



Monitoring Inflation: a new tool for official statistics

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Index

| | |
|--|-----------|
| 1. Introduction | 4 |
| 2. The concept of a general price index | 5 |
| 3. Indicators of inflation | 6 |
| Household consumption | 7 |
| Capital market | 7 |
| Real estate and investment | 7 |
| The production of goods and services | 8 |
| 4. High or low inflation | 8 |
| 5. The dashboard | 9 |
| The homepage | 9 |
| The follow-up page | 10 |
| 6. Future development | 11 |
| Literature | 12 |

1. Introduction

Very often, economists, politicians, policymakers and the media regard the price change of household consumption, as measured in the consumer price index (CPI), as the indicator for inflation. Considerations are that in the CPI the prices of a very wide spectrum of consumer spending are brought together, and consumption by citizens is one of the most primary goals of the economic process. In addition, the CPI is often more timely than other price statistics.

A number of developments in recent years have shown that the use of the CPI as indicator for inflation does not cope with inflationary price developments in other parts of the economy, such as the production of goods and services, investment and financial markets. For example, housing prices in the Netherlands, which are not part of the Dutch CPI, have developed completely differently over the past years than the CPI (figure 1). In recent years, the lowest points in consumer price trends were in July 2009, January 2015 and July 2016. The consumer price index (12-month change) was 0.2 percent, 0.0 percent, and -0.2 percent respectively. House prices, on the other hand, decreased by 4.5 percent in July 2009, rose 2.1 percent in January 2015 and 4.9 percent in July 2016.

Figure 1. Consumer price index versus the price index of existing privately owned dwellings



This raises the question whether we should not try to develop a price index that includes not only the prices of household consumption, but also the prices of investments, shares et cetera, or to supplement the CPI with a set of price indicators for the various parts of the economy.

Another reason for this is the recent Great Recession. Recent economic and financial crises have led to low economic growth, low interest rates and low inflation. Priority is given to debt restructuring and pay-off, and the expansion of credit to enterprises is limited. Investment in assets, bonds as well as shares seems the only possible way to obtain a higher yield on financial capital. Just as before the crises, this may lead to bubbles in assets and real estate markets. To identify the risks associated with such bubbles, we need information on price movements in these markets.

First, in section 2, we examine whether it is possible to develop a general measure of inflation that encompasses all prices: goods and services as well as assets. The conclusion is that there is a sound theoretical basis for a single general price index, but that the implementation of such an index is not possible nor useful because of the large number of model assumptions necessary, the lack of reliable data and the volatility of the index.

What can be done, is the development of a set of price indicators that cover all, or at least the major parts of the economy. This is what we will do in the remaining sections. First we determine which indicators are most relevant. From the large number of price-series available we choose indicators that represent the major markets and sectors. Then we present a visualization (dashboard) build upon the chosen indicators from which the current state of inflation can be seen at a glance and that allow users to customize the settings of the dashboard at their own discretion.

2. The concept of a general price index

The concept of a general price index has a long history, that goes back to the early decades of the 20th century. In particular in the USA several attempts have been made to define and measure a general price index with prices of transactions in goods as well as assets combined into a single index, for example Snyder (1926 and 1934). However, there was never any consensus about which goods and in particular which assets were to be included, nor about the weights of the goods and the assets sub-aggregates. Therefore, NSIs have never attempted to actually produce a general price index.

We will discuss a number of studies that have tried to develop a theoretical framework for a general price index; they all do this within the model of intertemporal consumer maximization. Using intertemporal economic theory, the concept of the general price index – or the iso-utility wealth price index, as they call it – has been clearly developed by Alchian and Klein (1973). They view consumption over the life cycle as the ultimate goal of economic activities. A utility maximization model is used to allocate life-time consumption over subsequent periods. The iso-utility wealth price index reflects the price changes of all current and future consumption. Unfortunately, future prices exist for only a small number of commodities. Therefore Alchian and Klein use the prices of assets, from which future production and consumption is financed, as a proxy for the price of future consumption. They emphasize that the assets include “*all assets – consumer and producer, durable and nondurable, tangible and intangible, financial and nonfinancial, human and nonhuman*”. They explicitly mention that their iso-utility wealth price index not necessarily equals the GNP deflator as GNP only includes newly produced assets and not already existing assets.

