New Findings on Living Standards and Human Capital in China in 18-20th Century

Joerg Baten
University of Tuebingen

Debin Ma
London School of Economics

Stephen Morgan
Nottingham University

Qing Wang
University of Munich

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Abstract:
This article mobilizes new time series data on real wages, physical heights and age-heaping to examine long-term trend of living standards and human capital for China during 18-20th century. Our findings confirm that gaps in living standards already existed between China and Northwestern Europe in 18-19th century. They also reveal a sustained decline in living standards and human capital at least in South China during the latter half of the 19th century with a a recovery in the early 20th century. Estimates based on age-heaping data reveal Chinese level of human capital were among the highest in the world during this period. We make a preliminary exploration of the historical implication of our findings.

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Abstract:
This article mobilizes new time series data on real wages, physical heights and age-heaping to examine long-term trend of living standards and human capital for China during 18-20th century. Our findings confirm that gaps in living standards already existed between China and Northwestern Europe in 18-19th century. They also reveal a sustained decline in living standards and human capital at least in South China during the latter half of the 19th century with a a recovery in the early 20th century. Estimates based on age-heaping data reveal Chinese level of human capital were among the highest in the world during this period. We make a preliminary exploration of the historical implication of our findings.

One prominent feature that underpins the phenomenal catch-up of East Asia from very low levels of per capita incomes in the post-War era is the rapid accumulation of physical and human capital. Some studies have traced its roots, especially in human capital accumulation. For example, data on average years of schooling compiled in Godo and Hayami (2002) show that the Japanese catch-up in human capital or formal education with that of the US in fact preceded that of per capita income 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]

Our paper presents several systematic series of real wages and heights based on large sample data to present a tentative but more integrated analysis of the long-term evolution of Chinese living standards in 19-20th century. Despite the voluminous literature on China's long and tumultuous 19th 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 the long-term trend in welfare and living standards. By

[1] Godo (200?) recently 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."

piecing together time series of real wage and anthropometric data, our findings confirm emphatically a general decline in living standards and human capital after the mid-19th century followed by a recovery only at the turn of the century.

From a comparative perspective, we find that Chinese living standards as measured by real wages and heights are closer to the relatively backward parts of Europe but lower than North-western Europe in the 18th and 19th centuries. So contrary to recent revisionism (Pomeranz 2000, Lee et al. 2002), our studies confirm the traditional view that divergences in living standards and per capita incomes between Europe and China already existed before the industrial revolution and only widened from the 19th century and afterward.

Finally, we integrate these series with a new data set on Chinese numerical abilities, which use age heaping as a proxy for numeracy. The degree of age heaping indicates how many persons in the society can report their age exactly, and how many can only report a rounded age (often rounded on multiples of five). Knowing one's exact age correlates with literacy and numeracy skills required for participation in commercial and industrial activities. Our age heaping measure reveals that human capital in terms of numeracy is fairly close to that of North-western Europe for 18th and 19th centuries. And they only fell behind Europe and Japan possibly during the mid-19th century.

Our preliminary findings show a high level of human capital in China and East Asia by international comparison. We explore the historical implication of this intriguing combination of relatively low living standards but high human capital in traditional China. We examine the importance of long-lasting institutions in China, such as the Civil-Service Examination, a unified written character, a precocious government bureaucracy, as well as the agrarian institution of independent small-holding peasantry coupled with a high degree of commercialization as possible explanatory factors. We further argue that the relatively large reservoir of human capital in early modern China and East Asia are highly relevant for explaining the rapid economic catch-up of East Asia in post-War era and China for the more

recent period. However, the delays and lags of economic catch-up within East Asia over the past two centuries point to the fact that human capital becomes effective factors only after required institutional and ideological changes were accomplished. This is best exemplified in the rapid industrial development that occurred in Meiji Japan during the second half of the 19th century.

In the following section, we will first discuss recent results about comparative studies on real wages in China and Europe, before we mobilize the second welfare indicator "height" in the second section. Section 3 will present new evidence on the share of Chinese who reported their exact age, and review the literacy, before the concluding section compares the welfare and human capital indicators.

1. Real Income and Wages in Comparative Perspective

In the debate on 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.[1] However, the evidence brought to this debate rested on rather fragile basis. 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 scraps of information about wages and prices (see for example Pomeranz, 2000, Lee and Wang, 1999). Our knowledge of real incomes in Europe is broad and deep because scholars since the mid-19th century have been compiling databases of wages and prices for European cities from the late Middle Ages into the 19th century when official statistics begin.

The ideal comparison would be to start with per capita GDP, which has the advantage of being the most commonly acceptable measure of the overall economy and productive

1. For instance Pomeranz, *Great Divergence*; Lee and Wang, *One Quarter of Humanity*; Allen, Bengtsson, and Dribe (eds.), *Living Standards in the Past*.

capacity, despite long-held caveats that stem from its inability to capture non-market income, such as the earnings of women and children that are often crucially important for welfare in developing economies, and distributional dimensions. Unfortunately, there are not any meaningful GDP series for China before the 20th century.[3] The influential estimates by Maddison are largely guess-work based on narrative history and backward projection from 20th century estimates. They might be useful as a guide for rough comparisons across benchmarks but they give little indication of fluctuations between the benchmarks.

