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NEW INCOME COMPARISONS FOR THE LATE NINETEENTH AND EARLY TWENTIETH CENTURY

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We provide current price GDP comparisons covering 13 Western economies for 1872 and 1910. The current price measures compare income with the prices of the comparison year rather than the fixed recent prices of earlier approaches. Our work fills a gap in the literature since current price GDP comparisons generally do not reach before 1950. As it turns out, the current price results differ from the familiar Maddison projections in constant 1990 prices as they raise relative income for the U.S. and Canada while they lower income for Belgium, the Netherlands, Switzerland and the U.K.

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1. INTRODUCTION

Modern economic growth began in Western Europe and spread outwards. The study of the characteristics of growth—structural change, convergence/divergence and changes in economic leadership—requires comparable long run GDP. Over recent years, the monumental work of the late Angus Maddison (1995, 2001, 2007) has dominated the field. Maddison compared income using 1990 relative prices. Recent years, however, have witnessed major changes in how economists compare GDP; see Feenstra *et al.* (2015). Most notably, the field has moved to using current prices, that is, to comparing income with prices close in time to the desired comparison year rather than with the fixed recent prices of earlier approaches. The latest version of the Penn World Tables (henceforth the PWT) exemplifies this change as it provides a series for GDP comparing income using multiple current price benchmarks.

This paper provides current price historical GDP comparisons for thirteen western economies. The benchmarks cover 1872 and 1910. They fill a gap in the

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literature as current price comparisons generally do not reach before 1950. The results, as it turns out, differ from fixed price projection in significant ways. To summarize, they raise U.S. and Canadian income while they lower income for Belgium, the Netherlands, Switzerland and the U.K. The Swiss case stands out. The fixed price projections show Switzerland as the leading economy for 1910 with income per capita that is forty percent above the U.S. whereas current price comparisons show the Swiss as well down the pack.

As mentioned, traditional approaches compare income over long time spans using fixed recent prices. Maddison (1995, 2001, 2007) popularized this approach and his work is carried on by the Maddison Project, see Bolt and Van Zanden (2014). Maddison compares income as follows. First, he takes a purchasing power parity (PPP) adjusted GDP comparison for 1990 from the International Comparison Program (henceforth the ICP). Next, he projects his ICP benchmarks backwards using GDP growth rates.[1] The resulting series are in 1990 prices.

The Maddison GDP projections face three difficult index number problems. First, they compare income across space for a recent year. Second, they compare income over long spans for the base country and, finally, they compare income over long spans for the comparison country. Half a century ago, the distinguished economic historian Robert Gallman projected income for France, Britain and the U.S. from 1950 to 1840 using a 1950 base year comparison. His description of the conceptual difficulties he faced (Gallman, 1966, p. 6) holds for all subsequent efforts:

> The procedure has one very important disadvantage: the results are difficult to interpret. As a first approximation, we are comparing 1840 (circa) national products valued in 1950 prices, since the extrapolated estimates are in 1950 prices. But the extrapolators are not based on 1950. The price base of a constant price national product series affects the rate of growth of the series; in general, the earlier the price base, the higher the rate of growth. Since the base years of the extrapolators are earlier than 1950, the extrapolated 1840 values are really smaller than 1840 national 'products in 1950 prices. If the extent of "bias" in the three series were identical, the comparisons would be unaffected, of course; but there is no good reason for supposing that they are. The date of the price base differs from series to series. In addition, the extent to which an early price base raises the rate of growth of a national product series, compared with a late price base, depends on the extent of changes in the price structure over time. There is no good reason for believing that the price structures of the three economies changed at the same pace.

We would add a further difficulty to Gallman's list. Suppose we project GDP for two countries to the distant past, say 1870. A change in the base year or a revision in the underlying GDP series for either economy *between 1870 and the base year* will change the 1870 projection. Since such revisions are inevitable, projections are condemned to forever rewriting history—a point made six decades ago by Simon

[1]Clark (1940) appears to be the first researcher to use projections for long run income comparisons.

Kuznets (1956, p. 7). Switzerland provides a striking example. Due to the revisions in the underlying Swiss GDP series, GDP per capita for 1910 went from ninety percent of the U.S. to one hundred and forty percent across recent rounds of the Maddison project. In simple terms, GDP projections depend on the entire sequence of prices/quantities from the base year to the year compared. In contrast, the current price GDP comparisons compare income using prices and quantities from the comparison year. In this way, current price comparisons write history just once as data revisions outside the comparison year have no bearing on measures of comparative GDP.

Given the changes in the Penn World Tables and the fact that the theoretical literature generally favors current price estimates, we would expect increased interest in current price historical comparisons as economic historians seek to make their methodology consistent with the best practice in the field.[2] This appears to be the case and there seems wide agreement more current price estimates are needed—if only to crosscheck projections. We contribute to this research program by providing current price historical GDP comparisons for the major western economies constructed along consistent lines based on disaggregated price, quantity and expenditure data.[3] The core of our estimates are price data collected by contemporary agencies specifically to compare price levels. In total, we compare real income for 13 countries—Australia, Belgium, Canada, Denmark, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, the U.K. and the U.S.[4] There are no previous attempts to provide current price historical benchmarks for such a large group. Our comparisons cover 1872 and 1910, thus, bracketing the beginning and end of a great globalization episode.

To generate the current price comparisons, we develop a methodology which adapts the ICP framework to the realities of historical data. Most notably, our approach departs from the ICP by emphasizing quantity as well as price comparisons. Here we hark back to Gilbert and Kravis (1954) as we find their price/quantity approach is often better suited to the exigencies of historical data.

[2]As Lindert (2016) notes, a further stimulus to the development of current price historical estimates are the various controversies where projections and current price estimates yield different results. An early debate concerns the relative standing of the U.K. and U.S. Maddison's projections show the U.K. with a substantial income lead for the nineteenth century with the U.S. taking over in the early 1900's. Prados De la Escosura (2000) and Ward and Devereux (2003, 2004, 2005) argue for an early U.S. income lead using current price estimates. Broadberry (2003) and Broadberry and Irwin (2006) defend the Maddison projections while Woltjer (2015) hews to a middle ground. Recently, the literature has taken an unexpected turn as Peter Lindert and Jeffrey Williamson, Lindert and Williamson (2016), find a larger U.S. lead before 1870 and one stretching further back in time than claimed by Prados De la Escosura (2000) or Ward and Devereux (2005).

[3]There are other current price methodologies. Leandro Prados De la Escosura (2000) compares GDP for the major developed economies in current prices from 1820 to 1990 using a short cut regression model. More recently, Lindert (2016) supplies benchmarks for a wide range of countries over longer time spans using a current price methodology with few data requirements.

[4]The literature provides isolated pre-1950 current price benchmarks. O'Brien and Keyder (1978) consider France and the U.K. for the nineteenth century. Alan Heston and Robert Summers (Heston and Summers (1980)), two of the creators of the ICP, compare India and the U.S. for 1870. The next work is by Haig (1989) and Thomas (1995) who compare Australia and the U.K. The 2000's saw increased interest with, amongst others, Van Zanden (2003) for Java/Netherlands, Ward and Devereux (2003, 2005) for the U.S/U.K., and Fukao et al. (2006, 2007) for China/Korea/Taiwan/U.S. Recent work includes Broadberry, Custodis and Gupta (2015) on India/U.K. Bolt et al. (2018) list most studies.

