

How is inflation measured?

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CPI as a target variable for monetary policy

According to the Sveriges Riksbank Act, the objective for monetary policy is to maintain price stability. The Riksbank has specified this as a target for inflation, according to which the annual percentage change in the consumer price index (CPI) is to be 2 per cent. Most inflation-targeting countries have opted for some sort of CPI as a target variable.² In Sweden, the CPI was chosen as a target variable primarily because it was the best known measure of inflation in Sweden. It was considered particularly important when confidence in a new monetary policy regime was to be established at the beginning of the 1990s. The CPI was also considered to have many other advantages; it encompasses a substantial part of household consumption, it is published regularly and it has statistical qualities that are well known.³

However, use of the CPI as a target variable for monetary policy has sometimes presented elucidatory difficulties for the Riksbank. At an early stage, for example, the problem was realised of the direct effect of changed interest expense on the CPI going “in the wrong direction”, i.e. a rate hike with the purpose of curbing inflation instead having a counteractive effect on the CPI. This is because the CPI includes household mortgage rates. Therefore, the Riksbank has often supplemented the analysis with other inflation measures. For instance, since 2008 the Riksbank has been publishing forecasts for CPI with a fixed interest rate (CPIF). The rate of increase in the CPIF is not directly affected by changes to household mortgage rates. The Riksbank also regularly publishes forecasts for CPIF excluding energy.

How is the CPI calculated?

The CPI is calculated and published monthly by Statistics Sweden. The CPI is intended to show the average progression of consumer prices for the goods and services consumed by households. Each month, Statistics Sweden collects hundreds of thousands of prices from thousands of points of sale.⁴ Prices are collected directly in stores and also online or over the phone.⁵ For food, for example, a great volume of prices are collected through cash register data, i.e. price records directly from stores' cash register systems. A price index is then calculated and weighed in with weights based on a composition of consumption that is as accurate as possible.

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2. Berg, Claes (2005), Experience of inflation-targeting in 20 countries, *Economic Review* 2005:1.

3. See the Riksbank's press release of 15/01/1993, “The Riksbank specifies the target for monetary policy”. See also Bäckström, Urban (1995), Price Stability and Monetary Policy, *Quarterly Review* 1995:1 and Heikensten, Lars (1999), The Riksbank's inflation target – clarifications and evaluation, *Quarterly Review* 1999:1. See also the document *Monetary Policy in Sweden* (2010) available on the Riksbank's website, www.riksbank.se.

4. See also *The Consumer Price Index (CPI), Description of the statistics*, Statistics Sweden 17/02/2015. It is difficult to provide figures for the number of points of sale. All prices from e.g. Systembolaget and various pharmacies are measured in the survey.

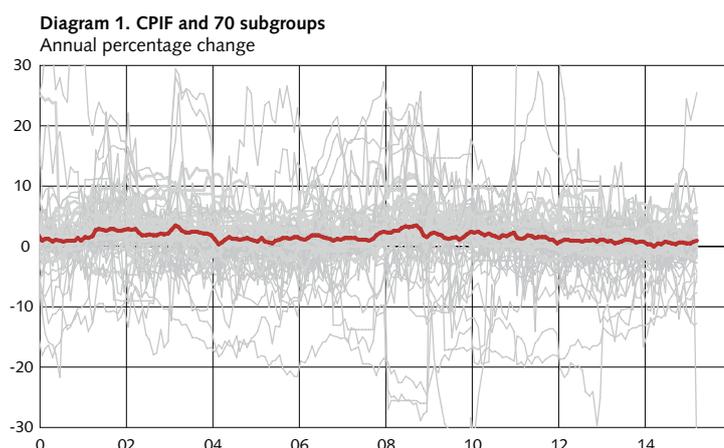
5. In the home electronics area, 17 per cent of the amount of observed prices were collected online in 2014 (weighted). The equivalent number for clothing and footwear was 10 per cent, and for books and media 38 per cent. Within “retail, other” (home furnishing, sport and leisure, construction trade and toys) no prices were collected online in 2014. Ahead of 2015, the proportion of prices collected online was extended in the CPI in order to better correspond to e-commerce market share. In terms of transport services, online price collection represents a substantial share. Price collection is conducted by means of Statistics Sweden making test bookings of e.g. flights. E-commerce for which the vendor is abroad is not included in current price measurements, however, although Statistics Sweden is exploring the possibility of also including this type of trade in the CPI.

