Evolution of Living Standards and Human Capital in China in 18-20th Century: Evidences from Real Wage and Anthropometrics

Joerg Baten
University of Tuebingen

Debin Ma
London School of Economics

Stephen Morgan
Nottingham University

Qing Wang
University of Munich

Oct. 2008

Abstract:
This article mobilizes and integrates 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 the existence of a substantial gap in living standards between China and North-western Europe in 18-19th century. They also reveal a sustained decline in living standards and human capital at least in South China from the mid-19th century followed by a recovery in the early 20th 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.

JEL Classifications: N15, N35, O15, O53, I31

Keywords: China, Standard of Living, Human Capital, Real Wages, Height, Numeracy

Acknowledgement: 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 on Conference on "Economic Change around the India Ocean" in July 2008. Joerg Baten thanks for mobility support from ESF GlobalEuroNet and research assistance from Valeria Prayon 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.

Evolution of Living Standards and Human Capital in China in 18-20th Century: Evidences from Real Wage and Anthropometrics

Abstract: This article mobilizes and integrates 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 the existence of a substantial gap in living standards between China and North-western Europe in 18-19th century. They also reveal a sustained decline in living standards and human capital at least in South China from the mid-19th century followed by a recovery in the early 20th 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.

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. The most relevant study is the work of Godo and Hayami (2002), which compiled data on average years of schooling to 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] Similarly, 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 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 human capital in 19-20th century based on the integration of large-sample based real-wage and anthropometric evidences. Our data series

[1] Godo (2006) 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."

confirm 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. They also reveal Chinese living standards as 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. However, in contrast to the findings of real wages and heights, our age heaping index which measures Chinese numerical abilities reveals a relatively high level Chinese human capital closer to that of North-western Europe for 18th and 19th centuries than the comparable comparison of living standards.

We explore the historical implication of this rather intriguing combination of relatively low living standards but high human capital in traditional China. The concluding section makes some preliminary discussion on the unique institutional features in traditional China such as Civil-Service Examination, a unified character-based language and a precocious government bureaucracy as relevant 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 relatively 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 the modern era once the required institutional and ideological changes were accomplished.

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

1. Real Wages

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. However, the evidence brought to this debate rested on rather fragile basis, using indirect comparison on scattered output, consumption or demographic data. This is in contrast to our knowledge of real incomes in Europe 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. [2]

The ideal comparison would be per capita GDP, which has the advantage of being the most commonly acceptable measure of the overall economy and productive capacity, despite the long-held caveats that it was not able to capture non-market income that are often crucially important for welfare in developing economies, and distributional dimensions. Unfortunately, there are no 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 (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

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

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

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 18-19th centuries than any available alternative estimates. Figure 1 reproduces one of their real wage comparisons, 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

[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).

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.

2. Heights

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.[5]

[5] 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.

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.[6] 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.[7]

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. We believe that the reported 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 living standards at least for the southern Chinese. Below we explain our data sets in six different categories.

Conversely, where inequality worsens average height might decline even in the presence of increasing GDP. See Steckel, 1995.

[6] 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).

[7] 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, 2008. Also, 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). 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).

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.[8] The occupations of the Chinese were vaguely 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 1830-34 to 1845-49. As explained later, they reveal very similar height features to migrants to Indonesia.
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 petty crimes.
3. *Prisoners 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. When the alluvial gold petered out, those who remained in Australia mostly turned to rural occupations.
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 comprised more of small merchants, market gardeners and tradesmen who went to destinations such as Melbourne and

[8] 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.

Sydney (Morgan, 2006). Those who settled in northern Australia, such as Queensland or the Northern Territory, were engaged in mining and agriculture which were more typical of the earlier gold-rush period migrants, and were also shorter than those residing in Melbourne or Sydney. The current data set numbers 3,692 subjects.[9]

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.[10] Only in the case of the government employees (sample 6) was the regional spread larger, but we took care to extract a series – unskilled railway workers from South China. We can therefore assume that the estimates approximate trends in Southern China.

[9] The data are from the National Archives of Australia (NAA) series B13/0, B78/1, J2482, and E752/0. Detailed description of these series can be obtained from the NAA online search facility at www.naa.gov.au.

[10] All measured Chinese immigrants were reported to have come from the South or simply "China." Our statistical t-test reveals that the differences in mean heights for migrants identified as Canton or another place of South China, or China and "China" groups as indistinguishable at the 1 per cent level.

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.[11] 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 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). 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 up until the 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

[11] 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.

the last century with a rebound and recovery in the first two decades of the 20th century. The co-movement of these series is remarkably consistent.

In Figure 3, we 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 1810-1920, 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 filled by simple linear interpolation.[12] 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, after which their heights began to rise above the Southern Chinese. Figure 3 thus 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.

