Discussion paper

Challenges for the construction of historical price indices: The case of Norway, 1777-1920

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Abstract

This paper reviews some methodological and practical problems encountered in the construction of historical price indices. The underlying data sets in such studies are often characterized by heterogenous and incomplete price series. It is shown that by using the repeat sales method for constructing the subindices for individual commodity groups some of the main problems can be overcome. The procedures are illustrated by material from the construction of monthly price indices for Norway from the year 1777 to 1920. The price indices shed new light on two great wartime inflationary episodes in Norway: 1807-1817 and 1913-1920. In spite of a 61-fold increase in the price level in the first period and a 4-fold increase in the second, it is found that, after inflation had been brought under control, prices reverted to a level consistent with the purchasing power parity principle.

Keywords: Price index, price history, purchasing power parity

JEL Classification: E31, N13, N14

1 Introduction

The first generation of historical price indices was largely motivated by the desire to study the influence of the supply of precious metals on the variation in the general price level. The pioneering studies by Jevons (1865), Giffen (1879), Soetbeer (1886) and Sauerbeck (1886) were all sparked by the debate concerning the role of the supply of gold as the cause of the falling prices during the 'great depression' of the 1880s. However, the most influential price index was probably the one published by *The Economist*, which first appeared in 1869. This index grew out of the tables of commodity prices prepared by Newmarch, printed in the journal's *Annual Commercial and Financial History* supplement, from 1874 also updated in monthly reviews of market prices. In these sources prices of a number of basic commodities, primarily agricultural goods and raw materials, were collected, and indices were computed by averaging unweighted price relatives.

A second generation of price index contributions appeared after WWI, still motivated by the influence of the currency standard on prices, but also taking a broader perspective in their approaches to the measurement of prices. The inflationary upheavals of the war and its aftermath, and the pervasive effects that large price movements had on living standards and real debt burdens, had made it obvious that correct price level information was of utmost importance. Flux (1921), Rousseaux (1938) and Gayer et al. (1953) for Britain; Åmark (1921) for Sweden; Jacobs and Richter (1935) for Germany; Posthumus (1946) for the Netherlands, and Warren and Pearson (1932) and Cole (1938) for the United States are some key contributions to this literature.[1] These studies were technically superior to the first generation of indices; more attention was paid to commodity coverage, weighting and index formulae.

Another strand in the literature was represented by studies motivated by the task of measuring business cycles, such as Persons and Coyle (1921), Silberling (1923) and Tintner (1935). In this approach the sample was restricted to a limited number of price series that were sensitive to demand disturbances, thus being suitable to form a barometer of business fluctuations on the premise that prices were procyclical. But the majority of studies still remained within the tradition of measuring the general price level on a broader basis. Arguing against the business barometer approach Gayer et al. (1953, p. 465) maintained that '[t]he primary characteristic of a general commodity price index should be its inclusiveness.' This is still considered as the main approach to the construction of historical price indices[2]

This approach, which is followed here, is demanding with respect to sources and commodity coverage. Statistical theory can give us guidance as to the proper methods of computing indices, and extensive data searches can – and should – be made in order to make the index numbers as representative as possible. But if reliable market prices for a particular commodity did not exist a hundred years ago, elaborate statistical handling and overwhelming computer power cannot resolve this problem today. This point was poignantly phrased by Hoover (1958, p. 301): 'Despite great care and exercise of judgment in the selection of commodities for the index numbers, the investigators could not apply niceties of statistical sampling techniques to secure adequate coverage in the face of major gaps in data.'

This paper tries to illustrate how the practical problems of data availability can be handled in the case of constructing a price index for Norway, with a sample extending over 144 years, from 1777 to 1920. A monthly, rather than annual, price index is essential in studies of business

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[1] A more complete list of the early contributions can be found in the surveys in Fisher (1927, pp. 458-460) and Hoover (1958). The index presented in Flux (1921) only goes back to 1913, but his contribution is nevertheless of great importance in this connection because it contains a perceptive review of earlier indices and discusses many practical problems associated with the construction of historical price indices in a lucid manner.

[2] The requirement that price indices should be as broadly based as possible must inevitably be relaxed in studies spanning many centuries, as in Özmucur and Pamuk (2002) and Clark (2004).

cycles, financial crises and financial market behaviour in general. Therefore the main focus is on constructing high-frequency, i.e. monthly, price indices at what used to be referred to as the 'wholesale' level (to be discussed in more detail below), but the general issues reviewed here may also apply to annual indices or those within the cost-of-living or consumer price tradition.[3]

Although much price information may be available, it is a fact that with most data sets compromises must be made as to validity, reliability and frequency of price observations in order to construct a price index with a reasonably comprehensive coverage of goods. In this respect it will be argued that the application of the repeat sales method, well known from the construction of house price indices, is a valuable tool when dealing with incomplete historical data sets. The principles behind this method is explained and a simplified example of the technical details involved in computing this index is provided. The index numbers are derived directly from a least squares regression involving a set of dummy variables, requiring as data input only information on the rate of change of the individual price series and the dates at which the data are observed. It is argued that this method is particularly useful in the construction of high-frequency, i.e. monthly, price indices, but it may turn out to be useful whenever the underlying price series are characterized by incomplete observations. It should, however, be pointed out that the simple unweighted version adopted here is most applicable at the lowest level of aggregation, i.e. for specific commodities such as butter or pig iron. Once continuous time series of indices for individual commodities are constructed, these can be weighed together in the conventional manner.

A further problem, which is peculiar to the construction of monthly indices, is that some important data series may only exist on a lower frequency, for example annual. The material presented here illustrates one way of incorporating annual information into a monthly index, which seems to work well in many cases.

The next section reviews issues related to data sources, index measurement and statistical methods. Sections 3 presents aggregate price indices divided into three subperiods: 1777-1830, 1830-1913 and 1913-1920. In section 4 the new Norwegian indices are compared with German and British price indices for the same periods. This section also contains some analysis of price movements from the perspective of the purchasing power parity principle, which provides a useful cross-check on the performance of the new indices.

2 Data and methodology

2.1 Data sources

The price observations that would be most ideal for the construction of the families of price indices considered here are those determined on commodity exchanges.[4] Market prices originating from actual transactions undertaken by commodity brokers are also highly useful. Price currents of wholesale prices, giving a fair and well informed statement as to the actual level of commodity prices, are also within the desired range of sources. Such price currents existed for many of the leading commercial centres in the nineteenth century and earlier. The best known example is perhaps the *Economist's* weekly price current, which stated that '[t]he prices in the following list are revised on Friday with the assistance of an eminent firm in each department.' The universal price currents formed the backbones of several important early price studies, including the price

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[3]Much space should also be devoted to a discussion of the sources and characteristics of individual price series, which may highlight the strengths and weaknesses of the data material underlying the price indices, but space does not permit this here. See Klovland (2013) for a detailed analysis of these aspects.

[4]This is of course subject to commodity descriptions being standardized, so that prices are strictly comparable over time. The colonial wool sales in London, where quality standards varied over time and across auction houses, is one example from the nineteenth century which does not fulfill this criterion.

indices for Britain 1790-1850 constructed by Gayer et al. (1953), who drew their material from the Prince's Price Current in London. The authors put great emphasis on the criterion that each price series should be evaluated as to reliability and completeness, ending up with discarding 54 out of a group of 132 price series, mainly because data were fragmentary or the accuracy of the data was questionable. While the latter reason is based on sound principles it will be argued below that the problem of incomplete data series can be dealt with, thus obviating the need to discard potentially useful information.

Examples of similar sources may be found for Norway in the period covered here, 1777 - 1920, but they only exist for part of the period and mostly for a limited range of commodities. The weekly price current published in the Norwegian weekly financial newspaper *Farmand*, beginning in February 1891, is the closest we get to the *Economist's* price current.

In the early part of the sample the semi-official *Bergen Price Current* is an extremely valuable source. It contained monthly price quotations for export and import goods traded by merchants in Bergen. This source is available from May 1777.[5]

Figure 1: *The Bergen Price Current May-June 1777.*

When our sample started in May 1777 it was a rich source of price information on 'incoming' (import) goods such as wheat, rye, barley, oats, malt, salt, spirits, tobacco, iron, hemp, flax, linen cloth and canvas; there was also an extremely well specified price list of 'outgoing' (export) goods such as herring, stockfish, clipfish, fish oil, roe, tar, hides and skins. A page of the Bergen Price Current from June 1777 is shown in Figure 1.[6]

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[5]The city brokers (*stadsmeglerne*) obtained certain privileges from the king in Copenhagen in 1759, but by then they were well established. Coldevin (1938, p. 146) maintained that the Bergen Price Current dated at least back to the 1740s, and there are in fact traces of the Bergen Price Current as early as 1739, see Brautaset (2002, p. 51). Original issues of this source covering the period from May 1777 to December 1812 are at present located at the Regional State Archives in Bergen.

[6]The left hand side showing export goods refers to the previous month (May).

However, the price current gradually deteriorated as to coverage of quoted goods during the Napoleonic Wars. Figure 2 shows the Bergen Price Current in September (export goods) and October 1807 (import goods). In September 1807 the English bombardment of Copenhagen took place and the British blockade of Denmark-Norway became truly effective. No price quotations were recorded for September; in October it was basically only grain, salt and spirits left of the import goods and a few fish quotations from the export price list.

It has not been possible to locate the original issues of this price current after 1812. However, there exists a complete run of records containing weekly reports from the city brokers to the magistrate in Bergen giving information on the prices of selected commodities, chiefly cereals. In addition, much material containing the underlying market quotations in Bergen have been recovered from various other sources, including minute books of brokers, contemporary newspapers and the Wedervang Archive at the Norwegian School of Economics and other archival sources.[7]

Figure 2: *The Bergen Price Current August-September 1807.*

A very special source is The Nordland Price Current. In the summer months fishermen from the north of Norway came to Bergen to sell their stocks of dried and salted fish, fish oil, roe and, on a smaller scale, skins. In exchange the Nordland fishermen bought grain, salt, spirits and textiles. This activity peaked in May and August, when the Nordland fairs (*Nordlandsstevne*) were taking place. [8] The merchants of Bergen prepared in advance a comprehensive price list of goods sold to the Nordland fishermen and of fish products bought from them. Prices were stipulated with a view to give maximum prices for goods sold and minimum prices for goods bought from the fishermen, which is a quite remarkable principle. Coldevin (1938) made a thorough study of the relationships between prices from the Nordland Price Current, the actual

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[7]See Grytten (2007) for information on the Wedervang Archive.
[8]Coldevin (1938), Solhaug (1983).

prices paid according to archived invoices and the market prices in Bergen. His conclusions were that the first two set of prices were in general highly correlated, but that the prices actually obtained by the fishermen were somewhat more favourable than stipulated in the Nordland Price Current. There is also some evidence that the prices stipulated in the Nordland Price Current basically reflected going market prices, with a reasonable markup. We have access to the original printed sheets of the Current from 1815-1865, and some additional information before this from archival sources.[9]

Otherwise our sources include various contemporary newspapers, which published price information from town markets and local trade fairs. However, the most important information can be derived from prices stipulated by commodity brokers or grocers, which were published in Christiania from the early 1820s and in Bergen from 1861. The publication of the Christiania source petered out towards the end of the 1840s but the Bergen price lists continued to be published until 1916. In cases when no useful market price series were forthcoming unit prices from trade returns were used to some extent; such sources present special problems, which are dealt with below.

This brief review of data sources highlights the fact that most of the price series must be extracted from publications which are discontinued, incomplete and, in some cases, no longer accessible. This may be typical of many studies in price history. But even if sources are available on a continual basis there will inevitably be numerous cases when a particular data series is discontinued or contains substantial gaps. For many agricultural goods supply conditions may vary according to season, also being affected by occasional crop failures, thus creating lacunae in the price series; in general, quality descriptions may be altered and publication practices may change. The problems facing the researchers then is how to put together the bits and pieces of price material at hand to form continuous time series of the commodity prices.