Different from Alchian and Klein, Weitzman (1976) shows that in a similar intertemporal model net national product is a proxy for the present value of current and future consumption. Under perfect foresight net national income is the “*stationery equivalent of future consumption*”. So real national income is the quantity index of consumption over the life cycle, which implies that the implicit deflator of national income is the general price index.

Pollak (1975) combines the prices of current and future consumption to arrive at an intertemporal cost of living index for life-time consumption. Consumers choose their current and future consumption by optimizing an intertemporal utility function. Once a consumer has chosen a life-time consumption path, later deviations from this path are not allowed. For prices of future consumption Pollak presents two options. The first is the use of “*futures prices*”, the second is the use “*spot prices and interest rates*”. For the latter, perfect foresight is assumed. Both options leads to a similar result. The difference is that the role of interest rates is explicit in the “*spot prices and interest rates*” option, while it is implicit in the “*futures prices*” option. If interest rates increase, the current value of future consumption will decrease and as a consequence the intertemporal cost of living index will decline.

Shibuya (1992) extends the ideas of Alchian and Klein and develops a dynamic equilibrium price index. This price index is the geometric weighted mean of the conventional consumer price index

and the price index of assets. He implements this index for Japan with a weight of 3 percent for the ordinary consumer price index and 97 percent for the price index of assets. His conclusion is that for specific periods the dynamic equilibrium price index rose much faster than both the consumer price index and the deflator of GDP.

Wynne (1994) implements the intertemporal cost of living index of Pollak, using spot prices and interest rates. Instead of the assumption of perfect foresight he assumes rational expectations. Expected prices are derived from past prices, following a simple time series model assuming trend stationarity and difference stationarity. He implements his model using data on yields on government securities. He concludes that if his intertemporal price index is the true price index, the currently used CPI sometimes overstates and sometimes understates the true price index.

Like other authors, Reis (2005) states that the current cost of living inflation suffers from an intertemporal substitution bias and the omission of future prices. Consumers live for more than one period and consumption decisions include current and future consumption. Consumers are supposed to maximize total welfare over life, which equals the expected discounted sum of all period utilities. There are three types of goods: consumption goods that affect utility in one period, durables that affect utility in a number of subsequent periods and assets, which prices measure the relative prices between today and future. He implements his index, using data for the United States. This index turns out to be more volatile than the CPI.

Aoki and Kitahara (2010) follow Reis. But where Reis assumes a Cobb-Douglas preferences, they adopt the homothetic preferences of Epstein and Zin (1991). Their dynamic price index turns out to be smoother and more correlated with the CPI than Shibuya's and Reis' indices.

All aforementioned authors focus on household consumption as they implicitly or explicitly assume that the ultimate goal of the economy is to maximize the utility that households derive from their (lifetime) consumption.

Goodhart (2001) asks whether one should take notice of the inflation experienced by sectors in the economy. If so, the implicit deflator of GDP seems an obvious indicator. However, an important drawback is that import prices enter the GDP deflator with a negative weight (Diewert 2002). As a consequence, the GDP deflator can rise, even if all prices are falling. Goodhart refers to the Final Expenditure Price Index (FEPI) as an alternative (e.g. Wall 1997). FEPI is the change in the prices paid by households, businesses, government and non-profit institutions for final purchases of goods and services. This is what remains of the implicit deflator of GDP when imports are left out. The Office for National Statistics (ONS, United Kingdom) has published some experimental FEPI-series. Due to the difficulty to produce reliable price indices for government output, these series were discontinued with the December 2001 issue (Jones 2002).

