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The common component of the CPI: A trendy measure of Icelandic underlying inflation*

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Abstract

This paper presents a new measure of underlying inflation in Iceland: the common component of the CPI. It is obtained from a factor model that is estimated using monthly data on individual subcomponents of the CPI. The results indicate that the common component is most responsive to imported inflation. Over the entire estimation period, the common component explained, on average, half of the total variation of individual subindices. Following the easing and stabilisation of inflation and inflation expectations in recent years, the majority of the variance of individual subindices is explained by sector-specific shocks over a shorter estimation period. The performance of this measure was also checked along several dimensions. It appears robust to the estimation period used, and both the level of aggregation and the impact of revisions due to real-time extraction of the common component were negligible. The common component could serve as a useful complement to existing measures of underlying inflation already monitored by the Central Bank of Iceland.

Keywords: Underlying inflation, Factor model, Iceland

JEL Classification: C38, E31, E32, E52, E58

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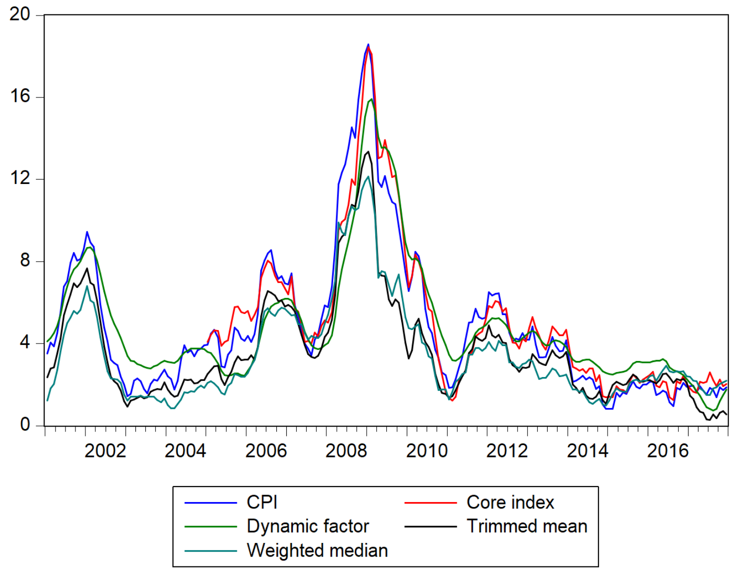
1 Introduction

Since 2001, the Central Bank of Iceland has been tasked with keeping inflation, defined as the twelve-month percentage change in the consumer price index (CPI), close to 2.5 per cent. Due to factors such as the forward-looking nature of price setting and the lagged effect of monetary policy, an inflation-targeting central bank needs more information than past realisations of the headline inflation rate to achieve this goal. Measures of underlying inflation form an integral part of the information set utilised by central banks. While underlying inflation is neither an observable variable nor precisely defined, at a conceptual level it is usually thought of as the 'persistent' or the 'generalised' component of inflation. It is intended to reflect changes in the general price level and, to this effect, to exclude transitory factors that are beyond the central bank's control. Two common examples are food and petrol prices, which change frequently due to factors such as weather and political issues, neither of which is within a central bank's sphere of influence. Insofar as these price changes do not affect inflation expectations, a central bank would be erroneous in responding to a temporary rise in inflation stemming from factors unrelated to economic fundamentals. Being able to distinguish between a general and persistent change in the price level – one meriting a policy response – and a mere blip in an inflation reading is therefore a vital task for any inflation-targeting central bank. The Central Bank of Iceland therefore monitors a handful of measures of underlying inflation. Several of them are plotted in Figure 1, along with headline inflation.[1]

But how do central banks recognise inflation blips, and how do they measure underlying inflation? The simplest and most widely used methods are exclusion-based inflationary measures, often referred to as core indices. Core indices measure underlying inflation by excluding a fixed set of components of the CPI basket. The components selected tend to be those that have historically been volatile and are thought to reflect transitory changes in the inflation rate, such as food and petrol prices, as well as official price decisions such as indirect taxes and public services prices, which affect the price level permanently but change the inflation rate only temporarily. Core indices have the advantage of being easily communicated and understood; however, they have a significant drawback in that the excluded components are predetermined. As a result, they cannot extricate other temporary and unforeseen factors affecting the headline inflation rate. An example of this

[1]The measures included are: a core index (which excludes the effects of indirect taxes, volatile food items, petrol, public services, and real mortgage interest expense. Published by Statistics Iceland), the weighted median, a trimmed mean measure, and a measure based on a dynamic factor model (see Einarsson, 2014).



Sources: Central Bank of Iceland, Statistics Iceland.

Figure 1. Various measures of underlying inflation, monthly data, twelve-month change (%)

is airline prices, which have become increasingly volatile due to changing market conditions and have often been the source of rather large and unanticipated changes in the Icelandic headline inflation rate. Another example is changing relative prices, which are often due to technological advances and therefore outside the scope of a central bank's influence: for instance, the prolonged decline in telecom prices seen recently in many countries, which has been a drag on headline inflation. In order to look past such changing relative prices, a measure that does not exclude a fixed set of components is needed. One such method that has become quite popular is the use of trimmed mean measures, which exclude the most extreme price changes in each inflation reading, thereby allowing users to filter unanticipated transitory shocks from general price changes. Such trimmed mean measures have been found to outperform core indices in capturing persistent changes in prices (see, e.g., Pétursson, 2002 and Khan, Morel, & Sabourin, 2015).