2.2 Dealing with incomplete data series

The traditional way of dealing with this problem is to splice the time series at a point in time when there is overlapping information.[10] Applying this method necessitates great care and involves substantial work. If there are many time series and gaps to fill, as is the case with monthly data, this procedure may become virtually impossible to implement.

2.2.1 The principles of the repeat sales method

Given these problems we suggest using a type of index extensively employed in the construction of house price indices, where it is referred to as a *repeat sales* index.[11] When there are no gaps in the data this index is an ordinary chain index. The repeat sales index has been developed for a market where the price of each object is quoted infrequently and at irregular intervals, which typically characterizes the house market. A somewhat similar, but far less extreme situation is typical of our sample. Here, the gaps between the observed price quotations are in many cases much shorter, often of a seasonal nature. However, the problems encountered in splicing and aggregating the individual time series to an overall index are in principle the same, and the repeat sales method can easily take care of this.

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[9]A detailed account of all sources can be found in Klovland (2013).

[10]See for example Kennedy and Solar (2007) and Solar and Klovland (2011) for some recent studies in which this principle is systematically applied.

[11]The method was first launched by Bailey et al. (1963). One of the key house price indices in the United States, the Case-Shiller home price index, is based on this principle. The principles of this index are more fully discussed in Shiller (1993).

Formally, the index is derived from estimating the model

$$\ln(p_{it}) - \ln(p_{i,t-j}) = \gamma_1 D_{i1} + \gamma_2 D_{i2} + \gamma_3 D_{i3} + \ldots + \gamma_t D_{it} + \ldots + \gamma_T D_{iT} + \varepsilon_{it}$$

where p_{it} is the price of a particular commodity i (for example Black Sea wheat) at time t; similarly, $p_{i,t-j}$ is the price pertaining to exactly the same commodity j months earlier; D represents a set of dummy variables that take on a value of 1 at time t, a value of -1 in month $t-j$ when the last price observation of this particular description occurred, and zero elsewhere (so that $D_{it} = 1, D_{i,t-j} = -1, D_{i,t-s} = 0$ for $s \neq 0$ or $s \neq j$); ε_{it} is an error term. The estimates of the vector of γ-parameters can be obtained by standard regression methods. The final stage is then to compute the values X_t of the *repeat sales index* at time t as

$$X_t = 100 \cdot \exp(\gamma_t)$$

and then rebasing all index values in order to establish a base period value of 100.

In order to get an idea of how this method works in practice we may consider a stylized example shown below. Assume that we have collected price observations on three qualities X1, X2, X3 of a certain commodity, say salt, with the purpose of computing a price index (equal to 100 in period 2) for the seven periods shown here.

Period	X1	X2	X3	Index
1	NA	90	NA	100.0
2	100	90	110	100.0
3	NA	92	116	103.8
4	NA	93	NA	104.1
5	NA	NA	117	105.5
6	110	99	121	110.0
7	110	NA	NA	110.0

Because all data series contain gaps (NA observations) the main problem here would be to put together the information from all price series in a consistent way. For period 3 it would be natural to combine information from X2 and X3, which increase by 2.2 and 5.3 per cent, respectively, from period 2.[12] The average increase is 3.8 per cent, which is also what the index formula gives. But for the ensuing periods there is no unique way of splicing these time series, and in practice, with many time series such procedures would not be feasible to handle in a consistent manner.

The repeat sales method uses a simple least squares regression on time dummies to produce the estimated index values. In line with the chain principle it utilizes information on the rate of change from one period to the next (for example in the case of X2 and X3 from period 2 to period 3). In addition a procedure for searching backward in the sample if the observation is missing in the previous period is applied, using the rate change from any previous period (for example X3 between period 3 and 5 or X1 between period 2 and 6). These rates of change over one or more periods are referred to as transaction pairs.

In this example the actual data that are fed into the regression set look like this:

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[12] These rates of change are computed as continuously compounded rates in order to be consistent with the chain index principle and log specification of the index formula.

Obs. no.	ΔP_k	D_{k1}	D_{k2}	D_{k3}	D_{k4}	D_{k5}	D_{k6}	D_{k7}
1	.095	0	-1	0	0	0	1	0
2	.000	0	0	0	0	0	-1	1
3	.000	-1	1	0	0	0	0	0
4	.022	0	-1	1	0	0	0	0
5	.011	0	0	-1	1	0	0	0
6	.063	0	0	0	-1	0	1	0
7	.053	0	-1	1	0	0	0	0
8	.009	0	0	-1	0	1	0	0
9	.034	0	0	0	0	-1	1	0

The data set consists of the nine transaction pairs that can be formed from the rates of change in the price series. There are seven dummy variables corresponding to the seven time periods.[13]

The first two transaction pairs of price change in the ΔP_k column, which correspond to observations 1 and 2, are extracted from X1. X1 increases by 9.5 per cent between periods 2 and 6 and is unchanged from period 6 to 7. In observation 1 the dummy variable D_2 obtains a value of -1, D_6 a value of 1 and the other dummies a value of zero. Observations 3 through 6 are derived from X2 and the remaining from X3 in the same manner. Running a least squares regression on this data set produces a set of coefficient estimates on the seven dummy variables. Taking the antilog to these estimates, and (arbitrarily) assigning an index value to 100 in the second period gives the index values in the table above.

2.2.2   The advantages and the limitations of the repeat sales method

Filling the gaps in the price series

The repeat sales method can handle gaps in the data series of any length, thus utilizing all information in the data set. This is a great advantage of this method compared with a cumbersome manual splicing of time series of individual prices which is required in the traditional approach. It should also be noted that if there are no gaps in the data series this method simply produces an ordinary chain index, which has many appealing properties.

An application of the repeat sales method to late eighteenth century malt prices is shown in Figure 3. The available data comprise two monthly price series of German malt, two Danish and one English for the period from May 1777 to December 1799. The most complete series is Rostock malt, but even in this case data observations are missing for 31 months out of a sample of 272 months. By combining information from all time series an index of malt prices with a nearly complete coverage can be obtained, only estimates for two months are missing.

Weighting

The literature on the statistical properties of different price index formulas, from the 'ideal index' proposed by Fisher (1927) to the 'superlative index' of Diewert (1987), gives some guidance as to the choice of index formula, but in practice some modifications will have to be implemented in order to make the computations feasible. A chain index with continuously updated weights is presumably close to the theoretical ideal, but hard to implement. As noted above the repeat sales method would correspond to a simple chain index if there were no gaps in the data. 'Best practice' for price indices at present seems to follow the theoretical principles to some extent, but relaxing the requirement of frequent updating of weights to something like every five years.[14]

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[13]If a constant is included in the regression one of the seven dummy variables must be excluded.
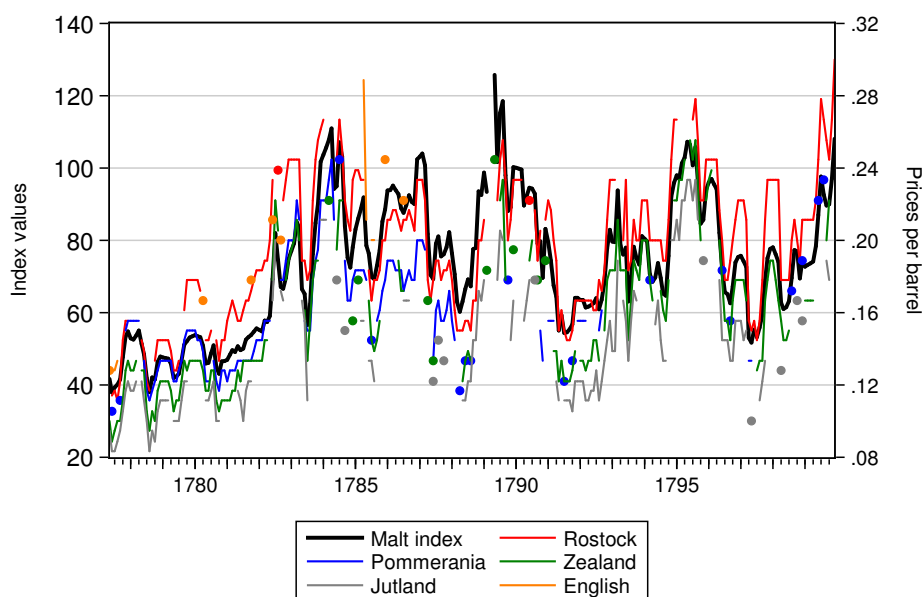[14]See for example IMF (2004) and Eurostat (2006).

Figure 3: *Malt prices and index values May 1777 - December 1799.*

In the case of historical price indices, for which the derivation of weights is more problematic, it is realistic to widen the time between revision of weights even further.

Instead of relying on the price of one single 'representative' commodity, this method makes it feasible to use all available price information, including prices on various commodity descriptions traded in the market to establish the 'representative' price.[15] One problem with this approach may be that the regression equations, from which the price index numbers are derived, treat all observations as equal. Implicitly, variables observed more frequently than other ones will exert a stronger influence on the index, simply because there will be more observations in the data set originating from this variable. An approach which attaches more weight to commodity specifications regularly quoted in the market because these are very often the ones most frequently traded might be a sensible way to proceed in many case. In the nineteenth century commodity markets in the United Kingdom there are many examples of such 'leading descriptions' which were nearly always quoted. The Sauerbeck (1886) price index is almost exclusively based on the prices of such articles, for example common Congou tea, best Friesland butter, Scottish pig iron, Manilla fair roping hemp, Wallsend Hetton house coal and so on. However, instead of relying solely on the information from such data series our approach allows for a broader information set by also including observations on other qualities that were less regularly quoted.

If this assumption of linking the regularity of quotations with the implicit weighting is not acceptable it may in some cases be possible to obtain a more representative sample by a careful choice of price series to be included. In the UK butter market, for example, the most important sources of supply in the middle of the century came from Ireland and Holland, later also from Normandy and in particular from Denmark. Quotations of Cork butter were widely publicized,

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[15]Flux (1921, p. 178), who saw an analogy between using individual price observations to measure the price level and shots from a rifle against a target: 'When a commodity is of great importance in our economic life, its price-position should have an influence on the index-number such as many shots from the same rifle might have in the case of the target.' from a rifle

specified for up to five qualities, in later years for both fresh and mild cured butter. Because the lower qualities were very inferior and not much traded one would be reluctant to include those in the sample. During the winter months some, or sometimes all, of the foreign qualities might temporarily disappear from the market, in which case the prices of Cork butter might be the only piece of information available on the market.

It may be argued that less weight should be attached to observations calculated from rates of change over long periods of time than on changes from adjacent periods, partly because changes in product specifications or other characteristics are more likely to have changed if there are large time intervals between the observations. This may be more of a problem in the construction of house price indices by the repeat sales method, where price observations on the sale of a particular property may be years or decades apart. But a correction for such effects may be applied in the case of price indices as well if preliminary tests indicate this to be a problem. Case and Shiller (1989) suggested a weighted three-step least square procedure to deal with this problem.[16] This method was applied in some cases on the Norwegian data reported in the final part of this article, but in general the index estimates were not much affected.

However, it follows from this discussion that this procedure lends itself mostly to the lowest level of aggregation, that of a particular commodity, say butter or pig iron, for which explicit weighting of different price observations is less urgent. If indices with a complete set of observations can be calculated at the commodity level it is an easy task to produce more aggregate indices.

Changes in commodity descriptions over time

Ideally one would like to observe an exact price over time for an invariant specific commodity description, but this requirement is seldom encountered in practice. New qualities are introduced on the market and old ones disappear. For some commodities, such as grain, the sources of supply may vary from season to season. In the second half of the nineteenth century wheat might come to Western Europe from North America, Russia, India, Australia and Argentina, but very often one or more of these sources experienced crop failures and supplies to Europe dried up. In such cases it is useful to work with many potential price series to ensure that there is an overlap in time between the various data sources.

