Some approaches to explaining the behaviour of inflation since the last financial and economic crisis

Following the sharp downturn in 2008-09, the real economy recovered only gradually in most industrial countries and unemployment remained high. By contrast, inflation rates were relatively stable. The widely feared deflation did not materialise, even if concerns in this regard have been expressed more loudly again in the public debate recently. The following article discusses a number of factors which have made a significant contribution to this inflation picture. First, the links between capacity utilisation of the domestic economy and domestic inflation appear less significant than previously. Another consideration is that the measurement of an economy's capacity utilisation is surrounded by considerable uncertainty, especially at the current end. Furthermore, global factors have obviously gained significance. On the other hand, inflation expectations have reacted little to prevailing events. This indicates that central banks have succeeded in anchoring expectations solidly and close to their target figures and thus preventing a self-reinforcing spiral of actual and expected price changes. Looking ahead, it is important to sustain this confidence. To this end, it is not only crucial to keep monetary policy transparent and to continue with a policy of stability. Fiscal policymakers also need to reduce deficits again, so that no lasting conflicts with monetary policy arise in this respect.

Introduction

The current economic outlook for the euro area leads us to expect that a gradual recovery from the severe crisis is setting in, with growth even in those countries most severely hit by the economic downturn picking up again. Nonetheless, inflation has fallen in past months (see chart on page 63). At 0.5% currently, it is below the Eurosystem's target, which aims for an average inflation rate below but close to 2% over the medium term.

Low inflation rates in the United States and particularly Europe at present

Inflation has also declined in most of the other industrialised economies in the recent past. At 1.5%, it is currently below the average of the last ten years in the United States, which has recently seen a significant revival in growth. Japan is a special case, to an extent, with prices currently pointing upwards again after many years with negative inflation rates.

Speculation about risks of deflation and inflation

This picture has led to fears of deflationary risks and their negative consequences of late. There are several reasons why it is deemed important to avoid continually falling prices. For one, the debts of private and public sector agents rise in real terms and this would lead to negative consequences for their behaviour and the economy overall. Furthermore, there would be reason to fear that such a development would impact the stability of the financial system, because more debtors would be seen to be at risk. There are also concerns that consumers would limit their spending in anticipation of a further reduction in prices, which might lead to a self-reinforcing downward price spiral. Finally, this picture is compounded by the fact that in a deflationary climate monetary policy might find itself in a situation where it can no longer exert the usual stabilising effect, because nominal interest rates cannot fall substantially below zero.

However, immediately following the sharp downturn in economic activity in 2008-09, the debate centred on the fact that inflation rates overall quickly rose again to a level roughly equivalent to that before the crisis, although the real indicators suggested a serious under-utilisation of capacity in some instances. Speculation therefore arose about the reasons for the surprising resilience of inflation rates and concern was expressed about expansionary economic policy possibly paving the way for a future acceleration of inflation.

Assessment of future price development more difficult since the crisis

An assessment of prospects for future price trends has been made more difficult in recent years by the fact that the economic situation is characterised by a series of special factors, ranging from structural distortions and the crisis in the financial sector, to the unusually severe and worldwide downturn in growth in 2008-09, and the extraordinary monetary and fiscal policy countermeasures. These include central bank rates at, or close to, zero and unconventional monetary policy measures, whereby the central banks purchased securities, on a large scale in some cases, as well as expansionary fiscal policies with a sharp increase in government deficits.

The following first briefly examines how inflation has behaved since the onset of the crisis. A common instrument of analysis, the New Keynesian Phillips curve, is then used as a framework for explaining the determinants of price behaviour. It seems that the relationship between prices and real movements in the economy has become somewhat weaker, while international influences have become more important. However, inflation expectations in particular appear significant for the actual behaviour of prices.[1] They are also therefore very relevant for the central banks, which is why we shall subsequently examine how these inflation expectations can be measured. Finally, we shall put forward some considerations deserving attention if inflation expectations are to be anchored close to their target in the future.

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1 See J Galí and M Gertler (1999), Inflation dynamics: A structural econometric analysis, Journal of Monetary Economics, 44(2), pp 195-222.

Prices since the start of the crisis

Moderate inflation rates before the crisis

Inflation in the euro area showed a favourable pattern before the crisis and fluctuated only slightly around the target of just under 2% set by the Eurosystem as part of its mandate. There was a similar pattern in the United States, albeit with somewhat higher inflation. The inflation rate for the overall index of consumer prices and a measure of core inflation (excluding the typically very volatile components energy and unprocessed food) showed a similar dynamic. However, headline inflation began to rise significantly in 2007, reaching a peak in July 2008. This was due amongst other things to developments in the energy markets, where the oil price reached a new all-time high.