Another way of measuring underlying inflation is to use factor models, which have been gaining traction in recent years. Factor models have the advantage of utilising all of the information available; that is, they do not exclude any components from the construction of the underlying inflation rate, but rather attempt to evaluate an unobserved common force that is driving general price movements. Several central banks have added factor models to their information set: the Central Bank of Iceland already employs a dynamic factor model (Einarsson, 2014)[2], as do the Reserve Bank of New Zealand (see Kirker, 2010 and Giannone & Matheson, 2007) and the Central Bank of the Republic of Turkey (Tekatli, 2010), while the Bank of Canada (Khan, Morel, & Sabourin, 2013) and Norges Bank (Husabø, 2017) have static ones. As is stated in Khan et al. (2015) and Husabø (2017), these static factor models have become one of the favoured measures of underlying inflation at the Canadian and Norwegian central banks.

This paper presents an additional measure of core inflation based on a static factor model, which we label the common component of the CPI. It will be added to the Central Bank of Iceland's information set as a gauge for underlying inflation. Furthermore, the current paper adds to the analysis performed in Einarsson (2014) by examining the number of factors that should be included, as opposed to Einarsson (2014) where one factor was assumed sufficient. The main difference between the common component and the dynamic measure already being monitored by the Bank is the relative simplicity of the common component. Due to its simpler structure, the common component is easier to interpret and communicate. Furthermore, studies have found no clear evidence in favour of the dynamic models, as the additional complexity can make them prone to overfitting (see, e.g., Boivin & Ng, 2005 and D' Agostino & Giannone, 2012).

The remainder of the paper is organised as follows. Section 2 presents the model, and Section 3 covers the data used. Results are presented in Section 4, and Section 5 discusses the performance of the common component. Section 6 concludes.

2 Factor models and their application to measuring underlying inflation

A factor model is a statistical procedure well suited for estimating underlying inflation. It consists of two parts: one or more factors representing the co-movement of the variables being modelled, and an idiosyncratic term capturing the part unexplained by those co-movements. As underlying inflation is most commonly thought of as a generalised rise in the price level, it should be seen in the data as price changes common to many of the subindices of the CPI. Hence, a factor model should be able to pick up co-movement in prices and give an informative measure of underlying inflation while filtering

[2]See a comparison between the two factor model measures in Section 5.4.

out noisy idiosyncratic price changes.

Let π_{it} denote the twelve-month change in the ith subindex of the CPI at time t, and let $\boldsymbol{\Pi_t} = (\pi_{1t}, \pi_{2t}, ..., \pi_{Nt})'$ be an $N \times 1$ vector of the N subindices. Then, the general form of the factor model can be expressed as

$$\boldsymbol{\Pi_t} = \boldsymbol{\Lambda F_t} + \boldsymbol{\varepsilon_t}, \tag{1}$$

where $k \leq N$ is the number of factors included in the $k \times 1$ vector $\boldsymbol{F_t}$, which captures common sources of price movements.[3] These could be due to aggregate shocks affecting all sectors – for example, monetary policy changes, exchange rate movements, and collective wage agreements – or they could be due to shocks affecting most but not all sectors, such as changes in energy prices. The $N \times k$ matrix $\boldsymbol{\Lambda}$ consists of coefficients indicating how each subindex responds to the k factors. The $N \times 1$ vector $\boldsymbol{\varepsilon_t}$ is an idiosyncratic term representing sector-specific disturbances that are uncorrelated with $\boldsymbol{F_t}$ and captures the price variations that are specific to each subindex. The factor model in Equation 1 is estimated by the method of principal components following Stock and Watson (2002a, 2002b).

The factors or co-movements of the variables can be seen as common underlying inflation pressures and the idiosyncratic term as unrelated sector-specific events. Hence, the factors from Equation 1 are used to estimate underlying inflation.

$$\pi_t^{CC} = \hat{\alpha} + \hat{\beta}_1 F_{1t} + \hat{\beta}_2 F_{2t} + ... + \hat{\beta}_k F_{kt} \tag{2}$$

Here π_t^{CC} is the common component of the CPI at time t, and F_{1t} is the first factor in $\boldsymbol{F_t}$ and the one that explains most of the co-movement of the data. F_{2t} is the second factor, and so on. The coefficients in Equation 2, $\hat{\alpha}$ and $\hat{\beta}_1, \hat{\beta}_2, ..\hat{\beta}_k$, are estimated from a regression of the twelve-month change in headline inflation, π_t on the factors:

$$\pi_t = \alpha + \beta_1 F_{1t} + \beta_2 F_{2t} + ... + \beta_k F_{kt} + u_t \tag{3}$$

This model is static, meaning that π_t^{CC} is uncorrelated with sector-specific shocks only contemporaneously. Dynamics can be introduced to the model to capture factors that are uncorrelated with sector-specific shocks at all leads and lags.

[3] In theory, as many factors can be extracted as the number of series – that is, $k = N$ – but because the purpose of a factor model is to find a parsimonious way to represent a large panel of data, in general $k < N$. Selecting k, the number of factors to be used, requires some judgement (see Section 4.1).

3 Data

The consumer price index and its subindices are published monthly by Statistics Iceland. The subindices, which cover 268 categories, have been published since 1998. In this study, we use 38 series that cover 100 per cent of the CPI basket. By using a coarser aggregation, we make sure to include new indices as they are introduced by Statistics Iceland (such as telecommunication services). The 38 CPI series used are listed in Table 1 and plotted in the Appendix. The data are expressed as the twelve-month change in each subcomponent and are standardised prior to estimation.

4 Results

In this section, we report the main findings of our estimation of the common component. First we discuss the selection of factors for inclusion. Next we present underlying inflation as measured by the common component in relation to other measures of inflation and underlying inflation before discussing how individual CPI components contribute to the common component.