Our index methodology makes it feasible to work with a very detailed commodity classification, and when the underlying price sources permit, we fully exploit all price information there is. In our Norwegian sample there are in some cases, such as herring, more than 50 price series, for stockfish about 80 series (many of which contain data for subperiods only). This procedure ensures that relative price changes from season to season of the various fish qualities are taken into account as far as possible. In general, however, the main reason for including a large number of individual price series for a particular commodity is that it produces a price index with fewer gaps. For example, in the case of rye there are 40 market price series, but none of them covers the whole period without gaps. The final price index for rye is nearly complete on a monthly basis for the whole span of 144 years, only during the period 1800-1814 are there a few missing observations in some years.

Seasonality

Regressing price changes on the set of time dummies automatically ensures that any seasonal pattern in the data are reproduced in the index number series. If seasonally adjusted data are

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[16]A second step involves regressing the residuals from the first step of the simple method outlined above on a constant and the time interval between the price observations (corresponding to the sales in the case of house prices). In the third step a weighted generalized least squares regression is run on a revised data set obtained by dividing each observation in the step-one regression by the square root of the fitted value in the second-stage regression.

desirable this can be achieved by the usual methods.

2.3 The use of annual data from foreign trade statistics

In the present case it was considered inevitable, as a last resort, to use unit prices from trade returns to represent some commodity groups for which no usable market data could be obtained. The main argument against using implicit prices from trade statistics is that the commodity item may in some cases be too broadly defined to give an accurate estimate of price movements. If the composition or product qualities are changing over time, the computed prices may be rather misleading. The use of these data should therefore be confined to homogenous commodities where quality differences and relative price changes are not contaminating the data.

However, even if one grudgingly accepts unit prices from the foreign trade statistics as part of the data base, there remains the problem of converting the annual average data to a higher frequency, if the aim is to construct a monthly index. Simply inserting the annual averages for each month is not an acceptable solution because it would create discontinuities in the computed monthly price series at year-ends.

To overcome this problem a smoothing algorithm that produces monthly data, but preserves the annual averages, is applied to the annual prices. The method applied here employs a procedure suggested by Litterman (1983), using related series (in this case only a constant and a time trend) and certain statistical assumptions about the error term to distribute the annual values over the twelve months of the year. In addition to smoothing the intrayear movements this method ensures that the annual average of the estimated monthly data equals the true annual average.[17]

In order to get an idea of how this method works in practice an illustration using an actual monthly time series is shown in Figure 4. The data series chosen is the monthly price of brown fish (cod liver) oil as quoted in Bergen from 1830 to 1913. This is a commodity with fairly wide cyclical fluctuations, occasionally subject to speculative behaviour with the inevitable subsequent collapse.

First, annual average values of the monthly data series, which only have minor gaps in some years, were computed. Then the Litterman procedure was applied to the annual time series, distributing its values over the months according to our assumptions about the related series (time trend) and the error term. The original monthly data in Figure 4 may then be compared to the estimated values using this procedures. It will be seen that the two time series track each other quite well. The inherent assumption that annual averages of the monthly series ought to be equal to the annual figures ensures that large and persistent discrepancies never occur.

The general features of the *intrayear* movements of the estimated series are relatively encouraging; the direction of change within the year is in most cases correctly reproduced and the timing of the peaks and troughs are not bad. What the smoothed series cannot pick up is of course the minor and irregular movements of the true series, also missing the extreme values of the more pronounced cycles by a wide margin. For example, it may be noted that the all-time high extreme value of the 1857 commercial boom, which occurred in June 1857, is grossly underestimated, but the dating of the peak is correct. The following steep decline of fish oil prices and the subsequent recovery is quite well picked up by the distribution procedure, however.

This illustration may be typical of the correlation between the true data and the estimated series, but in practice we will of course never know exactly how close the distribution procedure can mimic the true price series. However, the method seems to work sufficiently well to warrant

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[17]This procedure is implemented in slightly modified form in RATS version 8.0, with a different handling of the initial periods. An ARIMA(1,0,0) specification for the error term is generally assumed, but in some cases more reasonable results were obtained with a first-order serial correlation assumption only.
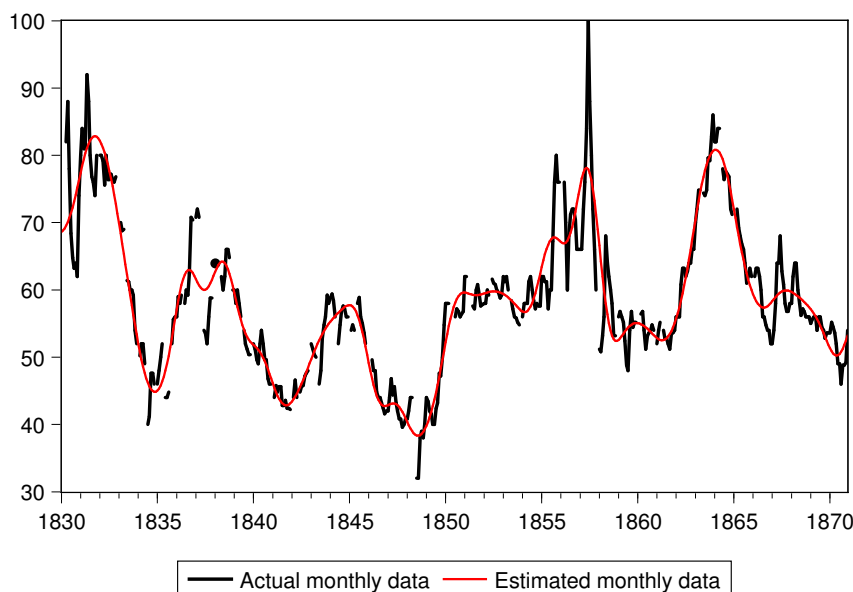
Figure 4: *Actual and estimated monthly time series for brown cod liver oil, 1830-1870.*

its use here. This procedure is only applied to annual trade return data for which little or no other intrayear information is available.

2.4 Wholesale and producer price indices

The first and second generations of price indices were commonly referred to as wholesale price indices. The term 'wholesale' may be defined as 'prices charged for sales in large lots, usually at the first commercial transaction or in major trading centers'.[18] These indices typically comprised both domestically produced goods and imported goods, but the principles of weighting were as a rule not applied in a consistent manner. According to Flux (1921, p. 177): 'The determination of appropriate weights for wholesale price indices has always been a problem involving a choice between conflicting conceptions.' He used cotton as an illustrative example; whether cotton and cotton goods are viewed from the perspective of producers or consumers makes a lot of difference in the case of UK price indices. In practice, the actual weights seemed to have been based on an uneasy compromise.

In recent years the focus has shifted more towards producer price or output price indices. These indices focus on prices obtained by domestic producers, thus including domestic goods sold at home, and, as an option, also exported goods, excluding imported goods altogether. It is also feasible to construct an index for the total supply of goods: domestic, exported and imported goods.[19] In any case, these choices should be made explicit.

By combining the product categories and price level definitions a whole family of indices can be derived.[20] The following types of indices are considered here, using the abbreviations *DOM* for gross output of domestic goods (sold in the home market), *EXP* for exported goods; *IMP* denotes imported goods :

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[18]Hoover (1958, p. 298)

[19]This was the alternative chosen by Flux (1921).

[20]See IMF (2004, pp. 61 - 72) for a useful discussion of these issues.

- **PPI:** producer price index (*DOM, EXP*)

- **WPI:** wholesale price index (*DOM, IMP*)

- **TPI:** total supply price index (*DOM, EXP, IMP*)

We use these labels for reference here, acknowledging that they may differ somewhat from the present use of these terms. A producer price index may often refer to domestic goods only, in principle also measuring prices net of taxes. However, taxes on domestic output is less relevant for historical indices of the nineteenth century or earlier, perhaps except for excise taxes on alcohol.

On the other hand the principle of using market prices, inclusive of duties, should be strictly adhered to with respect to imported goods.[21] Flux (1921, p. 188) noted that previous price indices in Britain had failed to apply this principle in a consistent manner. Gayer et al. (1953, p. 466) also criticized this practice, stating that prices quoted in bond (i. e. before import duties are paid) 'are, in a sense, nobody's price in England... In any case, under no circumstances is the subtraction of duty warranted for the purpose of an index of the British price level.' [22]

Two further points are worth mentioning in this connection. A case can be made for making some reduction in weights based on gross output measures if a raw material is used extensively in the production of a more finished good, and both are included in the index. Coal used in the production of iron and steel is a typical example of this, but in practice it is a matter of judgement how far this principle can be pushed.[23]

A second point concerns the fraction of agricultural goods that was not sold on the market but consumed on the farms. For historical price indices this may be a highly relevant consideration. In this study some allowance has been made for this in the cases of such goods as butter, meat, oats and hay, although the quantitative basis for doing so may be even more fragile than the output estimates themselves.

3 Highlights from Norwegian price history 1777 - 1920

This section presents some features of the new monthly price indices for Norway for the period 1777 to 1920, with particular focus on two periods, 1777-1830 and 1910-1920 in which price fluctuations were large due wartime disturbances. One purpose of this narrative is to verify that this approach produces sensible estimates of the index numbers, in particular by a comparison with foreign price indices. This requires attention to the movements of the exchange rate as well, which is most conveniently approached within the purchasing power parity framework. A second purpose is to show how the insight into the price history can shed new light on selected episodes in Norwegian economic and financial history. We give most attention to the early decades of the sample, in particular the Napoleonic War period, which were years of extreme financial turmoil in Norway.

In this study the repeat sales method is only applied to the lowest level of aggregation, at the commodity level, say for rye, barley, wheat etc. In order to aggregate the 110 commodities into

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[21]This does not apply to the case of pure import price indices and terms of trade measurement; here the relevant price measure may be ex duty or *cif* prices.

[22]The widely used Sauerbeck (1886) index failed to implement this principle, quoting sugar prices ex duty. This distorted the course of index numbers of sugar prices relative to other goods as duty rates on sugar were reduced and finally abolished in May 1874; a further anomaly is due to to the fact that there were differential duty rates on West Indian and Java sugar. See Klovland (1993) for further discussion and a revised Sauerbeck index based on market prices.

[23]See Flux (1921, p. 183), who also reduced the weight of maize due its role as a feeding material in meat production.

16 commodity groups (cereals, meat etc.) chained Laspeyres indices were used, with weights based on output or trade values determined in 1835, 1870, 1890 and 1910. The same procedure was applied in the aggregation to the overall indices. The choice of 1835 as the first year is dictated by the availability of reasonably complete foreign trade statistics. Separate indices are computed for the four overlapping subperiods 1777-1839, 1830-1879, 1870-1899 and 1890-1920. The subperiod indices are then spliced together in the years 1839, 1879, 1899 and 1913. A more detailed review of the results, including discussion and data for individual commodities is available in Klovland (2013).

3.1 The period 1777-1830

3.1.1 The currency regimes

At first it is essential to review the basic features of the changing currency regimes of the early years of the sample. Prior to January 1813 Norway had a common currency with Denmark, the *rigsdaler (Danish) courant*. After the relative tranquil exchange rate environment of the last quarter of the eighteenth century, the first three decades after 1800 present a marked contrast. These years were a period of extreme instability in currency values in Norway. Excessive inflation and a strongly depreciating currency necessitated two major currency reforms, one in 1813 and one 1816. The *rigsbankdaler* that was launched in January 1813 failed to stem the inflationary environment. However, the value of the new *speciedaler* currency introduced in 1817 was not permanently undermined by a reckless monetary policy, as had been the case in the previous currency regimes, but still the exchange rate against silver fluctuated wildly until the late 1820s.