Insert Figure 3 here

Perhaps more interesting is that the Southern Chinese seemed to perform poorly in the East Asian context. As shown in the data, although Japanese started as unusually short but managed to grow at a rate of about 1.0 cm a decade from the late 19th century. Similarly, Chinese in Taiwan (largely of South China origin) also grew taller rapidly from the early decades of Japanese colonialism in the late 19th century (Olds, 2003; Morgan and Liu, 2007), Overall, we see a case of China lagging behind the better performers during the 19-20th century.

[12] 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. 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 only recently, Crayen and Baten (2008) have compiled large international data sets on a global scale. 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:

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

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 as high as 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 (see A'Hearn, Baten, Crayen 2006). A'Hearn, Baten, Crayen 2006 and Crayen and Baten 2008 have also confirmed this correlation for the 19th century data. Age-heaping index reflects numerical skills even more than literacy skills, which could be more important for technical, commercial and craftsmen activities.

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 to traditional China. We perform a test to examine the linkage between literacy and numeracy using an exceptional sample of Chinese migrants in the US, 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 2,435 Chinese males in the United States, 220 of which were U.S. born. The data were extracted from the Individual Public Use Microdata Set (IPUMS) data set of 1850-1910 is a representative sample based on the U.S. censuses. We exclude the females (their number was too small for reliable analysis) calculate age heaping for those of the birth decades of the 1830s – 1880s.

For our purpose, we use the standard occupational classification to create nine categories for the 2,435 Chinese immigrants between 23 and 72. The occupations ranged from income level of 600 $ per year in 1950 (group 1) to between 1,500 and 2,000 (group 5), and to more than 2,500 (group 9). The distribution of incomes was not linear, and some occupation accounted for a large share of the Chinese population, so we took care that sufficient numbers of observations fell in each group.

Figure 4 reveals a high negative relationship (with a correlation coefficient of -0.8) between literacy rates and whipple index for these nine occupation categories. More interestingly, this correlation seems actually tighter than the correspondence between income categories and literacy rates. While the higher income groups 7 to 9 has the highest literacy, and the poorest group 1 the lowest, income 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.[13]

Insert Figure 4

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 17th and 18th century. The court files 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.[14]
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-19th century. Although small in sample size, this data set is particularly valuable as other 19th 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.[15]
4. We have 8209 subjects of Sydney-resident southern Chinese immigrants located in ST84/1 series at the NAA, Sydney Office.

[13] 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 modest than heaping on multiples of 5s.

[14] 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 routine memorial copies in it contain information on land prices, land rents, interest rates ("usury") referring to a variety of Chinese regions. A small part of these memorials, especially from the Qinanlong 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 in those sources are always self-reported, which is important for our study.

[15] 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

5. The data set of 2,435 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 18th and 19th century data with an endpoint in the early 20th century.

Figure 5 plots the whipple indices of the different data series.[16] The late 17th and early 18th 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 18th century, whereas the early 18th century levels of France and Germany were much higher (in the range of 160-220).[17] We do not have data for the period between the early 18th century and the 1830s. But for series starting from the 1820s, the picture that emerged in figure 5 for 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.[18] 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 corhorts) onward, figure 5 reveals a drastic improvement in age-heaping almost across all the

[16] For calculating age-heaping, 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 to ensure that age heaping is estimated more conservatively than the obvious alternative to estimate age brackets 20-29, 30-39, 50-59 etc. 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.

[17] 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. While we need to be careful about the interpretation of small sample data, we find that it may point to a low level of literacy and numeracy among the class of seamen who were usually social outcasts barred, for example, from taking part in the Civil-Service Examination system, see Wakemen Jr. 1966, chapter 1. Data on Chinese seamen are from Ryūkyū ōkoku hyōjōsho monjo henshū iinkai, 1988.

[18] For the US 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), so we believe that our result is not biased by possible differences in the age composition of the various samples.

data series.[19] By the early 20th century, age-heaping seems to have largely disappeared based on the National census data of the 1950s.[20]

Insert Figure 5

Figure 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 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). Despite the mid-19th century surge, the Chinese degree of numeracy thus measured were impressive by international comparison, being among the highest in the world along with Western and Eastern Europe in the 19th century (also see Crayen and Baten 2008). In fact, we could make a general case for East Asia. The earliest source on Japanese age-heaping in 1879 (published 1882 for the province of Kai which is modern-today Yamanashi) that could be located so far 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.[21] Figure 6 shows that while UK and France were achieving better values already in the early 19th century, Poland, Russia (European part) and Ireland were actually doing worse than China with India or Turkey (and many other developing countries around the world) faring far worse.

Insert Figure 6 here

[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.

[20] We also calculated whipple index for the data series of the railway and other modern organisations for the early 20th 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, as these data also recorded birth dates and years, making the calculation of age-heaping index highly problematic.