The first part of the paper outlines our procedures and data sources. As one would expect, researchers face formidable challenges using historical data to build current price GDP comparisons. On the contrary, we find important unexploited data sources in the form of price data collected by contemporary agencies specifically to compare price levels internationally for the late nineteenth and early twentieth centuries. Sections three and four present the current price GDP benchmarks. As mentioned, the current price comparisons differ in crucial respects from standard GDP projections. To be clear, some divergence between projections and the current price benchmarks is inevitable.[5] As Deaton and Aten (2017) point out—projections and benchmarks *cannot* be equal because comparisons over space (the current price estimates) and comparisons over time and space via projections involve different sets of prices and quantities and hence *must* yield different outcomes.[6]

A thorny issue facing economic historians is, therefore, how to choose their preferred GDP measure when current price and fixed price GDP projections conflict. To take a concrete example, what measure better captures the relative position of Switzerland for 1910? Is it the world income leader (projections) or is it somewhere in the middle (current prices and earlier projections)? The PWT resolves such conflicts in favor of current price estimates on largely theoretical grounds. Put simply, the current price comparisons have desirable theoretical properties while projections do not. Yet, we do not advocate this *a priori* approach for historical GDP comparisons given the nature of historical data where prices, quantities and nominal income come with considerable measurement error. Rather, we argue the choice between projections and current price estimates requires empirical evidence.

Accordingly, we provide two approaches to evaluate the current price historical GDP comparisons. Building on Prados De la Escosura (2000), we first investigate whether the current price estimates are consistent with what we know about relative price levels in the past. The second approach crosschecks the current price estimates using sectoral output data, along the lines of Rostas (1948) and Paige and Bombach (1959), and real wages as suggested Heston (1998).

The crosschecks are broadly supportive of the current price estimates.

2. Comparing Price levels—Sources and Methods

We compare final spending on the components of GDP: consumption, investment and government. The first step in the comparison computes relative price levels while the second step uses the price levels from the first step to compare real GDP. This section outlines data sources and methods for the price comparisons.

[5]Differences between benchmarks and projections exist for every ICP round. The most famous examples are China and India where projections from the 1993 round differed from the 2005 benchmarks by fifty percent. Remarkably, the release of the 2011 round of the ICP in 2014 reversed some of the 2005 changes see Deaton and Aten (2017) and Inklaar and Rao (2017).

[6]Kravis et al. (1982), Summers and Heston (1988a, 1988b) and Aten and Heston (2002) provide early discussions of why projections do not equal benchmarks. Feenstra et al. (2009), Deaton (2012) and Deaton and Aten (2017) give recent treatments. Inklaar and Rao (2017) is an important recent paper on this question. The issue is, however, an old one. For example, Clark (1950, p. 33) finds his projections from 1929 do not equal his benchmarks for the 1900's.

The Supporting Information file associated with this paper provides a complete account along with underlying price and expenditure data.

We compare price levels with a Fisher Ideal price index—the geometric average of a price index constructed with base country weights and an index constructed with partner weights. The Fisher Ideal is widely used for historical comparisons as it has appealing theoretical properties. As Diewert (1976) showed, it is a superlative index, and therefore, approximates a true welfare measure.[7]

The U.S. is the base economy. Following standard terminology, we refer to the U.S. weighted price index as the Laspeyres index and the partner weighted price index as the Paasche. Equation (1) is the Fisher Ideal price index for country I in year T relative to the U.S. where P^{us} and P^{i} are price indices calculated using U.S. and partner weights, P^{F} is the Fisher Ideal and p and x are prices and quantities.

$$P^{F}\left(p^{us}, p^{i}, x^{us}, x^{i}\right) P = \left(P^{us}\left(p^{us}, p^{i}, x^{us}\right) * P^{i}\left(p^{us}, p^{i}, x^{i}\right)\right)^{0.5} \quad (1)$$

To understand how the comparison works, we focus for the moment on the Laspeyres price index. Equation (2) re-expresses the index as a weighted average of price relatives where weights are U.S. expenditure shares, denoted by θ_j^{US}.

$$P^{US}\left(p^{US}, p^{i}, x^{US}\right) = \sum \theta_j^{US} p_j^{i} / p_j^{US} \quad (2)$$

To compare price levels we use price data, mainly retail prices taken from contemporary surveys from the nineteenth and early twentieth century, discussed later. In addition, we supplement the retail price data with unit values derived from quantity data. In this, we return to Gilbert and Kravis (1954)—the forerunner of the ICP.[8] As their quantity approach is not widely known, we illustrate it with a U.K./U.S. example. For concreteness, we term the item compared "beef." Suppose we lack price data for beef, but we know beef consumption in lbs. and its expenditure share. Define θ_i^{US} as the share of U.S. expenditure on beef and Y^{US} as U.S. nominal GDP per capita. Equation (3) gives the U.S. price, or more correctly the unit value, denoted by $p_i^{US,}$ implied by expenditure and quantity data where, x_i^{US} is the quantity measure for beef.

$$p_i^{US} = Y^{US} \theta_i^{US} / x_i^{US} \quad (3)$$

We obtain U.K. unit values in a similar fashion. Since we use price and quantity comparisons to compare the overall price level, the price indices in (1) contain prices but they also contain unit values.[9]

[7]Gilbert and Kravis (1954) use the Fisher Ideal. The index, however, is not transitive and the ICP and the PWT later switched to multilateral comparisons.

[8]The ICP uses quantitative indicators for comparison resistant services such as education but their focus is on prices, see World Bank (2013). Gilbert and Kravis (1954, 1955, 1958) relied more on quantitative indicators/unit values because of gaps in their price data.

[9]For future reference, notice that unit values depend on nominal income.

TABLE 1
Expenditure Categories, Price and Quantity Indicators

	U.S. Weights 1910	Price Indicator	Quantity Indicator
Consumption			
Food and Beverages			
Wheat flour	0.035	x	x
Rye flour	0.001	x	x
Corn meal	0.004	x	x
Beef	0.046	x	x
Mutton	0.008	x	x
Pork	0.034	x	x
Eggs	0.028	x	x
Fresh milk	0.032	x	x
Butter	0.029	x	x
Cheese	0.004	x	x
Potatoes	0.016	x	x
Tea	0.002	x	x
Coffee	0.012	x	x
Sugar	0.016	x	x
Housing	0.158	x	x
Fuel and Light	0.031	x	
Shoes and Clothing	0.120	x	
Alcohol			
Beer	0.023		x
Spirits	0.028		x
Wine	0.003		x
Tobacco	0.024		x
Domestic Service	0.025	x	
Travel			
Railway	0.032		x
Other	0.018		x
Communications	0.006		x
Education	0.025		x
Investment			
Construction	0.152	x	
Machinery	0.052	x	
Government			
Labor	0.021	x	
Other purchases	0.014	x	

Turning to weights, Table 1 gives the expenditure breakdown for both years. For consumption, we compare spending on food, rent, fuel and light, clothing, alcohol, tobacco, communication, transportation, education and domestic service. Within food, there is flour, beef, mutton, pork, butter, cheese, tea, coffee, sugar, potatoes, eggs, and milk. In total, we compare thirty-three categories of spending.[10]

The Table shows where items are compared with prices and where items are compared with quantity/unit value indicators. The price comparisons cover rent, clothing, gross capital formation and government while the quantitative indicators/unit value comparisons cover services, transportation, communication and tobacco/alcohol. For some items, most notably food and housing, we have both.

[10]There are gaps in coverage. For food, we lack data for poultry and fish as well as vegetables, other than potatoes. In addition, we have no information on consumer durables such as furniture. Our coverage of personal services is sparse and so on.

