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Peter H. Lindert

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ABSTRACT

Economic historians' Divergence debates since 2000 have asked a different question from that asked by Angus Maddison. The issue has become "when did countries' contemporaneous purchasing powers diverge?", not "when did countries' productivity grow at different rates?" The two questions have different answers, especially before 1914. Using pre-1914 prices to compare real purchasing powers on six continents, this article sketches some historical geography of the departures from the conventional Maddison estimates.

One underlying reason for the divergence between projections back from 1990 and direct price comparisons from long ago is that before the great 1870-1914 wave of trade globalization, consumer staples were not traded over great distances, and regions specialized in narrow luxury trade. Inter-continental price ratios for subsistence goods thus varied more widely than since 1914.

The new measures open up a new economic history of international differences in purchasing power before 1914. Northwest Europe was further ahead of Asian countries than earlier measures have shown. The discrepancy stems from a Gerschenkron effect, magnified before 1914 by Engel effects as well as by Balassa-Samuelson. Yet Northwest Europe was behind America and Australia across the nineteenth century, consistent with the same accounting framework but not with Maddison's estimates.

Peter H. Lindert
Department of Economics
University of California, Davis
Davis, CA 95616
and NBER
phlindert@ucdavis.edu

I. What do we want to compare?

To understand how some countries became richer than others, we want to know how and when their relative purchasing power differed in the past. To trace out how we got to today's gaps between rich and poor, say between Britain and Asia, requires answering one of these two similar-looking questions for any past date, say 1700:

(1) How did the purchasing power of the average British resident compare with that of the average Asian back in 1700, given what we know about their average purchasing powers today, and about their GDP growth rates since 1700?

(2) How did the purchasing power of the average British resident compare with that of the average Asian back in 1700, given their nominal (current-price) GDPs and the prices they paid back in 1700?

At first glance, the two questions might seem to be the same, and might seem have a common answer. After all, the questions read exactly the same, until we read about what data are given. Wouldn't we get the same answer either way, if we had full data?

The two questions would indeed have such equivalent answers if we lived in a world where each country produced only one good with only one human input. Suppose that every country's population produced only one good called "GDP thing," which could be used for anything. That is, suppose that this GDP thing could be eaten, shaped into a factory, or made to perform a Bach cantata. The difference in the two countries' per-person purchasing power would be the same thing as the difference in their average human productivity in any year. We can compare their average abilities to buy the GDP thing back in 1700, either by finding the ratio of their quantities per person today, and knowing how fast the two average quantities have grown since 1700, or by going to the archives and finding its values and prices in the two places back in 1700.

Yet we live in a world of multiple products, and the "index number problem" is massive. For the real world of multiple products and varying budget shares, the different kinds of comparisons would be algebraically inconsistent, even if we had perfect data.

Using today's weights for different products is not the same as using weights that reflect their importance back in 1700. Indeed, the products themselves come and go. A comparison of average purchasing powers in 1700 using the prices and quantities of oatmeal, mutton, lamp oil, and carts in 1700 will give a different answer from a calculation that uses national growth rates and today's prices of Cheerios, Big Macs, electric lighting, and cars.

Since they will give different answers, these two approaches are not the same, and hard choices have to be made. At the close of the twentieth century, the first approach was preferred, because we had better numbers for comparing people's purchasing power between, say, Britain and Asia in 1990, and we had pretty good ideas of national growth rates going back in time.[1] Using this indirect "projection" approach, the late Angus Maddison gave us the best available history of every country's real incomes, or purchasing power. True, the national growth estimates only went back into the mid- or late nineteenth century, so for any earlier time Maddison had to use rougher guesstimates about growth rates and about when societies first rose above bare subsistence. While some scholars thought Asia was as rich as Britain in 1700 or so, Maddison's own projections convinced him that Britain and Northwest Europe had been far ahead for many centuries. His estimates still dominate our view of past income levels.[2]

Starting around the year 2000, some economic historians chose the second path, the one that used only numbers from history itself. Going directly to historical data, without projections back from today's international comparisons, has the drawback that the needed data are still scarce and questionable. Yet it has the obvious virtue of being true to the historical context. It also simplifies by giving us just one set of tough index number decisions (say, British conditions versus Asian conditions in 1700) instead of three sets of them (choosing index numbers for British growth in a changing world, for

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[1] That the first approach, the back-projection approach, dominated at the close of the twentieth century does not mean that the second approach had never been applied. For a successful undertaking of the task of directly comparing per-capita purchasing powers for Britain and France 1781-1913, see Patrick O'Brien and Çağlar Keyder (1978, pp. 34-74).
[2] See Maddison 1995, 2001, 2010; and Maddison Project 2013. For an update of his historical national accounts of many countries, 1870-present, see the Groningen site http://www.rug.nl/ggdc/historicaldevelopment/na/.

Asian growth in a changing world, and for British conditions versus Asian conditions today). The direct historical path also benefits from the fact that the electronic revolution is improving our quantitative view of deeper history faster than our view of already-quantified recent history.[3]

Using the second approach, the direct or current-price approach, these scholars have opened up a whole new debate about "the Great Divergence" of purchasing power between Europe and Asia, and some "Little Divergences" of purchasing power within Europe and its overseas extensions. Were the leaders in the nineteenth century also the leaders in the sixteenth century or earlier? And when did American catch up to Britain? The leaders here were Kenneth Pomeranz on China versus Europe, Robert Allen and his co-authors on real wage rates in five continents, and Marianne Ward and John Devereux on America versus Britain in the nineteenth century.[4]

This paper follows the second path, preferring comparisons that use data only from the historical contexts shared by the comparison countries. It generalizes and globalizes the recent literature, going beyond China versus Europe or America versus Britain, and judging overall national purchasing powers instead of real wage rates. I offer three kinds of tentative conclusions:

- The direct comparisons, the ones using only historical data, yield international contrasts that are often very different from those that Angus Maddison saw through the lens of long-run back projection.
- The revisions reveal some rough patterns. If the direct comparisons are correct, Maddison underestimated Eurasian inequalities. Before 1914, Asia was even further behind Britain in average purchasing power. On the other hand, rich settler countries like America and Australia were even richer, relative to Britain, than Maddison and others thought.

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[3] For the growing (and downloadable) quantitative global history of incomes, prices, and wage rates, see the internet sites of the Global Price and Income History Group (gpih.ucdavis.edu), the International Institute of Social History (iisg.nl/hpw), and the Maddison Project site at the University of Groningen (Bolt and van Zanden 2013).

[4] See Pomeranz (2000, 2005, 2011), Allen (2001, 2005, 2007, 2013), Allen et al. (2011, 2012), Ward and Devereux (2003, 2004, 2006, 2016), and for Latin America versus Europe, Arroyo Abad, Davies, and van Zanden (2012).

• The discrepancies between the new direct historical comparisons and Maddison's back-projections seem to relate to the greater share of non-tradables in the world economy before 1870, to the Balassa-Samuelson effect on relative purchasing powers, and to a Gerschenkron effect inherent in international comparisons anchored in a postwar price base.

The rest of this paper travels through three stages to reach to these concluding suggestions. First, Sections II and III take a tour of some benchmark historical comparisons on six continents, using some available benchmarks on nominal incomes per capita and the prices of staple goods to generate measures of subsistence (or "barebones") purchasing power per capita for various countries relative to Britain. Each of these ratios, of the form (other country / Britain), is compared with the corresponding ratio from the Maddison estimates, in search of discrepancies. Section IV notes a striking pattern in the relative costs of subsistence goods before and after 1870, and links this pattern to the Balassa-Samuelson effect, using the fact that subsistence goods were non-tradable and had a large budget share.

The second stage confronts the tension between the breadth of the GDP per capita numerator and the narrowness of the "barebones" price denominator of each of our ratios for deriving real purchasing power: Shouldn't one divide nominal GDP by a GDP deflator that covers the whole economy? Having internationally comparable prices only for the most common staple goods would seem to be a weakness. Section V of the paper turns this potential weakness of the purchasing-power ratio into a strength. True, other goods – luxury consumer goods and capital goods in particular – are harder to compare across countries or eras because these goods are so heterogeneous and changing in quality. Yet I present evidence suggesting that the price of such luxury and capital goods, relative to staples, was lower in Northwest Europe than anywhere else in the world between 1500 and 1914.

The final stage interprets this new evidence in Section VI. The departures from Maddison's estimates are tentatively explained, leading to Section VII's menu of take-aways for revising our history of international inequalities.

II. A disturbing initial result: America versus Britain

Although economic historians have heavily used Angus Maddison's pioneering estimates, some have recognized that his estimates could give misleading impressions about the comparisons of real incomes in the past. Maddison himself repeated general warnings about his numbers, and invited revisions based on better evidence. The current Maddison Project aims to add such revisions, as better evidence comes available.[5] While many have noted the general possibility that Maddison's international comparisons might be misleading, only a few have stepped forward to offer specific alternative measures. For the world as a whole back to 1820, Leandro Prados de la Escosura (2000) offered a plausible compendium of alternative conjectures of GDP per capita for high-income countries back to 1820, based on statistical regressions capturing patterns from 1950-1990 in the relationship of economic structure to GDP per capita in the International Comparisons Project (Penn World Tables). Prados's plausible conjectures, like those of Maddison, call out for confirmation or contradiction based in deeper evidence on as many bilateral comparisons as possible.[6] The two bilateral comparisons that have attracted the most attention are America versus Britain and China versus Northwest Europe. The American-British comparison, unlike that between China and Northwest Europe, offers a disturbingly sharp challenge to Maddison's view of relative real incomes.

The new American-British direct (current-price) comparisons depart dramatically from Maddison's projections of the ratio of American to British purchasing power since 1700. The conventional wisdom quantified by Angus Maddison is that British colonial America was far behind the mother country in average living standards, and that the independent United States continued to lag behind Great Britain in incomes until around 1900. So say the Maddison Project estimates expressed as an American / British ratio in Figure 1. Indeed, the current Maddison Project estimates for 1720 imply that per capita

[5] Maddison (1995), Maddison (2001, p. 44), Bolt and Van Zanden (2014, p. 628). For up-to-date online revisions, consult http://www.ggdc.net/maddison/maddison-project/data.htm and Bolt and Van Zanden (2014).
[6] Prados (2016) has now underlined his critique of the Maddison procedure with calculations of the biases it introduces in the case of Spanish history.

incomes in the British mainland colonies of North America were only 53 percent of those of Great Britain, and still only 79 percent of British average incomes 150 years later.

Such conjectural contrasts have been challenged. Even without seeing alternative numbers, one may ask how it could be that so many English kept migrating to America, where the average incomes were allegedly so much lower, even among whites alone. That is mathematically feasible, of course, either if migrants kept repeating the same economic mistake, or if America attracted only the dregs of British society for generations. Still, the idea is at best counter-intuitive. Another challenge came from the American-British contrasts reported by Prados (2000), who implied that the United States had already matched Britain in average income as of 1820, the earliest date to which he applied his regression-based technique. Meanwhile, Marianne Ward and John Devereux (2003, 2004, 2006), compared nominal incomes and prices contemporaneously for the United States and Britain in the nineteenth century. They found an even greater American advantage over Britain.[7] Several other scholars, including Robert Allen, have begun to make direct international comparisons between workers' real purchasing powers. Where these studies included North America, they similarly found that real wages in the thirteen counties were near that of London in 1725-1749, and well above the London real wage later in the eighteenth century (Allen *et al.* 2012).

Jeffrey Williamson and I have now compared American and British purchasing powers per capita, producing new estimates for the entire period 1650-1870 (Lindert and Williamson, 2016, Chapters 2-6 and Appendices A-G). These independent estimates of nominal national income for America, anchored in the benchmarks 1774, 1800, 1850, 1860, and 1870, are derived from the income side of the national accounts. We estimate that the nominal national income of the thirteen mainland colonies in 1774, on the eve of their rebellion, was about 30 percent higher than the guesses made by other scholars. Our nominal income figures are similarly above those of earlier scholars for 1850-1870, though our 1800 benchmark produced little disagreement with past guesses. For the nominal income of Great Britain, we have used the new estimates from Broadberry *et al*. (2015). The nominal incomes on both sides of the ocean are then deflated by the

[7] Broadberry (2003) expressed doubts about the initial comparisons by Ward and Devereux.

respective costs of a fixed barebones subsistence bundle, as estimated by Robert Allen. In effect, our direct comparison addresses the same question implicitly addressed by Prados and by Ward and Devereux: How did the two countries compare in their ability to use all of nominal national income to purchase a given bundle of consumer products, where all data come from the same year? And, as Figure 1 shows, we get an even stronger Anglo-America contrast.[8]

There is more to the emerging story of American-British contrasts than just the finding that America was ahead. Our new estimates have a richer history to tell, one that includes Figure 1's three episodes in which the Americans briefly lost their leadership – during the Revolution, during the Civil War decade, and again in the early 1930s. The moment of greatest American advantage over Britain in purchasing power was, of course, at the end of World War II. Over the long run, the average American has usually had a purchasing power about 30 percent about the British average -- in the century before the Revolution, or in the mid-nineteenth century, or around 1900, or even today. Maddison's belief that America did not surpass Britain in average purchasing power until 1900 is off the mark by at least two centuries, according to direct current-price comparisons from the past.[9]

The sharp challenge to Maddison's view of American versus British incomes raises an obvious question, to which we now must turn: What would happen to the relative positions of other countries over recent centuries, if we again replace his back-projections with direct current-price historical comparisons? How would the new procedure and new evidence affect the different "Great Divergence" and "Little Divergence" debates?

III. Global departures from Britain before 1914

[8] Vincent Geloso (2015a, 2015b) has similarly found that the ability to buy a barebones bundle was higher for workers in colonial French Canada than in France, 1688-1760. However, this Canada-France contrast did not hold up when the comparison involved more middle-class "respectability" bundles.