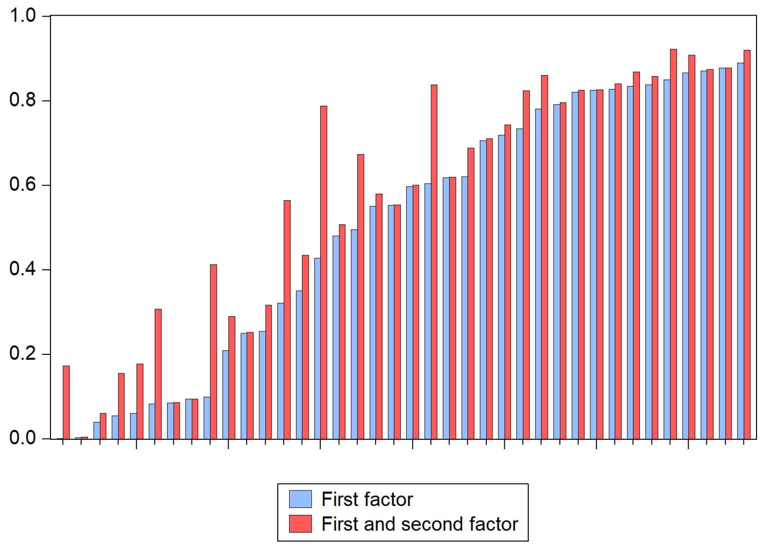
4.1 Selecting the number of factors

No consensus has been reach in the literature on factor models on the number of factors that should be extracted from the model, and selecting the number of factors to be used requires some judgement. Khan et al. (2013) extract only one from the model because, in theory, there is only one common underlying inflation pressure. Einarsson (2014) does likewise. However, Husabø (2017) extracts two factors, which are interpreted as evidence for two forces driving underlying inflation: imported inflation and domestic labour costs. Kirker (2010) used up to five factors but ultimately settled on two, one representing tradable inflation and the other nontradable inflation.

Our results indicate that for Icelandic data, one factor is sufficient. At a first pass, visual inspection via scree plot suggested that one factor would suffice, and further analysis shows that adding a second factor does not contribute in any meaningful way to the analysis and interpretation of underlying inflation. The first factor explains 78 per cent of the variation in headline inflation, while adding the second factor increases that number to 88 per cent.[4] The second factor appears to follow developments in imputed rent

[4]Measured as R^2 from a regression of headline inflation on both the first and the first two factors from the factor model over the estimation period.

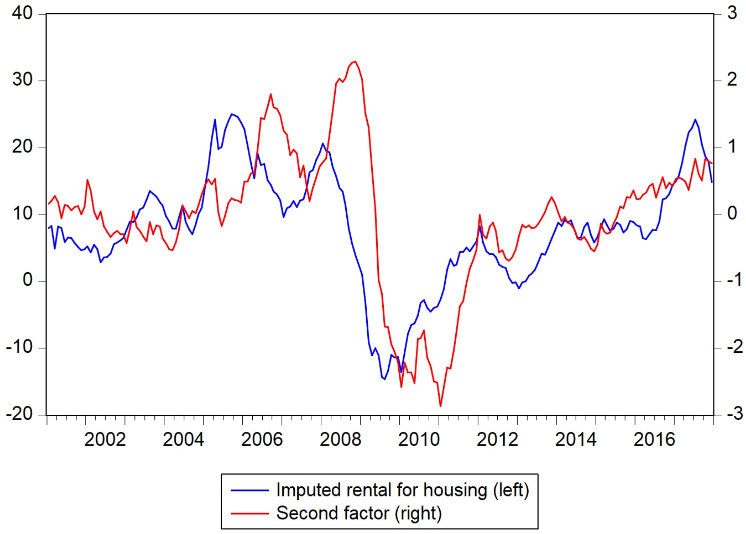
but has little co-movement with most other indices. Figure 2 shows the fraction of sample variances of the subindices explained by the first factor and the first two factors. The subindices are ordered by the fraction of variance explained by the first factor. The second factor improves the percentage of explained variance for only a handful of subindices, most notably those related to housing. The largest improvement, 40 percentage points, is for imputed rent, while actual rent saw an improvement of 20 percentage points. Of the other components that showed sizeable improvements, most are made up largely of prices set by officials.



Source: Authors' calculations.

Figure 2. Percentage of explained variance of each subindex

Figure 3 shows the subindex imputed rent, as well as the second component extracted from the factor model. The correlation between the two is 0.6. The purpose of extracting factors from the data is to describe the co-movement of the variables in a parsimonious way, but having a factor largely representing one particular subindex does not serve that purpose. One factor was therefore deemed sufficient.



Sources: Statistics Iceland, authors' calculations.

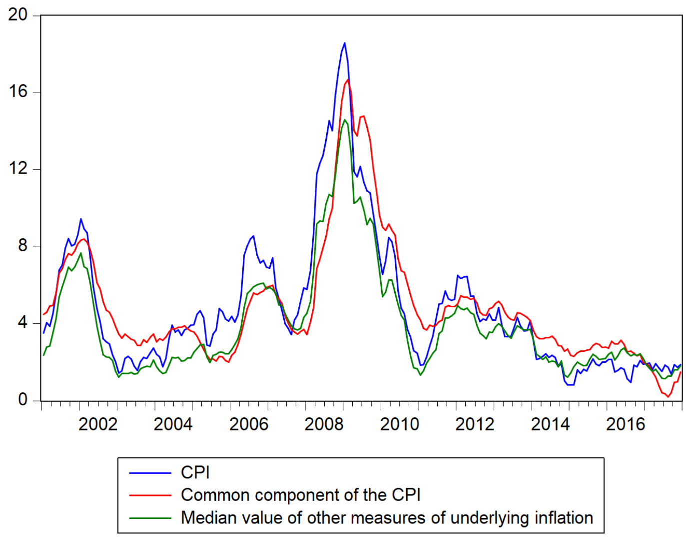
Figure 3. Second factor and imputed rent. Monthly data, twelve-month change (%)

