# The Maddison Project

Prices and Quantities in Historical Income
Comparisons – New Income Comparisons for the
late Nineteenth and Early Twentieth Century

Marianne Ward and John Devereux

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# Prices and Quantities in Historical Income Comparisons – New Income Comparisons for the late Nineteenth and Early Twentieth Century*

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Summary

This paper provides current price GDP comparisons along modified ICP lines covering thirteen Western economies for 1872 and 1910.  The results differ in fundamental respects from the familiar Maddison income projections.  In particular, the current price estimates raise the relative income of the US while they lower the income of Belgium, the Netherlands, Switzerland and the UK.  A striking example is Switzerland.  Previous estimates show the Swiss leading the world in terms of income per capita for 1910 whereas the current price comparisons show the Swiss as well down the pack.

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1. **Introduction**

Modern economic growth began in Western Europe and spread outwards.  To study the central characteristics of growth -  structural change, convergence/divergence and changes in economic leadership - requires comparable data on GDP.  The last decade has seen dramatic changes in how economists compare income, see Feenstra et al (2015).  In particular, the field has moved to comparing GDP with current prices - that is the prices closest in time to the desired comparison year - as compared to the fixed prices of earlier approaches.  This change in intellectual fashion is best seen in the latest version of the Penn World Tables (henceforth the PWT) which now compares income using multiple current price benchmarks.

This paper provides current price historical GDP comparisons covering the major western economies for 1872 and 1910.  Our work fills a gap in the literature as current price GDP comparisons do not reach before 1950 for most countries.  As it turns out, the new current price comparisons differ from the previous estimates in fundamental ways.  To summarize, they raise the relative income of the US while they lower the income of Belgium, the Netherlands, Switzerland and the UK.  The case of Switzerland stands out.  Consider 1910.  Previous comparisons show the Swiss with the highest living standard in the world with income per capita forty percent above America.  In contrast, the current price comparisons show the Swiss as well down the pack.

Until recently, the literature compared income over long spans using fixed prices.  This approach was popularized by the monumental efforts of the late Angus Maddison (1995, 2001 and 2003) and was carried on by early versions of the Maddison

Project, see Bolt and Van Zanden (2014).  The Maddison comparisons work as follows.

First, Maddison takes a purchasing power parity (PPP) adjusted GDP comparison for a

recent year, 1990, from the International Comparison Program (henceforth the ICP).

Second, he projects the ICP benchmarks backwards using GDP growth rates.[1]  The

results are in 1990 prices.

To compare income for the past, the projections must solve three difficult index

number problems.  They first compare income across space for a recent year.  Second,

they compare income over time for the base country and, finally, they compare income

over time for the comparison country.  Half a century ago, Robert Gallman projected

income per capita for France, Britain and the US to 1840 using a 1950 base year

comparison.  His description of the conceptual difficulties he faced (Gallman (1966 page

6) holds for all subsequent projections:

> *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.*

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

We would to his litany one final problem. Suppose we compare GDP for two countries for a year in the distant past, say 1870. It should be obvious that any change in the base year or any revision in the underlying GDP series for either economy *between 1870 and the base year* will change the 1870 projections. Since revisions are inevitable, projections are condemned to forever rewriting history – a point made long ago by Kuznets (1956, page 7). Put simply, the projections depend on the entire sequence of prices/quantities from the base year to the year compared. In contrast, current price estimates are conceptually simple since they compare income using only the prices of the comparison year. History is written just once.

Given the recent changes in the Penn World Tables and given the consensus of researchers in favor of current price comparisons, we might expect increased interest in current price historical income comparisons by economic historians as they seek to make their estimates consistent with the best practice in the field.[2] At a minimum, there is wide agreement among economic historians that more current price estimates are necessary if only to crosscheck the Maddison projections.

We have two contributions. First, we provide current price historical GDP comparisons constructed from disaggregated price, quantity and expenditure data for

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[2] As Lindert (2016) notes, a further stimulus to the development of current price estimates are ongoing debates where projections and current price estimates yield different results . An early debate concerns the relative standing of the UK and US. The Maddison projections showed the UK with a substantial income lead for the nineteenth century with the US taking over in the early 1900's. Prados De la Escosura (2000) and Ward and Devereux (2003, 2004, 2005) argue for an early US 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. The literature has recently taken an unexpected turn as Peter Lindert and Jeffrey Williamson, Lindert and Williamson (2016), find a larger US lead before 1870 and one that stretches further back in time than claimed by either Prados De la Escosura (2000) or Ward and Devereux (2005). The vigorous UK/US debates anticipated many of the points raised in the later ICP/Penn World Tables literature.

the major western economies.[3]  There are no previous attempts to provide such

historical benchmarks along consistent lines for such a large group.  We compare real

income for thirteen countries - Australia, Belgium, Canada, Denmark, France, Germany,

Italy, the Netherlands, Norway, Sweden, Switzerland, the UK and the US – the core

western economies.[4]  The comparisons cover 1872 and 1910 and they bracket the

beginning and the end of a great globalization episode.

To generate the current price historical estimates, we develop a methodology

that adapts the ICP framework to the realities of historical data.  Our approach departs

from the ICP in that we emphasize quantity as well as price comparisons harking back to

Gilbert and Kravis (1954).  We argue that the Gilbert and Kravis price/quantity approach

is more appropriate for the past as compared to the ICP price based approach given the

unavoidable measurement error found in historical data.

The first part of the paper outlines our procedures and data sources.  There are,

as we might expect, formidable challenges when using historical data to build current

price GDP comparisons.  On the other hand, we find rich and unexploited data sources.

Sections three and four present the current price GDP benchmarks.  As mentioned, the

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[3] There are other current price approaches.  Leandro Prados De la Escosura (2000) is the pioneer in this area.  He compared GDP for the major developed economies in current prices from 1820 to 1990 using a short cut regression model.  More recent work by Lindert (2016) supplies benchmarks for a wide range of countries over a much longer time spans using a different methodology with fewer data requirements.

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

current price estimates differ in crucial respects from GDP projections.  The divergence

is not surprising given that differences between projections and benchmarks are the

norm in the ICP/PWT literature.[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 via projections involve different sets of prices and

quantities and must yield different outcomes.[6]  For this reason, economists working in

the area have abandoned the notion that projections and current price benchmarks

should always agree.

The question then arises how to choose between current and fixed price

estimates.  To take a concrete example, what income measure better captures the

relative position of Switzerland for 1910, the projections or the current price estimates?

For recent years, the PWT resolves conflicts on largely theoretical grounds in favor of

the current price estimates.  Put simply, the current price comparisons have desirable

theoretical properties while the projections do not.  We do not advocate this *a priori*

approach.  Rather we argue that the choice between projections and historical

benchmarks should be made by appealing to empirical evidence.  Towards that goal, we

provide two ways to evaluate historical current price comparisons.  This is the second

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[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 of the ICP differed from the 2005 benchmarks by fifty percent.  Remarkably, the release of the 2011 round of the ICP in 2014 reversed many of the 2005 changes see Deaton and Aten (2017) and Inklaar and Rao (2017).

[6] Kravis, Heston and Summers (1982), Summers and Heston (1988a, 1988b) and Aten and Heston (2002) provide early discussions of why projections do not equal benchmarks.  Feenstra, Ma and Prasada Rao (2009), Deaton (2012), Deaton and Aten (2017) give more recent treatments.  The recent work of Inklaar and Rao (2017) is particularly important.   Finally, the problem is long standing as it was noticed early on by Clark (1950 page 33) when he found that his projections from 1929 did not equal his benchmarks for the 1900's.

contribution of the paper. First, building on Prados De la Escosura (2000), we test whether the current price benchmarks are consistent with what we know about relative price levels. Specifically, we test whether they are consistent with Balassa Samuelson and historical evidence on relative food prices. The second approach uses the different methodologies of international comparisons to evaluate the current price estimates. More precisely, we check our expenditure based estimates using comparisons based on sectoral output data, see Rostas (1948) and Paige and Bombach (1959), and real wages building on the insights of Heston (Heston (1998)).

The final section of the paper shows that the empirical evidence on relative prices, real wages and sectoral productivities tends to support the current price comparisons over the fixed price projections.


## 2. Comparing Price levels – Sources and Methods

Following the lead of the ICP, we compare final spending on the components of GDP - consumption, investment and government. The first step computes relative price levels while the second compares GDP with the price benchmarks. This section outlines data sources and methods for the price level comparisons. We save a complete account for the data appendix.

We compare price levels with a Fisher ideal price index - the geometric average of a price index constructed with base country weights and a price index constructed with partner weights. The Fisher index is widely used for historical comparisons. In

addition, it has appealing theoretical properties. As Diewert (1976) showed it is a

superlative index and thus approximates a true welfare measure.[7]

The US is the base economy. Following the standard terminology, we refer to

the US weighted index as the Laspeyres price index and the partner weighted index as

the Paasche. Equation (1) is the Fisher Ideal Price index for year T for country I relative

to the US.

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

Where $P^{us}$ and $P^i$ are price indices calculated using US and partner expenditure

weights and p and x are prices and quantities. To understand how the price comparison

works, we focus for the moment on the US weighted index. Equation (2) re-expresses

the index as a weighted average of price relatives where the weights are US expenditure

shares denoted by $\theta_j^{US}$.

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

To compare price levels, we use price data from contemporary price surveys

outlined later. We also use unit values derived from quantity data.[8] Price comparisons

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[7] The OEEC studies of the early 1950's, the forerunner to the ICP, used the Fisher ideal see Gilbert and Kravis (1954). The Fisher index, however, does not ensure transitivity. As a result, the ICP and the PWT rely on multilateral comparisons.

are well known from the ICP.   Yet price comparisons are not feasible for all items of

spending.  The ICP, for example, uses quantity based comparisons for "comparison

resistant services" such as education.  As we shall argue, historical income benchmarks

must rely more on quantity/unit value comparisons than the ICP because of the large

gaps in historical price data.

We illustrate a quantity/unit value comparison with a UK/US example.  For

concreteness, we term the item "beef".  Suppose we know the expenditure share for

beef.  Let us define $\theta_i^{US}$ as the share of US expenditure on this good and $Y^{US}$ as US

nominal GDP per capita.  Suppose we do not have a price for beef but we know beef

consumption in terms of pounds of beef consumed.  In terms of notation, $x_i^{US}$ is the

quantity measure for beef.  Equation (3) gives the US price, or more correctly the unit

value, denoted by $p_i^{US,}$ implied by the expenditure and quantity data.


(3)                $p_j^{US} = Y^{US}\theta_j^{US}/x_j^{US}$


We obtain UK unit values in a similar fashion.  The price indices in (1) and (2)

therefore contain prices and unit values.

Table 1 gives the expenditure breakdown used in our study.  For consumption,

we have food, rent, fuel and light, clothing, alcohol, tobacco, communication,

transportation, education and domestic service.  Within the food group, we cover flour,

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[8] Our work is greatly influenced by the OEEC studies of Gilbert and Kravis (1954, 1955 and 1958) who faced similar data problems to ours.  The World Bank (2013) provides a recent discussion of the ICP methodology.

beef, mutton, pork, butter, cheese, tea, coffee, sugar, potatoes, eggs, and milk.  In total,

we compare thirty-three categories of expenditure.[9]

The Table also shows where we use price and quantity/unit values 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, we have price

and quantity indicators.  We cannot apply quantity indicators to all items as such

comparisons are not feasible for heterogeneous items such as clothing or investment.

Overall, the price comparisons cover about eighty percent of spending for most

countries while the quantitative indicators cover about fifty percent

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[9] There are gaps.  For example, we omit consumer durables such as furniture.   In addition, the coverage of personal services is sparse as we lack data on medical services, hotels, recreation etc.   For food, we do not include vegetables, other than potatoes, or fruit.

Table 1
Expenditure Categories, Price and Quantity Indicators

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|  | Price Indicator | Quantity Indicator |
|---|---|---|
| **Consumption** | | |
| **Food and Beverages** | | |
|   Wheat Flour | x | x |
|   Rye flour | x | x |
|   Corn Meal | x | x |
|   Beef | x | x |
|   Mutton | x | x |
|   Pork | x | x |
|   Eggs | x | x |
|   Fresh Milk | x | x |
|   Butter | x | x |
|   Cheese | x | x |
|   Potatoes | x | x |
|   Tea | x | x |
|   Coffee | x | x |
|   Sugar | x | x |
| **Rent** | x | |
| **Fuel/Light** | x | |
| **Shoes and Clothing** | | |
|   Shoes | x | |
|   Clothing | x | |
| **Alcohol** | | |
|   Beer | | x |
|   Spirits | | x |
|   Wine | | x |
| **Tobacco** | | x |
| **Domestic Service** | x | |
| **Travel** | | |
|   Railway | x | x |
|   Other | | x |
| **communications** | | |
|   Letters | | X |
|   Telegrams | | X |
|   Telephone | | |
| **Education** | | x |
| | | |
| **Investment** | | |
|   Construction | x | |
|   Machinery | x | |
| **Government** | | |
|   Labor | x | |
|   Other purchases | x | |

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*Expenditure Weights*

The national accounts supply the overall weights for consumption, government and investment. We take the aggregate UK weights from Feinstein (1972), the Dutch weights from Smits *et al* (2000) and so on. Where possible we use the national accounts for disaggregated weights. Unfortunately, historical national accounts do not always provide sufficient detail. In addition, categories are not always consistent across countries – for instance expenditures on heat and water are sometimes included in housing and sometimes not. [10] To fill the gaps, we supplement the national accounts with expenditure studies such as the US Bureau of Labor (1890, 1891) and the Board of Trade (Board of Trade (1908, 1909, 1910, and 1911) and many country sources. A drawback of the budget studies for this period is their expenditure patterns often relate to relatively low incomes. As a result, they show higher food shares than the national accounts. The budget studies also reflect mainly urban consumption patterns whereas we require overall (urban plus rural) expenditure weights.

The data appendix provides our expenditure shares.

*Sources for Price Data*

We searched for retail price data collected by contemporary agencies to compare price levels internationally. Ideally, the sources would use a common price schedule that specified quality. To our surprise, we found a range of studies to satisfy these requirements. As several of our sources are little known, we discuss them briefly.

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[10] One of the few attempts to tackle these problems is Kuznets (1962, 1966) in his classic work on the structure of consumption.