[9] See the detailed evidence in Lindert and Williamson (2016, Chapters 2, 3, 5, 6, and 10, and related appendices). We note that broadening the price deflator, going beyond common staples to include luxuries and capital goods, would dampen the American-British contrast in estimates only slightly.

For certain countries and benchmark dates, the direct current-price approach can serve as a valuable cross-check against the Maddison back-projection approach to the history of relative purchasing power.[10] This paper exploits the occasional existence of credible measures of nominal GDP (or GNP) per person, and of prices in both of two countries being compared. For readers' convenience, all countries will be compared with the same base country, Britain, where Britain means England and Wales up to 1700, then Great Britain 1700-1870, then the United Kingdom including all of Ireland until World War I, and then today's United Kingdom.[11] What makes the British base so convenient is the landmark Broadberry-Campbell-Klein-Overton-van Leeuwen study of *British Economic Growth 1270-1870* and the abundance of English historical price series since 1209, mainly the price series collated by Gregory Clark.[12]

For the nominal GDP numerator, the usual choice is between an aggregate value of all production, an aggregate value of all expenditures on what the same nation produces, and an aggregate value of all income earned from production.[13] In a perfect-data world all three values would be equal. Where the data yield a credible aggregate value from the income side, I prefer that version of GDP because it is the most distant from the information used by Maddison, so that it holds the most promise as an independent valuation. In many other cases, however, the data appear to have been more solid on the production side, the side used most heavily by Stephen Broadberry and his co-authors.

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[10] Comparing countries' real incomes in the past was not Maddison's only objective or his only achievement, however. His work has also served as the best statement of what is known about the global history of national growth rates in GDP.

[11] To see the per capita income adjustments of moving from one national unit to another, one can use these (Baxter) per capita income ratios from 1867: Great Britain/Eng-Wales = 0.961, and Great Britain /UK = 1.113. Using such ratios to imagine an equivalent Great Britain before 1700 would call for lowering the income per capita for England and Wales by 3.9%, and to imagine an equivalent Great Britain after 1870 would call for raising the UK income per capita by 11.3%, and lowering all purchasing-power international ratios by 11.3%. (http://gpih.ucdavis.edu/Distribution.htm, using the file "Baxter EW & UK 1867.")

[12] Broadberry *et al.* (2015), Clark (2006). Clark's price series are drawn from the compilations by Thorold Rogers, the UK Board of Trade, and William Beveridge.

[13] The concept measured here is actually gross national income, which is virtually the same as GNP for most economies. Yet we use the term "GDP" (gross domestic product") for reader familiarity, ignoring the small quantitative differences between GNP and GDP.

Where the production side (or expenditure side) is used, however, it will turn out that the most reliable data are also limited to those products that are most uniform and of most common use.

For the price denominator, data availability again dictates the choice. Here the binding constraints are familiar. For comparisons across countries or across centuries, the usual price series are again those of products that are most uniform and of most common use. In study after study, the set of prices ends up covering income-inelastic goods, alias consumer staples or necessities, plus such homogeneous intermediate goods as unprocessed grains, fabrics, or minerals. Other products – those consumer goods toward the luxury end of the spectrum, or capital goods, or services – tend to be too heterogeneous and too changing in their quality to generate reliable international price comparisons or price time series. In the case of prices, unlike quantities, we can sharpen our international comparisons with a two-stage procedure. For the rest of this section, we will use the prices of products in a staple-goods "bare-bones" bundle of necessities, à la Robert Allen, as if it were a comprehensive GDP price deflator. It is not, of course, but in Part V we will able to use a mix of history and economics to establish the direction in which having an all-covering GDP deflator would tilt the results obtained by using a simple subsistence deflator.

Let us turn to some Asian countries featured in the "Great Divergence" debate, beginning with Japan, a particularly well-researched case.

A. Japan 1602 – 1912

Thanks to the recent work of several scholars, we now have plausible estimates of Japan's national product, consumption patterns, and price structure across the Edo Period (Tokugawa Shogunate) and the Meiji Reign. The research team of Jean-Pascal Bassino, Stephen Broadberry, Kyoji Fukao, Bishnupriya Gupta, and Masanori Takashima (2015) has estimated Japan's real and nominal GDP for benchmark years extending from 725 to 1874, that is, for much of the pre-Edo and Edo periods. Like Broadberry and co-authors for Britain, they build GDP by sectors, combining information on labor force and productivity by sector, plus urban population shares, while also applying some likely consumer expenditure elasticities. Sectors are aggregated into real GDP by expressing all values in

terms of koku of rice, a common numeraire. Given this conversion to rice units, we can back out the nominal value of GDP in terms of silver using the silver price of rice.

For the years from 1600 on, the nominal GDP numerator can then be divided by the cost of a subsistence bundle, using the separate urban price series for each good. In order to compare the price of such goods with their price in Britain, one must first deal with the disconnect between Asian and European dietary habits. European diets featured wheat bread, rye bread, and oatmeal. None of these was a staple in Asian diets, except for bread-like products in North China and North India. Comparing the consumption bundles of Japan and Britain requires that we develop some equivalency between rice and something based on wheat or oats. The economist's usual answer of simply using relative prices would not work: Rice had a high price in Britain because it was an imported luxury not consumed by ordinary folk, and there was no reliable price series for wheat flour, wheat bread, or oatmeal in Japan, where these products were essentially unknown. Robert Allen (2001) introduced a procedure that we follow here. Compare separate daily diets in the two countries that would deliver a subsistence level of about 1,942 (kilo-) calories, with the subsidiary goal of delivering about 80 grams of protein. For each country find a set of staples that would deliver this modest daily nutrition at the lowest cost, given local prices. Given that societies typically consume diets that minimize the cost of a given level of nutrition, cost minimization will tend to favor the grain that actually prevails in local diets. Thus in Table 1, the 365-day diet for Japan delivers most of its calories from rice, while allowing smaller amounts of some other products that were commonly consumed and for which we have price series (soybeans, buckwheat, barley, fish, etc.). For Britain the corresponding diet features oats, beans/peas, and meat.

In setting the two diets, it is important to choose foods that are at similar levels of preparation, while at the same time yielding historical price data. It would not do to compare highly prepared foods in one country with unprocessed ingredients in the other, since this would impose the costs of preparation on only one of the two countries. We may think of this problem as avoiding the "let them eat bread" trap. In many European settings one has price data both for bread and for raw grains. Yet in Asian settings we are usually given data only on the prices of raw grains, such as rice or buckwheat, without allowing for the fuel, utensils, labor, and other costs of delivering table food. Accordingly,

Table 1 gives the European consumer only oats (cheaper than wheat), rather than prepared bread or oatmeal, to avoid marking up the European relative cost by providing a more useful product. Again, it is important to stick to comparing consumer bundles that supply similar hedonic final products in the two countries.[14]

Applying available prices to these separate subsistence bundles yields the bundle costs for Japan and Britain in 1750, displayed in Table 1.[15] Repeating this calculation for other benchmark years traces a history of Japan's and Britain's abilities to buy the same bundle over the sweep of the Edo period and the Meiji reign, in Figure 2 and Tables 2 and 3. Even at the start, around 1602, Britain's ability to buy the basics was already well ahead of stagnant Japan, and the lead widened across the eighteenth century. As historians have long known, Japan's incomes improved across the Meiji reign, here represented by the transition from our 1870 benchmark to that for 1912. Less familiar in appearance is the seeming acceleration of British purchasing power over that same 1870-1912 era. One reason for this improvement seems to be that the new cheapness of grains and other foods from abroad delivered an egalitarian twist to the first globalization era, as we shall note again later. Overall, Japan fell further behind Britain in the Edo period, and then kept pace in the Meiji era.

How do these comparisons of bare-bones purchasing power match up against the Japan/Britain contrasts already provided by Angus Maddison? Both accounts agree that Japan fell further behind Britain over the whole stretch of the seventeenth through nineteenth centuries. Yet, as Table 2 quantifies and Figure 3 summarizes, the new comparisons imply that Japan was always further behind Britain than Maddison's projections implied. So far, the America/Britain and Britain/Japan gaps look wider in the new data than in the back projections: While the new calculations suggest that Maddison may have missed America's lead over Britain in the eighteenth and nineteenth centuries, they also suggest that he understated Britain's advantage over Japan. To see if

[14] Alternatively, where the data permit, one could give the European consumers the same calorie content in the form of flour instead of raw grain, for the comparison with rice.
[15] As shown in the notes to the tables, the prices are averaged over a number of years around the benchmark year, to smooth out short-run price variation. The number of years depended on data availability, though a five-year centered average was preferred.

there are larger patterns here, let us explore other nations and years, with the help of Figure 3 and Table 3.

B. China 1840 and 1885

The contrast between China and Europe was, of course, the one that most ignited the "Great Divergence" debate. Kenneth Pomeranz's (2000) landmark book suggested that in the eighteenth century, the early Qing era, Chinese material living standards were still nearly on a par with those of Europe, and the Lower Yangzi region could have been as well off as Britain and the Netherlands. If that were true, then the Great Divergence came after 1800, and especially after the Opium Wars, with the further implication that foreign aggression was what dragged down a China that could have continued to be competitive. Although Pomeranz later modified his stance somewhat, the challenge remained and the debate continued.[16] One result of the subsequent work has been to emphasize the great probability that China's average incomes were as high as those in Europe and Japan way back in the Song and Yuan (Mongol) eras, i.e. from 960 to 1368.[17] Angus Maddison, for his part, continued to agree with David Landes (1999) and others who argued that Europe was well ahead of China and East Asia since the Middle Ages or earlier.

For China, the present procedure of dividing nominal incomes per capita by the costs of a barebones consumption bundle is not yet possible for the eighteenth century, a crucial period in the Great Divergence debate. Work must continue on China's national product, since estimates are quite shaky so far.[18] For the moment, we have only two nineteenth-century benchmarks, at 1840 and "the 1880s," which we may label 1885. For 1840 the research team of Stephen Broadberry, Hanhui Guan, and David Daokui Li (2014) has ventured to estimate China's nominal national product using the currently favored practice of combining labor force and productivity by sector, urban population shares, and some assumed consumer expenditure elasticities. For the 1880s, Chang-li Chang (1962, appendices) built an estimate of China's GDP to use as a denominator for his detailed

[16] Pomeranz (2005, 2011), Prados (2000), Maddison (2001, pp. 47-48), De Vries (2011).
[17] See Liu (2015).
[18] For stern warnings about the existing estimates of GDP for imperial China, see Deng and O'Brien (2016).

estimates of gentry incomes at the top of society. Dividing both years' nominal GDP by the cost of a barebones bundle in Beijing yields the two estimates of purchasing power per capita that are shown in Table 3 and Figure 3.

For China, more than for Japan, the nineteenth-century estimates support Maddison's view of relative purchasing power. The match in guesstimates is quite good for 1840, even though very different sources and procedures were used. For 1885 the new estimates imply that GDP per capita bought the common man less than Maddison implied. Yet the Chang estimate of GDP in the 1880s may have been too low. He struggled to limit the frequent suspicions that his official sources had underestimated the area under cultivation, and his estimates seem to miss miscellaneous manufactures and many private services. If the true GDP for the 1880s was significantly higher than Chang said, then again for the 1880s, as Albert Feuerwerker has implied, the new procedures seem to support the Maddison guesstimates about the ratio of Chinese to British incomes.[19] Yet until one can reach back into the eighteenth century or earlier with credible estimates of China's nominal GDP per capita and costs of common consumer goods, such direct current-price comparisons cannot help resolve the Great Divergence debate.

C. India 1595 and 1870

The same question has arisen for India: Was it far behind the West even before the early modern era, in this case meaning before the British incursions? With India as with the rest of Asia, Maddison sided with those who felt that Asia had been far behind for centuries. And with India as well, scholars in this century have suggested revisions in this view. Using available evidence from the scanty quantitative history of two Indian regions, Prasannan Parthasarathi argued that "in the eighteenth century standards of living, calculated in terms of grain wages, were comparable between Britain and South India and Bengal" (2005, p. 106). His emphasis on "grain wages" has since been echoed by the subsequent literature, which draws on wage rates and the prices of staple goods,

[19] Feuerwerker (1969) has argued that China's real national product in the mid-1880s was 20.0 percent higher than Chang's figured imply when converted into 1933 yuan. Angus Maddison (1995, p. 144) cautions that Feuerwerker's figures adjust Chang's figures "somewhat cavalierly," even though Feuerwerker's figures would raise the new estimates to a China/Britain ratio close to that implied by Maddison.

especially foods. Yet few others feel that Indian living standards were "comparable" to British or European standards as late as 1800. The current split seems to be between those who feel that back in 1600 Indian real wages were already only about a fifth of British hence no subsequent Great Divergence (e.g. Broadberry and Gupta 2006 (silver wage comparison); Allen 2007; Roy 2010, and Studer 2015, pp. 145-67, 172-78), and those who feel that in the Mughal apogee around 1600 Indian incomes were 60-70 percent of the British. This latter view believes in a Great Divergence with the arrival of the East India Company and the Crown, down to an agreed-on level of Indian poverty in the late nineteenth century.