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

Summary: towards an Integrated Narrative of Living Standards and Human Capital

The anthropometric and real wage evidences presented in this article allow us to piece together a quantitative profile of Chinese welfare and human capital for the 18-20th century 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-19th 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 destruction of lives and properties during the mid-1850s (see Spence 1999 and Wakeman, 1966). Our data reveals the severe negative impact of mid-19th 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 (see 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 19th 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 to return 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 (see Mary 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. While further research is needed to explain the sustained decline in heights during the latter half of the 19th century, we feel it could also be a reflection of a region-specific decline in South China with Canton lose its her eminent trading port status to Shanghai or other treaty ports in the post-Opium War era.

On the surface of it, the recovery in heights from the beginning of the 20th century - an era marked by the imminent dynastic collapse and national disintegration - seems rather surprising and counter-intuitive. However, recent scholarships have emphatically shown that the first three decades of the 20th century – despite the political and civil strife – were also marked by the onset of a region-based spurt of industrialization and modernization (Rawski 1989, Ma 2008).

Finally and possibly the most important, this study places the new time series data in an international context and reveals a rather intriguing combination of relatively low living standards with high human capital in traditional China. While our findings of a relatively low living standards 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, 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, 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 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 forged by the homogeneity of the Chinese written character. Rawski (1985) also noted the relatively low cost of paper and Chinese style of woodblock printing.

Besides literacy, scholars have also presented direct historical evidence of numeracy. Li (2003, p.8-9), 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 (see Gao 1982 and 1988, Gardella, 1992, for China; Jun and Lewis, 2006, for Korea).

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 Woessman (2008) shows 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 (p.653). Further research should explore the possible historical root of this 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, a precocious government bureaucracy, as well as the agrarian institution of independent small-holding peasantry.

It is important to note that these institutions 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 after 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 empirical insights as expounded for example in Glaeser et al (2004). It serves as a fresh reminder that by focusing exclusively on the comparison of physical living standards, 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.

References

A'Hearn, B., 2003. Anthropometric evidence on living standards in northern Italy, 1730-1860. *Journal of Economic History* 63, 351-81.

A'Hearn, Baten and Crayen, 2006. "Quantifying Quantitative Literacy: Age Heaping and the History of Human Capital" *UPF working paper* 996.

Allen, Robert 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, Robert C., Jean-Pascal Bassino, Debin Ma, Christine Moll-Murata, and Jan Luiten van Zanden, 2007. "Wages, Prices and Living Standards in China, Japan and Europe", Global Prices and Income Project, http://gpih.ucdavis.edu/Papers.htm.

_____, 2008. "Wages, Prices, and Living Standards in China, 1738-1925: in Comparison with Europe, Japan and India" Unpublished paper: http://personal.lse.ac.uk/mad1/

Bachi, R., 1951. "The tendency to round off age returns: measurement and correction". Bulletin of the International Statistical Institute 33, 195-221.

Bassino, Jean-Pascal and Debin Ma, 2005. "Wages and Living Standards of Japanese Unskilled Laborers in 1720-1913: an International Comparison", *Research in Economic History*, Vol. 23, Chapter 7.

Baten, Joerg, 2006. Global Height Trends in Industrial and Developing Countries, 1810-1984:An Overview. Working Paper, Tuebingen.

Baten, Joerg and Sandew Hira, 2008. "Anthropometric Trends in Southern China, 1830-1864", *Australian Economic History Review* 48-3 (forthcoming).

China, Ministry of Education, et.al. 2002. 2000 年中国学生体质与健康調研报告 (2000 nian Zhongguo xuesheng tizhi yu jiankang diaoyan baogao: Report on the physical fitness and health surveillance of Chinese school students), Beijing: Gaodeng jiaoyu chubanshe.

Crayen and Baten, 2006. "Numeracy, Inequality, Age Heaping, and Economic Growth: New Estimation Strategies for Western Europe and the U.S. (17th - 19th centuries)" Working Paper Tuebingen.

Crayen, D. and Baten, J. 2008. "Global Trends in Numeracy 1820-1949 and its Implications for Long-Run Growth", Working Paper Tuebingen.

Dore, Ronald P., 1965. *Education in Tokugawa Japan*. London: Routledge & Kegan Paul.

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., Debin Ma and Tangjun Yuan, 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*, Vol. 53 Issue 3: pps?.

Gamble, Sidney D. 1943. "Daily Wages of Unskilled Chinese Laborers, 1807-1902." *The Far Eastern Quarterly*, Vol. 3, No. 1: 41-73.

Gardella, Robert, 1992. "Squaring Accounts: Commercial Bookkeeping Methods and Capitalist Rationalism in Late Qing and Republican China." *The Journal of Asian Studies* 51(2): 317-39.

Glaeser, E. R. La Porta, F. Lopez-de-Silanes and A. Shleifer, 2004. "Do Institutions Cause Growth", *Journal of Economic Growth.* Vol. 9, No. 3. 271-303.