*Price data - 1872*

*Labor in Europe and America (1875) and the Fifth Annual Report of the Massachusetts*

*Bureau of Statistics of Labor (1874)*

Edward Young (1875) provides price and expenditure data for towns in Belgium,

Canada, Denmark, England, France, Germany, Italy, Netherlands and Norway.  At the

time of the study, Young was Chief of the Bureau of Statistics of the United States

Treasury.  He sought information from US consuls regarding the "rates of wages, the

cost of subsistence and the conditions of labor".  In response, the consuls gathered

retail prices using a common price schedule that carefully addressed quality.[11]  The

schedule covers nine categories of foodstuffs, ten categories of clothing, two categories

of rent, and miscellaneous items.

These 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. [12]

The report lists prices for towns in Europe and Massachusetts.  Altogether, Wright has

data for fourteen English towns, twelve German towns, two Belgian towns, two Danish

towns, three Swiss towns but only two Italian towns and three French towns.  The

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[11] The first appearance of the Young schedule appears to be Wells (1868), Appendix D page 117 prepared by Young.  The Weeks Report (US Congress (1886)) also collected price data using the Young schedule.

[12] 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 then as the US Commissioner of Labor developing a reputation for careful data collection based on the use of well-trained agents.   Wright is remembered today for his budget studies – the first large systematic studies in this area.  The Fifth Annual Report (1874) is the first of several reports compiled or directed by Wright that focused on the collection of comparable price data for the US and other countries.  See Leiby (1960) for an account of his life and work.

sources of the price data in the Fifth Annual Report are Young's investigations but

Wright improved upon Young (1875) by standardizing weights and measures.  He also

provides prices in US dollars rather than gold.  We use Wright supplemented by Young

(1875) and many other sources. [13]


*Price data 1910 - The Board of Trade and the Dominion Reports*

The Board of Trade, (Board of Trade 1908, 1909, 1910, 1911) provides food

prices, rentals as well as coal and paraffin prices for the UK, Germany, France, Belgium

and the US.  The studies are well known, see Kravis (1984), and do not require further

elaboration.  It is forgotten today but the Board of Trade investigations also led to follow

up work from 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)).   These "dominion" reports provide

valuable comparative price data for countries not covered by the Board of Trade.  In

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[13] This short description does not exhaust the sources of comparative price data for the early 1870's.
Most notable are the British Consular Reports on the relative cost of living see Foreign Office (1870, 1871,
1872).  These reports are less systematic than the US reports cited above as they do not use a common
price schedule.  In addition, there is the Colonization Circular issued by Her Majesty's Colonial Land and
Emigration Commissioners that provides price data for Australia, Canada and other dominions.  The
studies contain much valuable data that we use to cross check our 1872 price data.  There is reasonable
agreement across sources.  There are also studies that provide comparative retail price data between
1872 and 1900.  For example, the US Department of State issued circulars to consular officers on two
occasions requesting information on prices and wages to "facilitate considerations of US trade with
foreign countries" see US Department of State (1879), US 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 these reports to generate food and other price benchmarks for 1879
and 1884 to cross check the 1872 estimates.  For the most part, there is good agreement.

addition, there is a variety of other sources for comparative price data for the 1900's. Examples include the United States Bureau of Labor Statistics (1915) and Lodge (1911).

Where possible, we checked price the comparative price data against domestic sources- particularly food. For 1872, retail price data are scarce. By 1910, there are retail prices for all countries. For the most part, we found general agreement across various sources.

There are gaps in the price data. First, and foremost, we found no price data for capital goods. To compare investment price levels, we create price benchmarks for construction and for equipment and machinery. The construction benchmark compares raw materials prices and relative construction wages. For equipment and machinery, we compare wholesale prices of iron and steel. We also use tariff rates on capital goods. The investment price benchmarks are crude. In our defense, researchers have used similar price data to deflate investment in historical national accounts.

The second limitation of the price sources outlined above is that they neglect tobacco, alcohol and services. For these items, we use the quantity comparisons discussed earlier.

Third, our price data refer almost exclusively to urban prices. To compare GDP the ICP requires average or "national" prices, see Deaton and Heston (2010) for a recent discussion. The urban rural adjustment is potentially an important one given the largely

rural nature of most of our economies for 1872.[14]  As outlined in the appendix, we

uncovered a fair amount of information on urban/rural price differences for the late

nineteenth and early twentieth century.  To summarize, the prices differences were

marked only for food and rent.  The differences were also broadly consistent across time

and space - 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 the cities.

Finally, we encountered difficulties with quality differences.  To give one example, we

had to exclude bread from the benchmarks, despite a plethora of price data, because we were

unable to adjust for the different bread types of Europe – particularly between wheaten and

rye breads.[15]  Instead, we compare flour prices for wheat and rye.  The appendix describes the

various adjustments for clothing, alcohol, tobacco etc.


*Quantitative Indicators/unit value*

As we have noted, price data 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 miles travelled per capita by rail with

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[14] For 1872, ten of the thirteen economies had more than seventy percent of their population in rural areas.  By 1910, this was down to two – Norway and Sweden.

[15] We are in good company as the differences in bread qualities also defeated the Board of Trade.

automobiles added for 1910 and so on.  The details are in the appendix.  To summarize,

quantity data are widely available for 1910.  There are gaps for 1872 and we rely partly

on extrapolations and partly on less well documented sources such as Muhall (1899).

We also collected quantity measures to supplement the price comparisons.  The

most important example is food.  There are consumption data for sugar, coffee and tea

consumption for all countries.  There is data for most food items for Australia, Canada,

Italy, the Netherlands, Sweden, the US and the UK.  There is data on cereals and meat

for France and Germany.  But there are gaps for other countries especially for 1872.


The data appendix provides price/unit value data for the food items and the

broad aggregates.

### 3. *Comparative Price Levels and Real GDP per capita*

Table 2 provides GDP price levels for 1872 and 1910 derived from data on expenditure shares and prices/unit values. The 1872 estimates show Australia with the highest price level followed by the US, Belgium and the UK. Denmark and Sweden show the lowest price levels. By 1910, the relative price levels of the Western Offshoots have increased and the US has the highest price level followed by Canada and Australia. For this year, price levels within Europe are within a narrow range with the exception of low price Belgium.[16]

To evaluate the price benchmarks, we first check whether they exhibit the standard features of international comparisons. First, we expect the base country expenditure weights (the Laspeyres variant of the price index) to give a higher relative price level as compared to comparison country weights (the Paasche variant) given that prices and quantities are generally negatively related.[17] Second, we expect the spreads between Laspeyres and Paasche indices for countries at different levels of income to be greater than the spreads for countries at similar income levels reflecting divergent expenditure patterns, see Deaton and Heston (2010).

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[16] The Belgian price level for this period is also low in the Board of Trade Study (Board of Trade (1910)).

[17] As stated by Kravis, Heston and Summer (1982 pg. 74) this is a "usual but not necessary consequence of negatively sloped demand curves".

Table 2

Price Level Benchmarks for 1872 and 1910

(US = 1.0)

_____

|           | 1872 | 1910 |
|-----------|------|------|
| Australia | 1.20 | 0.95 |
| Belgium | 0.98 | 0.60 |
| Canada | 0.80 | 0.97 |
| Denmark | 0.76 | 0.73 |
| France | 0.84 | 0.71 |
| Germany | 0.83 | 0.70 |
| Italy | 0.82 | 0.74 |
| Netherlands | 0.84 | 0.70 |
| Norway | 0.88 | 0.70 |
| Sweden | 0.78 | 0.73 |
| Switzerland | 0.83 | 0.71 |
| UK | 0.90 | 0.77 |
| US | 1.00 | 1.00 |

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*Sources and methods*:  The price indices are Fisher Ideal price indices for overall GDP.  The data appendix provides sources and data.

The price benchmarks in Table 2 have these regularities as shown by Table 3, which provides the ratio of the Paache to Laspayres price indices, the spread, for both years.  From the Table, the spread is less than unity for all twenty-four cases.  As required, prices and quantities are negatively correlated.   In addition, the spreads for 1910 are smaller in most cases which is expected given the convergence in price structures discussed in a later section.

Table 3

The Ratio of Paache to Laspayres price indices

_____

|  | 1872 | 1910 |
|---|---|---|
| Australia | 0.83 | 0.81 |
| Belgium | 0.75 | 0.88 |
| Canada | 0.96 | 0.95 |
| Denmark | 0.85 | 0.94 |
| France | 0.77 | 0.84 |
| Germany | 0.81 | 0.90 |
| Italy | 0.81 | 0.89 |
| Netherlands | 0.85 | 0.84 |
| Norway | 0.85 | 0.93 |
| Sweden | 0.85 | 0.94 |
| Switzerland | 0.79 | 0.90 |
| UK | 0.87 | 0.96 |

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*Sources and methods*:  The Table gives the ratio of the overall price index measured relative to the US with partner country weights as a ratio of the price index with US weights.  See data appendix.

To be sure, the spreads are smaller than for the 1950's OEEC studies of Gilbert and Kravis (1954, 1958).   This is explainable by the lower precision of our price and expenditure data compared to the 1950's.  On the other hand, the spreads are mostly higher than for

developed economies over recent ICP rounds perhaps reflecting the fact that differences in

expenditure patterns were greater in the past.[18]

Using the price benchmarks, we next compare real GDP per capita in current prices.


**GDP per Capita in Current Prices**

We compare income with a Fisher Ideal quantity index.  Equation (4) is the Fisher

index for year T for country I relative to the US.


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


The current price Fisher GDP volume index is the geometric average of quantity

indices where output is valued at US and partner country prices.  To understand how

the comparison works we take a closer look at the index in US prices.  Equation (5) re-

expresses the index as a weighted index of quantity relatives where the weights are US

expenditure shares.


(5) $\quad Q^{US}(p^{US}, x^{US}, x^i) = \sum \theta_j^{US} x_j^i / x_j^{us}$


To construct (5), we have direct quantity measures from the quantity/unit value

calculations.  The ICP- style price comparisons yield indirect quantity measures.  To see

how the ICP measure works we return to our earlier example – beef.  Define $p^{US}_i$ as the

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[18] The spreads for the Board of Trade studies of the 1900's covering food prices and rents are much smaller than those in Table 3 for 1910.  This is a puzzle.

US price of beef obtained from an ICP style comparative price level survey.  We obtain

the implied quantity of beef for the US, $x^{US}_i$ by deflation:


(6)                  $x^{US}_i = Y^{US} \theta^{US}_i / p^{US}_i$


We generate the implied quantities for partner economies in a similar fashion.

The ICP calls the quantity measures "indirect" or "notional" quantities.

Table 4 illustrates the calculation of the current price GDP per capita

benchmarks.  Columns two and three give nominal GDP per capita for 1872 and 1910 in

dollars relative to the US.  The nominal GDP data are from national sources detailed in

the appendix.  Population is from Mitchell (2003a, 2003b) and national sources.  The

next columns repeat the price benchmarks from Table 2 while the final columns show

real income per capita in current prices obtained by deflating relative nominal GDP by

the price benchmarks.[19]  The GDP data refer to territories within the then borders.

From the Table, Australia, the US, Belgium and the UK have commanding leads in

nominal income per capita for 1872.  Italy and Sweden are some distance behind.  The

differences in nominal income are large as nominal income for Australia is five times greater

than for Italy.

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[19] Our price comparisons use prices and as unit values derived from quantitative indicators.  From equation (3), the unit values depend on nominal income.  This means that the price level is not independent of nominal income.

Table 4

Real Income per Capita in Current Prices for 1872 and 1910

(US = 1.00)

_____

| Country | Nominal GDP | | Price Benchmarks | | Real GDP in current prices | |
|---|---|---|---|---|---|---|
|  | 1872 | 1910 | 1872 | 1910 | 1872 | 1910 |
| Australia | 1.69 | 1.15 | 1.20 | 0.95 | 1.41 | 1.21 |
| Belgium | 0.90 | 0.55 | 0.98 | 0.60 | 0.91 | 0.92 |
| Canada | 0.60 | 0.81 | 0.80 | 0.97 | 0.75 | 0.83 |
| Denmark | 0.55 | 0.51 | 0.76 | 0.73 | 0.72 | 0.70 |
| France | 0.59 | 0.44 | 0.84 | 0.71 | 0.70 | 0.63 |
| Germany | 0.56 | 0.51 | 0.83 | 0.70 | 0.67 | 0.72 |
| Italy | 0.31 | 0.29 | 0.82 | 0.74 | 0.37 | 0.39 |
| Netherlands | 0.62 | 0.38 | 0.84 | 0.70 | 0.74 | 0.55 |
| Norway | 0.53 | 0.44 | 0.88 | 0.70 | 0.60 | 0.63 |
| Sweden | 0.39 | 0.44 | 0.78 | 0.73 | 0.50 | 0.61 |
| Switzerland | 0.56 | 0.55 | 0.83 | 0.71 | 0.68 | 0.77 |
| UK | 0.88 | 0.59 | 0.90 | 0.77 | 0.98 | 0.76 |
| US | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

_____

*Sources and methods*:  See data appendix.

Adjusting for price level differences, Australia leads in real income per capita for

1872 followed by the US and the UK.  Italy and Sweden bring up the rear.[20]  For 1910,

_____

[20] The US was recovering from the effects of the civil war in 1872.  Lindert and Williamson (2016) argue that these years were a low point in relative UK/US income levels.  In terms of output per worker, the current price estimates for 1872 show the US still had a commanding lead over the UK.  This is because the ratio of the labor force to population was much lower for the US.

Australia remains the richest economy in terms of real income per capita followed closely by the US.  After 1872, the UK and the Netherlands fall relative to the US and most European economies.

How do the current price GDP benchmarks in Table 4 compare to the familiar Maddison Projections?  As it stands, the estimates are not comparable since the current price comparisons are Fisher Ideal quantity indices whereas the Maddison projections value output with 1990 Geary Khamis international prices.  To allow comparison, we transform the Maddison projections to a 1990 Fisher ideal index and take a US base.  Table 5 shows the results.  The first columns provide the current price estimates from Table 4.  The next columns give the Maddison projections for 1872 and 1910 adjusted to a Fisher Ideal basis.

There are marked differences for some but not all countries.  The Madison projections for 1872 show US income per capita lagging Australia, the UK, Belgium, the Netherlands and Switzerland.  They show Australia and the UK with equal income.  They show Sweden with a slight lead over Norway.  They show Canada lags the UK by a large margin and Switzerland leads all of continental Europe.  Indeed, Swiss income per capita exceeds US income by sixteen percent!  In addition, the projections show relatively high income for Italy.  The current price estimates differ in all these respects.

