of reform, see Douglas Reynolds, *China, 1898–1912: The Xinzheng Revolution and Japan* (Cambridge, Mass.: Harvard University Press, 1993).

53. For cocoon output and raw silk exports, see Chen, p. 109; and Okumura.

For imports of Japanese silk-reeling technology in Wuxi and Yongtai's marketing activities in the United States, see Gao and Yan, pp. 325–29, 362–64. For Japanese investigators' warnings of the Lower Yangzi competition in the 1930s, see Benno, pp. 32, 39.

54. Francesca Bray, *Science and Civilisation in China*, vol. 6, *Biology and Biological Technology, Part II: Agriculture* (Cambridge: Cambridge University Press, 1984), pp. 609–10.

55. For a recent debate on this issue, see the articles that appeared in *Journal of Asian Studies* 61, no. 2 (May 2002): 501–663.

THE
ECONOMIC HISTORY REVIEW

Economic History Review, 62, 2 (2009), pp. 279–305

Lancashire, India, and shifting competitive advantage in cotton textiles, 1700–1850: the neglected role of factor prices[1]

By STEPHEN BROADBERRY and BISHNUPRIYA GUPTA

In the early eighteenth century, wages in Britain were more than four times as high as in India, the world's major exporter of cotton textiles. This induced the adoption of more capital-intensive production methods in Britain and a faster rate of technological progress, so that competitive advantage had begun to shift in Britain's favour by the late eighteenth century. However, the completion of the process was delayed until after the Napoleonic Wars by increasing raw cotton costs, before supply adjusted to the major increase in demand for inputs.

During the early modern period, India was the world's main producer of cotton textiles, with a substantial export trade. Indian textiles were exported to Britain on a large scale from the seventeenth century.[2] By the early nineteenth century, however, Britain had become the world's most important cotton textile producer, dominating world export markets, and even exporting to India.[3] This dramatic change in international competitive advantage, which must surely rank as one of the most important developments of the industrial revolution period, is often described entirely in terms of developments within Britain, without any reference to India, and with little or no reference to factor prices.[4] This paper attempts to redress the balance.

This paper links the development of the Lancashire cotton textile industry during the industrial revolution to factor price developments in Britain and India. The import substitution emphasized by Inikori is characterized as a two-stage process: first, a shift from production using traditional skills to production with machine-intensive technology; second, a faster rate of innovation in the machine-intensive technology.[5] The process was begun and sustained by a major difference in factor prices between Britain and India, with wages in Britain being much

[1] We are grateful to Huw Bowen and Sumit Guha for making unpublished data available to us. We would also like to thank Bob Allen, Maxine Berg, Nick Crafts, George Grantham, Santhi Hejeebu, Frank Lewis, Jonas Ljungberg, Patrick O'Brien, Richard Sutch, and seminar/conference participants at Berlin, Granlibakken (Clio), Kingston, Leicester (Economic History Society), Madrid, Montreal, Oxford, Utrecht (Global Economic History Network), Venice, and Warwick, for helpful comments and suggestions. The financial support of the European Commission Marie Curie Actions (contract no. MRTN-CT-2004-512439) and the ESRC (grant no. R000239492) is gratefully acknowledged.

[2] Baines, *History*, pp. 55–83; Robson, *Cotton industry*, p. 1.

[3] Ellison, *Cotton trade*, pp. 57–70; Robson, *Cotton industry*, pp. 1–3.

[4] Ellison, *Cotton trade*, pp. 14–70; Landes, *Unbound Prometheus*, pp. 82–8; Rose, *Firms*, pp. 22–37.

[5] Inikori, *Africans*, pp. 427–51.

higher during the eighteenth century.[6] This idea of factor price differences driving technological choice is well established in accounts of American industrial development during the nineteenth century. The argument is most closely associated with the work of Rothbarth and Habakkuk, who emphasized the role of land abundance in creating a labour shortage in the New World, and hence higher wages in the United States compared with Britain.[7] Faced with high labour costs, American entrepreneurs developed a more capital-intensive technology with higher labour productivity.[8]

Mokyr writes, after a discussion of the Habakkuk debate, that 'Most of the debate is carried out in the context of Anglo-American differences, with Britain, interestingly enough, considered the *low-wage* economy (though in the period of the Industrial Revolution it would, relative to the rest of Europe, be the high-wage economy). A comparison between Britain and the Continent during the Industrial Revolution would be worthwhile, but so far has not been attempted seriously'.[9] In fact, a wider comparison of the international wage differences suggests a much stronger *prima facie* case for factor prices playing an important role in the case of eighteenth-century Britain and India. As early as the seventeenth century, an unskilled labourer earned four to five times as much in Britain as in India.[10] In the middle of the nineteenth century, an unskilled labourer earned less than twice as much in America as in Britain.[11] Similarly, the British unskilled silver wage during the second half of the eighteenth century was also less than twice as high as in much of western Europe.[12] The Anglo-Indian factor price comparison is of particular importance in cotton textiles, where India was Britain's major competitor. Chaudhuri hints at the effect of factor prices on the choice of technique, but without really developing the argument. After noting that 'English labour was a great deal dearer than Indian', he goes on to argue that 'It is perhaps not entirely a chance occurrence that the large-scale application of machinery to the production process happened in the textile industry in England'.[13]

One reason for the neglect of factor prices in the history of the cotton industry is thus that the comparative analysis has rarely considered the diversity of wages in the global economy, tending instead to focus on Europe and the United States. However, there appears also to be a second reason, arising from a reluctance to characterize Britain as a high-wage economy during the industrial revolution, a period where the focus has been on the slow growth rather than the high level of British wages. Von Tunzelmann, for example, endorses Habakkuk's view of the US/Britain case, but rejects its applicability to the case of Britain and Europe during the industrial revolution.[14]

Some writers have considered the logical possibility of high wages affecting technological choice, but because of their focus on Europe, they have not perceived the huge silver wage gap with India. Consequently, factor prices have been

[6] Broadberry and Gupta, 'Early modern great divergence', pp. 13–18.
[7] Rothbarth, 'Causes'; Habakkuk, *American and British technology*.
[8] David, *Technical choice*; Broadberry, *Productivity race*.
[9] Mokyr, 'Editor's introduction', p. 88.
[10] Broadberry and Gupta, 'Early modern great divergence', p. 17.
[11] Williamson, 'Global labor markets', p. 178.
[12] Allen, 'Great divergence', p. 416; Broadberry and Gupta, 'Early modern great divergence', p. 5.
[13] Chaudhuri, *Trading world*, p. 238.
[14] Von Tunzelmann, 'Technical progress', pp. 159–60.

accorded only a minor role in the changing competitive advantage in the world cotton textiles market. Thus Landes devotes a short section to high wages as a stimulus to mechanization in his early work, but makes no mention of this inducement mechanism in his later work.[15] Others, such as Deane, only mention wages in the context of the British cotton industry in order to stress the importance of 'an almost inexhaustible low-priced labour supply'.[16]

The story of Anglo-Indian competition in cotton textiles begins with the growth of cloth imports into Britain via the East India Company from the seventeenth century. The new cloths, patterns, and designs became increasingly fashionable and thus threatened the livelihood of domestic producers of fine woollens and linens, which were the closest substitutes for printed cottons from India.[17] The pressure from these groups led to protective legislation that remained in force between 1701 and 1774, and opened up new opportunities for British manufacturers via a strategy of import substitution.[18] However, high silver wages in Britain meant that cotton textiles produced domestically using labour-intensive production methods could not compete with Indian goods in third markets. This stimulated a two-stage process of technological change.

First, high wages led to the adoption of a more capital-intensive technology in Britain. Second, this choice of technology resulted in a faster rate of productivity growth in Britain, because of the greater incentive to devote resources to improving technology where capital intensity is higher. This is consistent with the positive relationship between capital intensity, resources devoted to research and development, and the rate of technological progress, highlighted in Schumpeterian models of economic growth.[19] This effect can be explained partly by the greater learning potential on capital-intensive technology.[20] In Britain, however, the effect was amplified by the existence of an effective patent system.[21]

There was thus a stronger incentive to devote resources to innovation in the machine-intensive industry of Britain, compared with the labour-intensive industry of India. As productivity increased in the machine-intensive British cotton textile industry and stagnated in India, a shift in competitive advantage occurred. However, the shift was delayed in international markets during the late eighteenth and early nineteenth centuries by a temporary rise in raw cotton prices in Britain, as the increase in production put pressure on factor markets. The shift of competitiveness in the Indian market was delayed further by transport costs, which prevented the British from breaking into the Indian market on a large scale until after 1830.[22]

The paper proceeds as follows. Section I provides a brief quantitative overview of developments in the British and Indian cotton textile industries. Factor prices

[15] Landes, *Unbound Prometheus*, pp. 57–60; idem, *Wealth and poverty*.

[16] Deane, *First industrial revolution*, p. 97. R. C. Allen, 'The British industrial revolution in global perspective: how commerce created the industrial revolution and modern economic growth', Nuffield College, Oxford, 2006 [WWW document]. URL http://www.nuff.ox.ac.uk/users/allen/unpublished/econinvent-3.pdf [accessed on 13 June 2008], also argues for the importance of high wages in Britain for technological choice during the industrial revolution, although he appears to remain ambivalent about the existence of a real wage gap between Britain and Asia; see Allen, 'Real wages'.

[17] Baines, *History*, p. 106; de Vries, 'Purchasing power'; Berg, 'From imitation to invention'.

[18] Inikori, *Africans*, pp. 428–32; O'Brien, Griffiths, and Hunt, 'Political components'.

[19] Aghion and Howitt, *Endogenous growth*, pp. 85–121.

[20] Arrow, 'Economic implications'.

[21] Dutton, *Patent system*; Sullivan, 'England's "age of invention" '.

[22] Ellison, *Cotton trade*, p. 63; Twomey, 'Employment', p. 53.

in Britain and India are then examined in section II, establishing that money wages and the wage-rental ratio were much higher in Britain. Raw cotton was also more expensive in Britain. Section III uses input and output prices to derive estimates of comparative total factor productivity (TFP) levels. The most important proximate cause of the shift in competitive advantage was the faster growth of TFP in Britain, although a temporary increase in raw cotton prices at the end of the eighteenth century delayed the shift. Section IV relates comparative TFP to factor prices, drawing on analysis of nineteenth-century American and British industrial development. Section V concludes.