Except FEPI, none of the proposed indexes have ever been taken into production. An important reason is that prices of futures goods and services hardly exist, that proxies for future prices and interest rates heavily depend on rather restrictive model assumptions and model specifications, and that some asset prices, especially those of bonds and shares, heavily fluctuate. The latter leads to a strong fluctuating (general) price index, which makes it unsuitable for practical use.

And finally, one may question the usefulness of a general price index (or whatever one may call it). To quote Reis (2009): *"There is no universal best price index, but rather different indexes depending on what you are trying to measure"*.

3. Indicators of inflation

In the previous section we have seen that, although there is a sound theoretical basis for a general price index as indicator of overall inflation, implementation of such an index turns out to be very

difficult and perhaps even impossible. So another approach is in order. We propose a visualization (dashboard) with indicators of inflation on the main parts of the economy.

From the start, we have imposed some restrictions. First we want the data to be presented in an interactive way, allowing users to select prices for inclusion in the dashboard, showing movements over time. The presentation of data on a limited space (from desktop computer to mobile telephone) sets limitations on the number of indicators that can be displayed. Further, to avoid the impression that one segment of the economy is more important than another, all segments will have an equal number of indicators. After some experimenting it turned out that 16 indicators equally divided over four segments yielded the best results in terms of information content, flexibility (needed for the presentation on different devices) and graphic design.

The segments follow from the literature on the general price index, discussed in the previous section. So we should include prices of current household consumption and assets. The latter includes the capital market (financial assets) and real estate and investment (non-financial assets). This also corresponds to the needs of policymakers (Filardo 2000; Goodhart 2001 and 2005). In particular they want to use this information to judge the consequences of the regular inflation measured via the HICP, in order to give a broader view and analysis of inflation. Moreover, they explicitly deny the usefulness of a general price index. For example, Goodhart (2001) states: “... *there are strong arguments for keeping the status quo*”. In response to Goodhart’s question why not take notice of the inflation of other sectors, the fourth segment of the economy distinguished on the dashboard is the production of goods and services.

When selecting indicators for inflation, preference is given to variables that are published monthly. All series in the dashboard are monthly series, except one, which is a quarterly series. This series is converted to monthly series by interpolating and extrapolating. With a few exceptions, all series are in 12-months relative changes, i.e. the relative percentage change between the current month and the same month of previous year.

Household consumption

The first segment is household consumption, as measured in the CPI. Selected components in household consumption are foods, energy (natural gas, electricity, et cetera), industrial goods (excluding energy) and services. The latter two form the core inflation of household consumption.

Capital market

The second segment concerns the financial markets. Important indicators here are the long term interest rate (the interest rate on 10-years government loans), the short term interest rate (3-month loans interest rate) and the share price on the Dutch stock market (AEX). The two interest rate series are the only series on the dashboard that are not 12-month percentage changes.

We had some difficulty in selecting a fourth indicator, not being an interest rate. It was considered to select the exchange rate of foreign currency. However, a large part of the international trade in goods of the Netherlands is within the euro zone: 41 percent for imports in 2016 and 53 percent for exports. Moreover, on average the exchange rate of the euro against the currency of the main non-EU trade partners of European Union did not change very much during the last 15 years. Therefore, preference was given to the price of gold as the fourth indicator.

Real estate and investment

The third segment is fixed assets. Ideally, this segment contains information on the prices of private homes (new buildings and existing houses) and other buildings (offices, shops, warehouses, industrial buildings and so on), the rent of commercial property, the price of machinery, ships, aircraft, vehicles, et cetera. However, only few of these prices are available on

a monthly or quarterly basis. For real estate, the price of existing privately owned dwellings and a proxy for the price of new houses has been chosen. Investments is represented by the import price of machinery, equipment and tools and the producer price of capital goods produced in the Netherlands.

The price of newly built houses is approximated by the construction costs of new buildings. The difference is that the price of new buildings also includes the profit margin of the project developer as well as the price of the land on which the property is built.