Table 5

Comparing Estimates of Real Income per Capita

(US = 1.00)

_____

| Country | GDP in Current Prices | | Maddison GDP Projections | | Log Differences | |
|---|---|---|---|---|---|---|
| | 1872 | 1910 | 1872 | 1910 | 1872 | 1910 |
| Australia | 1.41 | 1.21 | 1.29 | 1.03 | 0.09 | 0.16 |
| Belgium | 0.91 | 0.92 | 1.06 | 0.81 | -0.15 | 0.13 |
| Canada | 0.75 | 0.83 | 0.70 | 0.82 | 0.07 | 0.02 |
| Denmark | 0.72 | 0.70 | 0.75 | 0.70 | -0.04 | 0.00 |
| France | 0.70 | 0.63 | 0.74 | 0.59 | -0.05 | 0.06 |
| Germany | 0.67 | 0.72 | 0.73 | 0.67 | -0.08 | 0.07 |
| Italy | 0.37 | 0.39 | 0.58 | 0.42 | -0.44 | -0.07 |
| Netherlands | 0.74 | 0.55 | 1.07 | 0.75 | -0.37 | -0.31 |
| Norway | 0.60 | 0.63 | 0.52 | 0.42 | 0.15 | 0.41 |
| Sweden | 0.50 | 0.61 | 0.54 | 0.50 | -0.09 | 0.19 |
| Switzerland | 0.68 | 0.75 | 1.16 | 1.37 | -0.53 | -0.60 |
| UK | 0.98 | 0.76 | 1.29 | 0.90 | -0.28 | -0.16 |
| US | 1.00 | 1.00 | 1.00 | 1.00 | | |

_____

*Sources and methods*:  We take the GDP projections from the latest version of the Maddison project adjusting the estimates to a Fisher Ideal basis using Maddison (1995) Table C-7 page 172.  The differences between the Fisher Ideal and Geary Khamis projections are small.


Turning to 1910, we again see differences.  Consider Switzerland.  The projections

show the Swiss as the world income leader followed at a distance by Australia and the US.

The Maddison projections also understate income for Norway relative to the current price estimates where Sweden leads Norway.

The final columns look at the differences between the current price benchmarks and the projections in logs. For 1872, the differences are twenty-eight percent for the UK, thirty-seven percent for the Netherlands, forty-four percent for Italy and a whopping fifty percent for Switzerland. For 1910, there are sizeable differences for Switzerland, Norway and the Netherlands.[21]

The current price estimates therefore provide a sharply different picture of economic leadership and convergence for the Western economies as compared to the Maddison projections. To summarize, the benchmarks show a higher income level for the US and Canada relative to Europe. They show the UK, the Netherlands, Italy and Switzerland with sharply lower income and so on. Thus, the current price estimates provide a different perspective on some classic debates in economic history – the relative position of the US and the UK, Frances versus the UK and much else too.

To restate a point made earlier, the fact that there are divergences between the projections and the current price estimates is not surpising. On the contrary, we expect to see such differences given that the current price benchmarks and projections embody a different set of relative prices. Indeed, differences exist for every round of the ICP see Heston and Aten (2017) and Inklaar and Rao (2017).

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[21] Bear in mind that the results for the projections depend on the base year. We could use as a base various ICP rounds from 1970 to 2011. Each would produce different results and would lead to larger divergences for some countries and smaller for others as compared to Table 4.

The question yet to be addressed by the literature on historical income comparisons is how to choose between projections and current price estimates. Consider Switzerland. Was it the world leader for 1910 as implied by the projections – the first miracle economy! Or was it somewhere in the middle as in the current price benchmarks?

The recent ICP literature holds that the current price estimates are superior on theoretical grounds because they are superlative measures. This line of reasoning led the Penn World Tables and the international comparison literature generally to favor current price measures.[22] The case of historical income comparisons is more complicated. With good data, it is hard to argue against current price estimates. Alas, we do not have pristine historical data. On the contrary, we face two fundamental sources of measurement error. The first arises from the imperfections in price, expenditure and quantity data discussed earlier. The second source of uncertainty is nominal GDP as all historical nominal GDP estimates contain some measurement error. Consider, for example, the well-known differences for the UK between nominal GDP measured from the income and expenditure sides, see Feinstein (1972). Other examples abound. To give one example Toutain (1987) and Levy-Leboyer and Bourguingon (1990) provide GDP estimates for France that can differ by twenty percent. For other countries, notably Belgium and Switzerland, we know little about the quality of nominal GDP data. Given these data uncertainties, the current price historical benchmarks require supporting evidence.[23]

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

[23] The latest version of the PWT forces the annual projections through current price benchmarks. Ward and Devereux (2003) had earlier used this procedure in the economic history literature to derive annual

## 4. Supporting Evidence

This section brings empirical evidence to bear on the current price income comparisons. We begin with a closer look at implied food quantities. The income benchmarks rely on food quantities obtained from the deflation measure of equation (6). We also have independent measures of food quantities from food balance sheets etc. This allows us to crosscheck the current price estimates for food - the largest item of consumer spending.

For the most part, the direct and indirect estimates of food consumption are similar. There are three exceptions. First, the deflation measure produced implausibly low 1872 levels of food consumption for France and Italy. Second, it showed Belgium with a suspiciously high 1872 food consumption - above the US! For these cases, we replaced the price data with quantity/unit values in the final comparisons.[24]

We take the close correspondence between the direct and indirect measures of food quantities for most countries as confirming evidence for the current price estimates. The more general point is that the implied quantities for individual items from expenditure comparisons should be checked against what is known about quantities for all historical income comparisons.

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long run UK/US GDP. By emphasizing current price estimates over projections, this implicitly assumes that the errors in the benchmarks are small relative to the errors in the projections. The early work of Summers and Heston (1988a, 1988b) suggests, however, that the best way to think of the relationship between benchmarks and projections is to assume that measurement error exists for both.

[24] It is not obvious to us why the problems arise for France and Italy. Our urban food prices are certainly high for these countries. Yet the Foreign Office Studies (Foreign Office (1870, 1871 and 1872) and the later US consular reports, US Department of State (1879) and US House of Representatives (1885) also show high urban prices. For France, we suspect nominal GDP may be too low. Possible explanations for Italy include urban taxes etc. For Belgium, as discussed in the data appendix, we suspect that the estimate of nominal GDP for 1872 is too high explaining the implausible results for food.

Prados De la Escosura (2000) suggested that economists might also evaluate historical income using the price levels implied by projections. We shall exploit his insight in two ways. First, we search for Balassa Samuelson – a staple of the trade and growth literatures – in the current and constant price estimates. Second, we consider the implications of what we know about relative food prices.

*(i)    Implied Price Levels*

The Maddison projections yield GDP in 1990 prices. To calculate the price levels implied by his projections, we divide relative nominal income per capita in Table 4 by the adjusted projections of Table 5. As we shall see, Balassa Samuelson holds for the current price GDP data but not for the GDP projections.[25]
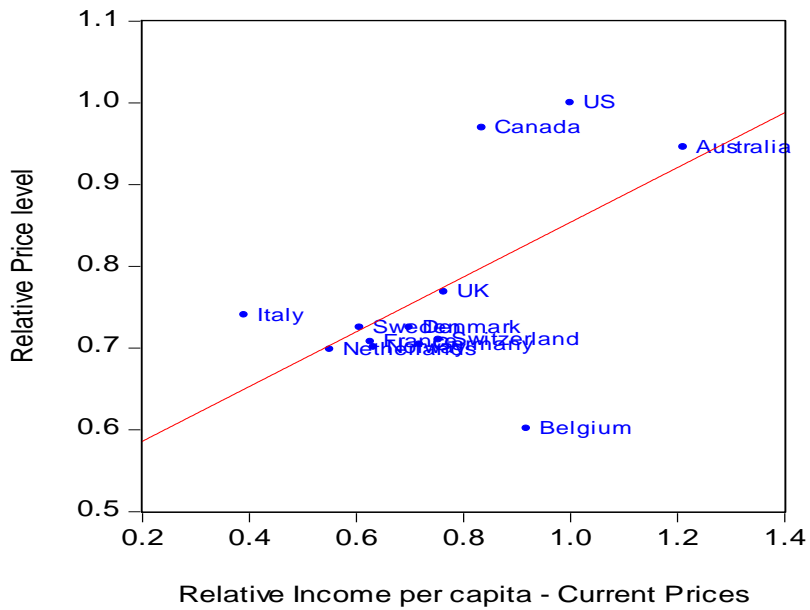
---

[25] By construction, the Prados De la Escosura (2000) current price estimates incorporate a Balassa Samuelson effect.

Figure 1

Price Levels and Income per capita
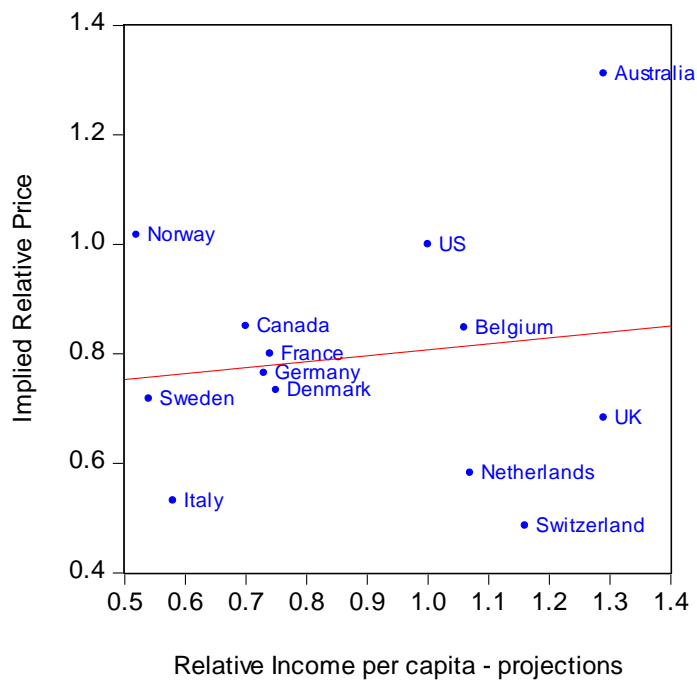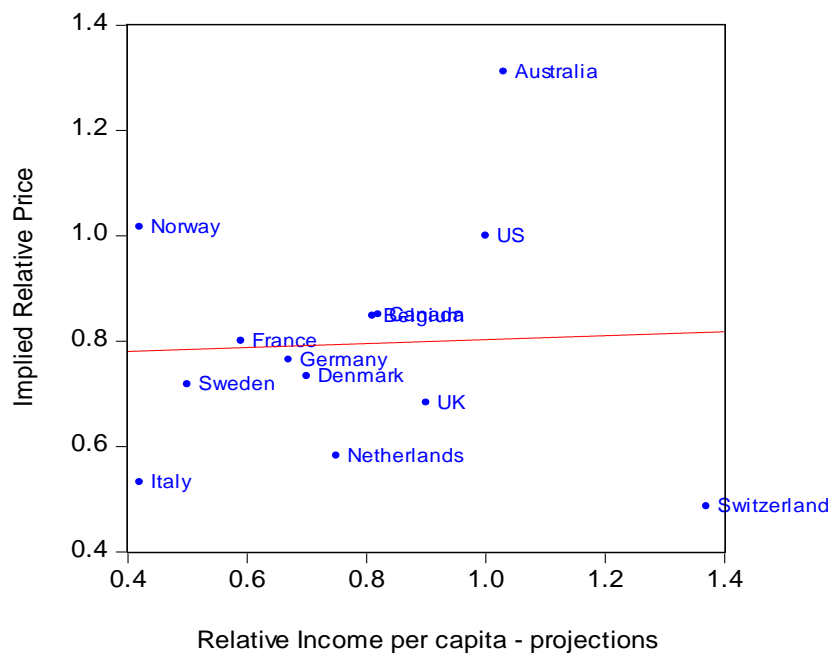
US = 1.0

I.    Current price estimates
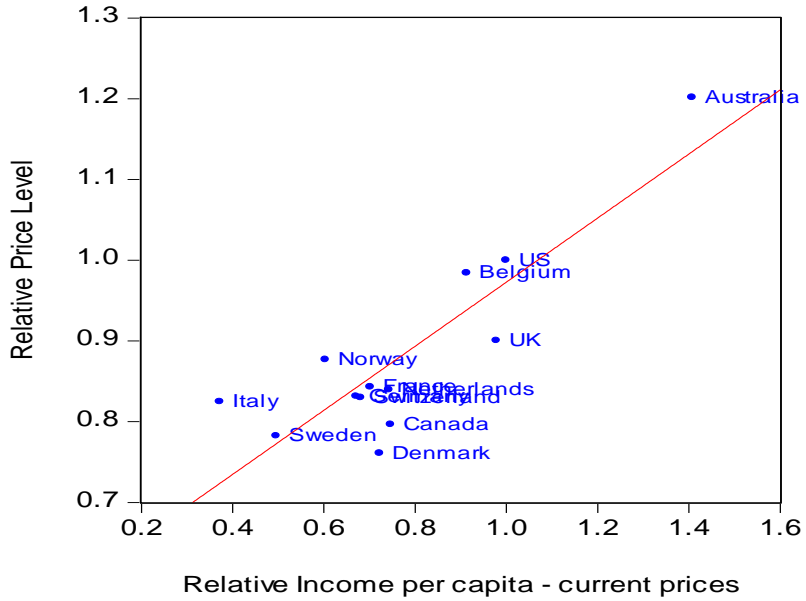


a.    1872



b.    1910

II. Income Projections



**a.  1872**



**b.  1910**
Source: Tables Three and Five.

Balassa Samuelson predicts that price levels increase with real income per capita. The first panel of Figure 1 tests this prediction by graphing the price level benchmarks for 1872 and 1910 against current price real GDP per capita.  For the most part, a higher 1872 income per capita is associated with a higher price level.  This is the case for Australia, the US and the UK.  Similarly, low income is generally associated with lower price levels.[26] Balassa Samuelson is also present for the 1910 current price benchmarks 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.