I

There is widespread agreement that the arrival on a large scale of Indian cotton cloth in Britain in the seventeenth century had a substantial effect on the domestic textile industry. Indian patterns and designs quickly became fashionable and forced domestic textile producers to react, on the one hand lobbying for protection, and on the other hand imitating through printing on wool, linen, and calico.[23]

The British cotton industry, which took root in the already established textile producing region of Lancashire, remained small throughout the seventeenth century and the first half of the eighteenth century, since it was not yet competitive with Indian cotton textiles.[24] The lack of competitiveness of the early British cotton textile industry can be seen most clearly in the trade data presented in tables 1 and 2. Trade data were collected by customs officials on a value basis, but at 'official' rather than current prices.

Although much attention has been focused in the literature on how these official values provide a misleading guide to current values of trade, particularly after the late eighteenth century, this does not invalidate their use as indicators of trade volumes. Indeed, Flux notes that '(t)he official values appear to give a much better indication on the movements in the volume of trade than one could have expected'.[25] Certainly, the increase in the volume of both piece goods and yarn exports during the first half of the nineteenth century (shown in part B of table 1) moves broadly in line with the official values of exports (shown in part A) over the same period. At the beginning of the eighteenth century, British cotton textile exports were a mere 0.5 per cent of their level at the beginning of the nineteenth century. By the 1750s, despite substantial growth, export volumes remained at just 3 per cent of their level in the early 1800s. In part A of table 2, the data on trade values at official prices show how British cotton textile exports were a small fraction of the imports of cotton cloth from India before the 1780s.[26]

Worries about competition from India in the British market led to pressures for protection. But it should be noted that the pressure for such measures came more from producers of woollens and linens than from the small community of British cotton textile producers, since fine woollens and linens were the closest substitutes for printed cottons from India.[27] Initial measures from 1690 took the form of

[23] Wadsworth and Mann, *Cotton trade*, p. 118; Thomas, *Mercantilism*, pp. 25–66.
[24] Wadsworth and Mann, *Cotton trade*, pp. 15, 527.
[25] Flux, 'Old trade records', p. 81, also cited in Mitchell, *British historical statistics*, p. 446.
[26] Davis, 'English foreign trade, 1660–1700'; idem, 'English foreign trade, 1700–1774'.
[27] Baines, *History*, p. 106.

Table 1. *Exports of cotton textiles, measured at constant official prices, Great Britain, 1697–1850 (£000 at 1697 prices)*

A. Annual average values at constant official prices (£000 at 1697 prices)

	Total		*Piece goods*	*Yarn*	*Total*
1697–9	16	1770–9			246
1700–9	13	1780–9			756
1710–19	8	1790–9	2,525	101	2,626
1720–9	16	1800–9	7,603	749	8,352
1730–9	14	1810–19	17,712	1,133	18,845
1740–9	11	1820–9	25,605	3,225	29,830
1750–9	86	1830–9	44,086	7,519	51,605
1760–9	227	1840–9	73,838	12,109	85,947

B. Annual average volumes

	Piece goods		*Yarn*
	Million linear yards	*Million lbs*	*Million lbs*
1800–9	109.5	20.0	7.4
1810–19	205.0	37.4	12.0
1820–9	320.3	58.5	35.5
1830–9	552.4	100.8	84.3
1840–9	977.5	178.4	136.1

Sources: Part A: 1697–1808: Schumpeter, *English overseas trade*, tabs. X, XI, pp. 29–34; 1808–1850: Parliamentary Papers, *Finance accounts*. Part B: Robson, *Cotton industry*, p. 331.

Table 2. *British imports and re-exports of cotton piece goods from India, compared with British exports of cotton textiles, 1663–1856*

A. Annual average values at constant official prices (£000 at 1697 prices)

	Imports	*Re-exports*	*Exports*
1663–9	182		
1699–1701	367	340	20
1722–4	437	484	18
1752–4	401	499	83
1772–4	697	701	221

B. Annual average values at current prices (£000)

	Imports	*Re-exports*	*Exports*
1784–6	1,344	395	797
1794–6	1,687	1,148	3,801
1804–6	823	777	16,339
1814–16	515	433	18,994
1824–6	363	430	17,375
1834–6	347	406	22,398
1844–6	478	450	25,835
1854–6	481	532	34,908

Sources: Part A: 1663–1701: Davis, 'English foreign trade, 1660–1700', pp. 164–5; 1722–74: Davis, 'English foreign trade, 1700–1774', pp. 300–3. Part B: 1784–1856: Davis, *Industrial revolution*, pp. 94–125.

import duties, but these were too low to make much impact on the huge labour cost differences.[28] From 1701, however, printed calicos and certain other types of cotton cloth imported from India were prohibited.[29] The 1701 Calico Act still allowed the importation of white cottons from India for printing within Britain, until further legislation in 1721 prohibited these imports unless they were for re-export. O'Brien, Griffiths, and Hunt see these protectionist measures, which remained in force with various amendments until 1774, as giving an important boost to the British cotton industry.[30]

By the mid-eighteenth century, Britain's cotton producers were still not able to compete seriously on world markets.[31] But the search for machine-intensive techniques, driven by the much higher wages in Britain than India, had already begun by this time, and developments occurred before the industrial revolution in all the main sections of preparation, spinning, and weaving.[32] However, the crucial 'macro inventions' of the industrial revolution period had not yet appeared, since searching for any particular invention does not guarantee that it will be found immediately.[33] Hence, while labour productivity in Britain was higher than in India, it was still not sufficiently high to offset the higher wages. Indeed, since wages increased more rapidly in Lancashire than in southern England during the eighteenth century, the Anglo-Indian wage gap in cotton textiles increased substantially.[34]

During the second half of the eighteenth century, however, labour productivity increased dramatically in the British cotton textile industry as a result of further technological progress, while technology and productivity stagnated in India. This led gradually and in stages to a shift in competitive advantage, so that by the early nineteenth century, Britain was dominant in world markets, and was even able to export to India. However, Britain's conquest of world markets was hampered between the 1780s and the 1820s by the high price of inputs resulting from the sudden surge in British demand. This applied most obviously in the labour market, where shortages of handloom weavers famously led to very high earnings. However, it also affected the price of raw cotton in Britain, which reached very high levels in the late eighteenth and early nineteenth centuries.[35] However, as supply increased, particularly from the United States, the price of raw cotton in Britain fell back, returning during the 1830s to its level in the early eighteenth century. From this point on, Indian producers were faced with the full force of British competition in their home market as well as in export markets.

Table 2 shows estimates of trade values in official and current prices.[36] The figures suggest that the size of the British market for Indian imports was lower than the quantities re-exported through London between the early 1720s and the early

[28] Davis, 'Rise of protection', p. 309.
[29] Wadsworth and Mann, *Cotton trade*, pp. 117–18.
[30] O'Brien et al., 'Political components', pp. 413–18.
[31] Baines, *History*, p. 81.
[32] Timmins, 'Technological change', pp. 34–9.
[33] Mokyr, *Lever of riches*, p. 13; Crafts, 'Industrial revolution', pp. 432–4.
[34] Gilboy, *Wages*, pp. 254–64, 280–7.
[35] Mitchell, *British historical statistics*, pp. 759–60.
[36] As current prices began to deviate substantially from official prices towards the end of the late eighteenth century, Davis, *Industrial revolution*, provides estimates of trade values at current prices, shown here in part B of tab. 2. Official prices show estimates at constant prices. Since the shares of imports, exports, and re-exports are being examined here in order to get an idea of the relative market sizes, it is unimportant whether current or official prices are used.

Table 3. *British cotton textile exports in the Indian market, 1810–19 to 1890–9*

	Annual average Indian consumption of cotton textiles (million yards)	*Share taken by British exports (%)*
1810–19	1,890	0.1
1820–9	1,890	1.3
1830–9	1,926	2.7
1840–9	1,998	11.5
1850–9	2,142	21.8
1860–9	2,250	24.9
1870–9	2,570	40.1
1880–9	3,200	61.4
1890–9	3,550	51.8

Sources: Indian consumption: 1810–69: derived from the population data in Roy, *Economic history*, pp. 281–3, and the per capita cotton consumption estimates of Ellison, *Cotton trade*, p. 63; 1880–1909: Twomey, 'Employment', p. 46. British exports to India: Sandberg, *Lancashire in decline*, p. 142.

1770s. However, after the repeal of protective legislation, the retention of imports in the home market exceeded re-exports by a considerable margin until the early nineteenth century. At the same time, the export of British-made goods rose dramatically from the early 1790s, indicating that the shift of competitive advantage was beginning to occur.

British-made cottons first broke into the export trade in the African and American markets during the eighteenth century, but success tended to be limited to periods when the availability of Indian goods was restricted by war. Indian goods were still able to take market share from the British-produced cottons in Africa when the disruption of the Seven Years' War ended in 1763.[37] The struggle over American independence added to the difficulties of Britain's cotton exporters. However, from the 1770s, technological developments made Britain competitive in Europe, finding a growing market for what were called in the trade data 'Manchester cottons and velverets'.[38] The ability of merchants and manufacturers to switch flexibly between the American and European markets was important during the period of the Revolutionary and Napoleonic Wars between 1793 and 1815.[39] Not only was British trade with Europe frequently disrupted by the fighting on the Continent during this extended period, but Britain also went to war with the United States between 1812 and 1814. Indian cottons continued to share the West African market equally with British-made cottons during the second half of the eighteenth century, but Lancashire goods pulled ahead decisively after the Revolutionary and Napoleonic Wars.[40]

The penetration of British cotton textile exports into the Indian market proceeded more slowly. Indian producers retained a transport cost advantage which they lacked in competition between the two countries in Africa, America, or Europe, as well as an informational advantage. In order to estimate Britain's share of the Indian market in table 3, it is necessary to make assumptions about cotton

[37] Wadsworth and Mann, *Cotton trade*, pp. 159–60.
[38] Ibid., pp. 168–9.
[39] Edwards, *Growth*, p. 50.
[40] Inikori, *Africans*, p. 444.

consumption in India, which in turn depend on estimates of population and per capita consumption of cloth. These estimates can be married up with more reliable data on British exports to India to obtain a rough idea of the timing of the shift of competitive advantage in this important market. Table 3 suggests that the British share of the Indian market was negligible before the 1830s, with Indian producers continuing to supply a larger share of their home market until the 1870s. The share of British exports rose to a peak in the 1880s before Indian producers regained some market share.