2.1. *Expenditure Weights*

The national accounts supply the weights for overall consumption, government and investment. For example, we collect aggregate U.K. weights from Feinstein (1972); Dutch weights are from Smits *et al.* (2000) and so on. Where possible, we use the national account sources for disaggregated weights. Unfortunately, the national accounts often do not provide enough detail. In addition, categories are not always consistent across countries.[11] To fill these gaps, we turn to expenditure studies such as the U.S. Bureau of Labor (1890, 1891), the Board of Trade (1908, 1909, 1910, 1911) and country sources. A drawback of the expenditure studies is that their expenditure patterns often relate to relatively low incomes. They show, for example, higher food shares than the national accounts. They also reflect mainly urban consumption patterns whereas we require national (urban plus rural) expenditure weights.

To better understand the coverage of the price and the unit value comparisons, Table 1 gives the example of U.S. weights for 1910. The price comparisons cover about 75 percent of U.S. spending while quantitative indicators cover about 58 percent. The coverage of quantitative indicators is lower for 1872 as there is no quantitative comparison for rent.

The Supporting Information file associated with this paper provides the expenditure weights.

2.2. *Comparative Price Data*

From the outset, we searched for retail price data collected by contemporary agencies to compare price levels internationally. [12] Ideally, the sources would use a common price schedule specifying quality. To our surprise, we found a range of studies satisfying these requirements. As some of the sources are little known, we discuss them briefly.

2.3. *Price data—1872*

Edward Young (1875), in *Labor In Europe and America*, provides retail price and expenditure data for towns in Belgium, Canada, Denmark, England, France, Germany, Italy, Netherlands and Sweden. At the time, Young was Chief of the Bureau of Statistics of the United States Treasury. He sought information from U.S. consuls regarding the "rates of wages, the cost of subsistence and the conditions of labor." In response, the consuls gathered retail prices using a

[11]One of the few attempts to tackle these problems is Kuznets (1962, 1966) in his classic work on the structure of consumption; see also Gilbert and Kravis (1958).

[12]We also looked at sources from the long tradition of price history, revitalized by Allen's (2001) seminal contribution. For the most part, these price data are at the wholesale/institutional level whereas we concentrate on retail price data collected specifically for international comparisons as it is difficult to adjust wholesale/institutional prices to the final expenditure level because margins differ over time and across countries—particularly for Western Offshoots. As explained in the Supporting Information file, we use institutional/wholesale price data to crosscheck our retail price data for 1872. On the contrary, GDP comparisons for countries where retail price comparisons do not exist must compare income with wholesale/institutional prices. Lindert (2016) provides a simple methodology to accomplish this.

common price schedule addressing quality.[13] The schedule covers nine categories of foodstuffs, ten categories of clothing, two categories of rent, and miscellaneous items. In addition, Young travelled to Europe and oversaw data collection.

Young's price data appear in a modified fashion in the *Fifth Annual Report of the Massachusetts Bureau of Statistics of Labor* (1874)—published by Carroll D. Wright.[14] The report lists prices for towns in Europe and Massachusetts. Altogether, Wright has data for 14 English towns, 12 German towns, two Belgian towns, two Danish towns, three Swiss towns but only two Italian and three French towns. The sources for the Fifth Annual Report are Young's investigations where Wright improved upon Young (1875) by standardizing weights and measures. He also provides prices in U.S. dollars rather than gold and, he has some price data that are not in Young (1875).

We use Wright and sometimes Young (1875) with the following exceptions: for Italy and France, we supplement Wright with the British Consular Reports, see Foreign Office (1870, 1871, and 1872).[15] For Norway and the Netherlands, we use British Consular Reports as our main source while we use Wood (1901) and the Colonization Circular as sources for Australia.

2.4. *Price data 1910*

The Board of Trade, (Board of Trade 1908, 1909, 1910, 1911) provides food prices, rentals and coal/paraffin prices for the U.K., Germany, France, Belgium and the U.S. These studies are well known, see Kravis (1984), and require no further elaboration. What is less known is that the Board of Trade investigations led to follow up work from the statistical authorities in Australia (Australia Commonwealth Bureau of Census and Statistics (1912)), South Africa (Union of South Africa, 1914) and Canada (Board of Inquiry into the Cost of Living, 1915). The "dominion" reports are forgotten today but they provide valuable comparative price data for countries not covered by the Board of Trade. In addition, there are

[13]The Weeks Report (United States Congress, 1880) uses the Young schedule. The first appearance of the schedule we found is Wells (1868), Appendix D, p. 117, prepared by Young.

[14]Wright is an important figure in the development of US official statistics. He served as the Chief of the Massachusetts Bureau of Statistics of Labor and later as US Commissioner of Labor developing a reputation for careful data collection based on trained agents. He is remembered today for his budget studies—the first large systematic studies in this area. As it turns out, the Fifth Annual Report (1874) is the first of several reports compiled or directed by Wright focusing on the collection of comparable price data across the U.S. and Europe. Leiby (1960) provides an account of Wright's life and work.

[15]This short description does not exhaust sources of comparative retail price data for the 1870's. Most notable are British Consular Reports on the relative cost of living, see Foreign Office (1870, 1871, 1872). These reports are less systematic than U.S. reports cited above as they lack a common price schedule. In addition, there is the Colonization Circular issued by Her Majesty's Colonial Land and Emigration Commissioners providing price data for Australia, Canada and other dominions in a consistent way. Except for Australia, the Netherlands and Norway, we use the U.K. sources primarily as crosschecks. Finally, there are other studies which provide comparative retail price data between 1872 and 1900. For example, the U.S. Department of State issued circulars to consular officers on two occasions requesting information on prices and wages to "facilitate considerations of U.S. trade with foreign countries", see U.S. Department of State (1879), U.S. House of Representatives (1885). There are 1879 reports for Australia, Belgium, Denmark, France, Germany, England, Ireland, Scotland, Wales, Italy, Holland and Switzerland. The 1885 study covered the same countries. The price data in these reports used similar commodity coverage to the Fifth Annual Report. Their drawback is weaker data on rents and clothing. We used price data from the reports to generate food and other price benchmarks for 1879 and 1884 to cross check the 1872 estimates.

many sources for comparative retail price data for 1900's. Examples include the United States Bureau of Labor Statistics (1915) and Lodge (1911). Where possible, we checked the 1910 price data against domestic retail sources. For the most part, there is agreement.

There are gaps in price data. An important example is investment. Other examples include tobacco, alcohol and services. To compare investment prices, we create price benchmarks for construction and machinery. The construction benchmark compares raw materials prices and relative construction wages. For machinery, we compare wholesale prices of iron and steel. The resulting benchmarks are, to be sure, crude. In our defence, researchers use similar measures to deflate investment in historical national accounts. For tobacco, alcohol and services, we use the quantity comparisons discussed earlier.

The second problem with price data from this period is quality. To give one example, we exclude bread, despite a plethora of price data, because we were unable to adjust for the different breads of Europe, particularly between wheaten and rye breads.[16] Instead, we compare prices for wheat and rye flour. The Supporting Information file describes quality adjustments for food, clothing, alcohol and tobacco.

The third problem is that price data typically refer to urban areas. To compare GDP requires average or "national" prices; see Deaton and Heston (2010) for a recent discussion. The urban/rural adjustment matters given the largely rural nature of most economies for 1872.[17] As outlined in the Supporting Information file of this paper, we uncovered a fair amount of information on urban/rural price differences for the late nineteenth and early twentieth century. To summarize, we find price differences are marked only for food and rent. In addition, the price differences are consistent across time and space as urban rents are typically between one and a half to two times rural rents while food prices are from ten to twenty percent lower outside cities.