Godo, Yoshihisa, and Yujiro Hayami, 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), 961–78.

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, Daoyang (郭道杨) (1982)《中国会计史稿》(Chinese Accounting History) Vol. 1,Wuhan: Chinese Finance and Economic Press 1982.

_____ (1988) 中国会计史稿 (Chinese Accounting History) Vol.2: Beijing: Chinese Finance and Economic Press. 1988.

Hanushek, E. and Woessmann, L. (2008), "The Role of Cognitive Skill in Economic Development" *Journal of Economic Literature* 46:3, 607-668.

Hayami, Akira and Hiroshi Kito, 2004. "Demography and Living Standards". In Akira Hayami, Osamu Saito, Ronald P. Toby, eds, *Emergence of economic society in Japan, 1600-1859 – The economic history of Japan: 1600-1990*, vol. 1, Oxford: Oxford University Press, 2004. pp. 211-246.

Historical Archive No. 1 and History Institute of the Chinese Academy of Social Sciences (eds.) (1981), Historical Materials on Tenancy Relationship in the Censorial Section of the Board of Punishments during the Qianlong period. Beijing.

Jun, S.H. and James B. Lewis, 2006. "Accounting Techniques in Korea: 18th-century Archival Samples from a Non-Profit Association in the Sinitic World." *Accounting Historians Journals*, Vol. 33, No. 1: 53-87.

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, Paul, 1994. "The Myth of Asia's Miracle". Foreign Affairs 73(6), Nov/Dec: 62-79.

Lee, J., and Wang, F., 1999. *One Quarter of Humanity: Malthusian Mythology and Chinese Realities, 1700-2000.* Cambridge, Mass.: Harvard University Press.

Li, Bozhong, 1998. Agricultural development in Jiangnan, 1620-1850. St. Martin's Press, New York.

Li, Bozhong (李伯重), 2003. "八股之外；明清江南的教育及其对经济的影响" (Beyond Eight-Legged Essay: Education and its impact on Jiangnan Economy in Ming and Qing). 清史研究 (Research in Qing History), Vol. 4, 2004.

Ma, Debin, 2004. "Growth, Institutions and Knowledge: A Review and Reflection on the Historiography of 18th-20th Century China", *Australian Economic History Review*, Vol. 44, Issue 3, pp??

_____ (2008). "Economic Growth in the Lower Yangzi Region of China in 1911-1937: A Quantitative and Historical Perspective". *The Journal of Economic History*, Vol. 68, No. 2 (June 2008) pp. 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.

Manzel, 2008, "Subsistence Crises, Education and Economic Development: the Impact of Subsistence Crises on Human Capital Formation". Working Paper Univ. Tuebingen.

Meng and Gamble, 1926. "Wages, Prices, and the Standard of Living in Peking, 1900-1924." *The Chinese Social and Political Science Review,* Vol. 20 (1926): 1-113.

Mokyr, Joel. 1983, Why Ireland starved: A quantitative and analytical history of the Irish economy, 1800-1850. London: Allen & Unwin.

Morgan, Stephen L. 2000. "Richer and Taller - – Stature and the Standard of Living in China, 1979-1995", *The China Journal*, 44, pp. 1-39.

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

Morgan, Stephen L., 2006, "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, Queensland University of Technology, Brisbane, 16-18 February. Available from: http://www.uow.edu.au/commerce/econ/ehsanz/pdfs/Morgan1.pdf

Morgan, Stephen L., 2008. "Stature and Economic Growth in China during the Nineteenth Centrury." *Explorations in Economic History* (forthcoming)

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), 617-20.

Olds, K., 2003. The Biological Standard of Living in Taiwan under Japanese Occupation. *Economic and Human Biology* 1(2), 187-206.

Pomeranz, Kenneth, 2000. *The Great Divergence* (Princeton: Princeton University Press).

Rawski, Evelyn, 1979. *Education and Popular Literacy*. Ann Arbor: The University of Michigan Press.

Rawski, Evelyn, 1985 “Economy and Social Foundation of Late Imperial Culture.” In David Johnson, Andrew J. Nathan, and Evelyn S. Rawski, eds, *Popular culture in late imperial China*, Berkeley : University of California Press.

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

Ryūkyū ōkoku hyōjōsho monjo henshū iinkai (ed.). *Ryūkyū ōkoku hyōjōsho monjo* Naha 1988.

Smith, Thomas C., 1988. *Native sources of Japanese industrialization*, 1750-1920. Berkeley, Calif.: University of California Press

Spence, Jonathan D. (1999) *The Search for Modern China* 2nd ed. New York: W.W. Norton.

Steckel, R. H., 1995. Stature and the Standard of Living. *Journal of Economic Literature* XXXIII, 1903-1940.