Before the dramatic rise of Lancashire in the late eighteenth and early nineteenth centuries, the world's most important cotton textile industry was located in India.[41] Chaudhuri argues that India's competitiveness in this industry can be explained by an abundant supply of skilled labour, with specialized tacit knowledge being passed down through the generations in classic Marshallian fashion.[42] It was this cheapness of skilled labour, rather than the quantity or quality of capital equipment, which underpinned India's domination of the world market. Estimates of weavers' fixed costs confirm that the technology used was highly labour intensive. In early nineteenth-century Bengal, the cost of a traditional loom, sticks for warping, and a wheel for winding amounted to little more than the cost of yarn sufficient for one piece of cloth.[43] Hossain's work on eastern Bengal in the eighteenth century echoes the same view that the capital input was minimal, with output being increased by drawing in surplus labour.[44] The spinning machine or charkha was a simple piece of equipment which needed only one person to operate, while the cleaning of cotton was an intricate, labour-intensive task. Cleaned cotton was dried in the open and teased with a small bow operated by women or a larger bow operated by men.[45]

Raw cotton was available locally and regional varieties often had a crucial impact on the type of cloth produced. Although spinning and weaving activities were widely dispersed throughout the country, regional specialization was a key aspect of the Indian cotton textile industry. Coarse cloth was produced for the local market and was spread across all regions. Fine cloth was produced for interregional and international markets, mainly in the four regions of Gujarat, the Punjab, the Coromandel Coast, and Bengal.[46]

The Gujarat cotton industry exported largely to the Red Sea ports, while exports from the Punjab went overland to Afghanistan, East Persia, and central Asia, and by river and sea to the Persian Gulf.[47] Before the growth of the European trade, the Coromandel industry exported mainly to south-east Asia, while Bengal supplied upper India. From the seventeenth century, substantial quantities of Indian cotton cloth were exported to Europe, particularly through the English East India Company (EIC) and the Dutch United East India Company (*Verenigde Oostindische Compagnie* or VOC).

[41] Robson, *Cotton industry*, p. 1.
[42] Chaudhuri, *Trading world*, p. 238. Marshall (*Principles*, p. 225) famously noted that 'The mysteries of the trade become no mysteries; but are as it were in the air'.
[43] Mitra, *Cotton weavers*, p. 174.
[44] Hossain, *Company weavers*, p. 20.
[45] Ibid., p. 37.
[46] Chaudhuri, *Trading world*, p. 243.
[47] Ibid., pp. 243–5.

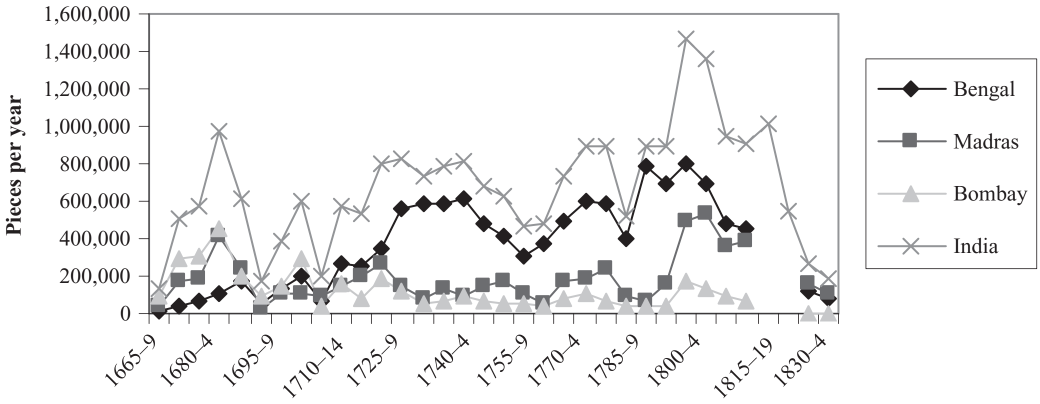

Figure 1. *East India Company imports of textiles from Indian regions (pieces per year)*
Sources: 1665–1759: Chaudhuri, *Trading world*, pp. 540–5; 1760–1834: Bowen, 'East India Company'.

Figure 1 shows the number of textile pieces imported into Britain between 1665 and 1834 by the EIC from Bombay (the Gujarat trade), Madras (the Coromandel Coast trade), and Bengal, with these three centres making up the total Indian trade. Textile imports from India to Britain, which were dominated by cotton cloth, show a strong growth from the 1660s to the 1680s, followed by a sharp downturn due to political conflict and war. A second downturn in the first decade of the eighteenth century can be explained by the introduction of measures to protect British textile producers, together with bullion shortage and war.[48] Thereafter, imports of Indian textiles to Britain fluctuated around 600,000 to 800,000 pieces for the rest of the eighteenth century. Following the repeal of the Calico Act, imports increased, reaching a peak during the period 1795–9, in line with the data in table 2. After this, imports from India began to trend downwards, collapsing precipitously after the end of the Napoleonic Wars.

The regional balance of this import trade from India changed substantially between the seventeenth and nineteenth centuries. Whereas Bombay and Madras were clearly more important during the seventeenth century, Bengal became the dominant supplier of textiles to the EIC during the eighteenth and nineteenth centuries. The declining importance of the Coromandel Coast as a supplier partly reflected the disruption caused by political conflict.[49] However, Chaudhuri also notes a relative cheapening of Bengal cottons.[50]

The EIC was the largest European importer of cotton textiles from India, followed by the VOC, with the French and Danish companies trading on a substantially smaller scale.[51] In attempting to understand the effects of British competition on the overall size of the Indian cotton textile industry, however, it is important to bear in mind that India's home market was much bigger than its export sector. Hence the impact on employment was delayed until well into the

[48] Ibid., p. 295.
[49] Arasaratnam, *Merchants, companies and commerce*, p. 153.
[50] Chaudhuri, *Trading world*, p. 296.
[51] Morineau, 'Indian challenge', pp. 252, 266.

Table 4. *Weekly earnings of cotton operatives in Britain and India, c. 1680–1820 (s./d.)*

	Lancashire	*India*	*Lancashire as % of India*
c. 1680	6 s./0 d.	1 s./6 d.	400
c. 1770	6 s./11 d.	1 s./6 d.	460
c. 1790	13 s./3 d.	2 s./0 d.	663
c. 1820	10 s./4 d.	2 s./0 d.	517

Notes and sources: India: *c.* 1680: Brennig, 'Textile producers', pp. 348–9, for southern India.
c. 1770: Arasaratnam, 'Weavers, merchants and company', p. 269, for southern India; Chaudhury, *From prosperity to decline*, pp. 161–2, for Bengal.
c. 1790: Arasaratnam, 'Weavers, merchants and company', p. 269; Ramaswamy, *Textiles and weavers*, p. 156; Mukerjee, *Economic history*, p. 28, for southern India. Chaudhury, *From prosperity to decline*, pp. 161–2; Hossain, *Company weavers*, pp. 52–3, for Bengal.
c. 1820: Mitra, *Cotton weavers*, pp. 128–9; Buchanan, *Purnea*, pp. 542–3; idem, *Bhagalpur*, p. 616; Buchanan Hamilton, *Dinajpur*, pp. 296–8, for Bengal. All Indian earnings given on a monthly basis and converted to a weekly basis on the assumption of a four-week month.
Lancashire: *c.* 1680: Gilboy, *Wages*, pp. 280–7; *c.* 1770: Wadsworth and Mann, *Cotton trade*, pp. 401–2; *c.* 1790: Wood, *History of wages*, p. 112; *c.* 1820: Wood, *History of wages*, p. 127. Lancastrian earnings given on a weekly basis, except Gilboy, *Wages*, given on a daily basis and converted to a weekly basis on the assumption of a six-day week.

nineteenth century, when Lancashire penetrated the Indian market significantly.[52] However, even here, it is important to realize that there were two phases in the development of the nineteenth-century Indian market. First, Indian producers faced the emerging competition from British goods. However, during the second half of the century, a modern Indian cotton mill industry developed, particularly in the spinning section. The falling price of yarn then allowed the handloom industry to remain competitive in some segments of the domestic cloth market.

II

In this section the wages of cotton textile workers in Lancashire and India are compared. An anonymous author arguing for the protection of the British textile industry in 1701 claimed that the same amount of labour that would cost a shilling in England could be had for two pence in India. He argued that: 'There is no reason to believe that the Indian will take any of our manufactures as long as there is such a difference between the price of English and Indian labour'.[53]

To what extent did this 6:1 wage differential exist in cotton textile production, and how did it vary over time? Table 4 presents a comparison of earnings in the cotton industry between 1680 and 1820. The Indian earnings are collected from a variety of sources for the Coromandel Coast and Bengal. Data for the early period are taken from several studies of the handloom industry in south-eastern India, while data for the later period are mainly from Bengal. This is in line with the regional shift of production for export between the seventeenth and eighteenth centuries.[54] The Lancashire earnings for 1770 are taken from the authoritative study by Wadsworth and Mann, and derive originally from the work of Young, based on the weekly earnings of a handloom weaver operating a single loom, with

[52] More recently, Clingingsmith and Williamson, 'Deindustrialization', have argued that de-industrialization began with the decline in the terms of trade for manufactured goods as agricultural prices rose due to disruption caused by the decline of the Mughal Empire in the eighteenth century.
[53] McCulloch, *Early English tracts*, p. 549, also cited in Chaudhuri, *Trading world*, p. 237.
[54] Chaudhuri, *Trading world*, pp. 540–5.

some assistance from his wife and children.[55] The Indian data for 1770 are derived from an estimate of the monthly earnings of a loom operated by one weaver and another adult male with the assistance of the weaver's wife and children.[56] These data put the Lancashire wage at 460 per cent of the Indian wage, a bit less than the 6:1 differential noted by the anonymous tract author, but still extremely large.

The evidence for the wages of spinners is less reliable than that for weavers, but also supports the idea of a large Anglo-Indian wage gap. For Lancashire in 1770, Wadsworth and Mann report a range of 2 s. to 5 s. per week, or an average of 3 s. 6 d., again based on Young's data.[57] In the case of south India, Wendt suggests an average of 0.44 pagodas per month for the seventeenth and eighteenth centuries for spinners of coarse yarn, with a range of 0.32 to 0.56 pagodas.[58] This works out at an average of 10.56 d. per week, which gives an Anglo-Indian wage ratio of approximately 4:1, fairly close to the ratio for weaving.

