# STAFF MEMO

# Effects of revised methodology for calculating the CPI

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MONETARY POLICY

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# Effects of revised methodology for calculating the CPI

Solveig K. Erlandsen, Pål Bergset Ulvedal and Nikka Husom Vonen[1]

*In 2013, Statistics Norway revised its methods for calculating price developments for two large components of the consumer price index (CPI): food and non-alcoholic beverages and rentals for housing. In this article we discuss and analyse possible effects of the revisions. We estimate that the new methods have resulted in an annual rise in the CPI that in each of the past three years is between 0.1 and 0.4 percentage point higher than the methods used prior to 2013 would have resulted in. The effects likely depend on cyclical developments and the extent of promotional activity in the grocery trade.*

## 1. Introduction

The compilation of statistics and calculation of indices often present challenges related to measurement error and bias in the statistics. This also pertains to calculations of consumer price indices. Twenty years ago, the “Boskin Report” (Boskin 1996) launched an international debate on measurement errors in the CPI. The report found that the US CPI substantially overestimated the actual rise in the cost of living, including by failing to adequately capture quality improvements in new products. Koht and Sandberg (1997) performed a similar analysis of the Norwegian CPI. They found that the Norwegian CPI probably also overestimated actual inflation, but that the effect was less pronounced than in many other countries.

Over time, Statistics Norway has refined and improved its methods for calculating many of the sub-indices of the CPI.[2] Some of these changes have been made in the light of the Boskin Report, others reflect improved data coverage, technological innovations or other causes. In January 2013, the methods for calculating price developments both for food and non-alcoholic beverages and for rentals for housing in the CPI were revised. These components are large and together account for nearly a third of CPI weights (Chart 1).

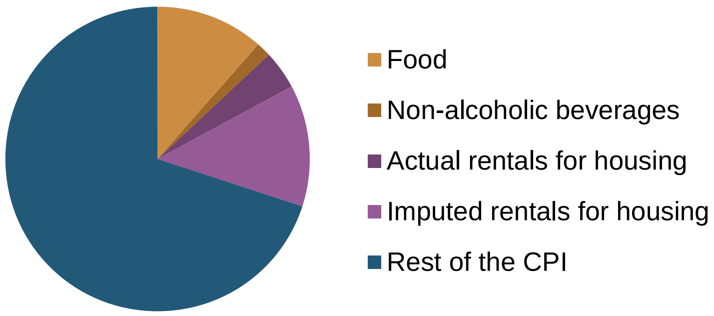
For Norges Bank, which has a flexible inflation target for monetary policy, it is important to understand how the methods for calculating the consumer price index (CPI), and revisions to them, affect measured inflation. In this article, we discuss possible effects of the revisions made in January 2013. We do not assess the methods or revisions in themselves, and the analyses in this article

[1] The authors would like to thank Leif Anders Thorsrud, Kjersti Haugland, Per Espen Lilleås and other colleagues at Norges Bank for useful input and comments. We would also like to thank the staff of the Division for Price Statistics at Statistics Norway for their helpful and thorough responses to our questions regarding methodology. The views in this article are our own and may not necessarily reflect the views of Norges Bank. Any errors or omissions are our responsibility.

[2] Note that the CPI is not revised retrospectively.

provide no basis for conclusions regarding the development of potential measurement errors in the CPI.

***Chart 1** CPI weights. January 2016. Percent*




Source: Statistics Norway

We find, in line with Statistics Norway's assessments before the revisions were introduced, that the revisions may have pulled up measured inflation for both sub-indices in 2013. For the price index for food and non-alcoholic beverages, the revision may have contributed to an increase in measured inflation by approximately 2 percentage points each year over the past three years, while the new measurement method may have resulted in a lower rise in the rent indices in the recent period than what the previous method would have resulted in. Overall, we estimate that the methodological revisions may have pulled up the rise in total CPI inflation by between 0.1 and 0.4 percentage point each year over the past three years.

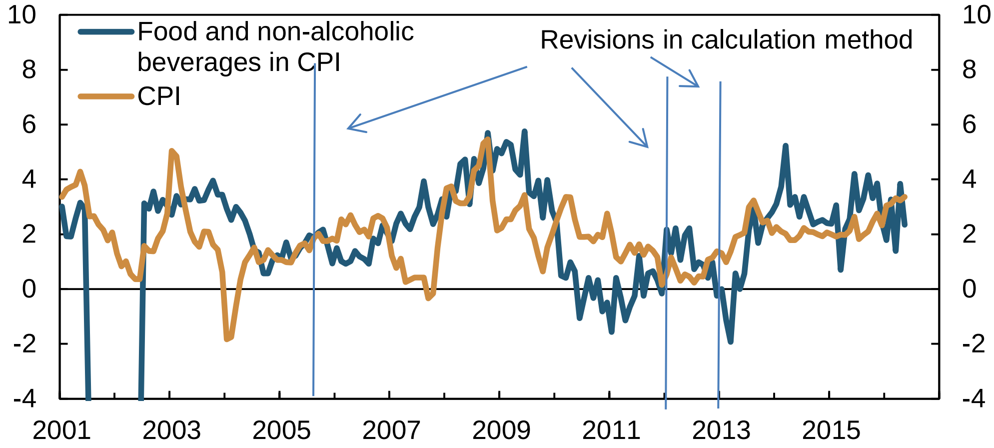
The remainder of the article is organised as follows: In Section 2, we present the method for calculating the price index for food and non-alcoholic beverages and discuss possible effects of revisions to it. We do the same for rentals for housing in the CPI in Section 3, while Section 4 is a summary.

## 2. Food and non-alcoholic beverages in the CPI

Food and non-alcoholic beverages are one of the divisions of the CPI and account for approximately 13 percent of the total index (Chart 1).[3] Over the past 15 years, the average rise in prices for food and non-alcoholic beverages has been broadly the same as the rise in the total CPI (Chart 2). The decline in 2001-2002 is attributable to the reduction in the VAT on food and non-alcoholic beverages, while the weak developments in 2010 and 2011 may reflect, as we shall return to below, increased promotional activity in the grocery trade and biases in the measurement method.

[3] The CPI is categorised according to the ECOICOP system (European Classification of Individual Consumption According to Purpose. Divisions are the least detailed level in the ECOICOP system.

***Chart 2*** *CPI. Total and sub-index for food and non-alcoholic beverages. Twelve-month change. Percent. January 2001 – May 2016*




Source: Statistics Norway

Major revisions were made to the method for calculating the price index for food and non-alcoholic beverages three times over the past 15 years: in August 2005, in January 2012 and in January 2013 (Chart 2).