The international financial crisis of 2008 and 2009 led to an abrupt reversal in increasing price levels and total inflation even declined to below zero briefly. Core inflation remained positive but fell below 1%. Inflation then initially rose to its pre-crisis level for a short time. It has subsequently declined again and is currently 0.5% in the euro area.
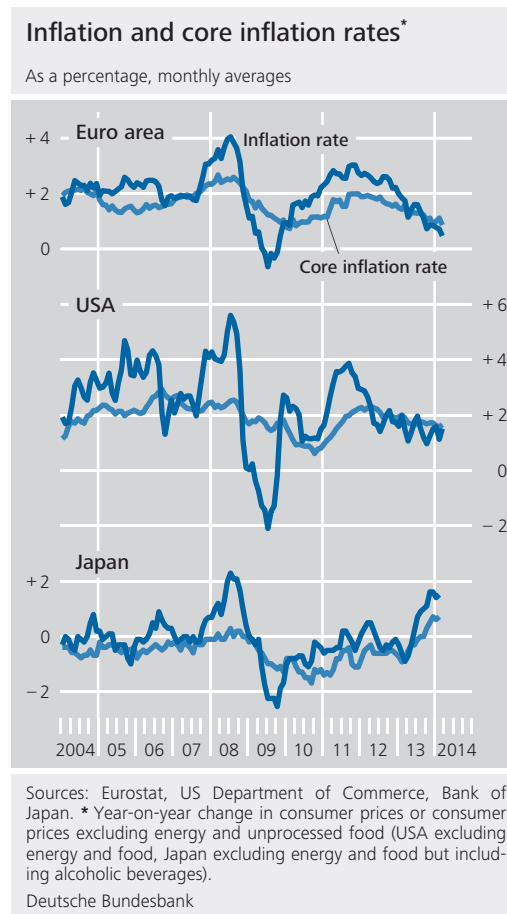
Initially only short-term decline in inflation …

This movement in prices might suggest that following a considerable but short-lived decline in output there was a fairly rapid recovery in the course of 2010. However, the recovery remained incomplete in many countries, as demonstrated especially by unemployment numbers.

… in spite of high unemployment

In the euro area, although the unemployment rate rose sharply in 2009, mirroring the decline in inflation, it did not return to its pre-crisis level. Instead, the unemployment rate continued to rise, after declining briefly at the beginning of 2011, and is now 12%.

The high unemployment rate, in other words an underutilisation of labour, is the reflection of an output gap, which is defined as the difference between actual output and estimated potential output. A gap implies that the actual

Inflation and core inflation rates*

As a percentage, monthly averages

Sources: Eurostat, US Department of Commerce, Bank of Japan. * Year-on-year change in consumer prices or consumer prices excluding energy and unprocessed food (USA excluding energy and food, Japan excluding energy and food but including alcoholic beverages).

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output is below the level to be expected under normal circumstances. A series of output gap estimates have shown a very high level of underutilisation of capacity in recent years.

Measurement of output gap uncertain

However, estimates of an economy's capacity utilisation are surrounded by considerable uncertainty, particularly at the current end. Therefore in the past significant revisions often became necessary, which might be equivalent to the size of the gap itself. Estimates by international organisations are no exception, as shown by an analysis in this Monthly Report (see On the reliability of international organisations' estimates of the output gap, pages 13 to 35). The special circumstances surrounding the severe financial and economic crisis have recently exacerbated this uncertainty further. It is therefore possible that the output gap was smaller than assumed with the usual measures.

By contrast, if one assumes that the usual measures deliver an accurate picture for the

Significant underutilisation of capacity would have suggested lower inflation rates

output gap following the crisis, then an explanation is needed, in particular, as to why, in spite of rising unemployment and output gaps in general following the crisis, inflation has not been at a much lower level for much longer than actually observed.[2] One important reason was probably the administrative and tax measures which many countries felt forced to adopt due to their fiscal difficulties. The following section examines in more detail other factors responsible for the behaviour of inflation observed since the beginning of the crisis. Particular attention will be paid to inflation expectations and, for the pre-crisis period, global factors as determinants of inflation – considerations which might also play a part in estimating future price trends.

Factors determining price development

As an analytical framework, the following discussion is based on the New Keynesian Phillips curve, which is often used to examine the factors determining inflation. As with the traditional Phillips curve, this curve, too, captures an interdependency between inflation on the one hand and the change in the output gap and other indirect or direct cost factors on the other. However, the defining feature of this new form of the Phillips curve is its microeconomic basis. This better reflects the link between changes in inflation and the underlying determinants of an enterprise's price-setting behaviour, for example its costs or competitive situation. In addition, this framework attaches great importance to forward-looking expectations. By contrast, the traditional Phillips curve took into account past inflation as an explanatory factor, which could imply that only past experience determines future expectations.