Recent studies by Allen, Basino, Ma, Moll-Murata and van Zanden (2006, 2007) represent the most ambitious attempt to use real wages to fill this gap for China in the 18th and 19th centuries. The wage series in these studies are constructed from data obtained from Imperial ministry records, merchant account books and local gazetteers, which have been deflated using an 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 the information is most complete for these cities and 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 18-19th centuries than alternative estimates. Figure 1 reproduces one of their real wage comparisons,

[3] See Fukao, Ma and Yuan for a review of GDP data in East Asian.

[4] One obvious question is the representativeness of the largest and fastest growing cities in Europe. Allen 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 (Allen 2001).

which paint a less optimistic picture of Chinese or Asian performance than the revisionists suggest.

Insert Figure 1 here

Figure 1 confirms the traditional view that the divergence in living standards between major urban centres of China and those of the Netherlands and England was already present in the 18th century. The standard of living of workers in London and Amsterdam was much higher than that of workers in Beijing or Suzhou in the 18th century. But consequently, a major surprise is that unskilled labourers 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.

Secondly, from the mid-19th 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 20th century, enough progress had occurred in even the backward parts of Europe (as shown in Milan) and Japan that their standards of living were beginning to creep above those in China, while London increased the lead over Beijing. This is what we could term the second divergence in the modern era.

Thirdly, and most relevant for our perspective, is the trend in the real wage series for Beijing (Figure 1). This series is composed of three series linked together: the first one for the 18th century based on the average of large number of scattered wage information; the second series based on Sidney Gamble (1943), which runs in 1807-1903, 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 19th century. As seen in Figure 1, it points to a clear and sharp drop in real wages during the mid-19th century, a period known for the severe

economic dislocation caused by Taiping Rebellion that devastated large swathes of southern and eastern China.[5]

2. Heights of Southern Chinese in 19-20th Century

Historical data on heights have long been an important complementary measure of living standard (Fogel, 1994; Komlos, 1994; Steckel, 1995; 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, which was influenced by economic scarcity during the 19th century.[7] Regional differences in China are large with Northerners far taller than people in the South, though the differences

[5] The Taiping Rebellion originated in the southern province of Guangxi in 1850 and spread north into east China, where the rebels occupied Nanjing, the provincial capital of Jiangsu, until their military defeat in 1864. Up to 30 million people died from war and economic disruption. The population of the lower Yangzi provinces of Jiangsu and Zhejiang were halved. A sometimes linked rebellion in Guangdong province, the Red Turbans, resulted in a huge lost of life in the mid-1850s as a result of the Qing government suppression. For a concise summary see Spence, Jonathan D. (1999) The Search for Modern China, and Fredrick Wakeman, 1966 (1996) Strangers.

[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 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).

have narrowed during the 20th century.[8] This suggests that the population is genetically homogenous. For example, today's educated young male adults in Beijing are not much shorter than United States Americans. 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 175.5cm on average (China, Ministry of Education, 2002).[9]

As shown below, the height trend and with certain qualifications - levels - during the 19-20th century is likely to be a robust long-term indicator for nutritional quality and *ceteris paribus* the health and longevity of the Chinese. For this research, we mobilize several large data set of heights of Chinese who migrated from South China to the United States, Australia and Indonesia during the 19th and 20th century, or who worked in modern organisations in China.

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. The bulk of the observations were measured in 1885 and 1886, with some perhaps in 1887.[10] The occupations of the Chinese were described as "mainly agricultural," but not explained further. Fortunately, Hagen reported the ages so that the approximate birth years can be calculated. This data set has 12,678 subjects, aged from 23 to 50 years. Overall, Hagen measured no less than 15,722 Chinese males who had migrated to Indonesia. We discarded all those above 50 and below 23 years of age in order to ensure that there was no residual growth: below the age of 23, there was still substantial growth in this data set. A similar, but much smaller data set of migrants to Suriname (159 cases) for the birth-cohort of 1830-34 to

[8] In the early 20th century the difference between north and south China was in the order of 6cm, compared with about 3cm in 2000. See Morgan, Stature and Economic Development

[9] Large-scale anthropometric surveys of children 7-22 years have been conducted in China since the late 1970s on a five-cycle. Analysis of the 1979 to 1995 surveys and survey methodologies is reported in Morgan (2000).

[10] 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.

1845-49 are also presented. They confirm similar height levels with a clear downward trend from the 1840s.

2. *Prisoners in the United States.* Carson (2006) collected a sample of 1,463 Chinese male immigrant workers who were incarcerated in the United States typically for smaller crimes.

3. *Prisoners and Migrants in Australia*. Morgan (2008) has compiled a data set of 1,492 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, and when the alluvial gold petered out those who remained in Australia mostly turned to rural occupations. Later in the century there was another wave of Chinese migrants, also mainly from South China, but who seem to have a slightly different selection, comprising more small merchants, market gardeners and tradesmen who went to destinations such as Melbourne and Sydney (Morgan, 2006). Those who settled in northern Australia, such as Queensland or the Northern Territory, were engaged in mining and agriculture more typical of the earlier gold-rush period migrants, and usually shorter in stature that those resident in Melbourne. The current data set numbers 3,692 subjects.[11]

4. *Migrants to the US*. A small sample was obtained from ship lists of Chinese migrants to the US or returning to China. They are located in the *National Archives and Records Administration* (NARA) archive of the Pacific Region. 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.