2.5. *Quantitative Indicators/unit value*

As noted earlier, comparable prices for tobacco, alcohol and personal services are scarce for the late nineteenth and early twentieth century. For these items, we use quantity comparisons and their associated unit values. For tobacco, we measure consumption as pounds of tobacco per capita. For alcohol, we measure consumption of beer, spirits and wine in gallons per capita. For communications, we look at letters and telegraphs sent per capita adding telephones for 1910. For education, we use students educated per capita. For transportation, we used distance travelled per capita by rail with automobiles added for 1910. Details are in the data Supporting Information file.

We also collected quantity measures to supplement price comparisons. The most important example is food. We have consumption data for sugar, coffee and tea for all countries. We have data covering most food items for Australia, Canada, Italy, the Netherlands, Sweden, the U.S. and the U.K. There is data on cereals and

[16]We are in good company as differences in bread quality defeated the Board of Trade.
[17]For 1872, ten of the 13 economies had more than 70 percent of their population in rural areas. By 1910, this was down to two—Norway and Sweden.

TABLE 2
Price Benchmarks (U.S. = 1.0)

	Price indices		Fisher Ideal	Spread
	Partner weights	U.S. weights		
a. 1872				
Australia	1.02	1.43	1.21	0.71
Belgium	0.90	1.18	1.03	0.76
Canada	0.80	0.84	0.82	0.95
Denmark	0.72	0.88	0.79	0.82
France	1.00	1.16	1.08	0.86
Germany	0.75	0.92	0.83	0.82
Italy	0.84	0.89	0.87	0.94
Netherlands	0.78	0.92	0.85	0.85
Norway	0.82	1.09	0.95	0.75
Sweden	0.74	0.86	0.80	0.86
Switzerland	0.78	0.95	0.86	0.83
U.K.	0.85	1.08	0.96	0.79
U.S.	1.00	1.00	1.00	1.00
b. 1910				
Australia	0.92	1.04	0.98	0.88
Belgium	0.59	0.64	0.61	0.92
Canada	0.96	1.02	0.99	0.94
Denmark	0.71	0.75	0.73	0.95
France	0.71	0.80	0.75	0.88
Germany	0.67	0.75	0.71	0.90
Italy	0.70	0.80	0.75	0.88
Netherlands	0.57	0.64	0.60	0.90
Norway	0.67	0.73	0.70	0.92
Sweden	0.72	0.74	0.73	0.97
Switzerland	0.69	0.76	0.72	0.92
U.K.	0.78	0.81	0.80	0.96
U.S.	1.00	1.00	1.00	1.00

Sources and methods: Price indices measure the GDP price level with U.S. and partner country weights. The Fisher ideal is the geometric average. The final column gives the ratio of the price index measured with partner country weights to the price index with U.S. weights—the spread. The Supporting Information file provides sources and data.

meat for France and Germany. There are gaps for other countries especially for 1872.

Lastly, we have quantity measures for housing in 1910 derived from Floud *et al.* (2011).

The Supporting Information file provides the quantity measures.

2.6. *Comparative Price Levels and Real GDP per capita*

Table 2 gives comparative price levels for 1872 and 1910 calculated from our expenditure shares and prices/unit values data. The Table gives the results using partner weights, U.S. weights, and the Fisher Ideal. For the moment, we focus on our preferred measure—the Fisher Ideal. Australia has the highest price level for 1872 followed by France, Belgium, the U.S., and the U.K. Denmark shows the lowest price level. By 1910, relative price levels for the Western Offshoots have increased as compared to Europe. The U.S., Australia and Canada now lead in prices. Within Europe, price levels are now within a narrow range apart from Belgium and the Netherlands who show lower prices.[18]

To evaluate the results, we first check whether they exhibit the standard features of international comparisons. Given a negative relationship between prices and quantities, we expect the index with U.S. weights (the Laspeyres index) to give higher relative price levels as compared to the index with comparison country weights (the Paasche index).[19] Second, we expect the spreads between Laspeyres and Paasche price indices for countries at different levels of income to exceed spreads for countries at similar income levels reflecting divergent expenditure patterns.

The final column provides the ratio of the Paasche to Laspeyres price indices—the spread. The results show the expected regularities. The spread is less than unity for all 24 comparisons. To be sure, the spreads are mostly smaller than for the 1950's OEEC studies of Gilbert and Kravis (1954, 1958) where spreads are in the 0.7 to 0.8 range. This is explainable by the lower precision of our price and expenditure data. On the contrary, the spreads for 1872 are higher, for the most part, compared to spreads for developed economies over recent ICP rounds suggesting differences in expenditure patterns were greater in the past. Finally, the 1910 spreads are mostly smaller than for 1872. This is expected given the convergence in price structures discussed in a later section.

3. GDP per Capita in Current Prices

We compare income with a Fisher Ideal quantity index, which is the geometric average of quantity indices valuing output at U.S. and partner country prices. Equation (4) is the Fisher quantity index for country i relative to the U.S. in year T.

$$Q^F(p^{us}, p^i, x^{us}, x^i)Q = (Q^{us}(p^{us}, x^i, x^{us}) * Q^i(p^i, x^i, x^{us}))^{0.5} \tag{4}$$

To gain further insight, Equation (5) re-expresses the quantity index in U.S. prices as a weighted index of quantity relatives where weights are U.S. expenditure shares.

$$Q^{US}\left(p^{US}, x^{US}, x^i\right) = \sum \theta_j^{US} x_j^i / x_j^{US} \tag{5}$$

To construct (5), we use the direct quantity measures discussed in (3) as well as indirect quantity measures generated from ICP style price comparisons. To understand indirect quantity measures, we return to the earlier example of beef. Suppose we have data on income (Y), the price of beef and the beef expenditure share. Then, deflation yields the implied U.S. quantity of beef, $x^{US}{}_i$:

$$x_i^{US} = Y^{US} \theta_i^{US} / p_i^{US} \tag{6}$$

[18]The Belgian price level is also low in the Board of Trade (1910).
[19]As stated by Kravis et al. (1982, p. 74) this is a "usual but not necessary consequence of negatively sloped demand curves."

TABLE 3
Real Income per Capita in Current Prices

	Nominal GDP per capita	Price Benchmark U.S. = 1.0	Real GDP per capita in Current Prices	Real GDP U.S. = 1.0
a. 1872	$		$	
Australia	293	1.21	243	1.15
Belgium	197	1.03	191	0.90
Canada	133	0.82	164	0.77
Denmark	119	0.79	150	0.71
France	150	1.08	139	0.66
Germany	117	0.83	141	0.67
Italy	66	0.87	76	0.36
Netherlands	134	0.85	157	0.74
Norway	110	0.95	116	0.55
Sweden	82	0.80	103	0.49
Switzerland	119	0.86	139	0.66
U.K.	208	0.96	218	1.03
U.S.	211	1.00	211	1.00
b. 1910				
Australia	340	0.98	347	0.96
Belgium	200	0.61	325	0.90
Canada	289	0.99	293	0.81
Denmark	188	0.73	257	0.71
France	202	0.75	268	0.74
Germany	182	0.71	257	0.71
Italy	107	0.75	143	0.40
Netherlands	136	0.60	225	0.62
Norway	161	0.70	229	0.63
Sweden	159	0.73	218	0.60
Switzerland	194	0.72	268	0.74
U.K.	235	0.80	294	0.81
U.S.	362	1.00	362	1.00

Sources and methods: See the Supporting Information file.