## 2.1 Calculation method and revisions[4]

The index for food and non-alcoholic beverages in the CPI is compiled by aggregating more detailed sub-indices. Prior to August 2005, the sub-indices at the most detailed level were calculated on the basis of price developments for a sample of representative goods, while it is subsequently based on price observations of all goods[5] sold in grocery shops (see Rodriguez and Haraldsen (2005)). From August 2005, price observations were gathered exclusively with the aid of scanner data. Scanner data also contain information on the various products' current turnover, and following the revision in 2005, turnover figures from scanner data were used as a basis for weighting the sub-indices at the most detailed level.[6] The weights were updated each month.[7]

After some years' experience with this calculation method, Statistics Norway found indications that the index underestimated actual price rises for food and non-alcoholic beverages (see Johansen and Nygaard (2010) and Johansen (2012)). The bias was due to the downward "drift" of the index, ie, the index did not return to the starting point after a period of promotional activity, even though prices did. Drift can arise when current weights based on turnover are used, combined with factors such as hoarding and seasonal demand. This is

[4] Portions of Section 2.1 are based on various Statistics Norway publications, including Johansen and Nygaard (2010), Johansen (2012) and Statistics Norway (2014).
[5] In the category food and non-alcoholic beverages.
[6] The index is a "superlative price index".
[7] By comparison, the CPI weights at the aggregate level were updated once a year.

because goods on promotion receive high index weights during the promotional period when turnover is high, but low weights when prices return to normal and turnover is low. Johansen (2012) pointed out that various forms of promotional activity had increased in scope in recent years, which may have contributed to the growing presence over time of drift in the index for food and non-alcoholic beverages.

To correct for these biases, Statistics Norway revised the method for calculating the index for food and non-alcoholic beverage twice in recent years (see Johansen (2012), Statistics Norway (2012) and Statistics Norway (2013a)):

- In January 2012, a new method was employed that corrected for the disappearance of goods. The revision helped to reduce downward drift in the index.
- In January 2013, the estimation method was changed by removing the direct use of current weights at the most detailed level. With the new method, all goods with turnover above a certain level over the past two months are weighted equally at the product level.[8] The new method will eliminate drift from the index.

To assess the effects of the revisions in 2012 and 2013, Statistics Norway has calculated the price index for food and non-alcoholic beverages in the CPI using various methods retrospectively (see Johansen (2012), Table 1 and Chart 3a). The method used since 2013 results in substantially higher average inflation than the methods used earlier, and the differences are widening over time. If the method introduced in 2013 had been used earlier, the actual published rise in prices for food and non-alcoholic beverages would have been 1.4 and 2.3 percentage points higher in 2010 and 2011, respectively. In the first seven months of 2012, the average increase would have been 1.7 percentage points higher. That the difference from the actual published index is less for 2012 than for the previous year probably reflects the fact that the method used in 2012 reduced drift in the index.

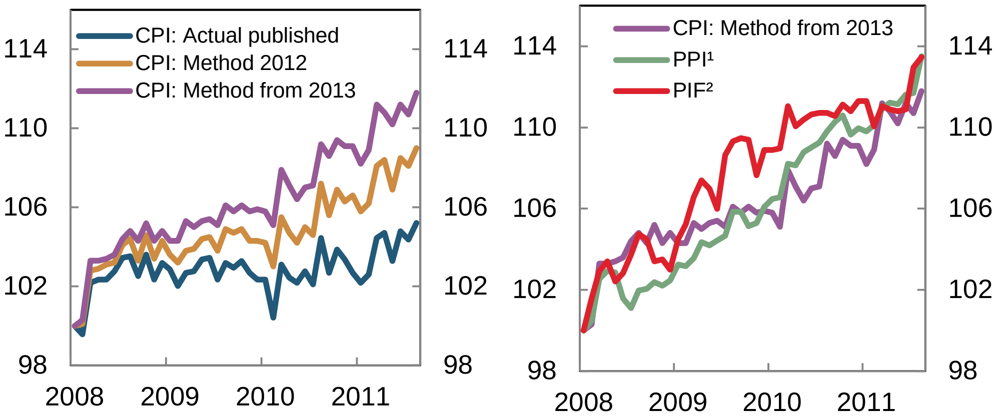
[8] In purely technical terms, the revision entails a changeover from using a Törnqvist price index at the most detailed consumption group level to using an unweighted Jevons price index on a sample of goods representing 80 percent of the turnover for the respective consumption groups.

***Table 1*** *Index for food and non-alcoholic beverages in the CPI calculated using various methods. Annual change. Percent (unless otherwise stated)*

| Method | 2010 | 2011 | 2012[1] |
|---|---|---|---|
| Actual published | 0.2 | -0.1 | 1.7 |
| Method in 2012 | 0.9 | 1.2 | 2.9[2] |
| Method from January 2013 | 1.6 | 2.2 | 3.3 |
| *Difference between actual published CPI and the method from January 2013, in percentage points* | *1.4* | *2.3* | *1.7* |

1 For 2012, the average twelve-month change from January to July is shown.
2 The method is the same as the one used in the actual published CPI in 2012. Nevertheless, the annual rise is different from the actual published index because this method was not used in 2011. In addition, the underlying data for these calculations are not identical with the data used in the calculation of the actual published index.
Sources: Statistics Norway and Norges Bank

***Charts 3a and b*** *Food and non-alcoholic beverages in the CPI calculated using various methods and other price indices. Index. December 2008 = 100. December 2008 – July 2012*




1) Producer price index for the food industry.
2) Price index for first-hand domestic sales for food.
Sources: Statistics Norway and Norges Bank

An indication that the new method captures actual price developments for food and non-alcoholic beverages better than the methods used earlier is that the index generated by this method generates is more consistent with developments in other comparable indices. Between December 2008 and July 2012, both the price index for first-hand domestic sales (PIF) for food, which measures price changes in the first-hand sales market for both imported and domestically produced goods, and the producer price index (PPI) for the food industry for the domestic market rose by 14 percent. In the same period, the actual published CPI for food and non-alcoholic beverages rose by only 5 percent. On the other hand, the CPI for food and non-alcoholic beverages compiled using the 2013 method rose by 12 percent (Chart 3b).

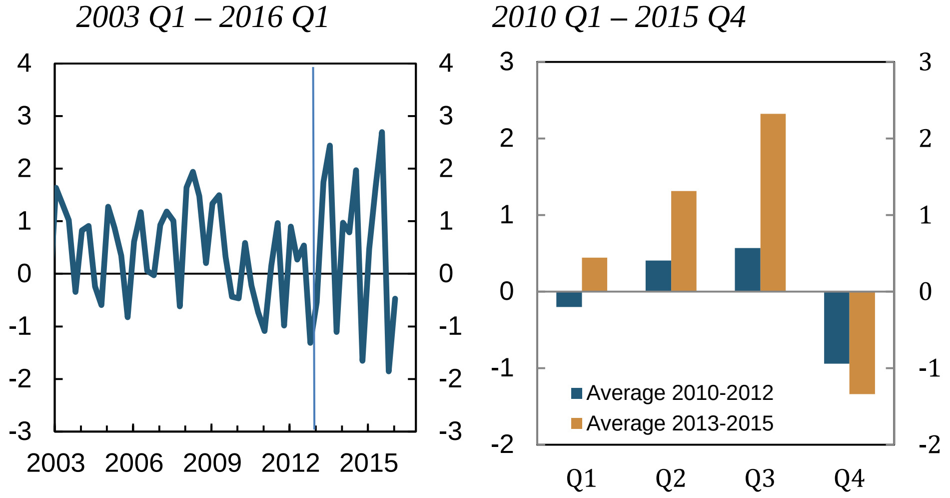
### 2.2 Possible effects of the methodological revision in 2013

The measured rise in prices for food and non-alcoholic beverages showed a substantial increase after the revision in 2013. The twelve-month rise in the index increased from around 0 percent in December 2012 to almost 3 percent one year later (Chart 2). Thereafter, the twelve-month rise has remained at about that level. There is reason to believe that the revision has contributed to the rise. At the same time, the higher rise in prices may also be due to other factors. For example, the Norwegian krone has depreciated considerably over the past years, resulting in higher price rises for imported food and beverage products. Since the krone depreciation began at around the same time as the revised method was introduced, it has become more challenging to find the isolated effect of the revision on inflation.