5. *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

[11] Preliminary analysis of this data set was reported at the Asia Pacific Economic and Business History Conference, Brisbane, 2006, and expanded on at the Third International Conference on Economics and Human Biology, Strasburg, June 2006. An expanded data set of 20,000 Chinese migrant travellers (including duplicates for multiple exit and re-entries) was collected at the National Archives of Australia, Sydney Office, in 2007.

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 and other institutions.

Insert Figure 2

Figure 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 (Baten and Hira 2008). The prisoners incarcerated in Australia and the United States were somewhat taller and on a similar level (although switching from a slightly more positive selection of United States prisoners in the beginning to the opposite at the end). The tallest group in this early period was the United States migrant sample – those who were measured in United States ports were a slightly more positive selection than those who committed crimes in the same country, and were put into jail there. Finally, the railroad employee data set for South China had a slightly higher value in the 1890s, but only by about half a centimeter.

We believe this seems a reasonable reflection of the selectivity biases in the migrant sample used here. It is likely that those who went to more attractive locations and had to incur higher costs of migration 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 debt securitised against property or other family assets (summarised in Morgan, 2008). Moreover, if they went as late teenagers or in their early 20s, they might have achieved some catch-up growth, if their environment improved. On the other hand, quite a large group of Chinese contract workers had moved to the tobacco plantations of Indonesia, leaving from a country of quite modest nutritional circumstances to another not much better. Heights in Indonesia varied around 158-163 cm during the 1890s and 1900s (van der Eng, 1995), whereas the white native-born Australians were the tallest nation in the world at the

time, and the Americans were not much shorter (Steckel and Floud, 1997). 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, and were with higher literacy level 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 between the 1810s and 1830-40s, all series started a decline from the mid-19th century that coincided with the devastating Taiping rebellion. 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 20th century. The co-movement of these series is quite remarkable.

The region of birth is clearly relatively homogenous: the south, and the province Guangdong in particular. Only in the case of the government employees (sample 5) was the regional spread larger, but we took care to extract a series – unskilled railway workers from South China – who were comparable with those in the other data sets. Otherwise, all measured Chinese were reported to have come from the South or simply "China", which on testing were statistically indistinguishable from those identified as Canton or another South China place.[12] We can therefore assume that the estimates approximate trends in Southern China. In Figure 3, we make an attempt to summarize these disparate sample series into a single continuous but notional series that we believe as representative of the height trend of the lower and working class Southern Chinese male in 1910-1920, but with sufficient human capital and wealth to move to Australia. The series splices together the Australia prisoner series for 1810 to 1840 with the migrant series estimated for migrants in the Northern Territory, whose occupation backgrounds is similar to the prisoners, and the gap 1840-50 is

[12] The means for the clearly identified South China and "China" groups were compared using an independent t-test, which reported the differences as not significant at the 1 per cent level.

filled by simple linear interpolation.[13] We also plot this trend line against other height series for international comparison. These clearly indicate 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. The Chinese in Taiwan became rapidly taller during the early decades of Japanese colonialism, though the Japanese in the home island were unusually short but becoming taller at a rate of about 1.0 cm a decade from the late 19thth century.

Insert Figure 3 here

In combination with our real wage data, we can piece together a century of quantitative profile of Chinese welfare. The heights data confirm much more strongly than the real wage series the unmistakable fall in living standards and perhaps overall welfare at least in Southern China since the mid-19th century. In fact, as shown in the heights data, the fall seems to have sustained throughout the latter half of the 19th century. The recovery in heights following the turn of the century correspond reasonably with the evidences we have on real wage series as well as information on per capita GDP series (Rawski 1989, Ma 2008).

Chinese height trend set in an international perspective in figure 4 is extremely illuminating. Figure 4 clearly confirms the so-called second divergence where both Dutch and Italian heights started an upward trend from the mid-19th century with rapid industrialization, while Chinese height stagnated or declined thereafter. More interestingly, height trend of Japanese and Taiwanese (who were under Japanese colonial rule) were clearly on the rise from the late 19th century (Olds, 2003; Morgan and Liu, 2007), where for the Southern Chinese, this is an era marked, at its best, by a recovery. Overall, we see a case of China lagging behind the better performers during the 19-20th century.

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

3. Human Capital

Ronald P. Dore's landmark study in 1965 marked a milestone for the optimistic assessment 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, p. 241). Other studies have also pointed to the existence of a dynamic booking 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 (ibid, p. 241-2; Smith, 19xx).

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 to 45% and females at 2 to 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 (1648-1911) 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 fulfil demand for commerce, local administration or even agricultural production (Rawski, 1979, chapter 1, Li Bozhong, 2003).

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 (2003) detailed the development of a thriving private and commercial publishing industry to satisfy the demand of a large reading public. In particular, Rawski

(1985) pointed out that in comparison with early modern Europe, both the cost of paper and Chinese style of woodblock printing were cheaper and the market size of a reading public, due to the homogeneity of the written character, was larger in China.[14]

Besides literacy, scholars have also presented evidence of numeracy. Li (2003, p.8-9), in particular, noted the widespread diffusion of popular arithmetic textbooks, the use 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. These account books meticulously recorded transactions and various summary accounts and revealed a degree of sophistication in accounting techniques comparable to the European system before the rise of modern accounting (Yuan and Ma, 2008, and Gardella, 1992, for China; Jun and Lewis, 2006, for Korea).