The majority of inflation-targeting countries – including Sweden – have some sort of consumer price index (CPI) as a target variable for monetary policy. In this Economic Commentary, the Swedish CPI and its characteristics are described. Also, certain difficulties are discussed regarding CPI calculation that might be important to be aware of when analysing the CPI and other inflation measures. In particular, quality adjustments and measuring housing costs are discussed. Quality adjustments and the choice of housing cost measurement method have a considerable impact on the CPI's rate of increase.

The CPI is considered to be of good quality and to reflect the progression of the cost of household consumption. Using CPI as a target variable for monetary policy has, however, posed elucidatory difficulties for the Riksbank, with the Riksbank's changes to the repo rate having considerable direct effects on the CPI. Therefore, the Riksbank has often supplemented the analysis with other inflation measures, such as the CPIF.

The CPI is not well suited to international comparisons of the inflation rate, one reason being that housing costs are measured differently in different countries. A better measure for international comparisons is the HICP, which is harmonised in the EU.

The CPI thus includes hundreds of various subindexes that are weighed into the total CPI. Substantial relative price changes occur over time. The prices of some goods and services rise faster, and others slower, than the average (see diagram 1).



Note. The red line shows the CPIF.
Source: Statistics Sweden

One important aim of the CPI is use for compensation purposes. For example, it is used to calculate the size of the base amount, which affects for instance the basic income tax deduction. The theoretical starting point for the CPI is the concept of the cost-of-living index. In brief, the cost-of-living index theory can be described as the CPI specifying “the relationship between the monetary amounts required to maintain, in two price situations, the same consumption standard, or the same level of utility”.⁶ This involves comparing two situations, in which not just prices, but also consumption composition, vary. One implication of this is that the index can change even if all prices are unchanged.

In the CPI, the basket of consumption at the basis of the calculations is updated at the turn of each year in order for price changes to be based on a consumption composition that is as accurate as possible. The source material used for calculating the weights for the goods and services included is mainly obtained from the national accounts. Because of the way in which updating is performed, the index level can be adjusted at the turn of years.

The effect of the changes to weights on inflation is often negative because consumers tend to consume less of the goods and services that have become relatively more expensive, and which might thus be given a lower weight, and more of the goods and services that have become relatively cheaper, and which might thus be given a greater weight. The size of the effect varies from year to year. It is commonly between -0.1 and -0.2 percentage points, but has been zero in the past three years (see Table 1).⁷

Table 1. Effect on the annual rate of change in the CPI from updated consumption basket composition (percentage points)

	2008	2009	2010	2011	2012	2013	2014	2015
Contribution from weight changes	-0.2	-0.2	-0.2	-0.1	-0.3	0.0	0.0	0.0

Source: Statistics Sweden

An alternative measure of consumer price inflation is the (EU) harmonised index of consumer prices – the HICP. That measure is not based on the concept of a cost-

6. Quote from the CPI inquiry, SOU 1999:124, p. 27.

7. For further information about how these calculations are made, please refer to “The basket effect” – effects of changes to basket composition, Memorandum from Statistics Sweden, 17/02/2015.

of-living index.⁸ Instead, the HICP is to serve as an “inflation index” and explicitly distances itself from the cost-of-living concept. An important difference between the Swedish CPI and the HICP is that the rate of increase in the HICP is not affected by weight changes in the same way as the CPI is. Instead, the HICP is a chain index, in which an index with December of the previous year as a base is used for calculating the index numbers. Hence, the rate of change in the HICP is not affected to the same extent as the CPI by shifts in the consumer pattern between different years.⁹

There is a specific board affiliated with Statistics Sweden and the consumer price index – the Consumer Price Index Board.¹⁰ The Board discusses and makes decisions on matters of a principle nature regarding the application of the fundamentals applying to the CPI. Typically difficult matters of principle in calculating the CPI include quality adjustments and price measurement of housing costs. They are discussed below under Quality adjustments and Price measurements of durable goods and housing.

