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A CONSUMER PRICE INDEX FOR SWEDEN, 1290–2008

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This paper presents a Consumer Price Index for Sweden 1290–2008. Constructing an index that covers more than seven centuries poses conceptual and empirical problems, and demands some methodological innovations. For example, during numerous occasions the currency unit was changed, and in some periods multiple currencies were used at floating exchange rates relative to each other. This paper also presents two different price indices, one that mainly serves the purposes of estimating real prices and real wages, and another that provides a measure of inflation. While the former follows the main currency unit, the latter also takes into account that debased coins were devalued during recoinage.

1. INTRODUCTION

This study presents a Consumer Price Index (CPI) for Sweden 1290–2008. We discuss some theoretical and conceptual problems in relation to a CPI covering more than 700 years, which requires certain methodological innovations. The terminology follows closely the one used in the international guideline, the *Consumer Price Index Manual* (ILO *et al.*, 2004).

One problem with price indices is that the pattern of consumption changes over time. Chaining is necessary if the studied period is very long, as is the case here. The best option may be an annual chain index, but this presupposes information on the composition of annual consumption, which can be difficult to obtain for the pre-industrial period. Furthermore, the further backward in time, the fewer products can be represented by long price series. This, of course, makes it difficult to construct an annual chain index, especially before the 19th century. The next best option is to change the weights regularly, although not as often as annually, i.e. to use so-called deflation periods; this is the chosen alternative in this study for the period before 1914.

There are two main uses of a CPI, one to deflate nominal series and the other to provide a measure of inflation. We think that both purposes are important, and therefore two different CPIs are presented, one that can be used to calculate real prices and real wages, and another that provides a measure of inflation. We label the former a "deflator index" and the latter an "inflation index."

Traditionally the focus for constructing historical CPIs has been to deflate nominal wages to estimate real wages. Previous international estimates of historical CPIs predominantly follow the methodology of our "deflator index." However,

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the concept of inflation has often been neglected in such studies. The metallic standard was not a guarantee of price stability, since debasement of coins was widespread and during shorter periods provided substantial incomes to the king, causing rampant inflation.

High inflation caused by debasement poses a theoretical and methodological challenge for the construction of a historical CPI. Under such periods prices can be expressed in different types of prices, one in the debased currency and one in a more stable currency unit, for example a foreign currency or previously minted coins in precious metals. Under recoinage the face value of the debased coins was reduced substantially and exchanged at this reduced rate for the new better coins of higher intrinsic metal value. A debasement cycle consists of the debasement period and the recoinage that restores the old value of the currency. Some price indices that have been presented for the pre-industrial period, in fact, followed currencies of more stable silver content, and thus tend to underestimate inflation during periods when the currency that was most in use was significantly debased. A major focus of this paper is to discuss how inflation could be measured during various debasement cycles occurring in Sweden.

2. Sources

The Period 1290–1539

The majority of the price quotations before 1539 stem from market transactions carried out by various institutions. Three sources are of particular importance: the collection of medieval letters that has been published on the internet by the National Archives (Svenskt Diplomatariums huvudkartotek över medeltidsbreven), transactions involving parish churches that regularly sold their surplus of grain resulting from the tithes delivered by their tenants, and the accounts of Stockholm City which report on various kinds of purchases.

Price tariffs set by the authorities are not used here. Tariffs generally aimed at reducing market prices during years of scarcity, and it is not known to what extent such maximum prices were respected.

The major part of the price quotations are from the province of Uppland, which included Stockholm, the largest town. Uppland was probably the most commercialized part of medieval Sweden, at least from the late 14th century. Several oxen and butter prices, however, are from the southern province of Småland, bordering on Denmark. Finland was part of the Kingdom of Sweden during the medieval era. For this reason, Finnish prices are also included, though their number is not large. Nearly all of them come from Turku (Åbo) in southwestern Finland, which appears to have been fairly price-integrated with Uppland.

From the early 15th century the price data is quite rich for the most important commodities, although not for all years. Before that period only few years and few commodities can be covered. The missing years have been interpolated for various commodities. The price of grain has been interpolated using the price of rye, and vice versa. The interpolations are based on silver prices, which is based on the exchange rate of the silver mark (containing 180–200 g fine silver) in Swedish marks (see Edvinsson *et al.*, 2009), and only in the second stage transformed to nominal prices.

The best data exist for seven goods: grain, beer, salt, oxen, butter, wax, and iron. Only for these goods, it seems, can price series covering 50 years or more be assembled. Grain prices are the most frequent (Franzén and Söderberg, 2006; see also Söderberg, 2007). Before 1500, grain prices usually refer to unspecified grain or barley, not to rye which was more expensive. The CPI also uses data on the prices of three other goods—rye, hops, and copper. For these three goods data exist mainly from the 1460s onwards.

Though the focus on these goods is motivated by the state of the sources, the mix has some advantages. Grain was of course the most essential good. Iron, copper, butter, and oxen were Swedish export articles, but were also important in domestic consumption. Salt was the only imported good, besides hops in the late Middle Ages, that was vital in popular consumption. Beer was an increasingly popular and important consumption good. The beer market widened during the late Middle Ages. This is closely linked to the increased use of hops in brewing, making for a more tasteful and durable beer. Compared to these goods, wax played a smaller role in the economy. It was mainly used for the making of candles for religious ceremonies.

The Period 1540–1732

Eli Heckscher constructed a price index for Sweden for the period 1540–1620 based on Stockholm prices. This price index has been improved by Arne Jansson and Johan Söderberg, with additional data. They have constructed a Laspeyres-type cost-of-living-index for Stockholm for the period 1539–1719 (Jansson *et al.*, 1991; Söderberg, 2002). This is the basis of the present CPI. One difference for the period 1539–1620 is that the price of rye has been changed from the consumption year to the harvest year (which is the practice internationally).

The prices were collected from various institutional accounts, most importantly the accounts of the Town Council of Stockholm, Stockholm Castle, the orphanage of Stockholm, and the accounts of Danviken Hospital.[1] Even though the citizens of Stockholm most probably had to pay higher prices for their daily needs, it is important in this context to note that the sources are of the same character throughout the period.

The price index for the period 1719–32 is based on Fregert and Gustafsson (2005), which in turn uses the Stockholm prices in Jansson *et al.* (1991).

The Period 1732–1914

For the period 1732–1913 the present CPI draws on the large collections of data in Jörberg (1972) and Myrdal (1933). For 1913–14 Myrdal's index is used.

Jörberg's work relied on a source labeled "market price scales." These price scales were determined once a year, in November or December, for a large number of commodities, forming an official price list. The system was based on the fact that the state and local government, as well as many institutions, received their

[1]Many of these price quotations are published in Jansson *et al.* (1991). With regard to the accounts of the Town Council of Stockholm, see Söderberg (1987).

incomes not in cash but in kind. The market price scales were generally accepted as monetary valuations of these commodities (Jörberg, 1972, Vol. 1, p. 8).

Jörberg critically evaluated the market price scales as an indicator of market prices. His conclusion, based on several comparisons between the two series, was that the price scales agreed very well with existing market prices both in the short and in the long run (Jörberg, 1972, Vol. 1, pp. 16–77). However, he noted that the deputies who determined the market price scales clearly tried to avoid sudden changes in prices. Large price increases in market prices were somewhat dampened in the market price scales. Market price scales thus did not fully record price fluctuations, though their direction was always correct (Jörberg, 1972, Vol. 1, p. 31). Gunnar Myrdal also regarded the price scales as fairly reliable price observations, and stated that the calculated averages for Sweden as a whole appeared to be "very safe" (Myrdal, 1933, pp. 32, 148 note 1).