The wage data must be interpreted with caution, since the quality of yarn and cloth varied with the skills of the workers, and this led to variation in earnings. It is therefore important not to pay too much attention to the earnings of a few highly skilled workers producing very high quality cloth or yarn. Although Parthasarathi reports monthly earnings of around 2.5 pagodas, or 5 s. per week in mid-eighteenth-century south India, Broadberry and Gupta show that these earnings cannot be taken as representative of average earnings, since they are not consistent with the extensive wage data collected by other authors for the same region at the same time and do not fit with developments over time in other Indian regions.[59] Parthasarathi claimed support for his high estimate of the amount of grain which an Indian spinner could buy with his monthly earnings from the work of Brennig, but Broadberry and Gupta point out that Brennig relied on a low grain price rather than high money earnings for this result.[60]

Working back from 1770, the 1680 figure for India has been taken from Brennig's study of the Coromandel textile trade in the late seventeenth century.[61] The weekly data are derived as one-quarter of the estimated monthly earnings of a master weaver operating a single loom with the help of an assistant. The weaver would also have been assisted in ancillary tasks by his wife. For Lancashire, Gilboy's estimate of the daily wage of a craftsman, assuming a six-day week, has been used.[62]

Working forward from 1770, the earnings in Lancashire in *c*. 1790 have been taken from Gilboy.[63] The figure used here is for skilled workers. Wood suggests even higher earnings for handloom weavers during the late 1790s, due to a substantial imbalance between the spinning and weaving sections of the industry at this time, following a number of dramatic improvements in spinning technology,

[55] Wadsworth and Mann, *Cotton trade*, pp. 401–2; Young, *Six months tour*, vol. iii, pp. 245–8. These figures for the earnings of English weavers are also used by Parthasarathi, 'Rethinking wages', pp. 83–4.

[56] Since all earnings are attributed to male weavers rather than allocated between weavers and other family members, the true wage of an individual weaver is, if anything, overstated in these sources.

[57] Wadsworth and Mann, *Cotton trade*, p. 402; Young, *Six months tour*, vol. iii, pp. 245–8.

[58] Wendt, 'Writing'.

[59] Parthasarathi, 'Rethinking wages', p. 97; Broadberry and Gupta, 'Early modern great divergence', p. 14.

[60] Brennig, 'Textile producers', p. 349; Broadberry and Gupta, 'Early modern great divergence', p. 15.

[61] Brennig, 'Textile producers'.

[62] Gilboy, *Wages*.

[63] Ibid., pp. 280–7.

Table 5. *Price of raw cotton in Britain, 1680–1879*

	d. per lb		*d. per lb*
1680–9	7	1780–9	23
1690–9	7	1790–9	24
1700–9	7	1800–9	15
1710–19	9	1810–19	17
1720–9	10	1820–9	16
1730–9	10	1830–9	8
1740–9	10	1840–9	5
1750–9	16	1850–9	6
1760–9	16	1860–9	15
1770–9	16	1870–9	8

Notes: Before 1800, annual averages for West Indian cotton are calculated as the mean of the range quoted, and decade averages are obtained from the incomplete number of annual observations. After 1800, data are annual average prices for upland or middling American cotton. Allowance has been made for the discount of the British pound against silver during the suspension of convertibility between 1797 and 1821 using data from Officer, *Dollar-sterling gold points*, p. 77.
Sources: 1680–1780: Wadsworth and Mann, *Cotton trade*, app. H, pp. 522–3. 1780–1879: Mitchell, *British historical statistics*, pp. 759–60.

but before the successful introduction of the powerloom.[64] However, Gilboy suggests a substantial increase in earnings during the course of the 1790s, and spinners' earnings were substantially lower, so Gilboy's figure gives the best guide to the situation in the industry as a whole at the start of the decade.[65] Since the wages of handloom weavers increased much more slowly in India, the English wage as a proportion of the Indian wage increased. For 1820, the Lancashire earnings data are taken from Wood and refer to all cotton operatives, including factory workers as well as handloom weavers.[66] With handloom weaving now being threatened by factory production, and with a general rebalancing of supply and demand in the labour market, English wages fell back in cotton textiles.[67] Mitra shows that the wages of Indian cotton spinners remained constant in money terms between 1790 and 1820.[68] This is consistent with the change we find in the data, with the English wage falling back to 517 per cent of the Indian level.

Table 5 shows that the price of raw cotton in Britain averaged about seven old pence per pound in both the late seventeenth century and the mid-nineteenth century. However, from the mid-eighteenth century to the early nineteenth century, the price of raw cotton in Britain increased substantially, in response to the sharp increase in demand. The figures need to be interpreted with care, because of the issue of cotton quality. As the English demand for cotton increased, it proved difficult to expand supply from traditional West Indian sources, particularly of the better quality staples.[69] As prices increased, supply responded from the United States, initially with the growth of long-staple Sea Island cotton in the islands and adjacent mainland of Georgia and South Carolina. Following the

[64] Wood, *History of wages*.
[65] Gilboy, *Wages*.
[66] Wood, *History of wages*, p. 127.
[67] Money wages also fell in line with prices in England during the postwar deflation; Gayer, Rostow, and Schwartz, *Growth and fluctuation*, p. 818.
[68] Mitra, *Cotton weavers*, pp. 128–9.
[69] Edwards, *Growth*, p. 79.

Table 6. *Comparative raw cotton prices in Britain and India, 1710–1830*

	Britain (d. per lb)	*India (d. per lb)*	*Britain/India (India = 100)*
1710	8	4.4	182
1740	9	4.6	196
1792–3	24	5.0	480
1802–3	13	6.3	206
1812–13	15	6.3	238
1822–3	8	6.3	127

Sources: India: 1710, 1740: Mukund, *Trading world*, p. 84, gives the cotton price in the south as 23 pagodas per candy of 500 lb in 1710, with one pagoda being equal to eight shillings; Chaudhuri, *Trading world*, p. 471. 1792–1823: Mitra, *Cotton weavers*, pp. 126–7, gives average cotton prices in Bengal as 12.42 rupees per maund of 74.5 lb in 1792–3. Britain: Wadsworth and Mann, *Cotton trade*, app. H, pp. 522–3; Mitchell, *British historical statistics*, pp. 759–60.
Notes: Allowance has been made for the discount of the British pound against silver during the suspension of convertibility between 1797 and 1821 using data from Officer, *Dollar-sterling gold points*, p. 77.

introduction of the yield-increasing ridge method of planting and the invention of Whitney's gin, cultivation spread westwards with short-staple upland cotton. By the early 1800s, American cotton was dominating the English market.[70] Our figures are average prices for West Indian cotton to 1800, and average prices for upland or middling American cotton thereafter. Note that prices have been adjusted to take account of the discount of the British pound against silver during the suspension of convertibility between 1797 and 1821, using data from Officer.[71]

Table 6 shows that India, with its local supply, faced a raw cotton price that was generally cheaper than in Britain. Again, care must be exercised here because of issues of quality. It is possible to find quotes of English merchants which show Indian cotton selling at a discount to upland or middling American cotton in the early nineteenth century. Edwards, for example, shows Surat cotton selling at around 80 per cent of the price of Bowed Georgia at Liverpool in 1801.[72] However, it must be borne in mind that the section of the Indian cotton industry about which quantitative information is available operated at the high quality end of the market producing for export, and that quotes for high quality cotton from Surat suggest that it sold at a premium.[73] The lower price of raw cotton gave India a further competitive edge over and above the lower wage costs. Furthermore, whereas raw cotton prices followed a sharply upward trend in Britain after 1740, the increase was much more gradual in India. Raw cotton prices remained high in Britain until the end of the Revolutionary and Napoleonic Wars.

Even allowing for quality differences and wartime inflation, the data in tables 5 and 6 suggest that relative raw cotton costs played an important role in the timing of the shift in competitive advantage. For just as the British cotton industry began to experience dramatic productivity growth in the late eighteenth century that could offset the high wages, raw cotton costs rose rapidly to delay the shift in competitive advantage. As raw cotton prices fell back after the end of the Napoleonic Wars, the effects of the productivity growth were realized and Lancashire cotton textiles replaced Indian textiles in world markets.

70 Ibid., pp. 89–93.
71 Officer, *Dollar-sterling gold points*, p. 77.
72 Edwards, *Growth*, p. 122.
73 Ibid., p. 81.

Table 7. *Interest rates in Britain and India (% per annum)*

	Britain			*India*
	Consols	*Land*	*Buildings*	*Secured loans*
c. 1680	—	4	6	8
c. 1770	4	4	6	10
c. 1790	4	4	5	12
c. 1820	4	3	5	12
c. 1840	3	3	5	7

Sources: Mitchell, *British historical statistics*, p. 678; Clark, 'Cost of capital', p. 273; idem, 'Debt', pp. 416, 434; Moosvi, 'Indian experience', pp. 337–9, 342, 351–2.

If the rental price of capital were also much higher in Britain, then the high wages would not have provided an incentive to substitute capital for labour. It is therefore necessary to consider the rental price of capital (R) in the two countries, given by:

$$R = P_K\left(i + \delta - \hat{P}_K\right) \quad (1)$$

where P_K is the price of capital goods, i is the rate of interest, δ is the depreciation rate and a circumflex over a variable indicates a proportional rate of change.

Table 7 provides a range of interest rate data for Britain, including the return on consols and the return on housing and on land.[74] For India, interest rates on secured loans are taken from Moosvi, who argues that by the mid-nineteenth century these rates were about 2 per cent above the London rates on equivalent loans.[75] Mitra's claim that an interest rate of 12 per cent was typically paid on loans to the European companies until the middle of the eighteenth century is consistent with this evidence.[76] This suggests broad comparability between the Indian series on secured loans and the British series on the rate of return on buildings. Feinstein shows a depreciation rate for Britain of around 1.5 per cent, and this is assumed to apply also to India.[77] In the absence of reliable continuous series on the price of capital goods, the capital gains term is set to zero for both countries. Allen measures the price of capital goods in Britain as an average of the prices of iron, non-ferrous metals, timber, and bricks.[78] For India, less comprehensive data are available, and thus table 8 has a more restricted focus on the price of bar iron. The price data for bar iron in Britain are taken from Mitchell and Hyde, and are compared with unpublished Indian price data made available by Guha.[79] Although the price of capital goods was higher in Britain than in India, this was offset by lower interest rates.[80]

[74] Mitchell, *British historical statistics*; Clark, 'Cost of capital'; idem, 'Debt'.
[75] Moosvi, 'Indian experience', p. 351.
[76] Mitra, *Cotton weavers*, p. 67.
[77] Feinstein, 'National statistics', p. 427.
[78] Allen, 'British industrial revolution' (see above, n. 16), p. 6.
[79] Mitchell, *British historical statistics*; Hyde, *Technological change*.
[80] It should be noted that although the price of capital goods was in general lower in India than in Britain, this did not apply to the modern textile machinery, which was largely imported from Britain; Saxonhouse and Wright, 'New evidence', p. 512.