The CPI, CPIF and interest expenses for owner occupied housing

The CPI includes a subindex for mortgage cost for owner occupied housing. This index makes up around 5 per cent of the CPI and its purpose is to measure the capital cost of households for living in owner occupied housing. The index is affected by how mortgage rates change, and also by how the value of the properties financed by the mortgages changes, in accordance with the simplified formula below.

$$\text{Mortgage cost index} = \text{Capital stock index} \times \text{Interest rate index}$$

The capital stock index measures the purchase price of properties. When property prices have risen a great deal over a long period of time, this will, through the effects on the capital stock index, be a factor in pushing up the interest expense index and hence so too the CPI.¹¹ The interest rate index measures the progression of the average interest rate for mortgages with the floating rate and interest rates with fixed terms of one, two, three, five and eight years. There is a strong link between the Riksbank’s repo rate and floating mortgage rates. When the repo rate changes, this therefore has a direct impact on the CPI, through the effects on the interest rate index. An increase to the repo rate then leads, in the short term, to CPI inflation increasing, despite the purpose of the hike being to curb inflationary pressure in the economy.¹²

In order to correct the inflation rate for the direct effects of altered mortgage rates, Statistics Sweden publishes, by assignment of the Riksbank, the CPIF measure. In that index, the interest rate index is held constant, while changes to property prices have the same effect on the CPIF as on the CPI. In the long term, when the interest rate has stabilised, the rate of increase to the CPI and CPIF will therefore be the same.

8. The harmonised index of consumer prices (HICP) is an index for European inflation comparisons. The HICP is in place for all EU countries plus Iceland, Norway, Switzerland and the US, as well as for the EU and for the EMU as a whole. The HICP is used as a target variable in the ECB’s monetary policy. The HICP is calculated according to harmonised rules for e.g. coverage, consideration for new products, updating product selection, adjustments for quality changes and index formulae for the calculations. The HICP differs from the Swedish CPI on a number of points. The items for owner occupied housing are largely not included in the HICP and the method for calculating the index numbers and price progression in the HICP differs to some extent from that for the CPI.

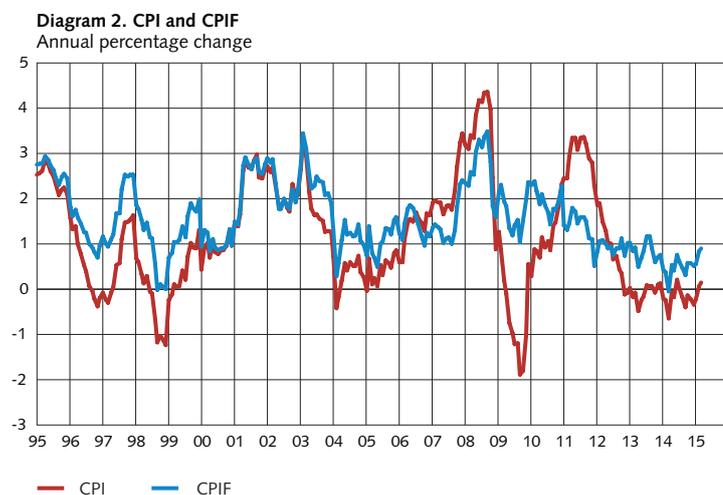
9. Prior to 2005, the Swedish rate of inflation was calculated excluding the effect of the updated weights. At the time, Statistics Sweden reported two different measures of the annual percentage change in the CPI, one of which was called the inflation rate and excluded the effect of the updated basket composition. Then, the Swedish inflation rate was calculated more or less using the same method as for the HICP. When a new index structure was introduced in 2005, the Consumer Price Index Board decided however to cease this distinction between the inflation rate and the annual percentage change in the CPI. See the CPI inquiry SOU 1999:124, section 9.2.2 and Statistics Sweden’s memorandum Improved CPI structure from January 2005: Technical description.