Myrdal's (1933) annual cost of living index covers the period 1830–1914 and is still used by Statistics Sweden (see Statistics Sweden, 2005). It includes potatoes, milk, coffee, and some other commodities that were not part of Jörberg's series. Myrdal's index draws mainly on two types of sources. One is price quotations in newspapers, usually given under the heading "market-place prices." The other source is the accounts of public institutions such as hospitals, prisons, and military depots.

Myrdal emphasized that the prices collected by him showed a remarkable conformity to the market price scales. The price level of the market price scales tended, however, to be somewhat lower than in the other sources used by him, that is primarily from institutions and newspapers. This was due to the fact that the market price scales were nearer to actual wholesale prices (Myrdal, 1933, p. 148 note 1). He also observed that there was a gradual transition from semi-wholesale to retail prices in the newspaper quotations over the period. During the 19th century, the prices paid by institutions were as a rule somewhat higher than the quotations in the newspapers. This difference in prices narrowed during the first decades of the 20th century (Myrdal, 1933, pp. 33–42).

Here, some supplements are made to Jörberg's and Myrdal's selection of commodities based on new price data which have been produced by various researchers. Salt prices as well as price indices of various industrial products are added.

The Period 1914–2008

From 1914 onwards, the CPI is the same as the one presented by Statistics Sweden.

The Labour Statistics Bureau of the Board of Commerce started publishing retail prices for a large number of commodities from summer 1903. The price quotations were collected by a number of commissioned agents with a large regional coverage. The quotations did not reflect prices in pure rural and agricultural districts, but rather towns, municipalities, and important industrial districts. In 1913 this task was transferred to the Social Board. The main concern was to represent the conditions of the life of the less well-to-do social layers. The Social Board calculated the first official cost-of-living index from July 1914 onwards. For simplicity, we label these prices "Social Board prices," including the 1903–12 retail prices from the Labour Statistics Bureau of the Board of Commerce (Bouvin, 1933, pp. 149–51). From 1918 onwards, the calculation of the cost-of-living index was carried out four times a year, on about the 1st of January, April, July, and October. This index continued on a quarterly basis up to 1954, when it was replaced by the monthly CPI.

On a few occasions, the Social Board compared the price statistics it had compiled to actual consumer prices as they were registered in household budget studies of living conditions. The latter prices were those paid by households in their purchases, and registered by them in budget books which were delivered to the Board for statistical analysis. In 1913–14 as well as in 1933, the Board observed a remarkable fit between these two kinds of prices. Most of the price differences could be explained by methods of measurement. For example, prices for all months had equal weight in the Social Board price statistics, whereas household purchases were, as a rule, not evenly distributed over the year (Socialstyrelsen, 1921, pp. 81*–86*; Kungl. Socialstyrelsen, 1938, pp. 147–52).

The present official monthly CPI has been published by Statistics Sweden since June 1954. The fictive lower-income family was abolished, and the index came to be a measure of price changes generally for private consumption as a whole. The CPI was linked to the cost-of-living index (Kungl. Socialstyrelsen, 1961, p. 107).

Discussion on Sources

During the period up to 1732, the price quotations are drawn from sources of a similar type. They are institutional prices that generally can be expected to have fallen below consumer prices. The market price scales from the period 1732–1914 are of another character as they are not actual market prices. Yet, being similar to wholesale prices, the price scales, too, would tend to be lower than consumer prices. The index for the period 1914–2008, finally, is closer to a CPI. This would presumably lead to a higher price level, as would the fact that quotations were collected from urban and industrial districts where prices should have exceeded those of rural areas, although the chaining of the times series partly eliminates those differences.

The question is how large the price differentials were between these types of sources. Two comparisons will be made here. The first deals with the price level in Myrdal's various series versus Jörberg's market price scales. The second compares selected commodities from the Social Board quotations from the early 20th century to some of Myrdal's series.

The comparison between Myrdal and Jörberg is presented in Table 1. The price differential is small for most goods. Only for birchwood and pinewood does the mean price between Myrdal and Jörberg differ by more than 10 percent. Birchwood prices are on the average 42 percent higher in Myrdal's series than in Jörberg's, and the corresponding figure for pinewood is 29 percent.

Jörberg thought that his prices scales did not always reflect sharp increases in market prices, and thus would underestimate the volatility in market prices. If this was the case, Myrdal's prices, being largely collected from institutional accounts

TABLE 1

Mean (Myrdal as Percent of Jörberg), Coefficient of Variation (CV), and Time Trend for Selected Commodities

Commodity	Mean	CV Myrdal	CV Jörberg	Time Trend	Time Trend, *t* Value
Rye	102.4	0.17	0.17	0.024	0.97
Barley	102.2	0.17	0.17	–0.011	–0.46
Wheat	103.5	0.18	0.19	0.047	1.99
Oats	103.3	0.20	0.21	–0.042	–1.44
Peas	104.6	0.20	0.17	0.175	5.53
Butter	107.4	0.26	0.26	0.042	2.57
Eggs	107.4	0.23	0.25	–0.054	–2.38
Pork	103.0	0.22	0.21	0.079	4.92
Beef, salted	92.2	0.33	0.34	–0.058	–1.74
Tallow	108.1	0.27	0.31	–0.006	–0.63
Tallow candles	98.5	0.10	0.10	–0.102	–7.17
Birchwood	142.3	0.23	0.20	0.166	1.84
Pinewood	129.4	0.28	0.29	–0.040	–1.24

Notes: The time period is 1830–1913 except for tallow (1830–1900), tallow candles (1830–75), and birchwood (1830–69).

and newspapers and thus being nearer to actual market prices, would be expected to exhibit greater fluctuations. For this reason, Myrdal's and Jörberg's series are also compared with respect to the coefficient of variation in Table 1. As it turns out, the CV is quite similar in all series. The largest difference occurs for tallow, but this is not in the expected direction since the fluctuations are larger in Jörberg's series than in Myrdal's. From this we conclude that the nature of Jörberg's price scales should not prevent them from being analyzed with regard to short-term fluctuations.

Finally, Table 1 also reports the time trend of the ratio between Myrdal's and Jörberg's series (Myrdal as a percentage of Jörberg). The following regression equation is estimated:

$$\text{PriceMyrdal}/\text{PriceJörberg} = a + b \times \text{Year}. \tag{1}$$

A positive b coefficient in the regression equation indicates that the price differential tended to widen over time. This is what should be expected if Myrdal's assumption that his material based on newspaper quotations would reflect a gradual transition from semi-wholesale to retail prices with time. Table 1 shows a statistically significant widening (at the 5 percent level) for 4 out of 13 goods: wheat, peas, butter, and pork. On the other hand, the reverse pattern is observed for some series, as the price differential for eggs and tallow candles tended to narrow over time, with a weaker such tendency for birchwood. For several goods (rye, barley, oats, salted beef, tallow, and pinewood), there is no definite time trend. There is in other words no general transition toward higher prices as would be expected from Myrdal's discussion.