#### 2.2.1 Increased seasonal variation following the methodological revision

Seasonal variation in the price index for food and non-alcoholic beverages appears to have increased following the revision (Chart 4a). From 2013, the rise in prices has been particularly high in Q3, while also the decline in Q4 has been more pronounced than previously (Chart 4b). This may be in part because the revised method has resulted in a new seasonal pattern in the index. At the same time, other factors, such as increased promotional activity in the grocery trade, may have contributed to the increased variation in the index.

***Charts 4a and b** CPI for food and non-alcoholic beverages. Quarterly change. Percent*




Sources: Statistics Norway and Norges Bank

### 2.2.2 Higher inflation following the methodological revision

To more closely examine possible effects of the 2013 revision, we estimate a simple regression model for the price index for food in the CPI.[9] In the model, the quarterly change in food prices is explained by the quarterly change in the price index for first-hand domestic sales (PIF) for food[10] and by various dummy variables. With the exception of the period between 2009 and 2012, the PIF for food has moved in line with the food index in the CPI (Chart 5a). The former index includes price changes for first-hand sales of imported food products, for which reason the variable also captures krone exchange rate effects. By including dummy variables in the model, we seek to take into account seasonal variations, the VAT reduction in July 2001, and rising promotional activity in the grocery trade from 2009[11]. In addition, the model has a dummy variable for Q3 beginning in 2013. This dummy variable may capture changes in seasonal patterns and rates of increase in the index following the revision. [12] See Appendix A for a more detailed description of the model.

The estimation results indicate that the revision has had significant effects on price developments as measured by the CPI. The dummy variable for Q3 from 2013 is positive and significantly different from zero. The estimated coefficient value also indicates that the effect is considerable. Without this variable, the model predicts that the rise in the CPI for food would have been approximately 2 percent lower each year from the second half of 2013 (Chart 5b). That the dummy variable is significant also indicates that the seasonal pattern in the index has changed following the revision.

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[9] The sub-index for food accounts for around 90 percent of the index for food and non-alcoholic beverages in the CPI (Chart 1). We use the price index for food as a left-side variable in the model, since this index is more comparable with the right-side variable PIF for food.

10 PIF measures the first-hand sale of a good. This is usually one stage before consumer retail in the value chain. The change in the PIF is therefore included lagged in the model.

[11] According to Johansen (2012), the gap between indices with and without drift grew especially from 2009. It is also from this year that we observe that the food index in the CPI deviates considerably from developments in the PIF. There is reason to believe than this reflects increased promotional activity in the grocery trade.

[12] We have also tested alternative dummy variables that could conceivably capture other effects of the 2013 revision, but these were not significant. In addition, we have tested for possible effects of the 2012 revision, without finding any significant effect.

***Chart 5a*** *Food in the CPI and the PIF for food. Index. December 2008 = 100. January 1995 – March 2016*

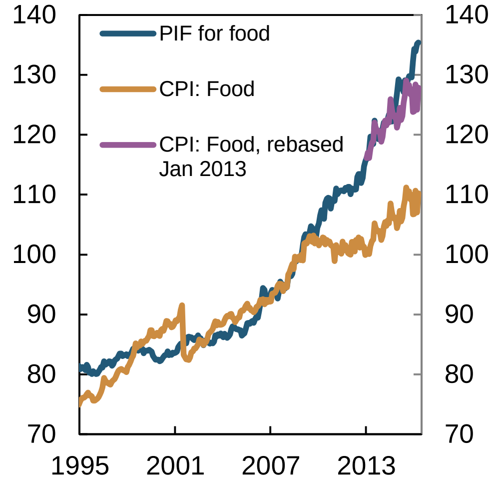
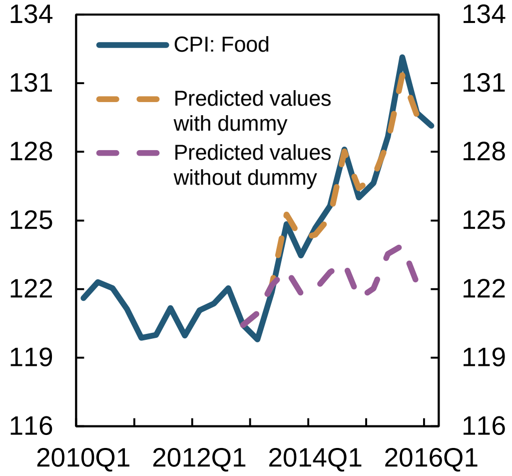



***Chart 5b*** *Food in the CPI. Actual and predicted values with and without dummy for Q3 from 2013*[1]




1 The model forecasts are "in sample" and the model is estimated over the period 1995 Q1 – 2016 Q1. The models are identical except for the dummy variable.
Sources: Statistics Norway and Norges Bank

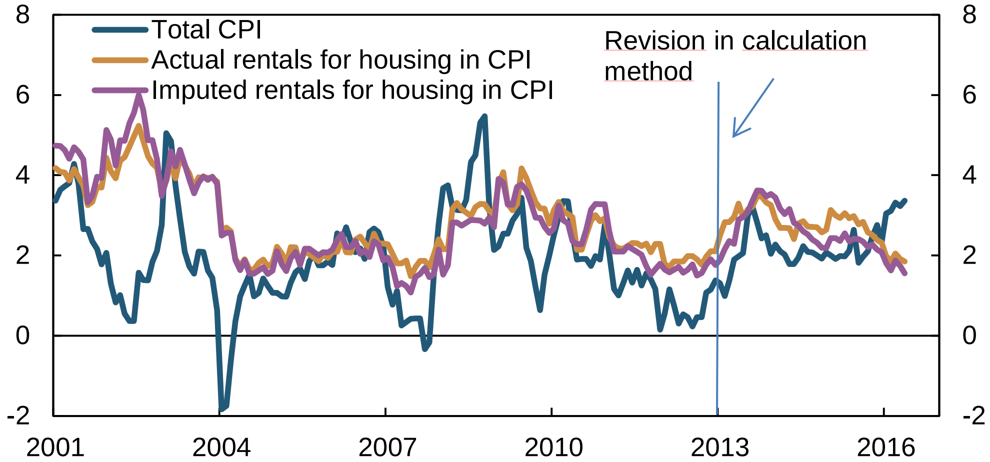
The model predicts broadly the same effect of the new calculation method in the period from the second half of 2013 that Statistics Norway calculated for the period 2010–2012 (Table 1). The estimated effect of the methodological revision on total CPI is just under 0.3 percentage point a year (see Appendix B).