The construction cost of new buildings is only available on a quarterly basis. In order to reach a monthly series of percentage year-on-year mutations, the quarterly indices are first projected on the middle month of the relevant quarters. The values for the intermediate months are obtained by linear interpolation. For the most recent months, the value of the most recent index available is duplicated. After that, the 12-month percentage changes are calculated.

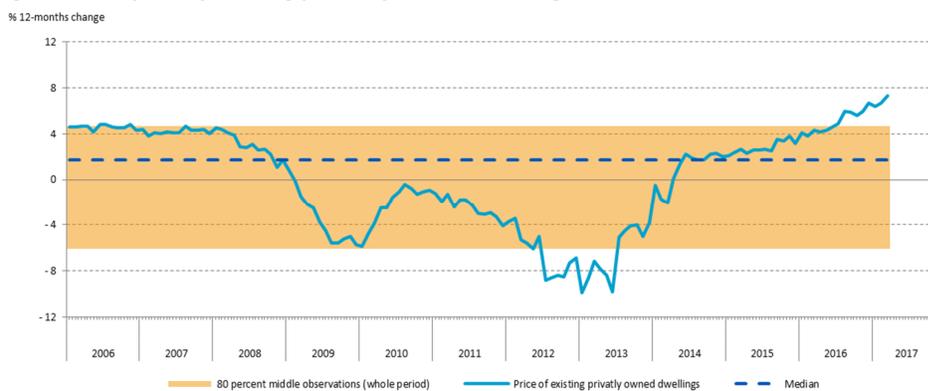
The production of goods and services

The last segment concerns the production of goods and services. As indicators we have chosen wage rates, the price of imports of goods and services (excluding energy) and the price of energy. The latter is represented by the price of crude oil. In addition, the output price of the industry is important. The output prices of services are not included because they are not available on a monthly basis. However, they are strongly related to wages, and wages are included in this segment.

4. High or low inflation

To be able to assess the data in the dashboard, we have indicated for each series whether there is a relatively large price increase, a normal price change or a noticeably low price change (sometimes also a fall in prices). To assess whether or not a price change is normal, it is compared to the median price development in the same series. If a price change falls within an interval around the median price development, it is considered normal. The width of the interval and the period over which the median and the interval are calculated, can be set by the user of the dashboard himself.

Figure 2. The price of existing privately owned dwellings



As an example, figure 2 shows the price change of existing privately owned dwellings for the period 2006 - March 2017. During this period, the 80 percent middle observations (i.e. from the 10th percentile to the 90th percentile) are considered normal price developments. These are all

price developments that fall within the yellow area in the figure. Only the price decreases in mid-2012 to mid-2013 and the high price increases in recent months are exceptional.

Figure 3. The price of existing privately owned dwellings



Figure 3 shows how things turn out if we take the last seven full calendar years as reference period and narrow the 'normal'-interval to the 50 percent middle observations (i.e. from the 25th to the 75th percentile). This shows that it does matter which reference period and which interval width is chosen to determine the 'normal' price changes. Moreover, if we had already had the dashboard in 2009, and we had compared the price changes in 2009 (-0.1 percent in February 2009) with those in previous years, then we had judged these price changes as very low. Now, eight years and two house price recessions later, we consider it as normal. This indicates that as a result of new unforeseen developments, the assessment of price developments may change over time.

5. The dashboard

In June 2017, Statistics Netherlands published the first experimental dashboard on prices (<https://www.cbs.nl/nl-nl/visualisaties/prijzendashboard>). A copy in English was published in ... The dashboard consists of two web pages: a homepage with limited functionality and a follow-up page with more detailed information and the opportunity for visitors to change the settings for 'normal' price changes. The database underneath the dashboard contains the data of twelve years, with the last year not having to be complete.