The second comparison involves the prices collected by the Social Board versus prices according to Myrdal. The expectation would be that the Social Board prices exceed Myrdal's prices for the same commodities, since the former had an urban bias and were closer to a retail index than the latter. To some extent, though,

TABLE 2

Prices (Kronor) of Selected Commodities in Sweden 1904–13 According to Social Board and Market Price Scales, Respectively

Commodity	Social Board Price, Myrdal = 100	CV Social Board	CV Myrdal	*t* Value
Peas, dried, kg	197.1	0.06	0.20	72.45
Butter, kg	111.1	0.04	0.04	37.34
Milk, liter	113.3	0.03	0.03	17.45
Eggs, score	114.0	0.09	0.06	4.85
Beef, fresh, kg	133.2	0.10	0.07	14.34
Pork, fresh, kg	103.0	0.07	0.07	26.12
Bacon, kg	121.6	0.06	0.06	21.84
Coffee, kg	106.7	0.19	0.16	4.27
Birchwood, cubic meter	109.5	0.07	0.09	17.04

Source: Myrdal (1933, pp. 174 ff., 186 ff., 201–3).

the bias of the Social Board prices toward the less well-to-do social layers, leading to a choice of cheaper qualities of the goods purchased, could have counteracted this upward price shift.

The comparison can be done only for those years for which both types of series are available, which is for the ten years 1904–13. Prices of nine commodities (peas, butter, milk, eggs, fresh beef, fresh pork, bacon, coffee, and birchwood) are compared. Even though the time series are short, the results in Table 2 are conclusive. For all goods, the means of the Social Board series clearly exceed Myrdal's prices. The *t* values in a paired samples test are highly significant for all commodities. The median of the nine goods is a 13.3 percent higher price in the Social Board's series.

The expectation that the Social Board prices of the early 20th century involve an upward price shift relative to Myrdal's prices for the same years is thus confirmed.

3. The Currency Unit for the CPI

For the construction of a CPI, the general rule should be to follow the currency that was most frequently used in transactions. The following currencies are used for different periods:

- Mark penningar 1290–1624
- Mark kopparmynt (in 1624 equal to mark penningar) 1624–1776
- Riksdaler specie (in 1776 equal to 72 mark kopparmynt) 1776–89
- Riksdaler riksgälds (in 1789 equal to the riksdaler specie) 1789–1855
- Riksdaler riksmynt (in 1855 equal to the riksdaler riksgälds) 1855–73
- Krona (SEK) (in 1873 equal to the riksdaler riksmynt) from 1873 onwards.

These currencies are the basis for the construction of a first variant of a CPI, the deflator index. It is an index of prices expressed in the main currency unit: 1 SEK = 72 marks. The inflation index is also constructed to take into consideration times of very high inflation, when inflation money was circulated which later was replaced by a more stable currency (recoinage). This occurred during six debasement cycles: 1351–54, 1361–64, 1521–24, 1561–76, 1590–93, and 1715–19. At the end of these debasement cycles, the inflation coins could be exchanged for the new coins, but at a much lower rate than was nominally assigned to the inflation coins. When prices were expressed in proper coins, they have been transformed to prices in inflation coins by using the exchange rate between the inflation coins and proper coins.

This could be compared to modern times when zeros have been struck from inflation notes on various occasions, for example when the new mark was introduced in Germany in 1924 and was set equal to one trillion old marks. The introduction of new notes implies that prices of products are sold at a lower nominal figure, but a price index should not record any dramatic deflation in such a situation, since this is just a matter of changing one currency for another. This is most clearly shown when prices are recorded in both currencies during the overlapping period, as is exemplified for Sweden below.

A genuine deflation can occur following a period of inflation, when the inflation money is appreciated for various reasons. An example of this is the deflation in Sweden in the early 1920s, when the CPI fell by more than 30 percent. The direct cause was the reintroduction of the same relation of the krona to gold as before the First World War.

The inflation index is based on the exchange rate between the inflation money and the new coins that were introduced, and the annual change in the deflator index is corrected accordingly.

High inflation periods caused by debasement cycles are reliably documented from the 16th century onwards. However, there are indications of two earlier debasement cycles following the Black Death, roughly in 1351–54 and 1361–64. Based on the few price and exchange rates notations that exist today, this study assumes that the debased coins were devalued by two thirds in 1354 and by half in 1364 (see Edvinsson *et al.*, 2009), respectively, which is the basis to calculate the difference between the deflator and inflation indices for this period.

In 1521–23 Gustav Eriksson (Vasa) led a rebellion against the Danish King Christian II, who also ruled over Swedish territories. Both Christian II and Gustav Eriksson (Vasa) minted so called klipping coins with a very low silver content compared to their nominal values, which led to price increases when the goods were paid in klipping coins. In early 1524, it was decided that the klipping coin would be devalued by one third, and shortly afterwards the klipping coins were demonetized. However, the exchange rates of the silver mark in proper and klipping coins, respectively, suggests that the klipping coins were worth less than half (19.25/50) of their nominal value in proper coins (Edvinsson *et al.*, 2009). In this study it is assumed that 1 new mark = 50/19.25 old marks, which is the basis to calculate the difference between the deflator and inflation indices for this period.

During and after the Northern Seven Years' War, 1563–70, a depreciation of the mark took place, causing rampant inflation. By a decision of May 12, 1575, the public could exchange the debased coins with new better ones. However, the exchange rate was different for various coins. One new mark was exchanged for 6.5 marks of 1571–74 (Wallroth, 1918, p. 23), which is the basis to estimate inflation from the deflator index in this paper. To calculate the inflation index, the ratio of the deflator index in year 1576 to the index in 1575 is multiplied by the factor 6.5, based on the exchange rate between the new and old marks.

In 1590–92 the Swedish mark deteriorated rapidly and the rampant inflation caused much confusion. In 1593 and 1594 the debased coins were exchanged for new coins. As in 1575 the rate was different for different debased coins. The worst one-mark coins of 1592 were reduced to one quarter of their face value. To calculate the inflation index from the deflator index in the period 1589–93, the deflator index is adjusted according to the exchange rate of the silver daler in the period 1589–92 (Edvinsson, 2009), while the relation 1 new mark = 4 old marks is assumed for 1593. Between 1589 and 1593 the inflation index increased by 291 percent.

Toward the end of the Great Nordic War, the monetary system turned into disarray, in 1715–19. The main cause was the circulation of token coins, which de facto were fiat money. Initially the token coins did not disturb the monetary system much, and were even met positively because of the easiness to handle this currency. However, later on the token coins contributed to inflation, and in 1719 they were in effect devalued by 50 percent. One question is whether the prices that are the basis for the deflator index are in proper coins or in token coins. The price of rye is based on proper coins, while the prices of other products are probably in token coins. Since the prices in token coins were depressed in Stockholm due to regulations, the assumption made in this study is that the basis for the deflator index was, in fact, prices in proper coins. To transform the deflator index to the inflation index, the assumption is made that the ratio of prices in tokens coins to prices in proper coins was 1.06 in 1716, 1.24 in 1717, 1.5 in 1718, and 2 in 1719 (end-of-year figures) (Edvinsson, 2009).

There were also two other inflation periods where it is unclear which currency to follow, namely the periods 1624–64 and 1789–1834. The deflator index in those cases follows the inflation coins. In those two periods the inflation currency became the main currency afterwards, whereas in the periods 1351–54, 1361–64, 1521–24, 1561–76, 1590–93, and 1715–19 the old, better currency was restored.