10. The Board’s first meeting was held in 1954. The Board’s tasks and composition are regulated in the instructions (2007:762) for Statistics Sweden. The Board consists of a chairman and eight other members. The chairman and the other members are appointed by Statistics Sweden, one by proposal of the Riksbank, one by proposal of the National Institute of Economic Research, and one by proposal of the Social Insurance Office, the Pensions Agency and the National Board of Health and Welfare. Out of the other members, three shall possess such scientific expertise that, as a whole, they are competent within the subject areas national economics and statistics.

11. The capital stock index can be fairly well approximated by a 25-year moving average of the property price index.

12. The interest rates for fixed loans come into the calculations as a sliding mean over the fixed interest term in question. For example, a change to the interest rate with a five-year fixed term comes in as a sliding mean over the past 60 months. A rate change thus affects the CPI for up to eight years.

It becomes clear that the decline in interest rates is an important reason for the low CPI inflation in the past few years when studying diagram 2. In the diagram, CPI inflation is compared with inflation measured using CPIF. The difference between the red and blue lines comes from the effects on the CPI arising from altered interest rates. The diagram shows that rate hikes in certain periods have helped push up CPI inflation (when the red line is above the blue one). However, looking over the entire period from 1995, the relationship has largely been the opposite. On average, mortgage rates have declined and helped keep a lid on inflation. Hence, CPI inflation has on average been lower than CPIF inflation since 1995.



New products and points of sale in the CPI

Over a calendar year, Statistics Sweden follows the prices of a selection of goods and services at a selection of points of sale. The selections are renewed annually so that the CPI reflects consumption that is as accurate as possible. When consumers start to consume new goods and services, Statistics Sweden starts to measure their prices in line with them becoming sufficiently significant. Price comparisons are only made within one and the same point of sale.

The switch of consumption itself from one type of product or service to another does not directly affect the CPI. For example, the price change potentially perceived by consumers from starting to consume music through streaming services instead of by purchasing CDs, will not be directly captured in the CPI. Streaming services will be treated as a new service, whose price is measured separately. However, the prices of CDs can be indirectly affected when a growing number of people use streaming services. And the weight for CDs will be smaller.

In the same way, the establishment of new discount stores will not directly affect the CPI. For example, if a new discount food store is opened and a growing number of people start shopping there, and it is right next door to an existing food store, the switch of store itself will not affect the index, other than indirectly because of price pressure from the cheaper store. It is not until Statistics Sweden updates its store selection that it can potentially start to measure the price trend in the new store.

Quality adjustments

A difficult question when calculating the CPI is how to distinguish between price and quality changes. The CPI is only to measure "pure" price changes. Hence, a price change that is due to the features of a product having changed shall not affect the CPI. For around a quarter of the CPI's product basket, regular quality adjustments are made.

For example, when Statistics Sweden is to measure the price of a bicycle, it uses a detailed specification as a basis, such as “Men’s bike, 7 gears, 28 inch”. Somebody from Statistics Sweden then visits the bicycle store and asks what the best-selling bike has been according to these specifications. Based on this, they select a bicycle and follow its price each month. If the selected bicycle disappears from the store or if another one with the same specification starts to sell better, Statistics Sweden switches to that bicycle. However, if the quality of the new model does not equal that of the previous one, a quality adjustment must be made. In a quality adjustment, the value of the quality difference between the bicycles is estimated and the price of the new model is adjusted accordingly. This is of course difficult to do with perfect precision, and a number of different methods are used to establish a value (see table 2).

The approach for many products is to let the price collector assess the value of the quality difference when collecting prices. The price collector shall state an amount in SEK that is to equal what the difference in quality is considered to be worth to consumers. This amount is included in the CPI calculation so that the price progression is adjusted with due consideration for the difference in quality.

A more advanced method is based on a statistical method in which an estimation is made of the implications of various product features for the price (known as hedonic regressions). Using these estimations, the value of the difference in quality can then be adjusted for in the index calculation. In the CPI, this method is applied to e.g. clothing. The method is considered to be reliable, but requires a lot of data to be collected about the products.

For computers, for instance, a simpler method is used. In that method, the average price progression from one month to the next is calculated for computer models that were on sale in the store during both months. Then, the monthly changes are multiplied together to obtain the price progression over several months.