Steckel, R. H., Floud, R., 1997. “Conclusions.” In: Richard Steckel and Rodney Floud, (Eds.), *Health and Welfare during Industrialization*. University of Chicago Press, Chicago, pp. 423-449.

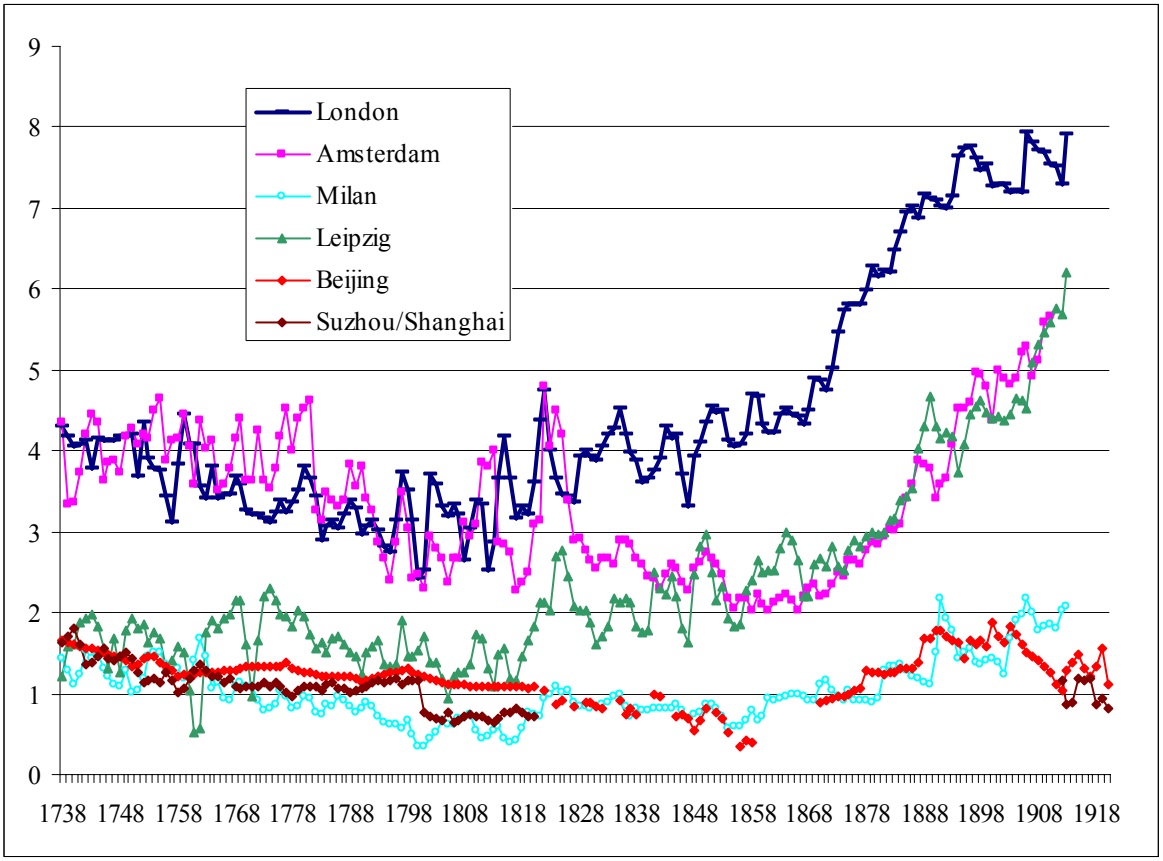
Sugihara, K. 2007. “The Second Noel Butlin Lecture: Labour-intensive Industrialisation in Global History”, Australian Economic History Review 47(2): 121-54

van der Eng, P., 1995. “An Inventory of Secular Changes in Human Growth in Indonesia”. In: Komlos, J. (Ed.), *The Biological Standard of Living on Three Continents: Further Explorations in Anthropometric History.* Westview Press, Boulder, pp. 175-188.

Wakeman, Frederic E., 1997 (1966). *Strangers at the Gate: Social disorder in South China, 1839-1861*. Berkeley: University of California Press.