The difference between the two indices is most clearly illustrated by the development in the last decades of the 16th century, displayed in Figure 1. Between

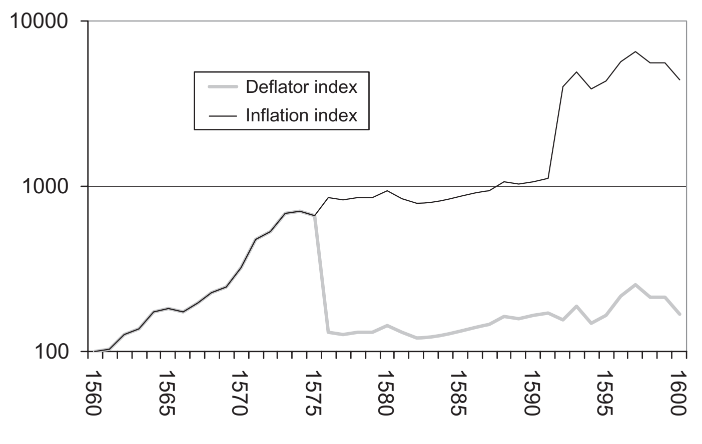

Figure 1. The Deflator and Inflation Indices 1560–1600 (1560 = 100)

1574 and 1576 the deflator index records a fall by 82 percent. The question should be asked whether the period 1574–76 really was a period of severe deflation. What happened was that a new mark was introduced in this period with a larger silver content than the old mark. For example, while a 4 öre coin (a half mark) of 1572 had the silver content of 0.5142 g, a 4 öre coin of 1575 contained 3.088 g, i.e. a six-fold increase (Wallroth, 1918, pp. 37, 41). Our inflation index also records an average increase in prices by 20 percent in 1574–76. The same sequence of events as in 1560–76 was repeated in the early 1590s, but much more rapidly so that this debasement cycle is not clearly visible from the direct price observations.

The deflator and inflation indices partly reflect different purposes. If the CPI is to be used to deflate nominal wages over time, for example expressed in the Swedish currency unit "mark" (as shown by the deflator index in Figure 1, the new mark coin of 1576 had almost the same purchasing power as the mark coin of 1560), then it is most practical to use the deflator index. However, if the price index is to be used as a measure of inflation, the inflation index is preferable.

4. Expenditure Shares and Index Formulas

In this study it is the Laspeyres formula that is used up to the early 20th century. The Laspeyres price index is a measure of the level of prices in period *t* in relation to period 0 (the price reference period), expressed in the quantities of the weight reference period, which for the Laspeyres price index is the same as the price reference period, or algebraically (where *i* refers to the specific commodity, *p* is price, *q* quantity, and *s* expenditure share):

$$P_{0,t}^{L} = \frac{\sum_i p_{t,i}q_{0,i}}{\sum_i p_{0,i}q_{0,i}} = \sum_i \left(\frac{p_{t,i}}{p_{0,i}} s_i^0 \right). \tag{2}$$

Since the weights are quite difficult to estimate, the calculations are based on estimates of expenditure shares during certain base periods. Equation (2) shows that this gives the same result.

The Expenditure Shares for 1290–1539

The index construction is different for the periods 1290–1330, 1330–1420, and 1420–1539 (see Table 3). For the period 1420–1539, ten commodities are covered:

TABLE 3

Weights (in Percent) in the Present Study to Calculate the CPI, 1290–1539

Period	Grain	Rye	Beer	Butter	Iron	Copper	Oxen	Wax	Salt	Hops
1290–1330	46.15	30.77		23.08						
1330–1420	33.71	22.47	5.62	16.85	6.74	3.37	11.24			
1420–1539	30.00	20.00	5.00	15.00	6.00	3.00	10.00	3.00	3.00	5.00

grain, rye, bear, butter, iron, copper, oxen, wax, salt, and hops. With the exception of 1445, there exist price data at least for one commodity in every year of this period. For the period 1330–1420, the price index is based on seven commodities: grain, rye, beer, butter, iron, copper, and oxen. For the period 1290–1330, the index is mainly based on the price of grain and rye, complemented with some annual data on the price of butter.

For the period 1420–1539, the largest weight (55 percent) is given to rye, grain, and beer, since vegetable products were the most important part of consumption.[2] The 5 percent weight given to beer may seem to be quite small, but here we assume that the price of beer was largely determined by the price of rye and grain. Animal products (butter and oxen) are assumed to have accounted for 25 percent of the total budget. Non-food products are only given the weight 12 percent. Their share was probably larger, but it may be assumed that the prices of other non-foodstuffs (for example, linen and wool) partly followed the prices of various foodstuffs. The relative weights for earlier periods are the same as for 1420–1539 (see Table 3), with the difference that some commodities are missing.

The annual fluctuations of the CPI in the period 1420–1539 should be interpreted carefully since not all years could be covered. For the period 1290–1420, the CPI is not an indicator of annual fluctuations, but should rather be used as an indicator of long-term trends.

The Expenditure Shares for 1539–1914

For the subsequent period, 1539–1732, fish (herring and Baltic herring) are introduced with 10 percent of the total budget (Table 2), whereas the role of butter is reduced. Coarse cloth is also included during this period with a weight of 10 percent. During the Reformation period starting in 1527, wax lost most of its importance in connection with religious ceremonies and is dropped from the index from 1539 onwards.

The weights change again for the periods 1732–82, 1782–1830, 1830–70, and 1870–1913 (see Table 4). The weights have been adjusted in accordance with earlier studies by Jörberg and Myrdal, and to fit the pattern of consumption according to the historical national accounts (Edvinsson, 2005).

Jörberg's assumption that the share of non-foodstuffs was only 16.7 percent in 1732–1864 and 18.7 percent in 1865–1914 is unrealistic, and we have increased that share to 25 percent in 1732–1829, 28 percent in 1830–69, and 30 percent in 1870–1913. Our assumption is somewhat above Robert Allen's for the pre-industrial period (Allen, 2001, p. 421), but somewhat below Ola Grytten's for Norway in the 19th century (Grytten, 2004, p. 66).

We also assume, following Jörberg, that the share of vegetables in food consumption increased after 1870, but we do not agree with Jörberg that less vegetable than animal produce was consumed in the first half of the 19th century than in the 18th century.

[2]See Jansson *et al.* (1991) for a further discussion on the budget composition in the 16th century.

TABLE 4

Weights (in Percent) in the Present Study to Calculate the CPI, 1539–1914

	1539–1732	1732–82	1782–1830	1830–70	1870–1913
Grain	45.0				
Rye		21.0	21.0	14.4	9.8
Barley		7.5	7.5	7.2	4.2
Wheat		2.25	2.25	2.16	4.9
Oats		4.5	4.5	4.32	2.8
Hard ryebread				1.44	1.4
Coffee				0.72	0.7
Sugar				0.72	0.7
Salt		0.75	0.75	0.72	0.7
Potatoes				2.88	2.8
Peas		2.25	2.25	2.16	1.4
Oxen	12.5				
Beef		4.5	4.5	4.32	5.6
Pork		6.75	6.75	6.48	9.8
Butter	7.5	18.75	18.75	2.88	4.9
Milk				15.12	12.6
Cheese		1.5	1.5	1.44	2.1
Eggs		0.75	0.75	0.72	1.4
Herring	5.0				
Baltic herring	5.0	2.25	2.25	2.16	2.1
Dried fish		2.25	2.25	2.16	2.1
Birchwood		3.0	3.0	3.0	2.0
Pinewood		3.0	3.0	3.0	2.0
Charcoal		1.0	1.0	1.0	1.0
Gas					1.0
Coke					1.0
Tallow	3.75	2.3	1.0	1.0	1.0
Tallow candles			0.65	0.8	2.5
Rape oil			0.65	0.8	
Linen		6.0	6.0	6.5	7.0
Coarse cloth	10.0	6.0	6.0	6.5	7.0
Tanned cow hides		1.2	1.2	1.4	1.5
Pig iron		0.5	0.5	1.0	1.0
Bar iron		0.5	0.5	1.0	1.0
Bricks	2.5	1.0	1.0	1.5	1.5
Lime	2.5				
Tar	2.5	0.5	0.5	0.5	0.5
Total	100.0	100.0	100.0	100.0	100.0

The Index Formulas for 1914–2008

In the period 1914–31, the quantities of the cost-of-living index were based on a budget enquiry in 1913–14, which happened to coincide with the price reference period (July 1914) (Bouvin, 1933, p. 160). During this period the cost-of-living index could therefore be considered to be of a Laspeyres type. In 1931–43 the weight reference period was not the same as the price reference period. Therefore, the cost-of-living in this period was strictly speaking not a Laspeyres price index, but rather a Lowe price index (of which the Laspeyres index is a special case). From 1943 an annual chain index of Edgeworth type was used (Kungl. Socialstyrelsen, 1961, pp. 92–106).

