The Treatment of Seasonal Breaks in the Seasonal Adjustment of Harmonised Indices of Consumer Prices[1]

Matthias Diermeier[2] and Martin Eiglsperger[3,4]

1 Introduction

Harmonised Indices of Consumer Prices (HICPs), as published by Eurostat, the statistical office of the European Union, and the national statistical institutes of the European Union, are used by the European System of Central Banks for analysing and forecasting inflation in EU countries. The year-on-year growth rate of the euro area HICP is used by the ECB as a reference in its definition of price stability in the Monetary Union.

HICP inflation is primarily presented in terms of annual growth rates. However, insights into most recent dynamics are gained from short term developments, typically derived from seasonally adjusted month-on-month rates of change. The seasonal adjustment of HICPs, conducted in the European Central Bank (ECB), has to take into account several specific properties of HICPs of EU countries. Most recently, breaks in the seasonal profile appeared, caused by the introduction of harmonised compilation practices for price indices of seasonal goods and services, while the seasonal pattern of the back data was not changed. This paper elaborates on approaches for treating these seasonal breaks with the aim of compiling seasonally adjusted HICP series which are not unduly affected by them. Standard applications of seasonal adjustment procedures require that a new seasonal regime has been observed for several consecutive years. However, accepting distortions in seasonally adjusted data for some years until the new profile can be appropriately estimated may imply severe limitations in the usability of such data, in particular for forecasting purposes. This paper proposes how to pre-treat series affected by recent seasonal breaks prior to seasonal adjustment. In this pre-treatment either the new seasonal profile is imposed to pre-break periods or, alternatively, the pre-break seasonality is imposed for the post-break periods.

Given the role HICPs for industrial goods play in inflation projections by European central banks and the substantial impact seasonal breaks had in many of their seasonal patterns related to the treatment of seasonal clothing, the paper focuses on these series for illustrating approaches to break-adjustment.

Undistorted annual growth rates, as reported by national statistical institutes for the first year with the new seasonal regime, are used for this purpose. The series for Italy serves as an example.

This paper starts by explaining the reasons for statistical breaks in HICP series and describes how such breaks may impact on seasonal adjustment. The second section outlines the treatment of seasonal goods and services in consumer price indices and the harmonisation reached in HICP calculations in this area. An overview of the impacts of this harmonisation is provided in section 4.

By referring to the HICP for non-energy industrial goods of Italy section 5 illustrates how information about distortions due to the break can be used for compiling seasonally adjusted results not adversely affected by the break. Section 6 concludes.

2   Statistical breaks in HICP series and seasonal adjustment

While HICPs are broadly harmonised in terms of statistical concepts and methods, with a focus on compiling time series which are comparable across EU Member States, Eurostat and the national statistical institutes of the EU Member States continue working on further improvements in HICP compilations. Member States typically implement further harmonised and better statistical methods without revising data backwards. This may create significant breaks in HICP series of EU Member States depending on the extent to which formerly used national methods deviate from the harmonised approaches.

Due to the role HICP year-on-year growth rates play in the ECB definition of price stability in the euro area, for the computation of the convergence criterion for the entry to the euro area and, more generally, for reporting and commenting on HICP inflation, users of HICPs are primarily interested in getting indications of the impact a statistical break has on year-on-year growth rates. EU Regulations which lay down the requirements in terms of implementing improved or further harmonised statistical concepts and methods can commit statistical institutes to provide such impact estimates if they are significant and systematic.

Seasonally adjusted HICPs, which are used for reporting and analysing short-term developments in inflation and, in particular, for forecasting purposes, may be affected by statistical breaks in a more complex manner than year-on-year growth rates. If statistical breaks impact on seasonal profiles, standard applications of seasonal adjustment procedures could produce distorted results, since such procedures estimate seasonal patterns by moving averages. Such moving averages cannot cope with abrupt breaks.

