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Abstract. This paper presents and discusses a new database on nominal and real effective exchange rates for an extensive range of European countries spanning 1870-2016. Indeed, with the exception of a few countries, such long run historical series have not been previously constructed. To gage the validity of these series, comparisons with the BIS and IMF indices are conducted. In addition to stretching further back in time, it is shown that the new indices are more consistent and transparent in construction, even over the recent period. Limitations of the new series, relating to both some underlying data and the index problem are considered. Supplementary to the effective exchange rate indices, is a collection of cost of living or CPI indices 1870-1990, which are based on a critical survey in this paper of those indices which are widely used and abused.

Keywords: effective exchange rates, Europe, index problem, CPI

JEL codes: N13, N14, F31, E31

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1. Introduction

If the Law of One Price were omnipotent and exchange rates flexible, the Purchasing Power Parity (PPP) theorem would hold instantaneously. That is, price levels in different countries would be fixed to each other, as prescribed by the PPP theorem, and the exchange rates should fulfil the conversion to a common standard. In other words, any changes in nominal exchange rates would be counteracted by price movements so that real exchange rates stayed stable. Even if the PPP theorem in its "hard version" has few adherents like McCloskey and Zecher (1984), the view that it holds in the somewhat longer term might be the reason why the role of exchange rates for economic growth and convergence in the long term has been rather neglected.[1] It might be the reason why economic historians have devoted little energy to constructing long series of effective exchange rates (though there are some exceptions: Solomou and Catão 2000; Abildgren 2005; Bohlin 2010). The effective exchange rate differs from a bilateral exchange rate, in that it takes account of a currency's exchange rate against a multitude of other currencies, usually by a weighting according to trade. Such nominal and real effective exchange rates (NEER and REER) have now been constructed on a consistent basis back into the nineteenth century for a broad sample of countries in Western and Eastern Europe and are available in a public database: https://ekh.lu.se/en/research/economic-history-data/Exchange_Rates_1870-2016. This paper describes and critically discusses related methodological issues.

One motivation for the construction of a database on historical NEER and REER is that PPP poses a problem for the long term convergence of income levels also. Poorer countries as a rule also have lower levels of prices and wages. When they catch-up with the richer countries, and provided markets are somewhat integrated, they will not only grow faster, but they will also have higher inflation rates than the richer countries. In theory, such higher inflation rates will erode their gains in competitiveness and restrain the catch-up. How has this problem of asymmetric trends in prices been handled in history? The role of exchange rate arrangements for catch-up and convergence in European economic history since the late nineteenth century is still largely an unexplored field. Analysis in the context of growth and convergence is saved for other papers; here, the aim is to present the database and discuss some issues related to data and methodology. One such issue which this paper highlights, is the precariousness of

[1] The PPP issue has however spawned a large empirical literature using real exchange rates but for longer historical periods only bilateral or unweighted averages of a sample of bilateral exchange rates are used (Taylor 2002; Taylor and Taylor 2004; Taylor 2009).

the PPP theory. If PPP holds, real exchange rates would be stable, and even if this might seem to be the case with the standard chain index, it might not be so with the Paasche index, which is arguably more appropriate for long-term analyses.

The organization of the paper is as follows. The next section gives a general description of the NEER and REER and how they are calculated as chain indices. Section three presents the data that are used: bilateral exchange rates and trade statistics, whereas the price data used for the conversion from NEER to REER are separately treated in section six. Section four discusses the validity of the database on the basis of a comparison with the NEER of BIS (since 1964) and IMF (since 1980). Furthermore, the section develops into a critical appraisal of the BIS and IMF indices and suggests that the advantage of the present NEER and REER is not only that they provide indices further back in time, but also that they are superior for the recent decades. In section five, the index problem and its implications for the use of REER in tests of the validity of the PPP theory, are discussed. A whole section is then devoted to prices, that is, cost of living or consumer price indices, are devoted section 6, where available series for the different countries (Mitchell's *International Historical Statistics*, Reinhart/Clioinfra, Jordá-Schularick-Taylor, and others) are critically discussed. "The best available" CPI are suggested for 23 countries (and included in the database for 1870-1990). Section 7 concludes with suggestions for further improvements.

The overall contribution of the paper is a critical assessment along with the publication of the database on NEER, REER, and CPI, intended to be useful for long-term macroeconomic analyses. The paper also pretends to contribute to applied index methodology, to challenge the PPP hypothesis, and highlight use and abuse of CPI data – the latter where one would not expect it to occur!

2. NEER and REER for Europe, 1870-2016

NEER and REER are defined as single-weighted, which means that weights are based on imports and exports of a country:

$$NEER_h = \Sigma[(e_{hj}\, m_{hj}) + (e_{hj}\, x_{hj})]$$

$$REER_h = \Sigma[(e_{hj}\, m_{hj} * p_j / p_h) + (e_{hj}\, x_{hj} * p_j / p_h)]$$

where subscripts denote country *h* and *j* respectively; e_{hj} is the annual change in the exchange rate taken as the amount of country *h's* currency for one unit of country j's; *m* is the share of

country *h's* imports coming from country *j*; *x* denotes the same for the exports*; p* is the annual changes in the consumer price index. Since the exchange rate is expressed as the number of units of the home currency for one unit of the foreign currency, a depreciation is shown as a rise of the exchange rate, and an appreciation as a fall. The adjustment for relative prices in the calculation of REER is taken as the foreign prices over the domestic prices, and consequently a depreciation of the NEER would be counteracted by a relative rise of domestic prices or reinforced by a relative decline of domestic prices; and the reverse in case of nominal appreciation. In more concrete terms, imagine that the NEER of the Finnish markka rose from 100 in 1975 to 136 in 1993, that is, it depreciates by 36 per cent which would offer a gain in competitiveness to exporting firms. However, at the same time, the price level of Finland rose by almost 30 per cent relative to its trading partners, and therefore the REER only rose to 106 over the same period, thus inflation eroded most of the gain in competitiveness – or, the depreciation of the currency compensated for the higher inflation (see table 3, page 23).

The calculation of NEER is based on annual changes of exchange rates and consequently the result is chain indices with annual links. This also applies to REER, where adjustment is made for the inflation rates. Usually chain indices are of the Laspeyres type, that is, the weights pertain to the base year, be it the previous year or a somehow fixed estimate that is regularly changed. However, the idea of effective exchange rates is to measure the impact of currency movements and therefore it is preferable that the trade weights pertain to the current year. This is particularly clear if we want to measure the impact of a crisis such as the outbreak of the Great Recession: the NEER and REER of 2009 should consider the distribution of trade in the same year, not that of 2008 or any remote average. Accordingly, the present NEER and REER are chain indices of Paasche type – trade weights pertain to current year.[2]

In the database, the NEER and REER indices are presented for different periods with reference years in 1900, 1929, 1960, and 1999: 1870-1920, 1920-1945, 1945-1993, and 1993-2016. Several, although not all, indices overlap in the last and first year, and it is thus possible to link them into longer series. For some countries there are gaps which have been "bridged by Paasche links". This simply means that the base is taken from the last available previous observation with the weights of the current year, so that the series gains some continuity. In

[2] A practical reason for Laspeyres chain indices is that data on weights may appear with a delay of years, but in historical research this is no excuse.

principle, it is possible in that way to link all those indices that are broken by the wars, though this task might be undertaken in a later update.

From the adoption of the euro, the old currencies have been extrapolated with the exchange rate of the euro, linked with the conversion rate. Even though all countries in the Eurozone have the same bilateral exchange rates, the effective exchange rates differ significantly between them, due to their different trading partners and relative prices.

Table 1 provides an overview of the coverage and representativity of the database. The start and end year of the NEER and REER are shown, but there are also gaps of various lengths, primarily during WWI and WWII, but also during the 1920s for Germany and countries with hyperinflation. For Spain, the Civil War causes a gap 1936-1938 and for Bulgaria the transition causes a gap in the 1990s. Even if NEER and REER are constructed for several countries during years of war and hyperinflation, the "basket" of countries against which exchange rates are accounted for might differ. In some cases this reflects the actual development, such as zero British trade with Germany 1915-1919, but after WWII German exchange rates are reported first from 1953 although trade was resumed, for example with Britain, already in 1945. Occasionally, hyperinflations have played havoc with effective exchange rates and to avoid unreasonable figures, the "baskets" of all countries have been cleaned from exchange with the following partners during the noted years: Soviet 1922-1923, Germany 1923-1925, Austria and Poland 1926, and Hungary 1927.

The share of the trade weights in the total export and import in certain years is shown in the six columns to the right. Thus 80 for Austria-Hungary means that the sum of weights make out four fifths of the total foreign trade of the double monarchy in 1900, and so on for other countries and years. Since weights are annual, the exact percentage varies, but the figures give an indication of the nominal representativity of the indices. The real representativity might be higher or lower, most often higher as the currencies of trade partners not accounted for can be assumed to on average be approximated by the sample. The question of the real representability then concerns the countries which comprise the sample. The samples of trade partners for each country are reported in the Appendix. On average, as seen from the bottom line of the table, the nominal coverage declines from the nineteenth century to 1993, and then rises. The shift before and after 1993 is discussed in the next section, concerning the data.

If, despite what has been said about real versus nominal representativity, one would set a threshold to remind that one should be particularly careful, a nominal representativity of 60 per cent is suggested. As a consequence, table 1 shows several countries for which the indices

Table 1. Range and representativity of NEER and REER

	Range	Representativity: Share of weights in total trade, per cent					
		1900	1929	1960	1993	1994	2006
Austria-Hungary	1870-1916	80					
Austria	1927-2016*		78	66	66	87	86
Belgium	1870-2016*	80	62	?	69		86
Bulgaria	1890-2016*		84	96	54		79
Czechoslovakia	1920-1990*		69	58	82		
Czechia	1993-2016					87	89
Denmark	1870-2016	?	85	58	59	76	80
Estonia	1994-2016					94¤	84
Finland	1870-2016	81	69	63	50	84	81
France	1870-2016	56	48	61	67	78	78
Germany /West	1870-2016*	79	64	76	76	80	80
East Germany	1953-1988			75			
Greece	1877-2016					80	79
Hungary	1927-2016*		67	70	71	86	86
Ireland	1923-2016		93	71	58	85	80
Italy	1870-2016*	73	53	50	53	76	71
Latvia	1994-2016					91¤	90
Lithuania	1994-2016					87¤	89
Netherlands	1870-2016	88	69	64	61	79	82
Norway	1870-2016	83	74	74	70	90	91
Poland	1925-2016*		58	86	42	81	85
Portugal	1870-2016*	76	74	61	61	85	86
Romania	1882-2016*	55	?	82	38	74	82
Russia	1870-1913	85					
Spain	1870-2016*	53	48	50	46	81	77
Sweden	1870-2016	95	78	65	61	85	88
Switzerland	1870-2016	81	64	62	68	83	85
United Kingdom	1870-2016	72	74	59	69	76	79
Mean	-	*76*	*69*	*67*	*61*	*83*	*84*

Note: * denotes one or more gaps during wars and transition years; ? denotes that total trade statistics seems not compatible with the statistics on main trade partners; ¤ 1995.

could be improved, or corroborated, by an increase of the sample of trade partners. France before WWII, Italy in the interwar and postwar periods up to 1993, and Spain right up to 1993 are maybe the most prominent cases.

3. Data and consistency

Bilateral exchange rates

Most of the bilateral exchange rates are retrieved from *Global Financial Data* (GFD) as monthly close rates, which are then converted to annual averages. With some exceptions, it is the cross rates against the British pound, instead of the direct exchange rates, that are used. A comparison of cross rates and direct exchange rates was undertaken and showed that the difference for annual averages was insignificant except under exceptional circumstances such as during WWII, when the NEER and REER become volatile in any case.

For the latest period, 1993-2016, when the sample of trade partners are enlarged several bilateral exchange rates also had to be added, such as those of the former Soviet republics, Asian, Arab and African countries, for which other sources were used. These included the FRED database, websites of the Bank of England, the Bank of Sweden (*Riksbanken*), the Czech National Bank, the National Bank of Ukraine, the National Bank of the Republic of Belarus, and *xe.com*.[3]

For earlier periods, exchange rates of some currencies also had to be sought elsewhere than *GFD*. Thus monthly close rates 1870-1916 for the Finnish markka are from Autio (1992), while for 1916-1974 annual averages are from *Clioinfra*, and 1975 onwards from *GFD*. The Portuguese escudo has a gap 1915-1974 in *GFD*, and for these years annual averages are taken from Fontoura and Valério (2001).The ostmark of East Germany is reported with monthly averages from 1948 to June 1990 in statistical yearbooks of Berlin.[4] These quotations were collected from the *Wechselstuben* in West Berlin and reflected actual market rates (Collier and Papell 1988). A problem is that some currencies during certain periods have had

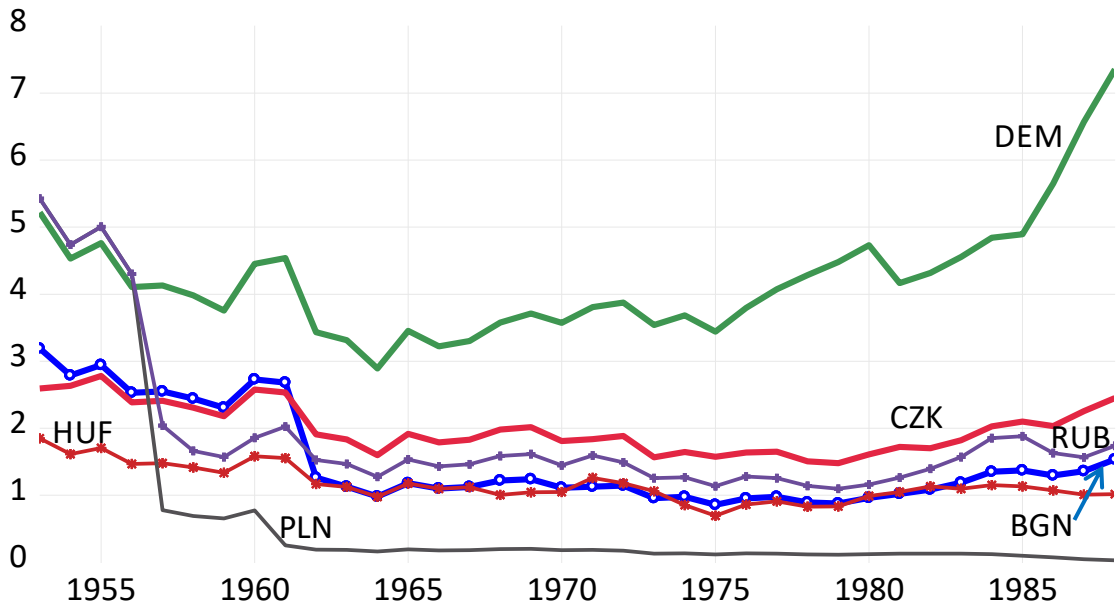
[3] With hindsight most could have been retrieved from the *IMF Financial Statistics,* which has bilateral exchange rates, often back to 1950. Exceptions are the Belarussian ruble and the Angolan kwanza. The former was published first in early 2019 back to 1997 (with the changeover in December 1996) by the Belarussian National Bank. The Angolan kwanza is however available at the *FRED* 1960-2010 and in *IMF* from 1995. Before 1960 I have assumed the kwanza (or its predecessor) was fixed to the Portuguese escudo as it in actual practice was from 1961 to 1974 or even 1975.

[4] *Berlin im Zahlen* (1950, 1951), *Statistisches Jarhbuch Berlin* (1952-1992).

one official rate and another in the black market, and the Ostmark had the dual system throughout its whole existence. Figure 1 shows on the one hand that the market rate against the German mark developed differently from official rates against other Eastern countries. Moreover, a closer look shows that the Eastern exchange rates, even apart from the drastic changes in the early period of the Polish, Russian and Bulgarian currencies, were not fixed against each other. For the calculation of NEER and REER, it has been assumed that the official rates reflect the transactions on current accounts just as the market rates do against Western currencies, via the cross rate to the British pound or German mark.