From June 1954, the chaining of the monthly CPI was based on a long-term index of an Edgeworth type, by estimating the change from December in the previous year to December in the present year, and a short-term index of a Laspeyres type, by estimating the change from December in the previous year to the month considered of the present year (Statistics Sweden, 2001, pp. 18–19).

From January 2005 Statistics Sweden has changed its method once again. The computations are made in two steps, applying an annual chain index. The long-term chaining is no longer made from December to December, but from one whole year to another using the Walsh formula (whereby the price reference period is the previous year, i.e. $0 = t - 1$) (Statistics Sweden, 2004; 2006, p. 61). However, to estimate a monthly index the price level of one month is compared to the price level of the year previous using that year's quantities, i.e. in that case the Laspeyres formula is used. Henceforth, to calculate the price level of month m in year t in the price level of year r, the following formula would be used ($r > 2003$, since Statistics Sweden used another method up to 2004):

$$I_r^{t,m} = \frac{\sum_i p_i^{t,m} q_i^{t-2}}{\sum_i p_i^{t-2} q_i^{t-2}} \prod_{k=r+1}^{t-2} \left(\frac{\sum_i \left(p_{k,i} \sqrt{q_{k,i} q_{k-1,i}} \right)}{\sum_i \left(p_{k-1,i} \sqrt{q_{k,i} q_{k-1,i}} \right)} \right). \quad (3)$$

Differences Between Index Formulas and Expenditure Shares

One question concerns the differences of the estimated inflation according to alternative expenditure shares or index formulas. Since we usually do not have access to annual changes in the composition of consumer products for the pre-industrial period, it is difficult to estimate indices such as of the Paasche, Edgeworth, Törnqvist, Walsh, or Fisher types that presuppose such information.

One class of indices that is increasingly used is the geometric index, which has some desirable qualities if consumers adjust their relative quantities in response to changes in relative prices. A geometric Laspeyres index is the weighted geometric average of price relatives using the expenditure shares of period 0 as weights (based on ILO *et al.*, 2004, p. 5):

$$P_{0,t}^{\mathrm{GL}} = \prod_i \left(\left(\frac{p_{t,i}}{p_{0,i}} \right)^{s_i^{0,0}} \right). \quad (4)$$

One advantage with the Laspeyres geometric price index is that it can rely on the same information input as the Laspeyres arithmetic price index. It assumes that the expenditure shares are constant over time, i.e. if the price of a product increases, then consumers reduce their consumption of this product so that the part of their income spent on this product is constant.

Only if the cross-elasticity of demand between various products is zero (so-called Leontief preferences), does the arithmetic Laspeyres index provide an exact measure of the cost of guaranteeing a certain level of utility or welfare (such an index is termed COLI (cost of living index) by the *Consumer Price Index Manual*) (ILO *et al.*, 2004, p. 158), which may seem unrealistic. The geometric index provides an exact measure of a COLI if the cross-elasticity of demand between various products is unity (when the consumer preferences can be represented by the

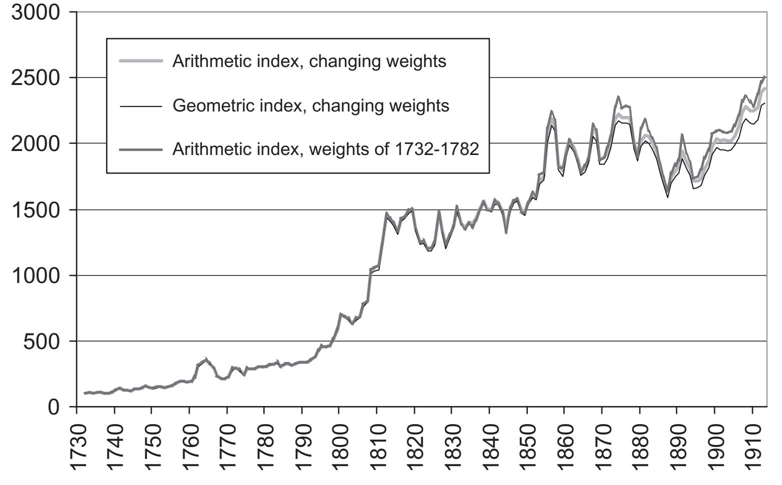

Figure 2. The CPI 1732–1913 According to the Laspeyres Arithmetic Index with Changed Weights, the Laspeyres Geometric Index with Changed Weights, and the Laspeyres Arithmetic Index with the Constant Weights (1732 = 100)

Cobb–Douglas function) (ILO *et al.*, 2004, p. 11). However, this assumption can also be unrealistic. It depends on the cross elasticity of various products. During the pre-industrial period the price elasticity of individual foodstuffs could be high, but the price elasticity of food expenditures as a whole was very low. There is, therefore, no *a priori* reason why the geometric Laspeyres index should better approach a continuous Divisia index than the arithmetic Laspeyres index in this period. Grytten (2004, p. 52), in fact, proposes a compromise: the use of geometric sub-indices combined with an arithmetic general formula. Furthermore, the formulas applied for the official Swedish cost-of-living or Consumer Price indices in the 20th century are also of the arithmetic type.

Figure 2 presents three difference price indices for the period 1732–1913: one Laspeyres arithmetic index that is used in this study with changed expenditure shares; one Laspeyres geometric index with the same expenditure shares as the former index; and one Laspeyres arithmetic index with the expenditure shares used for 1732–82 throughout 1732–1913.

Figure 2 shows that the differences between the three indices were virtually non-existent up to 1850. While annual inflation in 1732–1850 was, on average, 2.35 percent according to the two arithmetic indices, it was 2.34 percent according to the geometric index. Before 1850 consumption patterns generally did not change as much as they did afterwards, since real wages were stagnant in the long term (see Figure 8).

The differences were largest for 1870–1913, when consumption patterns changed more rapidly than before, but even for this period they must be viewed as quite small. In that period, annual inflation was, on average, 0.57 percent according to the arithmetic index used in this study, 0.52 percent according to the geometric index, and 0.63 percent according to the arithmetic index using expenditure shares of 1732–82.