So far, seasonal profiles of HICP time series have not been significantly and systematically affected by the great majority of improvements incorporated for HICP compilations. However, in two cases the impacts on seasonal patterns of HICP series were very prominent. First, the harmonisation of the treatment of sales prices for clothing and footwear, which was introduced in the early-2000s, impacted substantially on the seasonal behaviour on the respective HICP series, in particular in the end-of-season periods. Since most statistical institutes of EU Member States had not covered sales

prices as comprehensively as required for HICP purposes, such breaks in seasonality appeared in the series of many countries.

Second, the seasonal break caused by the incorporation of the new regulation on the treatment of seasonal items in HICPs affected several HICP subindices, including price indices for fruit and vegetables, for package holidays and for accommodation services. Price indices for clothing and footwear were affected as well, this time mainly in terms of the treatment of out-of-season products.

Seasonal adjustment procedures typically assume that seasonal profiles are sufficiently stable over time, in terms of size, date of appearance and by changing only gradually over time. Abrupt changes in seasonality, however, constitute a severe violation of this assumption. If the number of observations for each of the different seasonal patterns of a time series is sufficiently large for seasonal adjustment purposes, the series can be split into parts which exhibit homogeneous seasonality. Seasonal adjustment is then conducted part by part. A seasonal adjustment of the entire time series can be obtained by applying the seasonal factors, part by part, to the respective unadjusted values of the time series. However, this requires that each part contains at least three to four consecutive years of data.

Breaks in seasonal patterns occurring in more recent reporting periods could only be dealt with as soon as a sufficient number of data observations under the new seasonal regime has become available. In the meantime, standard seasonal adjustment, not split into different seasonal regimes, produces distorted results. Chart 1 presents the results of a seasonal adjustment of the HICP for non-energy industrial products.

<u>Chart 1:</u> **Seasonal adjustment of HICP for non-energy industrial goods of Italy without special treatment of seasonal break**
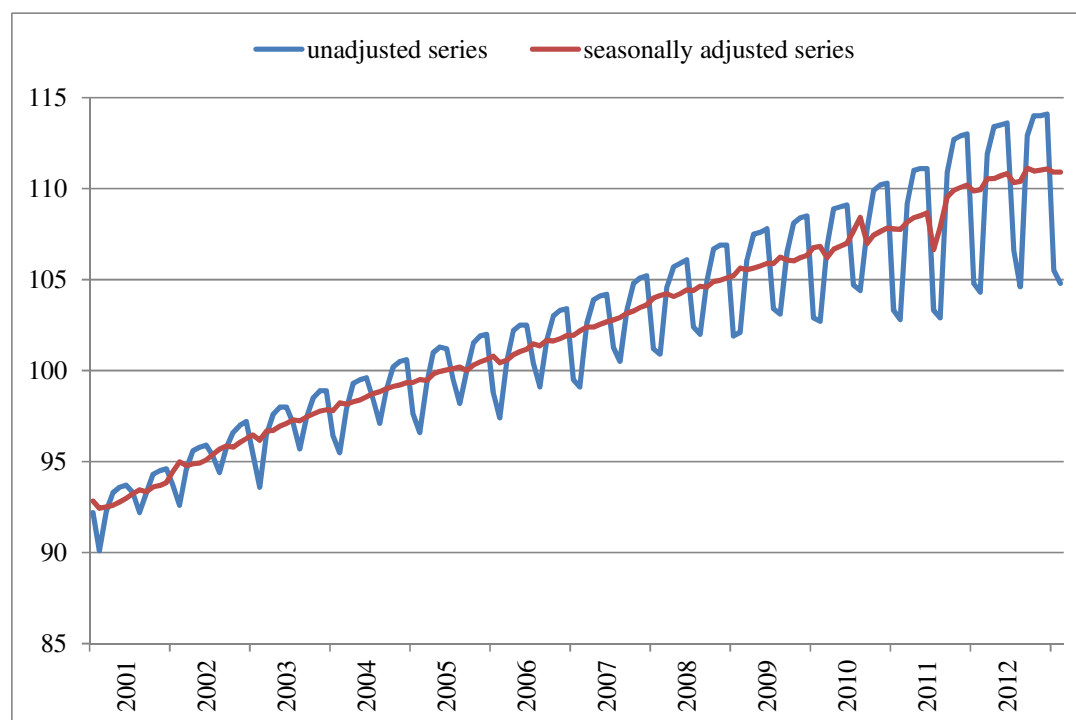
Source: Eurostat and own calculations