Another problem is highlighted by figure 1, namely *de facto* currency reforms, when the monetary authorities set a new nominal value on the currency. Unfortunately, the data on bilateral exchange rates are not informative about currency reforms, but these have been identified as sudden jumps. Jumps implying an appreciation with an even factor between two months can safely be interpreted as a currency reform, typically occurring with a currency that is rapidly falling, and such an appreciation arguably should not influence the NEER or REER. Such currency reforms have been adjusted and neutralized, in the calculations. Cases in point

Figure 1. Ostmark for other currencies: market rate and official rates, 1948-1988



Note: Sources, see text. DEM is the only market rate, for German mark; CZK Czechoslovak koruna; HUF Hungarian forint; RUB Russian ruble; BGN Bulgarian lev; PLN Polish zloty.

are the Belgian franc in 1926,[5] Soviet ruble in 1961 and Latin American currencies from the 1970s to the 1990s. Devaluations such as those of the Polish, Russian and Bulgarian currencies in the 1950s and early 1960s, visible in figure 1, are more difficult to handle. How to avoid neutralizing its real impact? Hence, only the devaluation of the Soviet ruble in January 1934, with a factor of 2.5 against the British pound, has been neutralized in its effects on NEER and REER for Western trade partners (NEER and REER for Russia has only been calculated for 1870-1913). Other devaluations have been accounted in full and this can easily be seen in the postwar NEER and REER for Bulgaria and Poland. However, in the early postwar years the Eastern countries seemingly pursued a harsh deflationary policy as also indicated by the NEER and REER.

A related problem is posed by the multiple exchange rates, which have been widespread not only in developing countries but were not uncommon in European countries from WWI until recently. Such arrangements could be conducted on the basis of applying one rate for current account transactions and another for financial transactions (Brault 2018; Marion 1994) or, as in Franco's Spain, with different exchange rates for different commodity groups (Serrano et al. 2017). Gros (1988) suggested however, somewhat contrary to the received view (at the time), that the dual differentials were eliminated in the somewhat longer term. Moreover, the trade weights used for the calculation of the NEER and REER pertain to the current accounts, which is why at least the dual rates should not be a problem for the present estimates. In any case, the sources do not clearly state which exchange rate is considered, and it is reasonable to assume that they concern current account transactions and represent a country's monetary relations in foreign trade.[6] That said, the extent of multiple exchange rates and their economic impact remains a problem that lies outside the scope of the database.

Imports and exports

The trade weights 1870-1993 consider commodity imports and exports with "main trade partners" in B.R. Mitchell's *International Historical Statistics* (2013). 1994-2016 weights are collected from the *World Bank WITS* database, which presents the data as considering trade in both commodities and services. The samples of trade partners for this period are those twenty

[5] During 1926 the Belgian franc depreciated sharply, until late October when the franc was replaced by the belga. On annual basis the result was an appreciation with approximately a factor of 3, which has been taken as the adjustment factor (Banque Nationale de Belgique 1927, Annexe F).

[6] The bilateral exchange rates in *GFD* often stretch centuries back, but it is difficult to track the precise definitions and sources. Unfortunately, Lund University's subscription on *GFD* expired during my research and the fee is prohibitively high why a closer examination of this source became interrupted.

with the biggest combined imports and exports in 2005-2007. Table 1 shows that in most cases this enlargement of the sample also means a significant increase of the nominal representativity of the indices. Before and after 1993 therefore produce inconsistency in the estimated NEER and REER. First, by the inclusion of services which of course would be desirable to have further back in time. Data on trade in services are, however, not easily available for all related countries before 1994.[7] Moreover, the role of services in trade was smaller before the 1990s explains why this inconsistency is of minor importance. However, for nations providing substantial shipping services to foreign countries, such as Norway and Greece, it might be of significance, which as yet remains un-investigated. Second, the increase of nominal representativity after 1993 is discussed below, but first a comment on the trade partners reported in Mitchell. For some countries, these partners are very few, such as for Ireland (4) and Finland (5), though more for Germany (9) and the United Kingdom (10). Yet, reporting is not always reciprocal, for example, Spain's trade with Germany is reported but not Germany's with Spain. This circumstance has made it possible to estimate Germany's trade with Spain and accordingly the number of trade partners have increased for some countries, in comparison with those directly reported in Mitchell. Importantly, Japan has been possible to add from 1950, when its European trade expanded, as a trade partner of France, Germany and the United Kingdom. For Spain, which unfortunately has few trade partners in Mitchell, one partner has been excluded: Cuba from 1960. While being historically significant in Spanish trade, the continuity of the exchange rate is very unclear after 1960, and the Cuban trade sharply declined. Argentina alone represents the Latin American connection of Spain. [8]

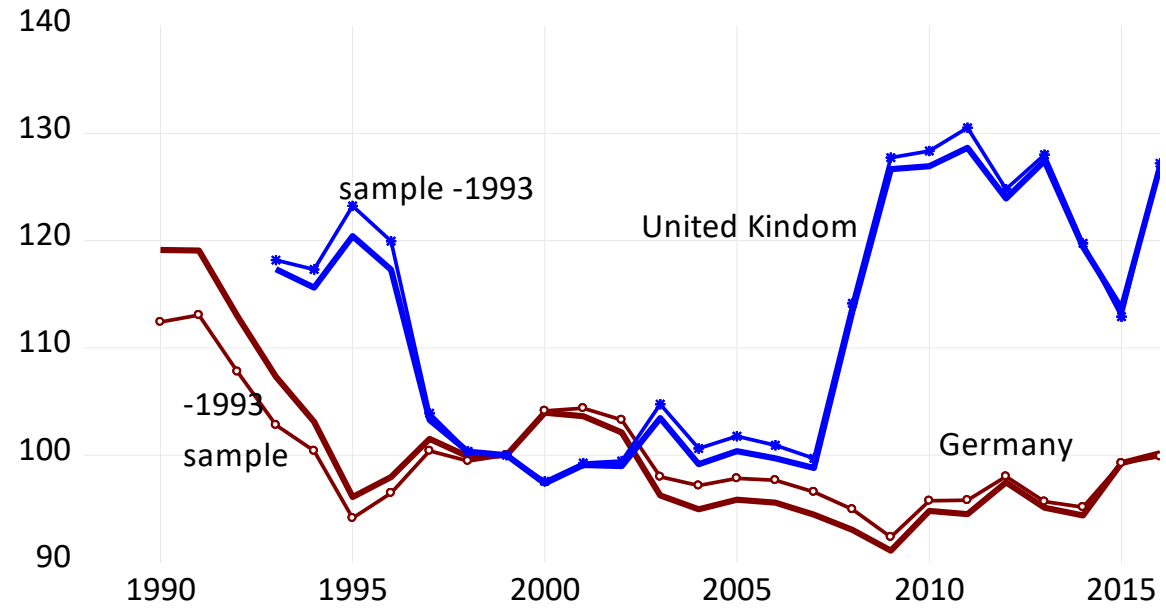
Where observations are missing in Mitchell (2013), extrapolations and interpolations have been undertaken. Importantly, for Germany no imports or exports are reported before 1880 and 1871-1879 are extrapolated, though adjusted for the growth of trade partners' total exports and imports and thus not just proportional to 1880. Further, Belgium is not reported until 1999 in the *World Bank WITS,* and has been extrapolated 1994-1998 as proportional with corresponding data for France, Germany and the Netherlands.

Concerning the representativity of weights before and after 1993, table 1 in columns "1993" and "1994" shows the weights share in total trade with the earlier and the later sample of weights. Assuming that the 1994 samples are more representative, it is not obvious that a lower share of weights in the 1993 samples implies a lower real representativity. In this

[7] The UN Comtrade database does not report trade in services before 2000.

[8] See the Appendix for the samples of trade partners.

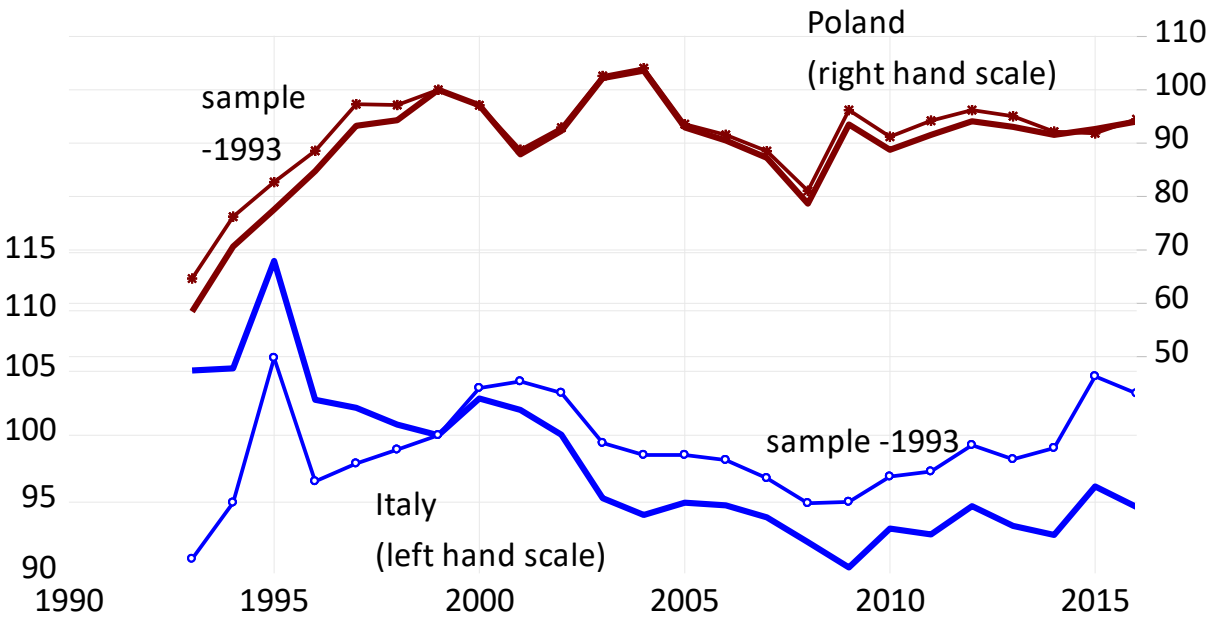
Figure 2. Comparison of NEER for Germany and the UK with different samples, 1990-2016



Note: sources, see text.

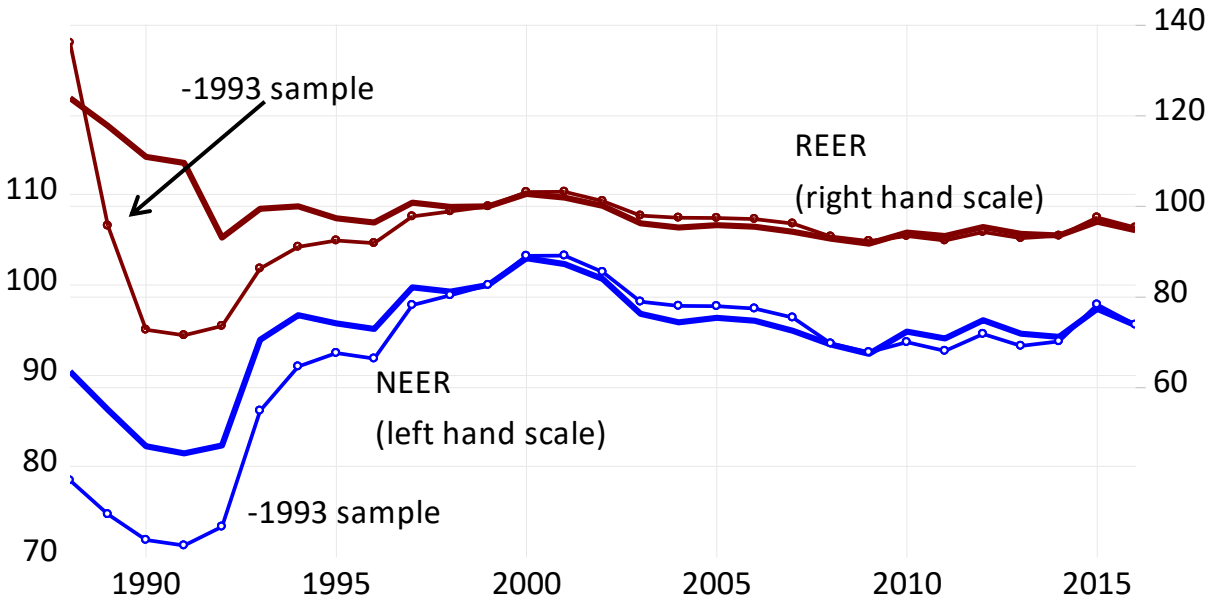
respect, the selection of trade partners clearly is very important, as illustrated by figures 2-4. In figure 2, the two versions of NEER display a smaller difference for the United Kingdom than for Germany, despite the former having a bigger increase of its share of the weights in total trade. In figure 3, Italy and even more so Poland have low shares in the early samples, but only Italy displays a significant and critical difference. Spain also has a low share in the early sample, but the difference, as seen in figure 4, is critical only before the mid-1990s. Of course, the chance for better real representativity is higher with a larger share of the weights in total trade and table 1 and the Appendix can be used as a guide for finding where the validity of the present NEER and REER is less strong.

Figure 3. Comparison of NEER for Poland and Italy with different samples, 1993-2016



Note: sources, see text.

Figure 4. Comparison of NEER and REER for Spain with different samples, 1988-2016



Note: sources, see text.

4. Comparisons with BIS and IMF

The BIS and IMF provide effective exchange rates for a number of countries since 1964 and 1980, respectively. The BIS enlarged its sample of countries from 26 to 60 in 1994, and since then publishes indices for both samples including the eurozone, labeled the "narrow" and the "broad". The calculation of the BIS rates are broadly explained by Klau and Fung (2006) and the indices as well as the sample of weights can be traced in the published data files. The press release launching the latest revision of the IMF (2019) indices, with 99 countries plus the Eurozone, though still missing Estonia and Lithuania, refers for the methodology to Bayoumi et al. (2005). The cited papers show that both BIS and IMF apply a kind of double-weighting, which has the aim to take account of competition with third countries (Klau and Fung 2006; Bayoumi et al. 2005). Even if the calculations go down to commodity level, they end up in a single figure as the weight for each trade partner. The BIS illustrates this with one matrix for the weights of the narrow sample and another for the broad sample of countries. This means that the BIS narrow only includes relations with the other countries in the sample and in no way relates to, for example, Eastern Europe (except, supposedly, if they belong to the euro area). Similarly the BIS broad sample has weights only from other countries in the sample and includes no other countries of the former Soviet Union than the three Baltic countries and Russia, which inevitably biases the estimates for these countries by not accounting for their relations with Belarus, Ukraine, Kazakhstan etc. Notably, in the BIS indices the Eurozone "is treated as a single entity in the indices for non-euro area economies" (BIS 2019), implying a deviation from the "true" REER estimates when the distribution of trade does not match with the average inflation in the Eurozone.

The weights of the BIS indices are three year averages starting with 1990-1992 and so on until 2011-2013, which are the weights still in use. This is similar to the new IMF indices which since 2004 also use three year averages pertaining from 2004-2006 to 2013-2015, which are now in use. IMF weights include merchandise trade, tourism, and manufacturing production – the latter to better take account of competitiveness. From merchandise trade, trade in petrol is deducted and services other than tourism are not included. Weights in the new IMF indices are said to be based on 31 partner countries while the old contained 19. "Prior to 2004, the old fixed-base indices are spliced to the new chained indices" (IMF 2019).