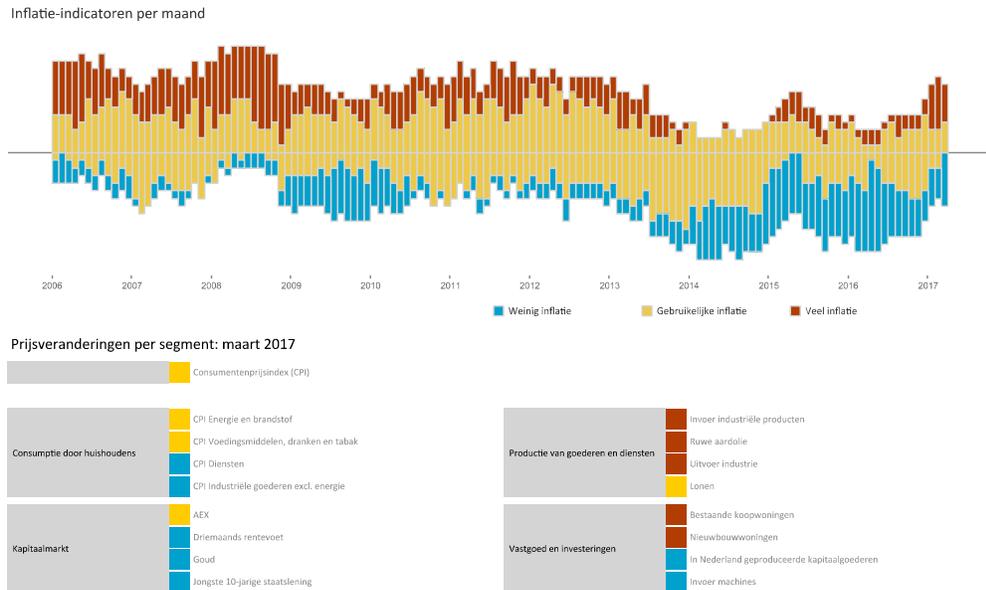
The homepage

Figure 4 is a screen print of the homepage. On top of the homepage there is a bar chart. Each bar in this figure refers to a month. The red part of a bar indicates how many of the 16 series show a more than normal price increase. The yellow section below indicates how many indicators have "normal" inflation. The blue part at the bottom of the bar represents the number of series with a lower than "normal" price change.

The yellow part of the bars move around the zero line. The part above the grey horizontal line refers to the series with a "normal" but higher than median price change; the section below the line represents the number of series with a "normal" but less than median price change. By placing the bars in this way, not only the colours but also the position of the bars in the figure is an indication of 'inflation'. If a bar is placed high – that is, many series show a higher than median development – there is relatively high inflation. If a large part of the bar is also red-coloured, as

in 2008, it indicates a period of exceptionally high inflation. If the bars are low in the figure and they are mainly blue, as in 2014 to 2016, then the reverse applies.

Figure 4. The homepage of the dashboard on prices (Dutch version)



As explained in the previous section, the assessment whether inflation is exceptional or not, depends on the choice of the reference period and (to a greater extent) on the ‘normal’-interval width. In this part of the dashboard, the reference period is equal to the entire period shown and the ‘normal’-interval width is 50 percent (from the 25th percentile to the 75th percentile). By choosing such a narrow bandwidth, relatively many months will show exceptional inflation. The figure at the bottom of the home page shows which indicators show an exceptional value and which do not. When the webpage is opened, this specification is shown for the most recent month, but by clicking on the top figure the specification of other months is shown. The number of squares of the same colour, except the square for the CPI, corresponds to the length of the same colour in the corresponding bar in the upper figure.