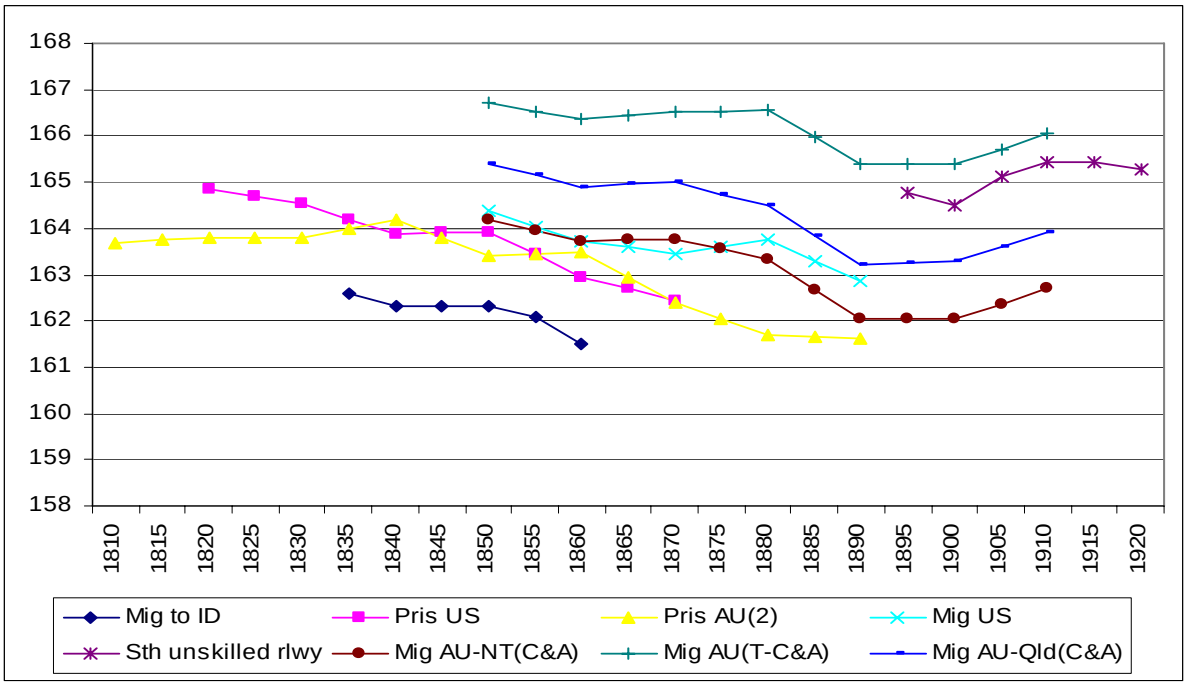
Wright, Mary (1962) *The Last Stand of Chinese Conservatism: the T’ung-Chih Restoration 1862-1874.* Stanford University Press.

Figure 1: Real wage trends in China and Europe



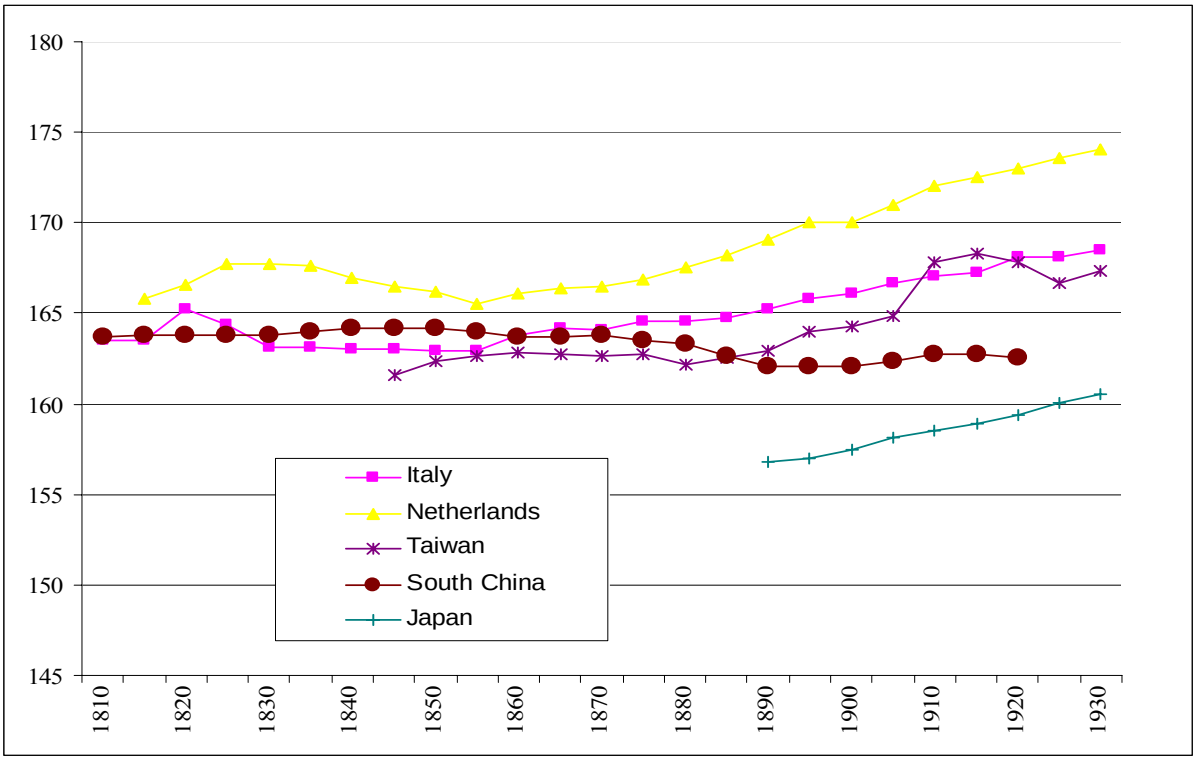
Source: Allen et al 2007.