The currency reforms and the inflationary periods present some problems for drawing a consistent picture of the true price movements in these years. A bird's eye view of the exchange rate development is presented in Figure 5, which shows indices of monthly values of the exchange rate against the silver valued currency Hamburg banco and the gold based pound sterling for the period 1777 - 1830.[24] The exchange rate indices are computed as the number of domestic currency units per foreign currency unit, thus an increasing value implies a depreciating domestic currency. The exchange rate series have been spliced using the official conversion ratios in order to obtain a consistent picture of the silver or gold value of the currency.[25] The primary market quotations are in rigsdaler (Danish) courant through January 1813; thereafter in rigsbankdaler. As from February 1817 actual market values of the speciedaler were used.

Between 1777 and 1813 the Danish-Norwegian currency, rigsdaler (Danish) courant, was the legal tender in Denmark-Norway. The par value against Hamburg banco was 125, before 3 December 1794 it was 122.5.[26] In January 1800 it was quoted at 138, or about 10 per cent below par. The rigsdaler depreciated slightly over the ensuing years, but not by more than a few per cent; it was quoted at 144.5 in January 1808. From then on the rate of depreciation increased considerably, approximately halving the currency value in terms of silver in each of the years 1811 and 1812. In January 1813, when the new currency, the rigsbankdaler was introduced, the old rigsdaler courant was quoted at 1750 in Bergen, possessing less than 10 per cent of its

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[24]The Hamburg banco retained its silver value throughout the period. In February 1797 the Bank of England suspended gold payments and the pound depreciated. The nadir was reached in August 1813, when the pound was worth only 70.8 per cent of its former value. Specie payments were resumed in May 1821. See Cannan (1925) for a review of these events.

[25]The official conversion ratios between these currencies were: in 1813, one rigsbankdaler for six rigsdaler (Danish) courant; in 1816, one speciedaler for ten rigsbankdaler. Commodity prices might be quoted in both old and new currencies in a transition period, reflecting these conversion rates. For a review of the main events of the currency history see Rygg (1918), Kristiansen (1925) and Keilhau (1952).
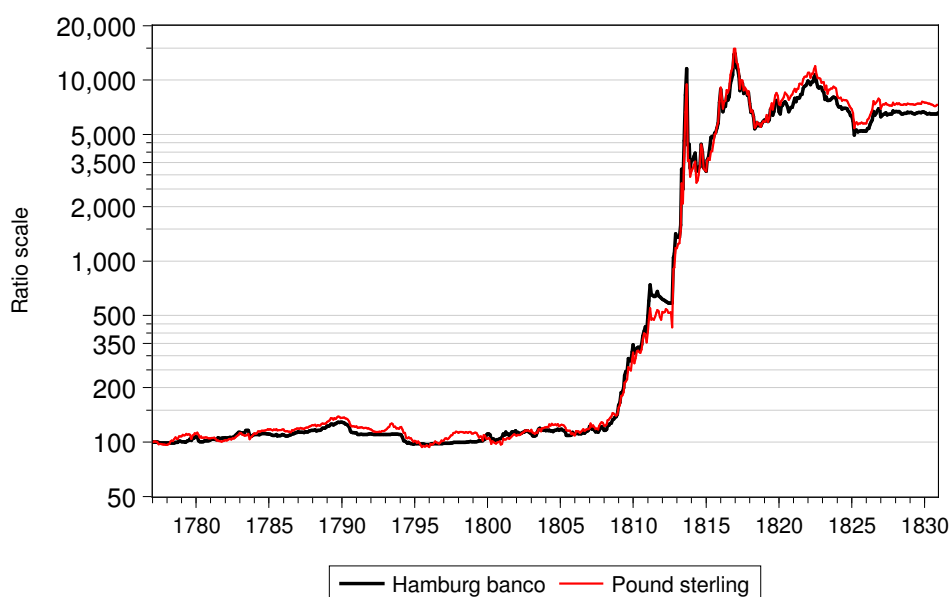
[26]Rygg (1918, p. 21).

Figure 5: *Exchange rate indices against Hamburg and London, 1777-1830. Januray 1777 = 100.*

original value.[27] A domestic merchant would then have to give up about 94 times as much in nominal domestic currency in 1817 as compared to 1800 to buy one Hamburg banco. In the next few years the currency appreciated markedly; in the 1820s the silver value of the speciedaler fluctuated much, nearly reaching its par value for a brief period in 1825, but the resumption of specie payments was delayed until April 1842.

Because of the magnitude of the currency depreciation and the financial turmoil surrounding the currency reforms the measurement of commodity prices may be associated with considerable uncertainty in these years. The problem is accentuated by the blockade during the Napoleonic war years. As an approximate guide to price level movements we should expect price fluctuations of roughly the same order of magnitude as in the currency values, given a reasonable stable foreign price level. A more exact guide, which takes into consideration fluctuations in foreign prices, is provided by the purchasing power parity analysis in section 4 below.

3.1.2 The aggregate price indices

In conformance with the discussion in section 2.4 three sets of indices are presented: producer price index (PPI), wholesale price index (WPI) and total supply price index (TPI). It will be recalled that the PPI index reflects the weighting of domestically produced goods sold at home and abroad; the WPI index differs from the PPI by including imported goods while excluding exported goods. The TPI index is constructed by using the combined weights of domestic goods, exports and imports.

When our sample starts in May 1777 it is seen from Figure 6 that prices were in general on a rising trend (although export prices were weak in 1778). It is difficult to single out any marked turning point in prices until August 1784, when all three price indices, PPI, WPI and TPI, reached a peak. At this time there is little or no further trend rise in prices until the final

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[27]Coldevin (1938, pp. 112).

years of the century, but there are some mild cycles. There were peaks July 1789 and September 1795 and periods of slightly lower prices in the middle of 1792 and in 1796 or 1797.

A much stronger price cycle starts in 1799, peaking in April 1801, when the price level is estimated to have increased by 63 per cent relative to January 1799 according to the PPI and by 94 per cent according to the WPI index. This difference is related to the fact that import prices rose much faster (138 per cent) than export prices (27 per cent) over the same period. The inflationary episode coincides with years of great expansion in the money supply after a decade of relatively constant volumes of the circulation of currency notes.[28] The Danish-Norwegian currency circulation increased by 15 per cent in 1799, by 32 per cent in 1800 and by 24 per cent in 1801, which is likely to have created an inflationary environment.

Considering the first three decades of the nineteenth century as portrayed in Figure 7 we get an overall view of the course of prices that is quite similar to the one conveyed by the exchange rate, see Figure 5. At first glance it appears to be a the strong similarity of price movements between the price indices in Figure 7. In contrast, during the more normal decades prior to 1800 the differences between the indices are more clearly identified, as shown in Figure 6. When the general price level movements become so large the general picture is largely independent of the choice of index, only during certain periods are there any discernible discrepancies between them. This is somewhat deceptive however, because there are important differences between the price behaviour of domestic and imported goods, which are highlighted below.

Prices showed cyclical fluctuations but no inclination towards a permanent rise in the first five years of the century. The great inflation period started in the final months of 1807. The surge in prices did not come to a halt until July 1814, when the WPI index was about 50 times the level of January 1800. It is seen from the graph that the WPI index led the way in the inflationary process, indicating that prices of import goods rose faster than export goods. We return to this issue in the next section.
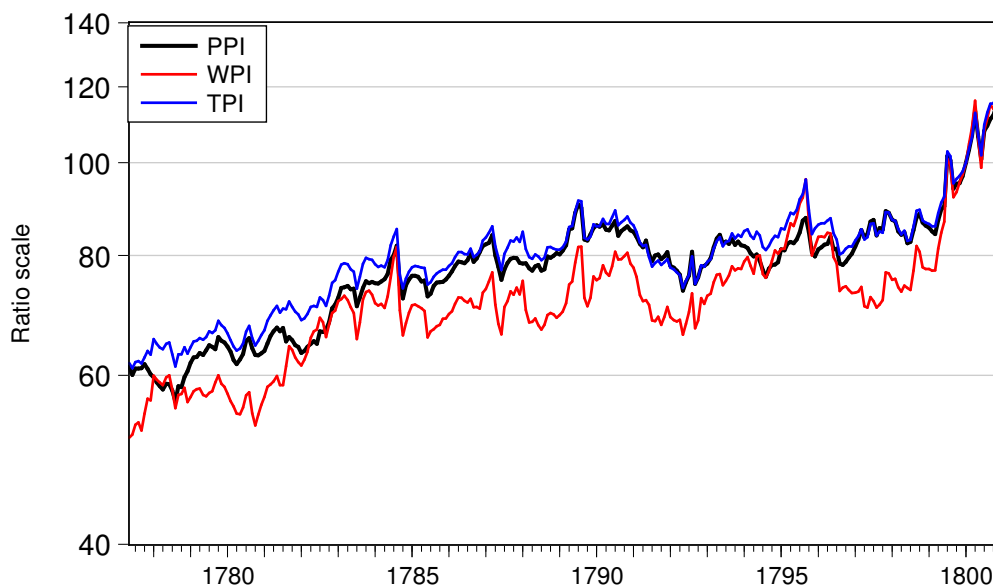

Figure 6: *Aggregate price indices 1777-1800. Seasonally adjusted. January 1800 = 100.*
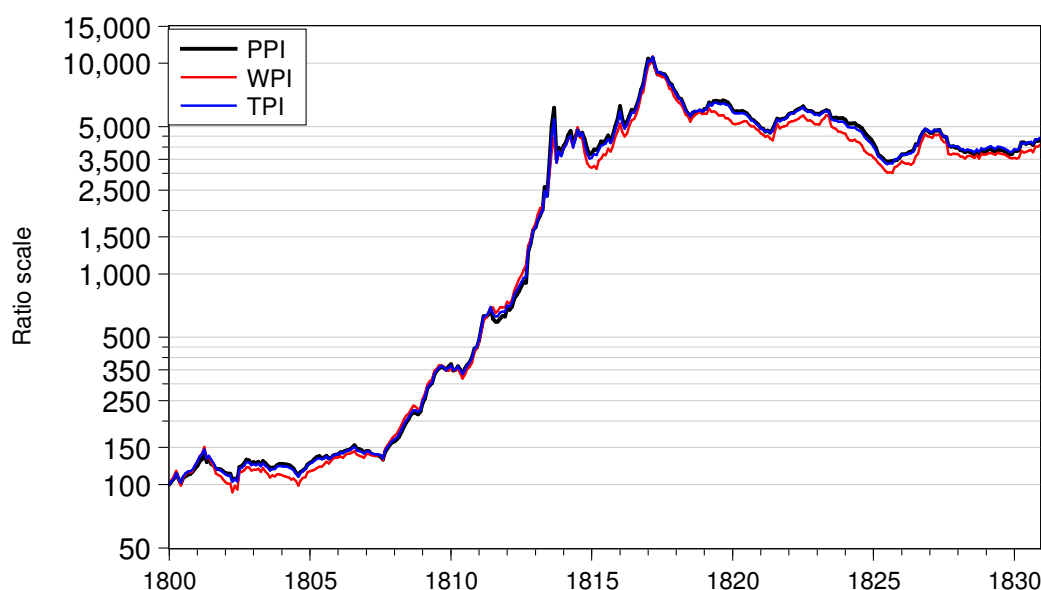
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[28]Svendsen (1968).

Figure 7: *Aggregate price indices 1800-1830. Seasonally adjusted. January 1800 = 100.*

During the second half of 1814 there was a short period of deflationary pressure as a reaction to the surge in prices in the preceding year – from the summer of 1813 to the summer of 1814 prices had risen almost 100 per cent. After March 1815 another period of sharply rising prices set in, which culminated in March 1817. It will be recalled that the exchange rate was at its weakest in January - February 1817. At its peak the WPI was more than 100 times higher than it was in the first month of the century, which is in line with the movements of the exchange rate as well. The characteristic bimodality of the silver value of the currency, as reflected in the exchange rate against Hamburg banco, applies to commodity prices as well. There are two distinct peaks in the price of banco, in September 1813 and January 1817 (Figure 5). The twin peaks of prices occur in September 1813 (July 1814 in the case of WPI) and March 1817. The winter of 1817 represents an all-time low for the international value of the currency and an all-time high for prices. In the case of the price index it took exactly one hundred years until this threshold was surpassed.