4.2 The common component and other measures of inflation

Figure 4 shows the common component of the CPI, along with headline inflation and the median of other measures of underlying inflation.[5] The common component and headline inflation have moved roughly in tandem, with the correlation of 0.88 over the entire sample and 0.82 in 2011-2017. The common component is noticeably smoother than headline inflation over the entire period, with standard deviations of 3.0 and 3.4, respectively. The largest deviations between the two occur when house prices are particularly volatile; for instance, in the run-up to and aftermath of the financial crisis, as imputed rent rose by nearly 20% in 2007, only to fall by nearly 14% in 2009. House prices have a direct effect on headline inflation through imputed rent, which weighs heaviest of all of the subindices. Their effect on the common component is limited, however. The difference between the common component and the median of other underlying inflation measures peaked at about 5 per cent in mid-2009. As with headline inflation, falling house prices are the most likely reason for the difference. By design, the core index does not

[5]Median of the dynamic factor measure, a trimmed mean measure, a weighted median measure, and a core index (only available from March 2008).

exclude imputed rent, and it is difficult for the trimmed mean measure to filter out falling house prices due to the sheer size of the imputed rent subindex. As a result, the bursting of the housing bubble exerted downward pressure on some of the other measures of underlying inflation. This illustrates the importance of having more than one measure of underlying inflation; at that time, the common component highlighted price movements common to many subindices, which could be linked to exchange rate pass-through, given the concurrent depreciation of the króna, whereas other measures show the mitigating impact of falling house prices on underlying inflation.



Sources: Central bank of Iceland, Statistics Iceland, authors' calculations.

Figure 4. Measures of underlying and headline inflation. Monthly data, twelve-month change (%)

The period beginning in 2014, when headline inflation stabilised around the inflation target, is of particular interest. The common component of the CPI indicates that underlying inflation exceeded headline inflation at the beginning of that period, but that this turned around at the end of 2016. Since then, house prices have risen sharply and have been the main driver of measured inflation, but with a negligible impact on the common component of the CPI. The common component, however, shows underlying inflation subsiding concurrent with the marked drop in imported goods prices (in response to the appreciation of the króna) and the slowdown in private services inflation.

4.3 The relationship between the common component and individual CPI subindices

To gain a better understanding of the relationship between the common component and individual CPI subindices, two statistics were mainly used. The first one is the contemporaneous correlation between the twelve-month change in inflation rates of individual CPI subindices and the common component of the CPI. This helps us to understand how closely changes in prices in each component are linked to changes in the common component. The second one is the fraction of the variation of the individual subindices that can be explained by the common component.[6] Both of these statistics are reported in Table 1.

The first half of the table shows the relationships from 1999 until 2017. Inflation rates of a majority of the subindices (33 of 38 components) are positively correlated with the common component of the CPI, which explained, on average, 50% of the variation in the individual indices. For comparison, Khan et al. (2013) and Reis and Watson (2010) find that underlying inflation accounts for roughly 20% of the variability of individual CPI components in Canada and the United States, with the majority explained by sector-specific shocks. This indicates that in Iceland the variation in the price indices has been driven predominantly by a common source of co-movement, represented by the common component of the CPI.

The indices that have the largest correlation with the common component tend to be those associated with imports, such as clothing (corr. 0.91), electrical appliances (corr. 0.93), and purchases of vehicles (corr. 0.84). This is in line with results from Norway, where imported inflation was the dominant factor explaining Norwegian underlying inflation (Husabø, 2017). In a survey conducted in 2008, Ólafsson, Pétursdóttir, and Vignisdóttir (2011) find that exchange rate movements have been an important factor in Icelandic firms' pricing decisions, especially for firms with a large share of imported input costs. Firms' responses were also found to be asymmetrical, with increased costs due to depreciation being passed on more readily. The correlation between the common component and the exchange rate[7] was over 0.8 (see Figure 5); however, the correlation between the CPI and the exchange rate was nearly 0.9.

The króna has generally been procyclical since the adoption of the inflation target. As a result, inflation in Iceland has often been countercyclical

[6]This is the R^2 obtained from a regression of each individual component's inflation rate on the common component of the CPI over the estimation period.

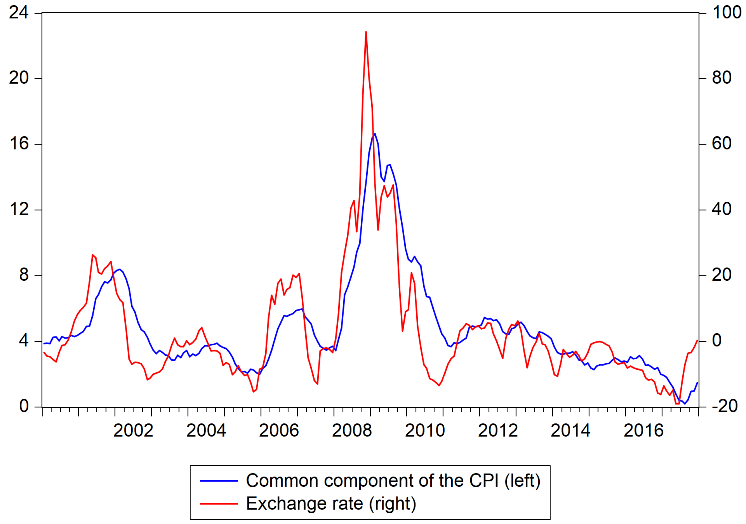
[7]Represented by the year-on-year change in the official narrow trade-weighted exchange rate index.