The model estimates are uncertain and must be interpreted with caution. The revised method has only been in use for just over three years. Moreover, the revision took place at the same time as a marked depreciation of the krone. Even if the model takes into account effects of the krone exchange rate, the effects may be different from what is captured by the model. The effects of the revisions are also situation-dependent. For example, the difference in the index using the new and old methods will vary with the extent of promotional activity in the grocery trade.

## 3. Rentals for housing in the CPI

Actual and imputed rentals for housing are included in the main group housing, water, electricity, gas and other fuels in the CPI, and the two groups account for 4 and 13 percent, respectively, of the CPI (Chart 1). "Actual rentals for housing" is intended to measure the price of housing consumption of tenants, while "imputed rentals for housing" seeks to measure developments in the value of owner-occupants' housing consumption. Price developments in the two groups normally track each other closely, and the average rise for these groups has over the past 15 years been somewhat higher than the rise in the total CPI (Chart 6).

***Chart 6*** *Total CPI and actual and imputed rentals for housing in the CPI. Twelve-month change. Percent. January 2001 – May 2016*




Source: Statistics Norway

**3.1 Calculation method and methodological revisions**

Actual rentals for housing in the CPI are measured with the aid of observed rentals in a representative sample of rental dwellings, while imputed rentals for housing are calculated indirectly using the rental equivalence approach (see Statistics Norway 2013b).[13] The calculation of both rent indices is based on the same rental market survey, but the weighting of various types of dwelling and geographical location is different in the two indices. In the housing rental survey, the same rental dwellings in the sample are followed for a period of one year. During this period, some of the dwellings have changed tenants, while the other dwellings have the same tenants through the entire period. The rent index in the CPI is thus intended to capture developments in rentals for housing in both new and existing leases.

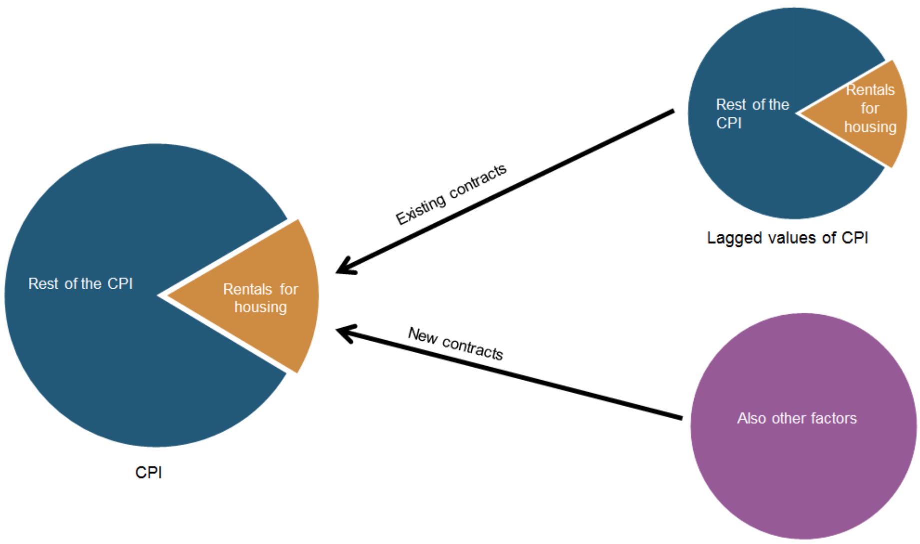
Changes in rentals for housing are normally different in existing and new leases (Chart 7). Rentals under existing leases are regulated by the Tenancy Act of 1999, which states among other things that at least one year must pass between each adjustment of rent. Moreover, the Act states that changes in the rent during the first three years of an existing lease may only be made in accordance with the rise in the CPI after the most recent setting of the rent.[14] On the other hand, when new leases are signed, the lessor has greater scope to make changes in the rent. To a greater extent than for existing leases, rent

13 The rental equivalence principle means that the price for the housing services the owner-occupant receives is calculated on the basis of the owner's opportunity cost associated with renting his own dwelling. It is thus assumed that the value of the services the owner-occupant receives from his dwelling follows developments in rentals for equivalent dwellings in the rental market (see also Statistics Norway (2004)).

14 The regulation is asymmetrical in that CPI inflation represents an upper limit for how much rent may be adjusted upward, but there is no corresponding limit for rent reductions. Note also that rent regulation implies that rentals for housing in the CPI are a function of themselves retrospectively, since rentals for housing are themselves part of the CPI.

under a new lease may thus be influenced by other factors, such as demand in the rental market, the cyclical situation and interest rates. A consequence of this is that in normal times, rents tend to jump when a new lease is signed.

***Chart 7*** *Relationship between total CPI and rentals for housing in the CPI*




In January 2013, a number of revisions were made to the calculation method for both actual and imputed rentals for housing (see Statistics Norway (2013b)). An important purpose of the revisions was to increase the importance of new leases in the rent index. According to Statistics Norway, it was previously a challenge to contact new tenants when there was a change of tenant in the dwellings in the sample, which resulted in a low share of new leases in the rental market survey. A key change therefore involved the actual data collection, in which improved tracing techniques were used to capture new tenants from 2013. This change has resulted in a substantially higher share of new leases in the sample. In addition, the actual calculation method was changed. One of the changes is a new method for dealing with non-response of tenants, so that the calculation method also takes account of the difference in price developments between new and existing leases.

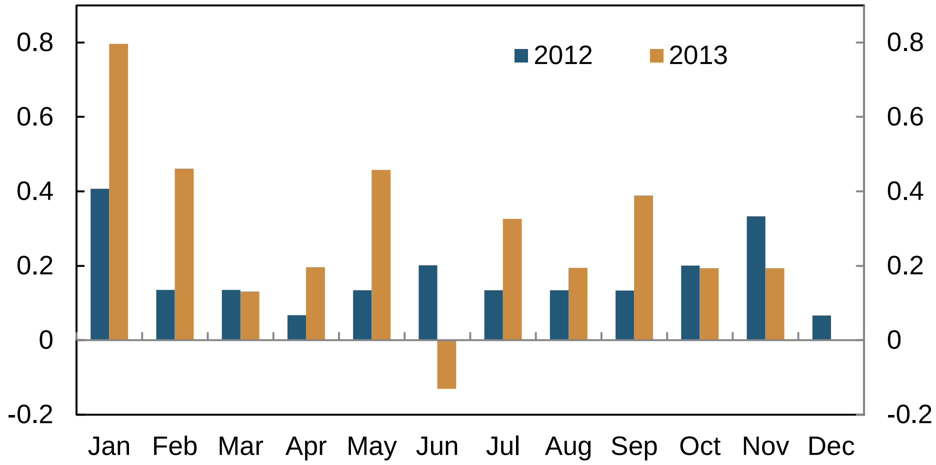
The effects these revisions have on the rent indices will likely depend on a number of different economic factors. As mentioned, rents tend to jump when new leases are signed. This is likely to be the case especially in periods where CPI inflation is relatively low, so that rent regulation has a dampening effect on the rise in rents under existing leases. In such a situation, the new method, which better represents new leases, results in a higher rise in the rent index than the old method. In another situation, where CPI inflation is relatively high, while demand in the rental market is slowing, the effect may be the opposite.