Table 8. *Rental price of capital in Britain and India (£ per ton)*

	Britain		India	
	P_K	$P_K(i + \delta)$	P_K	$P_K(i + \delta)$
c. 1680	15	1.125	8.63	0.820
c. 1770	15	1.125	8.63	0.992
c. 1790	19	1.235	8.63	1.165
c. 1820	11	0.715	8.63	1.165
c. 1840	9	0.585	8.63	0.734

Sources: Price of bar iron in Britain: Hyde, *Technological change*, pp. 44, 81, 104; Mitchell, *British historical statistics*, pp. 762–3. Price of bar iron in India: unpubl. data, made available by Sumit Guha. Interest rates from tab. 7. Depreciation rate from Feinstein, 'National statistics', p. 427.

Table 9. *Comparative Britain/India costs and prices (India = 100)*

A. Costs

	Wage (W/W)*	*Raw cotton price (C/C*)*	*Rental price of capital (R/R*)*	*TFI price*
c. 1680	400	182	137	206
c. 1770	460	320	113	270
c. 1790	663	480	106	357
c. 1820	517	127	61	150

B. Prices and TFP

	TFI price	*FOB price (P/P*)*	*TFP (A/A*)*
c. 1680	206	200	103
c. 1770	270	200	135
c. 1790	357	147	243
c. 1820	150	53	283

Sources: Wage, raw cotton price, and rental price of capital derived from tabs. 4–8. Prices FOB derived from Chaudhuri, *Trading world*, pp. 540–5, for 1680 and 1770, extended to 1790 and 1820 using Cuenca Esteban, 'British textile prices', pp. 101–2, and idem, 'Factory costs', p. 755. Weights of 0.25 for the wage, 0.5 for the raw cotton price, and 0.25 for the rental price of capital derived from Edwards, *Growth*, p. 240, and Jones, *Increasing return*, p. 105.

III

Table 9 shows comparative Britain/India total factor input (TFI) prices as a weighted average of wages, raw cotton costs, and the rental price of capital. The weights are based on the data of Jones and Edwards, with raw cotton costs making up around half of total costs, and with the other half split evenly between labour and capital costs.[81] It is tempting to think that this TFI price ratio reflects the comparative total factor productivity ratio (A/A*), since the levels equivalent of the familiar cost dual TFP equation is:

$$A/A^{\star} = \frac{(W/W^{\star})^{\alpha}\,(C/C^{\star})^{\beta}\,(R/R^{\star})^{1-\alpha-\beta}}{(P/P^{\star})} \tag{2}$$

where A is total factor productivity (TFP), W is the wage rate, C is the cost of raw cotton, R is the rental price of capital, P is the price of cotton yarn or cloth, and

[81] Jones, *Increasing return*, p. 105; Edwards, *Growth*, p. 240.

α and β are the shares of wages and raw cotton in costs. An asterisk indicates the numeraire country, which is taken as India. In competitive markets, the selling price must be equal, so the denominator in equation (2) may at first sight appear to be unity.

However, it is important to note that the correct prices to use in the denominator here are prices free on board (FOB), whereas the selling prices (*SP*) include transport costs (*T*):

$$SP = P + T \tag{3}$$

In table 9, it is assumed that the initial FOB price ratio was 200, obtained from information on the East India Company mark-up on Indian textiles.[82] This has been extended forwards from 1770 using a British cotton textile price index together with the assumption of stagnant FOB prices in India. The British price index is a unit value index of cloth exports taken from the work of Cuenca Esteban.[83] This takes on board some criticisms of an earlier series produced by Cuenca Esteban, which Harley believes overstated the decline in cloth prices.[84] Although Harley still argues in a further exchange that Cuenca Esteban overstates the fall in cotton cloth prices, the differences are now much smaller.[85] Furthermore, it is worth bearing in mind that there is also a bias in the other direction, since the Cuenca Esteban series excludes yarn prices, which fell much more rapidly than cloth prices during the period 1770–1820.[86] Evidence in favour of stagnating prices in India over this period is provided by Mitra and Hossain across different varieties of cloth.[87] The EIC increasingly ran into difficulties in fulfilling its orders for cotton cloth in India, yet was unable to offer higher prices because of the situation in the English market.[88] The contrast between falling cotton yarn prices in England and stagnating yarn prices in India between 1812 and 1830 is clearly visible in the data assembled by Specker on a variety of yarn counts ranging from 49 to 250.[89]

Given these developments in TFI prices and FOB prices on a comparative basis, it can be seen in table 9 that Britain's TFP advantage increased continually throughout the period, at around 0.3 per cent per annum before 1770, rising to 1.5 per cent per annum during the period 1770–1820. This would be quite consistent with the 1.9 per cent per annum TFP growth rate reported by Harley for the British cotton industry between 1780 and 1860, together with slowly rising or stagnating productivity in India.[90]

The change in competitive advantage in the production of cotton textiles occurred in stages. In the first stage, which continued until the 1770s, the British cotton industry sheltered behind protective measures, with the selling price of

[82] Chaudhuri, *Trading world*, pp. 540–8.
[83] Cuenca Esteban, 'Factory costs', p. 755.
[84] Cuenca Esteban, 'British textile prices', pp. 101–2; Harley, 'Cotton textile prices and the industrial revolution', pp. 57–60.
[85] Harley, 'Cotton textile prices revisited'; Cuenca Esteban, 'Factory costs'.
[86] Harley, 'Cotton textile prices and the industrial revolution', pp. 57–9.
[87] Mitra, *Cotton weavers*, pp. 192–6; Hossain, *Company weavers*, pp. 53–5.
[88] Gupta, 'Competition and control'.
[89] Specker, 'Madras handlooms', p. 207.
[90] Harley, 'Reassessing', p. 200.

goods produced in India but sold in Britain for re-export being substantially lower than the British FOB price. In the second stage, between the 1770s and the 1790s, competitive advantage started to shift in Britain's favour, with rapid technological progress raising productivity in Lancashire. However, with the wage and raw cotton costs moving in India's favour, the British FOB price remained above the CIF price of Indian goods in Britain. In the third stage, between the 1790s and the 1820s, rapid technological progress continued to raise productivity, while wage and raw cotton costs moved back in Britain's favour. The British FOB price now fell below the CIF price of Indian goods in Britain. As a result, Indian cloth was increasingly displaced from the British market, while Lancashire producers found it easier to compete against India in third markets such as Africa, where transport costs were similar for both countries.[91]

In the fourth stage, from about 1830, the productivity gains in Britain, particularly at this time in weaving, reduced the British FOB price still further, so that the British selling price in the Indian market, inclusive of transport costs, could fall below the Indian FOB price in at least some products. Table 3 shows Britain's share of the Indian market growing from 2.7 per cent in the 1830s to 61.4 per cent in the 1880s. This view of the dynamics of Britain's penetration of the Indian market during the nineteenth century is broadly consistent with the picture presented by authors interested primarily in the issue of Indian de-industrialization. Clingingsmith and Williamson argue that until the early nineteenth century the Indian cotton textile industry was adversely affected more by shocks emanating from other parts of the domestic economy than by international competition.[92] Twomey shows that although India became a net importer of cotton cloth from about 1830, handicraft production for the home market turned down only after 1850.[93]

IV

This paper stresses the link between high wages in Britain and technology, with growing British productivity leading to a shift in competitive advantage. The argument is familiar from the analysis of nineteenth-century industrial development in Britain and the United States, but has not been applied seriously to the shift in competitive advantage from India to Britain in the context of the industrial revolution, where Britain has to be cast in the role of the high-wage producer. As noted in the introduction to this article, we attribute this neglect of factor prices to the focus on Europe and the United States rather than Asia, where the wage differences were much greater, combined with a focus on the slowness of the growth of real wages in Britain rather than their high level.

We see a two-stage process leading from relatively high wages in Britain to substitution into capital-intensive production methods, followed by a faster rate of innovation in the capital-intensive technology. The analysis draws on David's framework.[94] The first stage, with high wages leading to substitution of capital for labour is analysed in figure 2, where country A is Britain and country B is India.

[91] Wadsworth and Mann, *Cotton trade*, pp. 168–9; Inikori, *Africans*, p. 444.
[92] Clingingsmith and Williamson, 'Deindustrialization'.
[93] Twomey, 'Employment', pp. 40, 53.
[94] David, *Technical choice*, pp. 19–91.

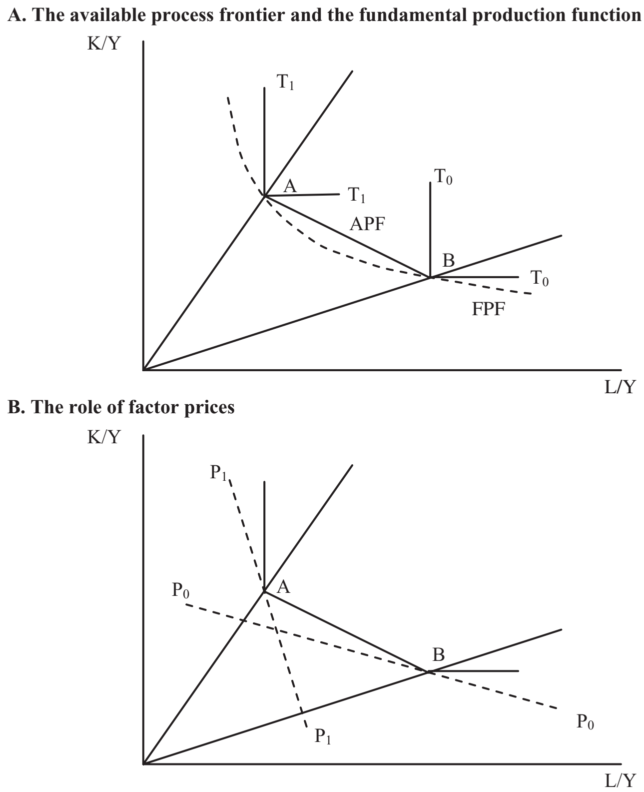

Figure 2. *Choice of technique*
Source: David, *Technical choice*, p. 63.

Figure 2A characterizes the initial different technical choices in Britain and India at the beginning of the eighteenth century. There are two available technologies, which differ in the proportions of capital (K) and labour (L). Once the technique has been chosen, substitution possibilities are very limited, so that to all intents and purposes fixed coefficient technology can be assumed. The convex combination of these alternative techniques determines the available process frontier (APF), since, in principle, a combination of both processes could be used. If we assume a further set of latent techniques spanning the range of factor proportions, then, joining up the points of minimum input combinations, we obtain a continuously differentiable isoquant of the fundamental production function (FPF).

In figure 2B, relative factor prices are added in. If, as in eighteenth-century India, labour is relatively abundant and hence relatively cheap, the relevant factor price line is P_0 and producers locate at B, using the relatively labour-intensive technique. On the other hand, if labour is relatively scarce and hence relatively expensive, as in eighteenth-century Britain, the relevant factor price line is P_1 and British producers locate at A. Note that although Indian and British producers use different techniques, they nevertheless have access to the same fundamental production function.