Table 2. Ongoing quality adjustments in the CPI

	METHOD	WEIGHT IN THE CPI 2014, PER THOUSAND
Services	Assessment	82.7
Clothing	Regression	42.4
Footwear	Regression	8.3
Second-hand cars	Regression	8.6
Furniture	Assessment	16.4
Recreation, culture	Assessment	19.9
Household textiles	Assessment	9.4
Household appliances	Assessment	4.2
Household articles	Assessment	9
Health and medical care	Assessment	3.5
Automotive, spare parts	Assessment	34.1
Miscellaneous goods	Assessment	11.2
Home electronics	Assessment	6.7
Telecom services, phones	Monthly chaining	4
Computers	Monthly chaining	4.6
Computer accessories	Monthly chaining	1.5
Total weight		266.5

Source: Statistics Sweden

Quality adjustments in product switches and sales

A typical pattern for many products in the CPI is that the price declines during its period of inclusion in the selection, and that a price increase only occurs when it disappears and there is a switch to a new product.

When SCB makes a new selection of products in the store at the end of the year, a product is selected and its price is then measured during the subsequent year. What often occurs during the year is that the product is sold out at a discounted price before entirely disappearing. Then, if not before, the price collector must select a new product, which is often more expensive because a switch is made from a product sold at a discount price to one sold at a regular price.

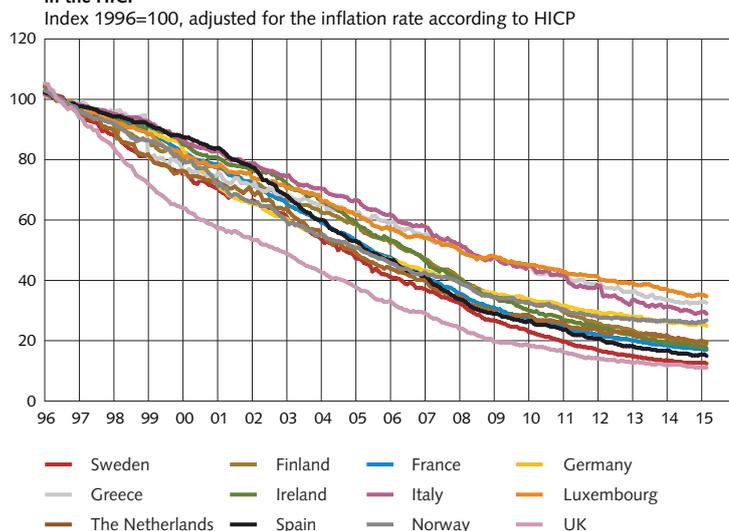
In a Statistics Sweden study, an “implicit quality index” is studied to assess the value of quality adjustments for a number of products.¹³ The study finds that, for many products, substantial quality adjustments are made when products are switched. For home electronics, this seems reasonable because such products tend to change rapidly. However, substantial quality adjustments occur for products such as household textiles too. It thus cannot seemingly be ruled out that too much of the price difference from the discounted product to the new product is adjusted away as increased quality. If that is the case, it could lead to actual inflation being higher than measured inflation.

Estimations of the significance of quality adjustment

Statistics Sweden has attempted to appraise how large the total effect of quality adjustments will be on the rate of increase in the CPI.¹⁴ The estimations suggest that the quality adjustments helped keep a lid on the annual rate of increase in the CPI by 0.3-0.4 percentage points on average in 2014. There is no international comparison of the significance of quality adjustments between different countries, and we therefore do not know the extent of the effect of quality adjustments in other countries. One way of attempting to see whether the size of the quality adjustments varies from country to country is to compare the price progression for goods sold in several countries, and whose prices can be expected to progress similarly.