New Keynesian Phillips curve starting point for analysis of inflation development

The New Keynesian Phillips curve is based on the notion that enterprises – under the given restrictions – set their prices in such a way as to maximise profits. For enterprises in the process of resetting their prices, both the prevailing

costs and the size of the potential profit margin are the key determinants in price selection. The profit margin which an enterprise can achieve according to the model of monopolistic competition is determined by its competitive situation. It is all the more favourable for the enterprise the less elastic the reaction shown by demand to its price changes.

When deriving the Phillips curve, it is also assumed that not all firms are in a position to change their prices at all times. Firms must therefore take into account both inflation and costs expected in the future when setting prices that cannot be changed for some time.

The equilibrium result of enterprises' decision-making can be explained on the basis of an overall relationship between current and expected inflation and average real marginal costs. In a closed economy, the marginal costs would be dependent mainly on unit labour costs, which are defined as wages divided by productivity per employee. In an open economy, in which enterprises also purchase intermediate goods from abroad, account must be taken, too, of international interlinkages between the economies, using exchange rates and import prices as further determinants.

Expected inflation, marginal costs and international influences determine current inflation

Empirical studies on the Phillips curve use various measures to try to record influences on inflation from marginal costs. These measures are intended to reflect the capacity utilisation of the economy. It is assumed, for instance, that high wage demands will lead to high cost increases if unemployment is low. This would suggest a connection between the labour market situation and inflation. Another commonly used measure is the output gap, where the actual output is compared with potential output.

Economy's capacity utilisation the measure of marginal costs

Significant uncertainty prevails in both cases. In measuring wage pressure using labour market

2 See IMF, The dog that didn't bark: Has inflation been muzzled or was it just sleeping?, World Economic Outlook, April 2013; ECB, Monthly Bulletin, October 2013.

variables, current unemployment must be compared with the unemployment rate for which the influence on inflation is neutral. Similarly, for the output gap a suitable measure must be found for potential output.

The well-known difficulties in measuring these variables were further intensified by the crisis. The question arose, for example, to what extent unemployed persons previously employed in sectors such as construction, which had been booming in some countries, but with little prospect of being rehired there in the foreseeable future following the end of the boom, could be assigned to the potential labour force. A similar problem arises when attempting to estimate the capital stock available to the economy, in view of severe structural changes, which are likely to mean there is no longer any demand for certain capital goods.

Reduction in influence of domestic capacity utilisation over time

Apart from the problem of capturing the capacity utilisation of economies correctly, there is also the question of to what extent it affects inflation and whether its influence has changed latterly. Various recent studies in fact show that the significance of the domestic output gap for changes in inflation in the past two decades has been relatively low (see the box on pages 21 to 24).[3]

Such empirical findings are consistent with the observation that in 2010 and 2011, when capacity utilisation appeared very low, the inflation rates tended to be high, whilst inflation decelerated again recently, although the economies are on the road to recovery, albeit to varying degrees. A series of possible arguments can help to explain this observation. They are not necessarily mutually exclusive.

Wage rigidity and financing restrictions possible causes

Several studies focus on wage rigidity to explain why the respective output gap has less of an impact on wages and prices. Wage rigidity can be influenced by institutional factors, such as the way in which negotiated wages are set or wage indexation. Furthermore, in the past this rigidity has been more pronounced in re-

cessions in particular, when actually wage decreases and not just weaker wage increases were to be expected. Whether these observations have continued to apply during the crisis remains an open question at the current time, however.[4]

Other studies focus on arguments which relate more to problems in the financial sector as an important aspect of the recent crisis. Banks have taken a more cautious approach towards lending in such an environment and accordingly it has been more difficult for underfunded enterprises in particular to finance themselves from external sources. In line with these considerations, it has been observed that in spite of a decline in demand such firms have not reduced prices or have even increased prices.[5] Overall, such behaviour also causes the established relationships between aggregate capacity utilisation and price changes to become less clear, at least for a time, and the Phillips curve to become flatter during this period.

