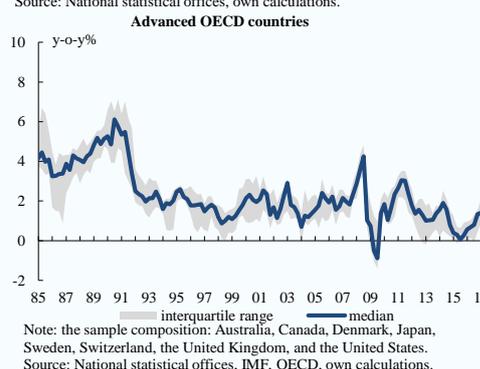
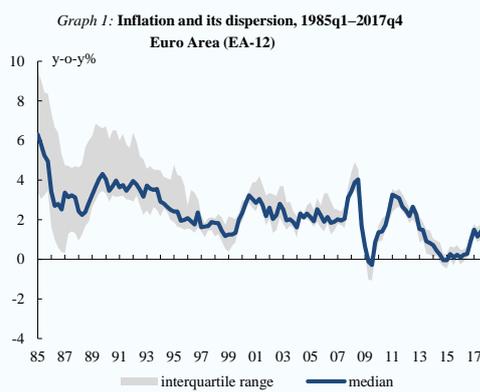


Box 1.1: Has inflation become more 'global'?

Inflation in the euro area has remained subdued despite the current cyclical upswing in both the euro area and the global economy (see Graph 1). Lower energy prices between the second half of 2014 and mid-2017 could explain only a part of this weakness because core inflation, which excludes energy and unprocessed food prices and reflects the underlying price pressures in the domestic economy, has also remained subdued as explained in the main text.⁽¹⁾ However, the recent literature and empirical studies of several institutions have emphasised the importance of factors common across OECD countries in determining domestic inflation. This box analyses the role of such common factors on consumer price inflation (CPI) using factor analysis tools.⁽²⁾

Inflation has followed a broadly similar path across OECD economies in recent years.⁽³⁾ A commonly used tool to describe the link between prices and domestic determinants is the Phillips curve framework. The Phillips curve relates changes in wages or prices to economic determinants such as, past or expected domestic inflation, productivity developments and the output or unemployment gap, which measure 'slack' in the economy. The Phillips curve framework is augmented with determinants that aim to capture the impact of the external environment on domestic price pressures. The direct impact from the external environment is traditionally reflected in the Phillips curve via trade openness variables (exports and imports, which

capture the links of the economy represented);⁽⁴⁾ the global output gap; global price developments, particularly commodity prices in general and the oil price in particular; and more competitive markets; the effects of changes in the structure of production (so-called global value chains); foreign demand; or changes in the labour market.⁽⁵⁾



⁽¹⁾ See e.g. IMF (2018). 'World Economic Outlook: Cyclical Upswing, Structural Change'. April.

⁽²⁾ OECD and CPI data were used due to data availability. A static factor model is utilised, see e.g. S. A. Mulaik (2009). 'Foundations of Factor Analysis'. (2nd ed.), Chapman & Hall. Factor analysis allows finding a statistical model for the correlations among the inflation series of the different countries. It assumes that there exist unobserved factors driving the observed inflation rates. Each inflation series is assumed to be dependent on a linear combination of the identified common factors, and their associated weights (known as loadings). Each inflation series also includes a component due to independent random variability (i.e. country specific variance).

⁽³⁾ See e.g. Ciccarelli, A., and B. Mojon (2010). 'Global Inflation'. *The Review of Economics and Statistics* 92:3, pp. 524–535; Bank for International Settlements (BIS) (2014). '84th Annual Report'. June; ECB (2017). 'Domestic and global drivers of inflation in the euro area', *ECB Economic Bulletin* 4, pp. 72–96; Carney, M. (2017). '[De]Globalisation and inflation'. Speech at the 2017 IMF Michel Camdessus Central Banking Lecture. Washington DC, 18 September.