We generate implied quantities for partner economies in a similar fashion. The ICP calls its quantity measures "indirect" or "notional" quantities. The GDP comparison of (5), therefore, combines direct and "indirect" quantity measures.[20]

Table 3 illustrates our calculations of current price GDP per capita. The second column gives nominal GDP per capita for 1872 and 1910 in U.S. dollars for each country. In choosing nominal GDP, we largely follow the previous literature. For example, we use Baffigi (2011) for Italy, and Grytten (2004) for Norway given general agreement they are the best series available. For some countries, however, there are competing nominal GDP series. Consider, for example, the well-known differences for the U.K. between GDP measured from the income and expenditure sides. For France, nominal income from Toutain (1987) and Levy-Leboyer and Bourguingon (1990) can differ by twenty percent for the 1870's. For the U.S., Lindert and Williamson (2016) provide GDP for 1870, which exceeds considerably earlier estimates. The Supporting Information file of this paper explains and

[20]The indirect quantity measures depend on nominal income while the direct quantity measures are independent of nominal income. From (5), if all quantity relatives are direct measures, then, relative real GDP is independent of nominal GDP. If all quantity measures are indirect then prices errors are reflected in GDP as, a ten percent change in nominal GDP will be reflected in a ten percent change in relative real income.

justifies our choices. It also provides estimates using alternative nominal GDP series. Finally, nominal income in Table Three refers to contemporary borders. For example, the U.K. estimates include Ireland.[21]

For 1872, the Table shows Australia, the U.S., the U.K. and Belgium have commanding leads in nominal income per capita with Italy and Sweden lagging. Nominal income for Australia is five times greater than Italy. By 1910, Canada has joined the other Western Offshoots with high nominal income. Sweden has improved but Italy again brings up the rear.

Moving on, the next column repeats the Fisher Ideal price benchmarks from Table 2. The fourth column gives real income per capita derived by deflating nominal GDP by the Fisher Ideal price level yielding real income per capita as a Fisher Ideal quantity index in current prices.

The calculation shows Australia leads in real income per capita for 1872 followed by the U.K, the U.S. and Belgium.[22] Italy has the lowest income, well behind Sweden.

By 1910, the U.S. has joined Australia at the top of the income league, and they lead Belgium, the U.K. and the rest of Europe. Canada has joined the rich economies and the Swiss have improved along with Norway and Sweden while Italy remains poor. [23]As shown in the Supporting Information file, these broad conclusions still hold when we consider alternative nominal income series. Indeed, they are strengthened in the sense the alternate series raise income in the U.S. and Canada and lower income for Europe.[24]

How do the current price GDP benchmarks compare with Maddison's Projections? As it stands, the current price benchmarks and the projections are not comparable for two reasons. First, the current price comparisons are Fisher Ideal quantity indices in 1872 and 1910 prices whereas Maddison's projections value output with 1990 Geary Khamis international prices. Second, his estimates refer to 1990 borders. To allow comparison, we transform Maddison's projections to a 1990 Fisher ideal index, and we adjust the estimates to historical borders. We then take a U.S. base.[25]

Table 4 shows the results. The second column provides current price estimates from Table 3. The next column gives Maddison's projections for 1872 and 1910 adjusted to a Fisher Ideal basis and historical borders. We use the most recent projections in 1990 prices from the Maddison project. As it turns out, there are marked

[21]The Supporting Information file provides results using current borders following Maddison (1995, 2007).

[22]For 1872, the U.S. is recovering from the effects of the civil war, see Lindert and Williamson (2016). As discussed later in the paper, the current price estimates for 1872 still imply the U.S. had a commanding lead over the U.K. in terms of output per worker. Furthermore, we show in the Supporting Information file that the U.S. has a large lead in income per capita for the 1870's if we use the nominal GDP estimates of Lindert and Williamson (2016).

[23]The current price approach also provides benchmarks for consumption, investment and government - difficult to obtain using projections. To save space, we provide these benchmarks in the Supporting Information file.

[24]While the alternate series for nominal GDP are not sufficient to change overall conclusions, they change results for individual countries. For example, the US is much richer, Australia is a little richer, and France is poorer reinforcing the point made earlier—current price comparisons depend on nominal GDP.

[25]We follow the literature by using a U.S. base but see Guttmann (2020) on potential problems of using the U.S. as base. For our purposes, the results hold using other base countries.

TABLE 4
Comparing Estimates (U.S. = 1.00)

	a. GDP per capita in Current Prices	b. Maddison Projections	Ratio b/a
a. 1872			
Australia	1.15	1.29	1.12
Belgium	0.90	1.06	1.17
Canada	0.77	0.69	0.89
Denmark	0.71	0.74	1.05
France	0.66	0.74	1.12
Germany	0.67	0.73	1.09
Italy	0.36	0.58	1.62
Netherlands	0.74	1.07	1.44
Norway	0.55	0.52	0.95
Sweden	0.49	0.54	1.11
Switzerland	0.66	1.16	1.77
U.K.	1.03	1.29	1.25
U.S.	1.00	1.00	1.00
b. 1910			
Australia	0.96	1.03	0.96
Belgium	0.90	0.81	0.90
Canada	0.81	0.81	1.00
Denmark	0.71	0.69	0.98
France	0.74	0.59	0.79
Germany	0.71	0.67	0.94
Italy	0.40	0.42	1.07
Netherlands	0.62	0.75	1.21
Norway	0.63	0.42	0.66
Sweden	0.60	0.50	0.83
Switzerland	0.74	1.37	1.85
U.K.	0.81	0.90	1.11
U.S.	1.00	1.00	1.00

Sources and methods: We take the GDP projections in 1990 prices from the latest version of the Maddison project adjusting the estimates to a Fisher Ideal basis using Maddison (1995) Table C-7, p. 172. We adjust the projections to historical borders using Maddison (1995, 2007).

differences for some but not all countries. The 1872 projections show the U.S. lagging Australia, the U.K., Belgium, the Netherlands and Switzerland. They show Australia and the U.K. with equal income. They show Sweden leading Norway. They show Canada trails the U.K. by a large margin and Switzerland leads all continental Europe. Indeed, Swiss income per capita exceeds U.S. income by 16 percent! Finally, the 1872 projections show a relatively high income for Italy—above Norway and Sweden. The current price GDP estimates differ in all respects for 1872 showing a fundamentally different picture of living standards for the western economies.

Turning to 1910, we again see some differences. Consider Switzerland. As noted earlier, the projections show the Swiss as the world income leader followed at a distance by Australia and the U.S. The projections also understate income for Norway relative to the current price estimates while income for the U.K. and the Netherlands is overstated.[26]

[26]We use projections in 1990 prices from the most recent version of by the Maddison project at http://www.ggdc.net/maddison/maddison-project/data.htm. The result that projections differ from 1872 and 1910 current price benchmarks is a general one. It holds for earlier versions of Maddison's projections—though the differences for Switzerland are smaller. It also holds for different base year projections. Changing the base year would produce larger divergences for some countries and smaller for others as compared to Table 4.