In contrast, the Maddison projections reject Balassa Samuelson.  This is clear from the second panel of Figure 1, which graphs the relationship between the Maddison projections and their implied price levels.  From the Figure, Balassa Samuelson does not hold for either period.   Consider 1872.  Three countries, Switzerland, the UK, and the Netherlands appear in the southeast quadrant of the Figure.  They combine high income with a low price level.  For 1910, we observe a low price level for a very rich economy Switzerland – fifty percent of the US - and a high price level for a poor country Norway – five percent above the US.  Finally, the large differences in implied price levels across Europe for 1910 are surprising given the stable exchange rates of the period.  Surely, contemporary observers would have noticed such huge price differences.  They did not.

The findings for Balassa Samuelson are suggestive.  On their own, however, they are unlikely to convince skeptics.  After all, the sample is small.  Nor is it obvious why Balassa

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

Samuelson should hold for all historical periods.[27]  Yet Balassa Samuelson serves a useful

point of departure because it focuses attention on the question of whether the relative

price levels implied by the projections are plausible.[28]  As we shall see, the reliability of the

projections can be determined in a simpler fashion by considering evidence on relative food

prices.

We start with 1872.   Transport costs were high for this period so we would expect

food prices to be lower in the food exporters - the US, Canada, Australia, and Denmark.[29]

The price benchmarks are consistent with this prediction.  As shown in the appendix, food

prices for 1872 are indeed lower in Australia, Canada, Denmark and the US.  The differences

between food price levels for food importers and exporters are up to fifty percent at the

retail level.[30]  We find this plausible.  It is consistent with other evidence, see O'Rourke and

Williamson (1999).  The patterns for the individual food items are also as expected with

flour and meat higher in importing countries with the larger differences for meat.

The food price results for 1872 are uncontroversial but they turn out to have stark

implications for overall price levels.  The second column in the Table 6 gives the overall

price level implied by the Maddison projections for three countries – the Netherlands,

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[27] Along these lines, Bergin, Glick and Taylor (2006) find that Balassa Samuelson is a relatively recent phenomenon that does not hold in the past.

[28]  To see how this works consider the following example - Maddison shows Swedish income per capita slightly above Norway for 1872.  His estimate also implies that the Norwegian price level is forty percent above Sweden.  We can therefore evaluate his relative income estimates by enquiring how believable are their implied price levels.

[29] Strictly speaking, this prediction holds at the wholesale price level only.  Prices could be higher or lower at the retail level depending on retail margins.

[30] The price gaps at the wholesale level between Europe and the US, Canada and Australia for 1872 were likely higher reflecting their higher wholesale/retail food margins.

Switzerland the UK.[31]   As noted earlier, the 1872 projections require low overall price levels

for Switzerland (0.49), the Netherland (0.58) and the UK (0.68).

Table 6

Food Price Levels for 1872

(US = 1.00)

_____

|  | Overall Price Level Implied by the Maddison Projections | Food Prices | Required Non food Prices |
|---|---|---|---|
| Netherlands | 0.58 | 1.32 | 0.26 |
| Switzerland | 0.49 | 1.51 | 0.05 |
| The UK | 0.68 | 1.44 | 0.36 |

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*Sources and methods*:  The price levels implied by the Maddison projections are described earlier.  We take the food price estimates from the current price benchmarks given in the data appendix.  To allow comparability we calculate food price levels for all countries using US weights.  We obtain similar results with partner country weights.  Food prices tend to be lower with these weights but the generally higher share of food in total expenditure offsets this.


The third column in the Table gives relative 1872 food prices taken from the price

benchmarks.  For Switzerland, food prices were fifty percent above the US.  UK food prices

are forty- four percent higher while the differences for the Netherlands are smaller.  These

estimates are consistent with other work in this area.  The final step combines the food

prices in column three with expenditure weights from the price benchmarks and the

implied overall price level from the projections to generate the non-food GDP price level

required by the Maddison projections.  We generate this price level by *assuming that the*

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[31] We omit Italy from the Table as we compare food consumption using quantitative indicators.

*food price benchmarks and expenditure weights are correct*.  The final column Table 6 gives

the results of this exercise.  It shows remarkably low non-food price levels for the

Netherlands and Switzerland – on the order *five* to *twenty-six* percent of the US.  Such price

levels are almost impossible.  For the UK, the calculation implies non-food price levels that

while possible are unlikely.

The calculations make an important point - if we believe that income per capita for

the Netherlands and Switzerland exceed the US for 1872 and if we also accept that their

food prices levels were well above the US then this requires that prices for non-food GDP –

clothing, housing, alcohol, fuel, travel etc. were a tiny fraction of the US levels.   We do not

see how this is possible.

Transportation costs fell dramatically after 1872. [32]   This means that food prices

must increase in the exporters relative to the importers.[33]  As it turns out, the price

benchmarks show precisely these changes.  By 1910, our estimates show food prices in the

US, Canada and Australia are higher than Europe reflecting the decline in transport costs

and their higher retail margins.  It is, however,  easy to show that the 1910 food price levels

for Switzerland render the Swiss/US price level implied by the projections highly unlikely.

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

[33] We do not mean to imply that all food items were tradable.  This was clearly not the case for milk,
vegetables etc.

*(ii)     Real Wages – A GDP comparison from the Income side*

Arising from Allen (2001) there is an important literature using data on real

wages to inform discussions of growth and convergence/divergence.  As mentioned in

the introduction, Heston (1998) suggests that real wages could be considered as part of

a GDP comparison from the income side.[34]  To understand his argument, equation (7)

uses an identity to capture the relationship between the economy wide real wage and

relative output per worker.  In terms of notation, $w_{i/us}$ is relative real wages in terms of

the US, $\underline{y}_{i/us}$ is relative output per worker in terms of the US, $\beta$ 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 here refers to the economy wide real wage and covers all labor income

- that is unskilled, skilled, clerical and professional workers.


(7)               $w_{i/us} = (\beta_i/\beta_{us})(p/p_c)\,\underline{y}_{i/us}$


The expression shows that relative output per worker can deviate from relative

economy wide real wages only if there are differences in labor shares and/or differences

in relative price levels for consumption relative to overall GDP.  With the exception of

the UK, the literature for the period provides little evidence that labor shares differ

across economies in a systematic fashion see Prados De La Escosura and Roses (2003).

As shown in the data appendix, relative consumption/GDP price levels were higher in

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[34] More recently, Lindert and Williamson (2016) and Lindert (2016) build on the real wage literature
arising from Allen (2001), and in particular on Allen, Murphy and Schneider (2012), to provide a simple yet
powerful approach to comparing GDP for the past.

Europe as compared to the Western Offshoots, which reduces their real wages as compared to output per worker. The differences are small. Thus, we expect as Heston (1998) suggests a close correspondence between economy wide real wages and output per worker.

We do not have real wage comparisons for this period covering all labor income. For the most part, the comparisons are for urban workers. Most notably, there are Williamson's (1995) real wages indices for urban skilled/unskilled manual workers. We would not necessarily expect to see a perfect agreement between his urban indices and economy wide wages given that there are differences across economies in the shares of urban workers in the labor force and urban/rural/skilled/nonskilled wage premiums, hours worked etc. Nonetheless, we would still expect rankings based on urban real wages to bear *some* relationship to the rankings for overall output per worker.

Table 7 uses equation (7) to derive the economy wide real wages implied by the current price GDP benchmarks for 1872. The second column gives output per worker from the current price benchmarks. The next column gives the implied economy wide real wages. We assume a labor share of 0.7 for all economies except for the UK where we assume 0.6.[35] For comparison, we provide Williamson's (1995) real wage indices for urban workers in the final column.

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

## Table 7:

## Output per Worker and Real Wages for 1872

## US = 100

| | Output per worker current prices | Real Wages implied by Current Price GDP Per Worker | Real Urban Wages Williamson (1995) |
|---|---|---|---|
| Australia | 1.27 | 1.25 | 1.03 |
| Belgium | 0.59 | 0.53 | 0.55 |
| Canada | 0.74 | 0.76 | 0.90 |
| Denmark | 0.51 | 0.50 | 0.32 |
| France | 0.49 | 0.47 | 0.42 |
| Germany | 0.57 | 0.51 | 0.50 |
| Italy | 0.23 | 0.21 | 0.21 |
| Netherlands | 0.65 | 0.61 | 0.45 |
| Norway | 0.44 | 0.39 | 0.30 |
| Sweden | 0.42 | 0.39 | 0.32 |
| Switzerland | 0.50 | 0.45 | 0.36 |
| UK | 0.75 | 0.58 | 0.59 |
| US | 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). *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.  We assume the share of labor in GDP of 0.7 for all economies except the UK 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 UK 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.

From the Table, the Western Offshoots (the US and Australia) have a larger lead in output per worker for 1872 than for income per capita seen earlier reflecting the lower average age of these societies. For the most part, the implied economy wide real wages from the benchmark comparisons are consistent with the Williamson (1995) real wage indices. In the case of Canada, the implied real wage is below Williamson. For Denmark, the Netherlands, Norway, Sweden and Switzerland the implied real wages are a little above Williamson. For the other economies, they are close.

On the other hand, it is easy to show that there are marked differences between the Williamson (1995) urban real wages and the economy wide real wages implied by the projections – particularly for the Netherlands and Switzerland. Without belaboring the point, it should be clear that what we know about real wages for the Netherlands and Switzerland are difficult to reconcile with higher income per capita relative to the US. Put differently, it may well be the case that these economies combined higher income per capita with lower real urban wages. It stretches credulity, however, to suppose that higher income per capita could co-exist with the levels of urban real wages in Table 7.[36]

We can make similar arguments for 1910 where it is easy to shows that the projections imply that Swiss real wages exceed US levels. This prediction strikes us as untenable.

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[36] One might also argue that if living standards were higher in Switzerland and the Netherlands for 1872 as compared to the US then contemporary observers would have noticed. The opposite appears to be the case.

*(ii)     GDP and Sectoral Labor Productivity*

Rostas (1948) and Paige and Bombach (1959) show how to compare GDP using sectoral output data.  For the most part, the data necessary to implement such output comparisons are not available for 1872 or 1910.  Nonetheless, we have enough information on sectoral productivities to crosscheck the current price GDP comparisons.

To see how this might work, we break the economy into three sectors, agriculture, manufacturing and the rest of the economy.  For reasons of space, we focus on 1872 but the argument extends to 1910.  For manufacturing, the evidence (as summarized in Broadberry (1997)) suggests US output per worker for the 1870's is twice UK levels.  The UK along with Germany are the manufacturing leaders for Europe.  Thus, manufacturing output per worker for the other European economies is at most half US levels.  For agriculture, the available information, outlined in the appendix, suggests that US output per worker in agriculture for the 1870's was well above, probably twice, Western European levels.  This claim is not controversial given the higher endowments of land and horses per US agricultural worker.  There is less information on relative productivities outside agriculture and manufacturing.  We would hazard the guess that service productivity for Europe, which includes transportation and wholesale/retail trade where the US was far ahead, at best equals the US.

The appendix shows how to use these conjectures to place an upper bound on output per worker relative to the US.  As shown there, the results are consistent with the current price benchmarks.  The sectoral results are, to be sure, "controlled conjectures".  The point is straightforward - if the US had a large lead in output per

worker for manufacturing and agriculture, as seems to have been the case, then the

Maddison projections for some countries, most notably Switzerland and the

Netherlands, are difficult to reconcile with what is known about sectoral productivities.


5.  **Concluding Comments**

This paper show that current price historical GDP comparisons are feasible for the

late nineteenth and early twentieth century by providing current price GDP comparisons

along modified ICP lines for thirteen currently developed economies.  The current price

comparisons differ in fundamental respects from projections based on recent prices.  In

particular, they raise the relative income of the US while they lower the income of Belgium,

the Netherlands, Switzerland and the UK.

There are differing schools on the proper role of current price benchmarks in

economic history.  One school holds that such comparisons are best used as a crosscheck

for projections.  The cases of the Netherlands and Switzerland fall into this category.  Given

the weight of the evidence, it is hard to see how projections showing 1872 income per

capita above the US for these countries are sustainable.  It is equally difficult to see how

Swiss income for 1910 could exceed the US by such a large margin.

We hope, however, that the current price benchmarks will do more than serve as

crosschecks.  Rather, they provide a fresh perspective on modern economic growth given

that they show different patterns of economic leadership as well as catch up and

convergence.  Most notably, they suggest that the US 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 and development, such as the relative price of investment to consumption (Collins and Williamson (2001)), that cannot be easily addressed by projections.

The current price benchmarks are a work in progress.  There is much to be done. We require, for example, better data on expenditure shares, more information on urban rural price differences, more food balance sheets and, most importantly, better measures of capital goods prices.  In addition, we have to increase the number of countries and provide additional benchmark years.[37]  Finally, there is unfinished business with methodology.  We require approaches to historical data that are robust to measurement error in nominal income, prices and expenditure shares– issues that we have barely touched on in this paper.  In sum, the difficulties faced by current price historical comparisons should not be underestimated.  On the other hand, the rewards will be substantial as the current price measures have the potential to sharpen our measures of growth and convergence for a crucial period of modern economic growth.

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**Data Appendix**

The appendix outlines sources and methods.  We begin by describing sources for nominal GDP followed by sections on expenditure weights, prices and quantities. We conclude with the testimony of sectoral productivity data.

**1.      Nominal GDP Per Capita:**

We use GDP at market prices from the sources detailed below.   Where available, we use GDP from the expenditure side.

Table 1(a)

Nominal GDP Series, 1872, 1910

| Country | GDP Data Sources |
| --- | --- |
| Australia | 1872 - Mitchell (2003a).  1910 - Butlin (1977). |
| Belgium | Smits, Woltjer and Ma (2009) provide nominal GDP measured from the output side.  Their estimates for 1872 are implausible as Belgian GDP per capita exceeds GDP per capita for the US and the UK.  Instead, we use the 1870 estimate from Prados De la Escosura (2000). |
| Canada | Urquhart (1993). |
| Denmark | Mitchell (2003b). |
| France | Levy-Leboyer and Bourguingon (1990). |
| Germany | Mitchell (2003b).  We raised NNP by 8% to get GDP. |
| Italy | Baffigi (2011). |
| Netherlands | Smits *et al*. (2000). |
| Norway | Grytten (2004). |
| Sweden | The Swedish Historical National Accounts 1800-2000 data base at http://www.ekh.lu.se/database/lu-madd/National%20Accounts/default.htm |

| | |
|---|---|
| Switzerland | Historical Statistics of Switzerland at http://www.fsw.uzh.ch/hstat/nls_rev/ls_files.php?chapter_var=./q&lang=en |
| UK | Updated Feinstein (1972) compromise estimate from Mitchell (1988). We adopt the compromise estimate rather than the expenditure side measure to ensure consistency with earlier work on the UK/US. |
| US | 1872, Gallman (1966) as given in Rhode (2002) adjusted to the commerce version of GDP by following the approach of Kendrick (1961). 1910, Kendrick (1961). |

Population is from Mitchell (2003a, 2003b) and the domestic sources outlined above.