– easing during expansions, along with an appreciating króna, and spiking during downturns, following a depreciating króna.

Table 1. Relationship between the common component and individual components of the CPI

	1999M01-2017M12		2011M01-2017M12	
	Correlation	% of explained variance	Correlation	% of explained variance
Food	0.86	0.73	0.88	0.78
Non-alcoholic beverages	0.77	0.60	0.80	0.63
Alcoholic beverages	0.92	0.84	0.72	0.52
Tobacco	0.59	0.35	0.13	0.02
Clothing	0.91	0.82	0.80	0.64
Footwear	0.74	0.55	0.40	0.16
Actual rentals for housing	0.57	0.32	0.61	0.37
Imputed rentals for housing	-0.65	0.43	-0.87	0.76
Regular maintenance	0.88	0.78	0.41	0.17
Other serv. relating to the dwelling	-0.05	0.00	0.71	0.51
Electricity, gas and other fuels	0.31	0.10	0.41	0.17
Furniture, furnishings, etc.	0.94	0.88	0.89	0.79
Household textiles	0.91	0.83	0.92	0.85
Electrical appliances	0.93	0.87	0.65	0.42
Glassware, tableware, etc.	0.85	0.72	0.76	0.57
Tools and equipment	0.91	0.83	0.44	0.19
Goods and services	0.94	0.89	0.85	0.73
Medical products, etc.	0.79	0.62	0.69	0.47
Out-patient services	0.31	0.09	0.07	0.00
Purchase of vehicles	0.84	0.71	0.91	0.83
Operation of personal transp. equipm.	0.50	0.25	0.58	0.33
Transport services	0.74	0.55	0.77	0.60
Communications	0.50	0.25	0.81	0.65
Audiovisual instruments, etc.	0.91	0.83	0.55	0.31
Major durables for recreation and culture	0.70	0.49	0.51	0.26
Other recreational items	0.93	0.87	0.87	0.76
Recreational and cultural services	0.29	0.08	0.03	0.00
Newspapers, books and stationery	0.89	0.79	0.52	0.27
Package holidays	0.78	0.60	0.61	0.38
Educational services	-0.20	0.04	0.27	0.07
Catering	0.79	0.62	0.06	0.00
Accomodation services	0.25	0.06	0.33	0.11
Personal care	0.92	0.85	0.78	0.61
Personal effects n.e.c.	0.69	0.48	0.79	0.62
Social protection	0.03	0.00	0.70	0.49
Insurance	0.46	0.21	0.01	0.00
Financial services n.e.c.	-0.23	0.05	0.15	0.02
Other services n.e.c.	-0.29	0.08	-0.58	0.33

Source: Authors' calculations.



Sources: Central Bank of Iceland, authors' calculations.

Figure 5. Common component of the CPI and exchange rate developments. Monthly data, twelve-month change (%)

Contrasting the effects of exchange rate movements were five subindices that had a negative correlation with the common component.[8] All of them are service-related, with imputed rent the most significant. As is discussed above, house prices tend to be procyclical, rising during booms and falling during downturns. Thus they have served as an antagonist to the exchange rate-induced countercyclicality of Icelandic inflation, causing the negative correlation.

The second half of Table 1 shows the same statistics using data from 2011 onwards. Inflation and inflation expectations subsided markedly during this period, and inflation has been close to target since 2014. This has been attributed in part to increased credibility of monetary policy and improved anchoring of inflation expectations (see Pétursson, 2018). Due to the forward-looking nature of price setting, lower and better anchored inflation expectations should lead to the easing and stabilisation of underlying inflationary pressures. Sector-specific shocks should therefore play a proportionately larger role in explaining the variation of individual subcomponents. For this shorter period, the common component explains, on average, 41% of the total variation in the individual components, down from 50% for the entire

[8] Extracting the common component from a dataset excluding these five subindices yields a very similar measure. The correlation is 0.99.

period, edging closer to the roughly 20% seen in the US and Canada, where inflation expectations have been better anchored. For the past few years, the majority of the average variation in individual components is therefore explained by sector-specific shocks rather than a common driving force.

5 Evaluation of the common component

Because underlying inflation is unobservable, it is difficult to test whether the factor model gives an accurate estimate. That said, the estimate should fulfil certain requirements. It should be easily communicated and interpreted, and headline inflation should follow its development over time. Therefore, an indicator that actually captures underlying inflation should be able to contribute to predictions of future developments in the headline CPI. The robustness of the common component to different assumptions such as model specification, the data used for the estimation, and real-time versus full-sample estimation were also examined.

5.1 Estimation period

The common component is estimated over a period that includes the financial crisis of 2008, resulting in rather extreme volatility of the subindices (see the figure in the Appendix). To check the robustness of the estimate, the common component was also estimated over the relatively more stable period of 2012-2017. The results are strikingly similar, and the correlation between the two estimates is 0.99. Yet there is a level difference of a maximum 0.8 percentage points, because inflation was markedly lower during the latter period. Capital controls were in effect for most of that period, however, thereby limiting exchange rate movements, which Ólafsson et al. (2011) showed to be a significant factor in firms' price setting decisions. Because exchange rate movements play a prominent role in price setting decisions, it was deemed more appropriate to utilise the entire dataset rather than a sub-sample featuring limited exchange rate movements.