Table 2 illustrates the differences in weights between the BIS broad sample and the present estimates for the UK. The countries shown are those 20 which were the UK's top trade

Table 2. UK's "top 20 trade partners" as shares of BIS "broad sample" weights (2011-2013), their shares of total UK trade, of the present NEER UK weights, and variability 2011-2016 (percentages)

	BIS 2011-2013	Trade 2011-2013	Present 2011-2013	CV, % 2011-2016
Australia	0.79	1.08	1.40	20.5
Belgium	-	4.39	5.69	1.8
Canada	1.29	2.15	2.78	15.2
China	12.69	6.31	8.17	12.8
Denmark	1.05	1.12	1.45	13.9
France	-	6.24	8.07	2.8
Germany	-	11.46	14.84	5.5
India	1.98	1.49	1.93	7.6
Ireland	-	3.91	5.06	2.0
Italy	-	3.13	4.05	7.1
Japan	3.46	1.83	2.37	15.1
Netherlands	-	7.21	9.33	5.6
Norway	0.77	3.15	4.08	18.9
Russian Federation	1.13	1.73	2.24	25.9
South Africa	0.65	1.15	1.48	24.5
Spain	-	2.71	3.50	9.5
Sweden	1.83	1.82	2.36	11.0
Switzerland	2.65	4.90	6.34	23.8
Turkey	1.76	1.28	1.66	14.1
United States	10.67	10.18	13.18	6.9
Euro area	43.7	(41.2)	(50.6)	-
Sum of these 20 (average for CV)	84.4	77.2	100	12.2

Note: Source, see text. The countries were UK's top 20 trade partners in 2005-2007. BIS "broad sample" includes 60 countries and the euro area, which in the BIS weights represents the individual countries. "Trade" considers shares in UK foreign trade 2011-2013, while "Present" are the shares in total weights of the present NEER-REER. Figures (for the euro area) are in brackets to avoid double counting. CV is the standard deviation for actual trade shares 2011-2016 over the averages for 2011-2013 (Trade).

partners in 2005-2007, and which are included in the sample 1994-2016 of the present NEER and REER for the UK. For comparison, the most recent BIS weights are taken, pertaining to 2011-2013 which are still used for the indices after 2013[9]. The figures indicate the percentage share in total broad BIS weights. The column "Trade" shows how big a percentage these countries had in the UK trade 2011-2013, while "Present" shows their average percentage share over the same years in the UK weights of the present NEER and REER. Thus, these

[9] 15 May 2019 the BIS indices were updated with weights pertaining to 2014-2016. This update has not been considered here though it might be of importance for a closer comparison of the indices. It does not matter, however, for the discussion about the principles of the construction.

countries had 84,4 per cent of the UK BIS weights, and made out 77 per cent of the total UK trade, while they had 100 per cent of the present NEER and REER weights. As a consequence they are over-represented in the present indices, although all to the same extent. In the BIS double-weighting, countries could be over- or under-represented compared to the share in the UK trade. Most striking is that China's weight is doubled compared to its share in the trade, and similarly for Japan. Even if this is motivated with consideration of market competition etc, a look at the column "CV" raises some doubts about the gain in realism or accuracy. The actual variability in China's trade was 12 per cent over the period 2011-2016. This period is taken because the 2011-2013 BIS weights are still in use. At the other end of the spectrum, countries with low trade shares, often have even higher variability and are at the same time under-represented in the BIS weights. Arguably, the sensitivity for market fluctuations could be better captured by annual current weights that is Paasche weights as in the present indices. Another aspect is that the latter weights are more transparent than the smoothed double-weights which are fixed over three or more years.

The double-weighting actually makes the BIS and IMF indices into a kind of composite indices. As is so often the case with composite indices, it is not exactly clear what is measured and therefore it is likewise un-clear how it can be used. While the double-weighting pretends to exactitude, it results in low transparency and the use of fixed weights for several years blurs the actual impact on the effective exchange rates.[10] So far the comparison is made for the BIS indices but the same criticism can be directed towards the IMF indices. IMF's exclusion of trade in petrol from the weights might be motivated for a special analytical purpose, but seems like an ad hoc adjustment for a general NEER or REER. The IMF's linking in 2004 of the fixed-base indices (without mentioning the base year) with the chained indices (yet with weights fixed for several years) diminishes their comparability over time.

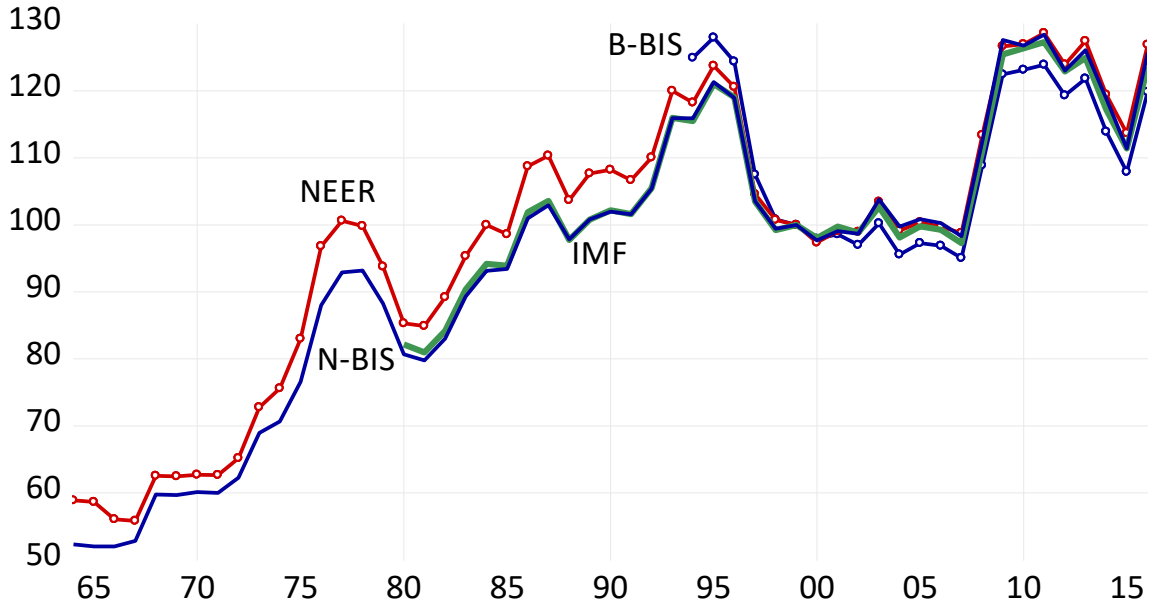
A remark should be added to the treatment of the euro area. In the BIS indices, for countries outside the euro, the eventual euro area is taken as a whole all the way back to 1990. After the introduction of the euro, this does not influence the NEER, but it influences the REER due to the different inflation rates between euro countries. Through the 1990s there was also a sizeable variety of exchange rate changes among the later euro countries, why this retrospectively lumping together of the euro area is not adequate. It should also be noticed

[10] Here I side with the early views of the BIS (Koch 1984). Of course the search for a more elaborate measure of competitiveness is justifiable, but it seems more appropriate to specify a model than construct a composite index.

that after the introduction of the euro, this treatment implies an inconsistency between the calculation of REER for countries inside and outside the euro area.

Despite what is said about the differences in weighting schemes, figure 5 which presents the different NEER indices for the United Kingdom, shows broadly the same development. In the 1970s the present NEER depreciates more than the narrow BIS, but from the early 1990s the present NEER, the narrow BIS and the IMF converge. It is the broad BIS that shows a slightly different picture from 1994 onwards. Two circumstances make the case that the present NEER is more rather than less plausible than the IMF and BIS indices for the United Kingdom before 1994: firstly, the similarity, shown above in figure 2, of the NEER for the recent period whether calculated with the sample used before or after 1994; and secondly, the fixed weights used in the BIS and IMF indices for early periods. Actually, if the weights of NEER are fixed in 1993, with the sample of 20 countries, it comes closer to the BIS index in particular in the 1960s and early 1970s. What seems a bit anachronistic with the BIS weights, both narrow and broad, is that the countries that eventually adopted the euro are treated as one entity, with 61 per cent of the weights for 1990-1992 in the narrow sample. If these, as in the very similar IMF index from 1980, are drawn back in the preceding decades (IMF 2019), the

Figure 5. Different estimates of NEER for the United Kingdom, 1964-2016



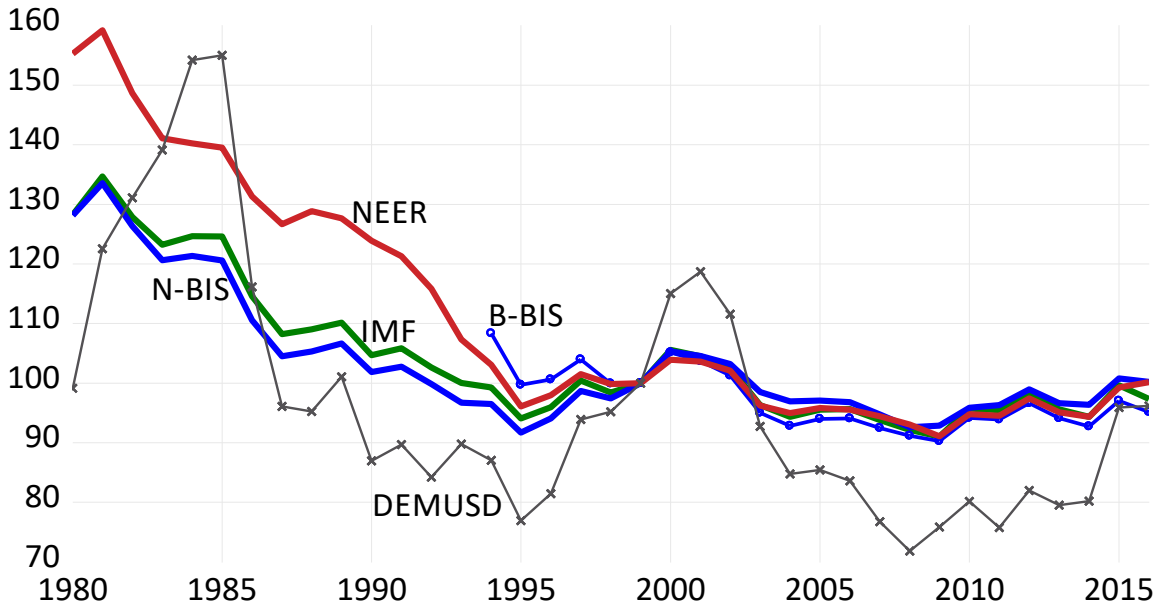
Note: Sources see text. B-BIS and N-BIS are the broad and narrow samples, respectively. In original, the IMF and BIS indices show an appreciation as an increase and a depreciation as a decrease – shown here are their inverses.

estimates inevitably lose in precision. The broad BIS, from 1994, has a slightly different trajectory than the rest. The lumping together of the eventual euro area makes it less transparent down to 1999 and difficult to trace the concrete cause. In the 2000s, the depreciation of the Chinese yuan can be show to have had a larger impact on the broad BIS, due to the double-weighting, which, as noted in table 2, significantly increased the weight of China in the UK effective indices.

For Germany, the "narrow" BIS and the present NEER also move broadly in parallel over the period 1964-1980, though with the latter appreciating somewhat faster at an annual rate of 0.6 percentage points, or at 4.3 per cent compared to 3.7. From 1980 (or 1979 to be precise) to the early 1990s was the period of the European Monetary System aiming at monetary stability, but in its first half there were frequent so called realignments. During its second half, exchange rates were almost fixed but these happy conditions ended with the EMS crisis and new realignments.

Over the whole period from 1980 to 1995 the Italian lira depreciated close to 60 per cent against the German mark and the British pound was almost halved, while several other European currencies behaved similarly. The US dollar appreciated in the first half of the 1980s but then dropped and over 1980-1995 it depreciated 22 per cent against the German

Figure 6. Different estimates of German NEER and DEM exchange rate with the US dollar, 1980-2016 (1999=100)



Note: Source see text.

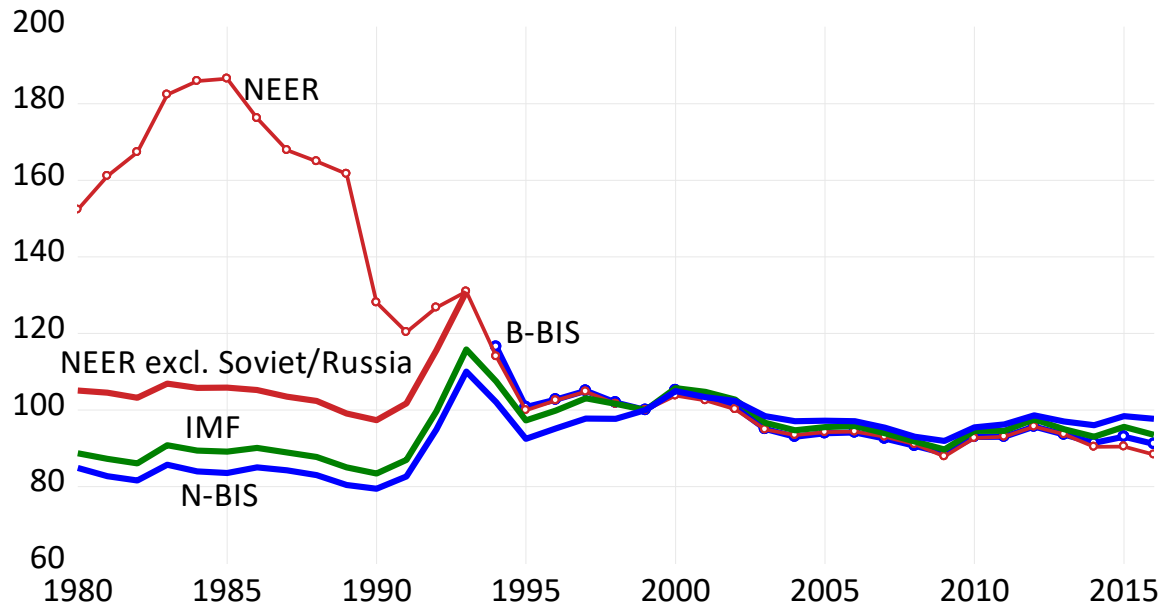
mark. These developments are reflected in the indices in figure 6, but why is the present NEER distinguished by a steeper appreciation than both the narrow BIS and the IMF index, in particular 1990-1994? While most Eastern currencies were stable until the late 1980s, they then fell headlong, the Russian ruble with 95 per cent only in 1990. The present NEER takes account of this with these countries making out about 5 per cent of total weights in NEER, while not included in the narrow BIS (and presumably neither in the IMF index).

A similar case is shown with Finland in figure 7. The share of NEER weights as a percentage of Finland's total trade is low (see table 1) and Soviet/Russia are up to 1993 the only Eastern trade partner in the weights. However, the share of Soviet/Russia in weights roughly corresponds to the Eastern trade in the total trade of Finland in the early 1990s. The appreciation of the Finnish markka against the Eastern currencies limited the depreciation that at the same time occurred against Western currencies (in the EMS crisis), and the latter depreciation is reflected in the other indices, while the movement against the eastern currencies is neglected. The present NEER as well as the broad BIS include eastern trade partners for Finland, meet in 1994 and follow each other closely to 2016, while IMF and the narrow are more similar on a slightly different track.

Ireland is another country with a low share of weights in the sample up to 1993. Actually, the sample consists of only Germany, USA, and the UK with Northern Ireland. However, while these countries' share in Ireland's foreign trade was down to 58 per cent in 1993, in the early 1970s it had been above 70 per cent. The countries included in the narrow BIS weights for Ireland 1990-1992 had above 90 per cent of her trade, and these weights might have been used back to 1964.[11] Looking at figure 8, one might therefore presume that the steeper curve for the narrow BIS compared to NEER up to the late 1970s is due to a better representativity. That inference is however precipitous. The distribution of Irish trade underwent a substantial change and the annual weights of NEER might have a higher representativity although they made out a smaller share of the total Irish trade. The reason for this proposition is that the gap between NEER and the narrow BIS almost disappears if NEER is recalculated with fixed 1993 weights. In the first half of the 1980s, NEER rises more than both the narrow BIS and IMF. These were the years of the appreciation of the US dollar and the so called realignments

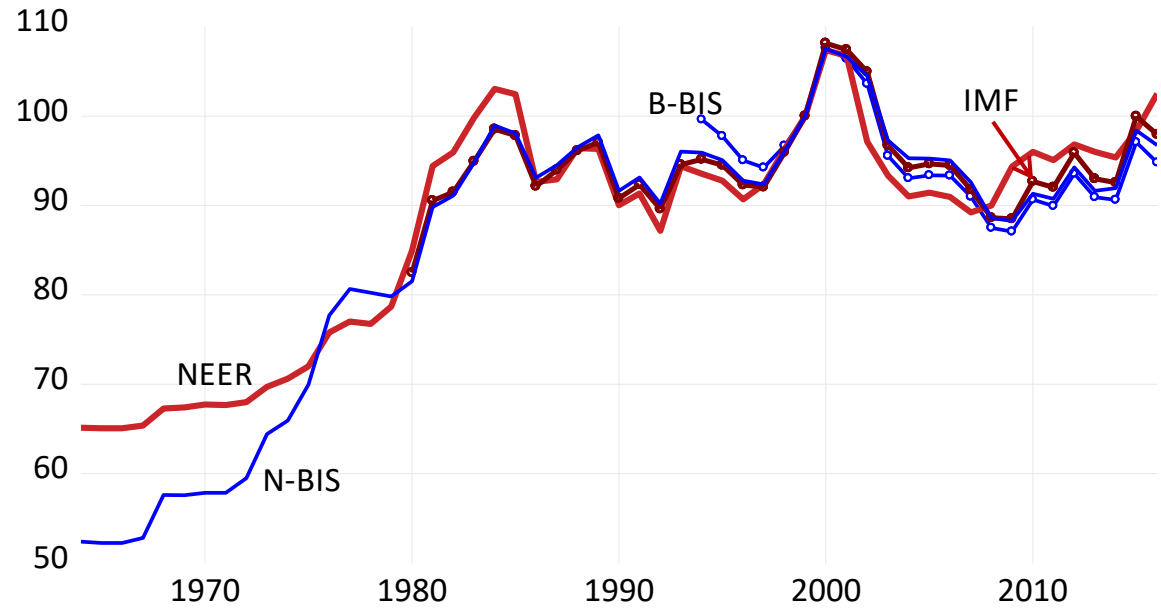
[11] In the 1980s the sample of countries for which effective exchange rates were estimated by the BIS was small, USA, Canada, Japan, Belgium, France, Germany, Italy, Netherlands, Sweden, Switzerland, and the UK (see Koch 1984). Ireland was included later.