In the debate about inflation determinants, the consequences of closer international integration of product markets, as well as labour and financial markets, have been a focal point for some time now. There is much to suggest in general that in view of increasing globalisation national determinants have lost some influence. One simple way of checking this is to include import prices as an additional determinant in the Phillips curve. Such empirical approaches often show that – measured by the corresponding coefficient – since the beginning of the past decade import prices have had a more pronounced influence on domestic prices in the industrialised countries.[6] However, import prices cannot automatically be regarded as pre-determined. First, foreign suppliers may

International determinants

3 See for example IMF (2013), op cit.
4 For a detailed description of wage dynamics in the euro area, see ECB, Wage dynamics in Europe, Final report of the wage dynamics network, December 2009.
5 See inter alia S Gilchrist, Inflation dynamics during the financial crisis, mimeo.
6 See for example IMF, World Economic Outlook, April 2013.

adapt to domestic price conditions and, second, the price-setting behaviour of foreign suppliers is influenced by conditions in their own countries, which in turn are dependent on other countries. In addition, the rest of the world may influence the domestic situation via other channels, such as immigration and emigration, and thus affect domestic inflation. Therefore, rather than merely focusing on import prices, a more compelling approach would be to attempt to identify the various global determinants and to ascertain their significance for domestic prices. The box on pages 67 and 68 describes this approach. The corresponding findings (for the pre-crisis period) indicate that the influence of domestic output gaps on domestic inflation rates has indeed weakened over time. Furthermore, it is evident that domestic rates of price change have been very dependent on global factors in the past three decades. It seems that, in particular, common trends on labour markets and in productivity, import price inflation, international competition and global interest rate developments have played a major role. This has also led not least to a marked synchronisation of inflation rates across the world.

The role of inflation expectations and how they are measured

Inflation expectations important for current prices

As mentioned above, one distinctive feature of the New Keynesian Phillips curve is the way that it emphasises the importance of forward-looking inflation expectations for current prices. Enterprises which are anticipating largely stable prices in future do not have any need at present to change their prices. Expectations of future price changes, on the other hand, prompt enterprises which are only able to make price adjustments at certain intervals to take appropriate action right away.

It is therefore essential for monetary policymakers to influence future inflation expectations in the desired manner to the best of their ability and to adequately respond to changes in inflation expectations. The measuring of inflation expectations presents a particular challenge, however.

Measuring inflation expectations …

There are a number of methods that can be applied to try to measure expected future inflation rates. One approach is to analyse relevant surveys, another is to derive the expected inflation rates from financial market prices. Surveys can be used to ask respondents directly about expected inflation rates. Inflation expectations are derived from financial market prices by using calculations that are based on certain assumptions that do not have to be made in the case of surveys. On the other hand, it can be assumed when analysing financial market prices that the market participants attempt, out of self-interest, to make the best possible forecast of future inflation, whereas this cannot necessarily be assumed in the case of survey participants. Furthermore, financial market prices are much more frequently available than survey results, which means that they can provide more up-to-date and detailed information.

… using surveys …

Many industrial countries carry out surveys of future inflation expectations using a range of different variants. These surveys may, for example, focus on different price indices, they can also target different groups of individuals or they can take account of various forecast horizons. Indicators in widespread use for the United States include the Blue Chip Survey and the Survey of Professional Forecasters (SPF). For the euro area, too, there are a number of surveys which focus on expected rates of inflation; these include, for instance, the Consumer Survey of the European Commission and the expert survey conducted by Consensus Economics. The SPF plays a special role in this respect, which involves the ECB questioning various financial and other institutions about their inflation expectations.[7]

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7 The homepage of the survey can be found at http://www.ecb.europa.eu/stats/prices/indic/forecast/html/index.en.html.

On the global dimension of inflation

A recent Bundesbank study[1] looks at the degree of co-movement in the inflation rates of 24 OECD countries and the most important global (and country-specific) determinants between the third quarter of 1980 and the first quarter of 2007. The analysis is based on a dynamic multi-country model of the Phillips curve in a reduced form. The most important determinants of domestic inflation in the baseline model are the output gap and unit labour costs. These variables are decomposed into common components (ie those parts of the variables that would be driven by global or country-specific factors, whose movements are transmitted to other countries within a quarter) and country-specific factors (ie changes that are not transmitted to other countries within a quarter). The components are incorporated into the model as separate regressors. This approach thus allows domestic inflation to be influenced by global factors through their impact on domestic demand and supply conditions. In addition, import price inflation and past inflation are used as regressors in the baseline model. As a result, the baseline model has the following form

$$\Delta p_{it} = \sum_{j=1}^{4} \alpha_{ij} \Delta p_{it-j} + \beta_i y_{it}^{ic} + \gamma_i y_{it}^{cc}$$
$$+ \sum_{j=0}^{4} \delta_{ij} \Delta ulc_{it-j}^{ic} + \sum_{j=0}^{4} \phi_{ij} \Delta ulc_{it-j}^{ic}$$
$$+ \sum_{j=0}^{4} \chi_{ij} \Delta imc_{it-j} + \sum_{j=0}^{4} \varphi_{ij} \Delta imnc_{it-j} + e_{it}$$