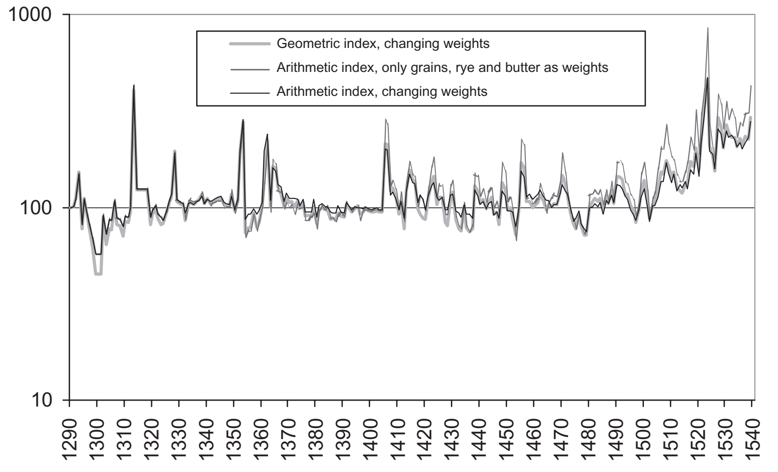

Figure 3. The Deflator Index 1290–1539 According to the Laspeyres Arithmetic Index with Changed Weights, the Laspeyres Geometric Index with Changed Weights, and the Laspeyres Arithmetic Index with only Grains, Rye, and Butter as Weights (1290 = 100)

According to the Gerschenkron effect, a price index that does not change weights normally displays a higher growth rate than an index that change weights often, since consumers tend to switch their expenditure toward products that become cheaper. When comparing the two Laspeyres arithmetic indices in Figure 2, such an effect can be observed, but it was quite small. The Gerschenkron effect was counteracted especially by the fall in the relative price of grains in the late 19th century, at the same time as their share in the consumer budget decreased.

A similar comparison of the three types of indices for the Middle Ages shows small differences as well (see Figure 3). The deflator index (which does not fully take into account the debasements of the 1350s, 1360s, and early 1520s) increased, on average, by 0.29 percent per annum in 1290–1539 according to the arithmetic index used in this study, by 0.31 percent according to the geometric index, and by 0.41 percent according to the arithmetic index using expenditure shares of 1290–1330 (which is based only on grains, rye, and butter).

In his study on European wages and prices in the pre-industrial era, Allen (2001, p. 424) also comes to the conclusion that the differences between geometric and arithmetic indices and alternative weights are very small. Grytten (2004) similarly finds small differences between the geometric and arithmetic indices for Norway in the 19th century.

5. Long-Term Inflation Rates in International Comparison

Figure 4 presents the deflator and inflation indices for the period 1290–2008. The scale is logarithmic. On average, the annual inflation rate was 2.5 percent in this period. The deflator index, on average, increased by 1.5 percent per annum in the same period. Henceforth, using only the deflator index would significantly

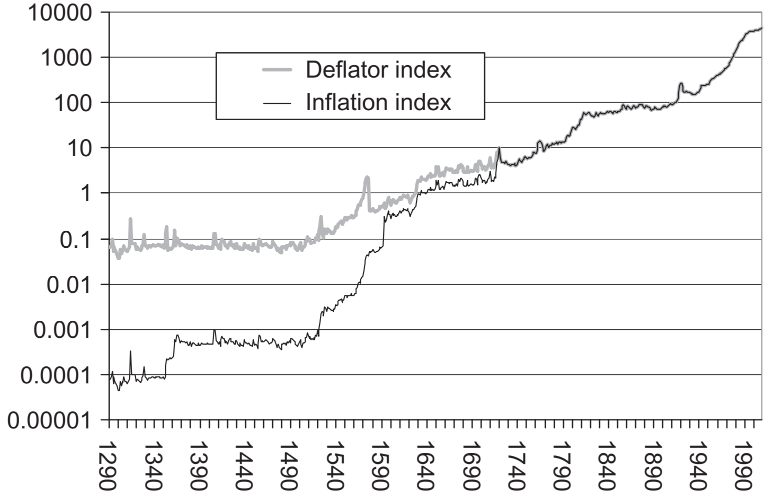

Figure 4. The Deflator and Inflation Indices for the Period 1290–2008 (July 1914 = 100)

underestimate the historical inflation rate, and this underestimation would be even greater for some shorter periods before 1720, especially in the 16th century.

Figure 4 also shows that there is a secular pattern in the movement of the general price level demarcated by major wars or international events.

High inflation characterized the 1350s and 1360s, and the 16th, 18th, and 20th centuries. The average annual inflation rate (based on the inflation index) was 18 percent in 1351–64, 6.3 percent in 1518–1633, 3.5 percent in 1715–1812, and 4.7 percent in 1914–91. The high inflation in the 18th and 20th centuries was caused by the introduction of a fiat standard, based on inconvertible money. Given that the relative price of bullion does not change dramatically, commodity money should be accompanied by price stability. However, inflation under commodity money is well known. The 16th century, not the 20th century, experienced the highest inflation rate, despite the existence of a silver standard at the time. High inflation periods coincided with expansionary phases in the expenditures of the State (before the 20th century predominantly war expenditures, but in the 20th century broader expenditures of the public sector).

Price stability characterized most of the Middle Ages (except for the years following the Black Death), the 17th and the 19th centuries, and the period from the early 1990s onwards. The average annual inflation rate (based on the inflation index) was 0.1 percent in 1290–1351, 0.04 percent in 1364–1518, 0.8 percent in 1633–1715, 0.5 percent in 1812–1914, and 1.7 percent in 1991–2008. While the price stability in earlier periods was connected to the prevalent metallic standards, the recent price stability is combined with a fiat standard. Whether the 21st century will become a low-inflation century is of course an open question.

Figure 5 compares the development of the Swedish inflation index, with the U.K. Retail Price Index 1264–2007 (Officer, 2008a), Dutch CPI 1450–2008 (International Institute of Social History, 2007), and Norwegian CPI 1516–2008 (Grytten, 2009).

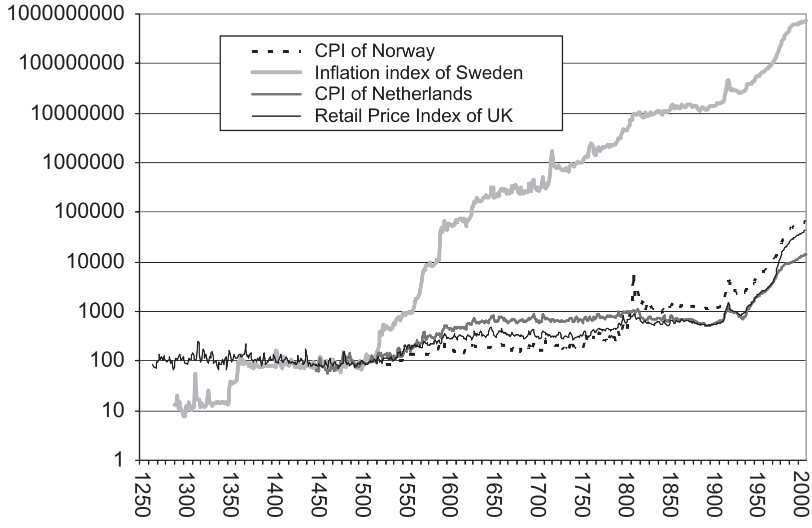

Figure 5. Consumer Price Indices of Sweden 1290–2008 (the Inflation Index), the U.K. 1264–2007 (Retail Price Index), Holland 1450–2008, and Norway 1516–2008, (1516 = 100)

There is a clear difference between the four indices up to the early 19th century (although Grytten finds a similar pattern of the secular movement of prices in Norway as in Sweden, from the 16th century to today (Grytten, 2004, pp. 73–4)). Prices rose most in Sweden. The U.K. and Dutch prices increased least through time, which also had the most stable currencies (the pound sterling and the guilder). From the early 19th century, the four indices move together.