Significant distortions appear not only in data for 2011 and 2012, but also in earlier periods, in particular in data for 2010. This is related to the use of moving-averages for estimating seasonal patterns, which are adversely affected by seasonal breaks if pre-break and post-break-data are used in the computations.

If information about the change in seasonal patterns is available, such distortions may be circumvented by creating artificial series which are adjusted for the seasonal break, e.g. by imposing the pre-break seasonal profile on post-break periods. Such information was provided by the national statistical institutes of EU Member States in form of year-on-year growth rate series which would have appeared had the regulation on seasonal items not been implemented.

Pre-treatments of time series before seasonal adjustment are common practice. Guidelines and recommendations on seasonal adjustment usually refer to pre-treatment methods in terms of outliers and adjustments for calendar effects, such as working- or trading-day patterns. The EU guidelines on seasonal adjustment mention, in more general terms, that some applications of seasonal adjustment procedures require time series to be considered as realisations of stationary stochastic processes.[5] Seasonal breaks can be considered as a source for non-stationarity in this context.

3 Treatment of seasonal products in Harmonised Indices for Consumer Prices

The treatment of seasonal products, i.e. goods or services for which supply or demand is weak or even insignificant during a certain period every year, [6] in the compilation of consumer price indices is an issue which has been investigated and discussed extensively. While several methods have been elaborated and incorporated into index calculations, none of these approaches can be considered superior in every relevant dimension. While comparisons with the same periods in earlier years may enable the reference to a fixed basket of seasonal items, provided that seasonal goods and services are offered and bought in the very same periods every year, month-on-month changes are affected by seasonal products appearing and disappearing in the course of a calendar year. In practice, the choice regarding which treatment of seasonal items is actually used in consumer price index compilation has primarily been based on practical aspects, resulting in different approaches applied in different countries.

In order to harmonise the treatment of seasonal items in price index compilation practices in the EU, a new HICP regulation[7] entered into force with the data release for January 2011. The particular

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[5] See "ESS guidelines on seasonal adjustment", p. 1:
http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-09-006/EN/KS-RA-09-006-EN.PDF

[6] The "Consumer Price Index Manual" uses a definition which distinguishes between strongly and weakly seasonal commodities. See ILO et al. (eds.), Chapter 22, Corrected version, p. 1:
http://www.ilo.org/public/english/bureau/stat/guides/cpi/

[7] Commission Regulation (EC) No 330/2009 of 22 April 2009 laying down detailed rules for the implementation of Council Regulation (EC) No 2494/95 as regards minimum standards for the treatment of

methods required by this regulation take into account that the HICP's general concept is a Laspeyres-type index with annual weights. The variation of weights for seasonal goods and services is limited to the distinction between in-season periods and out-of-season periods and has to be applied at a detailed level of breakdown, while the weights of broader product categories which contain seasonal and non-seasonal products are kept constant in the course of a calendar year.

Former practices in EU Member States varied widely. Some national statistical institutes used seasonal baskets applied at a detailed product level, some of them changed every month, while in some other countries broad product descriptions aimed at allowing to collect prices over the entire calendar year. In a few countries, moving average techniques were in place.

In most countries the new regulation was introduced without back-calculations. Only for Spain, the statistical institute recalculated the data for the year 2010, according to the requirements of the harmonised approach. Since the transition to the new treatment resulted in significant changes, in particular in the seasonal profile, seasonal breaks appeared in many affected HICP series in January 2011 and, for Spain, in January 2010. In order to provide users with quantitative information about the significance of the change-over, national statistical institutes provided information on the impacts of the implementation of the new regulation on year-on-year growth rates for the entire year in which the new regulation was newly implemented.