Figure 7. Different NEER for Finland, 1980-2016



Note: Source see text. NEER exclusive of Soviet/Russia ends in 1993.

Figure 8. Different NEER for Ireland, 1964-2016 (1999=100)



Note: Source see text.

in the EMS, where the punt belonged to the weaker currencies. But these were also years when the Irish trade with Germany and even more with the USA expanded, while it relatively fell back with the UK against which the exchange rate was more stable. The sharper rise in NEER to 1985 might thus give a more accurate picture. The deviations of NEER from the BIS and IMF indices after 2000 are so far puzzling. The countries in the NEER sample make out close to 90 per cent of the broad BIS weights, and the remaining countries in the latter sample have shares smaller than 1 per cent each, except Mexico with 1.2. Including Mexico in the sample makes not a noticeable change to NEER, and replacing NEER weights with the BIS broad weights in the sample of 20, only increases the difference. This raises the question about the data on the bilateral exchange rates and whether there are flaws in the GFD collection, but if so, why only visible in the Irish case?

5. The index problem and PPP

Tests of long-run PPP are often performed as stationarity tests on real exchange rates or some variety of cointegration test. Apart from the well-known ambiguity of such tests, it is questionable what can be shown with bilateral exercises in a multilateral world. Effective rather than bilateral exchange rates would be more telling. However, since NEER and REER are constructed as indices, the index problem lures.

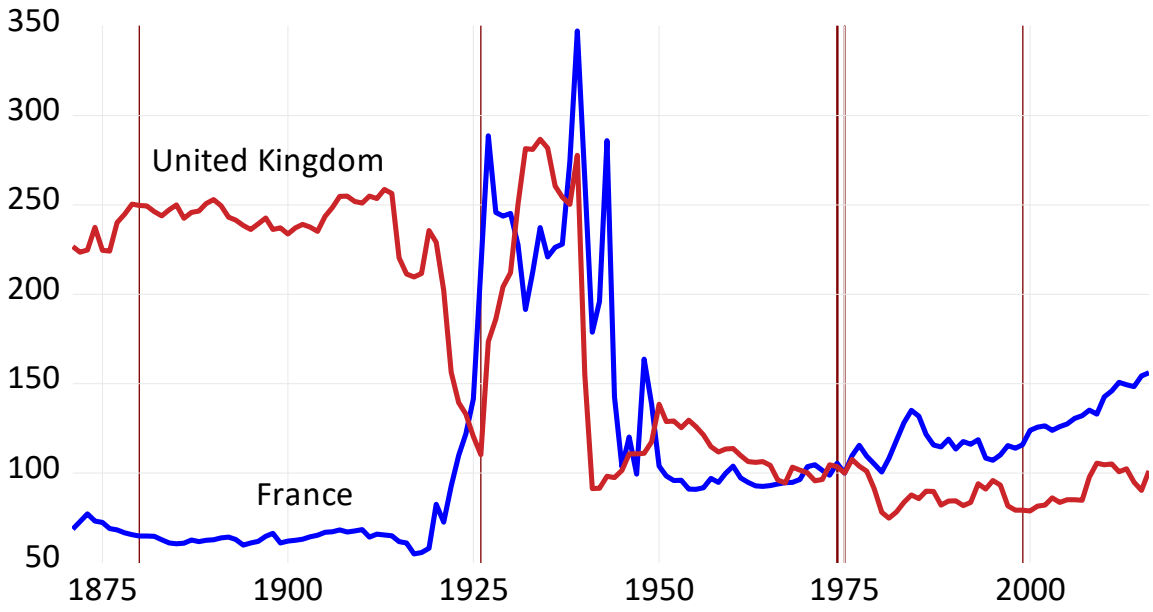
It is today a broad consensus that chain indices are "best". The present NEER and REER are also chain indices although unconventional in the sense that Paasche weights are used and not Laspeyres, as explained in section 2 above. However, a chain index, whether with Laspeyres or Paasche weights, has precision only for comparisons between adjacent observations while providing approximations of unknown exactitude between more distant observations. A basic reason is that the composition of the basket that is measured by the index is continuously changing and consequently over a longer period the index might measure quite different baskets. This is one aspect of the index problem, which Gerschenkron noticed as "gall and wormwood to the statistician and theoretical economist" but which might provide analytical opportunities for the economic historian (Gerschenkron 1962: 204).

The implication for the present chain indices (NEER and REER) is that they might not provide an appropriate tool for the analysis of the long-term impact of the changes of exchange rates. Table 3 illustrates that the two types of indices may provide (almost) the same values over a period, but often values are quite different. The magnitude of the difference is

entirely an empirical question. Gerschenkron employed the index problem to identify structural change, and similarly with the effective exchange rates, the differences between the chain and the Paasche indices indicate changes in the orientation of the trade, which are obscured by the chain index.

However, as forestalled in the Introduction, the discrepancy between chain and Paasche indices also has a bearing on the PPP issue. According to PPP, the REER would be stable or, in the softer version, tend to return to its equilibrium level. Thus, if we compare a REER index at two distant points in time, the index would be the same, or if any of the observations were out of equilibrium they would deviate randomly from each other. I will return below to the random deviation, yet first have a look at figure 10, showing the long-term REER for France and the United Kingdom. These REERs are of Paasche type for four different index periods with base years in 1880, 1926, 1975, and 1999, and spliced together with 1975 as reference year. Even apart from the turbulence during the interwar period, it is difficult to reconcile these curves with a PPP striving back to its equilibrium. The choice of base years has some influence on the levels and trends, but less so for the pattern of fluctuations.

Figure 9. Paasche linked REER for France and the United Kingdom, 1871-2016



Note: Sources etc. see text. The series are spliced from four periods: 1871-1920 with base year 1880 (indicated by vertical line); 1920-1945 (base 1926); 1945-1993 (base 1975); 1993-2016 (base 1999).

Assuming there are structural breaks roughly between the index periods, the fluctuations within periods might be random variations and thus not violating the softer version of the PPP hypothesis. A thorough examination of this issue is not within the scope of this paper, but table 3 raises further doubts about the PPP hypothesis. The table displays the different values with chain and Paasche indices in certain benchmark years, both for NEER and REER. Apart from showing that the indices may or may not show (almost) the same values, the table also shows that the REER is rarely stable. In the latest period, when international integration would quickly equalize price levels and adjust REER to PPP, this seemingly happens with the chained REER often having values close to 100, or exactly so as for Austria. However, given that the chain indices often are poor approximations over longer periods, one should instead notice that the Paasche REER shows larger deviations, for Austria 8 per cent. Given that the annual fluctuations usually are small could the larger deviations be taken as indication of a trend over the period. The second line from bottom of table 3 shows the average annual rate of the drift of REER over the different periods. Since periods are of different lengths, the rate of change has been annualized. Not surprisingly the interwar period seems violating PPP, as also Taylor (2002) found, but despite progress of market integration REER seems less stable in the 21st century than in the decades before WWI. Of course this is not a biting test of PPP, but given the number of countries, on average the deviations from the reference year value of REER would be low. Seen in this perspective the average stability of REER over the period 1880-1910 supports the PPP hypothesis, while it cannot be applied to the later periods, not even the first decade of the 21st century.

The differences between REER and NEER, for which the average over periods are reported in the bottom line of table 3, are telling in another respect: since a relative increase in REER over NEER means that the domestic price level has fallen compared to foreign price levels, the value tells about the economic policy regime. Hence this difference during the interwar period, with REER on average 12 percentage points higher than NEER, is an indication of the deflationary pressure. On the other hand, the negative difference over the period 1975-1993 tells about an expansionary monetary regime, while the difference over the period 1999-2010 is comparable with the interwar period. These disparate characteristics of the periods suggests that the international monetary regimes are important determinants of the behaviour of both NEER and REER.

Table 3. Comparison of chain and Paasche indices for NEER and REER

	1910 (1880=100)		**1938 (1926=100)**		**1993 (1975=100)**		**2010 (1999=100)**	
	NEER	REER	NEER	REER	NEER	REER	NEER	REER
Austria-Hungary				-	-	-	-	-
- Chain	103.7	104.6						
- Paasche	102.9	108.1						
Austria			*	*				
- Chain			100.2	85.7	72.1	92.3	100.3	100.0
- Paasche			97.8	79.6	80.5	89.1	100.6	108.2
Belgium								
- Chain	98.1	97.8	129.0	102.9	124.0	140.7	96.2	96.2
- Paasche	95.6	102.8	80.2	100.1	136.4	137.3	95.4	98.8
Bulgaria	#	#			¤	¤		
- Chain	100.0	78.4	94.0	129.9	42.9	9.3	81.6	78.2
- Paasche	90.8	75.1	90.5	126.9	33.5	24.9	80.8	123.2
Czechoslovakia	-	-	*	*	¤	¤		
- Chain			118.4	107.0	11288	9201		
- Paasche			112.4	104.4	1661.8	1806.7		
Czechia	-	-	-	-	-	-		
- Chain							68.8	68.7
- Paasche							68.6	73.5
Denmark								
- Chain	100.0	104.5	142.3	129.0	121.7	113.5	96.1	96.3
- Paasche	100.0	109.6	143.8	129.6	146.8	112.7	93.7	93.9
Estonia	-	-	-	-	-	-		
- Chain							90.8	90.2
- Paasche							92.5	111.0
Finland								
- Chain	102.0	94.0	144.3	156.4	93.6	131.4	192.1	193.3
- Paasche	101.5	102.0	139.3	164.2	136.2	105.6	90.9	119.7
France								
- Chain	99.6	105.2	128.6	79.1	151.0	119.9	97.3	97.2
- Paasche	99.2	105.5	174.8	127.9	142.6	118.9	96.5	123.1
Germany								
- Chain	101.2	87.6	71.0	87.2	58.2	116.3	95.7	95.6
- Paasche	100.3	84.8	86.2	108.2	55.2	65.1	95.7	110.0
Greece								
- Chain	93.0	88.4	203.5	145.4	574.3	110.1	90.7	88.8
- Paasche	97.4	84.8	200.6	158.2	634.0	94.4	89.5	103.6
Ireland	-	-						
- Chain			101.7	97.9	119.5	87.9	96.0	96.3
- Paasche			103.2	99.0	132.4	91.1	91.6	85.6
Italy								
- Chain	94.8	98.1	95.0	98.2	317.1	107.3	93.1	91.8
- Paasche	95.8	100.3	100.3	106.0	346.6	121.1	92.6	102.8
Latvia	-	-	-	-	-	-		
- Chain							94.7	89.7
- Paasche							94.7	89.8
Lithuania	-	-	-	-	-	-		
- Chain							68.57	63.8
- Paasche							68.1	98.9

Netherlands								
- Chain	100.9	107.0	99.3	110.8	79.5	91.0	96.5	96.4
- Paasche	100.4	110.4	144.5	218.9	79.3	88.1	96.2	99.6
Norway								
- Chain	100.1	105.6	105.1	113.2	123.9	110.5	92.1	92.0
- Paasche	100.1	109.4	106.4	108.7	126.5	104.0	91.2	95.3
Poland	-	-						
- Chain			78.0	164.0	98.8	294.6	88.8	88.5
- Paasche			80.1	189.2	114.1	69.7	88.6	90.9
Portugal								
- Chain	92.5	91.0	127.8	137.0	579.9	90.8	94.8	94.3
- Paasche	91.3	88.8	129.2	136.4	548.4	123.5	94.1	94.5
Romania	#	#			¤	¤		
- Chain	98.7	85.5	83.7	94.2	72.0	80.4	243.3	201.2
- Paasche	100.5	95.0	84.0	112.3	56.8	79.1	245.1	1281.3
Russia			-	-	-	-	-	-
- Chain	104.1	97.4						
- Paasche	98.9	96.4						
Spain			^	^				
- Chain	117.7	115.0	141.7	115.5	194.0	95.4	94.9	94.3
- Paasche	111.5	110.4	142.0	114.8	222.7	119.6	93.4	90.8
Sweden								
- Chain	100.8	97.2	127.0	118.6	211.9	132.1	102.7	102.5
- Paasche	100.6	98.7	127.7	118.2	232.8	135.3	103.0	115.1
Switzerland								
- Chain	99.6	108.4	112.4	125.7	68.6	106.1	92.3	91.8
- Paasche	99.8	115.8	107.7	122.4	79.8	108.0	92.0	105.2
United Kingdom								
- Chain	96.9	104.1	109.0	118.9	144.6	101.3	126.9	126.0
- Paasche	94.3	100.6	160.2	227.0	145.3	93.9	125.4	132.1
REER average annual drift. % (Paasche only)	*0.27*		*2.52*		*1.04*[§]		*0.95*[§]	
Average difference REER – NEER (Paasche only)	*1.0*		*12.1*		*-82.6*[§]		*10.5*[§]	

Note: # 1910 over 1891 for Bulgaria and 1910 over 1882 for Romania; * 1937 over 1927 for Austria and Czechoslovakia; ^1935 over 1926 for Spain; ¤1990 over 1975 for Bulgaria, Czechoslovakia, Hungary, Poland, and Romania; [§]excluding Czechoslovakia 1975 and Romania 2010 as outliers.

6. Consumer Price Indices

Which price indices should be used for the calculation of REER? For long-term estimates, back into the nineteenth century, one has to stick to the device of Edgeworth (1896): "Beggars cannot be choosers." This limits the choice to cost of living (CoL) or consumer price indices (CPI), for which series are available for most of the countries involved. Involved means not only that the countries for which REERs are calculated, but also their main trade partners. Arguably, CoL/CPI are also more appropriate as a measure of the general price level and costs than, for example the GDP deflator which indicates output prices. In short, to have a consistent construction of REER over the long-term, there is no choice but CoL/CPI.

However, one should be aware that there are problems with CoL/CPI. Only in recent years there is some kind of standardization between countries in their construction. A modern CPI is composed by a basket including different consumption goods, housing and taxes. The historical CPIs are most often cost of living indices at best including clothes and housing, besides foodstuffs. This is of course also the case with the CPIs collected and presented here. For early periods, indices might merely comprise proxies constructed from a few price series, while baskets and index methods might vary considerably between countries, or may not be described at all. As a scrutiny check, one would have a look at the series and see if there are conspicuous traits such as sudden jumps or deviations in comparison with neighbouring countries. Primarily such checks are performed of the indices of countries for which REER indices have been calculated, whereas peripheral trade partners have gone below the radar and the series available at Clioinfra have been taken.

In several cases the European Clioinfra series are identical or very close to those presented by Mitchell (2013), and in such cases the latter is used and cited here. In other cases arguments are given for why an alternative or new series is preferred. A common source for the Clioinfra series on CPI inflation is Reinhart and Rogoff (2011), with reference to Reinhart's homepage. As shown in the survey below, several of these series are remarkably fallacious, and for simplicity I shortly refer to "Reinhart".