Since new leases are not indexed to the CPI at the start of the lease period, but are determined to a greater degree by other factors, the increased representation of new tenants results in a lower rise in the rent index. In general, better representation of new leases in the rent index may result in weaker covariation between the rent indices and lagged values of the CPI.

### 3.2 Estimated effects of the methodological revisions in 2013

The measured rise in prices for both rent indices in the CPI increased markedly after the new methods began to be used (Chart 6). For most months, the monthly rise in both indices was higher in 2013 than in the same months in 2012 (Chart 8), and the twelve-month rise moved up from just under 2 percent in autumn 2012 to approximately 3.5 percent one year later. Developments through 2013 are in line with Statistics Norway's assessments when the new methods were introduced that the revisions could pull up the rise in prices in the rent indices in the CPI somewhat (see Statistics Norway (2013b)). In the past few years, the twelve-month rise in the rent indices has fallen back, to just under 2 percent.

***Chart 8*** *Actual rentals for housing in the CPI. Monthly change. Percent. 2012 and 2013*




Source: Statistics Norway

#### 3.2.1 Comparison with other rent indices

When the new methods were introduced in 2013, the rise in alternative rent indices was substantially higher than the rent indices in the CPI. The annual rise in Statistics Norway's rental market survey (RMS)[15], which is a survey of rent levels under both established and new leases, and Real Estate Norway's

[15] The RMS is a survey of rent levels that is intended to provide a snapshot of rents, rather than developments over time. The quarterly series for rents in the RMS ends in 2012 Q3.

rent index for new leases[16], was 5 percent and 7.5 percent, respectively, in autumn 2012 (Chart 8a). By comparison, the annual rise in the rent indices in the CPI was around 2 percent in the same period.

The alternative rent indices do not measure exactly the same things as the rent indices in the CPI, but they probably better capture developments in new leases than the CPI rent indices did previously. The gap between these indices and rents in the CPI prior to 2013 may thus indicate that increased representation of new leases in the CPI rent indices would pull up the rise in the rent indices. The increase in the rise in the rent indices in the CPI through 2013 is consistent with this.

In the past few years, the rise in Real Estate Norway's rent index has slowed. In the large cities, the decline has been most pronounced in Bergen and Trondheim (Chart 8b). Since the rent indices in the CPI now capture developments in new leases better than previously, it is reasonable to expect that the rent indices track developments in Real Estate Norway's index more closely than before. The falling trend in the rent indices in the CPI over the past few years may therefore likely reflect the improved ability of the new measurement method to capture actual developments in new leases.

***Chart 8a** Actual rentals for housing in the CPI, Real Estate Norway's rent index and the average rent in the RMS. Four-quarter change. Percent. 2008 Q1 Q1*

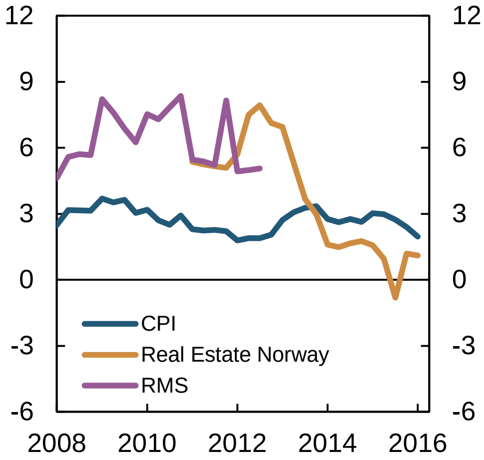
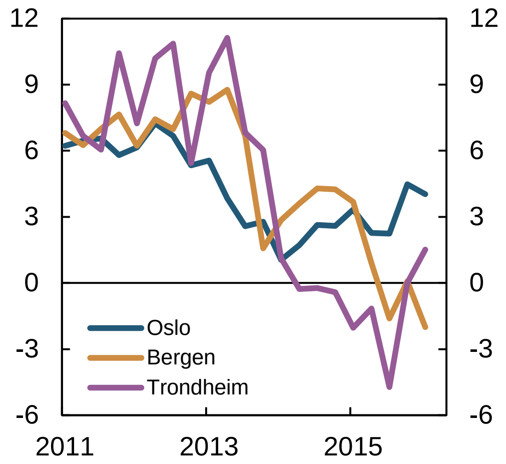



***Chart 8b** Real Estate Norway's rent index for Oslo, Bergen and Trondheim. Four-quarter change. Percent. 2011 Q1 – 2016 Q1 2016*




Sources: Real Estate Norway, Eiendomsverdi, Finn.no and Statistics Norway

[16] Real Estate Norway compiles the index together with Eiendomsverdi and Finn.no. The index begins in 2010 Q1. The index is intended to measure developments in rents over time. The index is based on rents on Finn.no and thus on price developments for new leases.

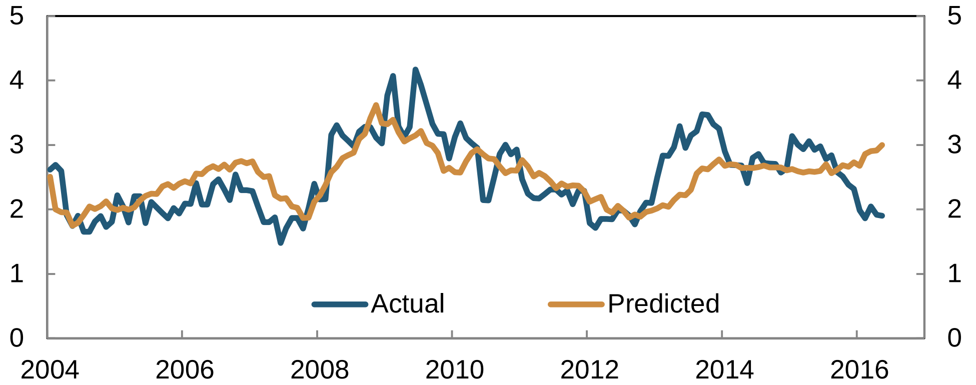
***Table 2*** *Correlation between the rent indices in the CPI and lagged values of the CPI. Correlation coefficients.*[1)]

| | Actual rentals | Imputed rentals |
|---|---|---|
| Jan. 2001 - Dec. 2012 | 0.38 | 0.35 |
| Jan. 2013 – May 2016 | -0.24 | 0.09 |

1) The average of the correlation coefficients between the twelve-month change in the rent indices in month t and total CPI in the months t-1 to t-6.