5.2 Predictive properties

Due to the lagged effect of monetary policy, it is vital that monetary authorities be able to predict where inflation is headed in the foreseeable future. Therefore, one of the key requirements for a sound measure of underlying inflation is its predictive ability. The predictive ability of the common component can be evaluated using the following regression:

$$\pi_{t+h} - \pi_t = \alpha + \beta(\pi_t - \pi_t^{CC}) + \varepsilon_t \tag{4}$$

where π_t is headline inflation, π_t^{CC} is the common component, and ε_t is the residual. This regression estimates whether the current gap between core inflation and headline inflation predicts future changes in headline inflation. The idea is that when transitory shocks occur, headline inflation temporarily deviates from core inflation. When these transitory shocks fade, headline inflation should revert to core inflation. If headline inflation is above core inflation, headline inflation can be expected to decrease in the future. This can be verified by testing whether $\beta < 0$ in Equation 4.

Table 2. Predictive properties test

Forecast horizon	1999M01-2017M12	2012M01-2017M12
6 months	0.30	-0.33
12 months	-0.04	-0.86***
18 months	-0.13	-1.27***
24 months	-0.23	-1.84***

OLS coefficient estimates. *, **, and *** indicate significance at the 90, 95 and 99% levels, respectively. Estimated HAC standard errors.

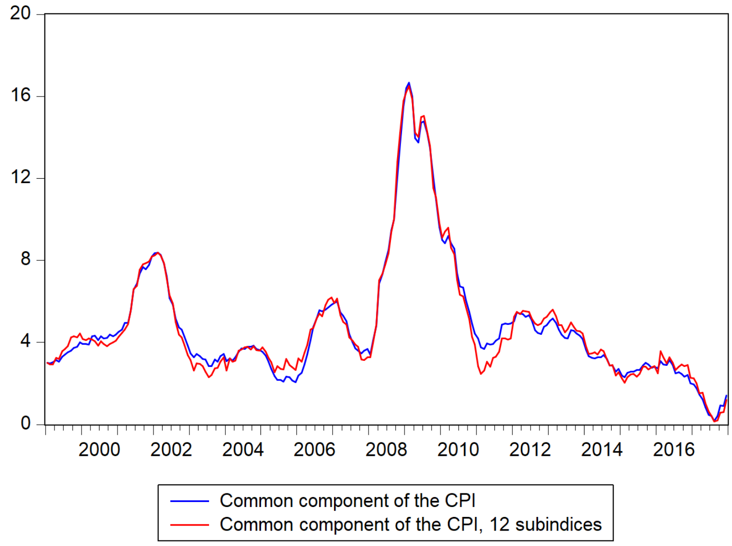
Source: Authors' calculations.

The results for $h = 6, 12, 18, 24$ are shown in Table 2. The results for the entire sample period (see Column 1 in Table 2) show that the β coefficient is negative but not significant (for most forecast horizons). However, when estimating Equation 4 for the period 2012 until 2017, the coefficients were significantly negative in most cases, indicating that the common component provides information on future developments in headline inflation 12-24 months ahead.

5.3 Higher level of aggregation

The 38 components of the CPI were chosen because they represent 100 per cent of the CPI basket and they are all available from 1998. At the most disaggregated level, Statistics Iceland publishes approximately 170 subindices, but not all of them are available over the entire sampling period. Some were discontinued due to reclassification, while others were introduced only recently. Therefore, in order to estimate the common component from the 170 subindices, those not available over the entire time span must be excluded. For example, telecommunication services, which were not introduced until 2002, account for 1.5 per cent of the CPI basket. Excluding them from the dataset would give a sample that does not fully represent the entire consumer basket.

Instead of estimating the common component from a more disaggregated level, in this sensitivity analysis the common component is estimated from a higher level of aggregation. Figure 6 displays the common component of the CPI extracted from 38 subindices of the CPI and a common component extracted from the 12 major groups of the CPI. Extracting a common component on the 12 most aggregated series yields a series that is broadly similar to the common component of the CPI obtained with 38 subindicies.



Source: Authors' calculations.

Figure 6. Common component of CPI with aggregated data. Monthly data, twelve-month change (%)

5.4 Static versus dynamic factor model

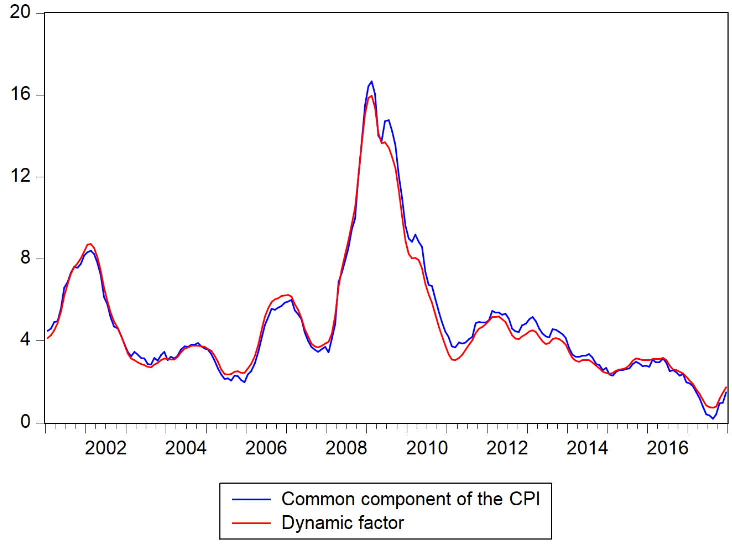
The two leading methods for estimating factors from a large panel of data are the dynamic method, used by Forni, Hallin, Lippi, and Reichlin (2005), and the static method, used by Stock and Watson (2002a). The main difference between the two is that the dynamic method assumes that the factors follow an autoregressive process, whereas the static one does not. The additional structure of the dynamic model may well be warranted given the typical persistence of inflation data; however, it increases the number of parameters to be estimated and can result in overfitting. The issue of whether to use static or dynamic factors remains unresolved in the literature. Boivin and Ng (2005) examine the forecasting performance of both methods and find that the static approach performs systematically better than the dynamic one, while D' Agostino and Giannone (2012) compare the predictive ability of both methods and conclude that they perform similarly. As is addressed in Khan et al. (2013), a simpler static approach may be preferred to a dynamic approach for practical reasons because the static approach is easier to interpret and communicate, which is essential for the conduct of monetary policy.