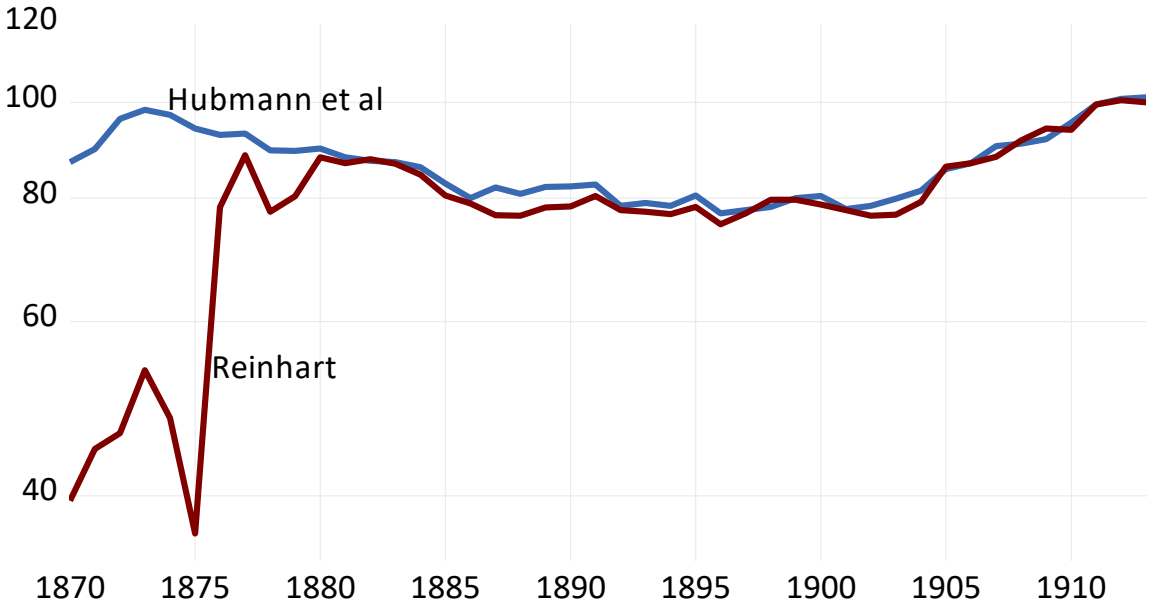
Apart from contributing to the REER estimates, I suggest that the presented series are the currently best available and might provide a point of departure for those who want to construct a reliable dataset, or use them in other research. In the survey country for country below, inflation rates are sometimes used as a check on the plausibility. A complete set of inflation rates for certain periods are provided in Appendix 2.

For most of the REER countries, unbroken series with reference year 1929 are presented in the database. For 13 of the European countries, along with four non-European, the Jordà-Schularick-Taylor *Macrohistory Database*[12] also offers CPI series back to 1870. For most countries their reference is to Taylor (2002) up to 1996 and then IMF. This leaves a gap 1948-1996, because Taylor (2002, p. 140 n) briefly states: "The principal pre-1948 price sources are the statistical volumes of Brian Mitchell." Where they give a specific reference for a European country, this is mentioned below, otherwise the comments to Mitchell pertain to their CPI as well.

Austria

The Clioinfra series is from Reinhart, who uses wheat prices for the nineteenth century through the 1870s. In this decade, the series displays excessive volatility, with 114 per cent inflation in 1876, as illustrated in figure 10. For 1881-1913, Reinhart used the "prices" in Flandreau and Zumer (2004), which mostly seem to be a kind of GDP deflator. For Austria, it rather closely follows the recent CPI by Hubmann et al (2019), which is the outcome of a

Figure 10. Consumer price indices for Austria, 1870-1914 (1914=100)



Sources: see text.

[12] Jordà et al. (2017), although available online is Release 4 (May 2019) which has been consulted here.

collaborative work at the Austrian National Bank which during 2019 will be published for the period since 1800, here with kind permission reproduced for 1870-1990, and used in the REER calculations to 2016.

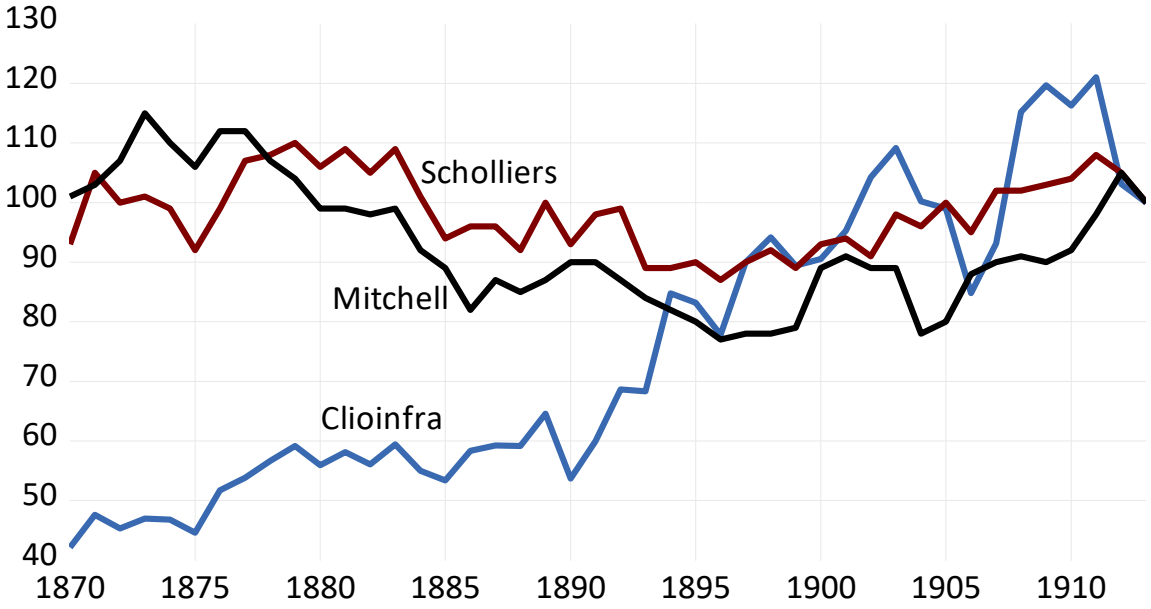
Belgium

For Belgium, different CPIs diverge before the mid-1890s. Figure 11 shows the Clioinfra series, rising at an annual rate of 2 per cent 1870-1896, while Mitchell falls at -1.3 and Scholliers at -0.5 per cent. Clioinfra uses Reinhart (2010), who refers to Allen (n.d. – at *iisg.nl*). In a related paper, Allen notes:

> There is considerable disagreement between Michotte (1934) and Scholliers (1995, pp. 107-108) as to the rate of inflation in Belgium. Scholliers was preferred. (Allen 2001, p. 437)[13]

If Allen relies on Scholliers, it is difficult to understand how Reinhart (and Clioinfra), when using Allen, can show 2.5 per cent higher inflation rate 1870-1896 and 0.5 per cent higher 1896-1913? A check with Allen's data at *iisg.nl* confirms the CPI from Scholliers (1995), but also produces a "new" CPI, which from 1873 is Scholliers adjusted for the declining price of

Figure 11. CPIs for Belgium, 1870-1913 (1913=100)



Source: See text.

[13] The devil has flung into the reference to Fritz Michotte's 1937 article. Scholliers and Allen have different though both wrong years, and Mitchell misspelt the name (see below).

silver. This of course makes sense when it is used as a deflator for nominal wages denoted in "silver prices". But it is reckless to take it as an indicator of CPI or to use it for deriving the inflation rate.

Mitchell (2013) used "Michelotte 1937" (should be Michotte) up to 1913 and some official calculations for the interwar period. According to Scholliers, the Michotte series was an unweighted average, of a relatively un-representative basket, while the interwar official indices was not much better. Jordà et al. refer for their CPI to Bank of Belgium for a series very close to Mitchell, and with the gaps 1915-1919 and 1940-1945 interpolated with a stock market index. Scholliers (1995) covers WWI and has, due to changing consumption patterns, four different baskets during the interwar years. His series has been used for 1870-1939, Mitchell (2013) for 1940-1960, and AMECO from 1961 onwards. A gap in Mitchell 1941-1945 has been interpolated according to trend 1940-1946.

Bulgaria

For Bulgaria, *South-Eastern European Monetary and Economic Statistics from the Nineteenth Century to World War II* (henceforth SEE 2014) present a retail price index 1890-1912, a "general price index" 1912-1932, and a CPI 1922-1941. The retail price index has been taken as a CPI, and the "general price index" has been used to estimate a CPI for the missing years.

Table 4. Bulgarian inflation regressed on inflation in Hungary and Austria, 1925-1943

Dependent Variable: BGINFL
Method: Least Squares
Date: 04/07/19 Time: 19:52
Sample: 1925 1943
Included observations: 19

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.837282	1.961268	-0.426909	0.6751
HUINFL	1.045629	0.214021	4.885640	0.0002
AUSTINFL	1.478767	0.691147	2.139584	0.0481

R-squared	0.664405	Mean dependent var	3.086829
Adjusted R-squared	0.622455	S.D. dependent var	12.94942
S.E. of regression	7.956727	Akaike info criterion	7.129852
Sum squared resid	1012.952	Schwarz criterion	7.278974
Log likelihood	-64.73359	Hannan-Quinn criter.	7.155089
F-statistic	15.83823	Durbin-Watson stat	1.772995
Prob(F-statistic)	0.000161		

Source: See text.

Mitchell (2013) presents a series for the interwar period through to 1947, which for the overlapping years is very close to SEE (2014), and this is used for 1942-47. For the following decades I have found no Bulgarian CPI until AMECO begins in 1985. For 1948-1984 I have dared a wild guesstimate, achieved by regressing Bulgarian inflation 1925-43 on inflation in Hungary and Austria and then forecasting the missing years. This series can, of course, only be very provisional as a CPI, and the resulting REER must also be very shaky, in particular for the late 1940s. An Eviews table (table 4 above) shows the fit 1925-1943. High volatility in the following years motivates a cut before 1947.

Czechoslovakia

Mitchell (2013) is used 1923-1990, although there is a gap. Up to 1948 it is a cost of living index for Prague and then there is the gap to 1953, which has been filled by help of Adam (1984, p. 110).

Denmark

Available CPIs for Denmark are confusing, since several refer to H C Johansen (1985 – who in turn refers to work by the labour historian Jörgen Pedersen for 1870-1913) as a source, but none perfectly match even if the trend is very close, as illustrated in table 5. Abildgren's (2005) series begins in 1875, and the historical CPI of Statistics Denmark in 1900. More worrisome than the minor differences in trends is that the number of outlier observations differ, and moreover poorly match. For example, in the series of Abildgren, only one of the observations with inflation above 5% coincides with the original series as presented by Johansen, and the other two differ in magnitude. What awoke my suspicions was the deflation of -10.6 per cent in 1882, according to Abildgren, when Mitchell had -1 per cent and Johansen -1.8. Given the unclear backgrounds of the alternative indices, Johansen is an easy choice. A problem in his series is a break between Pedersen's series, which stops in 1913, and the continuation from 1914 onwards. Despite a substantial acceleration in wholesale prices in 1914 (Johansen 1985), the official CPI shows a stagnation of CPI inflation from 2.7 to 2.6 per cent – I have followed Mitchell and Abildgren and assumed 5 per cent, still lower than the rise in wholesale prices with over 12 per cent. Small differences between the official CPI, Abildgren and Johansen in the following years up to the end of Johansen's series in 1980 are

Table 5. Comparison of CPIs for Denmark

	Abildgren	Mitchell	Stat. Denmark	H C Johansen
1875-1913	-0.14	-0.12		-0.12
1900-1913	0.85	1.13	1.09	1.15
1875-1913 No. obs >5%	3	5		4
1875-1913 No. obs <-5%	2	5		4
1900-1913 No. obs >5%	1	2	0	2

Note: Two top rows consider average annual rate of change in per cent, fitted trend.

probably due to rounding, while Mitchell deviates more in some few years. AMECO is used from 1961.

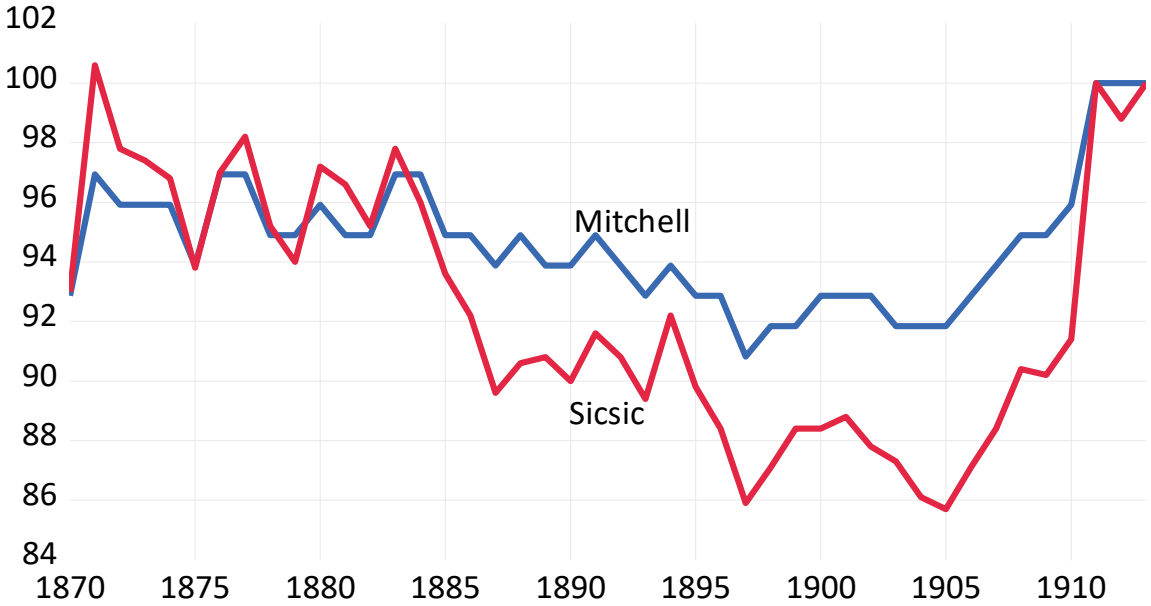
Finland

In her volume with historical national accounts for Finland, Hjerppe (1989) presents a cost of living index, with reference to a collaborative work of Heikkinen in 1983, for the period before WWI. Later, Heikkinen (1997) presented cost of living indices 1870-1913 for rural and urban Finland, as well as one for Helsinki and one for all Finland, which is slightly revised compared to that in Hjerppe (1989). Clioinfra is very close to both but does not exactly match any of them, whereas Mitchell (2013) has no CPI for Finland before 1914. Heikkinen (1997) for all Finland has been used here, and continues from 1914 with Hjerppe (1989) to 1960, whereafter AMECO is used. Hjerppe refers to official sources and the series matches well with Mitchell from 1914.

France

For France Clioinfra is identical to Mitchell. Mitchell refers to Singer-Kérel (1961) for the period up to 1914. However, Sicsic (1995) also refers to Singer-Kérel (1961), but presents a different series, as can be seen in figure 12. The thing is that Singer-Kérel constructed two cost of living indices, one composed of 214 items, which is very close to Mitchell (the difference might be due to rounding effects), and another with 213 items. With just a glance in the appendix table, the choice of the "214 articles" might look superior to the "213 articles". However, the 214th article is "gage", the word for remuneration of servants. And the

Figure 12. Cost of living indices for France (Paris), 1870-1913 (1913=100)



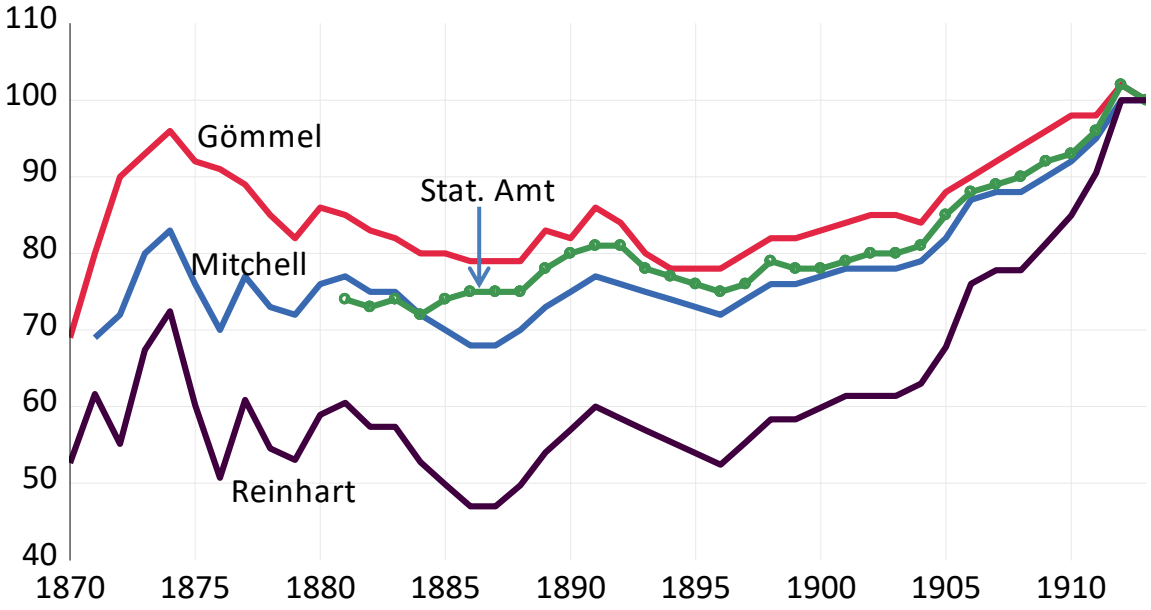
Sources: see text.

