A Long Term View on the Short Term Co-movement of Output and Prices in a Small Open Economy

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Received: November 16, 2011 Accepted: December 5, 2011 Published: February 1, 2012
doi:10.5539/ijef.v4n2p3 URL: http://dx.doi.org/10.5539/ijef.v4n2p3

Abstract

One assumption behind inflation targeting as objective for monetary policy is that inflation rates in the short run to some extent reflect output cycles. The present paper investigates the historical co-movements of output and prices for a small open raw material based economy, in this case Norway 1830 – 2006. Looking at contemporaneous movements we find more often negative correlations between the two variables than positive. The correlations do not give any evidence of causality. However, they may indicate that supply side shocks, often caused by the foreign sector, were more important for historical output cycles in Norway than assumed hitherto.

Keywords: Prices, Output, Business cycles, Demand, Supply, Economic history, Norway

1. Introduction

One of the rationales behind inflation targeting is the counter-cyclical element in increasing interest rates when inflation speeds up and *vice versa*. Inflation is to some extent assumed to reflect the output cycle. Thus, higher inflation is supposed to reflect that the economy is running faster. Hence, an increase in interest rates would cause the demand side in the economy to slow down. However, central bankers are of course aware of other possible connections. Thus, they often look at output gaps, stability of exchange rates and asset pricing when deciding on setting the key interest rate.

The notion of corresponding inflation and output fluctuations has been a central assumption in economic history writing. This is in line with the empirical findings of Nicolai Kondratiev, who mapped long output cycles in the economy by price series, and John Maynard Keynes, who explained historical business cycle downturns in general by negative shifts in aggregated product demand (Kondratiev, 1926, pp. 573 – 609; Keynes, 1936, pp. 23 – 24). There are, however, according to Keynes, exceptions. Jevon's theory that the trade cycle was primarily affected by harvests and thus, was prone to supply shocks, was quite reasonable for an economy dominated by agriculture. Nevertheless, Keynes argued that the "agricultural causes of fluctuations, are, however, much less important in the modern world". Thus, the relationship between prices and output should rather be negative than positive during harvest shocks (Keynes, 1936, chapter 22).

In the present paper we deal with short-term output cycles in general, i.e. both harvest and business cycles are included. This means that we analyze both supply side and demand side led swings in the economy. Conventional wisdom seems to believe that the latter are most common for short-term movements and the first for long-term movements. On the basis of empirical research this view is challenged here.

Empirically, it can easily be illustrated that prices often fell during bad times, e.g. the long depression from the mid 1870s till the late 1880s, during the post-war depression in the early 1920s and during the great depression in the 1930s (Kondratiev, 1926, pp. 573 – 609; Schumpeter, 1939, pp. 87 – 139). In fact these examples of falling output and prices have given name to the term depression. Nevertheless, it is not at all difficult to point out the opposite.

Prices tended to fall also during years of significant economic growth from the late 1880s to the mid 1890s, and even in many countries during the boom of the late 1920s. One may also find several examples of prices rising rapidly, despite output downturns, e.g. during the 1970s, when the combination of increasing inflation and stagnating output was named stagflation.

Most writers on Norwegian economy history seem to agree that short term output fluctuations have been demand side led, when most will agree that there will normally be supply-side led in the long run (Sejersted, 1973; Hodne, 1983; Bergh et al., 1983; Furre, 1991). However, for Norway limited work has been done in order to test the relationship between prices and output historically. In this paper we do not claim any definitive direction of causality between output and prices. Rather we limit ourselves to examine if there historically has been any empirical correspondence between short-term price movements and output volumes. We find that there is little evidence of positive correlations. For the period after WWII they are chiefly negative. This makes us to question if short run output cycles tend to be more supply side driven than often assumed.

In the analysis we use relatively newly published data covering all years from 1830 until 2006. To the authors knowledge this is the first paper to use such long time series to study this relationship for the small, open raw material based Norwegian economy.

2. Previous Work

Earlier empirical work on Norwegian data has for most parts used data from the post World War II - years. Wettergreen studied the influence of international output cycles on the Norwegian economy on the basis of domestic and international business cycle studies (Wettergreen, 1978). Bowitz and Hove examined the influence of Norwegian fiscal policy on business cycles 1973 – 1993 by using a macro econometric model. They conclude that local government tended to act pro-cyclical and central government counter-cyclical in their fiscal policy. Exceptions were made when central government aimed stabilizing the current account (Bowitz and Hove, 1996). In the study by Bjørnland who uses data from 1967 – 1994 she finds that "the business cycles properties vary considerably with the de-trending methods used" (Bjørnland, 2000, pp. 369). Hence, she finds both a pro-cyclical and counter-cyclical pattern depending on the type of filter applied. Research by Husebø and Wilhelmsen indicates "output and consumer prices in *levels* are negatively correlated for the period 1982 – 2003, with prices leading output" (Husebø and Wilhelmsen, 2005, p. 11). This can probably, at least partly, be explained by Norwegian dependency on petroleum and petroleum prices, which can act counter-cyclical to international cycles. Petroleum prices constitute a significant cost for the Western economies. Thus, demand will shift from output produced in the Western economies over to a necessary input to the economy. In consequence, prices increase and outputs decrease.