From the peak in 1817 the long-run movement of prices was downward over next decade. It is possible to identify several shorter cycles within this period, most notably a brief period of severe deflation reaching a trough in July 1825. This episode coincides with the dramatic appreciation of the exchange rate on Hamburg, which went from 216.5 in July 1822 to 101.5 in August 1825. The fall in the WPI index amounted to 82 per cent of the exchange rate depreciation over the same time span. This episode may have been sparked by speculative behaviour in anticipation of a resumption at the silver parity following a period of large export revenues from the timber trade with Britain, but it seems to have been short-circuited by the collapse of the export boom in the middle of 1825.[29]

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[29]See Rygg (1918, pp. 200-202) and Kristiansen (1925, pp. 163-166). For general background to the 1825 business cycle in Britain see e.g. Tooke (1838, pp. 145-171) and Gayer et al. (1953, pp. 174-210).

3.1.3 Export and import prices, terms of trade

Using export and import revenue shares in the benchmark years 1835, 1870, 1890 and 1910 we are able to derive monthly price indices of exports and imports for the whole period 1777-1920. We also compute time series for the ratio between export prices and import prices, referring to this for short as the terms of trade. It should be carefully noted however that this series deviates somewhat from the usual definition of the terms of trade, it may still be a useful indicative measure of the purchasing power of the nation's goods, excluding services.[30]

The new data series for the period 1777 - 1830 are shown in Figure 8. The export series is largely dominated by wood and fish products, including fish oil, which accounted for 43.6 and 50.1 per cent of the export price index, respectively. Other goods entering the export index in this period (weights in parentheses) are copper (2.6), iron (2.1) and tar (0.7). The most important components of the import price index are grain (44.6), textiles (14.0), alcohol and tobacco (8.0) and minerals (i.e salt and coal) (5.9), but the effective weights of these goods are higher, because price data for colonial goods (17.5) are not available prior to 1825.
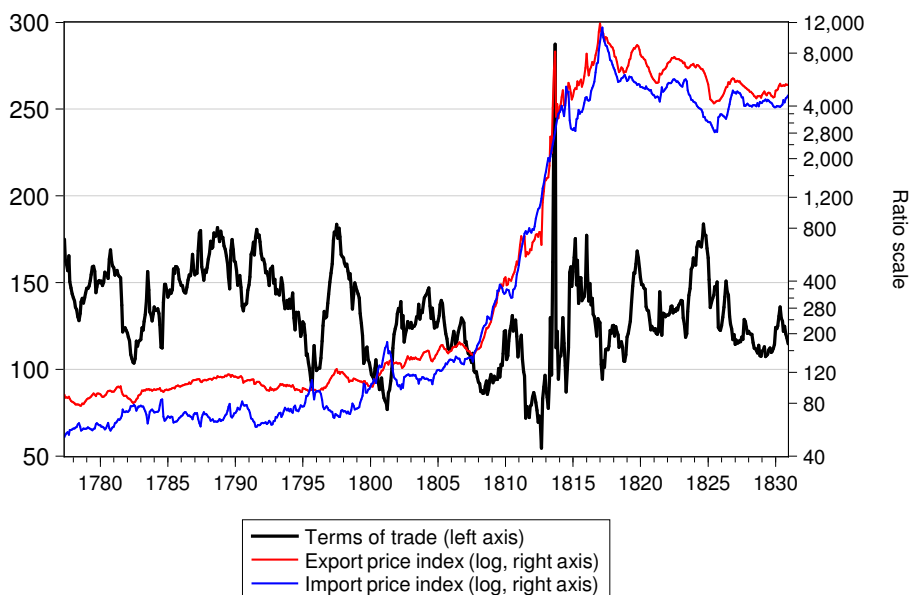

Figure 8: *Export and import price indices, terms of trade 1777-1830. Seasonally adjusted. January 1800 = 100.*

These caveats imply caution in interpreting the curves shown in Figure 8, but the graph nevertheless invites some tentative conclusions. There were large swings in the ratio of export prices to import prices, particularly from the middle of the 1790s. Prices of imports were on a slightly rising trend, but exhibited some distinct short cycles peaking in September 1795 and in April 1801. Import prices started to rise somewhat in 1805, and more strongly from 1807. Export prices rose in line with import prices as from the first years of the new century, but

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[30]One source of difference emanates from the fact that our import price index is based on market prices in Norway rather than being on a *cif* basis, thus comprising tariffs and excise taxes. A further difference derives from the fact that the price indices presented here refer solely to prices of commodities, excluding services. Because of the very important role played by the shipping industry in Norway a conventional and more comprehensive terms of trade may deviate from the time series shown here.

showed less cyclical movements than import prices.[31]

It is only in the second half of 1808 that we see any persistent upward movement in the prices of export goods. During the whole blockade and wartime period until 1813 import prices were more buoyant than export prices. The discrepancies between price fluctuations in exported and imported goods yield substantial movements in the terms of trade (as measured here). The export/import price ratio rises somewhat towards the year 1804, when a setback occurs. As discussed above, it is tempting to associate this with the effects of the political turmoil, from 1807 in particular with the naval blockade. In 1809 and 1810 the terms of trade are temporarily improving again, but a further decline sets in during the following year. The nadir is reached in 1812. After some violent swings, mostly due to wood prices, the terms of trade measure reverted to a level closer to the pre-blockade relationship only in 1819.[32]

Much has been written on the economic hardships facing Norway during the Napoleonic Wars and the final years before the secession from Denmark in 1814, but it has been difficult to underpin these stories statistically due to the almost complete lack of aggregate data on production and trade. Figure 8 may be one of the first pieces of hard evidence in this respect, although the uncertainty regarding the wood price index should be borne in mind when interpreting this graph, in particular short-run movements. The terms-of-trade evidence for Norway forthcoming here is broadly similar to the behaviour of relative prices found in some other countries during the high-water mark of the period of trade restrictions 1807-1814. Using price data to study the effects of the French and British blockades during the Napoleonic Wars Frankel (1982) and O'Rourke (2006, 2007) uncovered a marked tendency for prices of domestic manufactured goods to fall relative to imported goods in Britain, France and the United States. In the absence of reliable output data this evidence is taken as the most firm evidence that the embargoes bit, entailing a welfare loss for these countries.

Initially, Denmark-Norway declared itself neutral in the Napoleonic Wars, trading with both sides. But Britain attacked and captured ships, destroying large portions of the Dano-Norwegian fleet in two major battles in 1801 and 1807. Being a part of the Danish economy Norway was thus severely hit by the British blockade policy, following the British Order in Council in November 1807, stating that Norwegian ships would be seized if they tried to sail to a Continental port without putting in at British port first. But it was also greatly affected by Napoleon's Berlin Decree of November 1806, announcing the French blockade of British ports.

We can follow the disruptions created by this double squeeze more closely by looking at the prices of the two dominant export goods, fish and wood, relative to grain prices, as shown in Figure 9. As noted above fish and wood accounted for about 94 per cent of exports and Norway was heavily dependent on grain imports.

Norwegian fish products were largely sold on continental markets, in particular Germany (herring) as well as Spain and Italy (stockfish). As can been seen from Figure 9 fish prices were utterly depressed by the war-time trade disruptions, falling markedly relative to grain prices. Fish prices recovered after 1814 but did not regain their prewar level relative to grain until

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[31]This may partly be a statistical artifact because of the smoothing procedures applied to wood and copper prices. These data are only available on an annual frequency in this period and were transformed to monthly data series as explained in section 2.3 above.

[32]The price of Norway deals as quoted in London is the starting point for the calculation of wood prices in domestic currency, from which import duty, freight, insurance and commission in Britain were subtracted to arrive at an estimate of the cost in Christiania. This indirect approach was necessitated by the fact that little systematic information on wood prices in Norway was available, presumably due to the fact that the bulk of wood exports was sent as consignment goods. As a cross-check these estimates were compared to the actual cost of Norway deals in Christiania reported by Warburton (1835, p. 350). The final step in this calculation requires converting these estimates in pound sterling to Norwegian currency using the monthly sterling exchange rate, which causes extreme short-run fluctuations in this period. See Klovland (2013) for further details.
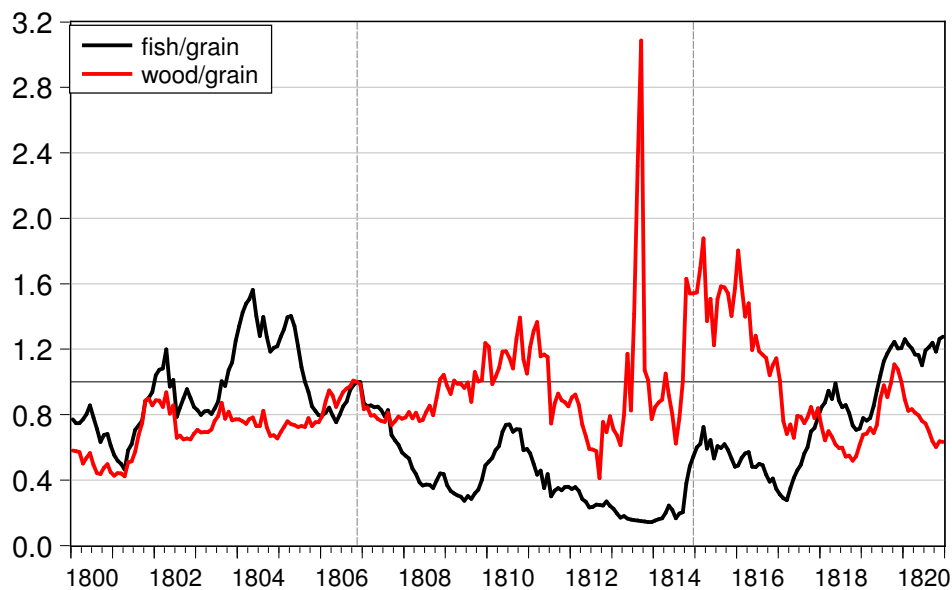
Figure 9: *Relative prices of fish and grain and wood and grain 1800-1820. Seasonally adjusted. November 1806 = 1.*

1818.[33]

Britain was the most important market for Norwegian timber and wood. In stark contrast to the case of fish prices, wood prices largely kept pace with grain prices in most of the blockade period. In a way this may reflect the superior naval power of the British navy in northern waters - wood cargoes to Britain had a much greater chance of slipping through foreign naval intelligence than fish cargoes to the Continent.

On the other hand, because Denmark-Norway sided with France in 1807, there was an official embargo on wood exports to Britain. Redirecting the wood trade via Gothenburg initially provided some relief; on the other hand huge tariff increases in Britain discouraged wood exports. The opening created by the trade in wood with Britain under the licence agreement starting in 1809 increased wood prices considerably, which is reflected in the terms of trade improvement at that time. But by 1810 wood prices were falling in Britain and freight costs and tariff rates increased, so that the wood trade was hardly very profitable any more. Thereafter wood exports dwindled and almost came to a standstill in 1813 and 1814.[34] The wood price movements in these years may therefore be of less importance for the wood export trade than in normal years - prices were fair, but only a limited number of timber cargoes were shipped to Britain.[35]

As from 1817 export and import prices (Figure 8) were both on a falling trend, which continued during the first half of the 1820s, but prices tended to converge toward a more stable level in the second half of the decade. The differential behaviour of the two indices are most

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[33]Jacks (2011) has shown that commodity prices were also affected by other factors than wartime events, in particular weather. The unusually bad grain harvests in Scandinavia in 1812 and 1813 may have contributed to the high grain prices in these years.