Despite this qualitative evidence, any systematic quantification of the extent of numeracy for the early modern China is non-existent. However, recent new research on the use of age-heaping measurement as a way to capture numeracy has made quantification possible both in comparative and long-term perspectives. Mokyr (1983) pioneered the use of this "age heaping strategy" in the modern economic history context, and Duncan-Jones (1990) had suggested the use for the study of ancient economies (after some earlier demographic studies, see Bachi 1951). Only recently, Crayen and Baten (2008) have compiled large international data sets to use this method on a wide scale. The age-heaping strategy is based on the tendency of poorly educated people in the past to round their age because of missing number knowledge or discipline. For example, when asked their age they answer more often "40", when they may in fact be 39 or 41 years. In contrast, better educated people more often

[14] The major difficulty we have with researching publishing, readership and literacy levels for the 18th through to mid-20th centuries is that we have examples of the publications and qualitative detail on their use, but we do not have data for print runs and sales of publications, let alone any data on the relationship between the supply and readership (use) levels.

report their exact age correctly. The age heaping index (also called a Whipple index) ranges from 100 for complete accuracy between reported and expected age in a population.[15]

A'Hearn, Baten, Crayen (2006) found that the relationship between illiteracy and age heaping for Less Developed Countries (LDCs) after 1950 is relatively close. The age heaping and illiteracy for not less than 270,000 individuals that were organized by 416 regions, ranging from Latin America to Oceania, produced a correlation coefficient as high as 0.63. Compared to the PISA (Programme for International Student Assessment) results for numerical skills, the data yielded an even higher correlation coefficient. This has been confirmed for the 19th century as well (A'Hearn, Baten, Crayen 2006; Crayen and Baten 2008), and the latter sources has specified the relationship with schooling, and potential distortions for East Asia.

The advantage of age heaping methods for the study of human capital is that data are widely available for poorly documented countries such as China in the 18th and 19th century, because many people were asked for their age in a more or less standardized way, in courts, in the military, when they migrated, and so on. In addition, age accuracy reflects numerical skills even more than literacy skills, which could be more important for technical, commercial and craftsmen activities in the production process than possession of simple literacy. We apply those methods to East Asia here for the first time.

For numeracy, we mobilized five different data sets to study the development of Chinese age heaping patterns. We will describe the five data sets first, before adding the evidence together to a first preliminary history of age heaping in China (Figure 4). The most abundant data was available on Chinese migrants, who were mostly from the Southern province of Guangdong. These data sets comprised:

[15] The age-heaping index is a measure of the concentration or degree of age heaping. It is obtained by summing the returns (age as reported) between 23 and 62 years inclusive, for example, and calculating percentage that is born by the sum of the returns of years ending with 5 and 0 to one-fifth of the total sum. An index of <105 indicates less than 5 per cent inaccuracy (or heaping), while an index >175 indicates severe inaccuracy with more than three-quarters of the reported ages being incorrect.

(1) Chinese labour migrants to Indonesia: a total of 12,678 who were born in the middling decades of the 19th century. The data set and its characteristics have been described in detail in Baten and Hira (2008).

(2) Chinese males in the United States: a data set of 2,215 of whom all but 55 were born in China, which was extracted from the Individual Public Use Microdata Set (IPUMS) data set of 1850-1910. From this data set, we exclude the females (their number was too small for reliable analysis) and those who were born in the United States and estimate age heaping for those of the birth decades of the 1830s – 1880s.

(3) A sample of Chinese from the late 17th and 18th century who reported their age in the archives of the Imperial Ministry of Justice. Most of the crimes were property crimes, conflicts over rents, usury, domestic conflict, often involving average farmers and peasants. The Ministry Justice courts filed as published covered a large number of Chinese regions. Overall, we have 602 reported ages between 23 and 72, which allows one point estimate for the late 17th/early 18th century, when those Chinese appearing in the court records were born.

(4) We also collected a smaller data set of mid-19th century born Chinese soldiers in Beijing. This data set is particularly valuable, because our other 19th century data are from migrants, which raises questions selectivity biases since migrants are typical younger, better educated and more skilled than those who remain. 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.[16]

(5) Our final data set is the first China-wide census was undertaken in 1953. From those censuses, we analysed those born in 1900s and 1910s, in order to complement the 18th and 19th century data with an endpoint in the early 20th century.

[16] 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

Insert Figure 4

The results are given in Figure 4. In the late 17th/early 18th century data, we find a modest, but still remarkable age heaping of around 110. Most European countries reached such a low level not before the late 18th century, whereas the early 18th century levels of France and Germany were much higher (in the range of 160-220). We do not know yet what happened between the early 18th century and the 1830s, but during the latter period, age heaping was much higher (we organize the age heaping indices by birth decade, because most of the basic numeracy is acquired during the first decade of life).[17] Among the migrants to the United States, the age heaping index stood at around 150 in the 1830s. Even more remarkable, during the tumultuous periods of the 1840s and 1850s, it further increased to very high values of around 170-190. This interesting result is confirmed by the much larger data set on migrants to Indonesia, which also has its highest values in the 1840s and 1850s, and then declines. Finally, the Beijing soldiers had a similar age heaping in the period 1840-60, which is represented by a long dash in the graph: their index value stood at 150. This is important, as one could have imagined that the data stemming from immigrants to the United States and Indonesia could have been biased in a way that only those with lower education went on labour migration contracts. More likely, however, would be the other expectation that only Chinese with a certain education were able to migrate, especially to countries with higher income such as the United States. However, we find that both Chinese soldiers who were asked for their age in Beijing, as well as Chinese-born migrants to Indonesia and the United States had similar levels of age-heaping.[18]

[17] Might those results be influence by the age composition of the various samples? No, the United States migrant sample age is relatively constant at 30-36 (except for the middle cohort of those born in the 1860s, with an average age of 41).