Existing research on other countries include the study by Cooley and Ohanian, who investigate the relationship between prices and output in US for different sub-periods 1822 – 1987 (Cooley and Ohanian, 1991). For the post-war period they find a negative correlation and the data shows a positive correlation in the interwar years. They argue that "with the important exception of the inter-war period, these data are not at all suggestive of the stylized fact of pro-cyclical prices that many macroeconomists hold" (Cooley and Ohanian, 1991, p. 47). Smith finds in his study of ten countries (US, UK, Canada, Australia, Sweden, Italy, Denmark, Norway, Japan and Germany) that the relationship is pro-cyclical until WWII and counter-cyclical for the post-depression period (Smith, 1992). A frequency domain analysis is performed on US data 1875 – 1994 by Pakko (2000). He observes that negative correlations tend to be associated with low frequencies while positive correlations are associated with higher frequencies. Den Haan who introduces a new methodology by analyzing correlation coefficients of VARs at different forecast horizons finds positive correlations in the short run and negative correlations in the long run for US 1948 – 1997 (Den Haan, 2000).

The same conclusion is reached for the G7 countries (Canada, France, Germany, Italy, Japan, UK and US) in the postwar period (Den Haan and Sumner, 2004). Parker (2005) extends the work by den Haan by looking further back in time. That is, he studies the years 1875 – 1914 and 1920 – 1941 in the US and concludes that pre WWI the relationship between output and prices are strongly pro-cyclical. For the interwar years he also looks at UK, Belgium, Canada, Germany and Sweden and finds that the price behavior is "overwhelmingly pro-cyclical across a number of different countries, confirming what it appears the economic literature has determined" (Parker, 2005) Further, Parker (2005) concludes that "it appears as if the emergence of counter-cyclical price behavior is a post-WWII phenomenon."

However, the same pattern of lacking positive correspondence between prices and output cycles during the last decades is also discovered for the US, which in nature is a quite different kind of economy (Stock and Watson, 1998; King and Rebelo, 2000.). On the other hand it is also found evidence of co-movement between prices and output in the US economy since World War II (Den Haan, 2000, p. 3 – 30).

3. A Small Open Raw Material Based Economy

Ever since the first steps towards an international Norwegian economy, when the Hanseatic League established itself in the foremost Norwegian city, Bergen, in the 1350s, Norway's export sector relied upon raw materials. Fisheries and forestry made up the two most important export industries until the nineteenth century. Thereafter, the merchant fleet showed a rapid growth in the mid-decades of the 1800s and became the predominant export industry together with fisheries and forestry (Brautaset, 2002, p. 197 – 205). The growth of the Norwegian merchant fleet was heavily dependent on worldwide transport of raw materials.

Since the 1970s the petroleum industry has become the predominant Norwegian export industry. However, still fish and wooden based products, like pulp and paper are important Norwegian export goods. Due to its dependence on foreign markets both regarding exports and imports, Norway has in large with a few exceptions been in favor of free international trade (Hanisch et.al., 1999, p. 17 – 20). Thus, one can definitely claim that Norway always has been a small, open, raw material based economy. This would apply that the Norwegian output cycle should very much depend on the cycles within our most important trading partners. Huge demand of raw materials should normally give both high prices and a boom in the economic activity.

On the other side the abundance of raw materials would be decisive for the level of supply and thereby both the price levels and economic activity in the economy. According to Keynes' view this could cause harvest cycles, when contrary to ordinary business cycles, output and prices were not correlated. E.g. small fish catches would normally cause fish prices to increase, when output volumes decrease. In such a case the cycle is caused by a supply side shock, and prices and output should be negatively correlated.

Likewise, for most of the nineteenth century agricultural cycles were very important for the fluctuations in total Norwegian output. Unlike modern business cycles, these would give a direct negative relationship between prices and output, since prices on food products tends to rise in times of bad harvests and *vice versa*.

In order to conclude on the possible correspondence between short-term output and price movements in Norway 1830 – 2006 one should look at different sub-periods of time. This paper deals with three such sub-periods.

1830 – 1913 The first sub-period stretches from 1830 till 1913, and represents the pioneer period of modern economic growth within a liberal economic order in Norway (Hodne and Grytten, 2000, p. 59 – 276). For most of this period the monetary system was fairly stable with a real silver standard 1842-1873 and a real gold standard 1874-1913(14). During the first years of the sub-period, i.e. 1830(16)-1842 the central bank monitored a nominal silver standard, with a careful deflationary monetary policy in order to obtain the par silver value of the *speciedaler*. For this period one might expect harvest cycles in agriculture to influence the results in a disturbing way. However, this argument should not be exaggerated since agriculture accounted for around 30 percent of total GDP for the first decades of this period and came down to less than 20 percent towards the end. In addition fish catches did not at all correlate with yields from agriculture, often making them work in the opposite direction or neutralizing the effects (Bjerke, 1966, p. 54 – 55).

1919 – 1939 Due to the huge external shocks during the two great wars, we leave the war years out in our analysis, but include the interwar years. This period still was a very volatile period for both the international and the domestic economy, characterized by turbulent years with financial and in particular monetary instability, crises and growth, inflation and deflation (Hanisch, 1996, p. 141 – 156).

1946 – 2006 Our final sub-period covers the years 1946-2006 and is characterized by a significant and growing public sector and a social-democratic economic planning regime inspired by John Maynard Keynes and Ragnar Frisch (Søilen, 1998, p. 417 – 446). Admittedly, Norway gradually returned to a more neo-liberalistic economic world order since 1979. Nevertheless, economic planning in a mixed economy is still a dominant economic regime. The monetary policy was fairly stable with the exception of some turbulence in particular in the 1970s, 1980s and early 1990s.