[34]Worm-Müller (1922, p. 78).

[35]According to Warburton (1835, p. 384) the volume of Norway deals imported into the United Kingdom in 1814 was only 18.6 per cent of the level during the height of the licence trade period in 1810 and 1811, the latter corresponding roughly to the normal level during prewar years.

marked around 1824, when the wood trade benefited from a boom on export markets while import prices declined steadily. Thereafter there was a quite marked decrease in the terms of trade towards the end of the decade.

3.2 The period 1830-1913

Figure 10 gives a bird's-eye view of the aggregate price indices over the period 1830 - 1913. The general picture is of one of strong cycles around distinct long-run price trends. In broad terms the new Norwegian indices follow the trend pattern of prices seen in many other European countries. The common features include the 25 years of generally rising prices from about 1850 to 1875, then a period of falling prices until the middle of the 1890s, often referred to as the great deflation, followed once again by an increasing price level towards WWI.[36] Upon these long-run trends is superimposed a picture of distinct price cycles, mostly of a five to ten years duration. The similarity with business cycles is not only with respect to amplitude and duration, but also with respect to timing. Many of the peak months of prices correspond to the business cycle peaks in chronologies for the major countries.[37] This is in particular the case for the decades beginning in the 1880s. All the peak years of prices in Norway – 1881, 1891, 1900, 1907, 1912/13, 1918, 1920 – fall in the same or within one year of the business cycle peaks in Britain. This might support a conjecture that prices were procyclical in this period, for which there is much international evidence, but the issue must await a more detailed econometric investigation.[38]
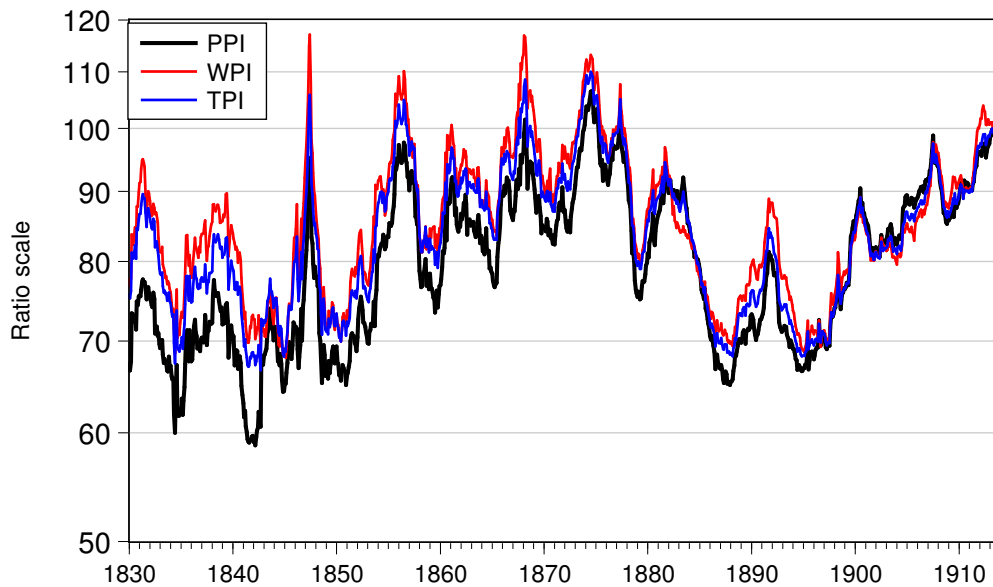

Figure 10: *Aggregate price indices 1830-1913. Seasonally adjusted. June 1913 = 100.*

We then look at a comparison with other available price indices with a view to see whether

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[36]Church (1975).

[37]Zarnowitz and Moore (1986).

[38]In a study including Norway in the sample Smith (1992) concludes that the international evidence supports the procyclicality hypothesis prior to WWI. Somewhat different results are obtained by Grytten and Hunnes (2012) in their study based on correlations between annual GDP output gaps and consumer price indices for Norway.

the new index conforms to the established picture of the trends and cycles in the price level in Norway. Only a consumer price index on an annual basis exists for comparative purposes for this period. Given the close links with Denmark, which was on the same metallic currency standards as Norway during this period, it may also be of some interest to make a comparison with a Danish consumer price index.

In the long run we would expect similar trend movements in WPI and CPI price indices. Short-term cycles, however, are often more pronounced in the WPI. This is essentially due to the fact that WPI contains a larger share of producer goods, such as raw materials, metals and minerals and, which are more sensitive to business cycles than consumer goods.
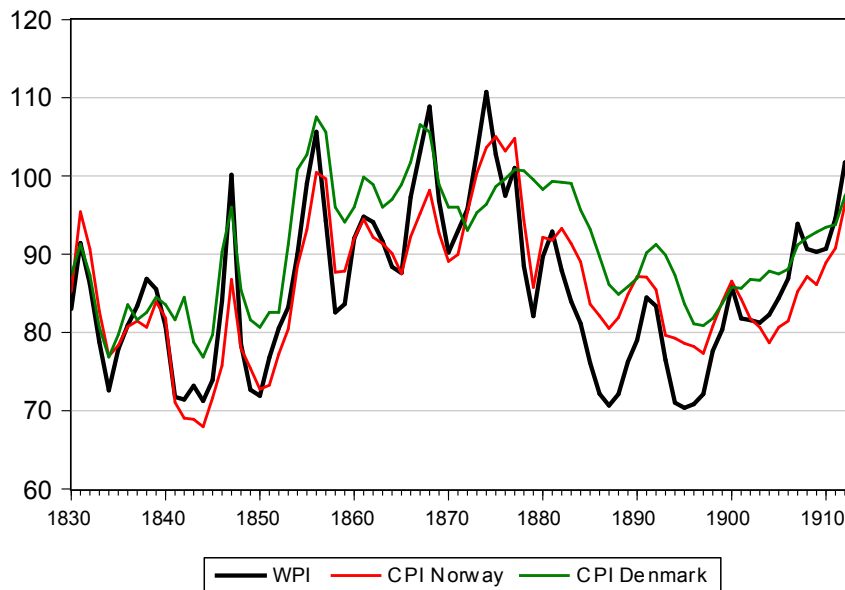

Figure 11: *Wholesale price index and consumer price indices for Norway and Denmark, 1830-1913. 1913 = 100.*

Figure 11 presents the new price indices with a consumer price index constructed by Grytten (2004) for the years from 1830 to 1913.[39] Also shown is the Danish consumer price index compiled by Abildgren (2009). The CPI indices are constructed as traditional Laspeyres indices. All indices have been recalculated to yield a value of 100 in 1913.

The correlation between the new WPI and the CPI indices is as good as can be expected given the differences in the composition, weighting and method of construction of the indices. The main deviation between the indices is a deeper swing in the WPI index in the 1880s and 1890s.

The long-run trend movements are very similar, with a gently rising trend in the price level during the middle of the nineteenth century until the 1870s, thereafter a deflationary environment until the middle of the 1890s, from which prices rose until World War I. This is a

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[39]The CPI index covers the impressive time span 1516 - 1871, with links to previous work extending the index right up to our time. After 1871 Grytten linked his index to a consumer price index constructed by Minde and Ramstad (1986). A comparison of our WPI index with the CPI index shows much the same cycles before 1830 as well, but these indices deviate much in the period 1812-1819 due to a different treatment of the currency conversions, see Klovland (2013) for further details.

familiar picture from the history of prices which was established long ago.[40]

The short cycles show much the same pattern, but the fluctuations are somewhat larger for the WPI compared with consumer price index, as would be expected. Prices were in general procyclical, with marked peaks around the upper turning points of business cycles. The correlation between the two Norwegian indices is fairly strong throughout the period, but somewhat weaker after the 1870s. In particular it is seen that the WPI records much deeper troughs in 1887 and 1895 than does the CPI. After 1900 WPI shows more buoyancy than CPI, with a local peak in the international boom year 1907.
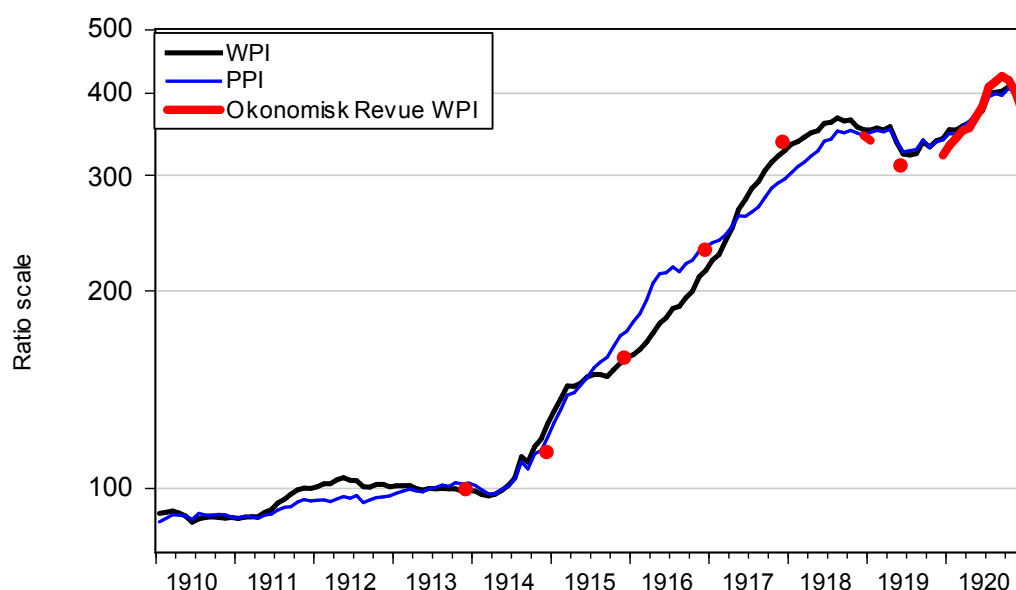
3.3 The period 1910-1920

Figure 12: *Norwegian price indices 1910-1920. June 1913 = 100.*

Figure 12 shows the wholesale (WPI) and producer (PPI) price indices for the 1910 - 1920 period. The great inflation of WWI and its aftermath is the dominant feature here. The tranquility of the prewar years is in marked contrast to the steeply rising prices during WWI. For comparative purposes the scattered index numbers available from a wholesale price index presented by the financial weekly *Økonomisk Revue* are also included. The index numbers are available at year-ends only from 1913-1919, in addition there is an observation from June 1919. Monthly data begin in 1920. It is seen that the new monthly indices are fully compatible with the evidence from the old index.

The war was a period of uninterrupted inflation rates hovering around 40 per cent per year. It is reasonable that PPI turns out to be the most buoyant price index during 1915 and 1916, which was an excellent period for Norwegian export industries. The WPI was rising faster in 1917, when the war boom was followed by severe impediments to trade. The relative changes in these price indices during these years reinforce the lesson from previous war episodes as to

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[40]A summary of the early evidence can be found in Warren and Pearson (1932) and Layton and Crowther (1938).

the importance of specifying the basis for commodity weights. The wartime inflation episode peaked just as the war was about to end, in October 1918 in the case of PPI and in August 1918 in the case of WPI. Then followed some months of falling prices until the postwar restocking boom began to take effect in the summer of 1919. The sharp inflation episode appears to have ended in October 1920. These features are similar to the ones experienced by many countries in these years.[41]

4 A comparison with foreign price indices

In view of the extreme inflationary environment of the first decades of the nineteenth century and the discrepancy between the new evidence presented here and previously published data for this period it may be useful to get a cross-check of the behaviour of the new indices for Norway, using foreign price indices as benchmarks. This analysis is undertaken within the framework of the purchasing power parity theory, although the purpose is not to undertake formal tests of this hypothesis. Rather, we turn the hypothesis on its head, assuming that the PPP principle holds, and then ask whether the implied course of domestic prices corresponds to the performance of the new domestic price indices.[42] These comparisons are in particular warranted for the wartime periods, considering the more than 100-fold increase in the domestic price level following the Napoleonic Wars and the 4-fold increase during WWI.