214 index is described as the "bourgeois" cost of living, while the 213 index is for a worker family. Apart from including the cost for servants, the 214 index has different weighting, for example just a fourth on food in the late nineteenth century as compared to two thirds for the 213 index. The Singer-Kérel indices are indeed ambitious, composed by a large number of commodities and reweighting the baskets with time. A drawback is that they do not consider all France but Paris. However, due to the careful and transparent construction, I have followed Sicsic (1995) and used the 213 articles index not only up to 1940, where Sicsic's study of real wages stops, but to 1954, when Singer-Kérel stops and the turbulence of the late 1940s was behind. Mitchell (2013), for the period after 1913 referring to the *Annuaire Statistique de la France*, is used for 1955-1959 and AMECO from 1960 onwards.

Germany

Compared to the original Mitchell CPI for Germany, it is puzzling that Clioinfra/Reinhart provide such a different series, despite Reinhart's reference to Mitchell (2003 – same in 2013). Something may have gone wrong in the handling of the material, since the inflation rate by Reinhart is exactly a multiple of 2, except for 1871 and 1872 where an extra quotation in 1871, by end of April, in Mitchell obviously caused trouble, and in years where both series

Figure 13. Different CPIs for Germany, 1870-1913 (1913=100)



Sources: see text.

have zero inflation. The doubling of the inflation rate implied by Mitchell continues in Clioinfra/Reinhart through to 1979.

It remains to choose between three other series in figure 13. Mitchell relies on real wage studies from the 1960s for the period before WWII. A more recent survey of the literature on real wages in Germany, by Hohls (1995), suggests alternatives. Only the cost of living index for Nürnberg, constructed by Gömmel (1979 – cited by Hohls 1995) stretch back to 1870. Gömmel suggested it was representative for Germany, though Hohls also presents a series 1881-1985 which is compiled from different CoL indices by Statistical Amts. From the late 1880s both series are similar but the rise in the mid-1880s makes the early Stat Amt series less probable and I use Gömmel up to 1914. From 1914 to 1960 the Stat Amt series is preferred over Mitchell. Both series are rather similar, but rounding (a consequence of low index figures) creates unnecessary noise in the inflation rate estimated with Mitchell, as well as in the long, linked index series. From 1961, AMECO is used.

Germany (East)

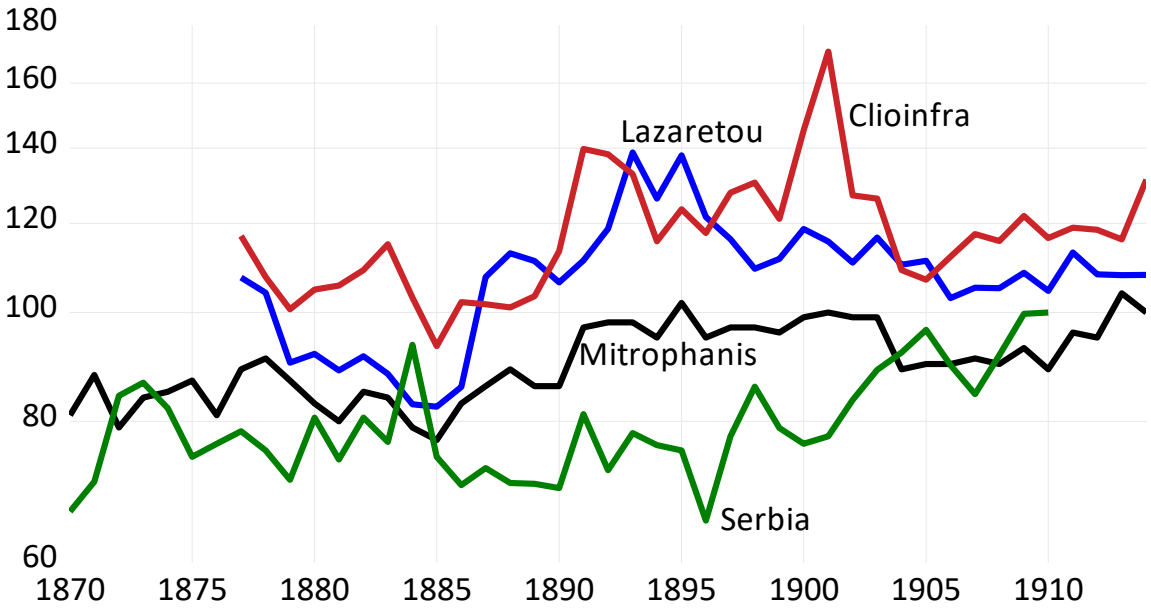
Mitchell (2013) is used for 1950-1989. The gap 1951-1954 is interpolated according to the trend between 1950 and 1955. From a glance at the series, one can presume that this index more reflects what the government thought the prices *should be* than what they actually were.

Greece

The inflation rate in Clioinfra (Reinhart) is based, down to 1939, on the GDP deflator from Kostelenos et al. (2007 – same in SEE 2014). Besides not showing the cost of living, the series displays an excessive volatility, as illustrated by figure 14. In an earlier work Kostelenos (1995) used another deflator with slightly less volatility, though with other timing of troughs and peaks. Why the differences occurred are not clear, except that the 1995 deflator is a Laspeyres while the later version is a Paasche index, but unless the underlying data are thin the differences should not be caused by the method. Lazaretou (1995) estimated an unweighted food price index on the basis of price quotations in larger cities of oil, butter, sugar, coffee and rice. It is indeed a narrow sample, and the long-term trends before and after the mid-1890s are different from most other countries. Volatility is somewhat less and with less concordance in timing than in the GDP deflators. The deviation from international trends may reflect a lack of integration, but one would presume that Greece were not more cut off from international markets than Serbia. Palairet (1995) presented a food price index for Serbia, based on five commodities (flour, black bread, beef, lard and soft cheese) and weighted to a household basket. As can be seen in figure 14, this index shows both a lower volatility and the familiar long-term pattern, with decline down to the mid-1890s followed by inflation. Yet, Mitrophanis and Riginos constructed a food or retail price index which is presented in Dertilis (2005), though with no information about its construction, referring only to whether it was averaged or weighted.[14] Given that the late Mitrophanis was a price

[14] I am indebted to Olga Christodoulaki for supplying the information about the Mitrophanis and Riginos index. Unfortunately the original index from 2002 was not published and seems only to have survived in Dertilis (2005). Yet, for 1914-1929 it is published in Christodoulaki (2015, p. 299), along with the official retail price index and the official CoL, as well as the 1995 and 2007 GDP deflators. Actually, a comparison of "Mitrofanis' index" with the official CoL for this period corroborates the former. For most years Mitrofanis is similar with the CoL, but while the latter has 2 per cent deflation in the middle of WWI (in 1917), Mitrofanis has 66 per cent inflation – yet in 1918 both arrive at about the same level, though CoL has now 135 per cent inflation while it has receded to 31 per cent in Mitrofanis, which is similar to the official retail price index. The CPI for Greece in Mitchell (2013) starts in 1914 and mirrors the official CoL, though illustrates the effects of rounding: while the latter has a rise from 323 in 1919 to 351 in 1920, resulting in 8.7 per cent inflation, Mitchell's index increases from 17 to 18, displaying 5.9 per cent inflation.

Figure 14. Prices in Greece and Serbia, 1870-1914



Source: See text.

historian, the co-author of a two-volume price history of Greek cities (Pizanias and Mitrophanis 1991), I have assumed that their index is the best available approximation of a cost of living index to 1914. As can be seen from figure 14, the trends before 1914 are still deviating from the international pattern, including Serbia, but it may reflect the development of the domestic market – a similarity with the Iberian Peninsula as will be seen below.

For 1914-1949 a CPI is available in Lazaretou (2014). For 1914-1928 reference is to the official CoL, based on price quotations for food, cleaning, heating and electricity in larger cities.[15] From 1929 until the 1950s price quotations were only from Athens but included more food stuffs as well clothing and housing rent (Lazaretou 2014, p. 132). To conclude, Mitrophanis is used for 1870-1929, Lazaretou (2014) for 1930-1949, Mitchell (2013) for 1950-1960, and AMECO from 1961 onwards.

[15] The index does not exactly match, however, the official CoL as reported by Christodoulaki with reference to the *Statistical Yearbook* of 1939, and has no deflation in 1917. According to Christodoulaki (2015, p. 54) the official price indices before WWII were unweighted averages. An alternative 1915-1929 might be Mitrofanis (from Christodoulaki 2015), though differences are very minor and Lazaretou's series is part of the ambitious SEEMHN project.

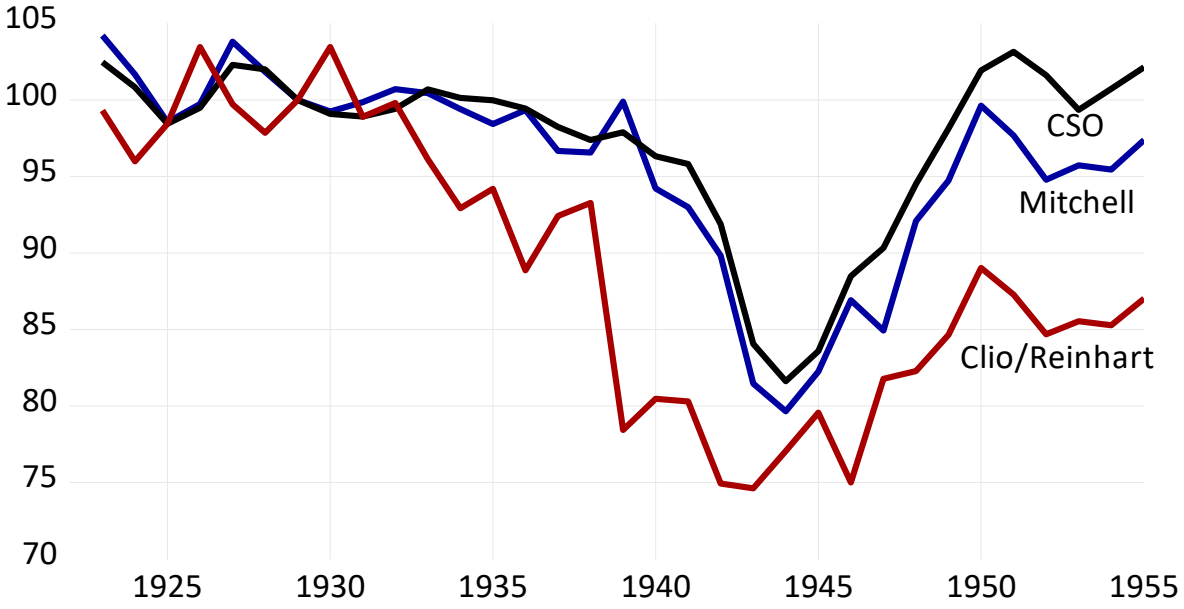
Hungary

Hungary is implicitly subsumed in the Austrian CPI up to WWI. The CPI is from Mitchell (2013) and starts in 1924, when the hyperinflation stabilized. The series is extended backwards to 1921 and with a value for 1914, based on the index figures for December each year, reported by Sargent (2013). Until November 1923 it is a retail price index based on 60 commodities with a base in July 1914 and reported by the Budapest daily *Pester Lloyd*, and from December 1923 to 1924 it is a wholesale price index based on 52 commodities 1923-24, calculated by the Hungarian Central Statistical Office and with the base in 1913 (Young 1925). Presumably both indices are just unweighted averages of the indexed price quotations. The figures, at least before 1924, are of course only rough approximations. Stabilization thereafter played havoc with the exchange rates and the REER for Hungary starts first in 1927. From 1973 the Mitchell CPI is replaced with AMECO.

Ireland

The *Central Statistics Office* of Ireland provides a CPI from 1922 (though with base 1914) onwards, which is used here (CSO 2018). It is very close to the series in Mitchell (2013), although the latter has a gap, unfortunately in 1956 which was a year of crisis in Ireland

Figure 15. REER for Ireland with different Irish inflation rates, 1923-1955 (1929=100)



Source: See text.

(Kenny 2016) and which produces a two-year gap in the inflation rate series. Clioinfra (Reinhart) provides a series of the inflation rate, which up to 1960 relies on Mitchell. However, Reinhart has lagged one year, allegedly providing inflation rates for 1922-1947, and somehow filling the gap for 1948, and then matching the source (Mitchell). Since occasionally there is a short-term volatility in the Irish inflation rate, the lag of one year conspicously changes the macroeconomic pattern, as can be seen from the effect on the REER for Ireland in figure 15. From 1961 CSO, Clioinfra, and AMECO are almost indistinguishable, and the latter has been used here.

Italy

Published Italian CPIs are an illustrative case of effects of rounding and incautious replication of typos. Clioinfra (Reinhart) follows Mitchell (2013) who refers to *Sommario di Statistiche Storicho Italiane, 1861-1955.* However, calculations of inflation, while the same with Mitchell and Clioinfra, are randomly different compared with calculations on the Italian original, where more figures are given for each observation. The differences may not be alarming (even if visible in the REER for Italy and major trade partners), until a clear typo in 1929 creates 33 per cent inflation, to be followed by 25 per cent deflation in 1930 (i.e., back to level), when the original results in 1.6 and -3.2 per cent respectively. Zamagni (1995), presents one urban cost of living index 1890-1946 and one rural 1913-1938, none of which displays a jump like Mitchell/Clioinfra, and broadly corroborate the official series. I have used the latter (Istituto 1958, 1968) up to 1960, and then AMECO.

Netherlands

For the Netherlands, van Riel (n.d.) has been used for 1870-1913, Mitchell (2013) for 1914-1960, and AMECO from 1961. Although van Riel's index is not a cost of living index but a deflator for consumption in historical national accounts, it can be judged superior to both Mitchell and Clioinfra (Reinhart). Mitchell begins only in 1880. The Clioinfra index displays a deflation rate of 2.7 per cent over 1870-1896, which is more than double the rate shown by van Riel. Even if the deflation according to van Riel still is steeper than in Britain and other neighbouring countries, though not very much than in Denmark, it seems the most realistic. Maybe a reweighting of the basket in a cost of living index would have emphasized the deflation even more, as consumers presumably changed to higher quality goods. Anyway, it is

based on a meticulous research in price history and the annual fluctuations, which differ between the three series, are probably most in line with the actual changes.

Norway

The CPI for Norway is constructed by O. H. Grytten (2004), done for the project on historical monetary statistics for Norway, and extends back to 1516. Jordà et al. (2019) refers to Statistics Norway and it seems to be the series by Grytten. Here only 1870-1990 is reproduced though in the REER calculations, it is used to 2003 and AMECO thereafter.

Poland

Clioinfra presents a CPI for Poland back to 1559 (with gaps), but of unknown origin before 1995. It is however identical with Reinhart (2010), who refers to Allen (n.d. – at *iisg.nl*) up to 1914 and to Mitchell for 1922-1963 and to IMF from 1964. However, since the REER begins first in the 1920s, I have used Mitchell (2013) up to 1960, except for 1949-1955, years for which Adam (1984) is used. Adam's figures are similar with Mitchell's except for 1950 where inflation would be 7 per cent instead of three times higher. I have simply assumed that Adam's pertinent study is more appropriate. Mitchell (and Reinhart) has a gap 1940-45, which years have been interpolated according to trend 1939-1946. From 1961 AMECO is used.