4 Impact of the HICP Regulation on the treatment of seasonal products

In several EU countries, the implementation of the new regulation changed the seasonal patterns of several HICP subindices substantially. Price indices for clothing and footwear were mostly affected due to the treatment of winter and summer collections. Price indices for fruit and vegetables also showed some substantial changes in their infra-annual behaviour, caused by the incorporation of more price representative information for fresh products. While seasonal fluctuations in price indices for fruit and vegetables have become more volatile, it was hardly possible to identify more regular patterns in the seasonality of those unprocessed food items. By contrast, the seasonal profiles of price indices for clothing and footwear changed in a more systematic manner.

Spain conducted back-calculations for one calendar year, thereby revising its HICPs for 2010 according to the new regulation. Other countries which had to implement the new statistical requirements did so as of January 2011. According to the impact estimates, provided by the national statistical institutes, significant distortions of the year-on-year growth rates appeared for Bulgaria, Cyprus, Germany, Spain, Greece, France, Italy, Latvia, Lithuania, Luxemburg, Hungary, Poland, Portugal, Romania and Slovenia. In other EU countries the historical approaches to the treatment of seasonal items were already broadly in line with those required by the regulation. Where impacts were

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significant, they materialised in particular in price indices for clothing and footwear, thereby affecting the non-energy industrial goods index. In terms of level effects, it turned out that the changes in the infra-annual profile did not cancel out over the affected calendar year.

In several cases the size of the impacts remained significant at higher levels of aggregation and for the total HICP. For example, the annual rate of change of the Spanish HICP for March 2010 was revised from 1.5% to 2.7%. The absolute average revision to the annual rates of change of the Spanish HICP in 2010 was 0.5 percentage point. The annual average rate of change for 2010 was revised from 1.8% to 2.0%, with pronounced effects in several months which only partially cancelled out in the course of the calendar year. The most pronounced impact was estimated in Greece, where the impact on clothing and footwear was -15 percentage points in August 2011 which resulted in a distortion of -1.1 percentage points in the total HICP. Impacts on food price indices and other HICPs significantly affected by the introduction of the new regulation were mostly much less pronounced and only rarely exceeded one percentage point in absolute terms.

Referring to 2011 annual averages, HICPs for non-energy industrial goods of Greece, France, Italy, Lithuania, Luxemburg and Poland showed downward impacts, while for Germany, Latvia, Romania, Slovenia, Slovakia and Sweden the respective annual growth rates were, on average, higher than they would have been had the previous approaches been applied.

At the euro area level, the impact on the annual percentage change in total HICP inflation in 2011 was, on average, -0.1 percentage point, reaching -0.2 percentage point in July and August. The impacts in these months were mainly driven by changes in the treatment of sales prices for seasonal clothing and footwear.

5 Approaches to the treatment of seasonal breaks in the HICP for non-energy industrial goods of Italy

This section presents two approaches to using undistorted year-on-year growth rates for creating seasonally adjusted series that are not unduly affected by seasonal breaks. As an example, the HICP for non-energy industrial goods of Italy is used, in which the seasonal break appeared in January 2011. The choice of an HICP for non-energy industrial goods is primarily motivated by its important role in economic analyses and forecasts. The treatments presented in this paper benefit from the fact that the nature of change in seasonality in HICPs for non-energy industrial goods seems to be more systematic compared to other series such as HICPs for fruit or for vegetables.