## 2.     Expenditure Weights

We begin with by describing the aggregate weights for consumption, investment and government spending followed by sources for the disaggregated weights.

### *Aggregate Weights for Consumption, Investment and Government Spending*

Where possible, we use the national account sources detailed above. For example, we take UK weights from Feinstein (1972), Table 2 and Dutch weights from Smits *et al.* (2000). We lack overall consumption/investment/government weights for Belgium and Switzerland. Belgian GDP is measured from the output side and we have not yet found aggregate Swiss weights. We substitute Dutch weights for Belgium. For Switzerland, we use German weights. The disaggregated weights for both countries are from the domestic sources described below.

***Disaggregated Consumption Weights***

We break consumption into food, rent, fuel and light, clothing, alcohol, tobacco, domestic service, education, communications and transportation; see Table 1 in the text. Ideally, the disaggregated weights would come from the national accounts. For most cases, however, historical national accounts cover broad aggregates such as food, clothing and rent rather than providing the detail we need. In addition, classifications are not always consistent. For instance, beverages such as coffee/tea and alcoholic drinks are sometimes in food and sometimes not, housing can cover rent alone or it can cover rent and other household expenditures.

To obtain weights for the missing items of expenditure we turn to expenditure studies – most notably US Department of Commerce and Labor (1890, 1891) and the Board of Trade studies of the 1900's along with information from the domestic sources outlined below. Finally, we crosschecked the food weights with data on food prices and food quantities using the approach described later.

The sources for the detailed consumption weights are:

***Australia:*** *1872 and 1910.* McLean and Woodland (1991), Thomas (1995) and McLean (1999). Coghlan (1904).
***Belgium:*** 1872: Segers (2004) supplemented by US Department of Labor and Commerce (1890, 1891).
1910: Segers (2004) and the Board of Trade (1910).
***Canada:*** 1872: Firestone (1958), Kuznets (1962, 1966). Young (1875)
1910: Firestone (1958), Kuznets (1962, 1966), Board of Inquiry into the Cost of Living (1915).
***Denmark:*** 1872 and 1910. Hansen (1974).
***France:*** 1872: US Department of Commerce and Labor (1890, 1891) along with data on food quantities and prices described later.
1910: Board of Trade (1909).
***Germany:*** 1872: Kuznets (1962). US Bureau of Commerce and Labor (1890, 1891)
adjusted to 1872 based on expenditure information in Young (1875).

1910: Kuznets (1962) and Board of Trade (1908).
*Italy:* 1872: Kuznets (1962).
1910: Kuznets (1962) and Williamson (1995).
*Netherlands:* 1870 and 1910. Smits *et al*. (2000) for broad weights. We obtain food weights from quantities and prices described later.
*Norway:* 1872 and 1910: Kuznets (1962). We derive food expenditure weights from the food quantities and prices described later.
*Sweden:* 1870. Kuznets (1962). We derived food weights using consumption quantities for the period 1881-1900 and prices from the Institute for Social Sciences (1937), pp. 200-203.
1910: Kuznets (1962) and Williamson (1995).
**Switzerland:** For 1872, we use US Department of Commerce of Labor (1890, 1891). We derive food weights from the quantities and prices described later. We use Studer (2008) for 1910.
*UK:* 1872: Thomas, (1995), Young (1875), US Department of Commerce and Labor (1890, 1891), Jeffreys and Walters (1955) and Prest (1954).
1910: Prest (1954), Table 112. Board of Trade (1908).
*US:* *1872* Kuznets (1962). Kloft (1995).
*1910*: Lebergott (1996). The Board of Trade (1911a).


### *Investment Weights*

We compare relative investment price levels with construction and

equipment/machinery benchmarks. The shares of construction and equipment/machinery in

capital formation are from Feinstein (1972), Table 39, columns 3, 4, and 5 for the UK, from

Kuznets (1962), pp. 254-255 for the US, and Columns 1, 2, and 3 and from Kuznets (1962) for

Germany, Denmark, Norway, Sweden and Canada. Thomas (1995) provides weights for

Australia while Dutch weights are from Smits *et al.* (2000). For France, Italy and Switzerland,

we assign construction seventy percent of the investment weight for 1872 and sixty-five

percent for 1910.

*Government*

For all countries, we assume a weight of 0.6 for nominal wages and 0.4 for goods and services prices.

Tables 2(a) and 3(a) provide the expenditure weights used to construct the price benchmarks.

### 3.      Price Data

**Consumption**

As noted in the text, we searched for contemporary studies that used a common schedule to compare prices internationally.   For 1872, Young (1875) and the Massachusetts Bureau of Statistics of Labor (1874) fit these specifications.  In particular, these sources provide rents and clothing prices, which are missing from other studies.

The Board of Trade (1908, 1909, 1910, and 1911) collected price data for the UK, Germany, France, Belgium and the US for food, rent and fuel and lighting for a large sample of cities for years around 1910.  For other countries, we rely on the dominion reports from Australia, Canada and South Africa along with BLS (1915) supplemented by other contry sources.   The dominion studies differ from the Board of Trade in that they did not collect their own price data.  Rather, they made matches from retail price data after correcting for unit differences etc.  Not all price data refer to 1910.  When prices relate to a different year, we project them to 1910 using disaggregated components of the CPI or wholesale price indices when we could not find the required CPI breakdown. Absent such data, we use the overall CPI.

**Food Prices**

We collected prices for wheat, rye and corn flour, beef, mutton, pork, milk, butter, cheese, potatoes sugar, tea and coffee. We follow Gilbert and Kravis (1954) and assume equal food quality. For some cases, food quality clearly differs but we were unable to adjust.

Our sources are:

**Australia**: 1872: Wood (1901). Coghlan (1904).
1910: Australia (1912) – simple average of prices for Sydney, Melbourne, Brisbane, Adelaide, Perth and Hobart. Board of Inquiry into the Cost of Living (1915).
**Belgium**: 1872. Massachusetts Bureau of Statistics of Labor (1874).
1910: Great Britain. Board of Trade (1910).
**Canada**: 1872. Young (1875), pp. 834-838.
1910: Board of Inquiry into the Cost of Living (1915).
**Denmark**: 1872: Massachusetts Bureau of Statistics of Labor (1874).
1910: BLS (1915). Australia (1912).
**France**: 1872. Massachusetts Bureau of Statistics of Labor (1874).
1910: Great Britain. Board of Trade (1909). Australia (1912) and BLS (1915).
**German**y: 1872. Massachusetts Bureau of Statistics of Labor (1874).
1910: Great Britain. Board of Trade (1908). Australia (1912) and BLS (1915).
**Italy**: 1872.Young (1875), pp. 630-631.
1910. Australia (1912) and BLS (1915).
**Netherlands**: 1872: Great Britain Foreign Office (1870, 1871) simple average of prices in Deventer, Rotterdam, the Hague and Amsterdam.
1910: Australia (1912) and Board of Inquiry into the Cost of Living (1915).
**Norway**: Great Britain. Foreign Office (1871), pg. 394.
1910: BLS (1915).
**Sweden**: 1872: Young (1875), pg. 860.
1910: BLS (1915), Institute for Social Sciences (1937), Table 27.
**Switzerland**: 1872: Massachusetts Bureau of Statistics of Labor (1874).
1910: BLS (1915) and Studer (2008).
**The UK**: 1872. Massachusetts Bureau of Statistics of Labor (1874).
1910. Board of Trade (1911) and Prest (1954).
**US**: 1872: Kloft (1995), pp. 476-647. (The original source is the Weeks Report) and Young (1875).
1910: Great Britain. Board of Trade (1911). Prest (1954).

**Rent**

Rents per room.  Young (1975) for 1872 and the Board of Trade for the 1900's

compare rents for workers dwellings.  The South African Report (South Africa (1914))

provides working class rents for a wider sample.  So far, we have not found usable 1910

rent data for Denmark or the Netherlands.  For these countries, we use a quantity

comparison based on persons per room derived from information from Floud *et al.*

(2011) with a UK base.

The rent sources are:

**Australia**: 1872 - Butlin (1962), page 238.  Average rents per room.
1910:  Australia (1912), Board of Inquiry into the Cost of Living (1915).
**Belgium**:  1872: Massachusetts Bureau of Statistics of Labor (1874).
1910: Great Britain. Board of Trade (1910).
**Canada**: 1872: Young (1875).
1910:  Board of Inquiry into the Cost of Living (1915).
**Denmark**: 1872: Massachusetts Bureau of Statistics of Labor (1874).
1910: Quantity comparison using persons per room from Floud *et al.* (2011) Table 5.7
page 570.
**France**: 1872: Massachusetts Bureau of Statistics of Labor (1874).
1910:  Great Britain. Board of Trade (1909).
**German**y: 1872: Massachusetts Bureau of Statistics of Labor (1874).
1910:  Great Britain. Board of Trade (1908).
**Italy**: 1872: Young (1875), pp. 630-631.
1910:  Williamson (1995).
**Netherlands**: 1872: Young (1875).  Estimates refer to 1875.
1910:  Quantity comparison using persons per room from Floud *et al.* (2011) Table 5.
7 page 570.
**Norway**: 1872: Young (1875). Rents for Christiana.
1910:  Board of Inquiry into the Cost of Living (1915).
**Sweden**: 1872:  Young (1875), pg. 860.
1910:  BLS (1915)
**The UK**: 1872:  Massachusetts Bureau of Statistics of Labor (1874).
1910: Great Britain. Board of Trade (1911).
**US**: 1872: Kloft (1995), pp. 476-647 and Young (1875).
1910: Great Britain: Board of Trade (1911).

**Fuel and Light**

For 1872, we calculate the fuel and light price level as a weighted average of

relative coal, wood and coal oil prices (as available) for 1872.  The 1910 benchmark uses

coal and kerosene.  So far, we have not located  fuel prices for the Netherlands or

Norway.

The sources are:

**Australia:** 1872: Second Annual report of the Ohio Bureau of Statistics of Labor (1879),
pg. 321. Price of coal is for 1876.
1910  Australia (1912).
**Belgium**: 1872: Massachusetts Bureau of Statistics of Labor (1874).
Great Britain: Board of Trade (1910).
**Canada**: 1872:  Young (1875), pp. 834-838.
1910:  Board of Inquiry into the Cost of Living (1915).
**Denmark**: 1872:  Massachusetts Bureau of Statistics of Labor (1874).
1910:  BLS (1915).
**France**: 1872:  Massachusetts Bureau of Statistics of Labor (1874).
1910:  Great Britain. Board of Trade (1909).
**German**y: 1872:  Massachusetts Bureau of Statistics of Labor (1874).
1910:  Great Britain. Board of Trade (1908).
**Italy**: 1872: Young (1875), pp. 630-631.
1910:  BLS (1915)
**Netherlands**: 1872: Substitute Belgian Prices.
1910: Substitute Belgian prices.
**Norway**: 1872:  Substitute Swedish Prices.
1910:  BLS (1915).
**Sweden**: 1872. Young (1875), pg. 860.
1910:  BLS (1915).
**Switzerland**: 1872: Massachusetts Bureau of Statistics of Labor (1874).
1910: BLS (1915).
**The UK**: 1872:  Massachusetts Bureau of Statistics of Labor (1874).
1910:  Prest (1952) and Great Britain. Board of Trade (1911).
**US**: 1872: Kloft (1995), pp. 476-647 and Young (1875).
1910:  Great Britain. Board of Trade (1911)

**Clothing - 1872**

It is a challenge to compare price for heterogeneous items such as clothing. Fortunately, Young (1875) provides prices for comparable items for 1872. His price data covers textiles rather than finished items of clothing. The drawback with his estimates is that they, implausibly, show clothing prices in Europe above the US. We suspect that the explanation lies in quality differences between American and Europe.[38] In other words, the lower US prices reflect lower US quality.

To form a clothing benchmark, we assume that quality is constant across Europe allowing us to compare clothing prices for Europe and the UK using Young (1875). Next, we obtain the UK/US price level from independent sources and adjust Young's (1875) estimates for all other countries based on the comparisons with the UK.

**US and UK** : We estimate the UK/US clothing price benchmarks using the sources outlined by Ward and Devereux (2003). The UK/US clothing index is 71 in 1872.
**Australia**: Thomas (1995), Table 4 estimates that clothing prices in Australia were 28 percent above the UK in 1891. We assume that this ratio also holds for 1872.
**Belgium, Canada, France, Italy, Germany, Netherlands, Switzerland and Sweden** : The Massachusetts Bureau of Statistics of Labor (1874) and Young (1875). We use the geometric mean of textile prices relative to the UK.
**Netherlands**: We adjust the UK/US relative price using the average level of duties on manufactured products in 1875 from Bairoch (1989), pg. 42.
**Norway**: Sweden*.*

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[38] Taussig (1931) notes that the US tariff structure in the late nineteenth century led to US production of "standardized fabrics of medium grade". Higher quality in Europe would explain the higher European prices for fabrics.

**Clothing - 1910**

For 1910, the UK/US clothing relative is the weighted average of cotton and wool/worsted relative prices for the UK and US as taken from the US tariff commission (US House of Representatives (1912a, 1912b) as described in Ward and Devereux (2003). We obtain relative clothing prices for other countries by adjusting the UK price with tariff rates on clothing manufactures exported from the UK. The tariff rates are from Webb (1911), pg. 102. This assumes that mark-up are constant across economies, which is unlikely to be the case

**Domestic Service**

We compare average yearly wages for live in domestic servants where we adjust weekly wages to a yearly basis by assuming a fifty-week year. In addition, we adjust cash earnings to account for board and lodging. For the US, the UK, Canada and Australia, we raise yearly cash earnings by fifty percent. For other economies, we increase yearly cash earnings by one hundred percent.