Portugal

For Portugal Nunes et al. (1989) have been used 1870-1960 (although for the interwar period neither NEER nor REER have been possible to calculate), and AMECO from 1961 onwards. Nunes et al. could rely on newly available price data for the nineteenth century, which were weighed in a basket and linked to the official cost of living index for 1900 onwards. In the early twentieth century there was one cost of living index constructed for Lisbon 1900-1916, according to Nunes et al who used the same weights for the nineteenth century. Mitchell (2013) presents a Portuguese index from 1929 onwards, which is said to be the cost of living in Lisbon until 1976. However, the official cost of living for Lisbon should not begin until 1948 and be followed by a national series from 1977 (Bastien 2001). Mitchell's series differs only due to rounding from the all-Portugal series in Nunes et al. during 1929-1947, but then

deviates by order of magnitude. The Clioinfra (Reinhart) series is identical with the inflation rates provided by the all-Portugal series in Nunes et al, except for 1900-1916 when it matches the Lisbon cost of living. Reinhart refers to Bastien (2001), which is a compilation of diverse series of prices and wages for the *Portuguese Historical Statistics* (Valério 2001), which for the cost of living in turn relies on Nunes et al. Nunes at al. (1989) thus seem to be an original source for 1833-1981, but has unfortunately been mixed up in the cost of living for all-Portugal and Lisbon in the 2001 *Portuguese Historical Statistics.*[16]

Romania

The present CPI for Romania runs from 1882 but must be taken with particular care before 1921, and again in the post-WWII period to 1970. 1882-1914 are estimated as simply the average of changes in the CPI of Austria and a food price index for Serbia (Palairet 1995), the latter missing for 1911-14 but is these years the Serbian index is extrapolated with Bulgaria. For 1915-21 it is assumed that inflation was the same as in Bulgaria. 1921-41 is the cost of living index in *South-Eastern European Monetary and Economic Statistics from the Nineteenth Century to World War II* (SEE 2014), continued 1942-44 with Mitchell (2013). 1945-70 have been estimated from a regression of the actual inflation rate 1925-41, on inflation rates in Hungary and Austria and then forecasted for 1945-1970. However, Hungary had hyperinflation in 1945 which in the estimate would spill over to Romania, why I have set inflation in 1945=1944. 1971-1987 the source is Clioinfra (Reinhart who refers to IMF), 1988-91 the European Bank for Reconstruction and Development (1991), and from 1992 AMECO.

Russia

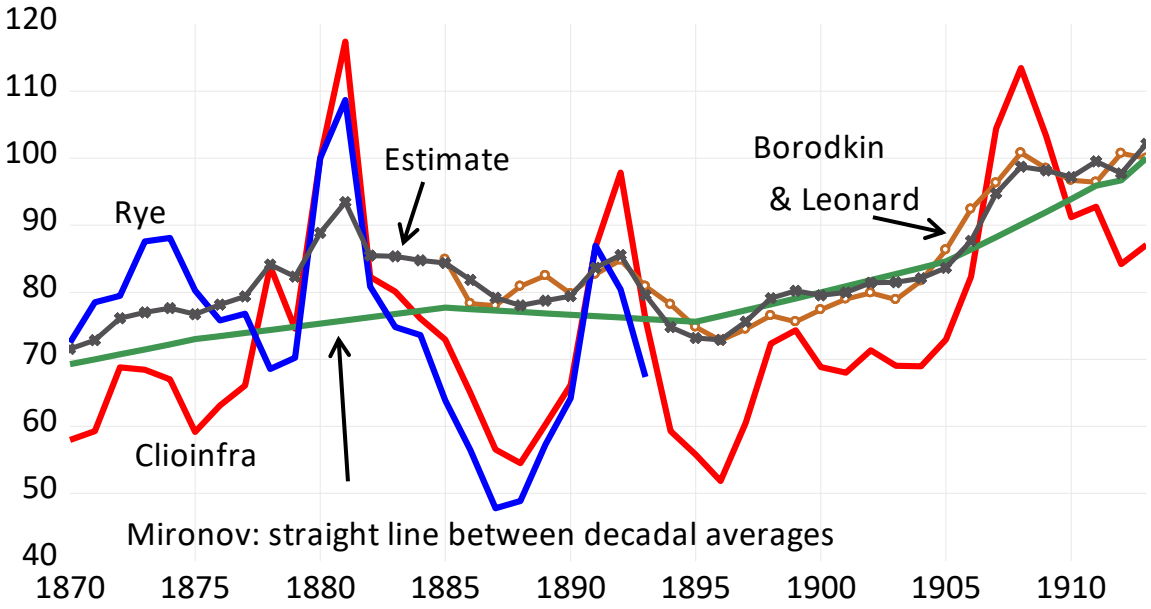
Gregory (1982) published different price and cost of living indices for Russia but only for 1885-1913. Borodkin and Leonard (2000) elaborated on the cost of living index but did not publish it – though they have kindly supplied it to me. However, it still only spans 1885-1913. Mironov (2010) presented a cost of living index for the period 1703-1913, but only with decadal averages. Clioinfra (Reinhart) has a series beginning already in the 1850s based on

[16] Though Clioinfra (Reinhart) has deviating inflation rates for 1867 and 1868, obviously by typing "85" instead of "86" for 1867, before retrieving the inflation rates. Jordà et al. (2019) refer to " Valério (ed) (2001)" which is the *Portuguese Historical Statistics,* but the article with the table is Bastien (2001).

prices for flour of wheat and rye, but for the years it is overlapping with the Borodkin and Leonard index, it shows an excessive volatility as can be seen in figure 16. Furthermore, one would expect a CPI or Cost of Living index to be less volatile than the prices of sensitive goods, even if these are important in the basket, such as rye in 19th century Russia. However, the Clioinfra index is more volatile than the rye prices in the port of St Petersburg, which rose with almost 60 per cent from a low in 1878 to a high in 1881, whilst from a low in 1875 the Clioinfra index rises with 98 per cent to 1881[17]. A comparison of the Clioinfra index with St Petersburg grain prices over the preceding decades shows indeed similarities, but while the index reaches a high in the early 1880s, the grain prices achieved the same level in 1868. One might conjecture that the impact of export demand, with a rise of the internal price level, was felt first 1880 which would support the Clioinfra index. However, against such a conjecture speaks an upward shift to a higher level of grain prices already after the Crimean war, in the late 1850s, and from that time until 1870 export quantities about trebled (Gulley 1987), why the impact of export demand would at least partly have worked through in the 1870s.

In order to provisionally solve the issue, I have prolonged the Borodkin-Leonard index backwards by an estimate with this model:

Figure 16. Prices and cost of living for Russia, 1870-1913



Source: see text.

[17] Online data to Andersson and Ljungberg (2015).

$$BL = \alpha + \beta_1 Clioinfra + \beta_2 Mironov + \beta_3 Time^2$$

which is estimated in an OLS regression for 1885-1913, and forecasted backwards to 1870. The different series as well as the estimate can be seen in figure 16, and the model fit in table 6. For the period after 1913 no Russian CPI is presented here, and no REER calculations forSoviet Russia are presented. REER for countries with Soviet as a trade partner have been constructed, though, with proxies for the Russian CPI based on neighbouring countries and, for 1947-1965 Mitchell (2013).

Table 6. Estimation of a cost of living index

Dependent Variable: LEONARD
Method: Least Squares
Date: 04/14/19 Time: 18:59
Sample (adjusted): 1885 1913
Included observations: 29 after adjustments

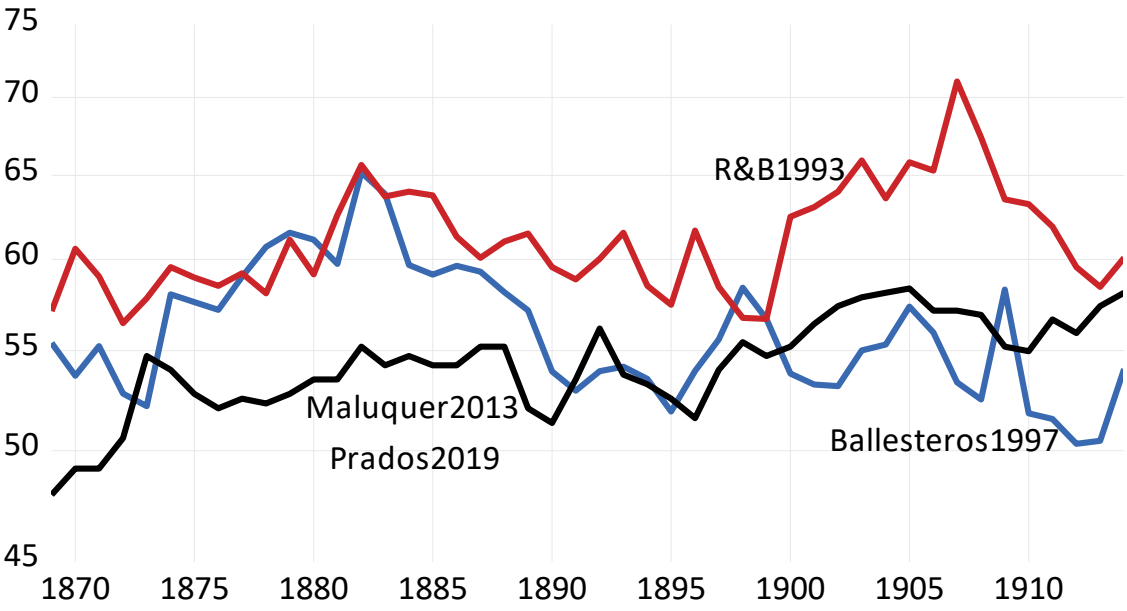
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-38.87629	13.09809	-2.968089	0.0065
MIRONOV	1.394388	0.193506	7.205922	0.0000
CLIOINFRA	0.239281	0.038850	6.159159	0.0000
TID^2	-0.009948	0.002664	-3.733502	0.0010

R-squared	0.929846	Mean dependent var	84.48966
Adjusted R-squared	0.921428	S.D. dependent var	8.965822
S.E. of regression	2.513182	Akaike info criterion	4.808419
Sum squared resid	157.9021	Schwarz criterion	4.997011
Log likelihood	-65.72207	Hannan-Quinn criter.	4.867484
F-statistic	110.4537	Durbin-Watson stat	1.180456
Prob(F-statistic)	0.000000		

Spain

Simpson (1995, p. 252) asserts "The price index for Madrid is the best available for Spain at the moment, although the range of products is especially limited in the 19th century." The index Simpson considered was constructed by Reher and Ballasteros (1993) and spans the period 1501-1991. This is the series also provided by Clioinfra, while Mitchell (2013) has a different series. However, later Ballesteros (1997) constructed a CPI for all Spain 1861-1936, based on price data from all provinces. Maluquer de Motes (2013) criticized previous indices, the one by Ballesteros for using prices in the nineteenth century not truly valid for the purpose of a CPI, and having inconsistent construction between different periods. Only in the timing of inflation 1937-39, Prados de la Escosura (2019) slightly differs from Maluquer de Motes, yet from 1939 they become more synchronized. Again in the 1970s there is a minor

Figure 17. CPIs for Spain, 1869-1914 (1929=100)



Source: See text.

difference. However, given that Prados de la Escosura (2019) links previous series, Maluquer de Motes (2006) to 1936, de Ojeda (1988) for 1936-1961, and the official statistics from 1961 onwards, I have taken Maluquer de Motes (2013) as the most recent update. Figure 17 compares the different Spanish CPIs over the period 1869-1914, when the differences between the earlier and later vintages are most significant. Intuitively Ballesteros 1997 seems most similar to countries in the west European core, but the decline after 1900 deviates from the international mild inflation. On the other hand, the trend of Maluquer-Prados is similar to the Portuguese (Nunes et al) CPI, and the absence of any deflation 1873-1896 might be due to a still feeble integration of the Iberian peninsula in the new Atlantic economy of the late nineteenth century.

Sweden

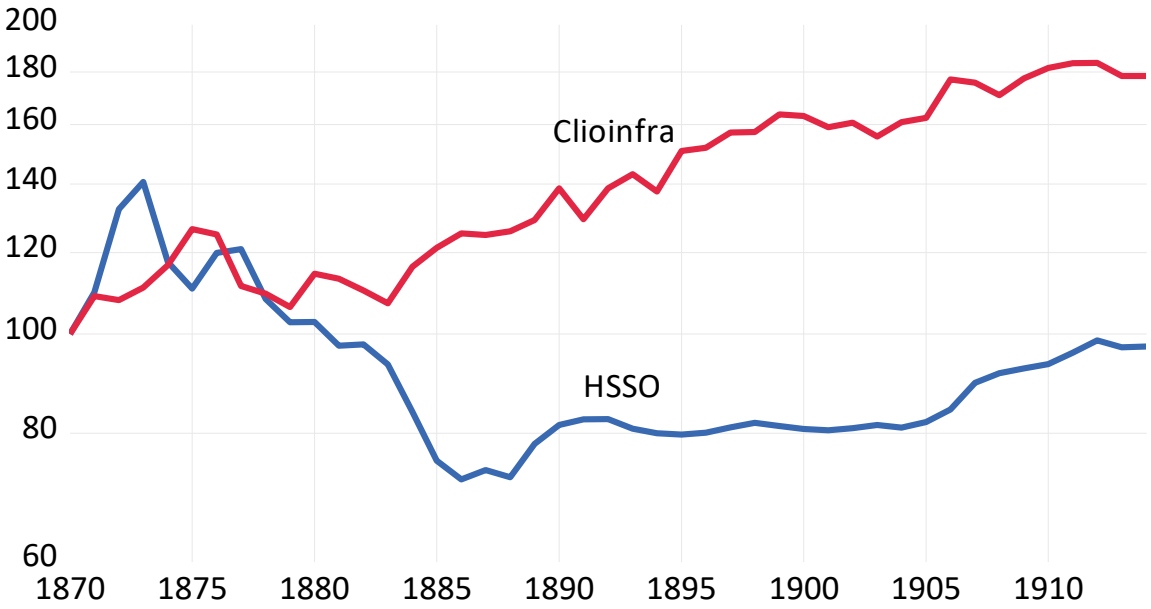
For Sweden the Cost of Living index by Myrdal (1933) is used 1870-1914, and from then onwards the official CPI. Myrdal based his estimate on a large and regionally representative price material characterized, due to the immature retail trade of nineteenth century Sweden, as "semi-wholesale prices" (1933, p. 24). It was weighted according to a budget, including

housing, which did not change under the period of consideration here. The official CPI was retrospectively calculated from 1914, during the interwar period reweighted only twice (SOS 1933, 1961).

Switzerland

For Switzerland, Clioinfra (Reinhart) provides the GDP deflator to 1913, and then reference is made to Mitchell (2013) until 1950 and IMF from 1951. A probably more valid CPI has been derived from the tables on nominal and real wages published by the collaborative project *Historische Statistik der Schweiz* (HSSO 2012). Both versions are shown for 1870-1914 in Figure 18. After 1914 the two series are rather similar but diverge in the 1940s. Here the HSSO CPI is used up to 1960 and from 1961 AMECO is used.

Figure 18. Switzerland, 1870-1914: CPI and GDP deflator as proxy CPI (1870=100)



Source: Clioinfra and HSSO (2012), tables G.02, G.05ab, and G.08a.

United Kingdom

For the UK several "CPIs" are available. In 2004 the Office for National Statistics authoritatively declared the one to trust:

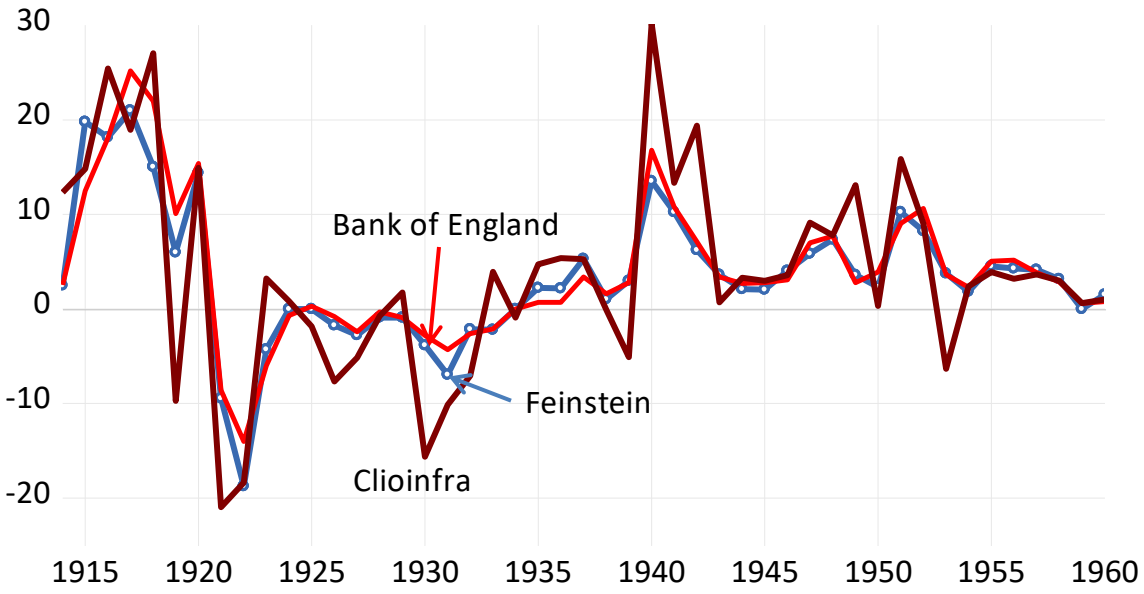
> This article presents a composite price index covering the period since 1750, which allows long-run comparisons to be made of consumer price inflation and the purchasing power of the pound. It replaces similar indices that have been published in the past by the Office of National Statistics, the Bank of England and the House of Commons Library …. The price index presented in this article therefore reflects movements in the prices and services purchased by the private domestic consumer, that is, ordinary households, rather than those purchased by businesses or public authorities. (O'Donoghue et al. 2004, p. 38)

However, while the presented "CPI" is a truly composite index it is actually for no period a CPI. Before 1870, of less concern here, it is composed of the somewhat dated price indices by Phelps-Brown and Hopkins (1956), to 1850, and Layton and Crowther (1935) 1850-1870[18]. From 1870 to 1947 it is the deflator for consumption expenditure in national accounts (Feinstein 1972), and from 1947 and onwards the official retail price index. Strangely the ONS project passed over later work by Feinstein, precisely aimed to a cost of living index, with annual observations 1770-1990 (Feinstein 1991, 1995, 1998). Recently Bank of England published the impressive database by Thomas and Dimsdale (2018), *A millennium of macroeconomic data for the UK* (henceforth *BoE*), where Feinstein (1998) is used for 1770-1882 followed by Feinstein (1991) to 1914, but then O'Donoghue et al. (2004), that is, Feinstein (1972), is used for 1914-1949. One should recall this is Feinstein's older consumption deflator and not cost of living index. From 1949 on *BoE* uses the official CPI (not the composite "CPI"). Figure 19 illustrates that the differences between Feinstein (1995) and the *BoE* series are minor, though not insignificant in certain years. Jordà et al (2019) uses the 2018 version of *BoE*. From the late 1940s, the series by O'Donoghue et al (2004), i.e. the retail price index, has minor differences with both *BoE* and Feinstein, but from 1980 their retail price index diverges upwards. Over 1980-2003 its inflation rate is 4.3 per cent, 0.5 and 0.6 per cent higher than AMECO and *BoE* respectively.