[18] We also checked if heaping on dragon year birth might be more relevant. We assessed the main source for heaping dragon years (which were 26, 28, and 62 in the largest sample), and found that there is actaully a modest dragon heaping among the Chinese migrants to the United States but it is much lower than the heaping on multiples of five. A Whipple Index of 170 means that ages ending

The Chinese migrants to the United States as well as those to Indonesia improved quite strongly in numeracy during the 1860s to 1880s (birth cohorts), when the educational situation might have gradually improved in China.[19] Finally, those born in the early 20th century show almost no age heaping. Apparently, the disappearance of age heaping happened in China during the 19th century later than in Northern and Central Europe (Crayen and Baten 2008). Most Europeans stopped age heaping during some decade of the early 19th century, except Iberia, Ireland and Eastern and Southeastern Europe, who had this development half a century later. Interestingly, we also see a European parallel to the Chinese case of increasing age-heaping around mid-century: the Irish, who also experienced a murderous famine crisis during the 1840s, also had strongly increasing age-heaping around mid-century. In a somewhat milder version, Manzel (2008) observed this for Spain as well. This would suggest that the Chinese increase during the mid-19th century might have been caused by the famine and civil war crisis which lead to malnutrition and the infant protein malnutrition syndrome, to negatively impact the capacity to acquire numerical and other skills.

In sum, we observe only modest age heaping in 18th century China, but a strong numeracy crisis in the mid-19th century, followed by an improvement. It is remarkable how consistent this pattern holds across various data sets derived from various institutional contexts. Figure 5 organizes the various age heaping measures for China into one single notional series and casts it in international context. Taking an average of the Chinese age heaping values reported above yields values around 150 during the 1820s, rising to 170 during the mid-century crisis period, and afterwards declining until full age numeracy is reached among the birth cohort of the 1890s (with a Whipple Index of 100).

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with a 0 or 5 are 70 per cent more popular than their reference values, whereas dragon ages are 21 per cent more popular.

[19] 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.

In an international comparison, the Chinese were doing quite well, jointly with Western Europe and Eastern Europe, China was among the three world regions with the highest numeracy in the 19th century (Crayen and Baten 2008). In fact, we could make a general case for East Asia. The earliest source on Japanese age-heaping in 1879 (province of Kai, today Yamanashi, published 1882 by the same Tokei-in) that could be located so far (starting in the mid-19th century did not show any age-heaping for the birth cohorts of the early 19th century, nor did the Taiwan list from 1905, taken by the Japanese colonial government.[20] Figure 5 shows the UK and especially France reaching better values already in the early 19th century, but Poland, Russia (European part) and Ireland doing worse than China. The Figure also shows the sharp contrast with India or Turkey (and many other developing countries around the world) which seemed to be fare far worse than China.

Insert Figure 5 here

Summary and Conclusion

Based on new time series data on real wages, physical heights and age-heaping, we find there already existed gaps in living standards as measured by real wages and heights between China and Northwestern Europe in 18-19th century. We also find a sustained decline in living standards and human capital at least in South China during the latter half of the 19th century with a recovery in the early 20th century. Estimates based on age-heaping data reveal Chinese level of human capital were among the highest in the world during this period.

We believe our findings shed light on long-term trend in living standards and human capital in 19-20th century where historical evidences presented so far have either been descriptive or indirect. Further research should explore the historical implication of this intriguing combination of relatively low living standards but high human capital in traditional

[20] We thank Osamu Saito for providing those lists on Japan and Taiwan.

China, in particular their linkage with long-lasting institutions in China, such as a relatively open Civil-Service Examination, a unified written character, a precocious government bureaucracy, as well as the agrarian institution of independent small-holding peasantry. Pending upon further research, we believe that the relatively large reservoir of human capital in early modern China and East Asia may underpin the rapid economic catch-up of East Asia in post-War era and China for the more recent period. However, the delays and lags of economic catch-up within East Asia over the past two centuries point to the fact that human capital becomes effective factors only after required institutional and ideological changes were accomplished.