4.1 1790-1830

We first look to the general price index for Germany constructed by Jacobs and Richter (1935) for our comparison. This is a price index which comprises many of the same goods as the Norwegian index, weighted roughly in the same proportions as our WPI.[43] Agricultural products, are of great importance, obtaining a weight of 45 per cent in the German index and 58.4 per cent in the Norwegian index.

The price material which forms the basis of the new price index is less than complete in this period, however. In addition, there are technical differences in the construction of the Norwegian and the German price indices. It may therefore be useful to perform the same cross-check as above, but making a comparison with British data as well. The monthly wholesale price index derived by Gayer et al. (1953), which starts in January 1790, is used for this purpose.

Figure 13 displays annual averages of the Norwegian WPI and the German price index converted to Norwegian currency for the period 1792-1830, with 1800 set equal to 100 (scale on right axis). Figure 14 shows the same variables on a monthly basis using British data. The real exchange rate (scale on left axis) is also shown, being computed as

$$SR = S \cdot P^*/P$$

where S is the nominal exchange rate, P and P^* the domestic and the German or British price indices, respectively. The hypothesis of purchasing power parity (PPP), if it were to hold exactly at each point in time, implies that domestic and foreign prices converted to Norwegian currency

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[41]Eichengreen (1992, pp. 100-124).

[42]There is a large body of evidence supporting the conclusion that the PPP relationship holds approximately in the long run, see e.g. Froot and Rogoff (1995) and Taylor (2002). Empirical testing of this hypothesis on Norwegian data has previously been undertaken by Edison and Klovland (1987), who found considerable support for an augmented PPP hypothesis on a century of Norwegian-British data 1874-1971, taking into account productivity and real interest rate differentials.

[43]The prices underlying the German index are computed from prices quoted in currencies with a fixed silver content (Jacobs and Richter (1935, p. 17)). There are several alternative index series in this source; here, we use the total index with 1820 weights tabulated on page 80. These data are annual and go back to 1792.

should be equal. It follows from the same principle that the real exchange rate, SR, should be invariant over time, equal to its value of 100 in the base year 1800.[44] In practice, this result is seldom or never obtained, even in periods of no impediments to trade and more tranquil and integrated commodity and financial markets. In this period there is even more reason not to expect the relationship to hold on an annual basis. What we should look for in this connection is whether there is a tendency to equality in the long run, which is a useful cross-check regarding the validity of the new price index.
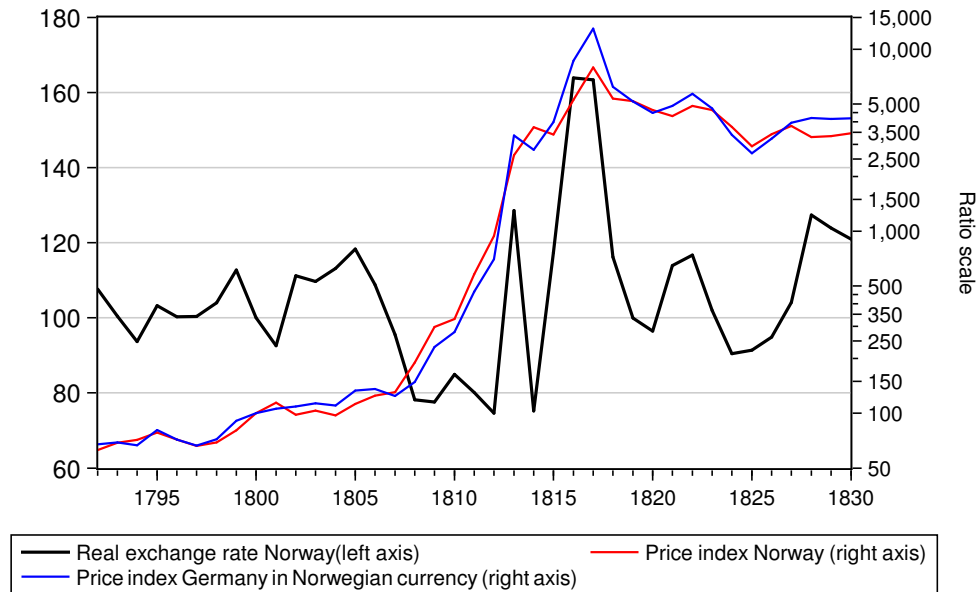

Figure 13: *Price indices for Norway and Germany and the real exchange rate, 1792-1830. 1800 = 100.*

Looking at Figure 13 the Norwegian and German price indices do indeed give an impression of following each other fairly well over time. The inflationary episodes occurring between 1797 and 1803 and the much more severe inflation period between 1808 and 1817 are closely related to the what one would expect given the German price index and the exchange rate on Hamburg. This also applies to the reversal of the trend in the direction of a deflationary environment in the 1820s. The British data in Figure 14 basically yield the same conclusions.[45]

The close long-run relationship does not preclude quite significant discrepancies on an annual basis, however. This phenomenon is best studied by looking at the behaviour of the real exchange rate. Before 1808 the real exchange rate against Germany hovered around 100, well in accordance with the PPP principle. After this there were larger swings in the real exchange rate. From 1807 to 1812 the real exchange rate took on values well below 100, which is tantamount to a real appreciation. This implies that either the nominal exchange rate is stronger (or depreciated less) than PPP predicts, or that domestic prices are higher – or a combination of both factors.

To a large extent the same features can be found in the case of Britain: a fairly stationary real exchange rate until 1805, then there is a real appreciation which is accentuated during the

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[44]The relative purchasing power parity hypothesis is that $S = k \cdot P/P^*$, where k is an arbitrary constant (for example 100). If the PPP hypothesis holds, it follows that $SR = k$, being invariant over time.

[45]Formal tests for cointegration (Johansen (1991)) show that the price indices and exchange rate are cointegrated in both cases.
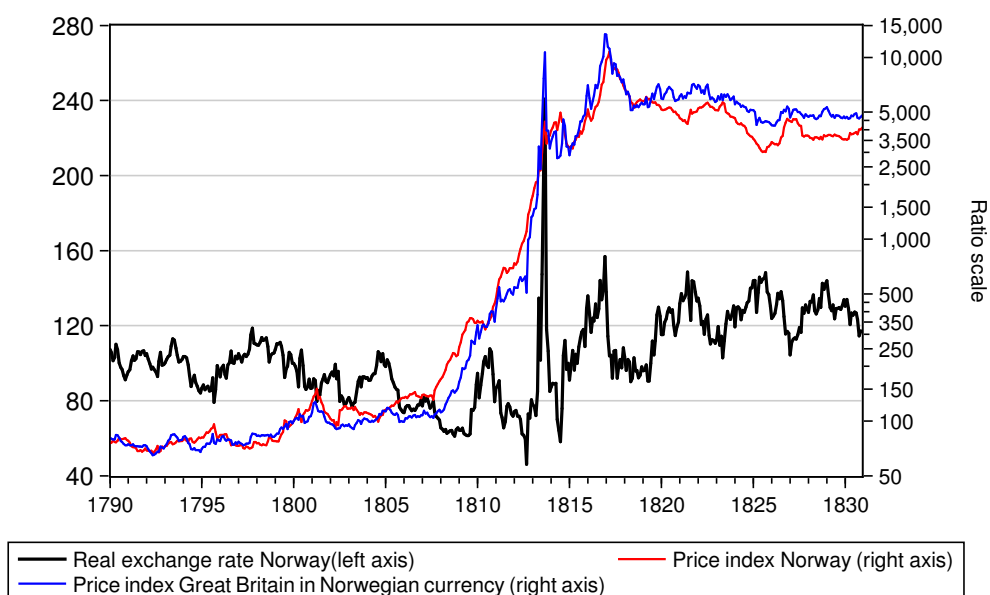
Figure 14: *Price indices for Norway and Great Britain and the real exchange rate, 1790-1830. January 1800 = 100.*

blockade period. Interestingly, there is a temporary return to a prewar level during the years in which the licence trade agreement, starting 1809, was in effect.

Between 1812 and 1818 the extreme short-term fluctuations in the nominal exchange rate were clearly not well reflected in the price level.[46] It is tempting to relate the real depreciation of the real exchange rate (increasing values) in Figures 13 and 14 to continued inflationary bias in the monetary policy of the new Rigsbank formed in 1813. This may well have eroded public confidence in the international value of the Norwegian currency beyond the limits set by PPP. The political secession from the Danish rule in 1814 may seem to have reversed the situation temporarily, but as the inflationary climate continued, the nominal and real exchange rates depreciated further in the years 1815 to 1817.

After 1817 the real exchange rate reverted to more normal levels. It is reasonable to assume that after the new speciedaler currency was introduced in 1817 and the new central bank began its operations in 1816 confidence in the new currency regime brought about more stability in financial markets. In 1819 the real exchange rate against Germany (1800=100) stood at 99.9. Between March 1817 and September 1819 the monthly real exchange rate against Britain fluctuated gently around 100, the benchmark value of January 1800, thus being very close to what the purchasing power parity principle predicts. Although the nominal price level had risen by a factor of 51.8 between 1800 and 1819 the relationship between the domestic price level, the foreign price level and the exchange rate was thus very nearly the same in 1819 as in 1800. This conclusion applies to both Germany and Britain. Since the exchange rate can be almost perfectly measured, and the German and British price indices originate from well-founded sources, this gives some confidence to the view that the new Norwegian price index rests on a firm basis as

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[46]Foreign exchange markets were in turmoil in 1813 and 1814 due to several factors: the political situation, the severance of the Norwegian currency from the Danish as from January 1813 and the near hyperinflationary environment.

well.

The 1820s were a much calmer period than the preceding decades in terms of price level and currency movements. There were still some swings in the real exchange rate, however. In the middle of the 1820s it is of some interest to note that in the case of Germany the real exchange rate (Figure 13) had reverted to virtually the same level as it started from in the year 1800, hovering around 100.

4.2   1830-1910

The long-run course of prices in Norway in this period follows the relative stable pattern found in other European countries. We now turn to the cyclical behaviour of prices, using British prices as the foreign benchmark. The monthly wholesale price index constructed by Gayer et al. (1953) for the period 1820 - 1845 was spliced to a modified and extended version of the Sauerbeck (1886) price index for the years 1846 - 1890, thereafter to the published contemporary estimates of the same index from 1891 - 1920.[47]

Figure 15 portrays cycles in the Norwegian WPI index and the British price index for the period 1830-1910. The British price index was converted into Norwegian currency in order to account for the exchange rate fluctuations in the early part of the period. This adjustment mainly affects the data before August 1842, the month in which Norway returned to the par value of silver envisaged for the speciedaler. Between this date and January 1874, when Norway adopted the gold standard, there might also be some slight effects from fluctuations in the relative prices of gold and silver. The cycles are derived by applying a Hodrick-Prescott filter to both series with a smoothing parameter (lambda) set equal to 129,600, following the suggestion in Ravn and Uhlig (2002).[48]

This graph clearly shows the strong positive correlation between British and Norwegian price cycles throughout the nineteenth century. The different monetary standards and the comprehensive tariff changes in the 1830s and 1840s did not blur the international impact on Norwegian prices. The most spectacular short-term cycle in Britain is the great price boom in 1847, which was basically driven by the surge in grain and provision prices following a season of bad harvests in northern Europe.[49] The Norwegian price index follows a very similar pattern, peaking one month later (June 1847) than the British index.