4. Data

As indicator for output cycles, we use newly published historical gross domestic product (GDP) figures, reflecting total economic value creation in the economy (Grytten, 2004b, p. 241 – 288). The available data sets allow us to compare annual figures for all years 1830 till 2006. As for the general price level we use a newly published combined cost of living index (CLI) and consumer price index (CPI) for Norway, hereafter denoted as a historical CPI (Grytten, 2004a, p. 47 – 98).

One could argue that the implicit GDP deflator, covering the entire economy, is more valid than the CPI for this purpose. The first presents total production when the latter includes consumption items only. In addition, the first

deflator contrary to the latter also includes investments, exports and imports. The impact of the last two of these is examined in an independent section of the paper.

However, the historical CPI is by far more reliable than the GDP deflator, since the latter is not calculated explicitly, but estimated implicitly by dividing output in current prices with output in fixed prices. Thus, the deflator is to a large extent based on estimated price patterns including unknown residuals rather then observed prices. Also, if we had adopted the GDP deflator in our analysis, we would have used two dependent variables in the co-movement analysis. That pitfall would definitely not have strengthened the analysis. In addition, the CPI is calculated from the demand side, when the GDP deflator is calculated from the supply side. This makes the first more relevant when examining the relationship between output and demand. It is also worth to note that presently central banks all over the world have chosen CPI as measure on price movements in their inflation targeting policy. Here we want to throw light on these two variables co-movement. Thus, naturally we use the historical CPI here.

4.1 Prices

The combined historical CLI-CPI, constructed for and published by the Norwegian central bank, is stretching back to 1516. It is constructed by a traditional Laspeyres approach, which is common for historical price indices (Grytten, 2004a, p. 47 – 98). In fact it is a mixture of a cost of living index and a consumer price index till 1959, meaning it does not reflect market prices only, but also the costs of providing necessities for working class families. From 1959 onwards, it stands as a pure consumer price index.

The series for the period in question in this paper is in fact spliced together of six different indices. The five first of them are constructed with one representative base year for each index, the latter with continuous shifts of base years. These are all spliced together in one index. The first covers the period 1819-1871 and includes 29 commodities within eight consumption groups 1819-1830 and 47 commodities within nine consumption groups 1830-1871, and includes most kinds of consumption less services. Almost all observations are monthly or quarterly retail or market place prices reported all over the country by governmental decree. Thus, the annual figures in the index are made up from several thousands of market price observations with high reliability (Sircular, 4th Royal Norwegian Ministry, January 20th 1816 and Wedervang Archive, file 272). The key source for these data is the Professor Dr. Ingvar B. Wedervang's Archive on Historical wages and Prices, kept at NHH the Norwegian School of in Bergen, Norway.

The second and third cost of living indices are basically compiled from data on prices and consumption patterns in the Oslo area. The first of these, covering the years from 1871 till 1901, is made up of an even richer price material reported by local public servants and controlled by central civil servants for 55 representative commodities. These are also kept in the Wedervang Archive. This index is very well documented and proved reliable by international scholars (Ramstad, 1982, p. 471 – 493). Thereafter, we use the cost of living index from the Statistical Office of Kristiania (Oslo) for the period 1901-1916, including about 70 items (NOS, 1978, p. 518 – 519). Again all major consumption groups are included in these monthly figures, except for services, which are lacking till 1900, and thereafter are underrepresented.

The fourth index series, constructed by the Ministry of Social Affairs, stretches from 1916 till 1919. It covers 16 of the major urban areas of Norway at the time and includes 60 retail commodities, fuel inclusive. The observations were taken on a monthly basis (NOS, 1994, p. 289 – 292).

From 1919 Statistics Norway took over as the major provider of cost of living indices. They conducted several consumption surveys, covering up to 31 urban areas and collected retail price data on some hundred consumption items, i.e. from 120 in 1920 to 700 in 1959. Data were compiled all over the country in order to construct this index. Finally, in 1959/1960 the cost of living index for working class households was replaced by a pure consumer price index representing all kinds of households and products, which can be bought in retail shops at market prices. The range of data compilation has been increased gradually. At present Statistics Norway collects retail prices of a set of about 1000 representative commodities from all over the country (NOS, 1994, p. 289 – 292).

4.2 GDP

In order to map the output cycles we use gross domestic product per capita in fixed prices, which is the common variable in output analysis. The historical national accounts for Norway stretch back to 1830, and were calculated in several steps.

In 1965 Statistics Norway published GDP per capita for the years 1865-1960 (NOS, 1965, p. 64 – 371). The calculations were carried out from the production and the expenditure side based on available data kept or published by the office. We use these figures for the period 1865-1950.

Thereafter, we use new calculations made of GDP back to 1830 by a group of scholars from NHH the Norwegian School of Economics in Bergen. These are documented in publications from the central bank (Grytten, 2004b, p.

272 – 289). Again, an important source, both of volumes and prices, is the Wedervang Archive. The calculations are made both from the production and the expenditure side, and to reach at estimates in fixed prices one has in principle used a double deflation technique, i.e. both output and input prices are deflated in order to arrive at value added in fixed terms.

On the basis of both input and output data from the main industries within both the public and private sector and annual price observations it has been possible to calculate relatively reliable series of value added in the Norwegian economy for the period. Important sources are records from local and central civil servants published by ministries and other public bodies connected to the government along with private archives and records and reports given by senior county officials. In particular the foreign trade statistics and industrial and population censuses have been of great importance.