Figure 7 shows a comparison of a dynamic factor (see Einarsson, 2014) and the static common component of the CPI.[9] These two measures of underlying inflation show similar results. Over the majority of the period, the measures are indistinguishable, although the dynamic factor is smoother, partly because of the persistence caused by the factor being modelled as an autoregressive process, as well as the smoothing introduced by the Kalman filter. As is acknowledged in Einarsson (2014), the Kalman filter might result in excessive smoothing of the factor – that is, underlying inflation is persistently overestimated during periods of low inflation and underestimated during periods of high inflation.

5.5 Real-time extraction of the common component

The common component of the CPI estimated with a factor model is subject to revisions as new data become available. To examine the magnitude of the revisions to real-time estimates, the following exercise was performed: The model was estimated over the period 1999-2009 and the resulting common component stored. Then the sample was expanded one month at a time and the common component extracted each time. This was repeated until the end of the full sample, December 2017. Figure 8 shows 96 extractions of the common component of the CPI. The average revision to the common component is 0.15 percentage points in absolute terms. The component was revised downwards more often than upwards, or in 79% cases. Historical revision is largest in the earlier part of the sample. The maximum revision, 0.9 percentage points, occurs in the beginning of 2005. It should be noted that in the beginning, when the sample, is quite small, the mean and standard deviation of headline inflation (with which the common component is scaled) are quite sensitive to additional observations. Therefore, the largest revision occurs when the sample is small. When the sample becomes larger, the mean

[9]Note that the dataset has been altered from the dataset presented in that paper, in line with Price (2013), to prevent indices from being included more than once. Here the dynamic factor is extracted from the same 38 subindices as the common component of the CPI and listed in Table 1.



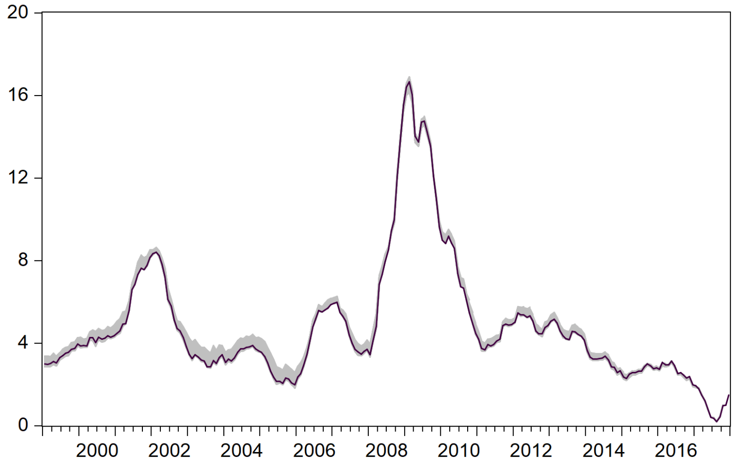
Sources: Central Bank of Iceland, authors' calculations.

Figure 7. Dynamic and static factor. Monthly data, twelve-month change (%)

and standard deviation are not as sensitive to additional observations and the revision becomes smaller. In addition, inflation has been markedly more stable in recent years, resulting in smaller revisions. The average revision to the common component is only half of the value in absolute terms for extractions done in January 2013 or later, or 0.09 percentage points.

6 Conclusions

In this paper, we have presented a new measure of underlying inflation for Iceland, the common component of the CPI. The measure is based on a static factor model that extracts co-movement among subindices of the CPI while limiting the impact of idiosyncratic movements. The simplicity of a static factor model relative to a dynamic one was considered desirable for the interpretation and communication of monetary policy. The common component and headline inflation are highly correlated, but the advantage of the common component is that it is less volatile. The largest deviations between the two occur during periods of particularly volatile house prices. House prices have a strong impact on headline inflation through the imputed rent subindex, whereas their impact on the common component is negligible.



Source: Authors' calculations.

Figure 8. Real time estimates of the common component of the CPI. Monthly data, twelve-month change (%)

We added to the analysis performed in Einarsson (2014), who introduced a dynamic factor model for Icelandic inflation, by examining whether the use of more than one factor was merited. The results indicate that one factor is sufficient, as the second factor appeared to reflect developments in a single subindex: imputed rent. When examining the relationship between the common component and individual CPI subindices, we found evidence that the common component was closely associated with import prices, in line with results seen in Norway (Husabø, 2017). First, the subindices with the strongest connection to the common component (in terms of both correlation and percentage of explained variance) are predominantly import-related. Second, the indices that have a negative correlation with the common component are all service-related. Furthermore, there is a marked difference in the share of the variance of each subcomponent that is explained by the common component (it is lower for service-related indices).

Also noteworthy is how the fraction of the variance of each subcomponent explained by common component changes over time. For the full sample period, it averages 50%, while for the period 2011-2017, which saw inflation and inflation expectations subsiding, it averages roughly 40%, edging closer to figures seen in the US and Canada.