The final column gives the ratio of the projections to the current price benchmark. For 1872, the differences are 25 percent for the U.K., 44 percent for the Netherlands, 62 percent for Italy and a whopping 77 percent for Switzerland. For 1910, there are sizeable differences for Switzerland, Norway, Sweden, France, the Netherlands and the U.K. Unlike 1872, differences work in both directions as projections can overstate and understate income.[27]

To summarize, the current price estimates provide a rather different picture of economic leadership and convergence from 1872 and 1910. They show a higher income level for the U.S. and Canada relative to Europe. They show the U.K, the Netherlands, Italy and Switzerland with lower income. They show Italy improving its relative position over time and they place Norway ahead of Sweden. The current price GDP comparisons thus provide a fresh perspective on classic debates—the relative position of the U.S. and the U.K, Frances versus the U.K. and much else too.[28]

To restate an earlier point, we expect some divergence between projections and current price estimates since the current price estimates embody a different set of relative prices. As also noted earlier, differences are present for every round of the ICP see Deaton and Aten (2017) and Inklaar and Rao (2017). The question to be addressed, therefore, is how to choose between the projections and current price comparisons when there are large divergences. Consider Switzerland. Was it the world leader for 1910 as implied by projections? Is it the first miracle economy? Alternatively, was it somewhere in the middle as earlier Maddison projections and the current price estimates show?

The theoretical literature in this area demonstrates current price estimates are superior on theoretical grounds. This line of reasoning led the Penn World Tables and the international comparison literature generally to favor current price measures.[29] With good data, it is hard to argue against the current price estimates. Yet, the situation with historical income comparisons is complicated because historical data are imperfect. Earlier, we emphasized the flaws in price, expenditure share and quantity data. And nominal GDP is also measured with error. Given these uncertainties, we believe that historical GDP benchmarks require supporting evidence before they can be accepted over projections—evidence which we now supply.[30]

[27]In an Important paper, Lindert (2016) suggests that projections may understate income for resource rich economies before the transport revolution at the end of the nineteenth century. His explanation rests on the fact that prices of food and other "subsistence goods" varied more widely before the fall in transport costs imparting a downward bias to projections for resource rich economies. This can explain why projections understate income in the Western Offshoots for 1872 relative to current price measures but less so for 1910.

[28]For example, the traditional income ranking for Scandinavia saw Norway leading Sweden with Denmark above both, see Krantz and Nilsson (1974). This is consistent with current price estimates but not the Maddison projections.

[29]With complete data, we could reconcile projections with current price benchmarks. So far, reconciliations have proved difficult even for recent years, see Inklaar and Rao (2017), as data used in income projections over time differs from data used in current price comparisons over space.

[30]The latest version of the PWT forces GDP projections through current price benchmarks. Ward and Devereux (2003) use a similar procedure to derive a long run U.K./U.S. GDP series. By emphasizing current price estimates over projections, the PWT implicitly assumes errors in the benchmarks are small relative to errors in the projections. Summers and Heston (1988a, 1988b) suggest, however, the best way to think of the relationship between benchmarks and projections is to assume considerable measurement error exists for both. This is certainly the case for historical current price comparisons.

4. Supporting Evidence

We begin with food. The current price benchmarks compare food consumption using implied food quantities obtained by deflation. As described earlier, we have independent direct food measures which allow us to crosscheck food—the largest item of consumer spending. For 22 of the 26 comparisons, food consumption is similar using direct and indirect quantity measures. The correspondence is encouraging. The exceptions for 1872 are Australia, Belgium and the U.K., all with suspiciously high 1872 food consumption. For Australia, food is 40 percent above U.S. levels! For Belgium, food consumption is also above the U.S. Similarly, food consumption appears too high for the U.K. relative to standard food balance sheets. For these countries, we have more confidence in the direct food measures, and we use them in the final calculations. The next case is the Netherlands for 1910 where deflation showed low food consumption.[31] We use direct food quantities for this case too.

Prados De la Escosura (2000) suggests a further crosscheck—we should evaluate historical income comparisons by using their implied price levels. We exploit his insight in two ways. First, we search for Balassa Samuelson, a staple of the trade and growth literatures, in the current price GDP measures. Second, we consider the implications of what is known about food prices for the 1872 projections.

4.1. *Implied Price Levels*

Balassa Samuelson predicts that price levels will increase with real income per capita. The first panel of Figure 1 tests this prediction by graphing the Fisher Ideal price benchmarks against real GDP per capita in current prices. For the most part, a higher 1872 income per capita is associated with a higher price level. This holds for Australia, the U.S. and the U.K.[32] France shows a high price level relative to its income, but this occurs in the aftermath of war with Prussia. Balassa Samuelson is also present for 1910 in current price data albeit in a weaker fashion as there are cases of a poor economy with a relatively high price level (Italy) and a prosperous economy with a relatively low-price level, Belgium.

Recall, the Maddison projections yield GDP in 1990 prices. To calculate his implied price levels, we divide nominal income per capita in Table 3 by Maddison's adjusted GDP projections from Table 4 and take a U.S. base.[33] The results show that implied price levels are not related to projected income. This is clear from the second panel of Figure 1, which graphs projected income against implied price levels. Consider 1872. Three countries, Switzerland, the U.K., and the Netherlands

[31]We suspect the 1872 problems for Belgium arise because Belgian nominal GDP is too high. The Supporting Information file provides further details. For Australia, our price data seem to understate food prices particularly for beef and mutton. This may reflect lower quality. Finally, Dutch food price data for 1910 may refer to higher qualities.

[32]We content ourselves with a graphic approach as there are formidable econometric problems estimating the relationship between price levels and real income per capita with historical data. In simple terms, errors in price levels and real income are negatively correlated by construction which imparts a severe bias to the slope estimates.

[33]Ideally, we would use the nominal income series appropriate to Maddison's projections. Maddison (1992) provides a nominal GDP series for seven of the economies, (Australia, Canada, France, Germany, Netherlands, U.K. and U.S.). For these countries, his implied prices are close to ours.

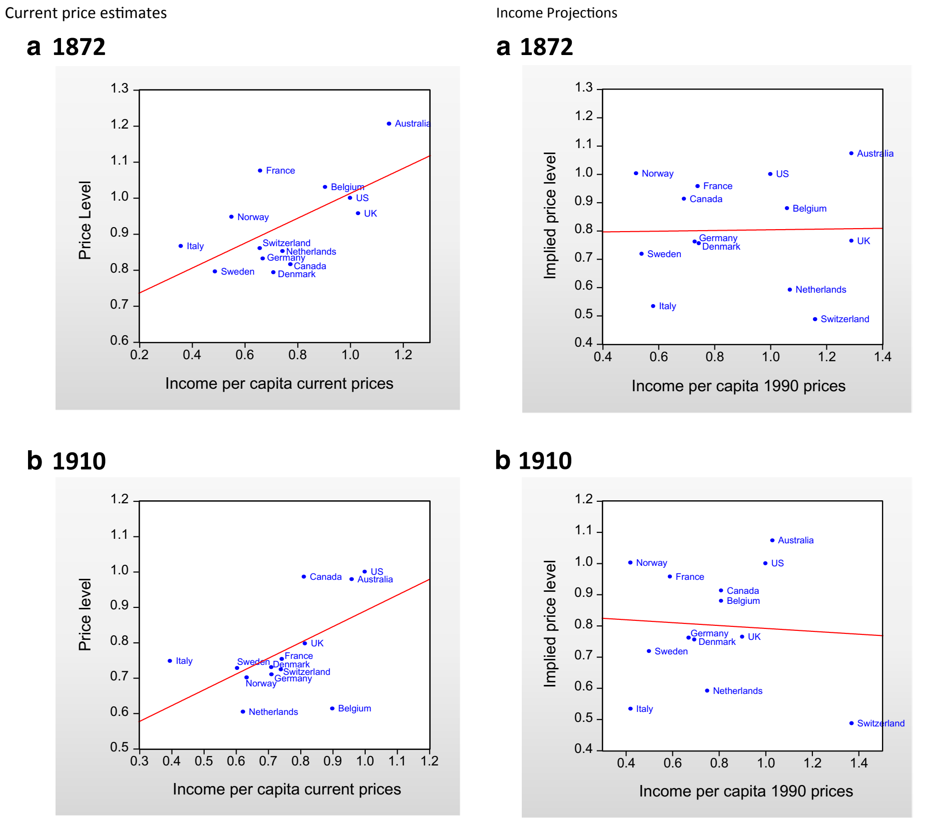

Figure 1. Price Levels and Income per capita U.S. = 1.0
Source: Tables Three and Five. [Colour figure can be viewed at wileyonlinelibrary.com]