The inflationary episodes of the middle of the 1850s and the early 1870s are broadly similar in the two countries, but the timing of the peaks differ. A great inflationary boom period was under way by early 1853. From the winter of 1854 the Crimean War interfered with the course of prices, primarily through sharply higher grain prices following the closure of the Black Sea ports. The well-known commercial boom of 1857 is not much visible in the Norwegian index, in contrast to the surge in the British index. The 1860s present a somewhat irregular pattern, but there is a distinct peak in Norway in the first half of 1868 not found in the British index. [50]

In the early 1870s there was a strong international boom in economic activity and prices in the major countries.[51] In Britain coal and iron prices were driven to unprecedented levels at the peak of economic activity at the end of 1872, with the peak in the price index occurring in January 1873. Prices of wood and timber had a somewhat delayed response to the general

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[47]Klovland (1993) presented monthly values of the annual Sauerbeck index for the years 1846-1890. This source also corrects some inconsistencies in the original index, using market prices (duty paid) for all commodities, and adding some of the data series that were missing for the early years. Beginning 1891 monthly figures were taken from the summary table published in *Journal of the Royal Statistical Society,* March 1922, p. 275.

[48]The cycles are computed as deviations from logarithmic trend values.

[49]Gayer et al. (1953, p. 508).

[50]Grain prices were particularly high in Scandinavia around 1868 due to bad harvests.

[51]According to Lewis (1978, p. 34), '[t]his would be the last time for eighty years that all four countries in the core [USA, UK, Germany and France] would be having a construction boom simultaneously.'
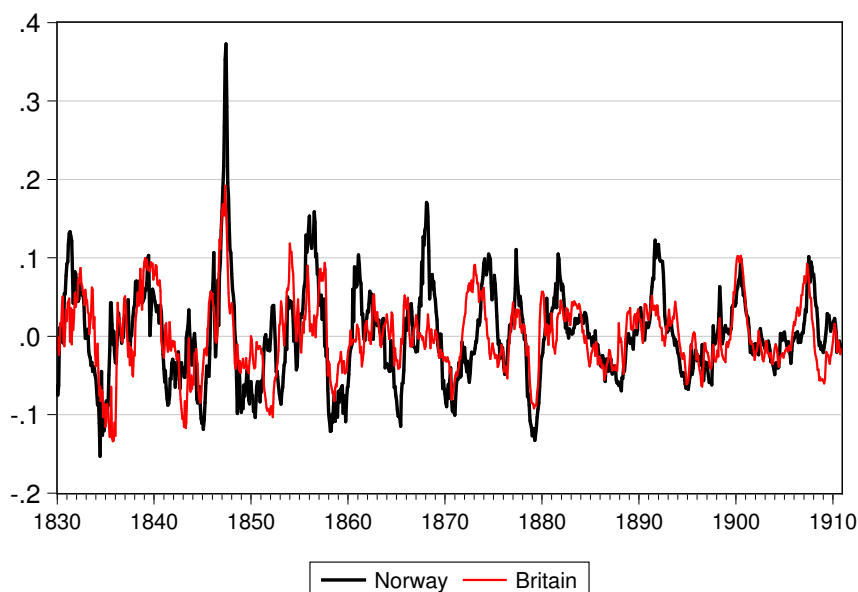
Figure 15: *Price cycles in Norway and Britain, 1830-1910.*

surge in demand, contributing to a later peak in Norwegian prices, in July 1874 according to our data. The final part of the 1870s was a period of subdued economic activity and persistent fall in prices until the nadir was reached in 1879, in March in Britain and in April in Norway.

The general view of common turning points in price cycles, with prices in Britain often leading Norway with a few months is evident from the data underlying Figure 15. The cycle peaks in Norway are September 1881, September 1891, July 1900 and July 1907. These are all close to dates of business cycle peaks in the international economy.[52] The dates are also within a whisker of the corresponding British price peaks.

Although similarities are far more evident than differences, particularly after 1891, there are two features which present a question mark. The first one concerns the years 1879 - 1882. Britain had a particularly strong but short-lived recovery in 1879-1880, driven by a surge in American demand for British iron. Prices rose sharply until the beginning of 1880, but then collapsed.[53] These factors did not affect Norway much, where prices rose more evenly from the trough in the middle of 1879 in line with the international expansion in economic activity. The second short period of diverging price behaviour occured in 1891-1892, a period when continental grain prices, particularly rye and barley, were very high. But, in general, the conclusion reinforces the view that commodity markets were highly integrated and that prices were procyclical.[54]

4.2.1 1910-1920

The great inflation of WWI and its aftermath is the dominant feature of Figure 16. The tranquility of the prewar years is in marked contrast to the steeply rising prices during WWI.

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[52]Moore and Zarnowitz (1986).

[53]This is documented in Klovland (1998b).

[54]For a review of the evidence on European commodity market integration see e.g. Jacks (2006) and Federico (2011).
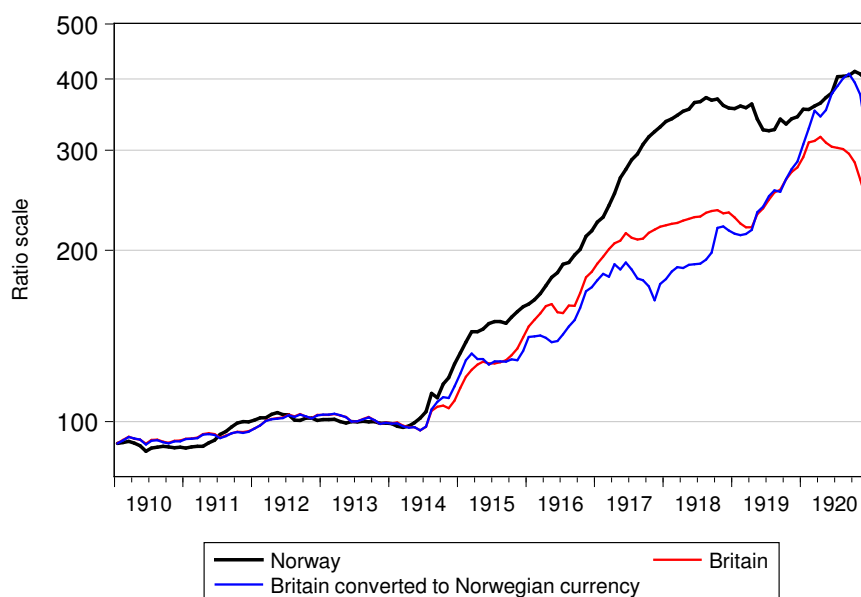
Figure 16: *Price indices for Norway and Britain, 1910-1920. June 1913 = 100.*

Prices in Norway got a kick-start in the first month of the war as the WPI rose by 7.7 per cent from July to August 1914. Foodstuff prices in particular rose steeply during the first weeks of panic following the declaration of war.[55] But then we see a slight reaction in September, with prices falling by 1.2 per cent in this month. A somewhat similar reaction can be observed in Britain as well, where there was a mild decline in prices from September to November 1914. Although this is a minor event, it is interesting to note this feature, which is likely to be connected with the lull in economic activity that can be observed world wide in the first few months of the war. The war implied major upheavals in the business of foreign trade which created much uncertainty, particularly concerning financing, insurance and direction of trade. Fayle (1920, p. 186), maintained that '[T]he proportion of the volume of British commerce thus brought to a standstill was serious'. Rygg (1954, p. 354) describes a similar reaction in Norway, but noting that the uncertainty was soon overcome. This is reflected in the price index, which started rising again in October 1914.

From then on prices in Norway rose without interruption until August 1918. The rate of inflation was remarkably steady during the war, being slightly below 40 per cent per year throughout most of the period.[56] Between August 1918 and August 1919 prices fell by 12.2 per cent. Price movements in this period present a rather messy picture that is difficult to squeeze into an index number because of the extensive price control measures and general interference with markets that were introduced. Government purchases comprised both major import goods such as grain, sugar, coal and fats, as well as large stocks of fish in conjunction with more or less forced agreements with the belligerent nations Britain and Germany. For fish there was an export ban, which implied that export market quotations ceased. Late in 1917 there was only one type of commodities, namely paints and linseed oils, for which price quotations still were not

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[55]The atmosphere of panic after the war was declared is vividly narrated by Keilhau (1927, pp. 11-19).

[56]Note that, since Figure 16 applies a ratio scale the rate of change in prices is constant if the price curve follows a straight line, which it basically does over the period from the autumn of 1914 until the beginning of 1918.

discontinued on the Christiania commodity exchange. Although the quality and completeness of the price data underlying the index calculations are getting poorer in this period it is nevertheless believed that our index gives a roughly representative view of the course of prices in these years as well. It may be added that there is a similar decline in the price level in Britain in the second half of 1918, but here the renewed expansion sets in earlier than in Norway.

From July 1919 the inflationary environment was back, as prices rose significantly until October 1920. In Britain we see a similar upward movement starting three months earlier, in April 1919, and ending six months earlier, in April 1920. A main factor driving this is the international restocking boom and dismantling of price controls 1919-1920. The spectacular 1920 boom ended in a short but particularly severe downturn in 1921 in many European countries.[57]

At the peak in October 1920 prices were a little more than four times as high as in June 1913. In Britain they rose to about three times the 1913 level. The reasons for the greater inflation in Norway and its effects on the exchange rate are intimately associated with monetary policy, but it cannot be dealt with here. However, we note with some interest from Figure 16 that the equilibrium relationship between the domestic and foreign price levels and the exchange rate is virtually identical to the one prevailing in the prewar period. After showing increasingly large deviations in the years 1915 - 1919 the price level in Norway was once again back to the value predicted by the PPP theory in 1920. This observation gives some interesting perspectives on the price and exchange rate behaviour in Norway during these years. According to PPP it follows that prices in Norway were higher or the exchange rate lower (stronger) than theory predicts for most of the period, but once again spot on when conditions were normalized in 1920. There are obvious reasons why a valid case can be made for a 'stronger than PPP exchange rate' interpretation: significant improvements in the terms of trade, including ocean freight rates, and a strong demand for Norwegian export goods and shipping transport ensured that revenues from commodity exports and shipping were pouring into the Norwegian economy during the war. This led to an appreciation pressure on the Norwegian krone, which at one stage, in November 1917, was about 25 per cent stronger than the prewar parity against pound sterling. But, as always, the bonanza was temporary, once the flow of extraordinary revenues ceased and the accumulated wealth was spent on imported goods, the relationship between the exchange rate and relative price levels was back on track.

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[57]See Eichengreen (1992, pp. 100-124) for the international evidence. In terms of industrial output loss (relative to peak production level) the 1921 slump was most severe business cycle in Scandinavia during the whole century, even surpassing the Great Depression of 1929-1932, see Klovland (1998a).

5 Concluding remarks

The Swedish price historian Lennart Jörberg once remarked that 'investigations into price history raise more questions than can be answered.'[58] Hopefully, this has also been achieved by the present study. Using price history as a starting point for further analysis of issues in macroeconomic history may prove to be useful in many instances. In early wartime periods, such as the Napoleonic Wars, price indices may convey information on the state of trade and economic hardship of the nation. The price level may be among the few available time series that can be accurately measured, and their strength is that, in a sense, they never lie.[59] Another topic, which has only been touched upon rather cursorily here, is the light that price history may shed on exchange rate movements and, in more general terms, public confidence in the way monetary policy is conducted. This is but one of many applications in which an accurate measure of prices may be useful.

But, as eloquently noted by the authors of recent history of agricultural prices in Ireland:[60] 'The case for price history can be pressed too far. Prices represent pinpoints of light in the darkness of the past: a kind of scatter diagram in the night skies, as it were. So supplementary information is often needed to illuminate the surrounding circumstances.'

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[58]Jörberg (1972, p. 3).
[59]O'Rourke (2007).
[60]Kennedy and Solar (2007, p. 3).

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2014

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03/14 January, **Ingvild Almås, Alexander W. Cappelen, Kjell G. Salvanes, Erik Ø. Sørensen**, and **Bertil Tungodden**, "Willingness to Compete: Family Matters".

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