Thirdly, we use the contemporary GDP-figures for 1950-2006 calculated and maintained by the department for national accounting at Statistics Norway. These are considered some of the most precise present national accounts in the world (www.ssb.no/emner/09/01/nr/index.html).

Finally, the historical GDP-calculations for 1830-1865, 1865-1950 and the revised contemporary 1950-2006 are spliced together. For the first sub-period 1850 is used as base year, for the second, 1910 and 1938, when for the third period base years shift at least every fifth year. The spliced series was first published by the central bank of Norway as part of a project on historical monetary statistics (Eitrheim et.al., 2004; Eitrheim et.al, 2007). They were also quality controlled by a research network on the construction of standardized and harmonized Nordic historical national accounts. Together with the price data they should constitute valid and reliable sources for examination of the correspondence between price movements and output cycles in Norway 1830-2006.

Figure 1 shows ln CPI (henceforth CPI) and figure 2 shows ln real GDP per capita (henceforth GDP) 1830 – 2006 both in levels and first differences. The figures show large variations from year to year for both prices and output. The output trend is ascending the entire time span, while a trend growth in prices appears after WWI.

5. Annual and Output Cycle Fluctuations

The data for GDP (per capita) and CPI enable us to look at the correspondence between annual changes in output and prices as plotted in figure 3. It is surprisingly difficult to spot any significant persistent correlation between the two, in particular not a positive relationship. Thus, we cannot trace any clear tendency by just looking at these graphs. Another problem with looking at annual fluctuations is that these changes are not measurements of output cycles. An output cycle is always of some length of time, which is normally more than one year, traditionally more often four to nine years. Hence, the next step in our analysis will be to use filters to extract the cycle component of the time series.

5.1 Separating Trend and Cycle

To split the data series into a trend and a cyclical component we employ two different filters. The first one is the Hodrick-Prescott (HP) filter, which is an algorithm for finding smoothed values, i.e., trends of a time series (Hodrick and Prescott, 1997).The filter separates an observed time series, $\{y_t\}_{t=1}^{T}$, into a smoothed or a trend component, g_t, and a cyclical component, c_t:

$$y_t = g_t + c_t. \tag{1}$$

In the filtering (de-trending) of y_t, the trend component g_t is determined by

$$\min \sum_{t=1}^{T}(y_t - g_t)^2 + \lambda \sum_{t=2}^{T-1}[(g_{t+1} - g_t) - (g_t - g_{t-1})]^2. \tag{2}$$

Here T is the sample size and λ is the smoothing parameter, specifying the smoothness of the trend. Although the filter has been influential and is used extensively in the economics and finance literature it has some drawbacks. First, HP filter is known for "unusual behavior of cyclical components near the end of the sample" (Baxter and King, 1999, p. 576). Second, it is not straightforward to choose the size of the smoothing parameter lambda (λ). In this paper we apply a value of 100 for the λ, which is a 'normal' value for annual data. Third, the filter "can generate business cycle dynamics even if none are present in the original data" (Cogley and Nason, 1995, p. 253).

One important result from time series analysis is that almost any discrete-time stationary time series can be represented as (Hamilton, 1994, p. 152)

$$Y_t = \mu + \int_0^{\pi} \alpha(\omega) \cdot \cos(\omega t) d\omega + \int_0^{\pi} \delta(\omega) \cdot \sin(\omega t) d\omega. \tag{3}$$

That is, a time series Y_t can be approximated by a weighted sum of cosines and sines of different frequencies. The objective with spectral analysis is to determine which cyclical frequencies are important in determining the behavior of the time series. The theory of spectral analysis also states that it is possible to extract these components using what is called the 'ideal band pass filter.' The filter transforms the data linearly by keeping "intact the components of the data within a specific band of frequencies and eliminates all other components" (Christiano and Fitzgerald, 2003, p. 436). However, the 'ideal band pass filter' is not possible to compute since it requires an infinite amount of data. Some sort of approximation is required. In this paper we apply the Baxter-King (BK) filter (Baxter and King, 1999).

In general, Band Pass filters (BP) have become popular in recent years as an alternative to the HP filter. "BPs are appealing because they make the notion of business cycle operational by selecting fluctuations in the pre-specified range"(Canova, 2007, p. 94). Low frequencies imply longer cycles in the data while higher frequencies imply shorter cycles. Which frequencies that should be allowed to pass through the filter depend on the *a priori* expectations on the duration of a typical cycle. Hence, the band pass filter "passes periodic components that lie within a pre-specified frequency band and eliminate everything else" (Cogley, 2008). According to the cycle theory pioneer Joseph Kitchin the economy moves in inventory cycles of three to five years (Kitchin, 1923). According to another pioneer in the field, Clement Juglar, investment cycles of seven to eleven years are quite common (Juglar, 1916). These seem basically to be demand driven. Output cycles have tended to become shorter during the modernization of the economy. In applying the BK band pass filter, we have chosen periodic components between two and seven years.

In figure 4 we plot the estimated cycles from the BK filter of the time series. Still it is difficult to trace any consistent pattern in the co-movement between GDP and CPI. This could be explained by time lags or by the fact that output cycles last for several years. Thus, there is not necessarily strong contemporaneous correlation between the two variables, but there may be within the typical cycle period.

5.2 Correlations

We now compute the cross correlations between the cyclical components of GDP per capita and CPI in order to look at the strength and direction of their relationship. That is, whether prices were pro-cyclical or counter-cyclical. In addition we compute the correlation between the two when we allow that the CPI is a leading or lagging variable by one or two time periods. The calculations are done for all sub-periods. In addition to the two filters we also compute the correlations of the first order differentials (FOD). Most emphasize should naturally be put on the cycle data, since they are stronger against series correlated data.