Figure 2: Trends of Chinese height samples



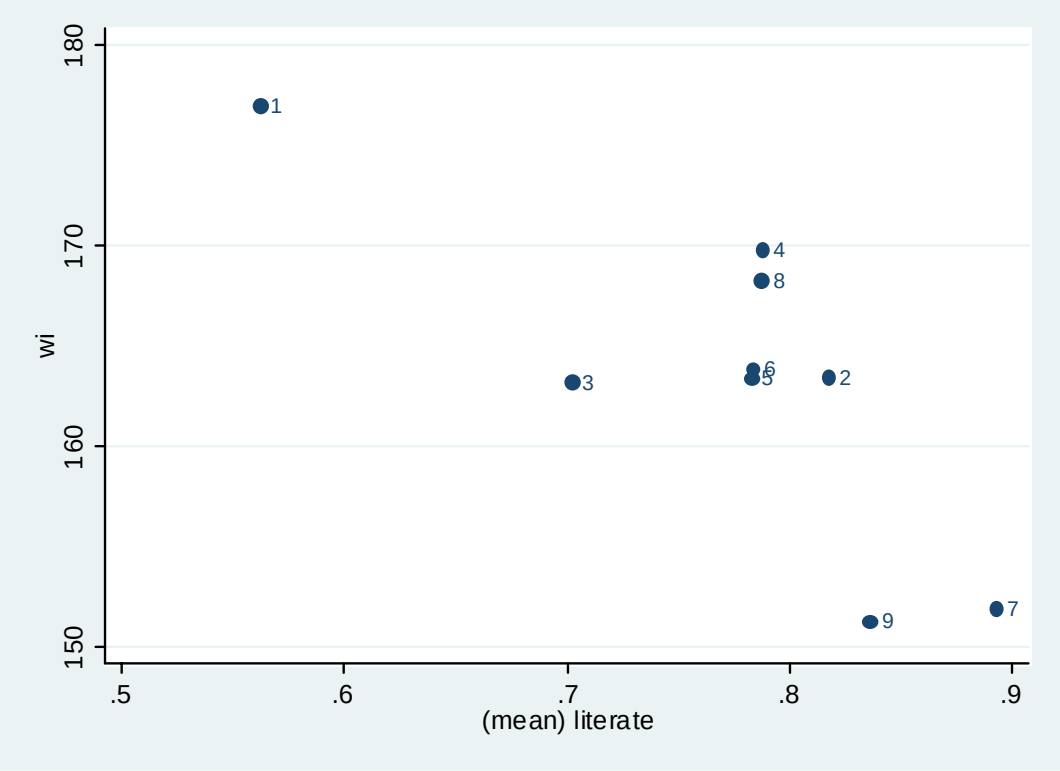
Notes:
Mig to ID: Migrants to Indonesia;
Pris US, Chinese prisoners in the United States;
Pris AU(2), Chinese Prisoners in Australia;
Mig US, Migrants to the United States;
Sth unskilled rlwy, unskilled railway workers from south China;
Mig AU-NT(C&A), Migrants to Australia's Northern Territory;
Mig 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 as explained in Morgan (2008).