Fortunately, this wage-based literature has now been supplemented by rough measures of nominal income per capita, for the Mughal benchmark 1595 (or c1600) and for 1860 and beyond. Here, and in Figure 3 and Table 3, we use only the 1595 benchmark and an 1870 benchmark, for comparison with Maddison's figures and with the recent findings of Broadberry, Custodis, and Gupta (2015).[20] For India, as for the rest of Asia, Maddison implied that average purchasing power fell further behind that of Britain, from an India/Britain ratio of over half (0.565) around 1600 to only one-sixth (0.167) in 1870. The new current-price comparisons will agree on the long relative decline, yet at lower initial and final levels. The mystery deepens when we compare the new estimates with those of Broadberry, Custodis, and Gupta (BCG). They offer two different results for 1600-1870 using different deflators. The estimates from the Broadberry-Gupta 2010 study implied an India/Britain ratio 0.145 in 1870 – a slightly more severe impoverishment than Maddison guessed for 1870. Then, using a silver conversion between rupees and pounds, BCG find that back around 1600 India's share of the British average was already only 0.145 – so no divergence, just persistent deep relative poverty for India. Alternatively, with a grain deflator (wheat price), BCG find that Mughal India had fully 0.712 of the British average purchasing power around 1600, before dropping to that 0.145 by 1870. Thus far, for India from 1600 to 1870, we have two suggestions of a great fall relative to

[20] For 1595, I use the Mughal "national" product from Shireen Moosvi 2008, pp. 2-3, implying 562.2 million rupees. Her estimates build on Moosvi (1987). Broadberry, Custodis, and Gupta (2015, p. 70) give a similar number, 559.68 million rupees, for "circa 1600." For 1870, I use Goldsmith (1983, p. 5), averaging the GDP estimates for 1868-1872.

Britain – Maddison's suggestion about GDP per capita, and the BCG grain wage – plus one suggestion of no change at all, namely that BCG silver wage ratio of 0.145 at both dates.[21]

Better price evidence is available for comparing India with Britain in both 1600 and 1870. Bob Allen and Roman Studer have amassed a long and detailed history of prices (and wages) for four regions of India from the late sixteenth century to the early twentieth. These make it possible to compare the ability of GNP per capita to buy hedonically-equivalent bundles of ten Indian products and nine British products.[22] These new comparisons, richer in prices, find India further behind Britain around 1600 than either the Maddison guess or the BCG wheat wage had implied. Yet for 1870, the different estimates do not disagree so much. Specifically, the new estimates have India falling behind in relative purchasing power from 0.289 around 1600 to 0.156 in 1870. Figure 3 and Table 3 re-state this result for India. We shall return to the task of interpreting this revision, after looking at new clues for other countries.

For India and Japan, then, the tentative new results illuminate a new Divergence currently being posed by the authors of a pioneering study of Japan's national product, who suggest that there was

> "a 'Little Divergence' within Asia. In contrast to Japan's persistent growth path which avoided significant growth reversals, Chinese per capita GDP was on a downward trajectory from its high point during the Northern Song dynasty …. On these estimates, Japan overtook China only during the eighteenth century. Like China, India experienced declining GDP per capita from the Mughal peak under Akbar, circa 1600 …. Again, Japan only pulled decisively ahead of India during the eighteenth century." (Bassino et al. 2015, p. 22)

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[21] In an earlier article, Broadberry and Gupta (2006, pp. 14-18) offer a plausible reconciliation of the silver-wage stability and the grain-wage decline, in terms of the advancing development of the British economy.

[22] For the data, at http://gpih.ucdavis.edu, download the file "India prices and wages 1595-1930 (Allen and Studer)." For a fuller presentation and interpretation, see Allen (2007) and the India-related passages of Studer (2015). In my calculations, for both dates, the Indian bundle consisted of millet, rice, gram, meat, ghee, soap, cloth, candles, fuel, and sugar, and the British bundle consisted of oats, beans, meat, butter, and again soap, cloth, candles, fuel, and sugar. Food calories and BTU of heating fuel were held the same in both countries.

The new direct comparisons agree, by re-affirming that India fell behind Japan sometime between 1600 and 1870.

What of other Asian countries? Did they also fall behind Japan at this time? We turn next to an Asian country that fell behind Japan dramatically, but not until the mid-nineteenth century.

D. Java 1820-1910

Thanks to recent efforts by Pim de Zwart and Jan Luiten van Zanden (2015, and Van Zanden 2003), we can now compare Javanese purchasing power with that of Britain during the nineteenth century, using the same barebones deflation of nominal GDP per capita as in other countries.

Starting with the most recent benchmark, that for 1910, we see a Java that fits the general patterns of relative purchasing power and its relationship to Maddison's guesses. As Table 3 and Figure 3 show, crowded Java was far behind Britain (or the Netherlands) in average purchasing power, and even farther behind than Maddison had conjectured. Yet a very different perspective emerges from Java's earlier experience. Back in 1820 or 1830, Java's average ability to consumer staples was fully 44-45 percent of the British level, according to the new estimates. And in that early era, Java's relative income was well above what Maddison had implied. As Figure 3 shows, this outcome contrasts with the results for India, China, and especially Japan.

What could have made Java sink so far in relative purchasing power between 1820 and 1910? While Van Zanden (2003) has explored the possible roles of changes in Dutch rule and other shocks, it seems likely that the explanation should start with a striking basic fact about nineteenth-century Java: It had unusually rapid population growth. Whereas India's population grew only by 36 percent from 1820 to 1900, Java filled up with about 5.6 times as many people in 1900 as in 1820, a population growth rate of about 2.2 percent a year (Peper 1970, p. 72). Such crowding presumably raised the relative price of rice, while the globalization of rice markets remained incomplete, thereby depressing Java's relative purchasing power.

E. Western Europe 1500-1910

Western Europe was richer than Asia in Maddison's estimation. The new estimates confirm and magnify this inequality. The same technique of dividing nominal income by a subsistence-bundle price deflator yields results for Italy since the sixteenth century and for France and Netherlands from 1820 to 1910 (Table 3 and Figure 3 again). These countries again appear to have been better off than the four Asian countries, and for France and Netherlands, our estimates do not fall below those of Maddison, but instead tend to agree.

Relative purchasing power in Western Europe is brought into even clearer focus by Ward and Devereux (2016). Figures 4 and 5 report their comparisons of some developed countries in 1872 and 1910. Their procedure is different from that of Robert Allen, which we have followed thus far. Ward and Devereux, like most economists, prefer a blended "superlative" index like the Fisher ideal index. The Fisher index geometric averages the two countries' indices, unlike Allen's use of a separately fixed bundles supplying about 1,942 calories. Ward and Devereux could avoid the Allen approach because their comparisons were restricted to Western countries with similar diets. I slightly prefer Allen's approach, on the grounds that it makes the subsistence bundle something fixed and more understandable for non-specialists. Nonetheless, let us now add the informative Ward-Devereux results in Figures 4 and 5.[23]

The main revision suggested by Ward and Devereux is to demote British and Swiss relative purchasing power relative to other advanced countries. On their telling (2006, 2016), America was even further ahead of Britain in the nineteenth and early twentieth centuries than Prados had conjectured, though not as far ahead as in the Lindert-Williamson view (2016). Ward and Devereux also reject the common belief that average purchasing power was higher in Switzerland than elsewhere in Western Europe.

F. Elsewhere

Finally, we can add benchmark observations for five other settings: Poland 1578, Mexico and Peru 1800, Australia 1868, and Cape Colony 1861. Most of these have

[23] Ward and Devereux presented indices comparing other countries with the United States. Taking advantage of the transitivity feature of their indices, we have converted to comparisons with Britain, for better comparability with the results in Figure 3.

additional limitations. The study of Poland in 1578, in which Mikoilaj Malinowski and Jan Luiten van Zanden (forthcoming 2017) extrapolate from the Voivodship of Krakow, lacks a Maddison estimate for comparison. So do the benchmark data from Peru around 1800. For Mexico 1800 and Australia 1868, we can only compare staple food costs, without the basic non-foods included in the other estimates. Still, these five scattered extra observations do expand the summary testing.

G. Patterns in the disparities before 1914

This tour of some historical benchmarks for directly comparing countries' real purchasing power reveals some broad patterns. The first is a limited affirmation of Maddison's original guesses. As one would hope, his estimates are positively correlated with those presented here. Yet we find serious deviations from his estimates of the ratios comparing other places to Britain. Among the more advanced countries in the nineteenth century, the new departures from Maddison tend to revise his view in the same direction as the earlier conjectures by Leandro Prados (2000) and the alternative estimates of Marianne Ward and John Devereux (2003, 2006, 2016).

The revisions away from Maddison's implied ratios were caused by differences in concept and in basics of economic geography. As we saw in Table 3 and Figures 3-5, some rich countries' purchasing powers were better, relative to Britain's, than Maddison implied. The countries favored by the new estimates are land-abundant rich settler countries (USA and Australia) and Northern European countries (Belgium, Denmark, Germany, Norway, and Sweden). The countries disfavored relative to Britain were mostly countries with lower real incomes by anybody's measure (India, Italy, and Japan). The exception was Switzerland's new downward revision, which Ward and Devereux (2016) attribute to simple errors in the Swiss data used by Maddison. Countries for which the comparisons with Britain look much the same as in Maddison's tables were France and Netherlands, and perhaps China and Java.

H. And since 1914?

For the period since 1914, with its higher average incomes, expanded global trade, and better data, the world has changed greatly in ways that call for a different kind of

measure. The obsolete early-modern barebones bundle, dominated by grains, must be set aside in favor of bundles involving less essential foods and housing rents, and these updated bundles in turn must be compared with nominal incomes per capita.

For the early twentieth century, the bundle-pricing steps in this advance have already been taken. In particular, Jeffrey Williamson (1995, appendices) has compared food and housing costs for nine countries in 1905-1914, and for seventeen countries in 1927. Gone are the nineteenth-century contrasts between the land-rich settler economies and Britain. In the early twentieth century the United States, Canada, and Australia began to have higher food costs for a given bundle than did Britain. On the other hand, the Continental European countries continued to have lower food and rent costs than Britain.

For the years since 1950, the data take the form of economy-wide prices, incomes, and exchange rates, as developed by the International Comparisons Project (ICP) and the Penn World Tables. The ICP became Angus Maddison's base point. Again, his procedure was to take the ICP detailed price and income comparisons for 1990, and back-project this international contrast back into history using the nations' separate real GDP accounts. As we have seen, this led his estimates to stray from what one would get from direct historical comparisons.

In fact, the index number difficulties caused by shifting product mixes are not just a challenge faced by economic historians. The same challenge faces non-so-historical economists today, with their attempts to compare countries in the richer data environment since 1950. Maddison, in choosing the long-span approach to illuminate international differences in the deep past from a comparison of 1990 purchasing power parities in "1990 international Geary-Khamis dollars", was applying a technique that the Penn World Tables project used to derive the widely-used numbers for the world since 1950. Just as Maddison fixed his historical backcasting to a very recent 1990 comparison of prices and nominal incomes, so too the Penn World Tables have based comparisons back to 1950 on the latest price comparisons, most recently the international price comparisons of 2011. Thus Maddison's technique has reflected the state of the art among economists. Yet the underlying problem of inconsistent historical comparisons has not gone away, either for the economic historians or for the larger economics community.

As it happens, the "new generation" of the Penn World Tables project, which has now shifted to the University of California – Davis and to the University of Groningen, has just launched an important reformulation of its data displays, partly in order to quantify the biases that one gets from choosing the less appropriate comparison procedure. Starting with Penn World Tables version 8.1, its organizers explain,

> [W]e distinguish whether real GDP is intended to measure the standard of living across countries or to measure productive capacity…. [Furthermore,] to hold prices constant over time, past versions of PWT relied upon real GDP growth from the national accounts for each country. That is, the level of real GDP across countries was constructed for the most recent ICP [International Comparisons Project, for comparing prices] benchmark and then projected backwards and forwards in time by using national accounts growth rates for each country. That approach meant that past years of ICP data were discarded. In PWT 8 we likewise include a variable that uses real GDP growth from the national accounts, but we further introduce measures of real GDP that correct for changing prices over time and use ICP [price] benchmarks *from multiple years*. [24]

The shifts in price structure make a big difference, even within the half-century covered by the Penn World Tables. From 1952 to the 2005 baseline, average living standards, using the international price comparisons from multiple years, improved faster than productivity growth in most countries. Among all 60 data-supplying countries, the two measures differed by an average absolute gap of 23 percent in 1952, whereas they are defined as equal in the base year 2005.[25] So even over the last half-century or so, the growth of purchasing power, the direct historical comparisons featured in the Divergence debates, has been quite different from the gaps implied by the growth rates of GDP per

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[24] Feenstra *et al.* (2015). Emphasis in the original. In terms of the terminology in the new-generation Penn World Table 8.1, the first sentence quoted here refers to the difference between cgdpe and rgdpo, whereas the rest of the quoted passage refers to the difference between rgdpe featured here and rgdpna (that's na for "national accounts"), the type of measure Maddison used, which followed the countries' separate real national product indices over time.

The new generation of Penn World Tables emerged in the wake of an extensive debate over the merits of the new international price comparisons for 2005, which dramatically re-shuffled nations in terms of real GDP per capita. See Johnson *et al.* (2009), Milanovic (2009), and Deaton and Heston (2010).

[25] This 1952 measure refers to gaps between rgdpe and rgdpna.

capita, or relative productivity growth, using national accounts.[26] It seems to follow that merely updating the base year, say from Maddison's 1990 to 2011, fails to address the basic problem: Price structures change, and so do shares of non-tradables in the economy, and such shifts make the historically relevant direct comparisons yield different results from back projections.