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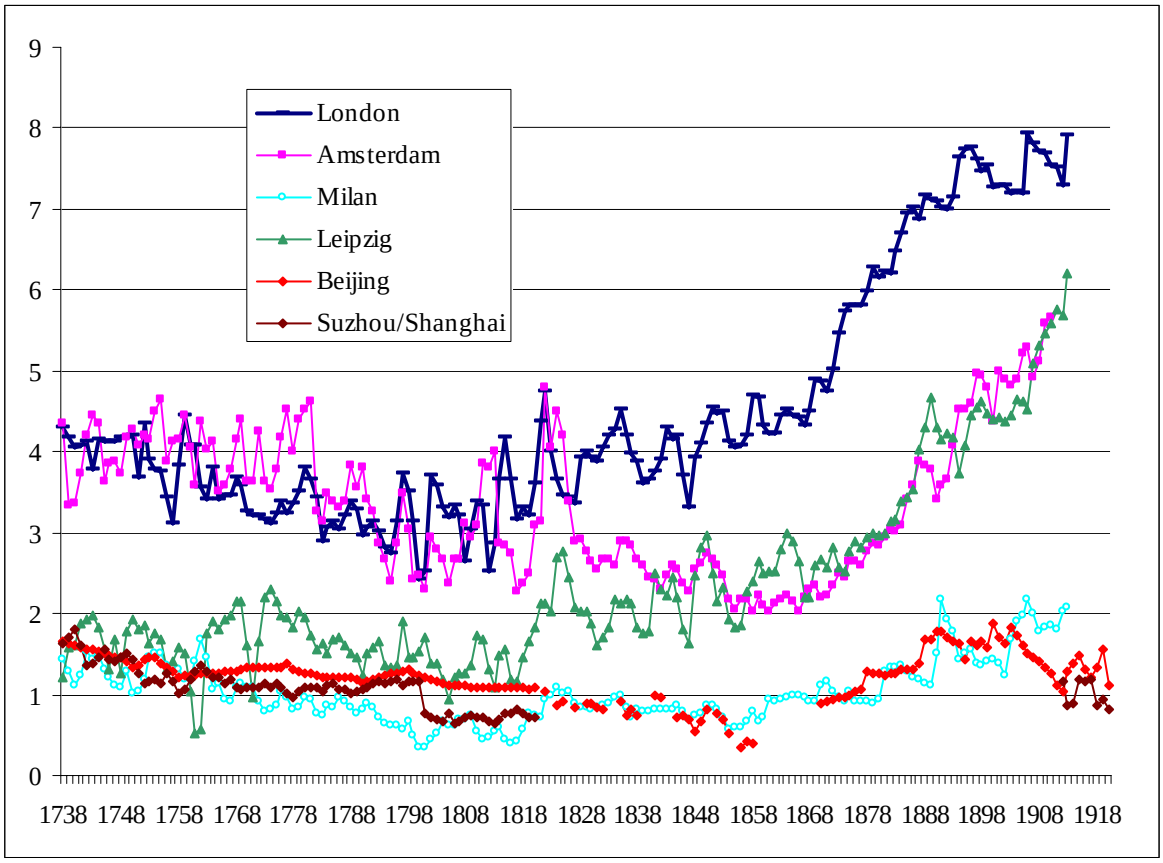
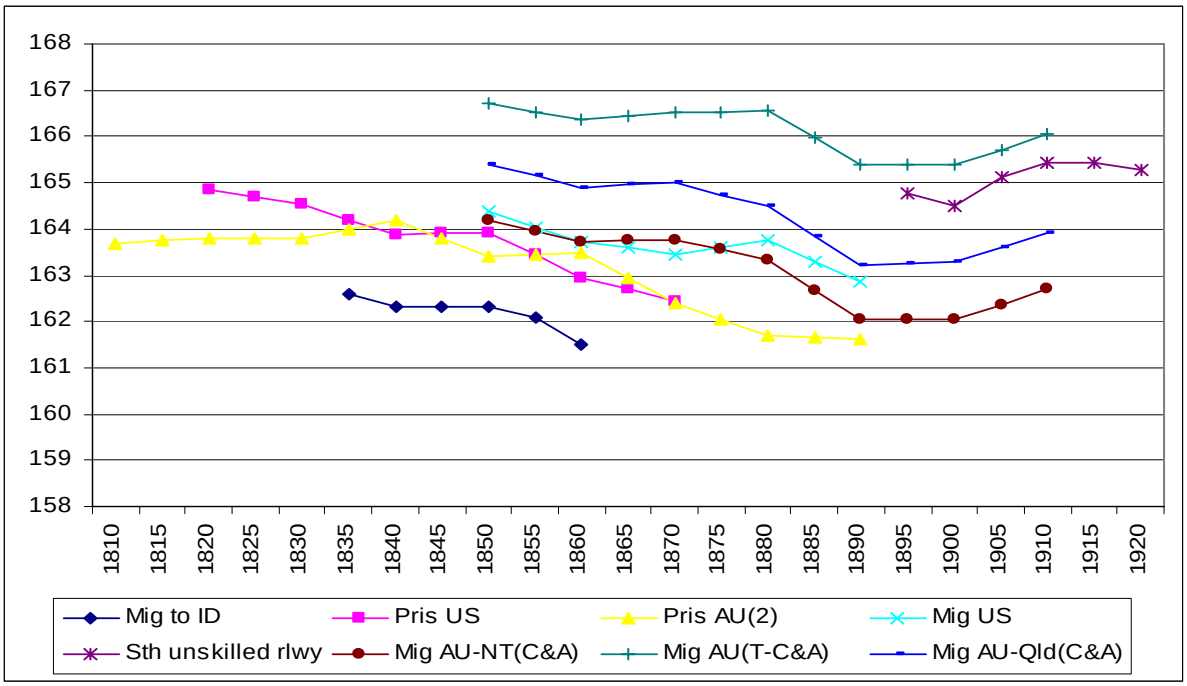
Figure 1: Real wage trends in China and Europe