where Δp_{it} is the (quarter-on-quarter) difference in the log consumer price index (CPI) of country i. Furthermore, index i denotes the country-specific (or idiosyncratic) components, whereas index c denotes the common components. Inflation is regressed on past inflation, import price inflation of commodities (Δimc_{it}), inflation of other

import prices ($\Delta imnc_{it}$), country-specific and common components of the output gap – as a trend deviation from real GDP determined using the Hodrick-Prescott filter – (y_{it}^{ic} and y_{it}^{cc}) and the corresponding components of log differences in unit labour costs (Δulc_{it}^{ic} and Δulc_{it}^{cc}). The common and idiosyncratic components of the output gap and of unit labour costs are estimated with the aid of a factor model with two factors. The model is estimated as a system using a seemingly unrelated regressions (SUR) estimator.[2] Possible correlations between residuals are taken into account. However, at the same time, the coefficients may vary across countries.

To assess how robust the results of the baseline model are and to establish whether, besides import prices and the common components of output gaps and unit labour costs, there are any additional global factors which have an impact on domestic inflation, the baseline model is then expanded to include other (observable) global factors. Finally, it is to be noted that the results of the (backward-looking) baseline model remain virtually unchanged if measures of inflation expectations (survey-based or based on own inflation forecasts) are used as additional regressors.

The analysis (baseline model and extended model versions) reveals three important findings. First, there is a strong co-movement

1 See S Eickmeier and K Pijnenburg (2013), The Global Dimension of Inflation – Evidence from Factor-Augmented Phillips Curves, Oxford Bulletin of Economics and Statistics, 75(1), pp 103-122.
2 See A Zellner (1962), An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias, Journal of the American Statistical Association, 57, pp 348-368.

of international inflation rates.[3] The first and the second global factor explain 59% and 11%, respectively, of the average variation in overall inflation rates across all countries. Other factors play only a subordinate role.

Second, the common component of unit labour costs clearly impacts on domestic inflation, which could be attributable to globalisation-related developments, such as migration flows, production facilities being shifted abroad, structural change away from the more unionised manufacturing sector towards services, institutional change in the labour markets (eg lower wage indexation) and general technological advances.[4]

Third, domestic inflation is also influenced by import price inflation (excluding supply shocks on the global crude oil market), external competition and global interest rate developments. Other global variables, such as worldwide demand conditions, oil supply developments and exchange rates are either not significant or their impact on inflation is not stable.

Political decision-makers looking to assess inflation developments therefore need to closely track global labour market and productivity developments, import prices and international interest rate developments.

In addition, the model was estimated on the basis of rolling windows as well. The relationship between domestic inflation and (both country-specific and global components of) the output gap appears to have weakened on the whole over time, although the results are dependent on the size of the window to a certain extent.

It is important to note that the analysis was carried out on the basis of a traditional rather than a micro-founded New Keynesian Phillips curve. Whereas the data are often better captured in a traditional New Keynesian Phillips curve, the structural interpretation of the results is easier on a micro-founded basis. Moreover, the study's observation period ends before the onset of the global financial crisis. It is possible that relationships have changed and that additional factors (eg financial factors) have gained importance in recent years (as outlined in the main text of this article).

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3 See also M Ciccarelli and B Mojon (2010), Global Inflation, The Review of Economics and Statistics, 92(3), pp 524-535.

4 The mean-group estimators of the coefficients of all countries and the total amount of lags (*t*-statistics) from the baseline model are lagged inflation: 0.41 (15.99), idiosyncratic and common components of the output gap: 0.03 (2.59) and 0.07 (3.43), idiosyncratic and common components of unit labour costs: 0.12 (6.83) and 0.37 (12.61), commodity import price rises: 0.03 (6.20) and (non-commodity) import price rises: 0.10 (8.41).

Unlike many other surveys, this survey does not just enquire about point forecasts. Participants are also asked to give their opinion on the likelihood of various inflation developments occurring. To this end, participants are presented with a series of intervals, which have a width of ½ percentage point and cover a range of between -1% and 4%. For each of these intervals, the participants are asked to give their opinion on the probability of the future inflation rate falling within the respective interval.[8] This allows important information to be garnered about the uncertainty of expected future inflation rates. Furthermore, the probability data can be used to calculate the expected inflation rate for each individual participant.[9] This can differ from the point forecast for a number of different reasons. The differences generally tend to be minimal, however. Both the expected inflation rates as well as the corresponding uncertainty can be important if one wishes to form a judgement as to how firmly anchored inflation expectations are.