One important difference between the Swedish index compared to some historical CPIs for other countries is that the latter do not fully consider switches in currency units. Although the U.K. and Holland did have quite stable currencies up to the 19th century, this was rather an exception, and monetary instability was quite widespread in the rest of Europe from the Middle Ages onwards. As in Sweden, there were successive debasements of the currency used in Denmark–Norway during the 16th century, but this is not visible in the Norwegian CPI since it seems to be based on a currency unit with a stable fine silver content. The Great Debasement in England in the mid-16th century is also not fully considered in the U.K. index. If an inflation index were to be constructed for France using our methodology, it would probably display an even higher inflation rate than in Sweden, due to the endemic debasements of the Middle Ages.

6. The Real Prices of Gold, Iron, and Labor Power

The CPI is an average measure of price changes. However, relative prices are also important. Using the CPI (deflator index) to deflate various price series enables us to estimate real prices (i.e. an index of how much in terms of goods and services included in the CPI it takes to buy an item over time). Below we briefly present three such examples. The first relates to the purchasing power of gold, the

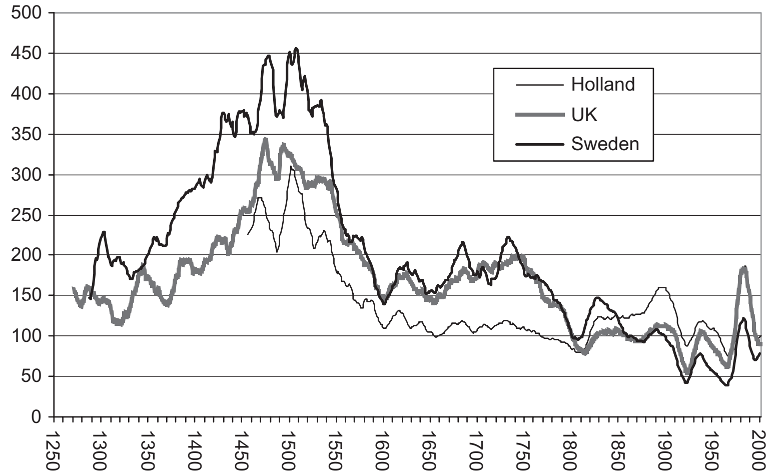

Figure 6. Fifteen-Year Moving Average of the Index of Gold's Purchasing Power in Sweden, Holland, and the U.K., Respectively (OECD average in 2005 = 100)

second to iron prices, and the third to real wages. This also provides a further test of whether the CPI gives reasonable results, especially concerning long-term developments.

The Purchasing Power of Gold

Figure 6 presents the index of gold's real price or purchasing power in the U.K., Holland, and Sweden, respectively.[3] Gold, together with silver, was the basis for currencies during the metallic standard. The inverse of the index provides a measure of how prices developed in terms of a currency of a stable gold content (for example, the ducat).

The purchasing power of gold is set equal to 100 for the OECD in 2005, which implies that it stood at 87.7 in the U.K., 82.6 in Sweden, and 92.6 in Holland in that year.[4] The three index series move closely together during most periods, despite the different methods behind their construction. The correlation between the Swedish and U.K. indices was the strongest one. This shows that the Swedish CPI gives reasonable results concerning long-term developments when compared to other countries, despite the problems discussed above concerning differences in price levels for various series.

The purchasing power of gold increased from around the Black Death in the mid-14th century up to around 1500, i.e. there was deflation when prices were expressed in gold coins. This explains why prices expressed in Swedish marks (the deflator index) were stagnant during the Middles Ages despite a long-term decline in the fine silver content of the Swedish mark (from 51 g in 1290 to 12 g in 1520).

[3]To transform the nominal indices to prices expressed in grams of gold, the following sources are used: Edvinsson *et al.* (2009), Edvinsson (2009), MEMDB (2009), and Officer (2008b).

[4]Based on the household purchasing power parities for the final consumption index. See OECD (2005).

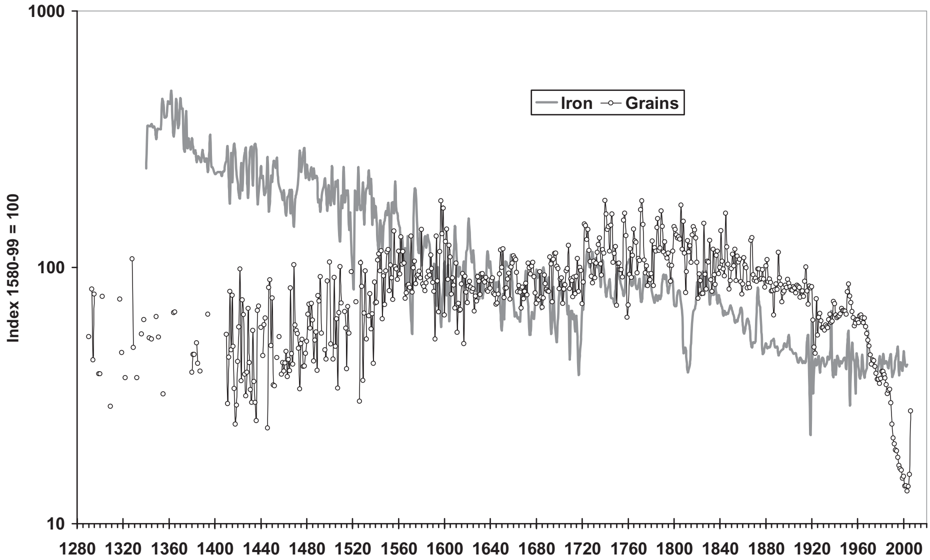

Figure 7. Prices of Iron and Grains in Sweden Deflated by CPI, 1291–2007 (Index 1580–99 = 100)

During the 16th century the purchasing power of gold decreased substantially due to the price revolution, back to the level in the late 13th century. It was stable in 1600–1750, decreased in the second half of the 18th century, and stabilized somewhat in the 19th century when the gold standard was spread. In the 20th century, when the gold standard was suspended and finally abandoned, the purchasing power of gold fluctuated substantially. Although the purchasing power of gold was higher in Sweden relative to the U.K. during the Middle Ages than in the 20th century, this should be expected since Sweden belonged to the European periphery in the Middle Ages. From around 1550 the purchasing power of gold was about the same in Sweden as in the U.K. In 1550–2007, the average of the index was 138 in the U.K. and 140 in Sweden.

In 1450–1800, the purchasing power of gold in Holland was, on average, 37 percent lower than in Sweden and 26 percent lower than in the U.K. according to the index, while it was, on average, higher than in Sweden and the U.K. in 1850–2007. This reflects the transition of Holland from being the most developed country in the world to being caught up by other countries in Western Europe.

Real Iron Prices

Figure 7 presents the evolution of the real price of iron in Stockholm in the very long term, from 1340 up to 1914. The medieval prices refer to osmond iron, but from 1540 onwards they pertain to bar iron (the two series have been linked at that year). Bar iron was a more refined product which cost about twice as much per weight unit as osmond iron.

From the latter 14th century up to the First World War, the real price of iron was reduced by a factor of ten. It is striking that the early modern era does not exhibit any acceleration in the decline of the iron price. Rather, the reduction of the real price proceeded at a fairly constant rate up to the early 18th century, when the price climbed. Presumably, technological progress and economies of scale were the main factors behind the long-term decline in the relative price of iron.

The upward shift in the real price curve around 1720, however, is probably due to the conscious attempts of Swedish authorities at holding back production and limiting the supply of exported iron in the hope that this would raise the price in the major market, England. As a result, exports were largely constant for half a century up to about 1780, despite a growing demand for iron in the world market.