The second stage is the faster rate of technological progress on the capital-intensive technology, which is analysed in figure 3. The link between capital

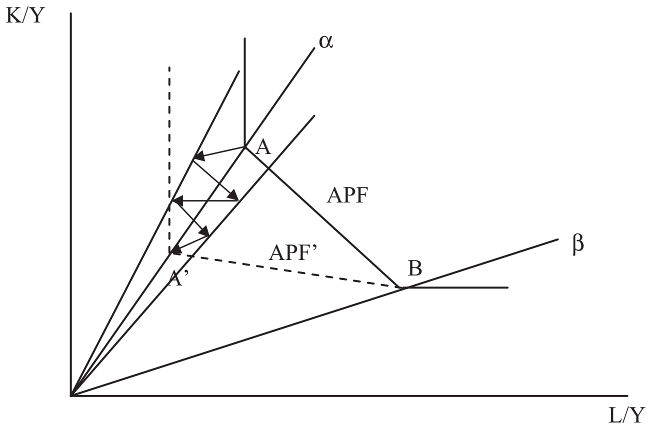

Figure 3. *Localized technological progress*
Source: David, *Technical choice*, p. 66.

intensity and the rate of technological progress is provided in the Schumpeterian growth model of Aghion and Howitt, partly via a process of learning by doing and partly via the scale of resources devoted to research and development (R&D).[95] More R&D occurs in more capital-intensive sectors. The argument is strengthened in the institutional context of the patent system in England, which provided a stronger incentive to search for improvements in machine-intensive processes, where innovations could be patented. Although economic historians have traditionally played down the role of the patent system, a revisionist strand of research beginning in the 1980s has suggested that by the middle of the eighteenth century patents were playing an important role in encouraging investment in innovation.[96] Although MacLeod has continued to take a more equivocal view, emphasizing the expense of patenting and the difficulties of enforcement, she nevertheless acknowledges that by the mid-eighteenth century, the system had 'developed its own momentum and promoted a first-strike mentality among its users: one neglected to patent at one's peril'.[97]

Although Griffiths, Hunt, and O'Brien seek to play down the role of patents in the textile sector during the industrial revolution period by pointing to the substantial number of non-patented inventions, it should be noted that the majority of the latter were produced in response to prizes offered by sponsoring societies.[98] Their evidence is thus quite consistent with this article's emphasis on the role of the profit motive in encouraging innovation in machine-intensive industry. Furthermore, the data show that the propensity to patent machinery was higher than for other innovations.[99] Thus figure 3 shows technological progress in the capital-intensive technology combined with technological stagnation in the labour-intensive technology.

[95] Aghion and Howitt, *Endogenous growth*, pp. 85–115.
[96] Dutton, *Patent system*; Sullivan, 'England's "age of invention" '.
[97] MacLeod, *Inventing*, p. 1.
[98] Griffiths, Hunt, and O'Brien, 'Inventive activity', p. 885.
[99] Ibid., p. 888.

Table 10. *Best-practice labour productivity in spinning 80 count yarn in England, 1780–1825 (operative hours to process 100 lbs of cotton)*

	Technology	*OHP*
1780	Crompton's mule	2,000
1790	100-spindle mule	1,000
1795	Power-assisted mule	300
1825	Roberts' automatic mule	135

Source: Derived from Catling, *Spinning mule*, p. 54.

Figure 3 also shows technological progress occurring in a trial-and-error process which was characterized by Atkinson and Stiglitz as local learning.[100] This results in locally neutral technological progress, which can be represented as a movement around a ray through the origin. The 'elastic barriers' surrounding the process ray α in figure 3 can be seen as representing non-convexities in micro-engineering designs.[101] Mokyr later made a distinction between macro and micro inventions, which captures the essence of this view.[102] Large 'door-opening' changes are followed by 'gap-filling' improvements which look fairly similar, only better. Technological progress under these conditions was modelled by David as a stochastic process between the elastic barriers around the α-ray, shifting the available process frontier from APF to APF' in figure 3.[103]

The substitution of capital for labour in the British cotton textile industry is well known, and is seen most obviously in the emergence of a machine-intensive factory system, particularly at first in spinning, where the introduction of Crompton's mule at the end of the 1770s led to a substantial gain in labour productivity. Although Inikori suggests that Lancashire firms producing for the West African market were already adopting machine-intensive methods before the ending of protection in 1774, the process accelerated following the repeal of the Calico Act, which opened up the home market to renewed competition from Indian cloth.[104]

Catling provides data on English labour productivity for spinning 80 count cotton yarn, using the concept of OHP, or operative hours needed to process 100 pounds of cotton, which is just the inverse of labour productivity.[105] This takes account of the effects of the increasing speed of the newer mules, the increasing number of spindles per mule, and the later practice of operating the mules as pairs. In table 10, the OHP requirement for 80 count yarn in Britain around 1780 was 2,000. For India, Buchanan Hamilton suggests that a woman spinner working full-time could clean and spin two-and-a-half pounds of cotton in a month.[106] Assuming a ten-hour working day and a six-day week, that would translate into around 100 hours to process a pound of cotton, or an OHP of 10,000. Buchanan Hamilton's figure for Bengal finds support in the calculations of spinning produc-

[100] Atkinson and Stiglitz, 'New view'.
[101] David, *Technical choice*, p. 81.
[102] Mokyr, *Lever of riches*, p. 13.
[103] David, *Technical choice*, p. 66.
[104] Inikori, *Africans*, p. 442.
[105] Catling, *Spinning mule*, p. 54.
[106] Buchanan Hamilton, *Dinajpur*, p. 289.

Table 11. *English cotton yarn and cloth prices deflated by general price index, 1780–1829*

	Yarn (d. per lb)			*Cloth (s. per piece)*	
	18 count weft	*40 count warp*	*100 count twist*	*Calico*	*Muslin*
1780/4	47	168	—	52	116
1785/9	47	142	761	43	80
1790/4	36	97	318	34	64
1795/9	36	77	112	29	44
1800/4	27	55	80	24	38
1805/9	19	39	66	16	35
1810/14	15	30	50	18	27
1815/19	15	30	62	19	31
1820/4	11	22	51	15	40
1825/9	10	20	52	10	33

Note: Deflated yarn and cloth prices are in constant 1825/9 prices.
Source: Harley, 'Cotton textile prices and the industrial revolution', pp. 55, 59.

tivity by Wendt for southern India, which puts the output of fine thread spinners at 2.2 to 2.4 pounds per month.[107] These figures are consistent with a substantial British labour productivity advantage in spinning as a result of a higher capital-labour ratio. However, it is necessary to be cautious here, because the example is based on a very fine yarn, which was not representative of the industry as a whole. After 1780, real prices fell much more dramatically on fine yarns than on coarse yarns, as can be seen in table 11. Nevertheless, this differential productivity growth had not yet occurred in 1780, so the Anglo-Indian productivity difference on fine yarns may still give a good indication of the overall productivity difference in spinning at this stage.

In weaving, it seems likely that the British capital per worker advantage around 1780 was smaller than in spinning, since technological progress was more limited in weaving before the introduction of the powerloom. As with yarn, there was some variation across cloth qualities in the extent of price falls, with the price of calicos falling more than the price of muslins (table 11). Although Wadsworth and Mann indicate ancillary labour inputs from family members in the Lancashire weaving industry during the first half of the eighteenth century, each loom was operated by only one full-time male weaver.[108] By contrast, there is abundant evidence of more than one weaver per loom from the major cotton textile producing regions of India. In Coromandel weaving, Brennig (for the late seventeenth century) and Arasaratnam (for the late eighteenth century) indicate two full-time male operatives per handloom, in addition to ancillary labour inputs from family members.[109] For Bengal, Mitra's evidence suggests that two men worked per loom in the late eighteenth century, while Prakash reports estimates of one-and-a-half to two persons per loom.[110] For finer cloths, more workers per loom were often required.[111]

[107] Wendt, 'Writing'.
[108] Wadsworth and Mann, *Cotton trade*, pp. 324–39.
[109] Brennig, 'Textile producers', p. 348; Arasaratnam, 'Weavers, merchants and company', p. 269.
[110] Mitra, *Cotton weavers*, pp. 113–15; Prakash, *Dutch East India Company*, p. 241.
[111] Baines, *History*, p. 71; Hossain, 'Alienation of weavers', p. 325.

This would all be consistent with Lancashire being able to draw on the technological change that had occurred in the European cotton industry and in textile manufacturing in general during the late medieval and early modern periods.[112] In the Indian context, by contrast, Habib has argued that the ordinary loom for the simple weave was practically impossible to develop further until the invention of the flying shuttle.[113] Rather, innovation tended to take the form of new weaving designs and new types of dyeing.[114]

The analysis so far has painted a picture of stagnating labour productivity in India while the British cotton textile industry was being transformed, which raises the issue of whether the Indian industry was acting rationally in its choice of technology. Here, an analogy can be drawn with the literature on allegations of entrepreneurial failure in late Victorian Britain.[115] In many industries, Britain lost market share in the late nineteenth century to American producers using new technology, while the British continued to use old technology.[116] As was pointed out by a number of authors in an influential volume edited by McCloskey, however, the new technologies would not have been profitable at British factor prices.[117] The same argument applies to British and Indian technology in cotton textiles during the early nineteenth century. Given the much lower wages in India, the savings on labour costs would not have offset the higher capital costs of adopting the British technology. However, when costs on the new technology had fallen sufficiently by the mid-nineteenth century, it became possible to adopt the new technology profitably in India, and a modernized cotton textile industry emerged in Bombay. This indigenous modernized industry, however, adopted a lower capital–labour ratio in response to the low wage costs. For an equivalent machine imported from Britain, an Indian mill used at least twice as many workers as a British mill. Hence, although labour productivity in the modern sector was higher than in the traditional sector, it was still low in international comparative terms.[118] Nevertheless, the machine-made products were competitive with British imports at the lower quality end of the market as a result of very low wages, so that domestic producers managed to regain market share from the British after the 1870s.[119]

The literature following Habakkuk made an important distinction between factor substitution, with high wages leading to a one-off shift to 'more machinery' per worker, and biased technological change, with high wages leading to 'better machinery'.[120] Some writers sought to endogenize technological progress by arguing for a direct link from high wages to labour-saving technological progress. Cain and Paterson, for example, reported econometric evidence for labour-saving technological progress as well as substitution of capital for labour in American industry between 1850 and 1919.[121] However, in the case of Britain during the industrial revolution, von Tunzelmann argues that technological progress was only

[112] Mazzaoui, *Italian cotton industry*, pp. 73–86.
[113] Habib, 'Notes', p. 182.
[114] Ramaswamy, *Textiles and weavers*, p. 67.
[115] McCloskey and Sandberg, 'From damnation to redemption'.
[116] Broadberry, *Productivity race*, pp. 157–209.
[117] McCloskey, ed., *Essays*.
[118] Clark, 'Why isn't the whole world developed?', pp. 149–52.
[119] Ellison, *Cotton trade*, p. 63; Twomey, 'Employment', p. 46.
[120] Habakkuk, *American and British technology*; Temin, 'Labour scarcity'.
[121] Cain and Paterson, 'Biased technical change', pp. 59–60.

strongly labour-saving after 1830.[122] Note, however, that our argument does not rely on this type of endogenous innovation, with bias in the direction of technological progress. We argue only for an induced acceleration in the rate of technological progress following the shift to capital-intensive technology in response to the high cost of labour in Britain compared with India. As in figure 3, we do not then require a further bias in the direction of technological progress, but merely locally neutral technological change.