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



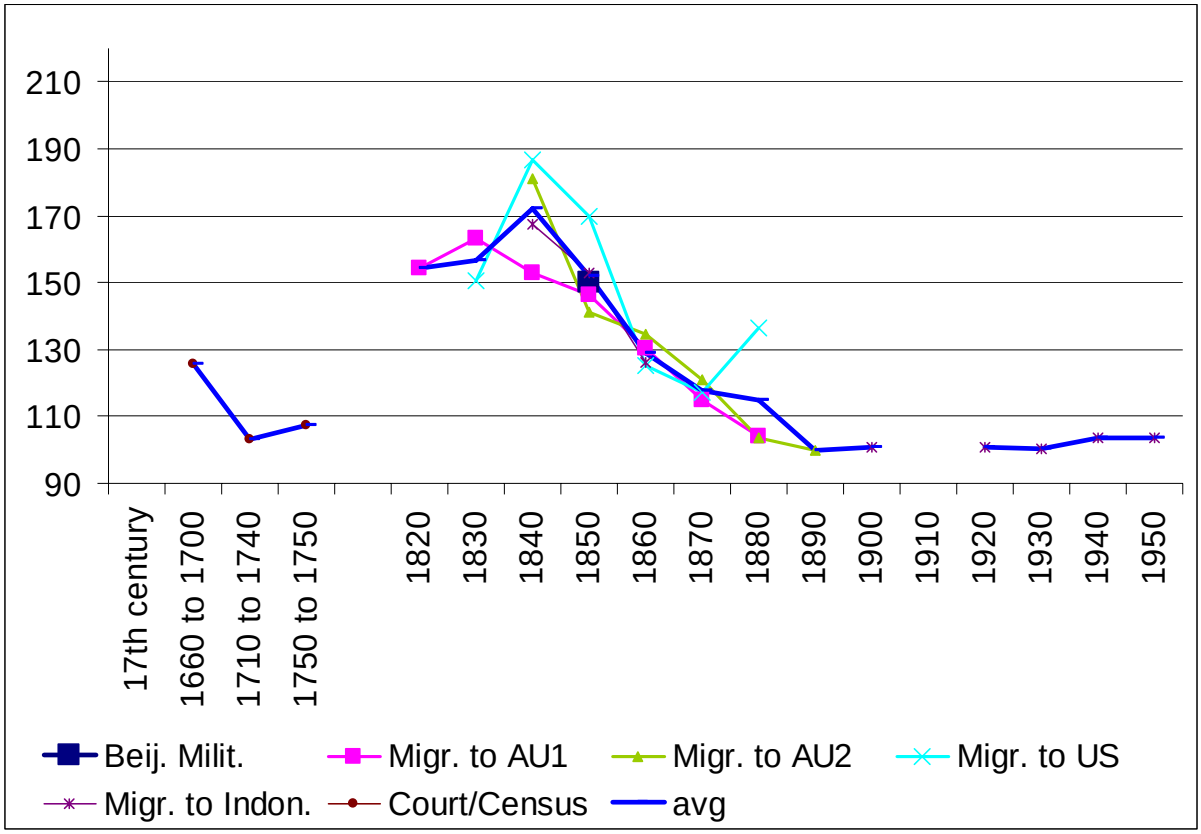
Notes: see the text

Figure 4: Literacy and Age heaping (Whipple Index) by nine different occupational classes among Chinese immigrants to the U.S.



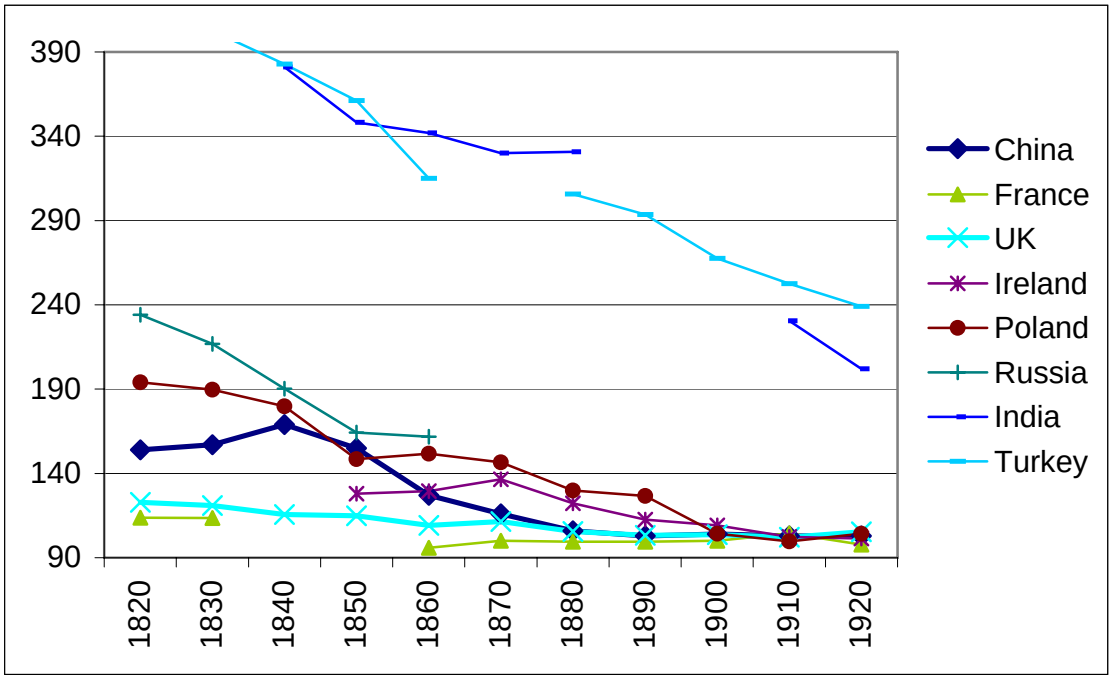
Notes: See the text. The sample size for the nine occupational categories (from one to nine) is: 178, 153, 239, 268, 202, 415, 158, 627, and 195.

Figure 5: Trends of age heaping among a variety of Chinese samples



Note: see the text.

Figure 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 (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.