Diagram 3 shows the price progression for home electronics in a number of European countries in the past 20 years. Home electronics prices tend to decline over time because computers, for instance, constantly get cheaper and better. In the calculations of the home electronics index in the CPI in Sweden, quality adjustments of around 10 per cent annually have been made in recent years. Prices have fallen somewhat faster in Sweden than in many other European countries. This has occurred while at the same time the Swedish krona has depreciated somewhat, which has a counteractive effect and ought therefore to have led to a somewhat faster price progression in Sweden than in other countries. However, it is difficult to say whether this difference is due to differences in quality adjustment or to other factors, such as an altered competitive landscape.

Diagram 3. Prices of audiovisual and photographic equipment and computer equipment in the HICP



Note. The index level is adjusted for differences in the inflation rate between the countries by dividing by the index for the total HICP in each country.
Source: Eurostat

13. Jörgen Dalén, Oxana Tarassiouk (2013), Replacements, quality adjustments and sales prices, Manuscript for Ottawa Group meeting, Copenhagen May 1-3, [http://www.ottawagroup.org/Ottawa/ottawagroup.nsf/4a256353001af3ed4b2562bb00121564/8bdac0e73d96c891ca257bb00002fdb4/\\$FILE/Jrgen%20Daln%20Replacements%20quality%20adjustments%20and%20sales%20prices.pdf](http://www.ottawagroup.org/Ottawa/ottawagroup.nsf/4a256353001af3ed4b2562bb00121564/8bdac0e73d96c891ca257bb00002fdb4/$FILE/Jrgen%20Daln%20Replacements%20quality%20adjustments%20and%20sales%20prices.pdf).

14. See the internal presentation “CPI challenges ahead – quality adjustments and their effects”, Peter Nilsson, Statistics Sweden, April 2015.

Price measurement of durable goods and housing

For many goods and services, it is relatively uncomplicated to determine the price to be measured, such as the price of a litre of milk. However, for durable goods (goods and services consumed several years after purchase), the price to be measured in a cost-of-living index is not so clear. The monthly cost of owning a car should, for instance, besides the purchase price, be affected by e.g. the rate of value depreciation and the alternative cost for the cash amount paid when the car was purchased.

For most durable goods, this problem is disregarded. The price of a car, for example, affects the CPI in the month of the price change, in the same way as the price of a litre of milk. In terms of housing costs for owner occupied housing, Statistics Sweden attempts, however, to measure various expenses for housing, such as capital, wear-and-tear, operating and maintenance costs. The cost of living in a tenant-owned apartment is however measured by monitoring rents for tenancy-right apartments.

The way in which housing costs are measured is also a reason for why it is difficult to compare inflation between different countries. For many products, comparability is not a great issue because price measurement for most durable and non-durable products alike is conducted more or less in the same way in many countries. However, the method in which housing costs for owner occupied housing are measured are an important source of non-comparability, partly because they make up a large proportion of the CPI (around 10 per cent in Sweden) and partly because there is no uniform standard for measuring them. There are primarily four different ways of measuring the costs of living in owner occupied housing.

- 1. User cost**

In a user cost calculation, households' costs of living in owner occupied housing are measured directly. The costs include capital costs, wear-and-tear costs and operating costs.

- 2. Rental equivalence approach**

In a rental equivalence approach, households' costs are measured by following rent progression for comparable homes.

- 3. Net acquisition approach**

In a net acquisition approach, costs are measured in the same way as for a litre of milk, i.e. by monitoring the price progression for new houses.

- 4. Only operating costs are measured**

Housing costs for owner occupied housing can also be omitted, and only operating costs – such as costs for water and sanitation – are measured.

Table 3 shows how a selection of inflation-targeting countries has opted to measure the costs of living in owner occupied housing in their primary measure of inflation. In HICP, housing costs for owner occupied housing are omitted, except for running operating expenses.¹⁵

15. When the theoretical basis for HICP was determined, the following was written: "It should encompass only market transactions; i.e., imputations such as user costs or imputed rental prices for owner occupied housing would not be included" and "It should not include interest rates or interest costs since "such costs are neither a good or a service but the instrument for balancing the supply and demand of money" and "The index should treat owner occupied housing in one of two ways: either exclude owner occupied housing from the index or to include new purchases of dwelling units, essentially treating purchases of new dwelling units like any other purchase of a consumer durable." See page 39 ff in Diewert, Erwin (2002), Harmonized Indexes of Consumer Prices: Their Conceptual Foundations, ECB Working Paper No. 130.