In our view, one factor explaining the acceleration of technological progress after the adoption of capital-intensive techniques was the existence of a patent system, which offered stronger protection of property rights to innovations embodied in machinery than to innovations without the involvement of machinery. This meant that more resources were devoted to innovation in the machine-intensive British cotton textile industry than in the labour-intensive Indian industry. Sullivan points out that machinery and motive power accounted for 42.9 per cent of all patents issued in Britain during the period 1661–1710, rising to 46.6 per cent by 1801–50.[123] The shift to a more machine-intensive technology in response to high wages thus carried with it a higher probability of resources being devoted to improving technology and hence a higher rate of technological progress. This description fits the British cotton textile industry very well, and textile innovations played an important role in the acceleration of patenting which occurred in Britain during the late eighteenth century.[124] Indeed, an examination of Woodcroft's subject matter index of English patents reveals that 'spinning' was the largest category.[125] All of this inventive activity in spinning led to a dramatic increase in productivity, as can be seen in tables 10 and 11.

It is important to note that this argument is quite consistent with the evidence on the stated aims of inventors in the patent records, which suggests that only a small proportion of innovations in the textile industry were driven by a desire to save labour.[126] Even allowing for the fact that there were difficulties in openly stating the aim of saving labour during the Luddite era, it seems likely that in a trial-and-error process of improvement, the direction of factor-saving bias would have been at best a secondary consideration.[127]

It should also be noted that in choosing to highlight the neglected role of the patent system, it is not our intention to deny a role for all of the other fundamental factors emphasized by other writers. Indeed, it should be clear that some of these other factors can be seen as underpinning the high wages that we have placed at the centre of our analysis. Mokyr, for example, emphasizes the importance of the skills of the labour force in creating an environment conducive to technological progress in Britain.[128] In our framework, these labour force skills can be seen as leading to high wages, and it is the interaction between high wages and the patent system which results in the adoption of a more capital-intensive technology and an acceleration of the rate of technological progress.

[122] Von Tunzelmann, 'Technology in the early nineteenth century', pp. 289–90.
[123] Sullivan, 'England's "age of invention" ', p. 442.
[124] Ibid., p. 430.
[125] Woodcroft, *Subject matter index*; Sullivan, 'England's "age of invention" ', p. 431.
[126] Griffiths et al., 'Inventive activity', p. 895.
[127] MacLeod, *Inventing*, pp. 158–81.
[128] Mokyr, 'Technological change', pp. 39–41.

Finally, consideration should be given to the implications of this approach for the question of why the key technological breakthroughs in cotton textiles occurred first in Britain. When Crafts posed this question, the obvious comparator country was France, which was being portrayed in revisionist work as having similar development potential.[129] However, the revisionism now seems to have been overdone, and in the recent literature on comparative levels of development, France emerges as a relatively low-wage economy in the eighteenth century.[130] As Zeira points out, where the new technology requires more of one factor as well as less of another, it cannot be adopted without appropriate relative factor prices.[131] As Allen emphasizes, the technology of the industrial revolution was particularly adapted to British factor prices.[132] The other high-wage European economy was the Dutch Republic, and it is therefore interesting now to restate Crafts's question as 'Why Britain, and not Holland?' rather than 'Why Britain, and not France?'.[133] The answer offered here is that while Holland had high wages like Britain, it lacked the large market to provide sufficient rewards for innovation; and while France had a large population to provide a large market, it lacked the high wages to stimulate the adoption of machine-intensive technology which underpinned the process of technological change that occurred in Britain.

V

This article has re-examined the shift of competitive advantage in cotton textiles from India to Lancashire between 1700 and 1850. As well as emphasizing the need to consider developments in Britain and India together, as two sides of the same coin, this article highlights the surprising neglect of the role of factor prices in previous accounts.[134] The growing imports of cotton cloth from India via the East India Company during the seventeenth century opened up new opportunities for import substitution as the new cloths, patterns, and designs imported from India became increasingly fashionable, and as domestic producers succeeded in securing protection. However, high silver wages in Britain meant that cotton textiles produced domestically using traditional labour-intensive production methods could not compete with Indian goods in world markets. This stimulated a search for new methods of production, which led ultimately to a shift of competitive advantage in Britain's favour.

The shift of competitive advantage occurred in stages. First, a domestic cotton textile industry was established in Lancashire behind protective barriers between about 1700 and the 1770s. Second, between the 1770s and 1790s, Lancashire's

[129] Crafts, 'Industrial revolution'; O'Brien and Keyder, *Economic growth*.
[130] Allen, 'Great divergence', p. 416.
[131] Zeira, 'Workers'.
[132] Allen, 'British industrial revolution' (see above, n. 16), pp. 4–8.
[133] Crafts, 'Industrial revolution'.
[134] Parthasarathi argues that although the early literature stressed competition with India as the driving force behind technological progress in the English cotton industry, India got written out of the story because of a later emphasis on imbalances between the spinning and weaving sections of the English industry as the inspiration for technological change (P. Parthasarathi, 'The European response to Indian cottons', paper presented at the Global Economic History Network Conference, Pune, 18–20 Dec. 2005 [WWW document]. URL http://www.lse.ac.uk/collections/economicHistory/GEHN/GEHNConference8Papers.htm [accessed 13 June 2008]). However, he makes no mention of factor prices, and indeed argues elsewhere (Parthasarathi, 'Rethinking wages') that India should be seen as a high wage economy.

competitive position began to improve with the adoption of more capital-intensive production methods, followed by a faster rate of technological progress on the more machine-intensive technology. However, in this second phase, there were offsetting factors, as raw cotton costs moved in India's favour. In the third phase, from the 1790s to the 1820s, with continued technological progress and raw cotton costs moving back in Lancashire's favour, Lancashire became competitive against India in third markets where transport costs were similar for both countries. In the fourth phase, after about 1830, further technological progress completed the shift of competitive advantage, making Lancashire competitive even in the Indian market.

University of Warwick

Date submitted — *4 May 2007*
Revised version submitted — *17 January 2008*
Accepted — *15 February 2008*

DOI: 10.1111/j.1468-0289.2008.00438.x

Footnote references

Aghion, P. and Howitt, P., *Endogenous growth theory* (Cambridge, Mass., 1988).
Allen, R. C., 'The great divergence in European wages and prices from the middle ages to the First World War', *Explorations in Economic History*, 38 (2001), pp. 411–47.
Allen, R. C., 'Real wages in Europe and Asia: a first look at the long-term patterns', in R. C. Allen, T. Bengtsson, and M. Dribe, eds., *Living standards in the past: new perspectives on well-being in Asia and Europe* (Oxford, 2005), pp. 111–30.
Arasaratnam, S., 'Weavers, merchants and company: the handloom industry in southeastern India, 1750–1790', *Indian Economic and Social History Review*, 17 (1980), pp. 257–81.
Arasaratnam, S., *Merchants, companies and commerce on the Coromandel coast, 1650–1740* (Delhi, 1986).
Arrow, K. J., 'The economic implications of learning by doing', *Review of Economic Studies*, 29 (1962), pp. 155–73.
Atkinson, A. B. and Stiglitz, J. E. 'A new view of technological change', *Economic Journal*, 79 (1969), pp. 573–8.
Baines, E., *History of the cotton manufacture in Great Britain* (1966 [reprint of 1835 edn.]).
Berg, M., 'From imitation to invention: creating commodities in eighteenth-century Britain', *Economic History Review*, L (2002), pp. 1–30.
Bowen, H., 'East India Company: trade and domestic financial statistics, 1755–1838', UK Data Archive, 2007 [WWW document]. URL http://www.data-archive.ac.uk/findingData/snDescription.asp?sn=5690 [accessed 13 June 2003].
Brennig, J., 'Textile producers and production in late seventeenth-century Coromandel', *Indian Economic and Social History Review*, 23 (1986), pp. 333–56.
Broadberry, S. N., *The productivity race: British manufacturing in international perspective, 1850–1990* (Cambridge, 1997).
Broadberry, S. N. and Gupta, B., 'The early modern great divergence: wages, prices and economic development in Europe and Asia, 1500–1800', *Economic History Review*, LIX (2006), pp. 2–31.
Buchanan, F., *An account of the district of Purnea in 1809–10* (Patna, 1928).
Buchanan, F., *An account of the district of Bhagalpur in 1810–11* (Patna, 1939).
Buchanan Hamilton, F., *Geographical, statistical and historical description of the district of Dinajpur* (Calcutta, 1833).
Cain, L. P. and Paterson, D. G., 'Biased technical change, scale, and factor substitution in American industry, 1850–1919', *Journal of Economic History*, 46 (1986), pp. 153–64.
Catling, H., *The spinning mule* (Newton Abbot, 1970).
Chaudhuri, K. N., *The trading world of Asia and the English East India Company, 1660–1760* (Cambridge, 1978).
Chaudhury, S., *From prosperity to decline: eighteenth century Bengal* (New Delhi, 1995).
Clark, G., 'Why isn't the whole world developed? Lessons from the cotton mills', *Journal of Economic History*, 47 (1987), pp. 141–74.
Clark, G., 'The cost of capital and medieval agricultural technique', *Explorations in Economic History*, 25 (1988), pp. 265–94.
Clark, G., 'Debt, deficits and crowding out: England, 1727–1840', *European Review of Economic History*, 5 (2001), pp. 403–36.