The sources of yearly cash earnings for 1872 are:

**Belgium, Denmark, France, Italy, Germany and Switzerland**: US Bureau of Labor (1900). French wages are for 1873.
**Canada, Norway and Sweden**: Young (1875). For 1873.
**US**: Lebergott (1964)
**UK**: Ward and Devereux (2003).
**Netherlands**: US House of Representatives (1879). Wages are for 1878.

The sources of yearly earnings for 1910 are:

**US**: Hansen and Douglas (1930), pp. 47-50.  We convert weekly wages in Chicago to a US average using Lebergott's (1964) 1900 benchmark.
**UK**: Ward and Devereux (2003).
**All other countries**: US Bureau of Labor (1900). Servants' wages for 1891-1899.  We assume that the relative levels also hold for 1910.

## The Investment Price Benchmarks

The investment price level compares prices for construction and for equipment

and machinery.

## Construction - 1872

The construction sub-index is an equally weighted index of relative materials'

prices and relative nominal wages.  We determine materials prices for the UK, US and

Germany using wholesale price data for pig iron, bar iron, steel and lead.  For the other

economies, we determine prices using tariff rates and transport costs from the UK taken

Bairoch (1989).

The sources for the wholesale price data are:

**US**:  1872*: Pig Iron (average of Foundry and Gray Forge Pig Iron); Bessemer Steel Rails, Iron Rails, Bessemer Pig Iron - Temin (1964), pp. 284-285
Bar Iron – best refined rolled – US Congress (1893)
Lead, pig – US Congress. Senate. (1893).
**UK**: 1872*: Pig Iron (average of Cleveland and Scottish Pig Iron) - Mitchell (1971)
Swedish bar Iron - US Congress, (1893)
Lead, English pig – US Congress (1893). United States War Industries Board (1919)
Iron and Steel Rails - Carr and Taplin (1962).  McCloskey (1973)
Bessemer Pig Iron - Carr and Taplin (1962); McCloskey (1973)
**Germany**: 1872: Pig iron, bar iron, lead: US Congress (1893), pp. 257-278.
Germany/US relative price of steel rails, 1881-1890: Allen (1979), Table 1.

We obtain relative materials prices for countries outside the UK, the US and

Germany by adjusting the UK prices to allow for transport costs and tariffs.  Bairoch (1989)

provides transport costs for bar iron and manufactured iron goods for overland transport.

He estimates the costs of a transatlantic crossing in 1850 and 1880.  Bairoch also provides

average tariff levels on manufactured goods for the 1870's.  For Belgium, Denmark, France,

Italy, the Netherlands, Norway, Sweden and Switzerland transport costs are the costs of

overland transport.  The cost of overland transport for 1872 is a weighted average of

overland transport costs in 1850 and 1880.

For Canada and Australia, we use transport costs for a transatlantic crossing.  In the

case of Australia, we add an additional fifteen percent to cover the additional distance.

The second component of the construction benchmark is wages.   Wages for 1872

are the average of weekly wages for blacksmiths, bricklayers, carpenters, masons, laborers

and painters from the Bureau of Labor (1900).  We supplement the Norwegian and Swedish

wages with data from Young (1875).   Swedish wages refer for 1873 while Norwegian wages

refer to 1871.  Australian wages refer to 1876.  We convert foreign wages from US gold to

US dollars using the gold/dollar market exchange rate.


**Construction - 1910**

The materials price index for 1910 is a geometric mean of the relative prices of

copper, iron, lead, steel, and tin. The comparisons for the UK, Canada, and the Netherlands

rely on 1905 price data projected to 2010.  All other comparisons refer to 1913 projected

backwards to 1910.  We use Norwegian prices for Sweden.  We use Dutch prices for

Belgium.   The sources are:

**Canada**: Board of Inquiry into the Cost of Living (1915).
**Netherlands**: http://www.iisg.nl/hpw/data.html
**Australia, Denmark, France, Germany, Italy**: "International Price Comparisons" (1919), a price bulletin compiled by the United States War Industries Board as part of *A History of Prices during the War.* The bulletin provides comparable wholesale prices for a wide variety of items in 1913.
**UK**: Pig Iron (average of Cleveland and Scottish Pig Iron) - Mitchell (1971)
Lead, Copper, and Tin –United States War Industries Board (1919)
Iron and Steel Rails - Carr, and Taplin (1962).  McCloskey (1973)
Bessemer Pig Iron - Carr and Taplin (1962); McCloskey (1973)
**US**: Pig Iron (average of Foundry and Gray Forge Pig Iron); Bessemer Steel Rails, Bar iron, Bessemer Pig Iron - Temin (1964), pp. 284-285
Lead, Copper and Tin –United States War Industries Board (1919).

The nominal wages in the wage benchmark are the average of (as available) carpenters,

bricklayers, masons, plumbers, plasterers, painters and laborers.  The sources for these

nominal wages are below:

**Australia and Canada**: Board of Inquiry into the Cost of Living (1915)
**Belgium, France, Germany, the US**, and the **UK**: Great Britain. Board of Trade (1908-1911)
**Denmark and Norway**: Great Britain. Board of Trade (1911).
**Italy and Sweden**: Williamson (1995), Table A3.1.  Average of skilled and unskilled building wages.
**Netherlands**: Zamagni (1995), table A. 8.  Daily wages converted to weekly wages by assuming a 5.5 days per week.

*Equipment and Machinery – 1872*

Equipment and machinery relative prices for the UK and US are relative prices of

iron and steel described earlier.  The German relative price for 1872 is the average of a

comparison based on wholesale prices and tariff rates.  We obtain equipment and

machinery relative prices for the other countries by adjusting UK prices with tariff rates and

transport costs for manufactured iron goods from Bairoch (1989).

### Equipment and machinery- 1910

The equipment and machinery relative price is the geometric mean of relative

iron and steel prices from the construction sources outlined previously.

### Government

The government price index is a weighted average of relative nominal wages and

goods and services' relative prices.  We follow the procedures described by Gilbert and

Kravis (1954), pp. 197-199.  The price index for goods and services is the geometric

mean of rent along with the fuel and light relative prices, which we take from the

consumption relative prices.

### 4.	Urban-Rural Adjustments

The retail price data refer to urban prices.  We adjust for urban/rural price

differences to approximate the national prices required by the ICP.  The evidence we

uncovered suggests price differences during the years covered by our benchmarks were

marked only for food and rent.

The sources for urban/rural price differences are:

**Canada:** Bellerby (1956) estimates urban/rural prices differences for food, clothing, fuel and rent in 1949. He finds that rent was 70 percent more expensive in urban areas, and food prices were roughly equal. Based on evidence from other countries, we assume that food prices for 1872 were ten percent lower in rural areas.

**Denmark**: US House of Representative (1885), pg. 1328 suggests that the price difference in 1884 for rent between rural areas and provincial towns is 212.5. Webb (1911) provides information on food prices for 1905. The urban/rural price ratio for food in 1905 is 115.

**Germany**: Young (1875), pp. 493-494 estimates rents in urban areas at approximately twice rural rents in the early 1870s. Urban food prices are approximately fifteen percent above rural prices. US House of Representatives (1879), pg. 222 show that urban food prices are approximately 25 percent above rural food prices.

**France**: Sisic (1992) provides estimates of the overall urban/rural price level at 108 in 1852 and 117 in 1892.

**Sweden**: Young (1875), pg. 681 finds that the cost of subsistence in villages was 25% lower than in towns. Bellerby (1956) estimates of the overall urban/rural price level in 1905-1910, 1934 and 1941. For all years, urban prices were approximately ten percent higher than rural prices.

**UK:** Hunt (1973) and Bellerby (1956).

**US:** Hatton and Williamson (1991), Bellerby (1956), Koffsky (1946) and Reid (1946).

**Australia:** Despite a wealth of price data from the various Coughlin studies, we have been unable to find data that allows us adjust for urban/rural differences though we suspect that they were significant.

**Italy, the Netherlands, Norway** and **Switzerland**: We found no estimates of urban rural price differences for these countries and we assume that urban food prices are ten percent higher than rural prices, and urban rents are twice rural rents.


In sum, the evidence on urban/rural differentials for the late nineteenth and early twentieth century's suggests that differences are important for food and rent and that differences were similar across economies.[39]

We determine national retail prices ($P_N$) for food and rent for each country using equation (2).

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[39] These estimates are similar to the results for recent decades. For example, Deaton and Dupriez (2011) finds price level differences across various economies for recent years that are similar to our estimates for the Western economies at the end of the nineteenth century.

(2)    $P_N = uP_U + (1-u)P_R$

Where $P_U$ and $P_R$ are the urban and rural retail prices and u and (1-u) are the

proportions of the population living in urban and rural areas respectively.


**Urbanization Rates**

We define urbanization as the ratio of the urban population (towns with a

population greater than 5,000) to the civilian resident population.  Bairoch and Goertz

(1986) page 288 provide urbanization rates in selected decades between 1850 and

1910.  Table 2(a) lists our assumptions about the urban-rural price differences for food

and rent, as well as urbanization rates.

## Table 2(a)

## Urban/ Rural Adjustment for Food and Rent. ($P_{rural} = 1$)

### 1872

| | Food | Rent | Urbanization (% of the population in urban areas) |
|---|---|---|---|
| Australia | 1.2 | 2.0 | 22.0 |
| Belgium | 1.1 | 2.0 | 40.5 |
| Canada | 1.1 | 1.7 | 13.5 |
| Denmark | 1.2 | 2.0 | 20.8 |
| France | 1.1 | 2.0 | 25.4 |
| Germany | 1.2 | 2.2 | 25.3 |
| Italy | 1.1 | 2.0 | 26.7 |
| Netherlands | 1.1 | 2.0 | 41.5 |
| Norway | 1.1 | 2.0 | 13.7 |
| Sweden | 1.3 | 2.0 | 11.2 |
| Switzerland | 1.1 | 2.0 | 18.0 |
| UK | 1.0 | 2.1 | 51.8 |
| US | 1.2 | 2.4 | 19.7 |

# Table 2(a)

## Urban/ Rural Adjustment for Food and Rent. ($P_{rural}$ = 1)

### 1910

| | Food | Rent | Urbanization (% of the population in urban areas) |
|---|---|---|---|
| Australia | 1.2 | 2.0 | 41.6 |
| Belgium | 1.1 | 2.0 | 56.6 |
| Canada | 1.0 | 1.7 | 41.6 |
| Denmark | 1.2 | 2.0 | 35.9 |
| France | 1.2 | 1.2 | 38.5 |
| Germany | 1.2 | 2.2 | 48.0 |
| Italy | 1.1 | 2.0 | 40.0 |
| Netherlands | 1.1 | 2.0 | 50.5 |
| Norway | 1.1 | 2.0 | 25.1 |
| Sweden | 1.1 | 2.0 | 22.6 |
| Switzerland | 1.1 | 2.0 | 37.1 |
| UK | 1.0 | 2.7 | 69.2 |
| US | 1.3 | 2.0 | 41.6 |

5. **Quantities**

We adopt quantity/unit value measures for items where we do not have price data (as in the case of alcohol) or for comparison resistant services such as education.  In addition, we have price and quantitative indicators for other items most notably food.  For housing, we have 1910 quantity data for Europe from Floud *et al.* (2011).

The estimates refer to years around the benchmarks.

**Alcohol**

We measure consumption as beer, wine and spirits consumed in US gallons.  We rely on standard sources for the US and the UK– The Historical Abstracts for the US and Prest (1954) for the UK.

1872:  We take cross-country data from Pinella (2014), Rowntree and Sherwell (1899) and Mulhall (1899).  Useful country sources for 1872 include Firestone (1958) for Canada, Allamani and Prina (2007), ISAT (1976) for Italy and Gould (1894) for Sweden.

1910: we use the Board of Trade (1906, 1911) for all countries.

We compare alcohol consumption in two ways.  First, we use US prices from Ward and Devereux (2003) to value consumption, as we do not have consistent price data for other countries.  Second, we measure consumption in terms of alcohol where we set the alcohol content of beer at 0.05, wine at 0.125 and spirits at 0.4.  The measures agree for most cases. The exceptions are the wine consumers - France, Switzerland and Italy.   Here the price measure yields a much higher consumption.  Of course, their average quality of wine consumed did not approach that for the US and hence US wine prices will overstate consumption.  To

construct the quantity index, we assume that wine quality is the same in all countries outside of France, Switzerland Italy.  Next, we made a rough adjustment for quality differences by comparing wholesale prices in France with UK import prices.  Finally, note that US prices will likely overstate consumption relative to partner country prices if prices and quantities are negatively correlated.  The final step adjusts for the difference between US and domestic prices by taking average spreads from the Gilbert and Kravis (1954) comparisons for 1950.

**Tobacco**

We measure tobacco consumption by domestic disappearances in lbs. per capita.  The 1910 data are from Hutson (1937) and the Department of Commerce (1915) while Jacobstein (1907), Hannah (2006) and Mulhall (1881, 1899) provide estimates for earlier years.  Firestone (1958) covers Canada.  The 1872 estimates rest on weaker data.  It is also clear that tobacco quality is lower outside of Australia, Canada, the US and the UK but we are unable to adjust for the quality differences.

**Travel**

We measure travel by rail passenger kilometers per capita for 1872 and 1910.  For 1910, we add automobiles.  Our data are from Mitchell (2003a, 2003b) and US historical statistics.  For 1872, we have passenger trips rather than passenger kilometers for some countries.  In these cases, we use the average trip length implied by later data.  Where the information is not available, we make assumptions.  For the UK, we assume that the average trip is sixteen km.  We assume that the Australian average trip equals that for the US.  Finally, the 1872 estimates

for Denmark and the Netherlands refer to 1875 and 1878.  The implicit assumption underlying

the comparisons is that the share of business and other intermediate travel and quality is

similar across economies.

We do not have automobile sales for 1910.  We therefore assume that expenditure on

cars is proxied by cars per capita.


**Communications**

We form a quantity index for 1872 with data on pieces of mail and telegraphs sent per

capita.  The 1910 index is an unweighted average of mail, telegraphs and telephones per capita.

Our sources are Banks (1971) and the US Postmaster General (1914) for mail.  For telephones

per capita, we rely on the US Postmaster General (1914) and Wallsten (2001).  These data do

not distinguish between consumption and intermediate use.  We assume that this ratio is the

same for all economies.


**Education**

Following the ICP, we use a quantity comparison.  In our case, we compare primary

pupils per one thousand people.  The data come from the online appendices to Lindert (2004).