Table 1 reports that 25 of the 45 estimated correlations are positive. However, for the contemporaneous and price lagged estimates we find that 18 out of 27 are negative. In other words, CPI tends to be counter-cyclical when we look at simultaneous and price lagged movements. On the other side 16 of 18 coefficients are positive when prices are leading to GDP.

During the first sub-period 1830 – 1913, the main finding from the series is that we have negative contemporaneous and price lagged correlations. All three series also give a positive relationship between current GDP and leading values of the CPI. Thus, increase in inflation rates tends to moves ahead of output, when positive output gaps tend to move ahead of falling inflation. As shown in figure 5 there is a clear negative correlation between harvest cycles and prices (Grytten, 2004c, p. 47 – 76; Grytten, 2004a, 47 – 98). The negative correlation coefficient in the agricultural sector (-.40), may indicate that supply shocks were decisive for the annual development of output and prices in this important industry, while the opposite seems to have been the case for the economy in general.

For the second sub-period 1919 – 1939 we find more or less the same pattern as in the first sub-period. This was a period with several shocks to the economy, as shown by Klovland in his study of Scandinavian business cycles in the interwar period (Klovland, 1998, p. 309 – 344). In the first place the two world wars took place just before and after these years. Inflation grew rapidly during the war years when output contracted. Secondly, two huge international depressions hit the economy devastatingly. Thirdly, Norway ran a strong deflationary monetary policy for most of the 1920s, causing a sharp and long period of deflation in the 1920s in addition to the international deflation in the 1930s. Between these years of crises and abnormal economic policy, significant growth took place. From 1919 till 1939 the recorded per capita GDP growth rate was impressively 2.2 percent (NOS, 1965, p. 348 – 351).

This implies that the years 1919 – 1939 constitute a period of substantial economic growth both when compared to historical and cross-country data. However, due to the two great wars, their aftermaths and the long period of deflationary monetary policy, one can easily see that the economy in many years may have been influenced by heavy supply side shocks and that prices could not necessarily have mirrored the business cycles.

As for the third sub-period 1946 – 2006, the coefficients for the contemporaneous and one period price lags are all – with one exception – clearly negative. Despite the dominant Keynesian paradigm in this period, we tend to find negative relationships between prices and output (Hanisch et.al., 1999, p. 17 – 28). Price leads are for all but one observation positive.

During the post WWII period till 1952, the government widely subsidized and directed the economy in order to prevent high inflation and thereafter a postwar depression (Hodne and Grytten, 2002, p. 77 – 196). On the other side there was not any significant primary sector to impose huge supply side shocks to the Norwegian economy after 1946. Still prices and output cycles were negatively correlated. This could partly be explained by the adoption of technology from the US, causing productivity to increase and the economy to boom and imported inflation rates to fall *cet par*. During the 1970s, the economies of the OECD countries were heavily influenced by the considerable positive shifts in petroleum prices caused by the OPEC I in 1973 (petroleum embargo), and the OPEC II in 1979 (Iraqi-Iranian war). Oil prices per barrel stepped up from three to forty dollars during the 1970s. In consequence, the OECD area experienced high inflation and fall in demand for domestically produced goods. Thus, changes in prices and output moved in opposite directions.

Summing up, on the evidence presented in table 1 we conclude that for the historical period 1830 – 2006, that is, looking across all three sub-periods, it is more common with negative correspondence between output and contemporaneous and lagged prices than positive. When prices are leading the correlation coefficients are chiefly positive. When inflation increases just ahead of GDP it might indicate that higher demand causes positive shifts in outputs. When inflation decreases just after output peaks it might indicate that supply shocks causes prices to fall. Thus, it is difficult to interpret the results of our analysis. However, looking at contemporaneous correlations both regarding first order differentials and cycles, which lasts for several years, we might arrive at more decisive and relevant conclusions. These reveal that inflation was more likely to move in the opposite direction than in the same direction as output, in particular for the post-WWII period. This may indicate that supply side shocks may be more important for output cycles than often assumed.

6. The Foreign Sector

In order to get a better understanding of the observed phenomena in the small open raw material based economy of Norway it is of importance to examine if the development trends have been influenced by the foreign sector. Thus, in this section of the paper we take a closer look at the correspondence between export and import prices versus output from the economy. The export and import prices used are taken from the historical national accounts (Wedervang Archive, files W272, W276 and W383). Sources for the export and import price series in the historical national accounts are public records and the already mentioned Wedervang Archive. Thus, these particular series are basically calculated on the basis of empirical observations contrary to several other deflators in the historical national accounts.

An important aspect of this examination is to find out how external shocks have influenced Norwegian output through import or export prices. Additionally, this examination can inform us on how other supply side shocks, e.g. low or high fish catches, output from forestry or oil and gas relative to demand has influenced the relationships between prices and output.

We conduct this examination with further calculations of correlation coefficients. When contemporaneous series are the most relevant when examining a possible Keynesian relationship between output and prices, simultaneous and price-led series would be the most relevant in this analysis. The idea is to examine if external supply side shocks can explain fluctuations in output.