IV. How did subsistence cost ratios relate to purchasing power ratios?

There is a striking pattern in the relative hard-currency costs of those subsistence bundles used in the comparisons with Britain – a pattern that can be explained by combining some theory and history. The relative bundle costs, graphed in Figure 6 and listed in Table 4, showed a remarkably consistent pattern up to 1870, a pattern that was then washed away in the globalization wave of 1870-1914. From the early 1500s up through about 1870, most other countries had lower bundle costs than did Britain, in terms of silver or the gold-standard pound sterling. The only exceptions, with higher silver costs of the subsistence bundle than in Britain, were Spain in the sixteenth and seventeenth centuries, and Italy in the sixteenth. In both exceptional cases a plausible initial explanation was that they were initial recipients of New World silver, famously raising the prices of basic goods in terms of silver. With those exceptions, the bundle costs were lower in all data-supplying countries other than Britain – and then this pattern vanished between 1870 and 1914, as can be seen in Figure 6. Thus Adam Smith's thinking that the "cost of subsistence" was lower in China than in Europe can now be expanded:

[26] In 1952, the first year of widespread data, Britain was near the bottom of the OECD ranks in its relative purchasing power. To be more exact, of the usual 21 core OECD industrialized countries, Britain ranked 16th in how much higher its purchasing power proved to be in the direct comparison at 1952 prices than in a Maddison-type back-projection from the 2011 price structure. Only Germany, Italy, Greece, Ireland and Norway were less favored than Britain by using the 1952 data in a direct comparison.

Subsistence was cheaper in most of the Eastern Hemisphere than it was in Northwest Europe.[27] This remarkable prewar cost history needs to be explained.

Why would subsistence goods be cheaper in most other places than in Britain before about 1870? And why would that pattern then be washed away? The answers lie both in a changing historical reality and in a mechanism noticed by economists in the postwar era. The changing historical reality is that goods essential to subsistence were not traded goods before the mid-nineteenth century, and then became traded goods. As long as they were not traded over long distances, their prices reflected only their local context. And as long as they were not traded over long distances, something called the Balassa-Samuelson effect made them cheaper in poorer countries than in richer countries like Britain. Let us first turn to that postwar Balassa-Samuelson effect, and then return to how the underlying realities changed its applicability before 1914.

The Balassa-Samuelson theory predicts that non-tradables are relatively cheaper in countries with lower overall labor productivity. A key (and realistic) assumption is that labor is mobile between the traded-goods and non-traded-goods sectors. Richer countries, with their faster advances in productivity concentrated in the traded-good sectors, bid up the labor wage rate. This draws labor from the non-traded sector, and raises relative costs and prices in this sector, where productivity is not going up. Result: In the richer country, prices of non-traded goods go up relative to traded-good prices. In the poorer countries, where productivity is more stagnant, non-traded goods can remain cheaper than in the richer countries.

Postwar data support this prediction.[28] The story rightly features differences in sectoral productivities. The reason why non-tradables appear to be cheaper in poorer countries than in richer countries, relative to traded goods, is that differences in capital accumulation and technology have kept productivity lower in traded goods, relative to non-traded goods, in those poorer countries that missed out on industrialization.

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[27] Adam Smith's assertion that "rice in China is much cheaper than wheat is anywhere in Europe" was cited in Allen et al. (2011, pp. 22-23).

[28] For the theory itself, see Balassa (1964), Samuelson (1964, 1994), Feenstra et al. (2015). An example of empirical confirmation on postwar data is Heston et al. (1994).

For the pre-1870 era, the staple goods essential to subsistence were not traded between continents, so they played the role of non-tradables in the Balassa-Samuelson model. Indeed, in the earlier low-income settings, staples were a large share of the non-traded sectors. Not surprisingly, the differential-productivity explanation for the Balassa-Samuelson effect does fit the pre-1870 global pattern revealed in by the prices of staple goods in Figure 6, with one noteworthy amendment. Although firm numbers are lacking, narrative histories suggest that high labor productivity and involvement in international trade did indeed occur in the same leading sectors and the same leading countries, leading to the relative-cost results in Figure 6.[29]

The one amendment relates to the Anglo-American contrast. Like the other countries being compared with Britain in this paper, and like China as observed by Adam Smith and by Allen et al (2011, p. 25), the American colonies and the United States had cheaper subsistence bundles than did Britain before 1870. The conventional interpretation of the Balassa-Samuelson effect says that this means that Industrial Revolution Britain had higher relative productivity in export sectors. So far, that interpretation fits the results. Yet the amendment is that we still need to allow for the possibility that both sides had absolute productivity advantages – the land-rich American economy in relatively non-traded staple goods and Britain in traded manufactures. Absolute productivity advantages on both sides would more easily fit the purchasing-power results we saw in Part II.

If thinking about relative sectoral productivities fits the pre-1870 relative cost pattern so well, how is one to explain the disappearance of that relative cost pattern after 1870? Did the labor productivities of tradable and non-tradable sectors converge all over the world? That seems less likely than a more straightforward explanation in terms of rising trade shares. All across the nineteenth century, an increasing share of world product involved international trade. While part of this trend reflects the rising productivity in the manufacturing sector of Northwest Europe, part of it reflects the famous decline in long-distance trading costs across the second half of the nineteenth century.[30]

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[29] Implicit here is that traded-good prices tended to be equal when converted to a common currency.

[30] The global rise of trade's share is noted in Maddison (1995, p. 38); Estevadeordal, Frantz, and Taylor (2003); and Federico and Tena (2016, pp. 4-7, 32-34). The splitting of

A reminder of this familiar pattern, and its relationship to the relative prices of the staples in the barebones bundles, appears in Figure 7's history of the price of wheat in England relative to different American cities. Before the 1850s the English price was usually much higher than in America, and the ratio between the two gyrated, as is common in separate markets. True, both countries traded internationally in wheat, but only separately on the two sides of the Atlantic. Thus wheat, like other staple goods, was a non-tradable in the context of intercontinental trade before mid-century, although it was, of course, traded between local hinterlands and urban centers. After 1850, and after 1870 and the ending of the US Civil War, British and American wheat prices converged and stabilized. The more visible change here is not some convergence of sectoral productivities around the world, but rather the switching of staple goods like wheat from having separate continental markets to having an integrated market. This is one reason why the prices of the barebones bundles in Figure 6 converged so visibly after about 1870.

V. Adding non-staple prices still leaves greater Eurasian inequalities

It is time to address the suspicion that the new measures of purchasing power are biased because they use a narrow set of staple-good prices to deflator all of nominal GDP. Perhaps all of the departures from Maddison estimates are due to incomplete price coverage in the new estimates? Why not use a full GDP price deflator, including luxury consumer goods, capital goods, government services, and exports? Such an extension has not been performed in the past because of severe data constraints – yet we now have sufficient data on non-staple goods' prices to establish that using the narrow subsistence price deflator has probably not overstated the true Eurasian gaps in purchasing power.

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its explanation between productivity growth and transport costs is documented by Jacks, Meissner, and Novy (2010) and by Jacks and Pendukar (2010). The text is emphasizing the decline of trade costs more than the global spread of productivity gains, because the present focus is on the tradability of staple grains more than on the rise of trade in all goods. On the earlier gradual convergence of Eurasian prices in non-subsistence goods, see De Zwart (2016) and the sources cited there. On the eighteenth-century partial globalization of grain markets, see Dobado-Gonzalez et al. (2012, 2015).

The daunting heterogeneity of luxury consumer goods and capital goods has been the main barrier to comparing prices, or for that matter output volumes, over long reaches of time or space. Luxury consumer goods are heterogeneous by design, especially where the goods are meant to convey superior status, ethnic distinctions, or the latest fashions. Most capital goods have also eluded reliable price series. Scholars have tried, laudably but unpersuasively, to solve the problem of pricing capital goods with a few input-price proxies, such as a mixture of wages plus iron bars. Such proxies could only be in proportion to the prices of the produced capital goods if productivity were fixed in the capital goods sector.[31]

Yet history has left us enough circumstantial evidence to suggest, for Northwest Europe versus Asia from the sixteenth century through the nineteenth, that the true gaps in average purchasing power for all goods were no less than our measures have shown using the narrow subsistence bundle costs. The main kind of circumstantial evidence consists of a few price series for true luxury or investment goods, ones of sufficiently uniform quality to yield comparable data across centuries and across oceans. Figures 8A and 8B show relative prices of a ream of paper, a kilogram of bar iron, and a medium-sized nail, all relative to the price of wheat, a subsistence good, and all indexed to a late-year base. By the sixteenth century, paper (Figure 8A) had become cheaper in England, relative to wheat. Then, from the sixteenth century to 1910, it remained cheaper – or, reciprocally, wheat remained more expensive – in England than in the scattered observations from China, India, Moscow, Warsaw, Sopron, or Peru. Only in Barcelona do the data show cheaper paper (more expensive wheat) than in England. So if we accept that wheat prices moved in step with the prices of the entire grain-dominated subsistence bundle, then the ability to purchase paper was even more unequal between Europe and Asia than was the ability to purchase staple foods.

A similar contrast shows for the wheat prices of nails or of bar iron, in Figure 8B. For the available years, nails were cheaper, relative to wheat, in England than in China,

[31] Collins and Williamson (2001, pp. 85-86) note this. They nonetheless conclude that even in pre-war data, 1870-1913, the relative price of equipment is negatively correlated with GDP per capita (2001, p. 75). Nuxoll (1994) found a similar negative correlation in postwar data.

India, Moscow, or Istanbul. Only for nineteenth-century Pennsylvania do we know they were as cheap as in England. And in one nineteenth-century benchmark for China, iron was also cheaper in England than in China. Philip Hoffman has found that muskets (guns) were also cheaper, per grain calorie, in England than in China in the 1620s (Hoffman 2011, p. 52). The implication, again, is that expanding the price deflator to include such non-staple goods would show the English had at least as great an advantage in purchasing power over their Asian contemporaries as we were able to see using the prices of subsistence goods only. And the comparisons using subsistence-good prices alone have already found wider Eurasian gaps in purchasing power than Maddison suggested.

VI. Gerschenkron effects over the centuries

Why would the new estimates show wider Eurasian divergences than the Maddison estimates? And why were those discrepancies bigger before 1914?

There is in fact a systematic reason for these discrepancies, one that has been hiding in plain sight since the 1950s. The most likely source of bias is the long-familiar Gerschenkron effect, or Gerschenkron inequality, caused by the inevitable relevance of substitution in responses to changes in relative prices. The OECD and World Bank define the Gerschenkron effect thus:

> "Gerschenkron effect. An effect applicable only to aggregation methods that use either a reference price structure (i.e., each country's quantities are valued by a uniform set of prices) or a reference volume structure (i.e., each country's prices are used to value a uniform set of quantities) to compare countries. For methods employing a reference price structure, a country's share of total GDP (i.e., the total for the group of countries being compared) will [seem to] rise as the reference price structure becomes less characteristic of its own price structure. For methods employing a reference volume structure, a country's share of total GDP will [seem to] fall as the reference volume structure becomes less characteristic of its own volume structure. The Gerschenkron effect arises because of the negative correlation between prices and volumes …. The Geary-Khamis and Iklé-Dikhanov-Balk methods are subject to this effect."[32]

[32] For the original statement of the effect, see Gerschenkron (1947, 1951). For the international agencies' definition quoted here, see

What does the Gerschenkron effect imply about the difference between back-projection à la Maddison and a direct comparison of relative purchasing power per capita in, say, 1700? Mdddison's present-day (1990) international price comparisons unavoidably attach heavier weights to cheap modern goods than would a price comparison from the past. By itself, this kind of Gerschenkron effect understates earlier divergences between more developed and less developed economies.

Bakcward projection is also likely to cause a downward bias in the national growth rates whenever the weights are chosen from later years. The further back we want to reach in history, the greater this likelihood.[33] A straightforward reason is the modernist bias in data availability. To qualify as a weight-base period, a year has to supply detail not only on quantities produced or purchased, but also on either prices or value added. Our measures of historical movements are thus pushed toward anchoring them in more recent times, when the faster-growing sectors were lower in price. Hence lower growth rates in any country, rich or poor, whenever prices are used as weights.

The push toward more recent weight bases inevitably affected Maddison's work as well. Recall that he had to shut off his backward projections from national accounts in the mid- or late nineteenth century, settling for acknowledged "conjectures" back to 1820 and earlier years, on the basis of assumptions and his reading of a sketchy and qualitative literature. For example, his careful use of national accounts covered Britain only from 1830 on; Italy only from 1861 on; Japan only from 1885 on; China only for 1885, 1933, and post-1950; and India only from 1870 on. He was forced to use weights that understated both the earlier Eurasian divergences and the growth rates of modernizing economies. Maddison deserves credit for using national sources in a way that included as much splicing of weights as possible, to capture the history of structural changes. Still, a Gerschenkron effect is evident in his base-year 1990 international comparisons in Geary-

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http://siteresources.worldbank.org/ICPINT/Resources/270056-1255977254560/6483625-1291755426408/7604122-1363984715044/27_Glossary.pdf. Emphasis added here.

[33] See Nuxoll (1994) for this growth-rate side of the Gerschenkron effect, with postwar evidence. I am indebted to John Devereux for this reference.

Khamis prices.[34] The weighting here clearly rests on a reference price structure, and one that is far from ("less characteristic" of) the pre-1914 world. Furthermore, the poorer the country being compared with Britain in, say, 1700, the farther still were its consumers from facing the 1990s choices between different countries' prices of modern foods, home electricity, and automobile use, and the like. Britain in 1700 was less distant from this 1990 world by virtue of its higher incomes and Engel effects, and by virtue of its advances in traded-sector productivity. Thus the Gerschenkron effect may have biased upward his estimation of poor countries' incomes in a year like 1700 relative to his estimation of British incomes.