appear in the southeast quadrant of the Figure. They combine high income and a low-price level. For 1910, we observe a low-price level for a rich economy Switzerland, 50 percent of the U.S., and a high price level for a poor country Norway, five percent above the U.S.

These results are, at best, suggestive. On their own, they will not convince skeptics. After all, the sample is small. In addition, we assume that our nominal income series are the correct ones to evaluate the Maddison projections, which may not be the case. Nor is it obvious why a positive relationship between income and the price level should necessarily hold for all periods.[34]

Nonetheless, Figure 1 is a useful starting point for a discussion of the Maddison projections because it reminds us that for every estimate of relative income there is a dual—an estimate of the relative price level. In some cases, we can

[34]Along these lines, Bergin et al. (2006) find Balassa Samuelson is a relatively recent phenomenon.

TABLE 5
FOOD PRICE LEVELS FOR 1872 (U.S. = 1.00)

	Overall Price Level Implied by Maddison Projections	Food Prices	Required Non-food Prices
Italy	0.53	1.47	0.18
Netherlands	0.59	1.32	0.32
Switzerland	0.49	1.51	0.10
The U.K.	0.76	1.44	0.51

Sources and methods: The price levels implied by projections are described earlier. We take the food price data from Supporting Information file. The U.K. price data are from the retail price comparisons. To allow comparability we calculate food price levels for all countries using U.S. weights. As shown in Supporting Information file, food has a weight of 0.27 in overall U.S. spending. We obtain similar results with partner country weights. Food prices are lower with these weights but the generally higher share of food in total expenditure offsets this.

determine the plausibility of relative income by looking the price dual.[35] To show this, we consider what the 1872 food prices require for projections. Transport costs were high for 1872 so we would expect lower food prices in the food exporters—the U.S., Canada, Australia, and Denmark.[36] As shown in the Supporting Information file, food prices were indeed lower in the food exporters with differences of up to fifty percent at the retail level. We find these estimates plausible. They are certainly consistent with other evidence; see O'Rourke and Williamson (1999). The patterns for individual food items are also as expected with larger differences for meat etc.

In sum, the food prices using this paper are reasonable. Yet, they have stark implications for overall price levels. To show this the second column of Table 5 gives overall price levels implied by the Maddison projections for four countries, Italy, the Netherlands, Switzerland and the U.K. These are countries with large differences between current price GDP and the Maddison projections. As we have seen, the projections imply low overall 1872 price levels relative to the U.S. for Italy (0.53), Switzerland (0.49), the Netherland (0.59) and the U.K. (0.76).[37] The third column gives relative food prices calculated using U.S. weights and our food price data. For Switzerland, food prices are 50 percent above the U.S. The U.K. food prices are 44 percent higher while differences are smaller for the Netherlands.

The final step combines relative food prices in column three with the overall price level implied by projections in column two to generate implied non-food GDP price levels. The results in the final column show remarkably low non-food price levels for Italy, the Netherlands and Switzerland—about *ten to 30* percent of the U.S. Such price levels are implausible if not impossible. For the U.K., the

[35]To see how this might work consider the following example—Maddison shows Swedish income per capita slightly above Norway for 1872. His estimates combined with standard series for nominal GDP imply Norwegian price levels are 40 percent higher. We can, therefore, evaluate his relative income estimates by enquiring how believable are his implied price levels. Along similar lines, the projections for 1910 require large differences in price levels across Europe for countries similar in nominal income. Such differences are surprising given the stable exchange rates of the period. Moreover, one might expect contemporary observers to have noticed such large price level differences. We found no evidence they did.

[36]Strictly speaking, the prediction holds at the wholesale price level. Retail prices could be higher or lower depending on retail margins.

[37]We assume that our nominal GDP series are the appropriate series.

calculation implies non-food price levels of 50 percent, which, while possible, are low.

The calculations make a simple point: since 1872 food prices were much higher in the food importers then a finding of higher income per capita for the Netherlands and Switzerland requires prices for clothing, housing, alcohol, fuel, and travel that are a small fraction of U.S. prices. Using different series for nominal GDP for these countries will change the details but they will not change the overall result, projections imply non-food price levels, which are unlikely.

Transportation costs fell dramatically after 1872.[38] This means food prices should increase in exporters relative to importers.[39] Our price benchmarks show these changes. By 1910, our food prices for the U.S., Canada and Australia are above Europe reflecting the decline in transport costs and higher retail margins. Finally, it is easy to show that 1910 Swiss food prices render the Swiss/U.S. non-food price level implied by the projections at 15 percent of U.S., which is hardly possible.

4.2. *Real Wages—A GDP comparison from the Income side*

Arising from Allen (2001), an influential literature uses real wages to inform discussions of growth and convergence. Early on, Heston (1998) suggests real wages are part of a GDP comparison from the income side.[40] To understand his argument, Equation (7) uses an identity to capture the relationship between economy wide real wages and relative output per worker. In terms of notation, $w_{i/us}$ is relative real wages in terms of the U.S., $\underline{y}_{i/us}$ is relative output per worker in terms of the U.S., α_i the share of labor income in GDP and p/p_c is the relative GDP price level divided by the relative consumption price level. The wage refers to the economy wide real wage and covers all labor income—unskilled, skilled, clerical and professional workers.

$$w_{i/us} = (\alpha_i/\alpha_{us})\left(p/p_c\right)\underline{y}_{i/us} \tag{7}$$

Equation (7) shows relative output per worker can deviate from relative economy wide real wages only with differences in labor shares and differences in relative price levels for consumption relative to overall GDP. Except for the U.K., the literature for the period provides little evidence to suggest labor shares differed in a systematic fashion see Prados De La Escosura and Roses (2003). As shown in the Supporting Information file, relative consumption/GDP price levels were higher in Europe as compared to the Western Offshoots, which reduces real wages as compared to output per worker. But the differences are small. Thus, we expect, as

[38]O'Rourke and Williamson (1999) find improvements in shipping and refrigeration reduced costs on Atlantic shipping routes by 45 percentage points between 1870 and 1913.

[39]We do not suggest all food items were tradable. This is clearly not the case for milk and vegetables.

[40]More recently, Lindert and Williamson (2016) and Lindert (2016) build on the real wage literature arising from Allen (2001), and, especially, Allen et al. (2012), to compare GDP in current prices for the past.