6.1 Exports

First we present correlation calculations for export prices versus GDP per capita in table 2. As in the previous section we apply the first differenced series, and the HP- and the BK-filters. The focus is again on the cyclical components. Our output data are taken from the historical GDP series for Norway, when the price series is the deflator for exports taken from the national accounts. Both the output figures and the price observations for the foreign sector are among most valid and reliable data cited in the Norwegian historical national accounts, as they are very much based on empirical observations rather than estimated residuals. Thus, these series clearly should be considered trustworthy and valid for our purpose (Grytten, 2004b, p. 281 – 283).

According to the estimates reported in table 2 it definitely tended to be a positive correlation between export prices and output 1830 – 1913. This indicates that positive shifts in export prices were mirrored in positive shifts in output during this sub-period. Thus, the export sector seems to contribute in order to explain the positive co-movements of output and prices in this period. This is fairly understandable for a small open raw material based economy.

As for the turbulent sub-period 1919 – 1939 we also find for most cases positive correlations. This is especially true for the contemporaneous correlation between GDP and export prices as well as between GDP and leading values of the export prices.

For the third sub-period 1946 – 2006 the results are very different for from the previous years. Now there is a majority of negative correlations. This is especially striking for the HP series.

For the entire time span 1830 – 2006, there seems to be shift from a positive relationship into a negative one as we approach the present. The negative correlations are more prominent between the output and the export prices than between output and consumer prices. Hence, supply shifts from the export industries seem to have had an effect on the economy. Supply side shifts from the export sector, which have made production costs decline, may have caused input volumes increase.

6.2 Imports

The estimated co-movements of import prices and outputs are reported in table 3.We find positive correlations for the first sub-period 1830 – 1913. The positive correlations indicate that negative supply side shifts from the import side had a negative effect on output. This can in a broader perspective be explained by international price movements, i.e., when international prices fell Norwegian output fell. In this way Norwegian output in the nineteenth century may mirror the international output cycles (Hodne, 1983, p. 262 – 269). This again confirms our findings that prices and output basically moved in the same direction 1830 – 1913.

For the interwar years the majority of the correlations are again positive. Similar as for output and exports we find a change in the sign of the correlations between output and import prices in the post-war period. That is, for the years 1946 – 2006 there is a considerable larger share of the correlations that are negative than earlier years. Almost half of the correlations are now negative. Both the HP and the BK series suggest a positive contemporaneous and negative import price lagged correlation to GDP.

To sum up this section, the results of our tests do not point unanimously in one direction. However, it seems evident that both export and import prices indicate that supply side shocks may have become more decisive in order to explain counter-cyclical movements between prices and output in Norway from WWI until present. This counter-cyclical tendency is strengthened for the post WWII years. During the years prior to the great wars, i.e., 1830 – 1913, we find less evidence of this counter-cyclical foreign trade price tendency.

7. Conclusions

This paper offers an empirical investigation of the short-term correspondence of historical output versus prices 1830 – 2006 for the small open raw material based economy of Norway. The examination is done by running correlations on contemporaneous and lead- and lag-data of GDP per capita and CPI-series. We use both first order differentials (FOD) and two different filters (HP and BK) in order to find cycle deviations from polynomial trends in our analysis.

For the years prior to WWI, we find negative correlations between contemporaneous output and output cycles on the one hand and price movements on the other when using FOD and BK, when they are positive for the HP. For the inter-war period we find negative correlations when using HP and weak positive correlations when using FOD and BK. Thus, we cannot conclude on any significant negative or positive correlation. As for the post WWII period we find strong negative coefficients for all three, showing that there clearly is a negative correlation between output cycles and consumer prices after WWII. We also find a clear majority of negative correlations when prices lag to output, and a majority of positive correlations when prices lead to output.

Our findings on the contemporaneous data are in opposition to the typical Keynesian view, also reflected in inflation targeting monetary policy, i.e. demand-led price movements should be mirrored in short-term swings in the economy. However, they did not for Norway during huge parts of the 20th century until present days. On the contrary, leaving out leads in price observations, short-term prices and output more often moved in opposite than in similar directions.

Correlation coefficients do not reveal causality. However, on the basis of the chiefly counter-cyclical historical movements between general output and prices and similar results for export and import prices versus output, one may suggest that supply side shocks can offer important information in order to understand short term output cycles.

Our historical findings support the inclusion of output gaps into inflation targeting when central banks are considering the setting of key interest rates.

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Table 1. Correlation coefficients between GDP per capita and CPI for Norway 1830 – 2006.

Lag	1830 – 1913			1919 – 1939			1946 – 2006		
	FOD	HP	BK	FOD	HP	BK	FOD	HP	BK
-2	0.0876	-0.0851	-0.0587	-0.5785	0.1053	-0.2479	0.2512	-0.0412	0.0764
	(0.4366)	(0.4471)	(0.6147)	(0.0095)	(0.6680)	(0.4142)	(0.0550)	(0.7564)	(0.5868)
-1	-0.0884	-0.0572	-0.1597	-0.0102	-0.3368	0.0064	0.4701	-0.1842	-0.2521
	(0.4299)	(0.6075)	(0.1652)	(0.9661)	(0.1465)	(0.9826)	(0.0002)	(0.1589)	(0.0659)
0	-0.0940	0.0515	-0.0291	0.1708	-0.0722	0.0211	-0.3307	-0.2919	-0.1839
	(0.3978)	(0.6419)	(0.8006)	(0.4593)	(0.7558)	(0.9405)	(0.0092)	(0.0225)	(0.1790)
1	0.2854	0.3319	0.2851	0.2737	0.1571	-0.1316	0.0814	-0.0944	0.0781
	(0.0093)	(0.0022)	(0.0120)	(0.2429)	(0.5083)	(0.6539)	(0.5364)	(0.4729)	(0.5745)
2	0.2447	0.3215	0.1499	0.1666	0.0055	0.1232	0.1070	0.1505	0.1062
	(0.0277)	(0.0032)	(0.1962)	(0.4954)	(0.9822)	(0.6885)	(0.4198)	(0.2552)	(0.4493)

The numbers show the correlation between the cyclical components of GDP per capita and current, leads and lags [-] of CPI. Lag equal to zero (middle row with numbers) indicates contemporaneous correlation. *p*-values in brackets.