If the probabilities for each interval are averaged across all participants, this allows the aggregate probability distribution to be obtained for the future rate of inflation. The expected rate of inflation, which is derived from the aggregate probability distribution, corresponds to the average across all the individual inflation expectations. The uncertainty of the aggregate probability distribution corresponds to the sum of the variance of the individual expected inflation rates (as a measure as to what extent the opinion of the respondents differs) and the average individual uncertainty of the participants (as a measure of how uncertain each individual respondent is).[10] The variance also serves as a measure of uncertainty in this context. A low level of uncertainty suggests a firmer anchoring of the inflation expectations.

The ECB's SPF is carried out on a quarterly basis. The participants are asked about their inflation expectations for various forecast horizons. The longest forecast horizon is four to five years and therefore contains information

Probability distribution for long-term inflation rates in the euro area

%

- November 2009
- February 2014

Expected inflation rate
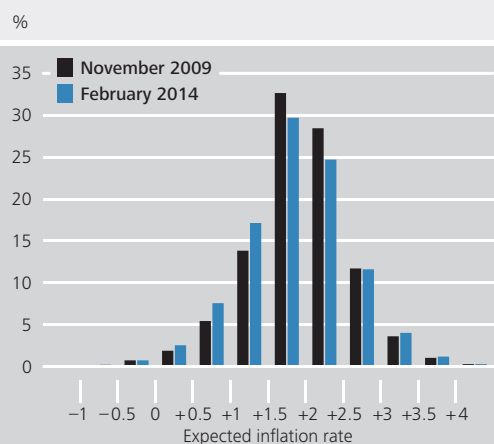
Source: ECB, Survey of Professional Forecasters.
Deutsche Bundesbank

about long-term inflation rates, ie about the annual rates of change in the Harmonised Index of Consumer Prices (HICP) in four to five years. The aggregate probability distribution for the long-term inflation expectations in the survey from the first quarter of 2014 shows only a slight shift towards lower inflation rates compared with the survey carried out in the fourth quarter of 2009 prior to the escalation of the sovereign debt crisis (see chart above). Realisations in the range of between 0.5% and 1.5% are now seen as being slightly more probable, whereas the probabilities in the range of 1.5% to 2.5% have fallen accordingly. The expected inflation rate has therefore declined only marginally. The degree of uncertainty has increased slightly, however.

As can be seen in the chart on page 70, the momentum and also the level of the various measures for the long-term inflation expectations extracted from the SPF for the euro area do not show any major differences over time.

… showed a large degree of stability during the crisis

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8 Participants are also asked about the likelihood of inflation rates below -1% and above 4%.
9 To this end, an assumption has to be made as to how the probability is distributed within an interval. It is assumed below that the overall probability is concentrated in the centre of the interval. Alternative assumptions generally produce only slightly different results.
10 See K F Wallis (2005), Combining density and interval forecasts: A modest proposal, Oxford Bulletin of Economics and Statistics, 67, Supplement, pp 983-994.

Expectations and uncertainty about long-term inflation rates in the euro area*

Quarterly
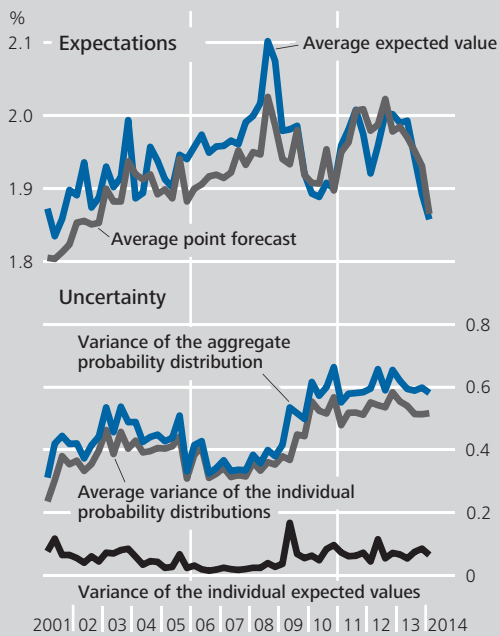
Source: ECB, Survey of Professional Forecasters. * The surveyed forecasters specify a probability distribution and a point forecast.

Deutsche Bundesbank

With a few exceptions, the average point forecast and the average expected value fall within a range which is in line with the Eurosystem's definition of price stability, ie just under 2%. Although the long-term inflation expectations fell slightly in the last two quarters, they still held up at around 1.9%.

With regard to the uncertainty of long-term inflation developments, the change in which over time is shown in the chart above, it can be seen that the inflation expectations exhibit only a very small standard deviation. This means that not only does the average expected value usually lie at just under 2%, but the individual expected values are also very frequently found close to this level. The uncertainty of the aggregate probability distribution therefore primarily feeds on the individual uncertainties of the survey participants. Although the survey participants generally assign the highest probability to a long-term inflation rate of just under 2%, they consider values which are a relatively long way above or below this level to be quite probable, too.