What role would a Gerschenkron effect play in the fact that Americans and Australians were more prosperous relative to industrialized Britain than Maddison had estimated? Would using, say, British price weights consistently cancel the purchasing power advantage of the Americans and Australians? Only a tentative, and mixed, answer is ventured here. Suppose that non-staples had all been cheaper in Industrial Revolution Britain, as was true of iron, cotton textiles, stockings, shoes, and boots before the 1830s. On the one hand, using such British price weights for a product-side estimate of GDP would actually raise the relative purchasing power of Americans and Australians relative to Britain, by attaching lower price weights to the quantities of industrial goods that Britain produced more. On the other, using British sectoral price weights in a cost-of-living deflator of nominal GDP would tip the advantage toward Britain. Add to this ambiguity the fact that some non-staples were cheaper in North America in the eighteenth and nineteenth century, such as timber, paper, and of course land.[35] So far, the circumstantial evidence suggests no clear change in the qualitative conclusion that America and Australia had great purchasing power in the nineteenth century. The exact

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[34] Maddison made no mention of the Gerschenkron effect. It can nonetheless be found hiding in his calculations of the Laspeyres (USA weighted), Paasche (other country's weights), and Geary-Khamis comparisons of GDP per capita. A less developed country's standing was closest to that of the US using US weights, and farthest using its own weights, with the Geary-Khamis results in between, except for Hungary and Yugoslavia (Maddison 1995, pp. 170-76).

[35] For the available price data on non-staples on both sides of the Atlantic in the eighteenth and nineteenth centuries, see Lindert and Williamson (2016, Appendix D).

accounting, with greater weights for non-staples, must await a fuller set of pre-1914 prices on both sides of the ocean.

Why were most disparities greater before 1914? The answer seems to lie in two facts about the pre-1914 era. First, Engel effects (budget weight differences) had more impact then. Poor countries spent more than half of their GDP on staple foods or agricultural products, whereas the shares of these for Britain had already dropped below one-third in the late seventeenth century. Pushed by Engel's Law, these food-related shares converged and shrank. The share of food consumption in GDP is now below one-fifth even in many lower-income countries, such as Guinea or Kyrgyzstan, in today's richer world. No longer do countries differ so much in their staple-consumption shares as they did before 1914. Second, as emphasized earlier, Balassa-Samuelson effects (relative price gaps enhanced by high non-tradable shares of national product) had greater impacts on relative purchasing power back when countries traded so little over long distances. The waves of globalization have shrunken the non-tradable sectors' shares of GDP, and the range of products with large international price gaps, down to just such services as housing and haircuts. While the International Comparison Project and the Penn World Tables still reveal purchasing power disparities, they cannot be as wide as they were in the nineteenth century and earlier.

VII. A take-away menu

This paper's introduction of new international comparisons of purchasing power, from six continents and over about four hundred years, suggests six take-away inferences for research and interpretation. The verb is "suggests," not "shows," because the new estimates need scrutiny as well as extension to other settings. That is, to borrow a deft phrase recently used by Stephen Broadberry and his co-authors, it is hoped that "... the results … while inviting refinement, are credible."[36]

[36] Broadberry et al. (2015, p. 364), discussing their sectoral productivity estimates.

The six "take-aways" underline how the historical geography of purchasing power may be expanded, and the sixth suggests an interpretation of the departures from the Maddison estimates for the sixteenth through nineteenth centuries.

(1) The now-greater Eurasian Divergence. Now that the Eurasian contrasts suggest a wider divergence back to about 1600 than the Maddison approach, further progress will depend on better quantification for the country at the center of the Great Divergence debate: Imperial China. Thus far the present direct-comparison approach is handicapped by insufficient Chinese population data, income data, and prices other than the rice price.

(2) Frontiers, food-rich and otherwise. Given that the dramatic revisions regarding North America relate to its cheapness of grains and other staple foods before the 1870s, it would be well to continue extending such direct comparisons to other early modern frontiers, particularly grain-rich Thailand, Cochin China, and the Philippines in Asia and to Poland, Russia, and Ukraine in Eastern Europe. There is also a case for deeper probing of GDP and prices in geographically varied Latin America and Africa. These frontiers differed greatly in their geography and relative staple-food scarcities.

(3) Luxury and capital-good prices. The history of purchasing-power inequalities, both international and intra-national, is increasingly constrained by the lack of prices, or shadow prices, of luxury goods and capital goods. This research frontier, well introduced in the intra-national context by Hoffman et al. (2002), needs a renewed push.

(4) Heating prices. Despite some comparisons of the costs of fuels in terms of millions of BTUs, especially by Robert Allen and his co-authors, we lack a systematic and downloadable documentation of the BTUs delivered by different kinds of firewood and other fuels from around the world. Scholars must also continue to quantify the dependence of heating costs on climate, given that warmer climates supply part of the needed warmth for free.

(5) Dating the rise and fall of purchasing power disparities. How will we put dates on the rise and fall of Gerschenkron inequalities, and the departures of direct historical comparisons from back-projection estimates? Were such disparities smaller in the less urbanized and industrialized world before, say, 1300? And when did they shrink again? Clearly, this paper's use of the "1914" shorthand cannot mean a sharp break in that year.

The convergence of index-number estimates happened sometime since the mid-nineteenth century, but when?

(6) Separate roles for the two approaches. The main take-away, of course, is to come to terms with the disparities between direct historical comparisons and Maddison's back projections.

The task of comparing aggregates is never free from the index number problem. If one really wants to compare purchasing powers in 1700 the way an observer should have seen them then, one should replace the 1990 price comparisons with 1700 price comparisons. Even then, of course, one would have to make an arbitrary choice. For Japan versus Britain, one can choose Japanese weights, British weights, or Allen's common hedonic price weights. Still, the preferred way to compare people's fortunes in the past is to use direct comparisons from exactly the historical settings they lived in – if our reconstructions of nominal national product and prices from their time are sufficiently reliable. On the other hand, the task of supplying and updating a global record of the growth of real national product and productivity will always be one for which the Maddison Project can accumulate, revise, and compare real national-account growth rates. This is a task that the benchmark direct comparisons, with their changing weights, cannot perform as well. Different questions call for different approaches.

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Table 1. Comparing Consumer Purchasing Powers of Nominal GDP per Capita, Japan versus Britain, 1750

The two consumer bundles, designed to have similar food calories, are:

(A.) "Japan A" basket (Bassino and Ma 2005), with a liter of sake added, for special occasions, yielding 1,942 daily calories and 82 grams of daily protein; and
(B.) The British "bare bones" bundle (Broadberry et al., 2015), with sugar added, yielding 1,942 daily calories and 83 grams of daily protein.

		Units per person-year		Prices, in grams of silver (gAg)	
	units	(A.) Japan	(B.) Britain	(A.) Japan	(B.) Britain
barley	kg	10	0	0.18	0.29
oats	kg	0	166		0.54
buckwheat	kg	16	0	0.61	
rice	kg	113.6	0	0.36	3.02
soybeans	kg	52	0	0.36	0.34
beans/peas	liters	4	21	0.22	0.34
meat	kg	0	5		3.10
fish	kg	3.5	0	2.18	
sake	liters	1	0	0.46	
edible oil	liters	1	0	1.35	6.89
butter	kg	0	3		5.88
sugar	kg	0	2.1		6.64
linen	m	5	5	1.17	10.79
lamp oil	liters	2.6	2.6	1.35	3.17

The total bundle costs, and aggregate results for 1750 are:

	(A.) Japan	(B.) Britain	Ratios
total cost of bundle (gAg)	90.4	208.2	0.434
real GDP, 1000 koku	86,905		
nominal GDP, mill. £		91.06	
nominal GDP, million gAg	4,654	9,707	
population, in millions	30.9	7.2	
GDP / cap (gAg)	150.6	1,344.3	0.112
GDP / cap, in bundles	1.666	6.456	0.258

Sources and notes for Tables 1-2 and Figure 2: See notes to Table 3.

Table 2. Purchasing Power per Capita: Japan as Percent of Britain, 1600-1912

	Maddison's file 2010	Maddison project 2016	This paper's "bare-bones" purchasing power per capita
1600	53.4	53.0	34.4 (1602)
1650		60.4	42.1 (1648)
1700	45.6	41.6	
1713			28.3
1750		35.3	24.6
1800		30.6	21.4
1820	39.2		
1850	29.1	29.2	25.0
1870	23.1	23.1	19.3
1880	24.8	24.8	
1888	23.4	23.4	19.6
1900	26.3	26.3	
1912	28.2	29.1	21.0

Table 3. Direct Comparisons of non-British with British Purchasing Power per Capita, 1525-1912

(Nominal GDP per capita, divided by cost of 1-man barebones bundle)
(Note: Britain values are specific to the comparison bundles for each country.)

Japan vs. Britain		
1602	1.7	4.6
1648	1.8	4.0
1713	1.6	5.3
1750	1.7	6.9
1800	2.0	8.8
1850	2.3	8.8
1870	2.5	12.5
1888	3.3	16.9
1912	4.3	20.6

Java vs. Britain		
1820	3.8	8.6
1830	5.0	11.1
1840	3.4	9.8
1850	2.4	10.9
1870	2.3	12.8
1890	3.2	25.1
1910	2.2	26.1

China vs. Britain		
1840	2.5	9.6
1885	1.4*	12.9

India vs. Britain		
1595	1.3	5.0
1870	1.8	12.4

America vs. Britain		
1700	10.0	7.3
1725	9.7	6.3
1750	9.8	6.6
1774	8.4	6.6
1800	6.5	7.1
1850	13.6	9.7
1860	14.5	9.7
1870	11.9	11.5

North-Central Italy vs. Britain		
1525	5.7	5.8
1575	4.7	4.9
1625	3.9	4.3
1675	3.6	5.3
1725	4.5	7.0
1775	4.2	7.5
1820	4.7	8.4
1870	3.8	10.1
1910	7.5	19.4

France vs. Britain		
1820	4.7	8.4
1870	6.6	10.1
1910	14.4	19.4

Netherlands vs. Britain		
1820	7.8	8.4
1870	7.7	10.1
1910	12.6	19.4

Poland vs. Britain		
1578	2.9	4.2

Peru vs. Britain		
1800	1.5**	8.8**

Mexico vs. Britain		
1800	3.9**	10.9**

Australia vs. Britain		
1870	8.3**	6.9**

Cape Colony vs. Britain		
1861	1.37	8.98

Sources and notes for Table 3 and Figure 3:

* See the text, noting the suspicion that Chang's GNP estimate is too low.

** Food basket only

As of November 2016, underlying calculations will be detailed further in a new set of files at gpih.ucdavis.edu.

Calorie and protein contents per metric unit are from Allen et al. (2011), Appendix Table II, with a few exceptions. Unlike the studies (co-)authored by Bob Allen, this paper omits fuel from the bundles, due to uncertainties about the conversion of fuel inputs (e.g. coal, firewood) into millions of BTU.

Britain: For Britain's nominal domestic product and population, I have used Broadberry et al. (2015) up through 1870, then splicing numbers from Mitchell (1988) onto the Broadberry et al. base. Broadberry et al. are also the source for the British bare-bones consumer bundle. Britain = England before 1700, Great Britain for 1700-1870, then United Kingdom. For British prices, the main source is Gregory Clark's collection of English price time series (gpih.ucdavis.edu). Where these series stop before 1914, the remaining years were spliced from the London series of Federico and Tena (2016).

(1) Japan (Tables 3-4 and Figure 2): The estimates of Japanese national product and population relied at first on Bassino et al. (2015), then with a revised estimates underlying Saito and Takashima (2016). I am indebted to Masanori Takashima for the revised GDP figures in millions of koku, 1600-1874.

Their estimates of real national product draw on a wide range of clues about sectoral value added, productivity, urbanization, demand patterns, and other indicators. Their real value added estimates are all converted into rice (koku) equivalents, implicitly using relative prices in a base period. I have converted their resulting real products into nominal product in grams of silver, using the price of rice in Masahiro Kimura (1987), Mitsui Bunko (1989), and the file "Japan 1885-1926," downloadable from http://gpih.ucdavis.edu. I am indebted to Jean-Pascal Bassino for supplying the Mitsui Bunko series, and to David Jacks for supplying the 1886-1926 file, to gpih.ucdavis.edu. These sources are also used for the Osaka prices in 1600-1604 ("1602" here), Kyoto prices for 1711-1715 ("1713") through 1866-1874 ("1870"), and Edo prices for 1886-1914.

There are uncertainties about the silver content of prices expressed in monme, as the sources note. My estimate of the silver content of the monme comes from the Bank of Japan's research center (http://www.imes.boj.or.jp/cm/english_htmls/feature_gra1-9.htm (1 August 2006)). The assumed rates are: for the 1600-1690's, 3 grams of silver per monme; for 1690's–1706, 1.875 grams of silver per monme; and for 1713-1870, 0.75 grams of silver per monme.

The Japanese consumer bundle is the "Japan A" basket of Bassino and Ma (2005), with slight adjustments.

On rice production and overall GDP, with comparisons to Maddison, see also Fukao et al. (2015, Appendix A).

(2) China 1840 and 1885:

(3) India 1595 and 1870: The Mughal GDP in millions of rupees for 1595 is from Moosvi 2008, pp. 2-3. For the population, I use Broadberry et al. (2015, p. 70). Habib's (1982a, p. 166) estimate of 107-115 million is based on 1941 census shares of British India, which seems risky. The 1870 GDP is from Goldsmith (1983).

The prices and consumer bundles are from the Allen and Studer data set at gpih.ucdavis.edu.

Silver content of rupee prices: The silver value of the rupee is set by Allen and Studer at 10.78 grams of silver in the current estimates. For alternative exchange rates of the rupee from 1823 on, see the Excel file "Indian rupee exchange rate values, 1823-1899, at http://gpih.ucdavis.edu. The choice of silver content does not affect any relative real wages, of course, though it threatens to affect relative prices and relative real GDP per capita if the exchange rates are inconsistent.

Broadberry and Gupta (2012) used 8.0 rupees per £ for circa 1600. This implies 14.62 gAg per rupee. They cite Chaudhuri (1978, p. 471), who gives that Rs 8.0 per £ for years from 1760 on. Habib (3rd ed, 2014, p. 433) says that "The weights of the [silver] rupee and the [gold] muhr remained practically unchanged through our period [1556-1707]." So Rs 8 = £1 even in 1595. Using the Broadberry-Gupta rate for 1600 thus would raise all silver prices, and income, in India 1595-1600 by more than a third (36.26%).