The follow-up page

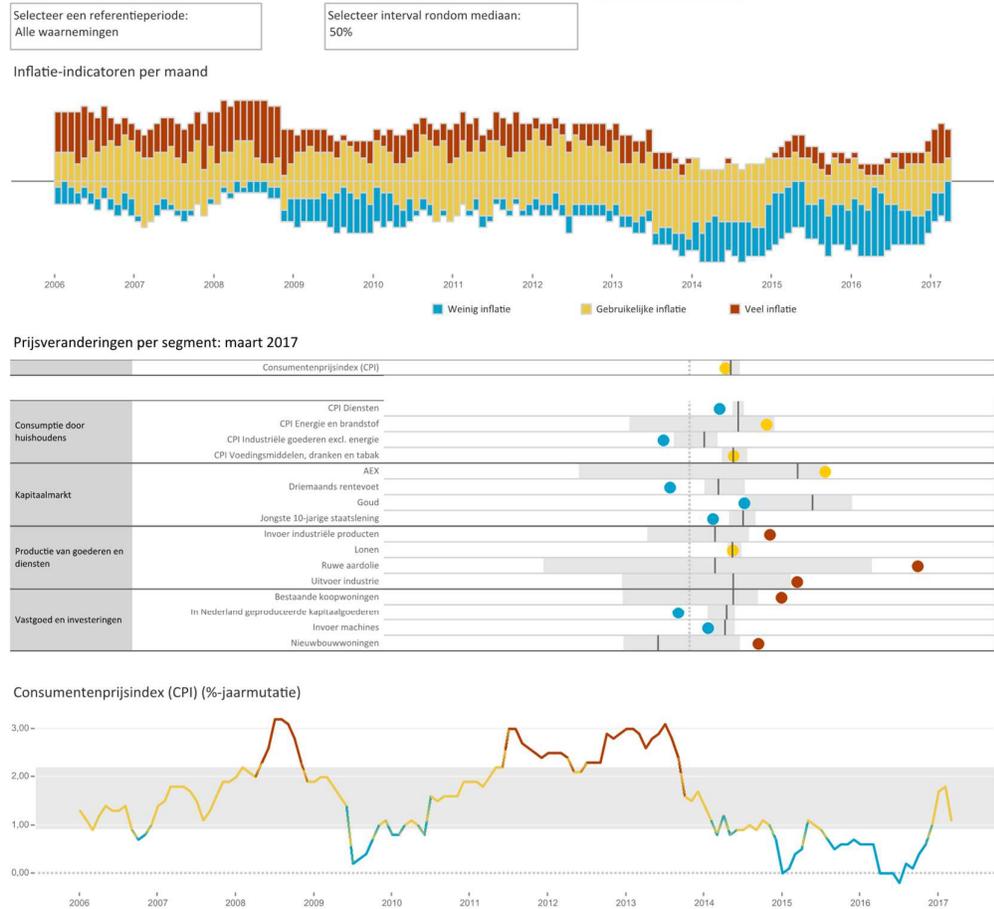
From the opening page one can proceed to a follow-up page (figure 5) with more information and the possibility to select different reference periods and ‘normal’-interval widths. This page has three figures. The first figure is equal to the first figure on the home page. The second figure is an extension of the second figure of the home page. The coloured squares are replaced by coloured dots, placed on a horizontal axis. The more to the left, the lower the value of the indicator, and the more to the right, the higher the value. Also for each indicator, the ‘normal’-interval and the median are displayed. Because the values of the indicators are quite different, the following nonlinear transformation is performed for the horizontal axis:

$$\begin{aligned}
 x &\rightarrow -\sqrt{-x} && \text{for } x < 0 \\
 x &\rightarrow \sqrt{x} && \text{for } x \geq 0
 \end{aligned}$$

This reduces the distance between extreme values more than the distance between the values that are closer to zero. Visually, the distance between 0 and 4 percent ($0 \rightarrow 0$ and $4 \rightarrow 2$) is as large as the distance between 4 and 16 percent ($4 \rightarrow 2$ and $16 \rightarrow 4$).

The third figure shows the time series of one of the indicators. Which one is shown, may be selected by clicking on one of the names in the second figure.

Figure 5. The follow-up page of the dashboard on prices (Dutch version)



6. Future development

The main purpose of the price dashboard is to show that inflation is more than just the increase or decrease of the prices of household consumption. This, we think, is met with the current version of the dashboard. But there are also some other goals which are not yet met with the current release. For example, we would like to provide users with the tools to visually search for relationships between various time series on prices, both changes and index numbers. After fine tuning the current dashboard, this will be one of the objectives for further development.

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