A simple regression model, in which the rise in actual rentals for housing in the CPI is explained by lagged values of CPI inflation, indicates that CPI inflation explains developments in rents after 2013 less well. See Appendix C for details regarding the model. While the model explains developments in actual rentals for housing well to the end of 2012, the model generates a rise for 2013 that is too low and too high from the end of 2015 and in the first months of 2016 (Chart 9). For 2013, the values predicted by the model are just over 0.7 percentage point too low on average, while they are approximately 0.9 percentage point too high in the first five months of 2016.

***Chart 9*** *Actual rentals for housing. Actual and fitted values from the model with lagged values of the CPI as explanatory variable. Twelve-month change. Percent. January 2004 – May 2016*




Sources: Statistics Norway and Norges Bank

### 3.2.3 …and stronger covariation with the output gap

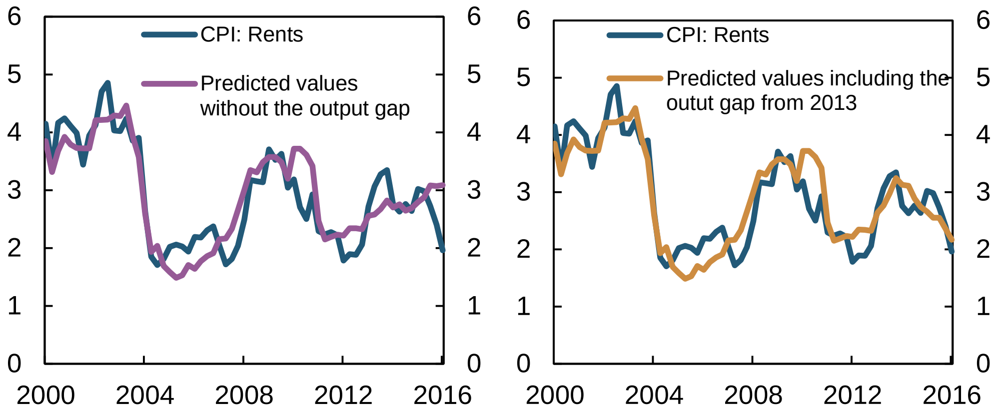
If the new method captures actual price developments in the rental market better than previously, and if rents are affected by general cyclical developments, cyclical developments may help to explain developments in rents in the CPI in the years following the revisions better than previously. To investigate this further, we estimate an equilibrium correction model for actual rentals for housing in the CPI. In the model, developments in actual rentals for housing in the long run are explained by developments in house prices and lending rates for households, which may be interpreted as a measure of the opportunity cost of renting a dwelling. The model also contains short-run effects of the CPI, the CPI adjusted for taxes and excluding energy products (CPI-ATE) and house prices. We also include dummy variables to capture the seasonal pattern and the gradual deregulation of rents through the 2000s. In addition, to capture possible effects of the 2013 methodological revision, the model contains a variable for cyclical developments – the output gap[17] – from 2013. See Appendix D for details regarding the model.

The estimation results indicate that cyclical developments affect the index for actual rentals for housing following the revisions. The coefficient for the output gap after 2013 has a positive sign and is significantly different from zero. On the other hand, the output gap is not significant if it is included in the entire estimation period. Nor do we find significant effects of a dummy variable from 2013 that is not linked to the output gap. This is an indication that the effect of the revision on the rent index is situation-dependent rather than constant.

The effect of including the output gap from 2013 as an explanatory variable in the model is considerable. The model that includes this explanatory variable captures developments after 2013 reasonably well (Chart 10b). On the other hand, the model without this variable predicts a rise that is too low through 2013, and a rise that is too high in the past year (Chart 10b). In the second half of 2013, the gap between the forecasts from the two models is 0.4 percentage point. For 2016 Q1, the model without the output gap predicts a rise in rents that is 0.9 percentage point higher than both the model with the output gap and the actual rise.

[17] The output gap is an estimated variable, which measures the percentage difference between GDP for mainland Norway and estimated potential mainland GDP. We use Norges Bank's estimate of the output gap as calculated in *Monetary Policy Report* 2/16.

***Charts 10 a and b*** *Rents in the CPI. Four-quarter change. Percent. Actual developments and forecast[1]. 2000 Q1 – 2016 Q1*




1) The model forecasts are "in sample" and the model is estimated over the period 1995 Q1 – 2016 Q1. The models are identical except for the explanatory variable for the output gap from 2013.
Sources: Statistics Norway and own calculations

### 3.2.4 Effect on total CPI

The models in Sections 3.2.2 and 3.2.3 seek to explain developments in the CPI index for actual rentals for housing. If we assume corresponding effects of the methodological revisions on imputed rentals for housing and use the average effects from the two models, the result is that these revisions pulled up the rise in total CPI by around 0.1 percentage point in the second half of 2013 (see Appendix B). For the past half year, the revisions for rents pull in the opposite direction. Use of new estimation method may have resulted in a rise in the total CPI that is nearly 0.2 percentage point lower in 2016 Q1 than if the former method were used.

The estimates from both rent models must be interpreted with caution. The revisions were introduced recently, and other factors also effect developments of rents in the CPI. It is also difficult to use the CPI as an explanatory variable in models of rents in the CPI, since rents themselves represent a considerable share of the CPI (Charts 1 and 7).

## 4. Summary

In this article, we have discussed and analysed possible effects of revisions of the estimation methods in 2013 for two important components of the CPI. We find that the revisions have had a significant effect on measured price developments for both the index for food and non-alcoholic beverages and the rent indices. For food and non-alcoholic beverages, the revisions appear to have pulled up inflation permanently, while the effect on the rent indices may vary more over time. The rent indices probably depend more now on cyclical developments and less on lagged values of changes in the CPI than previously.

Overall, we find that the revisions may have pulled up the rise in the total CPI by between 0.1 and 0.4 percentage point each year over the past three years.

The estimated effects of the methodological revisions are uncertain. Nevertheless, the effects appear to be of such a nature and scope that they are important to bear in mind in analyses of consumer price developments.

## References

Boskin, M. J. (1996): "Toward a More Accurate Measure of the Cost of Living," *Final Report to the Senate Finance Committee*, USA

Johansen, I. and R. Nygaard (2010): "Skjevheter i prisindeksen for matvarer og alkoholfrie drikkevarer?" ("Biases in the price index for food and non-alcoholic beverages"), *Notater* 30/2010, Statistics Norway (Norwegian only)

Johansen, I. (2012): "Bruk av strekkodedata i matvareindeksen" ("Use of scanner data in the food index"), *Økonomiske analyser* 6/2012, Statistics Norway (In Norwegian)

Koht, B. og L. Sandberg (1997): "Kilder til målefeil i konsumprisindeksen" ("Sources of measurement error in the consumer price index"), *Økonomiske analyser 5/97*, Statistics Norway (Norwegian only)

Rodriguez, J. and F. Haraldsen (2005): "Den nye matvareindeksen: Bruk av strekkodedata i konsumprisindeksen" ("The new food index: Use of scanner data in compiling the consumer price index"), *Økonomiske analyser* 4/2005, Statistics Norway (Norwegian only).