(4) The American estimates of real purchasing power per capita: As in Table 1, the source is Lindert and Williamson (2016, Chapters 2, 5, and 10, and Appendix D).

(5) – (7) Continental Western Europe 1525-1910: Nominal GDP figures are centered nine-year averages, except that Italy 1910 = that one year's value.

On North-Central Italy, 1525-1910, see Paolo Malanima (2010) and his (2012) "Consumer Price Indices and Wages in Central-Northern Italy and Southern England, 1300-1850: Statistical Appendix." http://www.paolomalanima.it/default_file/Italian%20Economy/StatisticalAppendix.pdf, accessed 21jan2016. Also available at gpih.ucdavis.edu, Nominal GDP Historical Series.

On France and Netherlands, 1820-1910, the nominal GDPs are available, with source citations, at gpih.ucdavis.edu. The bare-bones consumer basket costs for Paris and Amsterdam are from Robert Allen's (2001, p. 426) half-century averages, 1500-1549 through 1850-1899, and 1900-1913

Exchange rates up to mid-19th-century are based on the silver contents of the national currencies. Exchange rates for the 1870 and 1910 benchmarks are from Federico Giovanni and Antonio Tena-Junguito, (2016), "World trade, 1800-1938: a new data-set" WP 93. Web reference http://www.ehes.org/working_papers.html. I am indebted to Chris Meissner for this reference.

(8) Poland, 1578: All the estimates in this case are from a single secondary source. Malinowski and Van Zanden (forthcoming 2017, p. 28) have estimated Poland's nominal income, its subsistence basket cost for an average "individual" (adult income recipient?), and the ratio of these in both Poland and Britain for 1578. Their comparison is with England, not Great Britain. The comparison is not graphed in Figure 3 for lack of any competing Maddison estimate for sixteenth-century Poland.

(9) Peru, 1800: Nominal GDP was estimated by Seminario (2013 book ms., pp. 536-37) as 48,385,750 pesos fuertes of 1795. I have inflated this to an average for 1796-1804 of 51,424,823 pesos fuertes, or 1.247 million grams of silver, using his price ind3x from the same pages. The population of 1,268,848 is from also from Seminario, p. 278. The prices are from the gpih data file underlying Arroyo Abad, Davies, and Van Zanden (2012).

(10) Mexico 1800: Nominal GDP for 1800 is from Coatsworth (1978, 1989).

Population from Seminario (2013 book ms., p. 278). The exchange rate of 24.248 gAg per peso, or 3.031 gAg per real, is from the gpih data file underlying Arroyo Abad, Davies, and Van Zanden (2012). For Mexico, I have switched from the Arroyo-Davies-Van Zanden use of 165 kilos of maize to a wheat-maize mix that conserved the 1,943 calories while utilizing the availability of the wheat price series.

Maddison (2001) gives a Mexico/UK ratio of 0.447 for real GDP per capita. However, here I have used the Maddison Project's current Mexico/UK ratio of 0.399, yielding a smaller discrepancy between estimated ratios.

(11) Australia 1868: All figures other than population are averages over 1866-1870. Nominal GDP is from Butlin (1962, Table 2, p. 10/11). The interpolated population for 1868 is 1.495 million, from the Palgrave *International Historical Statistics* series. The consumer bundle consists of only six food products, with Sydney prices: bread, potatoes, tea, butter, cheese, and sugar.

The Maddison Project estimated ratio of real GDP per capita, 1866-1870 = 1.0148, versus the 1.205 ratio implied here.

(12) Cape Colony 1861: British nominal GDP and both places' bundle costs are based on five-year averages for 1859-1863. The British nominal GDP's are, again, those for Great Britain, based on Broadberry et al. (2015). The Cape GDP and population are those given for 1861 by Greyling and Verhoef (2015, Tables 2 and 3). The Cape Colony prices and the consumer bundle are those supplied in the Pim de Zwart data series on Cape Colony prices 1653-1913, at gpih.ucdavis.edu. I have adjusted the wheat consumptions of the De Zwart bundle to equal 193.5 kilograms, in order to scale the daily calories up to 1,942. The Cape/Britain ratio of purchasing powers per capita, equaling 0.151 for 1861, contrasts with the 0.247 ratio for the same five-year period (1859-1863) by the Maddison Project.

Table 4. How relative subsistence costs correlated with purchasing power, 1925-1912

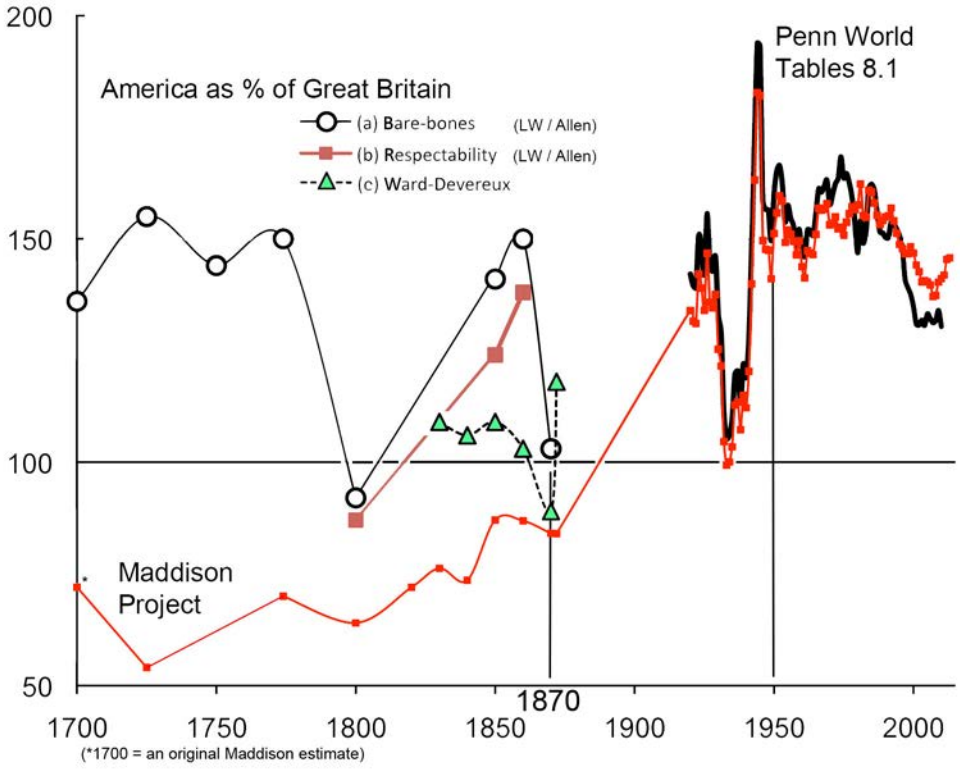
		Each country's level as a share of British level		
Comparison country	Benchmark year	Subsistence bundle cost ratio	Maddison Project income/cap	This paper's purchasing power / capita
Eurasia up to 1870 --				
China	1840	0.60	0.27	0.26
France	1820	0.84	0.58	0.56
France	1870	1.10	0.62	0.66
India	1595	0.43	0.73	0.26
India	1870	0.53	0.17	0.15
Japan	1602	0.54	0.53	0.37
Japan	1648	0.63	0.60	0.44
Japan	1713	0.69	0.40	0.29
Japan	1750	0.44	0.35	0.24

Japan	1800	0.29	0.31	0.23
Japan	1850	0.42	0.29	0.26
Java	1820	0.38	0.26	0.44
Java	1830	0.31	0.24	0.45
Java	1840	0.36	0.23	0.35
Java	1850	0.53	0.19	0.22
Java	1870	0.49	0.16	0.18
NC Italy	1525	1.47	1.40	0.99
NC Italy	1575	1.32	1.33	0.95
NC Italy	1625	1.04	1.38	0.90
NC Italy	1675	0.80	1.21	0.69
NC Italy	1725	0.71	0.94	0.64
NC Italy	1775	0.72	0.80	0.56
NC Italy	1820	0.65	0.72	0.56
NC Italy	1870	0.98	0.47	0.38
Netherlands	1820	0.65	0.90	0.93
Netherlands	1870	0.88	0.85	0.76
Outer continents up to 1870 --				
Australia	1868	1.13	1.03	1.21
Cape Colony	1861	1.45	0.25	0.15
Mexico	1800	1.04	0.40	0.36
USA	1725	0.72	0.53	1.55
USA	1772/4	0.76	0.68	1.27
USA	1800	0.70	0.62	0.92
USA	1850	0.82	0.79	1.41
USA	1860	0.77	0.79	1.50
USA	1870	1.08	0.77	1.03
After 1870 --				
China	1885	0.59	0.14	0.11
France	1910	1.12	0.68	0.74
Japan	1888	0.93	0.23	0.20
Japan	1912	1.56	0.29	0.21
Java	1890	0.68	0.14	0.13
Java	1910	0.71	0.14	0.08
NC Italy	1910	1.07	0.46	0.39
Netherlands	1910	0.89	0.80	0.65
USA	1900	0.83	0.91	1.31
USA	1912	1.08	1.09	1.18

Notes to Table 4:
The price and purchasing power results are derived as described in the notes to Table 3 and Figure 3. The preferred source for the Maddison Project income per capita is its internet site (Bolt and Van Zanden 2013), explained in Bolt and Van Zander (2014).

Three observations from Table 3 were omitted here. Peru 1800 and USA 1750 were omitted for lack of any Maddison Project estimates. Japan 1870, at the dawn of the Meiji restoration, was omitted because its new currency units gave questionable results, as evident in Figure 6.

Figure 1. American Real Income per Capita, Relative to Britain, 1700-2011
Direct Current-Price comparisons versus Maddison Back-projections



Sources and notes to Figure 1:
* The 1700 estimate is from Maddison (2001), rather that from the Maddison Project site. The sources are Maddison (1995, 2001, 2010); Maddison Project site (2013); Ward and Devereux (2003, 2004, 2006); and Lindert and Williamson (2016). For 1700-1872 the Lindert-Williamson series combines our own new estimates of nominal incomes with Robert Allen's barebones consumer price deflators for Philadelphia, Massachusetts, and the Chesapeake, along with his corresponding price series for England, and the Broadberry *et al.* (2015) estimates of the nominal income of Great Britain up to 1870. For

1950-2010 we use the expenditure-based income measure (cgdpe) per capita from Penn World Tables 8.1, and our ratios refer to the United Kingdom, not Great Britain.

The sources and assumptions for Figure 1 are described at length in Lindert and Williamson (2016, Chapters 2, 3, 5, 6, and 10 and Appendix D).

Figure 2. The Bare-bones Purchasing Power of GDP per capita,
Asian Countries Compared with Britain, 1595-1912

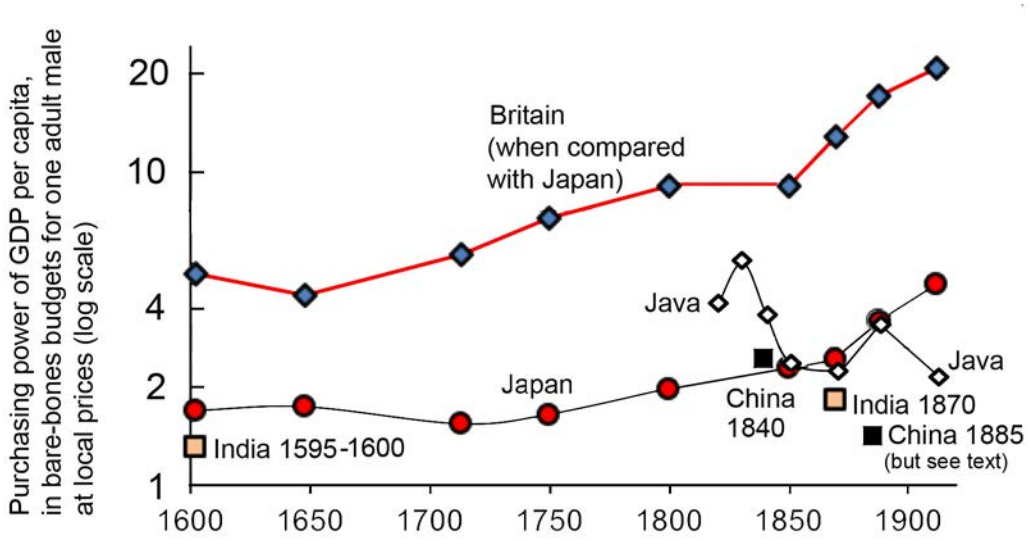


Figure 3. Comparing Current-Price Measures of Relative Purchasing Power per Capita with Maddison's GDP per capita, Several Countries Relative to Britain, 1525 – 1912