The individual uncertainty recorded quite a sharp rise in the period from the third quarter of 2009 to the second quarter of 2010, when there was an escalation of the sovereign debt crisis. Since then, the individual uncertainty has remained at roughly the same level as back then. This development is reflected in the uncertainty which applies in the aggregate probability distribution.

Expectations about future inflation rates can also be derived from the prices of financial market instruments. Inflation-indexed bonds and inflation swaps, for example, are designed in such a way that they compensate investors *ex post* for the inflation rates that are realised during their term. This is why market participants have to form a judgement about the expected future inflation rate when concluding the contract as this ultimately determines the payment stream and thus the price of the instrument. When deriving inflation expectations, additional premiums have to be taken into consideration to account for the counterparty default risk or the varying liquidity of the traded products. In the case of an inflation swap, the counterparties agree to swap pre-determined fixed payments in exchange for variable payments. The variable payment is directly linked to the rate of inflation during the term of the instrument. By contrast, inflation expectations are derived from bonds by taking the difference in yields on bonds with the same maturity with and without compensation for inflation. The derived values are known as break-even inflation rates (BEIR) as this is the point where the real yield plus the expected inflation rates and any possible premiums correspond exactly to the nominal yield. In the following, the expectations in five years' time will be considered, which relate to developments in the following five years. This is also referred to as the implied five-year forward inflation expectation five years ahead (forward BEIR). Economists use this variable as it is less susceptible to short-term

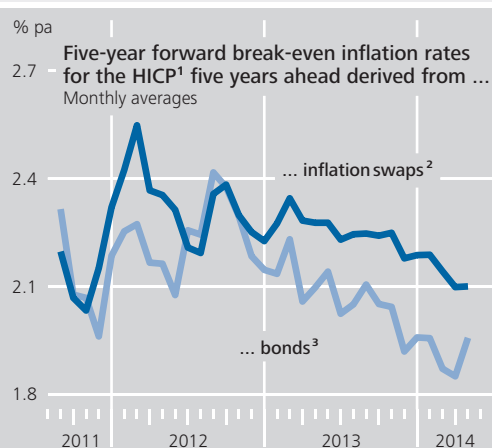*Measuring inflation expectations via the financial markets*

shocks. Over the course of the past three years, the forward BEIR extracted from inflation swaps exchanged in interbank trading hovered at around 2.2% per year, whereas the forward BEIR with the same maturity calculated from high-quality government bond yields fluctuated more in the course of the crisis and currently stands at just under 2.0%, as can be seen in the adjacent chart.[11]

One other way of deriving inflation expectations is through inflation options. These can be used to estimate probability distributions and thus also to determine the variance or the skewness, in addition to the expected value. An inflation option gives the bearer the right to a compensation payment in the event that the realised rate of inflation is above (cap) or below (floor) an inflation rate threshold agreed upon conclusion of the contract. It is standard market practice to fix the threshold values for the inflation rate in increments of 50 basis points. A risk-neutral probability distribution for the expected rate of inflation can then be derived from several inflation options with different threshold values. This is because, assuming that investors are risk-neutral, the value of an option is precisely equal to the present value – discounted at the risk-free interest rate – of the expected future-inflation-linked outpayment to the bearer of the option. The adjacent chart shows the distribution of the individual probabilities of occurrence at two points in time.[12] When the inflation option data became available in the autumn of 2009, the majority of market participants were still anticipating inflation rates of between 1% and 2% for the next five years. By way of comparison, the
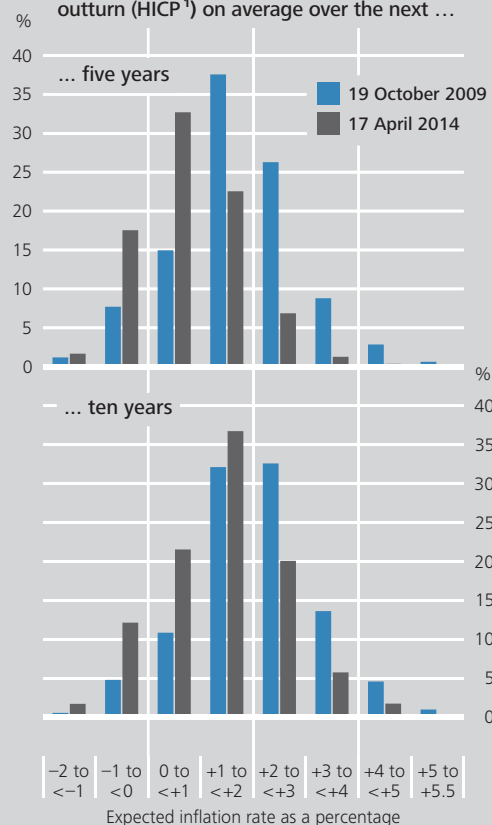
Inflation expectations based on financial market prices in the euro area

Five-year forward break-even inflation rates for the HICP[1] five years ahead derived from ...
Monthly averages
... inflation swaps[2]
... bonds[3]

Probability distribution[4] for an expected inflation outturn (HICP[1]) on average over the next ...