The empirical evidence is rather mixed, with known effects on domestic prices related to oil prices and relatively small effects attributable to

⁽⁴⁾ See e.g. Monacelli, T., and L. Sala (2009). 'The International Dimension of Inflation: Evidence from Disaggregated Consumer Price Data'. *Journal of Money, Credit and Banking* 41:1, pp. 101–20.

⁽⁵⁾ See an overview of other determinants in Carney (ibid.) or Neely, C. J., and D. E. Rapach (2011). 'International Comovements in Inflation Rates and Country Characteristics'. *Journal of International Money and Finance* 30:7, pp. 1471–90 (global prices); Andrews, D., Gal, P., and W. Witheridge (2018). 'A Genie in a Bottle? Globalization, Competition and Inflation'. *OECD Economics Department Working Papers* 1462 (value chains); Béreau, S., Faubert, V., and K. Schmidt (2018). 'Explaining and Forecasting Euro Area Inflation: the Role of Domestic and Global Factors'. *Banque de France Working Paper* 663 (foreign demand).

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Box (continued)

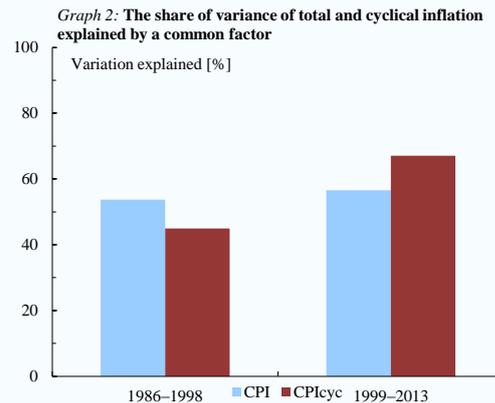
trade variables or the world output gap. The common underlying factors found via the analysis presented in this box reflect the shocks to these variables, but also other possible determinants, such as commodity prices, output and price shocks in large exporters, or common shocks from technological change.⁽⁶⁾ A precise analysis of the determinants of these factors is beyond the scope of this box.

This box presents further evidence of the existence of a common underlying factor driving inflation rates in developed OECD countries. The box analyses both headline (CPI) inflation and core inflation. This is important since commodity price developments are important for the variation in the former. The cyclical components of CPI and core inflation are used to show the importance of the common underlying factors for domestic inflation. The results indicate that the relevance of the common factor changes through time, which is to be expected given the large number of shocks that determine it. As the box shows that these changes have intervened during the 1990s, one possible explanation is related to the introduction of the euro, which unified monetary policy in a large set of the OECD countries and, as a consequence, could have engendered a closer correlation of the cyclical components of inflation in these countries. The data show the emergence of a second common supra-national factor after 1999, which could tentatively be interpreted as a factor which is common to euro area countries and exists in parallel with the common factor.

Inflation in the OECD countries has a common factor, whose relevance increased after 1999

Graph 2 shows that more or less 60% of the headline inflation variability in OECD countries

can be attributed to a common underlying factor. The sample is split into a pre-1999 period and a post-1999 period, and the graph shows that overall this factor has remained constant over time, i.e. that, when one considers CPI (solid blue bars), the main common factor explains almost the same percentage of the inflation series in the more recent period.⁽⁷⁾



Note: the graph shows the percentage of the total variation of both total and cyclical CPI, which can be attributed to the common factor constructed as the first principal component of a subsample of twenty developed OECD countries (these are listed in Table 1). Source: own calculations.