Statistics Norway (2004): "Konsumprisindeksen og boligpriser" ("The consumer price index and house prices"), http://www.ssb.no/priser-og-prisindekser/artikler-og-publikasjoner/konsumprisindeksen-og-boligpriser (Norwegian only)

Statistics Norway (2012): http://www.ssb.no/a/kortnavn/kpi/endringer_2012.html (Norwegian only)

Statistics Norway (2013a): "Changes in the CPI from 2013", http://www.ssb.no/en/priser-og-prisindekser/statistikker/kpi/maaned/2013-02-11

Statistics Norway (2013b): "New tenants in CPI rent indices", http://www.ssb.no/en/priser-og-prisindekser/statistikker/kpi/additional-information/new-tenants-in-cpi-rent-indices

Statistics Norway (2014): "Konsumprisindeksen (KPI): Slik beregnes prisutviklingen på matvarer i KPI" (Consumer price index (CPI): Estimated price developments for food in the CPI): http://www.ssb.no/priser-og-prisindekser/artikler-og-publikasjoner/slik-beregnes-prisutviklingen-pa-matvarer-i-kpi (Norwegian only)

## Appendix A: Model for food products in the CPI

***Table A.1*** *List of variables*

| Variable | Explanation | Source |
|---|---|---|
| $CPI_{FOOD}$ | Food in the CPI | Statistics Norway |
| $PIF_{FOOD}$ | The price index for first-hand domestic sales (PIF) for food | Statistics Norway |
| D2001Q3 | Dummy variable for reduction in VAT on food from 24 to 12 percent on 1 July 2001. Value «1» in 2001Q3, «0» otherwise. | |
| D2009 | Dummy for increased promotional activity in the grocery trade. Value «1» from 2009 Q1, «0» otherwise. | |
| D2013 | Dummy for revions of estimation method in 2013 for food and non-alcoholic beverages in the CPI. Value «1» from 2013 Q1, «0» otherwise. | |
| $D_i$, i = 1, 2, 3 | Seasonal dummies. Value «1» in Q1, Q2 and Q3, respectively, each year, «0» otherwise. | |

The model is specified by the following equation:

(A.1) $$\Delta cpi_{food_t} = C + \sum_{i=1}^{3} \beta_{1,i} D_i + \beta_2 D2001Q3 + \beta_3 D2009 + \beta_4 D_3 * D2013 + \beta_{5,1} \Delta pif_{food_{t-1}} + \beta_{5,2} \Delta pif_{food_{t-2}} + \varepsilon_t$$

In the equation, subscript *t* denotes the time period, lower case letters denote the logarithm of the variables, Δ denotes that the variables are difference terms, the βs are the coefficients we want to estimate, and ε is the model's residual term.

***Table A.2** Results of estimation of equation (A.1) for the period 1995 Q1 – 2016 Q1[1)]*

| Variable | Coefficient | S.E.[2)] | t-value |
|---|---|---|---|
| Constant (C) | -0.006*** | (0.001) | -5.12 |
| D1 ($\beta_{1.1}$) | 0.015*** | (0.002) | 8.70 |
| D2 ($\beta_{1.2}$) | 0.019*** | (0.002) | 12.57 |
| D3 ($\beta_{1.3}$) | 0.014*** | (0.002) | 6.99 |
| D2001Q3 ($\beta_2$) | -0.100*** | (0.002) | -46.41 |
| D2009 ($\beta_3$) | -0.008*** | (0.002) | -4.81 |
| D2013*D3 ($\beta_{4.3}$) | 0.019*** | (0.003) | 6.85 |
| $\Delta pif_{food_{t-1}}$ ($\beta_{5.1}$) | 0.160** | (0.080) | 2.01 |
| $\Delta pif_{food_{t-2}}$ ($\beta_{5.2}$) | 0.144* | (0.073) | 1.98 |
| Adjusted $R^2$ | 0.853 | | |
| Standard error | 0.005 | | |
| White test[3)] (p-value) | 0.032** | | |
| LM test[4)] (p-value) | 0.817 | | |
| Jarque-Bera[5)] (p-value) | 0.912 | | |

1) In the preferred model, we have only kept variables that are statistically significant at the 10 percent significance level. *, ** and *** indicates significance at the 10, 5 and 1 percent significance level, respectively.
2) Heteroskedasticity and autocorrelation consistent standard errors (Newey-West).
3) Test for heteroskedasticity. The null hypothesis is that the error terms are homoskedastic. Given the low p-value, we can reject the null hypothesis, which thereby indicates heteroskedasticity in the error terms. We have therefore used heteroskedastic-consistent standard errors.
4) Test for autocorrelation of the residual terms with five lags. The null hypothesis is that the error terms are not autocorrelated. Given the high p-value, we cannot reject the null hypothesis.
5) Test for normality of the residual terms. The null hypothesis is that the error terms have a normal distribution. Given the high p-value, we cannot reject the null hypothesis.

## Appendix B. Estimated effects of the 2013 methodological revisions

***Table B.1*** *Estimated effects of methodological revisions.[1] Effect on respective indices and on total CPI. In percentage points. 2013 H2 – 2016 Q1[2]*

| | 2013 H2 | 2014 H1 | 2014 H2 | 2015 H1 | 2015 H2 | 2016 Q1 |
|---|---|---|---|---|---|---|
| **Food** | | | | | | |
| Model for food products | 1.98 | 1.98 | 1.96 | 1.97 | 1.98 | 1.97 |
| *Effect on total CPI[2)]* | *0.26* | *0.26* | 0.26 | 0.25 | 0.25 | 0.26 |
| **Rents** | | | | | | |
| Rent model 1 | 0.72 | 0.03 | 0.05 | 0.41 | -0.09 | -0.94[3)] |
| Rent model 2 | 0.36 | 0.39 | 0.15 | -0.23 | -0.62 | -0.92 |
| Rent models (average) | 0.54 | 0.21 | 0.10 | 0.09 | -0.36 | -0.93 |
| *Effect on total CPI* | *0.09* | *0.03* | *0.02* | *0.02* | *-0.06* | *-0.17* |
| ***Total effect on the CPI*** | ***0.35*** | ***0.30*** | ***0.28*** | ***0.27*** | ***0.19*** | ***0.09*** |

1) Estimated effects are calculated in different manners in the various models.
2) Given the same effect on the sub-index for non-alcoholic beverages in the CPI as for food products.
3) For rent model 1, the most recent observation is the first five months of 2016.

## Appendix C: Model 1 for rentals for housing in the CPI

***Table C.1** List of variables*

| Variable | Explanation | Source |
|---|---|---|
| $CPI_{RENT}$ | Actual rentals for housing in the CPI | Statistics Norway |
| CPI | The consumer price index | Statistics Norway |

Model 1 for rentals for housing in the CPI, which is discussed in Section 3.2.2, is specified by the following equation:

$$\text{(C.1)} \quad \Delta_{12} cpi_{Rent_t} = C + \beta_1 \left( \frac{\sum_{j=1}^{12} \Delta_{12} cpi_{t-j}}{12} \right)_{t-3} + \beta_2 \Delta_{12} cpi_{t-1} + \beta_3 \Delta_{12} cpi_{t-4} + \varepsilon_t$$

In the equation, subscript *t* denotes the time period, lower case letters denote the logarithm of the variables, $\Delta_{12}$ denotes that the variables are 12-month changes, the βs are the coefficients we want to estimate, and ε is the model's residual term.