Table 2. Correlation coefficients between GDP and the price deflator for Norwegian exports 1830 – 2006.

Lag	1830 – 1913			1919 – 1939			1946 – 2006		
	FOD	HP	BK	FOD	HP	BK	FOD	HP	BK
-2	0.1326	0.0772	0.1681	0.0699	-0.0703	-0.1458	-0.0596	-0.0867	-0.1213
	(0.2379)	(0.4903)	(0.1466)	(0.7827)	(0.7749)	(0.6345)	(0.6566)	(0.5138)	(0.3871)
-1	0.1485	0.1854	0.1759	-0.2200	-0.0517	0.1697	0.0252	-0.0792	0.0549
	(0.1830)	(0.0934)	(0.1259)	(0.3654)	(0.8286)	(0.5619)	(0.8498)	(0.5477)	(0.6932)
0	0.0018	0.1819	-0.0382	0.4682	0.4171	0.0169	0.1021	-0.0415	0.1348
	(0.9871)	(0.0978)	(0.7399)	(0.0373)	(0.0600)	(0.9523)	(0.4377)	(0.7510)	(0.3265)
1	0.1684	0.2072	0.0493	0.0954	0.1517	-0.0524	-0.0971	-0.1142	-0.1615
	(0.1306)	(0.0602)	(0.6703)	(0.6978)	(0.5231)	(0.8588)	(0.4645)	(0.3847)	(0.2432)
2	-0.0302	0.0944	-0.0752	0.0254	-0.2644	0.0431	-0.1784	-0.0108	-0.2412
	(0.7888)	(0.3987)	(0.5187)	(0.9202)	(0.2740)	(0.8889)	(0.1802)	(0.9351)	(0.0819)

The numbers show the correlation between the cyclical components of GDP and current, leads and lags [-] of the implicit price deflator for Norwegian export. Lag equal to zero (middle row with numbers) indicates contemporaneous correlation. *p*-values in brackets.

Table 3. Correlation coefficients between GDP and the price deflator for Norwegian imports 1830 – 2006.

Lag	1830 – 1913			1919 – 1939			1946 – 2006		
	FOD	HP	BK	FOD	HP	BK	FOD	HP	BK
-2	0.1170	0.0362	0.0475	0.2054	0.0865	-0.1784	0.0284	-0.0911	-0.0491
	(0.2983)	(0.7470)	(0.6834)	(0.4136)	(0.7247)	(0.5597)	(0.8326)	(0.4923)	(0.7270)
-1	0.1626	0.3313	0.1963	-0.3364	-0.2881	0.1708	0.0855	-0.0628	-0.0404
	(0.1443)	(0.0022)	(0.0872)	(0.1591)	(0.2180)	(0.5593)	(0.5195)	(0.6336)	(0.7718)
0	0.2305	0.4144	0.2289	0.2234	0.1012	0.0918	0.3409	0.1973	0.0869
	(0.0361)	(0.0001)	(0.0439)	(0.3437)	(0.6624)	(0.7448)	(0.0077)	(0.1275)	(0.5279)
1	0.0411	0.2720	0.0027	0.1971	0.1865	-0.3289	0.1345	0.0578	-0.0649
	(0.7140)	(0.0129)	(0.9812)	(0.4186)	(0.4311)	(0.2509)	(0.3098)	(0.6606)	(0.6412)
2	0.0589	0.1042	0.0142	0.0600	-0.1165	0.0357	-0.0045	0.0889	-0.1132)
	(0.6013)	(0.3515)	(0.9029)	(0.8129)	(0.6347)	(0.9079)	(0.9735)	(0.5031)	(0.4195)

The numbers show the correlation between the cyclical components of GDP and current, leads and lags [-] of the implicit price deflator for Norwegian imports. Lag equal to zero (middle row with numbers) indicates contemporaneous correlation. *p*-values in brackets.

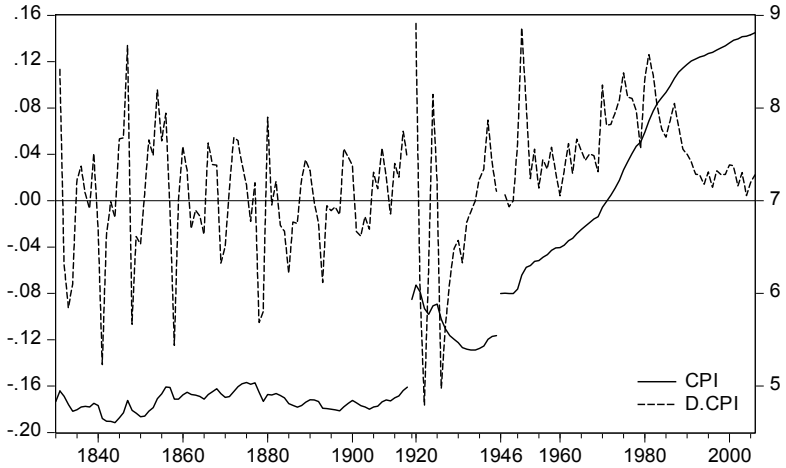

Figure 1. ln CPI in levels and first differences 1830 – 2006. Source: Grytten 2004a, 92 – 93.