A different result is obtained if the cyclical component of inflation is taken into consideration. Following Ciccarelli and Mojon (2010) and Kamber and Wong (2018), this box focuses on changes in the explanatory power of the common factor for the cyclical component of headline inflation, which is computed by a filtering

⁽⁶⁾ The evidence on global output gap is ambiguous; significant effects are found e.g. by: Borio, C., and A. Filardo (2007). 'Globalisation and inflation: new cross-country evidence on the global determinants of domestic inflation', *Bank for International Settlements Working Paper* 227; Bianchi, F., and A. Civelli (2015). 'Globalization and inflation: Evidence from a time-varying VAR'. *Review of Economic Dynamics* 18:2, pp. 406-433, other studies fail to do so: Ihrig, J., S. B. Kamin, D. Lindner, and J. Marquez (2010). 'Some Simple Tests of Globalization and Inflation Hypothesis', *International Finance* 13:3, pp. 343-375; Mikolajun, S. I., and D. Lodge (2016). 'Advanced economy inflation: the role of global factors'. *ECB Working Paper Series* 1948; Kamber, G., and B. Wong (2018). 'Global factors and trend inflation'. *Bank for International Settlements Working Paper* 688.

⁽⁷⁾ The choice of the sub-periods is driven by the introduction of the euro, which, by creating a new monetary area of a size comparable to the US can potentially have changed the commonalities of inflation in a large number of countries. The symmetry of the sample allows the use of the Baxter-King (BK) filter for the computation of the cyclical component of the inflation, as it shortens the series symmetrically (12 quarters on both sides). This implies that the analysis can be done only up to 2014. Finally this is the same sample as in BIS (ibid.), which makes it possible to compare the findings.

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Box (continued)

procedure.⁽⁸⁾ Headline inflation can be thought as the combination of different determinants: those that determine long-run developments of inflation, such as changes in the supply or the market competitive structure, or changes in consumer preferences; and those that are related to business cycle developments, e.g. demand changes. It is important to focus on the cyclical part of inflation because it generally moves in tandem with the business cycle and can be influenced by monetary policy. Moreover, one should take into account that in the 1990s, many countries moved to a lower-inflation environment while introducing changes in the conduct of monetary policy (like the use of inflation targeting) at the same time. Indeed, the common factor of the cyclical component of inflation (red bars of Graph 2) explains almost 70% of the variance of inflation in the recent period, against less than 50% in the first period, a noticeable difference with trend in the explanatory power of the common factor for total CPI.

explanatory power of the common factor for the series of the relevant OECD countries. There are only four countries in which the common factor explains more than 60% of the variation of the cyclical component of the CPI index during the pre-euro period. This number increases to thirteen in the euro period. There seems to be a country-specific pattern visible as only three countries showing an increased relevance of the common factor in explaining their domestic inflation are outside the euro area, and two others are EU members. Comparable results are obtained if one uses an average of inflation computed across countries (whether a simple average or a GDP-weighted one) instead of the principal factor extracted using factorial analysis to describe the common underlying inflation trend, in line with Ciccarelli and Mojon (2010).

Are commonalities in inflation mostly driven by energy prices?

As discussed above, the analyses based on augmented versions of the Phillips curve indicate that the presence of common shocks is an important explanation for cross-border co-movements in inflation, with the most important external variable affecting domestic inflation is found to be the price of oil (or of commodities more in general). By contrast, the relevance of other possible sources of commonalities, including common shocks and spillovers from other countries, is more difficult to establish. These results are partly supported by the analysis of the presence of common trends in core inflation.

Core inflation provides a picture of underlying price pressures by excluding volatile components from the consumer basket, particularly those that are related to energy.⁽⁹⁾ Graph 3 presents the variation in the cyclical components of core inflation along with that of the cyclical component CPI inflation. The graph shows two features of core inflation. First, the share of the variation of the cyclical component of core domestic inflation rates which is explained by the common factor is below 40% and 30% in the pre-1999 and post-1999 periods respectively. This is much smaller than the share of CPI inflation that was explained by the common factor. Moreover the difference in the explained variation of the cyclical component of