***Table C.2** Results of estimation of equation (C.1) for the period January 2004 - May 2016[1)]*

| Variable | Coefficient | S.E.[2)] | t-value |
|---|---|---|---|
| Constant (C) | 1.589*** | 0.184 | 8.62 |
| $\left( \frac{\sum_{j=1}^{12} \Delta_{12} cpi_{t-j}}{12} \right)_{t-3}$ $(\beta_1)$ | 0.214* | 0.124 | 1.73 |
| $\Delta_{12} cpi_{t-1}$ $(\beta_2)$ | 0.179*** | 0.062 | 2.88 |
| $\Delta_{12} cpi_{t-4}$ $(\beta_3)$ | 0.107* | 0.064 | 1.67 |
| Adjusted $R^2$ | 0.421 | | |
| Standard deviation | 0.439 | | |
| White test[3)] (p-value) | 0.173 | | |
| LM test[4)] (p-value) | 0.000 | | |
| Jarque-Bera[5)] (p-verdi) | 0.648 | | |

1) In the preferred model, we have only kept variables that are statistically significant at the 10 percent significance level. *, ** and *** indicates significance at the 10, 5 and 1 percent significance level, respectively.
2) Heteroskedasticity and autocorrelation consistent standard errors (Newey-West).
3) Test for heteroskedasticity. The null hypothesis is that the error terms are homoskedastic. Given the high p-value, we cannot reject the null hypothesis.
4) Test for autocorrelation of the residual terms with 13 lags. The null hypothesis is that the error terms are not autocorrelated. The low p-value indicates that the error terms are autocorrelated. We have therefore used autocorrelation-consistent standard errors. Owing to autocorrection in the residual terms, the coefficient estimates are not necessarily unbiased. They must therefore be interpreted with particular caution. However, the main point of this model is not to quantify the effect of a revision in the CPI on rents, but to show that there is a break in the relationship between the CPI and actual rentals for housing in the CPI.
5) Test for normality of the residual terms. The null hypothesis is that the error terms have a normal distribution. Given the high p-value, we cannot reject the null hypothesis.

## Appendix D: Model 2 for rentals for housing in the CPI

***Table D.1*** *List of variables*

| Variables | Explanation | Sources |
|---|---|---|
| CPI | The consumer price index (CPI) | Statistics Norway |
| $CPI_{RENT}$ | Actual rentals for housing in the CPI | Statistics Norway |
| CPIATE | CPI adjusted for taxes and excluding energy products | Statistics Norway and Norges Bank |
| HP | House prices | Eiendom Norge, Eiendomsverdi and Finn.no |
| $I_{HH}$ | Interest rate on loans to households | Statistics Norway |
| GAP | The output gap | Norges Bank |
| D2002Q1, D2003Q1, D2010Q1 | Dummy variables for gradual removal of rental regulation. Value «1» in 2002Q1, 2003Q1 and 2010Q1, respectively, «0» otherwise. | |
| D2013 | Dummy variable for revision of method for calculating rentals for housing in the CPI. Value «1» from 2013 Q1, «0» otherwise. | |
| $D_i$, i = 1, 2, 3 | Seasonal dummies. Value «1» in Q1, Q2 and Q3, respectively, each year, «0» otherwise. | |

The model is estimated by using the following equation as a starting point:

$$(\mathrm{D.1})\quad \Delta cpi_{rent_t} = C + \beta_1 D_1 + \beta_2 D2002Q1 + \beta_3 D2003Q1 + \beta_4 D2010Q1 + \beta_5 \Delta cpi_{t-1} + \beta_6 \Delta cpiate_{t-3} + \beta_7 \Delta cpiate_{t-4} + \beta_8 \Delta hp_{t-3} + \beta_9 z_{t-1} + \beta_{10} gap_{t-4} * D2013_t$$

The equilibrium correction term $z_t$, the deviation between actual rentals, $cpi_{rent_t}$, and the long-term solution for rentals, $cpi_{rent_t}{}^*$, is defined by the following equation:

$$(\mathrm{D.2})\quad z_t = cpi_{rent_t} - cpi_{rent_t}{}^* \quad = cpi_{rent_t} - (i_{hh_{t-2}} + hp_{t-3})$$

In the equation, subscript *t* denotes the time period, lower case letters denote the logarithm of the variables, Δ denotes that the variables are difference terms, the βs are the coefficients we want to estimate, and ε is the model's residual term.

***Table D.2*** *Results of the estimation of the equation (D.1) for the period 1995 Q1 – 2016 Q1*[1)]

| Variable | Coefficient | S.E. | t-value |
|---|---|---|---|
| Constant (C) | -0.007*** | (0.002) | -2.89 |
| D1 ($\beta_1$) | 0.002** | (0.001) | 2.36 |
| D2002Q1 ($\beta_2$) | 0.005* | (0.003) | 1.88 |
| D2003Q1 ($\beta_3$) | 0.005** | (0.003) | 2.03 |
| D2010Q1 ($\beta_4$) | 0.007*** | (0.003) | 2.65 |
| $\Delta cpi_{t-1}$ ($\beta_5$) | 0.117** | (0.046) | 2.58 |
| $\Delta cpiate_{t-3}$ ($\beta_6$) | 0.189* | (0.110) | 1.71 |
| $\Delta cpiate_{t-4}$ ($\beta_7$) | 0.178** | (0.085) | 2.09 |
| $\Delta hp_{t-3}$ ($\beta_8$) | 0.061*** | (0.018) | 3.46 |
| $z_{t-1}$ ($\beta_9$) | -0.006*** | (0.001) | -4.14 |
| $gap_{t-4} * D13_t$ ($\beta_{10}$) | 0.004* | (0.002) | 1.98 |
| Adjusted $R^2$ | 0.557 | | |
| Standard deviatiom | 0.003 | | |
| White test[2)] (p-value) | 0.888 | | |
| LM test[3)] (p-value) | 0.400 | | |
| Jarque-Bera[4)] (p-verdi) | 0.522 | | |

1) In the preferred model, we have only kept variables that are statistically significant at the 10 percent significance level. *, ** and *** indicates significance at the 10, 5 and 1 percent level, respectively.
2) Test for heteroskedasticity. The null hypothesis is that the error terms are homoskedastic. Given the high p-value, we cannot reject the null hypothesis.
3) Test for autocorrelation of the residual terms with five lags. The null hypothesis is that the error terms are not autocorrelated. Given the high p-value, we cannot reject the null hypothesis.
4) Test for normality of the residual terms. The null hypothesis is that the error terms have a normal distribution. Given the high p-value, we cannot reject the null hypothesis.