The third series in figure 19 is the one presented by Clioinfra (Reinhart). For 1870-1913 it is identical with Feinstein (1995), but from 1914 to the 1950s the differences are striking. Reinhart refers to Diaz et al. (2005), a mimeo or draft of a historical statistics for Chile, which

[18] In turn referring: "The index for the year from 1850 to 1910 was compiled by Mr. G.H.Wood" (Layton and Crowther 1935, p 232).

Figure 19. Inflation rates for the UK with different CPIs, 1914-1960



Source: See text.

later has appeared as a book (Lüders et al. 2016). The book does not, however, contain any CPI or cost of living index for the UK. Mitchell also has a CPI for the UK, which has some similarities though not matches the different versions of Feinstein discussed here. Feinstein (1995) has been used 1870-1960, and from 1961 onwards AMECO.

A fourth series has not been mentioned, despite probably being consulted by many economic historians: Greg Clark's series on earnings and prices in the UK 1209-2017 on *Measuringworth* (Clark 2019). For prices over the years 1870-1946, he relies on Feinstein (1995), which is defined as a cost of living index, and from 1947 onwards he uses the ONS retail price index. The inconsistency is pointed out above.

7. Concluding remarks

Although effective exchange rates arguably have a crucial influence on economies both in the short and long term, knowledge on their actual historical behaviour is scant. The new dataset presented and critically discussed in this paper covers an extensive share of Europe 1870-2016 and opens the field to further empirical and analytical research. Importantly, the NEER and REER series are constructed as chained annual Paasche indices, which makes them sensitive to movements both in the exchange rate and in trade. Compared with the available

effective exchange rates indices, such as those provided by the BIS and the IMF, the new NEER and REER cover a considerably longer period. However, the present indices also have other advantages such as consistency in construction and annual weights pertaining to the current year. As argued in the paper, the new indices are more transparent and representative in that they are single-weighted upon that which is actually measured, compared with the double-weighted, composite indices of the BIS and the IMF. For some countries, such as Germany and Finland, it is of paramount importance that the new indices in the years around 1990 have an adequate representation of the economic relations with Eastern countries.

Of course there are also weaknesses in the present NEER and REER indices. First, the larger volatility of the indices during, and in the years following, the world wars, as well as for the Eastern countries during the transition years around 1990, implies that the actual movements are more difficult to observe. The number of trade partners with reported trade diminishes during these years, and while not causing a gap in an index, the observations upon which it rests are reduced. On the one hand, this reflects historical conditions as they transpired but nevertheless, precision is diluted as a consequence of less data. Second, for some countries, a lower share of the trade weights were available and should be treated with more care. For some countries it can be shown that a lower nominal representativity does not necessarily mean a low real representativity, but a share of weights in total trade below, say, 60 per cent should be seen as room for improvement. Third, the implications of dual and multiple exchange rates are still unexplored. This has a particular bearing on the Eastern European countries during the Soviet dominance, but also several Western countries until recently had regulations of foreign exchange. It can, however, be argued that this is of less importance for the new NEER and REER indices as market indicators. Fourth, it has been shown that the chain indices are, even if superior as indicators of year-to-year movements, more or less accurate approximations of long-term changes. For the purpose of long-term analyses, it might therefore be advisable to construct Paasche indices with a fixed base year.

The construction of REER indices required the use of a variety of national domestic price indices. Cost of living indices, or CPIs, were chosen but it was found that the quality of easily available CPIs is often poor. Notably, the series for European countries published at Clioinfra, most of which emanate from Reinhart and Rogoff (2010/2011), contain serious flaws. This observation necessitated a critical survey of CPI statistics and an effort to find better data. Unfortunately, it was only possible to conduct this for the countries for which REER indices have been calculated, while non-European countries among the trade partners have not been

similarly scrutinized. This leaves room for further improvement and the CPIs for several European countries can be further developed since they only partly fulfill the requirements of a modern CPI. The survey in section 6 is a pioneer contribution to an improvement of historical CPI statistics, and accordingly the "currently best available" CPIs for 23 countries 1870-1990 are contained as a supplement to the NEER and REER indices in the database.

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Appendix 1: partner countries

Listed below are the countries for which NEER and REER have been estimated together with their respective partners, for which cross exchange rates, imports and exports, and relative prices have been used. Here are not detailed gaps, inter- or extrapolations, which are in overview mentioned in section 3, Data and consistency.

Austria-Hungary

1870-1914: Germany, India, Italy, Russia, UK, USA, Switzerland.

Austria

1927-1993: Czechoslovakia, Germany, Hungary, Italy, Poland, Switzerland, UK, USA, Yugoslavia (-1937).

1993-2016: Belgium, China, Croatia, Czech Republic, France, Germany, Hungary, Italy, Japan, Netherlands, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States.

Belgium

1870-1993: Argentina, France, Germany, India, Netherlands, Russia/Soviet, UK, USA.

1993-2016: Austria, China, Czech Republic, France, Germany, India, Ireland, Israel, Italy, Japan, Netherlands, Norway, Poland, Russian Federation, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

Bulgaria

1891-1993: Austria-Hungary/Austria, Czechoslovakia, France, Germany, Italy, Russia/Soviet, Turkey, UK, East Germany (1953-1990).

1993-2016: Austria, Belgium, Brazil, Chile, China, Czech Republic, France, Germany, Greece, Hungary, Italy, Netherlands, Poland, Romania, Russian Federation, Spain, Turkey, Ukraine, United Kingdom, United States.

Czechoslovakia

1920-1993: Austria, Germany, Hungary, Poland, Romania, Soviet, UK, USA, East Germany (1953-1990).

Czechia

1993-2016: Austria, Belgium, China, Denmark, France, Germany, Hungary, Italy, Japan, Netherlands, Poland, Romania, Russian Federation, Slovak Republic, Spain, Sweden, Switzerland, Ukraine, United Kingdom, United States.

Denmark

1870-1993: France, Germany, Norway, Sweden, UK, USA.

1993-2016: Austria, Belgium, China, Finland, France, Germany, Hong Kong, China, Ireland, Italy, Japan, Netherlands, Norway, Poland, Russian Federation, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

Finland

1870-1993: Germany, Russia/Soviet, Sweden, UK, USA.

1993-2016: Australia, Belgium, China, Denmark, Estonia, France, Germany, Italy, Japan, Republic of Korea, Netherlands, Norway, Poland, Russian Federation, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

Estonia

1995-2016: Belarus, Belgium, China, Denmark, Finland, France, Germany, Hungary, Italy, Japan, Latvia, Lithuania, Netherlands, Norway, Poland, Russian Federation, Sweden, Ukraine, United Kingdom, United States.

France

1870-1993: Algeria, Belgium, Germany, Italy, Spain, UK, USA, Sweden, Switzerland, Japan (1950-).

1993-2016: Algeria, Austria, Belgium, China, Czech Republic, Germany, Ireland, Italy, Japan, Netherlands, Poland, Portugal, Russian Federation, Singapore, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

Germany, East

1953-1988: Bulgaria, Czechoslovakia, Germany, Hungary, Poland, Soviet.

Germany

1870-1993: Austria-Hungary/Austria, Belgium, France, Italy, Netherlands, Russia/Soviet, Sweden, UK, USA, Spain, Denmark, Switzerland, Poland (1927-), East Germany (1953-1988), Czechoslovakia (1927-), Hungary (1928-), Japan (1953-).

1993-2016: Austria, Belgium, China, Czech Republic, Denmark, France, Hungary, Ireland, Italy, Japan, Netherlands, Norway, Poland, Russian Federation, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

Greece

Austria-HJungary/Austria, France, Germany, Italy, Russia/Soviet, Turkey, UK, USA.

1993-2016: Belgium, Bulgaria, China, Cyprus, France, Germany, Iran, Islamic Rep., Italy, Japan, Republic of Korea, Libya, Netherlands, Romania, Russian Federation, Saudi Arabia, Spain, Switzerland, Turkey, United Kingdom, United States.

Hungary

1927-1993: Austria, Czechoslovakia, Germany, Poland, Romania, Soviet, East Germany (1953-1988).

1993-2016: Austria, Belgium, China, Czech Republic, France, Germany, Italy, Japan, Republic of Korea, Netherlands, Poland, Romania, Russian Federation, Slovak Republic, Spain, Sweden, Turkey, Ukraine, United Kingdom, United States.

Ireland

1923-1993: Germany, Northern Ireland, Great Britain, USA.

1993-2016: Belgium, Canada, China, Denmark, France, Germany, Hong Kong, China, Italy, Japan, Republic of Korea, Malaysia, Netherlands, Norway, Singapore, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

Italy

1870-1993: Austria-Hungary/Austria, France, Germany, Switzerland, UK, USA.

1993-2016: Austria, Belgium, Brazil, China, France, Germany, Hungary, Japan, Republic of Korea, Netherlands, Poland, Romania, Russian Federation, Saudi Arabia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

Latvia

1995-2016: Austria, Belarus, Belgium, China, Czech Republic, Denmark, Estonia, Finland, France, Germany, Italy, Lithuania, Netherlands, Norway, Poland, Russian Federation, Spain, Sweden, Ukraine, United Kingdom.

Lithuania

1994-2016: Belarus, Belgium, China, Czech Republic, Denmark, Estonia, Finland, France, Germany, Italy, Latvia, Netherlands, Norway, Poland, Russian Federation, Spain, Sweden, Ukraine, United Kingdom, United States.

Netherlands

1870-1993: Belgium, Indonesia, Germany, Russia/Soviet, UK, USA, Norway, Sweden.

1993-2016: Austria, Belgium, China, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Norway, Poland, Russian Federation, Saudi Arabia, Spain, Sweden, Switzerland, United Kingdom, United States.

Norway

1870-1993: Denmark, France, Germany, Netherlands, Sweden, UK, USA, Canada (1909-).

1993-2016: Belgium, Canada, China, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Republic of Korea, Netherlands, Poland, Russian Federation, Spain, Sweden, Switzerland, United Kingdom, United States.

Poland

1922-1993: Czechoslovakia, Germany, Soviet, UK, USA, Hungary (1928-), East Germany (1953-1988).

1993-2016: Austria, Belgium, China, Czech Republic, Denmark, France, Germany, Hungary, Italy, Republic of Korea, Netherlands, Norway, Russian Federation, Slovak Republic, Spain, Sweden, Turkey, Ukraine, United Kingdom, United States.

Portugal

1870-1993: France, Germany, Portuguese colonies/Angola, Spain, UK, USA.

1993-2016: Algeria, Angola, Belgium, Brazil, China, France, Germany, Ireland, Italy, Japan, Netherlands, Nigeria, Norway, Russian Federation, Singapore, Spain, Sweden, Turkey, United Kingdom, United States.

Romania

1882-1993: Austria-Hungary/Austria, Czechoslovakia, France, Germany, Russia/Soviet, UK, Hungary (1928-), East Germany (1953-1990).

1993-2016: Austria, Belgium, Bulgaria, China, Czech Republic, France, Germany, Greece, Hungary, Italy, Republic of Korea, Netherlands, Poland, Russian Federation, Slovak Republic, Spain, Turkey, Ukraine, United Kingdom, United States.

Russia

1870-1913: Austria-Hungary, France, Germany, Romania (1883-), UK, Belgium, Netherlands, Finland, Sweden.

Spain

1870-1993: Argentina, Cuba (-1960), France, Germany, UK, USA.

1993-2016: Algeria, Belgium, China, France, Germany, Ireland, Italy, Japan, Republic of Korea, Mexico, Morocco, Netherlands, Poland, Portugal, Russian Federation, Sweden, Switzerland, Turkey, United Kingdom, United States.

Sweden

1870-1993: Denmark, France, Germany, Netherlands, Norway, UK, USA, Russia/Soviet, Finland.

1993-2016: Austria, Belgium, China, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Poland, Russian Federation, Spain, Switzerland, Turkey, United Kingdom, United States.

Switzerland

1870-1993: Austria-Hungary/Austria, France, Germany, Italy, UK, USA.

1993-2016: Austria, Belgium, Canada, China, Czech Republic, France, Germany, Hong Kong, China, India, Ireland, Italy, Japan, Netherlands, Poland, Russian Federation, Spain, Sweden, Turkey, United Kingdom, United States.

United Kingdom

1870-1993: Argentina, Australia, Canada, France, Germany, India, Netherlands, New Zealand, Russia/Soviet, USA, Denmark, Sweden, Norway, Belgium, Switzerland, Italy, Japan (1950-).

1993-2016: Australia, Belgium, Canada, China, Denmark, France, Germany, India, Ireland, Italy, Japan, Netherlands, Norway, Russian Federation, South Africa, Spain, Sweden, Switzerland, Turkey, United States.

Appendix 2

Table A2. Average annual rate of change of database CPI, different periods 1870-1989

	Austria	Belgium	Bulgaria	Czecho-slovakia	Denmark	Finland	France	Germany (West)
1870-1896	-0.80	-0,46			-0,83	-0,67	-0,36	-0,34
1896-1913	1,75	1,09	3,12		1,34	1,53	0,69	1,55
1914-1925	172	11,7	38,7		6,26	27,1	14,2	37,1 (-1920)
1925-1939	-0,15	1,43	-4,36	0,01	-0,31	-1,35	1,81	-1,56
1950-1969	3,39	2,02	4,25	0,04	4,07	5,10	4,38	2,07
1970-1989	5,18	6,58	9,95	1,41	8,81	9,67	9,18	4,00

	Germany (East)	Greece	Hungary	Italy	Nether-lands	Norway	Poland	Portugal
1870-1896		0,58		-0,29	-1,25	-0,90		0,17
1896-1913		-0,18		0,83	1,46	1,05		0,34
1914-1925		28,7		16,3	2,66	7,86		45,4
1925-1939		2,97	-1,02	-1,50	-2,13	-1,76	-5,75	-3,11
1950-1969	-2,96	3,65	1,18	3,51	3,17	3,56	2,85	1,71
1970-1989	-0,03	17,8	6,27	13,7	5,29	8,67	18,7	19,4

	Romania	Russia	Spain	Sweden	Switzer-land	UK	Serbia
1870-1896	-0,73 (1882-)	0,13	0,16	-0,71	-2,04	-0,98	-0,32 *
1896-1913	1,89	2,19	0,28	1,42	1,30	0,81	
1913-1925	45,4	48,3*	5,35	4,42	4,65	3,75	
1925-1939	-3,11	20,7*	2,15	-0,52	-1,86	-0,96	
1950-1969	1,71	-0,94 *	6,01	3,99	2,16	3,41	

1970-1990	2,31	0,62*	14,0	9,50	3,93	10,8	

Note: * not included in the database, source for Serbia is Palairet (1995).