Table 1: Total and cyclical inflation and the common factor

CPIcyc 1986-1998	Common Factor	CPIcyc 1999-2013	Common Factor
US	0.50	US	0.76
DE	0.31	DE	0.77
AU	0.01	AU	0.42
JP	0.43	JP	0.39
FR	0.71	FR	0.85
CZ	0.52	CZ	0.48
UK	0.37	UK	0.39
IT	0.59	IT	0.78
ES	0.10	ES	0.89
SE	0.38	SE	0.64
CA	0.14	CA	0.55
NL	0.53	NL	0.29
DK	0.06	DK	0.64
AT	0.59	AT	0.80
FI	0.53	FI	0.79
IE	0.36	IE	0.75
LU	0.76	LU	0.90
BE	0.84	BE	0.86
EL	0.00	EL	0.42
PT	0.80	PT	0.69

Note: the table shows the percentage of the variance of the inflation explained by the common factor, by country and by sub-period. Shaded cells contains values larger than 0.60. Table 1 shows a common factor computed using a static factor model (with one predefined factor), which is the most important factor in the model as it explains the largest share of the total variance. This is equivalent to the first principal component of the principal component analysis used to compute Graph 2. Source: ECFIN (2018), OECD (2018), and own calculations.

Table 1 provides an insight on the country dimension of this result, by showing the

⁽⁸⁾ In line with the literature quoted above, in order to estimate the cyclical component of inflation, a Baxter-King filter is used, which isolates pre-defined frequencies of the underlying series; e.g. Christiano, L. J., and T. J. Fitzgerald (2003). 'The band pass filter'. *International Economic Review* 44:2, pp. 435-465. In this procedure, headline inflation is decomposed in its long-run trend, and the business cycle fluctuations.

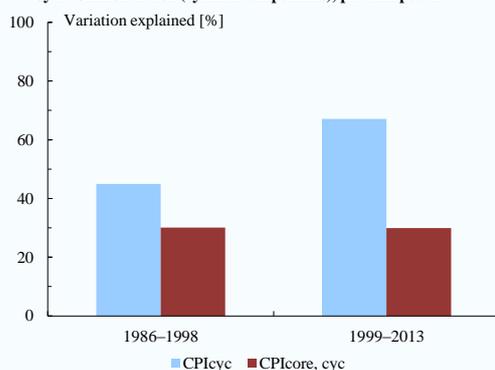
⁽⁹⁾ CPI core inflation is calculated on the CPI index excluding prices of volatile components, i.e. food and energy, whose combined weight is around 1/5th.

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Box (continued)

core inflation across periods is much smaller than for headline inflation.⁽¹⁰⁾ While the explained share for the cyclical CPI is 20% larger than in the case of the cyclical component of core inflation before 1999, this ratio is more than the double after 1999.

Graph 3: Share of the variation of total and core inflation explained by a common factor (cyclical components), pre and post 1999



Note: the graph shows the percentage of the total variation of both cyclical CPI and cyclical core inflation that can be attributed to the common factor, see note under Graph 2. The core inflation rate is defined as CPI minus the unprocessed food and energy components. The country sample consists of twenty developed OECD countries as in Table 1. Source: ECFIN (2018), OECD (2018), and own calculations

The finding of a weaker common factor effect in the core index is not surprising because core inflation excludes energy and unprocessed food. Oil, and other commodities, is itself affected by global shocks common to OECD economies.⁽¹¹⁾ It would seem that for the price items that compose the core inflation index, domestic determinants play a larger role and these determinants differ across countries, even if a factor, common across the sample of OECD countries used here, still explains one third of the variance of core inflation. Moreover it is interesting to see that while (cyclical) headline inflation has clearly increased, its correlation with common factors, this is not the case for core inflation. Further analysis would be needed to understand the drivers of the commonalities of core inflation, for example the respective role of its non-energy industrial component and its service component.

⁽¹⁰⁾ The cyclical component of core inflation is computed in the same way as for CPI.

⁽¹¹⁾ Already Ciccarelli and Mojon (ibid.) find this result; similarly a more recent study by Béreau et al. (ibid.).