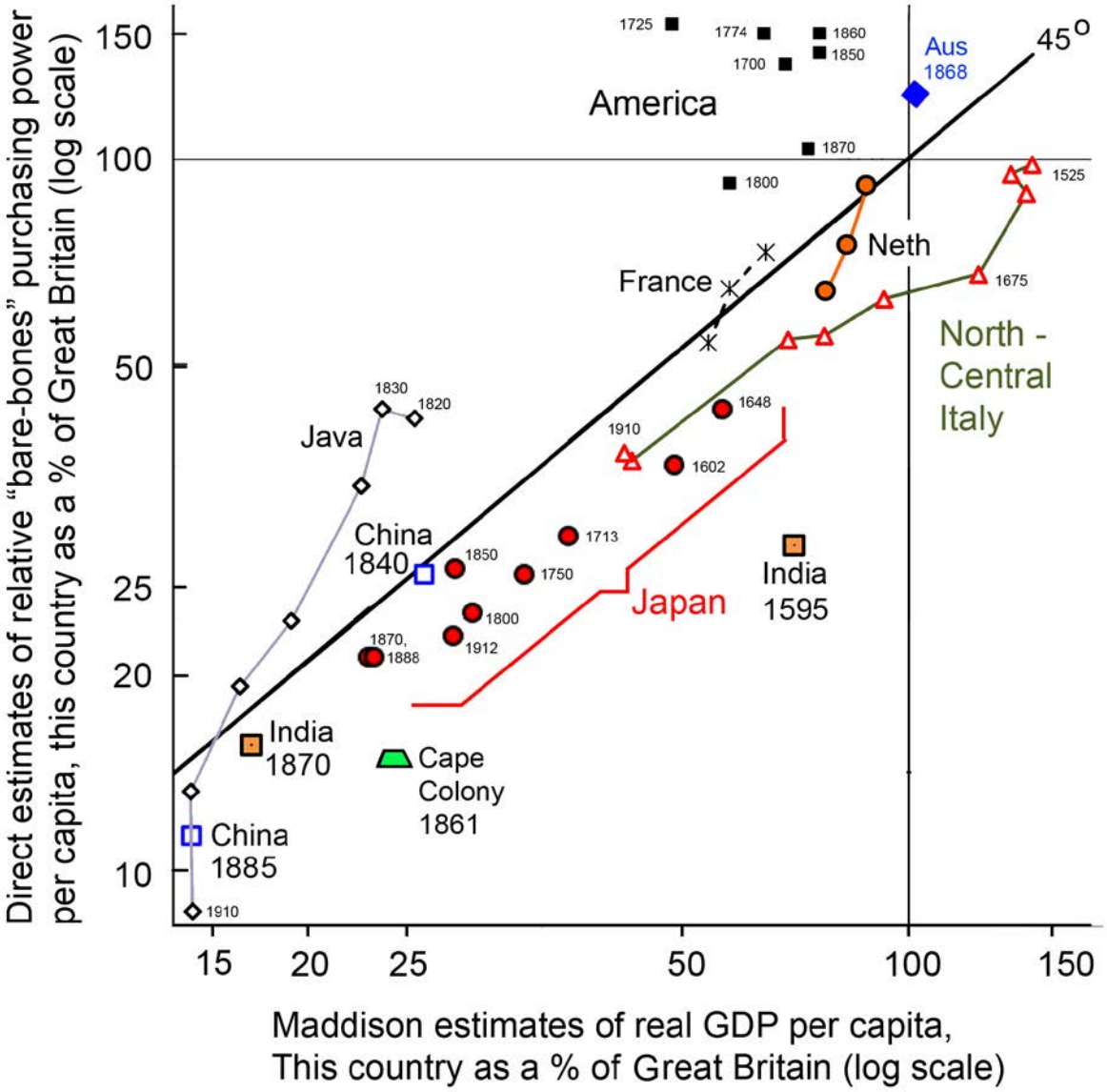


Figure 4. Comparing Current-Price Measures of Relative Purchasing Power per Capita with Maddison's GDP per capita, Several Countries Relative to Britain, 1872 and 1910

(Based on Ward-Devereux 2016.)

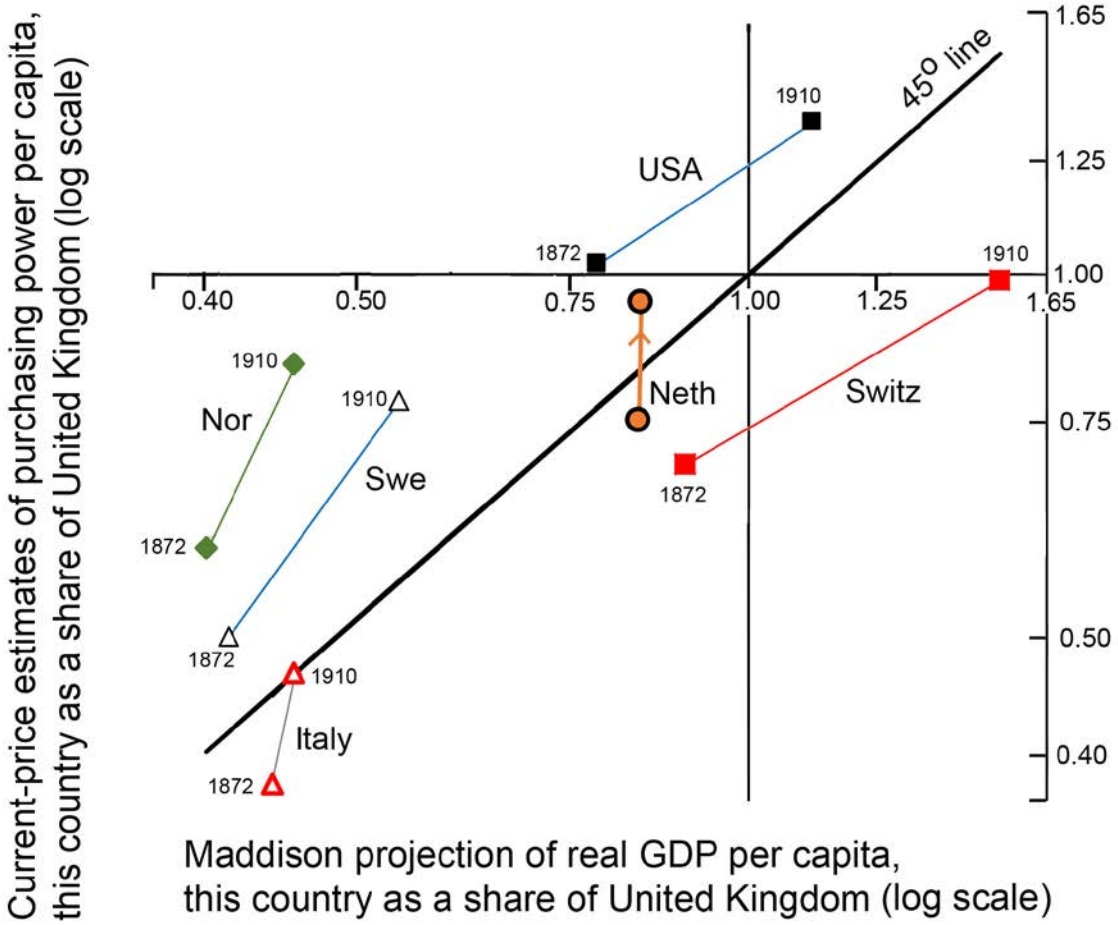


Figure 5. Comparing Current-Price Measures of Relative Purchasing Power per Capita with Maddison's GDP per capita, Several Countries Relative to Britain, 1872 and 1910

(Based on Ward-Devereux 2016. For each country, the upper dot refers to 1910.)

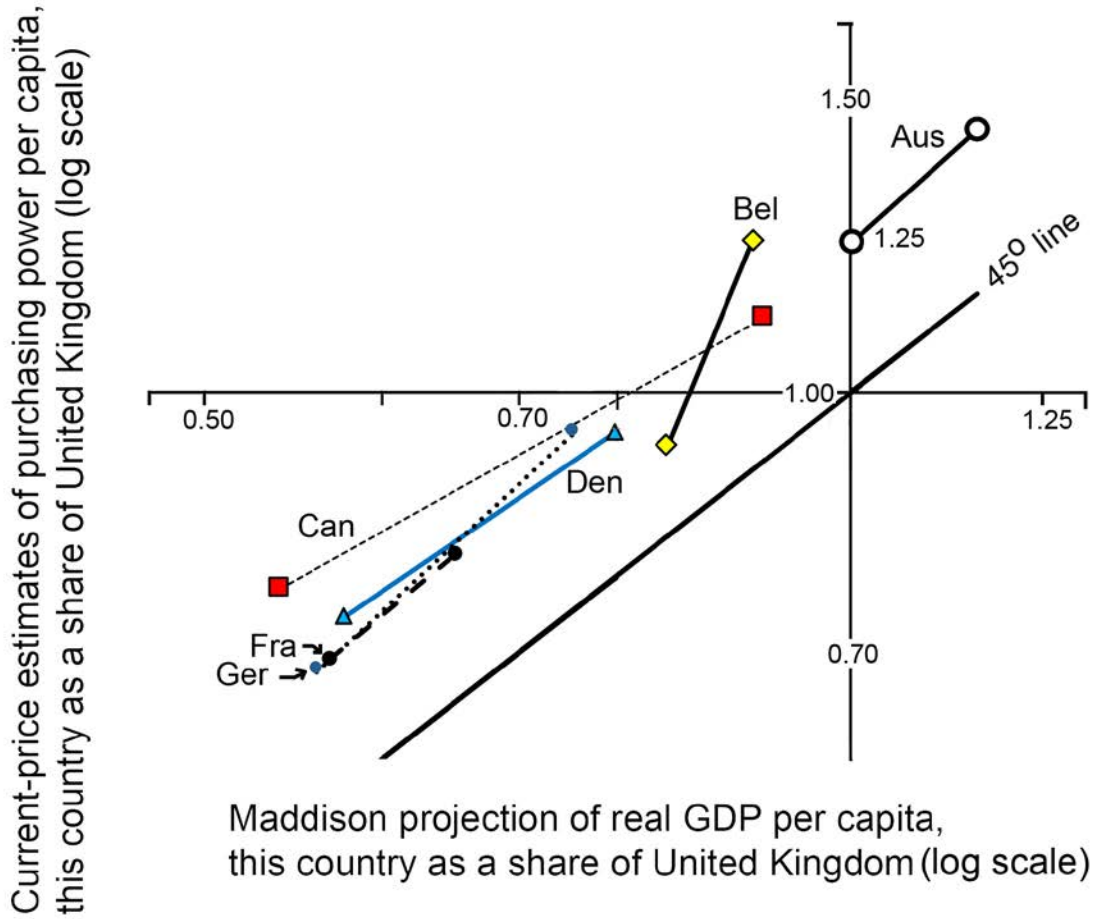
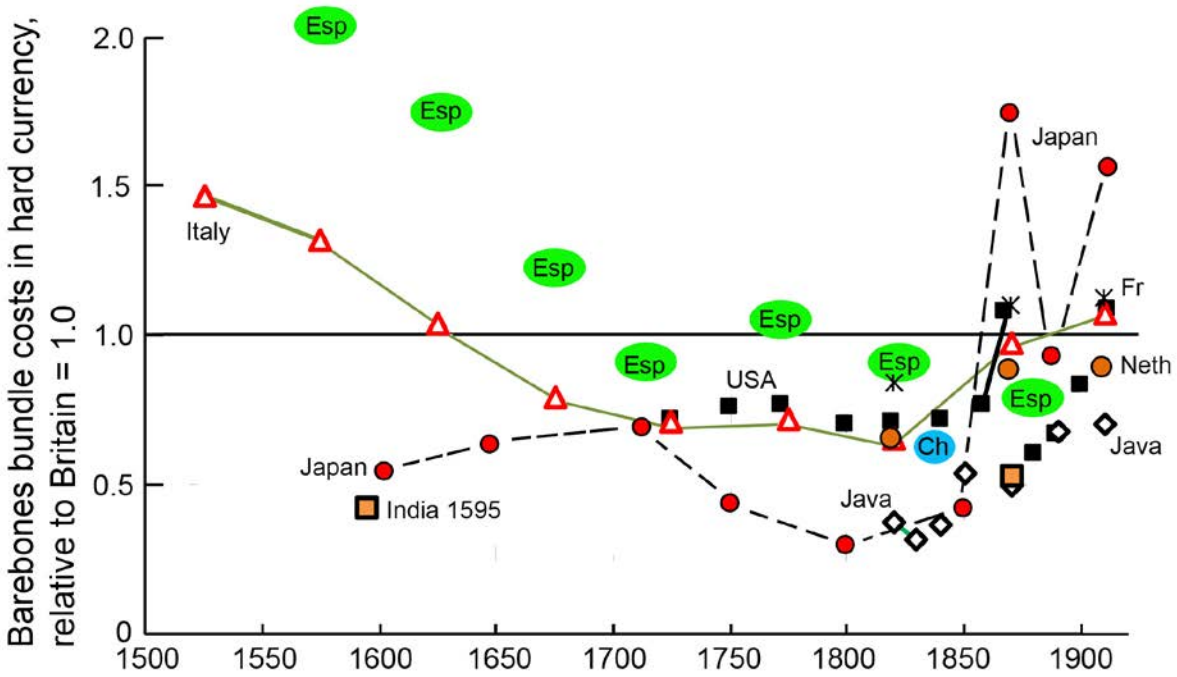


Figure 6. Relative Costs of Barebones Consumer Bundles in Hard Currency, 1525-1912

(Costs relative to Britain = 1.000)



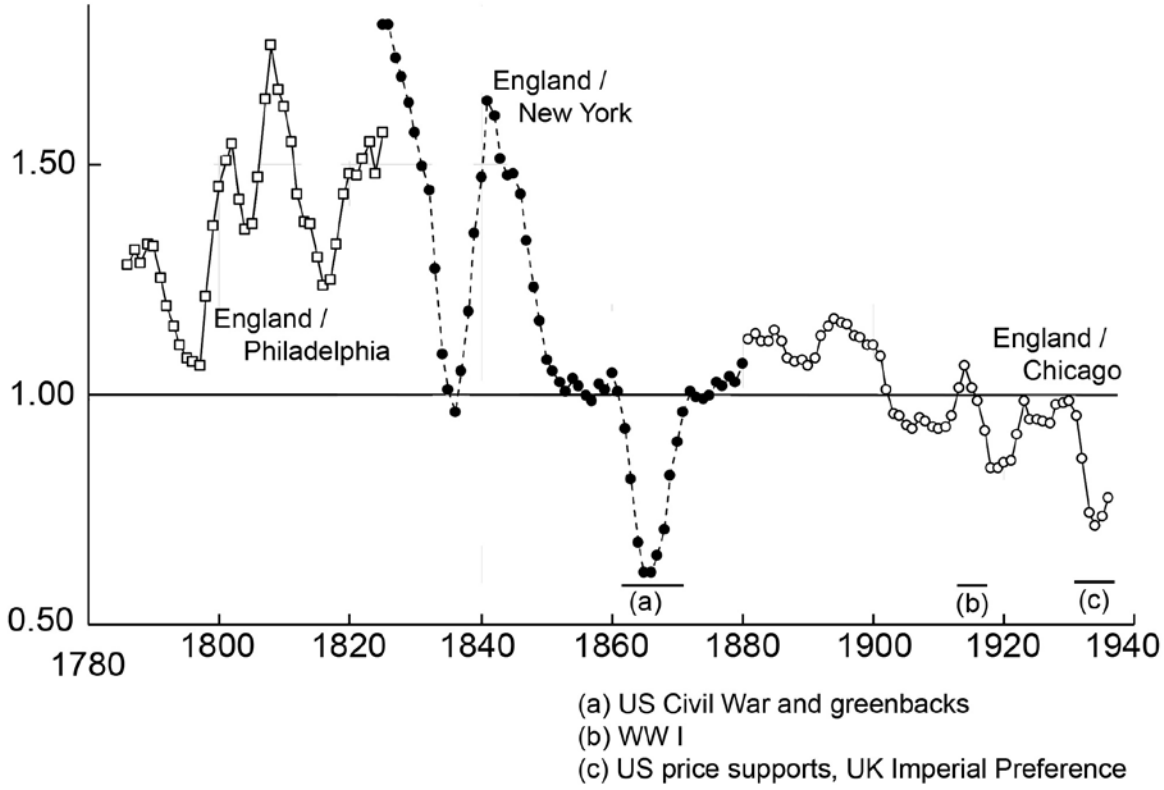
Sources and notes to Figure 6:

The sources are the same as those described in the notes to Table 3 and Figure 3.