We experimented with other comparisons including secondary and third level enrollments

without changing the results.

**Food**

      We collected data on disappearances of wheat and rye flour, corn meal, beef, mutton and pork, butter, cheese, milk, coffee, tea and sugar. Ideally, these data would come from food balance sheets. Consumption data for sugar, coffee and tea is available for all countries. For most countries, complete food balance sheets are still unavailable. We have information for Australia, Canada, Italy, the US and the UK covering most food items. There is data on cereals and meat for France, Germany the Netherlands and Sweden. There are gaps for other countries, particularly for 1872. Even where these data exist, we suspect that the margins of error for items such as potatoes and milk are considerable

      Turning to sources, Crawford (1899), Webb (1911) and Mulhall (1899) provide comparative estimates for early years. Where these data are not available, we projected our 1910 estimates to 1872 using data from Mulhall (1899) or other sources.

      There is a wide range of comparative sources for 1910. Webb (1911) provides cross-country data for many items. Yeats (1960) provides complete balance sheets for Belgium, France, Germany, Switzerland and the UK. Pirtle (1922) provides comparative data on dairy products, Holmes (1916) covers meat and Bennett (1933) covers wheat flour. The League of Nations (1937) also provides comparative data for many items.

      The following country sources are helpful:

**Australia**: Coghlan (1904).
**Canada**: Urquhart (1993) and Board of Inquiry into the Cost of Living (1915).
**Italy**: ISTAT (1976).
**Netherlands**: Van Zanden and Van der Veen (1989).
**Sweden**: Sundbärg (1904) and Institute for Social Sciences (1937).
**UK**: Prest (1954) and Floud *et al* (2011).

**US**: Bennett and Peirce (1961) and Floud *et al* (2011).

6.      **Sectoral Productivity**

The data necessary to implement complete GDP comparisons from the output

side are not available.  Nonetheless, by making plausible assumptions about sectoral

productivity we can provide a rough estimate of comparative income per capita.  For

reasons of space, we focus on 1872 but the results also extend to 1910.

We break the economy into three sectors, agriculture, manufacturing and the

rest of the economy.  Table 4a illustrates the approach.  The first column gives output

per worker in agriculture for 1872 relative to the US.   The UK/US estimate is from Ward

and Devereux (2005).  For other countries, save Belgium, we rely on Van Zanden (1991)

with a rough adjustment of his gross output estimates to a value added basis.  For

Belgium, we use Bairoch (1973) as the Van Zanden (1991) estimates appear to us to be

low.  We do not have 1870 agricultural output comparisons for Canada or Australia.

The Table shows US output per worker in agriculture at generally more than

twice European levels.[40] The estimates are believable given higher levels of land, horses

and machinery per worker in the US.[41]

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[40] The comparison of output per worker for agriculture, particularly for Europe, is complicated by the differences in how agricultural labor is measured.  While this distorts our measures of output per worker in agriculture it does not matter for income per capita since we use the same labor force to calculate overall output per worker for the current price benchmarks and the sectoral comparisons.

[41] The Van Zanden European rankings are similar, for the most part, with Federico (2004) and Bairoch (1973, 1992).  Our UK/US rankings agree with those of Hayami and Ruttan (1971, 1985) and Bairoch (1992) if we use comparable labor force data and agricultural output adjusted to a value added basis. Broadberry (1997) finds higher relative UK output for agriculture.  He obtains his result because his 1908 benchmark uses British rather than UK value added and because he greatly understates US value added. For further details along with reconciliation with the Broadberry estimates with theirs see Ward and

Next is manufacturing.  Broadberry (1997) shows that US output per worker is twice UK levels for this period.  We assume that manufacturing output per worker for the other economies is at most half US levels.  For the remaining sectors, we assume that labor productivity is equal to the US.  This conjecture overstates the situation for Europe whether output per worker in sectors such wholesale/retail trade and transportation is well below US levels.  We adopt the assumption to provide an upper bound on output per worker.

Using these conjectures along with information on sectoral labor force shares as well as US sectoral output shares, we compute overall output per worker in US prices.  Keep in mind that by valuing output at US prices we overstate GDP for all countries as compared to the Fisher Ideal measure.[42]

Column five in Table 4a provides the resulting GDP per worker.  The expenditure based current price estimates of GDP per worker, also in US prices, are in column six.  For most cases, there is a reasonable correspondence between the current price GDP benchmarks and the conjectural upper bound.  Indeed, the current price benchmarks are above the conjectural estimates for Belgium, Germany and the Netherlands suggesting that, if anything, the current price estimates overstate income relative to the US.

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Devereux (2005).  Woltjer (2015) provides more recent discussion of UK/US agriculture also finding a large US lead for 1910.

[42] We do not have the data required to compare GDP with Fisher Ideal indices.

Table 4a

Comparing Output per Worker around 1870 using Sectoral Productivity

_____

| Country | Agriculture | Manufacturing | Services etc | GDP per worker in US prices implied by Sectoral Productivity | Expenditure Based GDP Per Worker in US Prices |
|---|---|---|---|---|---|
| Belgium | 0.42 | 0.50 | 1.00 | 0.59 | 0.65 |
| Denmark | 0.41 | 0.50 | 1.00 | 0.52 | 0.55 |
| France | 0.46 | 0.50 | 1.00 | 0.52 | 0.54 |
| Germany | 0.42 | 0.50 | 1.00 | 0.51 | 0.63 |
| Italy | 0.26 | 0.50 | 1.00 | 0.31 | 0.24 |
| Netherlands | 0.35 | 0.50 | 1.00 | 0.59 | 0.71 |
| Norway | 0.56 | 0.50 | 1.00 | 0.56 | 0.46 |
| Sweden | 0.31 | 0.50 | 1.00 | 0.34 | 0.45 |
| Switzerland | 0.39 | 0.50 | 1.00 | 0.57 | 0.56 |
| UK | 0.56 | 0.50 | 1.00 | 0.83 | 0.81 |
| US | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

_____

*Notes and Sources*: Gross output per agricultural worker for all economies except the Belgium, the UK and the US is from an unpublished appendix to Van Zanden (1991).  We adjust his estimates to a value added basis using estimates of non-agricultural inputs from Federico (2004).  For the US and UK, we calculate relative GDP per worker using nominal value added and farm gate price benchmarks from Ward and Devereux (2005).  For Belgium, we use Bairoch (1973).  We calculate aggregate GDP per worker using the above estimates of sectoral labor productivity in US prices.  Our US GDP sectoral shares are from Gallman (1960) and Gallman and Weiss (1969).  These estimates refer to 1870.  *Labor Force:* The sectoral distribution of the labor force for all economies is from Mitchell (2003a, 2003b).  The estimates for agriculture labor differ across economies. The expenditure based estimates refer to 1872.  They are in US prices.

It is easy to show that there are sharp differences between the upper bounds in Table 4a and output per worker implied by the Maddison projections. The differences are largest for Netherlands and Switzerland where the projections show output per worker of 0.94 and 0.85 as compared to the upper bounds in Table 4a of 0.59 and 0.57.

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Table 2a
Expenditure Weights - 1872

| | Australia | Belgium | Canada | Denmark | France | Germany | Italy | Neth | Norway | Sweden | Switz | UK | US |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wheat Fl | 0.050 | 0.102 | 0.064 | 0.037 | 0.127 | 0.045 | 0.192 | 0.053 | 0.056 | 0.022 | 0.098 | 0.062 | 0.051 |
| Rye flour | 0.002 | 0.018 | 0.004 | 0.114 | 0.031 | 0.067 | 0.004 | 0.059 | 0.073 | 0.059 | 0.009 | 0.001 | 0.002 |
| Corn Meal | 0.002 | 0.001 | 0.004 | 0.002 | 0.002 | 0.003 | 0.049 | 0.002 | 0.002 | 0.002 | 0.001 | 0.000 | 0.013 |
| Beef | 0.056 | 0.050 | 0.040 | 0.039 | 0.048 | 0.031 | 0.051 | 0.055 | 0.036 | 0.079 | 0.045 | 0.044 | 0.045 |
| Mutton | 0.031 | 0.015 | 0.011 | 0.014 | 0.013 | 0.002 | 0.009 | 0.004 | 0.013 | 0.002 | 0.011 | 0.027 | 0.007 |
| Pork | 0.011 | 0.030 | 0.040 | 0.021 | 0.029 | 0.063 | 0.050 | 0.053 | 0.027 | 0.030 | 0.037 | 0.029 | 0.062 |
| Eggs | 0.012 | 0.023 | 0.014 | 0.006 | 0.012 | 0.006 | 0.027 | 0.023 | 0.010 | 0.017 | 0.009 | 0.012 | 0.012 |
| Fresh Milk | 0.028 | 0.019 | 0.023 | 0.037 | 0.034 | 0.034 | 0.035 | 0.036 | 0.045 | 0.040 | 0.042 | 0.021 | 0.013 |
| Butter | 0.022 | 0.036 | 0.044 | 0.031 | 0.033 | 0.021 | 0.010 | 0.039 | 0.034 | 0.036 | 0.015 | 0.028 | 0.027 |
| Cheese | 0.004 | 0.015 | 0.009 | 0.012 | 0.009 | 0.008 | 0.032 | 0.016 | 0.039 | 0.011 | 0.015 | 0.015 | 0.003 |
| Patatoes | 0.016 | 0.033 | 0.023 | 0.014 | 0.036 | 0.023 | 0.018 | 0.043 | 0.034 | 0.037 | 0.022 | 0.023 | 0.018 |
| Tea | 0.019 | 0.002 | 0.025 | 0.002 | 0.000 | 0.000 | 0.005 | 0.010 | 0.004 | 0.000 | 0.002 | 0.014 | 0.009 |
| Coffee | 0.001 | 0.038 | 0.006 | 0.025 | 0.023 | 0.011 | 0.011 | 0.030 | 0.025 | 0.015 | 0.010 | 0.002 | 0.012 |
| Sugar | 0.035 | 0.033 | 0.039 | 0.029 | 0.019 | 0.014 | 0.014 | 0.015 | 0.044 | 0.021 | 0.008 | 0.022 | 0.028 |
| Rent | 0.121 | 0.081 | 0.134 | 0.112 | 0.075 | 0.091 | 0.050 | 0.069 | 0.135 | 0.126 | 0.091 | 0.085 | 0.117 |
| Fuel/Light | 0.036 | 0.030 | 0.044 | 0.067 | 0.034 | 0.042 | 0.028 | 0.037 | 0.046 | 0.072 | 0.042 | 0.075 | 0.027 |
| Clothing | 0.151 | 0.121 | 0.138 | 0.112 | 0.099 | 0.097 | 0.075 | 0.149 | 0.098 | 0.123 | 0.097 | 0.160 | 0.151 |
| Alcohol | 0.094 | 0.081 | 0.039 | 0.082 | 0.148 | 0.108 | 0.132 | 0.047 | 0.041 | 0.067 | 0.108 | 0.127 | 0.067 |
| Tobacco | 0.016 | 0.020 | 0.015 | 0.019 | 0.017 | 0.014 | 0.016 | 0.019 | 0.009 | 0.014 | 0.014 | 0.014 | 0.018 |
| Domestics | 0.027 | 0.051 | 0.020 | 0.022 | 0.027 | 0.014 | 0.019 | 0.028 | 0.027 | 0.034 | 0.014 | 0.032 | 0.030 |
| Travel | 0.030 | 0.020 | 0.032 | 0.030 | 0.022 | 0.027 | 0.019 | 0.028 | 0.012 | 0.008 | 0.027 | 0.014 | 0.013 |
| communications | 0.013 | 0.008 | 0.010 | 0.007 | 0.007 | 0.007 | 0.005 | 0.014 | 0.007 | 0.004 | 0.007 | 0.002 | 0.008 |
| Education | 0.027 | 0.020 | 0.030 | 0.022 | 0.017 | 0.020 | 0.009 | 0.019 | 0.027 | 0.029 | 0.020 | 0.045 | 0.030 |
| | | | | | | | | | | | | | |
| Investment | 0.153 | 0.101 | 0.142 | 0.096 | 0.099 | 0.193 | 0.099 | 0.101 | 0.114 | 0.107 | 0.193 | 0.097 | 0.204 |
| Government | 0.042 | 0.052 | 0.052 | 0.045 | 0.041 | 0.060 | 0.041 | 0.052 | 0.038 | 0.044 | 0.060 | 0.050 | 0.036 |