TABLE 6
Output per Worker and Real Wages for 1872 U.S. = 1.00

	Output per worker current prices	Real Wages implied by Current Price GDP Per Worker	Real Urban Wages Williamson (1995)
Australia	1.15	1.14	1.03
Belgium	0.69	0.72	0.55
Canada	0.77	0.78	0.90
Denmark	0.57	0.55	0.32
France	0.63	0.58	0.42
Germany	0.66	0.60	0.50
Italy	0.28	0.25	0.21
Netherlands	0.66	0.62	0.45
Norway	0.43	0.39	0.30
Sweden	0.34	0.33	0.32
Switzerland	0.53	0.49	0.36
U.K.	0.75	0.57	0.59
U.S.	1.00	1.00	1.00

Notes and Sources: GDP in current prices is from Table 4 while labor force data is from Mitchell (2003a, 2003b) and Bairoch (1968). To improve comparability, we exclude female employment in agriculture. We assume the ratio of the labor force to population is 0.4 for Denmark and we use the Maddison (1995) estimates of the labor force for Sweden. *Real wages implied by current price benchmarks*—We derive the economy wide real wage using Equation (7) where relative consumption and overall price levels are from the price benchmarks. The share of labor in GDP is 0.7 for all economies except the U.K. where it is 0.6.

Real urban wages for all countries except Switzerland—from Table A2-1 of the updated data appendix to Williamson (1995). We form the U.K. index by combining real wages for Great Britain and Ireland using labor force weights to obtain implied real wages. For Switzerland, we derive real wages using the real wage series from Studer (2008) and his 1905 benchmark excluding rents.

Heston (1998) suggests, a close correspondence between economy wide real wages and output per worker.

We do not have real wage comparisons covering all labor income. For the most part, existing real wage comparisons only cover urban workers. Most notably, Williamson (1995) provides real wages indices for urban skilled/unskilled manual workers. We do not expect perfect agreement between his urban real wage indices and economy wide real wages given differences across economies in shares of urban workers in the labor force and urban/rural/skilled/nonskilled wage premiums, hours worked etc. Nonetheless, we expect urban real wages to bear *some* relationship to rankings for overall output per worker.

Table 6 looks at the economy wide real wages implied by current price GDP for 1872. The second column gives output per worker in current prices. The next column gives implied economy wide real wage using (7). We assume a labor share of 0.7 except for the U.K. where we assume a share of 0.6.[41] For comparison, the final column provides Williamson's (1995) real wage indices for urban workers.

From the table, the Western Offshoots (Canada, the U.S. and Australia) have a larger lead in output per worker for 1872 than for income per capita reflecting the lower average age of these societies. Turning to real wages, implied economy wide real wages are mostly consistent with Williamson's (1995) urban real wage

[41]Growth accountants for Great Britain typically assume a labor share of around 0.6 see Crafts (2004) Table 1. Matthews et al. (1982) show slightly lower labor shares before the First War.

indices. In the case of Canada, the implied real wage is below Williamson. For Denmark, the Netherlands, Norway, and Switzerland implied real wages are above Williamson. For the remaining economies, they are close.

On the contrary, there are marked differences between Williamson's (1995) real wages and real wages implied by the projections—particularly for the Netherlands and Switzerland. Without belaboring the point, real wages for these countries are difficult to reconcile with higher income per capita relative to the U.S. Put differently, these countries may have combined higher income per capita as compared to the U.S. with lower real urban wages but it stretches credulity to suppose higher income per capita could co-exist with the levels of urban real wages in Table 6.

Similar arguments hold for 1910 where, for example, the projections imply Swiss real wages exceed U.S. levels.

4.3. *GDP and Sectoral Labor Productivity*

Sectoral GDP comparisons provide a powerful crosscheck of current price GDP since they are largely independent of the expenditure comparisons, see Rostas (1948) and Paige and Bombach (1959). For the most part, the data necessary to implement such GDP comparisons are not available for 1872 or 1910. Nonetheless, what we know about sectoral productivities provides a rough crosscheck of the current price estimates. To see how this works, we break the economy into three sectors, agriculture, manufacturing and the rest of the economy, which we term services. For reasons of space, we focus on 1872 but the argument extends to 1910.

For manufacturing, the evidence (as summarized in Broadberry (1997)) puts U.S. output per worker for the 1870's at twice U.K. and German levels. Thus, manufacturing output per worker for the other European economies is at most half U.S. levels. For agriculture, the available information, outlined in the Supporting Information file, suggests U.S. output per male worker in agriculture for the 1870's was well above, probably twice, Western European levels.[42] The claim is uncontroversial given the higher endowments of land and horses per U.S. agricultural worker. There is less information on relative productivities outside agriculture and manufacturing. But the U.S. was likely ahead of even the U.K. for transportation and wholesale/retail trade, which constitute a large portion of services.

The Supporting Information file uses these assumptions to crosscheck the current price estimates for 1872. The results support the current price estimates. The sectoral results are, to be sure, "controlled conjectures." Yet, they make a straightforward point—if the U.S. had a large lead in output per worker for manufacturing and agriculture, as seems to be the case, then, Maddison's projections for Switzerland, the Netherlands and perhaps the U.K require implausible levels of output per worker in services.

[42]These conjectures have a long history. For instance, Mulhall (1896) compared agricultural output per worker in wheat units across the US and Europe for the 1890's showing the US with a commanding lead. He also compared output per worker in manufacturing using a rough adjustment for price level differences showing US output per worker at double U.K. levels and well above other European economies.

5. Concluding Comments

This paper shows current price historical GDP comparisons are feasible for the late nineteenth and early twentieth century by providing comparisons along modified ICP lines for the core Western economies. The results of the current price GDP comparisons differ in key respects from Maddison GDP projections based on recent prices as they raise the relative income of the U.S. while they lower income for Belgium, the Netherlands, Switzerland and the U.K.

Economic Historians differ on the proper role of current price historical GDP comparisons. One school holds that such comparisons are best used as crosschecks for projections. In our case, the Netherlands and Switzerland show the value of such a crosscheck as it difficult to see how Dutch income could have exceeded the U.S. in the 1870's, or how the Swiss could have led the world in 1910.[43] A second school holds that current price benchmarks can do more than serve as a crosscheck. Rather, they can provide fresh perspectives on important issues as they show different patterns of economic leadership as well as catch up and convergence. Most notably, they suggest the U.S. was the world leader in income and productivity from very early on, generalizing a point made by Lindert and Williamson (2016). The benchmarks also allow us to study fundamental features of growth, such as the relative price of investment to consumption (Collins and Williamson (2001)), not easily addressed by projections.

To be sure, the current price GDP benchmarks are work in progress. To improve them requires better data on expenditure shares, more information on urban rural price differences, improved food balance sheets and, most importantly, better measures of capital goods prices. As emphasized throughout, progress also requires a consensus on the best series for nominal GDP. In addition, we must increase the number of countries and provide additional benchmark years.[44] Finally, there is unfinished business with methodology, as current price comparisons require approaches to historical data which are robust to measurement error in prices and expenditure shares, and especially nominal GDP—issues we have only touched on. In sum, we should not underestimate the difficulties facing current price historical GDP comparisons. On the contrary, the rewards of the current price approach are likely to be substantial as they have the potential to sharpen our measures of growth and convergence for crucial periods of modern economic growth.

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[43]Stohr (2016) reaches similar conclusions for Switzerland using real wage comparisons as a cross check.

[44]We have price benchmarks for Austria, Ireland and New Zealand for 1872 and 1910 we have not reported as we lack confidence in nominal Income. In addition, we have 1910 benchmarks for Russia and Japan and benchmarks for 28 economies in 1929.

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Supporting Information

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