The real prices of grains, on the other hand, roughly follow an inverted U-shape curve. The relative price of grains rose during the late Middle Ages and the 16th century, stagnated during the 17th century, climbed again, and peaked during the latter decades of the 18th century. These trends conform to the trends in population, with the 16th and 18th centuries as growth periods. In the first half of the 19th century, however, something decisive happened. The real price of grain began to drop. For the first time, per capita harvests rose for long periods.

These price relations capture the fundamental production problems of pre-industrial society. Agricultural per capita growth came late, and this large but relatively immobile sector dominated the economy for centuries. The iron industry shows that there was a dynamic sector in the pre-industrial period that could exhibit significant advances in productivity. However, before the industrial revolution this sector was too small to generate substantial increases in the living standards of the majority of the population. Once agriculture began to industrialize, however, the changes were dramatic and rapid. During the second half of the 20th century, the price drop for grains was much larger than for iron. The fall in the relative price of grains has continued until very recently. Signs of a reversal occur at the very end of the series, though this is an upsurge from a historically extremely low level of grain prices.

Real Wages

The CPI can of course also be used to calculate real wages. In many previous studies this is also considered to be the main purpose of a CPI. Figure 8 shows real wages of laborers. In the period 1365–1864, wages relate to unskilled laborers in Stockholm (the 1365 quotation actually refers to Nyköping). From 1864 onwards, this series is linked to the series of wages for industrial and mining workers in Sweden (Prado, 2008).

Previous research has charted the main trends in real wages after 1539 (Jansson *et al.*, 1991), which are characterized by a decline during the latter part of the 16th century, a recovery during the 17th century, a new phase of real wage decline from about 1730 up to 1800, and finally a strong upsurge after 1800. These trends are in agreement with a Malthusian model, which, according to Gregory Clark (2006), predicts that real wages should be trendless before the Industrial Revolution. Strong population growth during most of the 16th and 18th centuries pushed real wages downwards, whereas they improved during the 17th century when population pressure was weaker. The most surprising feature is perhaps that the wars and the militarization of the economy during the Great Power Era

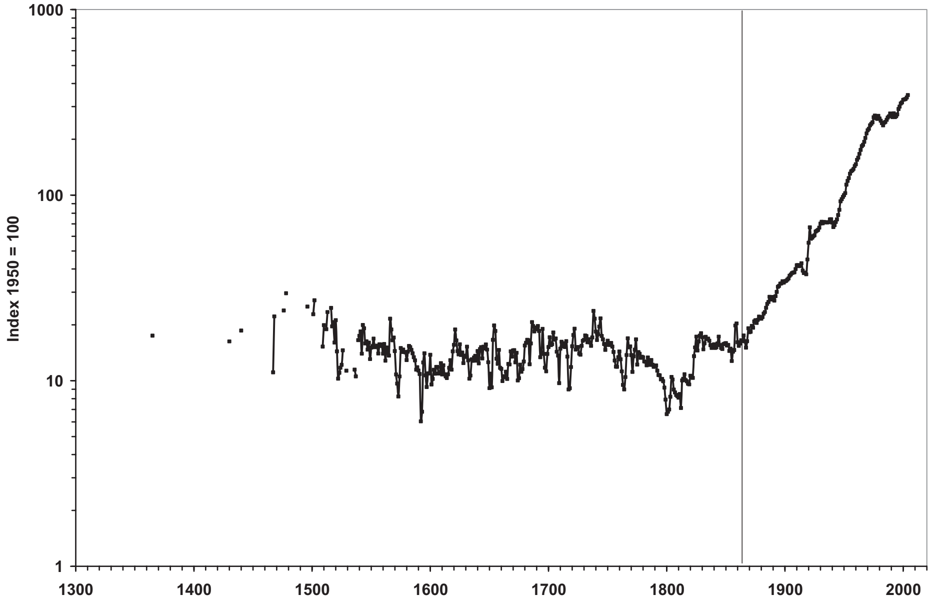

Figure 8. Real Wages of Unskilled Laborers in Stockholm, 1365–1864, and Industrial Workers in Sweden, 1865–2004 (Index 1950 = 100)

Note: A vertical line marks the change in 1865 from unskilled laborers in Stockholm to industrial workers in Sweden.

(ending in 1721) did not prevent a growth in real wages. The catastrophic decline in real wages around 1800 is also known for Continental Europe, while technological advance in the Netherlands and England implied that only there could real wages remain flat despite population growth (Allen, 2001, p. 435).

The new CPI data before 1539, though scanty, can add to the picture. There is some support for the hypothesis of a late medieval golden age in real wages. No clear trend can be discerned before 1540. Real wages were quite volatile in the 1510s and 1520s. This is a turbulent period in Swedish history, characterized by war and civil unrest. The high volatility may indicate a low welfare level where basic living conditions were unstable.

The dominating feature of Figure 8 is of course the enormous rise in real wages after 1800, which is combined with a reduced volatility. Despite some setbacks during the two world wars and a tendency toward weaker growth after the late 1970s, the curve is one of strong and nearly uninterrupted growth during two centuries.

7. Summary and Conclusions

This paper presents a CPI for Sweden for the period 1290–2008. Constructing an index that covers more than seven centuries poses conceptual as well as empirical problems. There are two main purposes of a CPI: to deflate nominal series into real ones, most importantly to calculate real wages; and to measure inflation. We also construct two different CPIs that serve the two purposes. We term the first one "deflator index" and the second "inflation index."

In previous studies on pre-industrial price indices, much focus is on how alternative index formulas and weightings affect measured inflation. Our study confirms that the differences are not so great, especially between the arithmetic and geometric formulas. However, potentially more problematic for establishing pre-industrial inflation rates is how various currency switches are treated, as the differences between our two indices show.

The currency unit was changed on numerous occasions, and in some periods multiple currencies were used at floating exchange rate relative to each other. During so-called debasement cycles, the currency deteriorated and was later replaced by a stronger currency at a reduced value (recoinage). There are different ways to construct a price index under such circumstances.

The deflator index follows the main currency unit through time. The inflation index takes into account that the inflation coins were devalued at the end of these debasement cycles, while the deflator index does not. When prices were expressed in proper coins, they have been transformed to prices in inflation coins by using the exchange rate between the inflation coins and proper coins. This paper argues that if the purpose is to measure the inflation rate during a long time period, the currency most in use, usually the weaker one, should be followed. Under such circumstances the old, debased currency, and the new, better currency must be viewed as two different currencies (going under the same name).

The Swedish inflation index displays a pronounced secular price movement. There was price stability in the 15th, 17th, and 19th centuries, while the 14th, 16th, 18th, and 20th centuries experienced periods of significant inflation. When the Swedish inflation index is compared to the price indices for the U.K., Holland, and Norway, a significant difference is visible in relation to the long-term trends before the 19th century. Prices in Sweden increased fastest due to successive debasements and note inflation in the pre-industrial era; the U.K. and Dutch prices increased least. These latter countries also had the most stable currencies.

Our deflator index can also be used to estimate the real prices and real wages. For example, our study finds that the real price of iron declined significantly from the later 14th century to the early 18th century, while the real price of grain either increased or stagnated during the pre-industrial period. The real wage even declined between the Middle Ages and the early 19th century, which also happened in Continental Europe. The purchasing power of gold in Sweden had a very similar development as in the U.K., which constitutes supporting evidence that the historical CPIs of those two countries adequately describe long-term price changes.

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