For Italy a comparison of the impacts on price indices for clothing and footwear in the HICP and in the national consumer price index provides further empirical evidence on impacts. While ISTAT, the national statistical institute of Italy, introduced the requirements of the regulation on seasonal items not only for the HICP of Italy, but also for the national consumer price index, sales prices for clothing and footwear are excluded from the national consumer price index. The impact of the introduction of the seasonal-items regulation is primarily driven by the new treatment of prices for seasonal clothing

and footwear. According to the harmonised method for these cases, i.e. the counter-seasonal price estimation method, price changes for out-of-season clothes and shoes are estimated by referring to the price changes of the in-season products. This amplifies the impact of sales prices, affecting HICPs for clothing and footwear, while due the exclusion of sales prices the national consumer price index is not affected.

The first approach to adjusting for the seasonal break back-estimates the new seasonal profile. Data for 2010 are derived from index values reported for 2011 by back-calculations on the basis of 2010 undistorted year-on-year growth rates for 2011. Estimates for earlier years are then subsequently derived from reported year-on-year growth rates. Approach 2 forward-extends the former seasonal pattern via undistorted growth rates from 2010 data. The application of undistorted growth rates in both cases gives rise to level effects caused by the fact that the impacts do not cancel out over the affected calendar year. Charts 2 and 3 illustrate these level effects in the HICP series for non-energy industrial goods in Italy. As outlined earlier in this section, the reason for these level effects is the amplification of the sales price effect for clothes and shoes to the out-of-season items.

Chart 2: **Applications of undistorted growth rates to HICP for non-energy industrial goods of Italy according to approach 1**
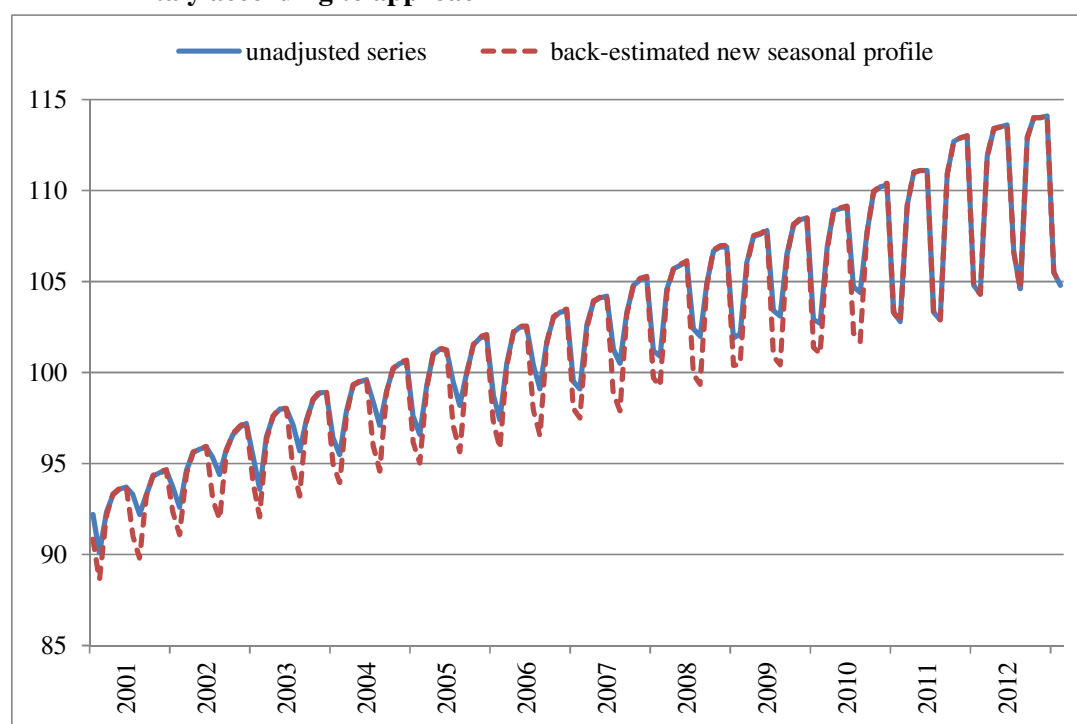
Source: Eurostat and own calculations