Table 3. Methods for measuring housing costs in owner occupied housing in each country's main inflation measure

COUNTRY/REGION	METHOD	THEORETICAL FOUNDATION
Sweden, Canada ¹⁶	User cost	Cost-of-living index
US, Japan, Norway	Rental equivalence approach	Cost-of-living index
Australia, New Zealand	Net acquisition approach	Cost-of-living index
Euro area (HICP), UK (HICP) ¹⁷	Only operating costs	"Inflation index"

Sources: Each relevant statistics authority

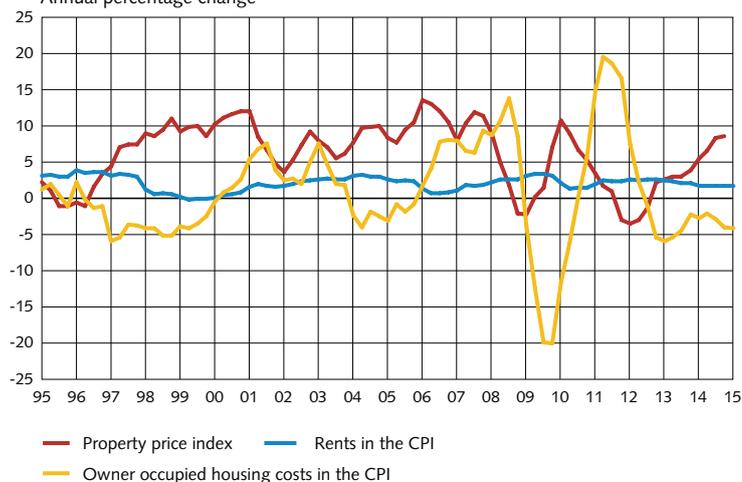
The fact that the difference between the various methods can be considerable is shown in table 4 and diagram 4. Owner occupied housing costs in the CPI rise more slowly than rents and the property price index on average.¹⁸ This is linked to the fact that mortgage rates have declined on average since 1995. At the same time, owner occupied housing costs have fluctuated much more than rents and the property price index.

Table 4. The annual rate of increase and its standard deviation in the property price index, owner occupied housing in the CPI and rents in the CPI

	AVERAGE RATE OF INCREASE 1995-2014	STANDARD DEVIATION IN RATE OF INCREASE 1995-2014
Property price index	6.1	4.4
Rents in the CPI	2.1	1.0
Owner occupied housing in the CPI	0.7	7.1
– Of which interest rate index	-4.7	14.9
– Of which capital cost index	4.1	1.5

Sources: Statistics Sweden and the Riksbank

Diagram 4. Property price index, owner occupied housing costs in the CPI and rents in the CPI
Annual percentage change



Source: Statistics Sweden

16. For a discussion housing cost measurement in CPI in Sweden and Canada, see Palmqvist, Stefan (2013), "Konsumentprisindex i Sverige och Kanada är inte så lika", blog post at Ekonomistas, <http://ekonomistas.se/2013/11/20/konsumentprisindex-i-sverige-och-kanada-ar-inte-sa-lika/>.

17. In the UK, it was decided in 2003 that the monetary policy target should be expressed in terms of HICP, and they subsequently started calling this the CPI.

18. The property price index is used here as an estimation of how an index would perform according to the net acquisition approach. Price progression for new homes is assumed to be the same as the price progression for the total new home stock.



Summary and conclusions

The CPI is considered to be of good quality and to reflect the progression of the cost of household consumption. However, use of the CPI as a target variable for monetary policy has often presented elucidatory difficulties for the Riskbank, because the Riksbank's own repo rate changes have major direct effects on the CPI. Also, these effects go in the "wrong direction". A rate cut with the purpose of increasing inflation leads to a short-term drop in CPI inflation. Therefore, the Riksbank has often supplemented the analysis with other inflation measures, such as CPIF.

The CPI is not well suited to international comparisons of the inflation rate, one reason being that housing costs are measured differently in different countries. A better measure for international comparisons is the HICP measure.