When testing the robustness of the common component, we found it satisfactory along several dimensions. The common component extracted was found to be robust to alternative specifications of the factor model, the time period used for estimation, and the level of aggregation. When estimated over a shorter period, however, it was sensitive to level shifts, yet its development was nearly indistinguishable from the full sample estimate. This suggests that the development is quite robust, whereas the precise value depends on the period used for estimation due to rescaling. Furthermore, we found that revisions of real-time estimates of the common component were not a source of concern, as average revisions for recent extractions amounted to 0.09 percentage points in absolute terms. The predictive properties of the common component for headline inflation were not statistically significant when estimated using the entire sample. When estimated over the period 2012-2017, however, they were statistically significant for three out of four forecast horizons considered. The forecasting performance of the common component and its performance compared to other measures of underlying inflation warrants further research, to be covered in another forthcoming paper. Given the evidence provided in this paper, we believe that the common component is a useful complement to existing measures of underlying inflation already monitored by the Central Bank of Iceland.

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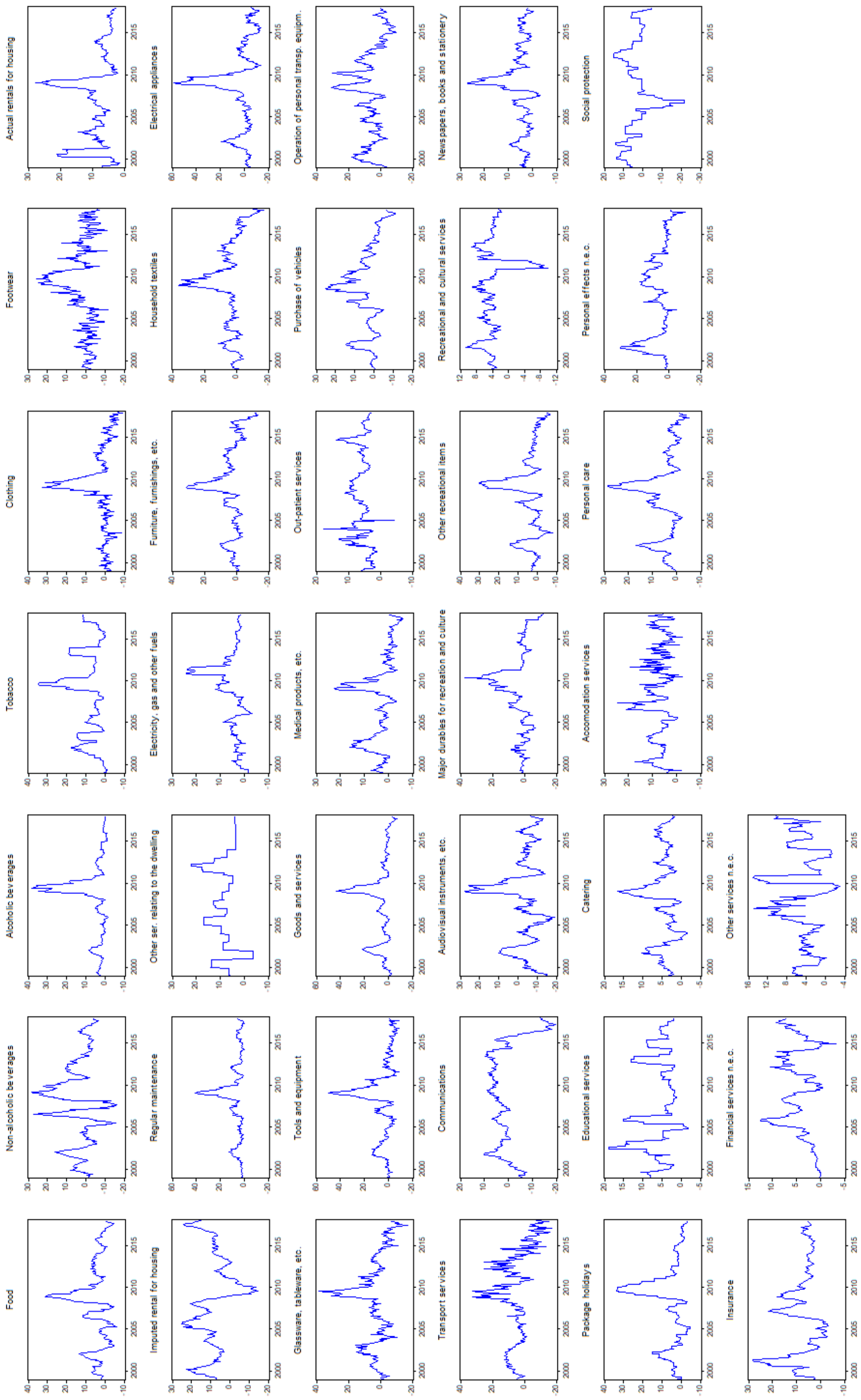
A Appendix


Food
Non-alcoholic beverages
Alcoholic beverages
Tobacco
Clothing
Footwear
Actual rentals for housing
Imputed rental for housing
Regular maintenance
Other ser. relating to the dwelling
Electricity, gas and other fuels
Furniture, furnishings, etc.
Household textiles
Electrical appliances
Glassware, tableware, etc.
Tools and equipment
Goods and services
Medical products, etc.
Out-patient services
Purchase of vehicles
Operation of personal transp. equipm.
Transport services
Communications
Audiovisual instruments, etc.
Major durables for recreation and culture
Other recreational items
Recreational and cultural services
Newspapers, books and stationery
Package holidays
Educational services
Catering
Accommodation services
Personal care
Personal effects n.e.c.
Social protection
Insurance
Financial services n.e.c.
Other services n.e.c.