Chart 3: **Applications of undistorted growth rates to HICP for non-energy industrial goods of Italy according to approach 2**
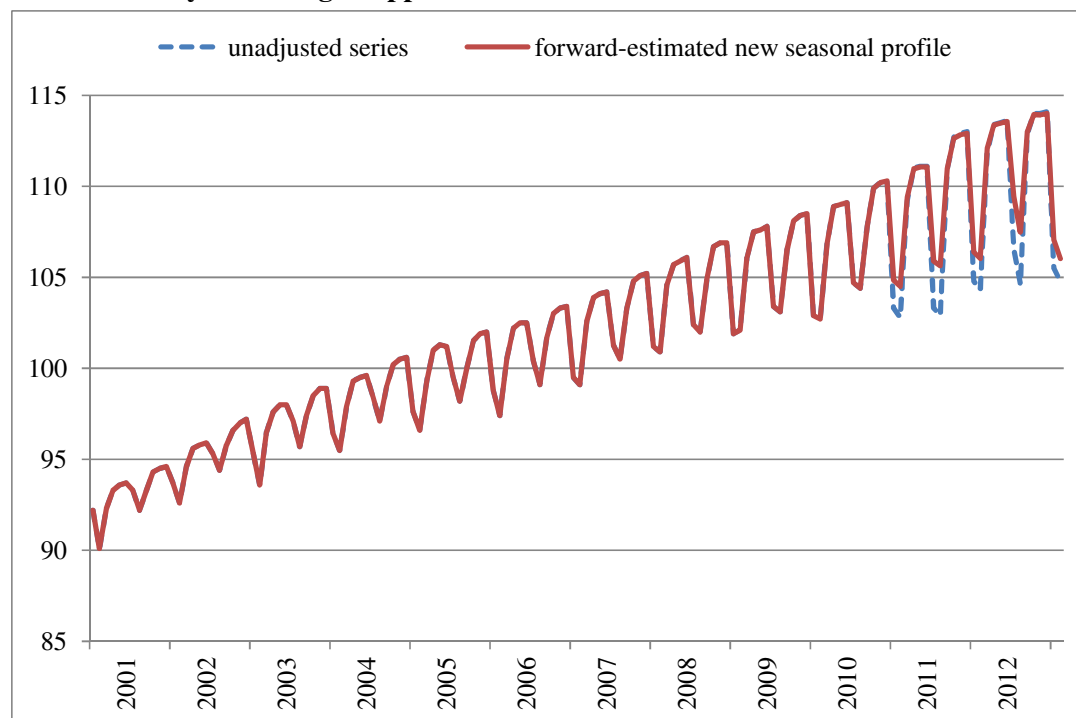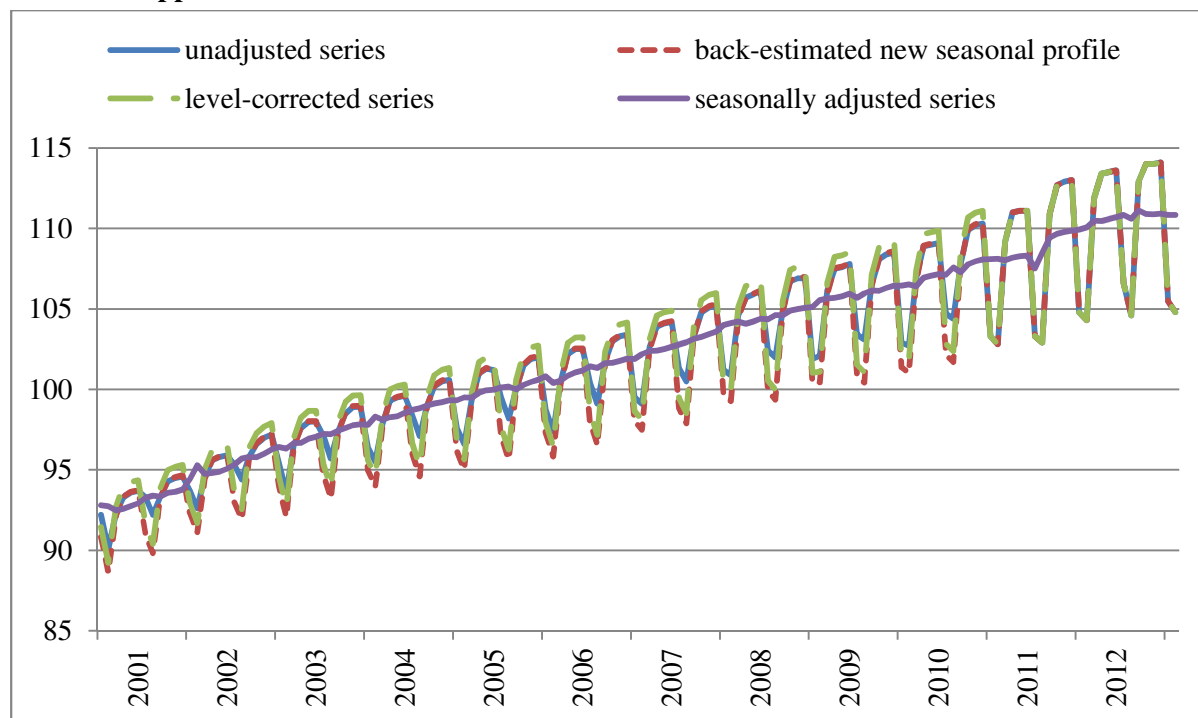