Clingingsmith, D. and Williamson, J. G., 'Deindustrialization in 18th and 19th century India: Mughal decline, climate shocks and British industrial ascent', *Explorations in Economic History*, 45 (2008), pp. 209–34.
Crafts, N. F. R., 'Industrial revolution in Britain and France: some thoughts on the question "why was England first?" ', *Economic History Review*, 2nd ser., XXX (1977), pp. 429–41.
Cuenca Esteban, J., 'British textile prices, 1770–1831: a comment on the Crafts-Harley view of the industrial revolution', *Economic History Review*, XLVII (1994), pp. 66–105.
Cuenca Esteban, J., 'Factory costs, market prices, and Indian calicos: cotton textile prices revisited, 1779–1831', *Economic History Review*, LII (1999), pp. 749–55.
David, P. A., *Technical choice, innovation and economic growth* (Cambridge, 1975).
Davis, R., 'English foreign trade, 1660–1700', *Economic History Review*, 2nd ser., VII (1954), pp. 150–66.
Davis, R., 'English foreign trade, 1700–1774', *Economic History Review*, 2nd ser., XV (1962), pp. 285–303.
Davis, R., 'The rise of protection in England, 1689–1786', *Economic History Review*, 2nd ser., XIX (1966), pp. 306–17.
Davis, R., *The industrial revolution and British overseas trade* (Leicester, 1979).
Deane, P., *The first industrial revolution* (Cambridge, 1965).
Dutton, H. I., *The patent system and inventive activity during the industrial revolution, 1750–1852* (Manchester, 1984).
Edwards, M. M., *The growth of the British cotton trade,* 1780–1815 (Manchester, 1967).
Ellison, T., *The cotton trade of Great Britain* (New York, 1966 [reprint of 1886 edn.]).
Feinstein, C. H., 'National statistics, 1760–1920', in C. H. Feinstein and S. Pollard, eds., *Studies in capital formation in the United Kingdom, 1750–1920* (Oxford, 1988), pp. 257–471.
Flux, A. W., 'Some old trade records re-examined: a study in price movements during the present century', *Transactions of the Manchester Statistical Society*, Session 1898–9 (1899), pp. 65–91.
Gayer, A. D., Rostow, W. W., and Schwartz, A. J., *The growth and fluctuation of the British economy, 1790–1850: an historical, statistical, and theoretical study of Britain's economic development* (New York, 1975 [reprint of 1953 edn.]).
Gilboy, E. W., *Wages in eighteenth century England* (Cambridge, Mass., 1934).
Griffiths, T., Hunt, P. A., and O'Brien, P. K., 'Inventive activity in the British textile industry, 1700–1800', *Journal of Economic History*, 52 (1992), pp. 881–906.
Gupta, B., 'Competition and control in the market for textiles: the weavers and the East India Company', in O. Prakash, G. Riello, and T. Roy, eds., *How India clothed the world: the world of South Asian textiles, 1500–1850* (Leiden, forthcoming).
Habakkuk, H. J., *American and British technology in the nineteenth century* (Cambridge, 1962).
Habib, I., 'Notes on Indian textile technology in the seventeenth century', in B. De, ed., *Essays in honour of Professor S. C. Sarkar* (New Delhi, 1976), pp. 182–3.
Harley, C. K., 'Reassessing the industrial revolution: a macro view', in J. Mokyr, ed., *The British industrial revolution: an economic perspective* (Boulder, Colo., 1993), pp. 171–226.
Harley, C. K., 'Cotton textile prices and the industrial revolution', *Economic History Review*, LI (1998), pp. 49–83.
Harley, C. K., 'Cotton textile prices revisited: a response to Cuenca Esteban', *Economic History Review*, LII (1999), pp. 756–65.
Hossain, H., 'The alienation of weavers: impact of the conflict between the revenue and commercial interests of the East India Company, 1750–1800', *Indian Economic and Social History Review*, 16 (1979), pp. 323–45.
Hossain, H., *The company weavers of Bengal* (Delhi, 1988).
Hyde, C. K., *Technological change and the British iron industry, 1700–1870* (Princeton, N.J., 1977).
Inikori, J. E., *Africans and the industrial revolution in England: a study in international trade and economic development* (Cambridge, 2002).
Jones, G. T., *Increasing return: a study of the relation between the size and efficiency of industries with special reference to the history of selected British and American industries, 1850–1910* (Cambridge, 1933).
Landes, D. S., *The unbound Prometheus: technological change and industrial development in western Europe from 1750 to the present* (Cambridge, 1969).
Landes, D. S., *The wealth and poverty of nations: why some are so rich and some so poor* (1998).
McCloskey, D. N., ed., *Essays on a mature economy: Britain after 1840* (1971).
McCloskey, D. N. and Sandberg, L. G., 'From damnation to redemption: judgements on the late Victorian entrepreneur', *Explorations in Economic History*, 9 (1971), pp. 89–108.
McCulloch, J. R., *Early English tracts on commerce* (Cambridge, 1954).
MacLeod, C., *Inventing the industrial revolution: the English patent system, 1660–1800* (Cambridge, 1988).
Marshall, A., *Principles of economics* (8th edn. 1977).
Mazzaoui, M. F., *The Italian cotton industry in the later middle ages, 1100–1600* (Cambridge, 1981).
Mitchell, B. R., *British historical statistics* (Cambridge, 1988).
Mitra, D. B., *The cotton weavers of Bengal, 1757–1833* (Calcutta, 1978).
Mokyr, J., *The lever of riches: technological creativity and economic progress* (Oxford, 1990).
Mokyr, J., 'Editor's introduction: the new economic history and the industrial revolution', in J. Mokyr, ed., *The British industrial revolution:* an economic perspective (Boulder, Co., 1993), pp. 1–131.

Mokyr, J., 'Technological change, 1700–1830', in R. Floud and D. McCloskey, eds., *The economic history of Britain since 1700, vol. 1: 1700–1860* (Cambridge, 2nd edn. 1994), pp. 12–43.
Moosvi, S., 'The Indian experience, 1600–1900: a quantitative study', in K. N. Panikkar, T. J. Byres, and U. Patnaik, eds., *The making of history: essays presented to Irfan Habib* (New Delhi, 2001), pp. 328–58.
Morineau, M., 'The Indian challenge: seventeenth and eighteenth centuries', in S. Chaudhury and M. Morineau, eds., *Merchants, companies and trade: Europe and Asia in the early modern era* (Cambridge, 1999), pp. 243–75.
Mukerjee, R., *The economic history of India, 1600–1800* (Allahabad, 1967).
Mukund, K., *The trading world of the Tamil merchant: evolution of merchant capitalism in the Coromandel* (Hyderabad, 1999).
O'Brien, P. K. and Keyder, C., *Economic growth in Britain and France, 1780–1914: two paths to the twentieth century* (1978).
O'Brien, P. K., Griffiths, T., and Hunt, P., 'Political components of the industrial revolution: Parliament and the English cotton textile industry, 1660–1774', *Economic History Review*, 2nd ser., XLIV (1991), pp. 395–423.
Officer, L. H., *Between the dollar-sterling gold points: exchange rates, parity, and market behavior* (Cambridge, 1996).
Parthasarathi, P., 'Rethinking wages and competitiveness in the eighteenth century: Britain and South India', *Past and Present*, 158 (1998), pp. 79–109.
Prakash, O., *The Dutch East India Company and the economy of Bengal* (Princeton, N.J., 1985).
Ramaswamy, V., *Textiles and weavers in medieval south India* (Delhi, 1985).
Robson, R., *The cotton industry in Britain* (1957).
Rose, M. B., *Firms, networks and business values: the British and American cotton industries since 1750* (Cambridge, 2000).
Rothbarth, E., 'Causes of the superior efficiency of USA industry as compared with British industry', *Economic Journal*, 56 (1946), pp. 383–90.
Roy, T., *The economic history of India, 1857–1947* (New Delhi, 2000).
Sandberg, L. G., *Lancashire in decline: a study in entrepreneurship, technology and international trade* (Columbus, Ohio, 1974).
Saxonhouse, G. R. and Wright, G., 'New evidence on the stubborn English mule and the cotton industry, 1878–1920', *Economic History Review*, 2nd ser., XXXVII (1984), pp. 507–19.
Schumpeter, E. B., *English overseas trade statistics, 1697–1808* (Oxford, 1960).
Specker, K., 'Madras handlooms in the nineteenth century', in T. Roy, ed., *Cloth and commerce: textiles in colonial India* (New Delhi, 1996), pp. 175–217.
Sullivan, R. J., 'England's "age of invention": the acceleration of patents and patentable invention during the industrial revolution', *Explorations in Economic History*, 26 (1989), pp. 424–52.
Temin, P., 'Labour scarcity in America', *Journal of Interdisciplinary History*, 1 (1971), pp. 251–64.
Thomas, P. J., *Mercantilism and* the East India trade (New York, 1965 [reprint of 1926 edn.]).
Timmins, G., 'Technological change', in M. B. Rose, ed., *The Lancashire cotton industry: a history since 1700* (Preston, 1996, pp. 29–62.
von Tunzelmann, G. N., 'Technical progress during the industrial revolution', in R. Floud and D. McCloskey, eds., *The economic history of Britain since 1700, vol 1: 1700–1860* (Cambridge, 1981), pp. 143–63.
von Tunzelmann, G. N., 'Technology in the early nineteenth century', in R. Floud and D. McCloskey, eds., *The economic history of Britain since 1700, vol. 1: 1700–1860* (Cambridge, 2nd edn. 1994), pp. 271–99.
Twomey, M. J., 'Employment in nineteenth century Indian textiles', *Explorations in Economic History*, 20 (1983), pp. 37–57.
de Vries, J., 'Between purchasing power and the world of goods: understanding the household economy in early modern Europe', in J. Brewer and R. Porter, eds., *Consumption and the world of goods* (1993), pp. 85–132.
Wadsworth, A. P. and Mann, J. de L., *The cotton trade and industrial Lancashire, 1600–1780* (New York, 1968 [reprint of 1931 edn.]).
Wendt, I., 'Writing the rich economic history of the south Asian textile industry: spinners in early modern south India', in O. Prakash, G. Riello, and T. Roy, eds., *How India clothed the world: the world of South Asian textiles, 1500–1850* (Leiden, forthcoming).
Williamson, J. G., 'The evolution of global labor markets since 1830: background evidence and hypotheses', *Explorations in Economic History*, 32 (1995), pp. 141–96.
Wood, G. H., *The history of wages in the cotton trade during the past hundred years* (1910).
Woodcroft, B., *Subject matter index of patents of invention* (1857).
Young, A., *A six months tour through the north of England*, 4 vols. (1770).
Zeira, J., 'Workers, machines, and economic growth', *Quarterly Journal of Economics*, 113 (1998), pp. 1091–117.

Official publications

Parliamentary Papers, *Finance accounts: trade and navigation* (1801–50).