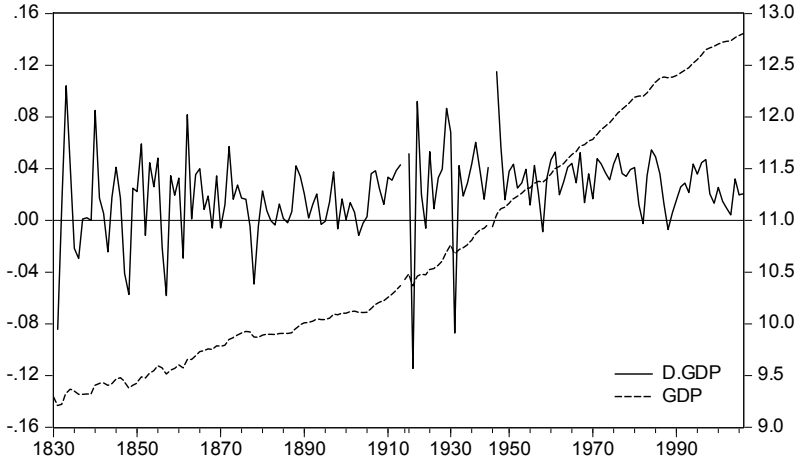

Figure 2. ln real GDP per capita in levels and first differences 1830 – 2006. Source: Grytten 2004b, 285.

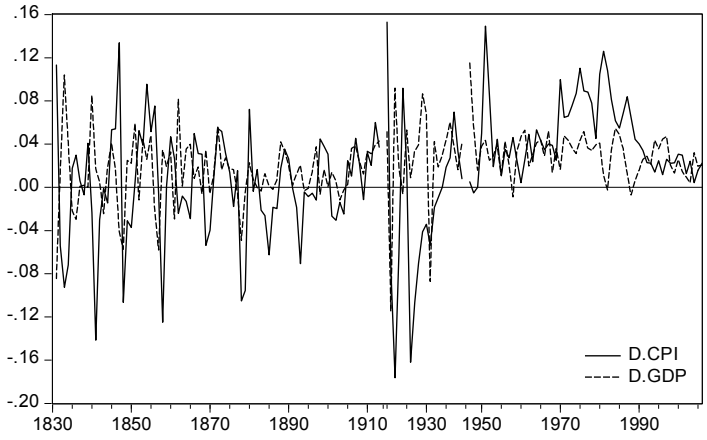

Figure 3. Annual fluctuations in CPI and GDP per capita for Norway 1830 – 2006. Sources: Grytten 2004a, 92 – 93. Grytten 2004b, 285.

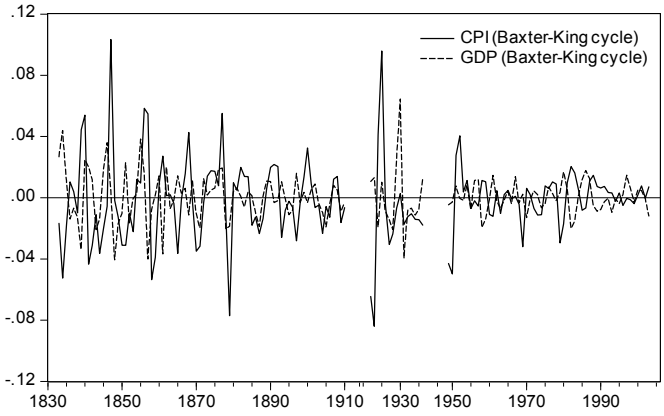

Figure 4. CPI and GDP per capita cycles 1830 – 2006 estimated by the Baxter-King band pass filter allowing periodic components between two and seven years. Sources: Grytten 2004a, 92 – 93. Grytten 2004b, 285.

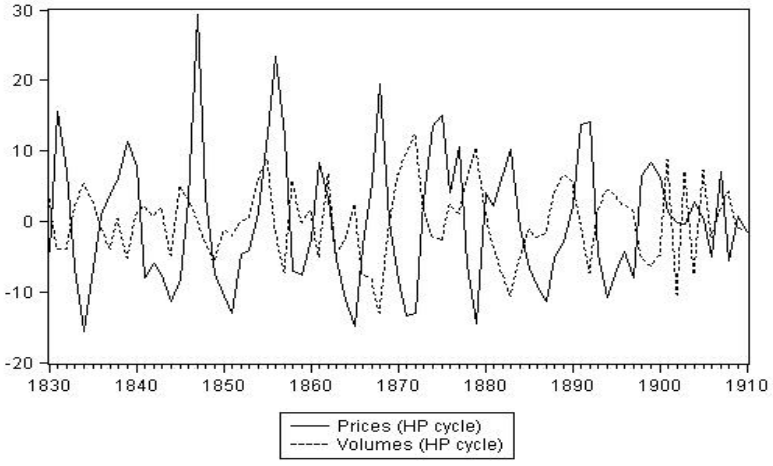

Figure 5. HP cycles ($\lambda = 100$) for prices and volumes in agriculture in Norway 1830 – 1910. Sources: Grytten 2004a, 90 – 91, Grytten 2004c, 47 – 76, Ramstad 1982, 493.