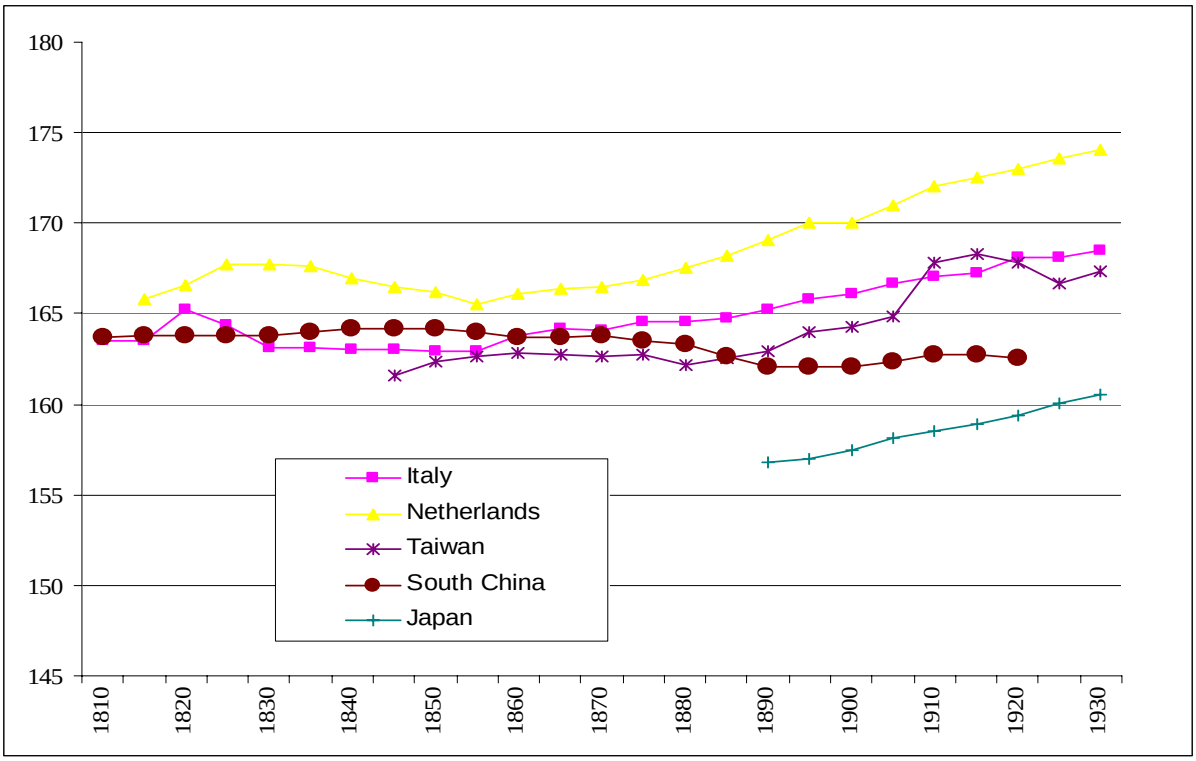
Source: Allen et al 2007.

Figure 2: Trends of Chinese height samples



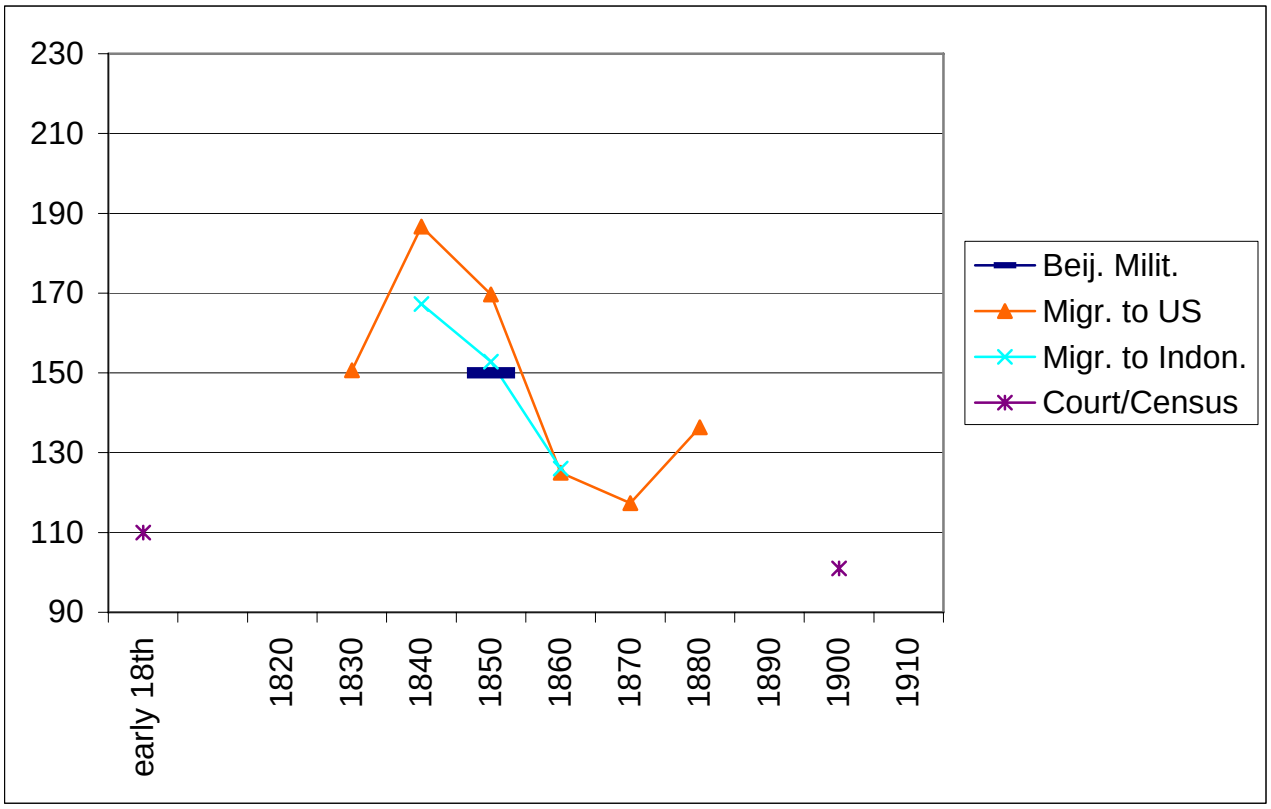
Notes: Mig to ID: Migrants to Indonesia; Pris US, Chinese prisoners in the United States; Pris AU(2), Chinese Prisoners in Australia; Mig US, Migrants to the United States; Sth unskilled rlwy, unskilled railway workers from south China; Mig AU-NT(C&A), Migrants to Australia's Northern Territory; Mig AU (T-C&A), Migrants to Melbourne/Victoria; Mig AU-Qld, Migrants to Queensland; the C&A indicates these series have been adjusted for age-related shrinkage, which is explained in Morgan (2008).