Has there been a euro area inflation factor since 1999?

Graph 2 above shows that there was a shift in the 1990s, with an increase in the variation in the cyclical component of inflation explained by common determinants. Table 1 shows that this change has affected many countries that are euro area members. It is therefore tempting to provide an interpretation of these results related to the birth of the euro area.

To explore this possibility a two-factor analysis⁽¹²⁾ is used on the cyclical component of CPI. The results indicate that adding a second factor provides, together with the first factor, a better explanation of the cyclical component of the CPI. The explanatory power of this second factor is strong for most euro area countries in the sample, adding credence to the idea that it may be related to euro area membership. However, as the determinants of factors in general are very diverse, this result should not be over-interpreted.

Graph 4 presents the change in the explanatory power of the first (which could be interpreted as a more global factor) and the second (which could be interpreted as rather euro-area related) factor between the pre-euro and euro era periods for the countries considered. There is a visible pattern that cyclical inflation in the members of the euro area becomes more correlated to a second factor in the post-1999 period than it was in the pre-1999 period (solid blue bars with a positive sign) with a corresponding loss in the explanatory power of the global factor (negative dashed bars with a negative sign). This could tentatively suggest the presence of a new euro-area factor alongside the global factor for the Euro period. The main exceptions to this pattern are Greece and Spain, which show a diminished correlation with the euro area factor (Greece) and an increased correlation with the world factor (both Greece and Spain). Both cases could be in principle justified. Spain has continued increasing its internationalisation since adopting the euro, while Greece, on the other hand, started using the euro only in 2002 and has had a very

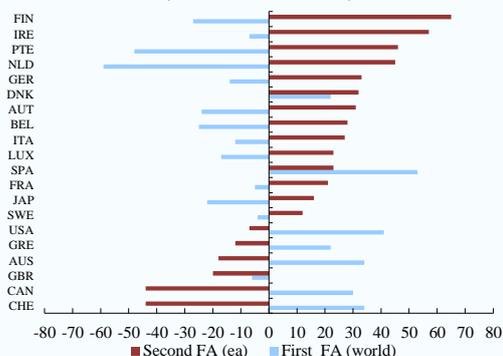
⁽¹²⁾ A two factor model is estimated using the maximum likelihood estimator (MLE) and with an oblique rotation on the found factors. It should be noted that the use of the oblique rotation produces factors that are not orthogonal to each other, and in the present case are highly correlated. This makes it difficult to give a separate interpretation of the two factors and their determinants, which should not be over-interpreted.

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Box (continued)

different behaviour in several aspects from the rest of the area.

Graph 4: Differences in the explanatory power of the first two factors based on the cyclical component of inflation by sub-period (1999–2013 vs. 1986–1998)



Note: differences in the share (expressed in pp) of variation in cyclical inflation as explained by the 1st and 2nd factors (computed using the BK-filtered CPI series) between the period 1986–1998 and the period 1999–2013. Descending order given the difference in the 2nd factor. Source: own calculations.

Conclusions

This box presents evidence of the existence of a common factor driving the cyclical component of

CPI headline inflation and core CPI inflation in advanced OECD countries, in line with the literature. The importance of the common factor increases over time for the cyclical component of the CPI inflation and remains stable in the case of core inflation, differently to what has been argued in part of the literature.

The result is possibly related to the different drivers of headline inflation versus core inflation, as the literature has shown that global oil and commodity price shocks – which constitute the difference between headline inflation and core inflation – are an important driver of domestic inflation in advanced OECD countries.

The box also tentatively indicated the possibility that this behaviour is partly related to the emergence of the euro, which has unified monetary policy in a large set of OECD countries. Among its many consequences, use of a common currency seems to have engendered a closer correlation of the cyclical components of inflation in these countries. Some evidence is provided in this sense by examining the data indicating the presence of a second common supra-national factor after 1999, whose effect can be related to most euro area countries present in the sample and complements the common global factor.