Source: Eurostat and own calculations

Approach 1 corrects for these level distortions by multiplying the level-distorted data with the ratio of trend-cycle estimates obtained for the level-distorted series and for the seasonally adjusted series which only uses pre-break data. Since these trend-cycle estimates result from direct seasonal adjustment, they do not exhibit residual seasonality, while properly reflecting medium-term movements.

By contrast, time series methods cannot be applied for approach 2, because the level differences appear only for the time span beginning in January 2011. Benchmarking to annual averages of the unadjusted series provides a simple approach which is applied in this paper for the purpose of level correction.

Chart 4 and 5 present the level-corrected series and the seasonally adjusted HICP for non-energy industrial goods of Italy resulting from the respective approaches.

Chart 4: **Seasonal adjusted HICP for non-energy industrial goods of Italy according to approach 1**
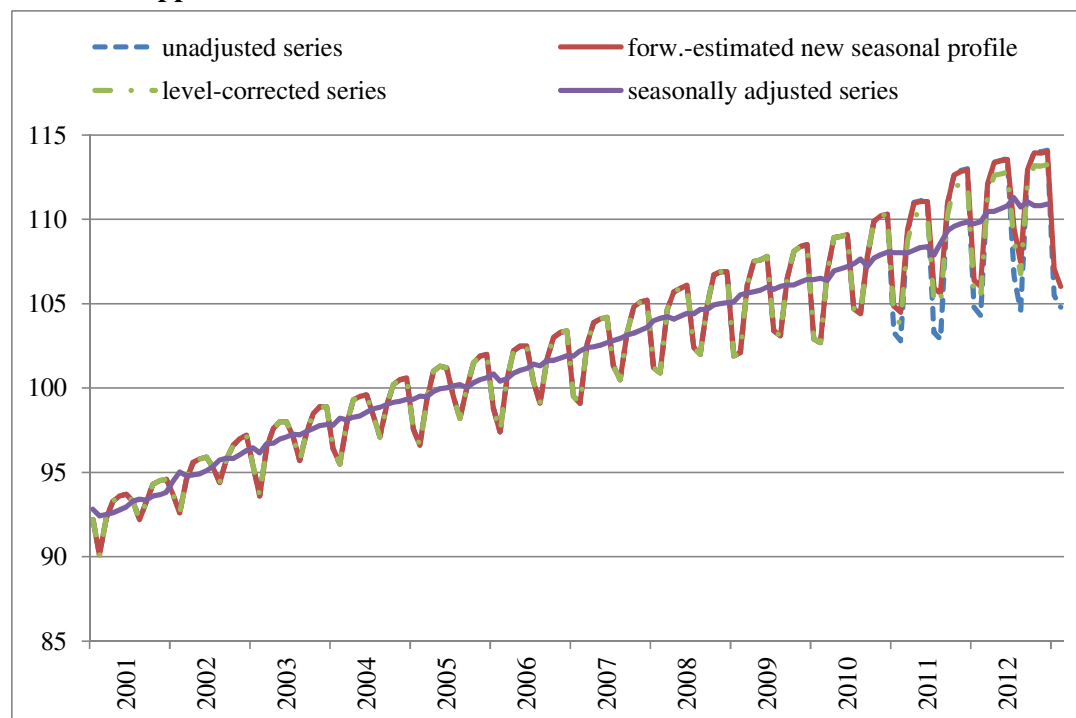