The compositions of the bundles vary from one country's time series to another's, though all bundles' foods deliver about 1,942 kilocalories.

Hard currency here means either grams of silver or the pound sterling, both for Britain and for the indicated other country.

Figure 7. English / American Price Ratios for Wheat, 1786-1936



Figures 8. The Wheat Price of Lesser Luxuries, 1215-1912

Figure 8A. The Wheat Price of Paper, England and Elsewhere, 1355-1912

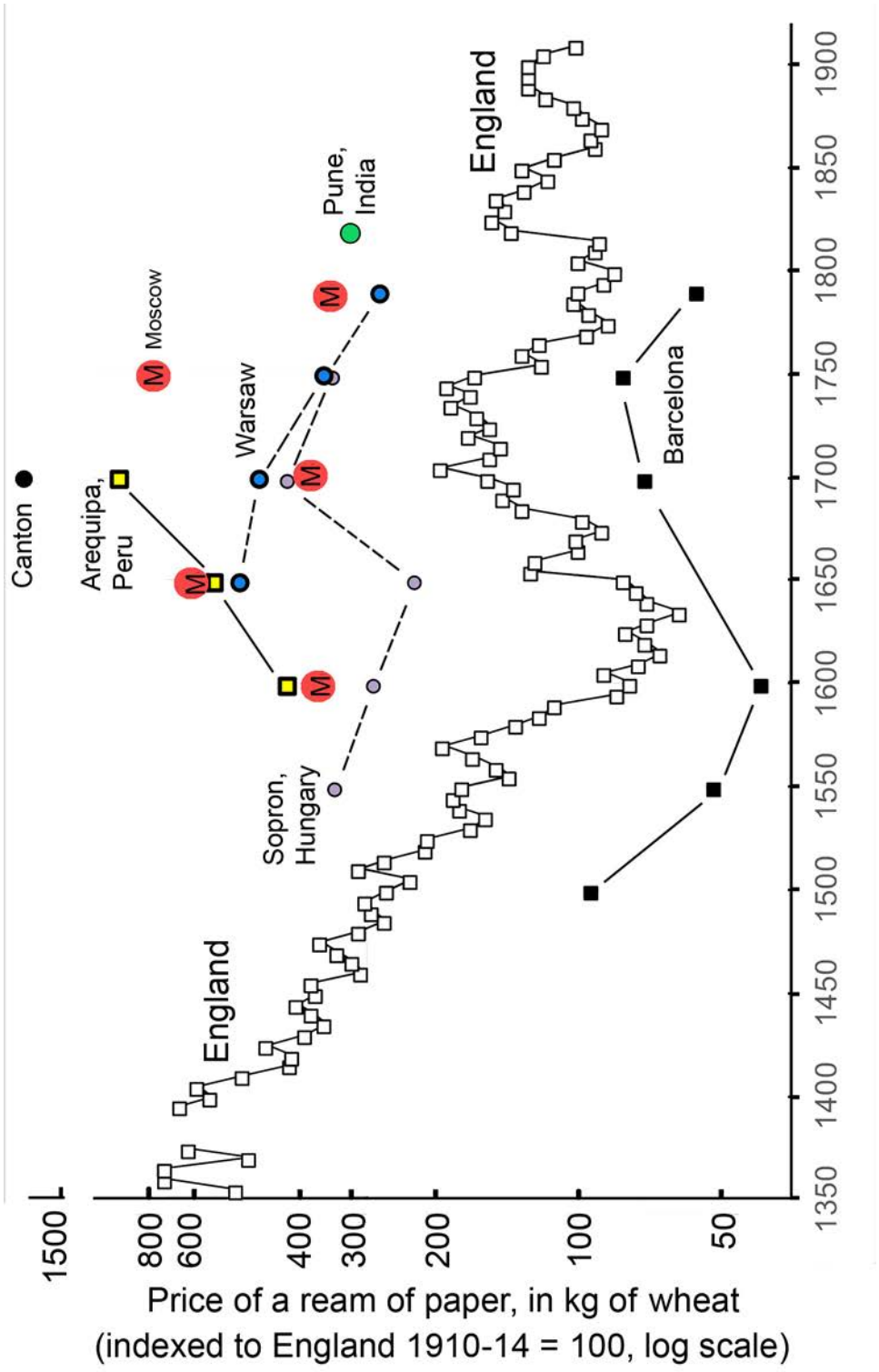
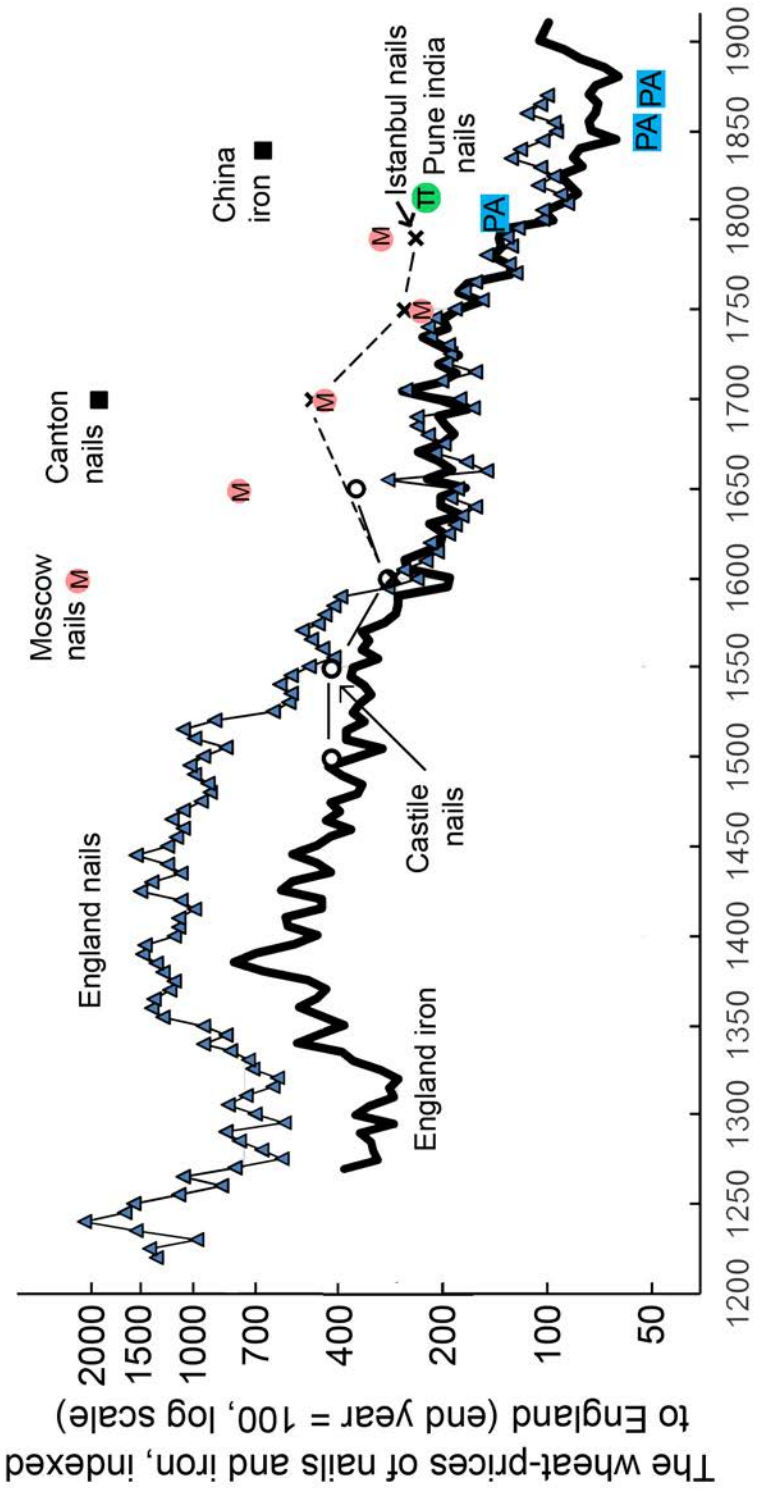


Figure 8B. The Wheat Price of Nails and Iron, England and Elsewhere, 1220-1912



Sources and notes to Figure 7:
The English price series are from Clark in gpih.ucdavis.edu, with values for 1914-1938 spliced on from the series given in Federico and Tena (2016).
The American price series are from Carter et al. (2006, series Cc205-Cc209. For 1881-90 the "Chicago" series is spliced onto the 1890-1913 Chicago "Spring and winter" series. For 1914-38 the BLS series is spliced onto the Chicago spring and winter series.
The exchange rate is from Federico and Tena (2016).
The prices are centered five-year averages.

Sources and notes to Figures 8A and 8B:

The English series are from the corresponding files in gpih.ucdavis.edu, with a few exceptions. The figures comparing China with England in 1840 are from Broadberry, Guan, and Li (2016, Table 3).

The figures are generally quinquennial averages centered on the stated years, indexed to the base of England, 1910-14 (except for indexing nail prices to 1866-1870). Those for England are from Clark's 1209-1914 price file at gpih.ucdavis.edu, converted to logarithms. Those for other places are ratios of the log form ln (Other place / England), with the England denominator not necessarily coming from the Clark series.

The index 100-base years are the end-years of the series, namely 1910 for paper and iron and 1870 for nails.

These log-ratios of departure from the England price ratio in the same benchmark year are, as follows:

Figure 8A, paper: Arequipa (Peru), year 1600 = 1.62, 1650 = 1.94, and 1700 = 1.74. Barcelona, 1500 = -0.97, 1550 = -1.19, 1600 = -0.62, 1700 = -0.75, 1750 = -0.70, and 1790 = -0.56. Sopron, Hungary, 1550 = 0.60, 1600 = 1.21, 1650 = 0.98, 1700 = 0.95, 1750 = 0.67. Warsaw, 1650 = 1.81, 1700 = 1.08, 1750 = 0.72, and 1790 = 0.94. Moscow, 1600 = 1.47, 1650 = 2.00, 1700 = 0.84, 1750 = 1.51, and 1790 = 1.19. Canton 1700 = 2.32. Pune, India 1820 = 0.72.
The Clark-based English wheat price indices for paper, to which these log-departures are added, are England 1500 = 0.90, 1550 = 0.54, 1600 = -0.25, 1650 = -0.22, 1700 = 0.42, 1750 = 0.48, 1790 = 0.00, and 1820 = 0.31 (all in logs).

Figure 8B, ln (other country/GB) for nails: Castile (average of New and Old), 1500 = -0.85, 1550 = -0.16, 1600 = 0.18, and 1650 = 0.66. Istanbul, 1600 = 0.16, 1700 = 0.97, 1750 = 0.34, and 1790 = 0.60. Moscow, 1600 = 2.22, 1650 = 1.43, 1700 = 0.87, 1750 = 0.22, and 1790 = 0.82. Canton 1700 = 2.36. Pune, India 1819 (1817-21 average), for British medium-sized nails, from Divekar (1989).
The Pennsylvania nail price series (PA) is from the file "Pennsylvania 1720-1896, spliced" at gpih.ucdavis.edu.
It is based on the data supplied by Anne Bezanson and collaborators.

The Clark-based English wheat price indices for nails (based in 1866-70, and logged), to which these log-departures are added, are 1500 = 2.27, 1550 = 1.58, 1600 = 0.86, 1650 = 0.59, 1700 = 0.58, 1750 = 0.60, 1790 = 0.27, 1820 = 0.06, and 1840 = 0.18.
Figure 7B, ln (other country/GB) for manufactured iron shapes: Canton 1840 = 2.36. Pune, India 1819 = 0.74.
The Clark-based English wheat price indices for manufactured iron (based in 1906-1910, and logged), to which these log-departures are added, are 1820 = -0.13 and 1840 = -0.22.
In figure 7B, the wheat price of iron is not graphed for Pune, India 1819, because it is too close to the relative wheat price of nails for the same date.