| | Australia | Belgium | Canada | Denmark | France | Germany | Italy | Neth | Norway | Sweden | Switz | UK | US |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wheat Fl | 0.049 | 0.082 | 0.045 | 0.046 | 0.116 | 0.030 | 0.153 | 0.036 | 0.061 | 0.032 | 0.074 | 0.074 | 0.035 |
| Rye flour | 0.002 | 0.038 | 0.000 | 0.077 | 0.006 | 0.042 | 0.003 | 0.034 | 0.053 | 0.045 | 0.007 | 0.001 | 0.001 |
| Corn Meal | 0.002 | 0.001 | 0.000 | 0.002 | 0.001 | 0.002 | 0.058 | 0.002 | 0.001 | 0.002 | 0.001 | 0.001 | 0.004 |
| Beef | 0.071 | 0.040 | 0.038 | 0.045 | 0.059 | 0.039 | 0.049 | 0.053 | 0.054 | 0.047 | 0.062 | 0.062 | 0.046 |
| Mutton | 0.041 | 0.010 | 0.007 | 0.014 | 0.013 | 0.004 | 0.009 | 0.005 | 0.020 | 0.001 | 0.014 | 0.026 | 0.008 |
| Pork | 0.011 | 0.033 | 0.036 | 0.027 | 0.035 | 0.078 | 0.055 | 0.055 | 0.034 | 0.049 | 0.044 | 0.042 | 0.034 |
| Eggs | 0.014 | 0.021 | 0.033 | 0.017 | 0.021 | 0.016 | 0.026 | 0.027 | 0.015 | 0.018 | 0.014 | 0.020 | 0.028 |
| Fresh Milk | 0.035 | 0.030 | 0.027 | 0.050 | 0.031 | 0.037 | 0.045 | 0.025 | 0.043 | 0.053 | 0.052 | 0.025 | 0.032 |
| Butter | 0.025 | 0.035 | 0.042 | 0.038 | 0.024 | 0.033 | 0.010 | 0.031 | 0.043 | 0.031 | 0.022 | 0.041 | 0.029 |
| Cheese | 0.004 | 0.011 | 0.011 | 0.009 | 0.014 | 0.008 | 0.027 | 0.014 | 0.023 | 0.006 | 0.016 | 0.011 | 0.004 |
| Patatoes | 0.018 | 0.029 | 0.014 | 0.017 | 0.023 | 0.020 | 0.020 | 0.031 | 0.031 | 0.035 | 0.018 | 0.018 | 0.016 |
| Tea | 0.015 | 0.000 | 0.008 | 0.001 | 0.000 | 0.000 | 0.000 | 0.011 | 0.003 | 0.000 | 0.001 | 0.021 | 0.002 |
| Coffee | 0.001 | 0.014 | 0.004 | 0.019 | 0.021 | 0.012 | 0.017 | 0.047 | 0.026 | 0.022 | 0.011 | 0.002 | 0.012 |
| Sugar | 0.034 | 0.018 | 0.019 | 0.028 | 0.015 | 0.011 | 0.019 | 0.018 | 0.044 | 0.035 | 0.018 | 0.023 | 0.016 |
| Rent | 0.099 | 0.102 | 0.137 | 0.115 | 0.115 | 0.118 | 0.076 | 0.106 | 0.105 | 0.111 | 0.118 | 0.112 | 0.158 |
| Fuel/Light | 0.032 | 0.039 | 0.044 | 0.069 | 0.053 | 0.056 | 0.028 | 0.055 | 0.041 | 0.032 | 0.056 | 0.042 | 0.031 |
| Clothing | 0.148 | 0.121 | 0.150 | 0.115 | 0.116 | 0.100 | 0.075 | 0.108 | 0.133 | 0.153 | 0.100 | 0.112 | 0.120 |
| Alcohol | 0.086 | 0.083 | 0.054 | 0.062 | 0.067 | 0.059 | 0.111 | 0.047 | 0.025 | 0.074 | 0.059 | 0.099 | 0.054 |
| Tobacco | 0.023 | 0.019 | 0.015 | 0.019 | 0.019 | 0.014 | 0.017 | 0.022 | 0.010 | 0.016 | 0.014 | 0.021 | 0.024 |
| Domestics | 0.026 | 0.044 | 0.020 | 0.023 | 0.031 | 0.014 | 0.019 | 0.033 | 0.030 | 0.022 | 0.014 | 0.023 | 0.025 |
| Travel | 0.034 | 0.049 | 0.065 | 0.031 | 0.045 | 0.028 | 0.028 | 0.055 | 0.013 | 0.024 | 0.028 | 0.059 | 0.049 |
| communications | 0.007 | 0.008 | 0.010 | 0.008 | 0.009 | 0.007 | 0.005 | 0.011 | 0.008 | 0.008 | 0.007 | 0.004 | 0.006 |
| Education | 0.026 | 0.019 | 0.029 | 0.023 | 0.022 | 0.021 | 0.009 | 0.022 | 0.030 | 0.032 | 0.021 | 0.016 | 0.025 |
| | | | | | | | | | | | | | |
| Investment | 0.170 | 0.070 | 0.211 | 0.119 | 0.177 | 0.179 | 0.177 | 0.179 | 0.143 | 0.159 | 0.179 | 0.070 | 0.123 |
| Government | 0.075 | 0.091 | 0.074 | 0.079 | 0.055 | 0.071 | 0.055 | 0.071 | 0.086 | 0.087 | 0.055 | 0.091 | 0.094 |

Table 3a
Relative Prices – 1872 (US = 1.00)

| | Australia | Belgium | Canada | Denmark | France | Germany | Italy | Netherlands | Norway | Sweden | Switzerland | UK | US |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wheat Fl | 0.933 | 1.617 | 1.062 | 1.210 | 1.017 | 1.613 | 1.275 | 1.535 | 2.039 | 1.555 | 1.881 | 1.354 | 1.000 |
| Rye flour | 1.466 | 0.922 | 0.871 | 1.331 | 1.910 | 1.759 | 1.061 | 0.773 | 0.947 | 1.153 | 2.369 | 1.586 | 1.000 |
| Corn Meal | 1.058 | 1.835 | 1.261 | 1.525 | 2.333 | 2.452 | 1.064 | 1.610 | 1.567 | 1.398 | 3.272 | 2.013 | 1.000 |
| Beef | 0.578 | 2.129 | 0.790 | 0.996 | 1.140 | 1.608 | 1.593 | 1.552 | 1.057 | 1.186 | 1.403 | 1.891 | 1.000 |
| Mutton | 0.422 | 0.659 | 0.698 | 0.876 | 0.240 | 1.207 | 0.304 | 0.944 | 0.901 | 1.012 | 1.198 | 1.638 | 1.000 |
| Pork | 1.330 | 2.823 | 0.929 | 0.861 | 1.579 | 1.756 | 2.046 | 1.257 | 1.255 | 1.106 | 1.777 | 1.587 | 1.000 |
| Eggs | 1.707 | 2.091 | 0.987 | 0.739 | 0.597 | 0.973 | 0.835 | 2.366 | 1.315 | 1.124 | 1.401 | 1.445 | 1.000 |
| Fresh Milk | 1.380 | 3.162 | 0.858 | 0.436 | 2.945 | 0.701 | 2.532 | 0.959 | 1.032 | 0.921 | 0.731 | 1.248 | 1.000 |
| Butter | 1.053 | 1.150 | 0.826 | 0.871 | 1.362 | 1.107 | 0.489 | 1.322 | 1.746 | 1.051 | 1.085 | 1.176 | 1.000 |
| Cheese | 1.215 | 2.093 | 0.882 | 0.575 | 0.642 | 0.951 | 1.161 | 0.778 | 1.295 | 1.156 | 1.083 | 1.131 | 1.000 |
| Patatoes | 0.886 | 0.560 | 0.516 | 0.426 | 0.476 | 0.635 | 0.780 | 0.598 | 1.164 | 0.708 | 1.044 | 1.575 | 1.000 |
| Tea | 0.463 | 0.934 | 0.739 | 0.506 | 0.313 | 0.881 | 9.048 | 0.478 | 1.026 | 1.037 | 1.243 | 0.705 | 1.000 |
| Coffee | 1.124 | 1.920 | 1.137 | 0.983 | 2.476 | 1.189 | 1.715 | 0.869 | 1.091 | 0.999 | 0.962 | 1.256 | 1.000 |
| Sugar | 0.772 | 1.957 | 0.983 | 1.022 | 0.910 | 1.236 | 1.280 | 1.313 | 1.779 | 0.991 | 1.053 | 0.764 | 1.000 |
| Rent | 2.150 | 1.095 | 0.691 | 0.644 | 0.819 | 0.937 | 0.475 | 1.171 | 0.720 | 1.043 | 0.937 | 0.677 | 1.000 |
| Fuel/Light | 1.196 | 1.332 | 1.110 | 2.210 | 2.030 | 1.283 | 1.577 | 1.332 | 1.142 | 1.142 | 1.283 | 1.028 | 1.000 |
| Clothing | 0.909 | 0.724 | 0.705 | 0.814 | 0.918 | 0.747 | 0.642 | 0.746 | 0.783 | 0.783 | 0.747 | 0.710 | 1.000 |
| Alcohol | 1.779 | 0.381 | 0.412 | 0.281 | 0.400 | 0.435 | 0.396 | 0.316 | 0.632 | 0.276 | 0.433 | 0.756 | 1.000 |
| Tobacco | 1.675 | 1.172 | 0.779 | 0.453 | 0.981 | 0.353 | 0.733 | 0.399 | 0.351 | 0.507 | 0.272 | 1.749 | 1.000 |
| Domestics | 1.320 | 0.500 | 0.720 | 0.500 | 0.500 | 0.466 | 0.434 | 0.470 | 0.326 | 0.330 | 0.466 | 0.810 | 1.000 |
| Travel | 5.055 | 2.608 | 1.647 | 4.119 | 1.586 | 1.771 | 1.853 | 0.808 | 6.970 | 2.129 | 1.299 | 0.831 | 1.000 |
| communications | 2.659 | 0.906 | 1.025 | 0.797 | 0.814 | 0.800 | 0.603 | 1.223 | 1.197 | 0.783 | 0.238 | 0.100 | 1.000 |
| Education | 2.164 | 1.163 | 0.637 | 0.658 | 0.572 | 0.549 | 0.358 | 0.649 | 0.741 | 0.603 | 0.561 | 2.314 | 1.000 |
| | | | | | | | | | | | | | |
| Investment | 1.132 | 0.642 | 0.896 | 0.711 | 0.718 | 0.599 | 0.631 | 0.636 | 0.627 | 0.651 | 0.599 | 0.547 | 1.000 |
| Government | 1.181 | 0.527 | 0.745 | 0.596 | 0.717 | 0.549 | 0.453 | 0.569 | 0.505 | 0.563 | 0.549 | 0.564 | 1.000 |

Note: the food price levels for Belgium, France and Italy are the price levels implied by the quantity comparisons.

Table 3a continued

## Relative Prices – 1910 (US = 1.00)

| | Australia | Belgium | Canada | Denmark | France | Germany | Italy | Netherlands | Norway | Sweden | Switzerland | UK | US |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wheat Fl | 0.845 | 0.821 | 0.996 | 0.949 | 1.415 | 1.112 | 1.116 | 0.931 | 1.108 | 0.978 | 1.505 | 1.233 | 1.000 |
| Rye flour | 1.026 | 1.103 | 1.087 | 0.994 | 1.131 | 1.011 | 1.220 | 1.037 | 0.591 | 1.018 | 1.610 | 1.033 | 1.000 |
| Corn Meal | 1.026 | 0.853 | 1.087 | 0.766 | 0.881 | 1.308 | 0.735 | 0.798 | 0.812 | 1.000 | 1.282 | 0.795 | 1.000 |
| Beef | 0.795 | 0.920 | 1.131 | 1.025 | 1.062 | 1.229 | 1.194 | 1.490 | 1.084 | 0.756 | 1.180 | 1.067 | 1.000 |
| Mutton | 0.567 | 0.864 | 1.068 | 0.822 | 1.051 | 1.362 | 0.936 | 1.163 | 1.028 | 0.823 | 0.990 | 0.876 | 1.000 |
| Pork | 1.062 | 1.246 | 1.185 | 1.065 | 1.332 | 1.471 | 1.297 | 1.405 | 1.198 | 1.014 | 1.357 | 1.365 | 1.000 |
| Eggs | 1.062 | 0.879 | 1.557 | 0.843 | 0.825 | 1.039 | 0.678 | 1.379 | 0.649 | 0.593 | 0.763 | 0.874 | 1.000 |
| Fresh Milk | 1.566 | 0.867 | 1.572 | 0.753 | 0.958 | 1.040 | 1.424 | 0.640 | 0.769 | 0.668 | 0.940 | 0.667 | 1.000 |
| Butter | 0.772 | 0.752 | 0.860 | 0.754 | 0.719 | 0.855 | 0.836 | 0.842 | 0.760 | 0.740 | 0.906 | 0.767 | 1.000 |
| Cheese | 0.966 | 0.829 | 0.876 | 0.449 | 0.852 | 0.937 | 1.075 | 0.813 | 1.034 | 0.803 | 0.939 | 0.759 | 1.000 |
| Patatoes | 1.086 | 0.461 | 0.594 | 0.484 | 0.511 | 0.462 | 1.080 | 0.561 | 0.786 | 0.504 | 0.644 | 0.631 | 1.000 |
| Tea | 0.672 | 0.794 | 0.773 | 0.921 | 1.464 | 0.756 | 1.245 | 1.821 | 1.257 | 0.893 | 0.839 | 0.787 | 1.000 |
| Coffee | 1.624 | 0.709 | 1.757 | 1.095 | 1.843 | 1.076 | 1.650 | 2.271 | 1.345 | 1.031 | 1.256 | 1.688 | 1.000 |
| Sugar | 0.961 | 1.200 | 1.143 | 0.831 | 1.063 | 0.909 | 2.281 | 1.625 | 1.156 | 1.402 | 0.888 | 0.855 | 1.000 |
| Rent | 0.815 | 0.337 | 0.914 | 0.638 | 0.405 | 0.493 | 0.299 | 0.822 | 0.443 | 0.530 | 0.493 | 0.550 | 1.000 |
| Fuel/Light | 1.380 | 1.062 | 1.233 | 0.967 | 1.518 | 1.154 | 1.322 | 1.046 | 1.293 | 1.212 | 1.364 | 0.907 | 1.000 |
| Clothing | 0.721 | 0.768 | 0.796 | 0.802 | 0.911 | 0.850 | 0.864 | 0.700 | 0.762 | 0.836 | 0.850 | 0.680 | 1.000 |
| Alcohol | 2.519 | 0.364 | 1.434 | 0.340 | 0.208 | 0.319 | 0.420 | 0.408 | 0.471 | 0.609 | 0.354 | 0.837 | 1.000 |
| Tobacco | 2.159 | 0.442 | 0.885 | 0.562 | 0.824 | 0.567 | 0.962 | 0.291 | 0.374 | 0.499 | 0.374 | 1.356 | 1.000 |
| Domestics | 0.734 | 0.500 | 0.413 | 0.500 | 0.500 | 0.359 | 0.366 | 0.285 | 0.205 | 0.330 | 0.359 | 0.560 | 1.000 |
| Travel | 0.201 | 0.531 | 1.062 | 0.559 | 0.535 | 0.288 | 0.740 | 0.399 | 0.476 | 0.423 | 0.273 | 0.861 | 1.000 |
| communications | 1.048 | 1.009 | 1.538 | 0.846 | 1.385 | 0.884 | 1.442 | 1.727 | 1.155 | 1.212 | 1.052 | 0.443 | 1.000 |
| Education | 1.339 | 0.666 | 1.018 | 0.621 | 0.523 | 0.516 | 0.223 | 0.424 | 0.644 | 0.755 | 0.598 | 0.490 | 1.000 |
| | | | | | | | | | | | | | |
| Investment | 1.211 | 0.530 | 0.866 | 0.830 | 0.795 | 0.739 | 0.724 | 0.504 | 0.773 | 0.848 | 0.739 | 0.734 | 1.000 |
| Government | 0.813 | 0.388 | 0.891 | 0.570 | 0.517 | 0.483 | 0.652 | 0.339 | 0.525 | 0.627 | 0.483 | 0.508 | 1.000 |