Source: Eurostat and own calculations

The level of the back-estimated seasonal profile is upwardly corrected in order to maintain the previous level of the series in which the impact of sales prices was lower. As a result of this level correction, the more pronounced new seasonal pattern imposed to the pre-break period shows seasonal peaks which exceed the previously observed ones.

The seasonally adjusted series is derived from a direct seasonal adjustment of the level corrected series. A more pronounced irregular effect appears in summer 2011, indicating that price reduction for summer clothes and shoes was more pronounced in that year than usual. In most recent periods, the seasonally adjusted series shows a flattening.

Chart 5: **Seasonal adjusted HICP for non-energy industrial goods of Italy according to approach 2**

Source: Eurostat and own calculations

The seasonally adjusted series obtained by applying approach 2 shows, by and large, similar properties as the results of approach 1. One visible difference is related to the irregular effects appearing in summer 2011 and 2012. For summer 2001, the result of approach 2 show a negative, but less pronounced one-off effect, while the irregular effects in summer 2012 differ in terms of sign. The availability of additional data under the new seasonal regime might help get more insight into the phenomenon in the future.

6   Conclusions

This paper illustrates how a pre-treatment can improve the statistical quality of seasonal adjustment in cases of seasonal breaks occurring in recent observations. Seasonal adjustment procedures which apply pre-defined smoothing filters, like Census X-12 used in the ECB, are unable to cope with abrupt seasonal breaks when the break appears in more recent periods. Accepting such seasonal breaks in seasonal adjustment without any special treatment leads to seasonally adjusted results which are distorted not only in the periods in which the break occurred and shortly thereafter, but also in the pre-break periods, due to the use of two-sided filters. In such cases the results of seasonal adjustment imply shortcomings regarding the usability of seasonally adjusted series for reporting and forecasting purposes.

Taking the HICP for non-energy industrial goods of Italy as an example, this paper illustrates how information about the distortion caused by the seasonal break in the unadjusted data can be used for

improving seasonal adjustment. Undistorted year-on-year growth rates, as they would have appeared had the existing seasonal regime had not been changed, are used for the purpose of break adjustment. These growth rates are used for back-estimating the new seasonal regime. In a second approach, the pre-break seasonal pattern is forward-estimated. Both calculations result in series which exhibit some level differences compared with the original series. The requirement that seasonal adjustment does not affect time series in terms of levels calls then for a correction of these level distortions.

Our first approach, which uses undistorted growth rates for back-calculations, corrects for level distortions by means of ratios of trend-cycle component estimates. The second approach imposes the previous seasonal profile to post-break periods. Since the new seasonal regime has been in place only since January 2011, a more sophisticated correction for level effects is not feasible. Rather, annual averages are used as benchmarks.

Altogether, the insights gained from the investigations in this paper call for the application of approach 1, which has the further comparative advantage that the new seasonal profile is not altered, which is preferable for forecasting purposes. Nevertheless, approach 2 could be a viable alternative. Referring to it might provide useful insights, e.g. for benchmarking purposes.