Figure 3: A Notional Trend of Secular Height of Southern Chinese in 1810s-1920s in Comparative Perspective



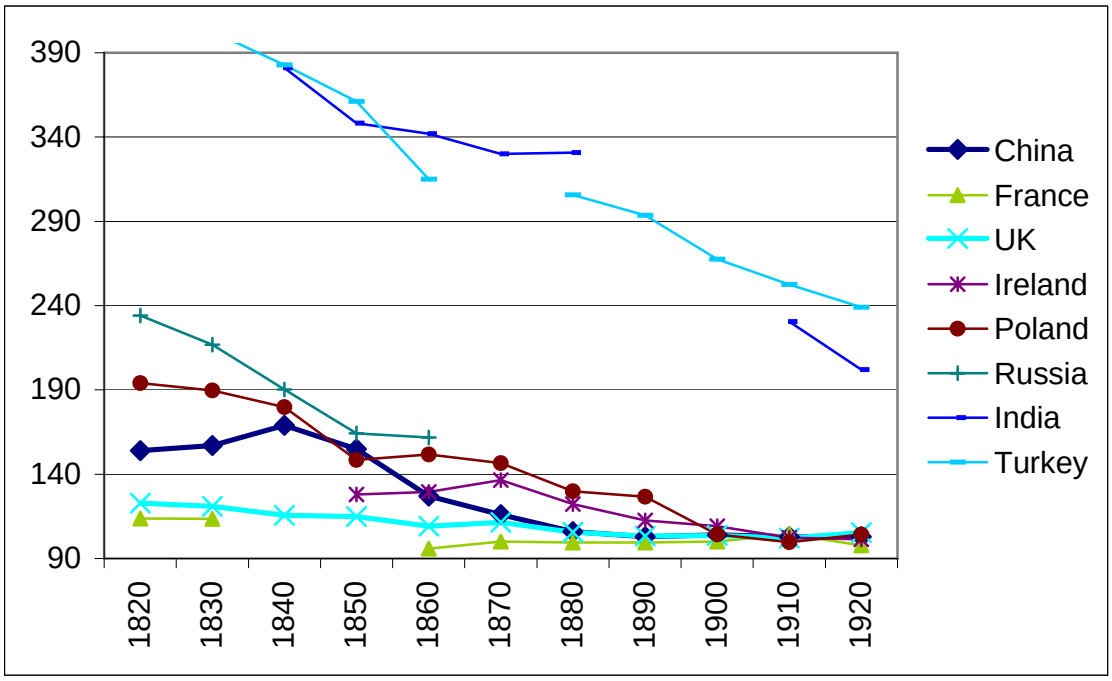
Notes: The South China series is an integrated series derived from splicing together the estimates from several separate data sets in a way to create a single series that approximates a nominally unskilled Chinese but with sufficient resources to be able to have migrated as a 'free' laborer. See text for details.

Figure 4: Trends of age heaping among a variety of Chinese samples



Note: We aggregate all age statements into the age groups such as 23-32, 33-42, 53-62 etc., and denote those born mostly in the 1850s as "1850" in the graph (even if this sometimes refers to those born actually 1847-56 etc). This methodology is common in the age heaping literature. This makes sure that age heaping is estimated conservatively, compare with the obvious alternative to estimate age brackets 20-29, 30-39, 50-59 etc. The problem with this method would be that the strongest heaping would be, for example, on age 50, and in societies with low life expectancies there are often much less survivors until age 53, compared to age 50. There are also much less survivors to age 59, compared with 55. Hence survival effect and age heaping effect would be mixed, whereas taking age brackets 23-32 etc places the most strongly preferred age 30 and 25 to the middle of the distribution, hence minimizing this risk.

Figure 5: 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 (2008). For India, this includes only the part of the country included in the late-19th C censuses (age heaping might have been higher for the 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 2008 judge as broadly representative for the Turkish average). We thank Dorothee Crayen for assisting us with relevant data and information.