... five years
19 October 2009
17 April 2014

... ten years

Expected inflation rate as a percentage

Source: BGC Partners, Bloomberg, EuroMTS and Bundesbank calculations. **1** Excluding tobacco. **2** Derived from the fixed interest rate of inflation swaps that is exchanged for the annual realised inflation rates of the next five or ten years. **3** Derived from separately estimated yield curves of German and French inflation-linked and maturity-matched nominal bonds which are subsequently aggregated using GDP weights. **4** Based on inflation options. The method used to extract and interpret the probability distribution is discussed in D Breeden and R Litzenberger (1978), Prices of state-contingent claims implicit in option prices, Journal of Business, Vol 51, p 621 ff, and in T Smith (2012), Option-implied probability distributions for future inflation, Bank of England, Quarterly Bulletin 2012Q3, p 224 ff. No data are available for strike rates above or below the values shown here.

Deutsche Bundesbank

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11 In times of crisis, there is always an increase in demand for nominal bonds with the highest credit rating, especially Bunds, as these are seen as secure and liquid assets. This has an impact on their yield and thus on the derived BEIR. By contrast, inflation-indexed German government bonds are less liquid owing to the smaller number outstanding and the lower number of issues and, compared with nominal bonds, there is no increase in demand during times of severe crisis.
12 A detailed description of the probability distribution for an expected inflation outturn can also be found in Deutsche Bundesbank, Monthly Report, November 2012, p 44 f.

probability of the occurrence of inflation rates of between 1% and 2% declined in April 2014. According to this method, a larger number of market participants are now expecting inflation rates of between 0% and 1% for the next five years. As already seen in the SPF, the distribution has, on the whole, shifted to the left. Furthermore, market participants now consider the risk of deflation to be somewhat more likely. Nevertheless, the assumption of risk neutrality overestimates the likelihood of tail risks, with the result that the actually expected probability of a deflationary scenario occurring is likely to be much lower.[13] The more stable probability distribution of expected inflation rates over a longer time horizon of ten years also suggests that lower inflation rates are primarily expected for the next five-year period.[14]

Long-term inflation expectations very stable throughout the crisis

On the whole it can be stated that long-term inflation expectations, in particular, have remained very stable throughout the crisis, right up to the current end. This is probably also one of the main reasons why the actual rates of price change in the euro area have not altered as much on the whole as could have been expected based on the trends in output gaps and unemployment rates.

The observed anchoring of the inflation expectations in the face of considerable challenges is often connected to a clear, price stability-oriented monetary policy mandate, the greater independence of the central banks and their clear and transparent monetary policy strategies. The transparency of the strategy helps market participants to assess the determinants and the consequences of monetary policy action. On the other hand, the transparency has the effect of strengthening the commitment of central banks to achieving their own targets: any attempt to deviate from their announced targets would, under these circumstances, provoke counterreactions from the market participants and thus call into question the success of the respective attempts from the outset.[15]

Sharp rises in government deficits lead to inflation concerns in the long run

The severe and persistent economic crisis, which has been ongoing since 2008, has, however, led economic policymakers to implement a number of extraordinary measures. The long-term consequences of these measures are difficult to assess for all the parties involved. Government debt has risen sharply and continuously in the industrial countries. In the public debate, this has to a certain extent aroused fears of rising inflation rates in future. In fact, there are theoretical considerations which suggest that such a connection exists. In the past, there have been frequent phases where high sovereign debt and high rates of inflation accompanied each other. There are, however, also a number of examples where this was not the case: government debt in Japan, for instance, rose from 80% of GDP in 1994 to over 200% in 2012, whereas the price level declined slightly during this same period. It would appear that the links between government debt and inflation are of a more complex nature. The box on pages 73 to 76 presents a number of theoretical considerations and describes how the relationship between government debt and inflation has developed in the United States since the beginning of the 20th century. According to this article, there is much to suggest that confidence in an independent and stability-conscious central bank is an important – albeit not a sufficient – condition for ensuring that high government deficits do not have an adverse impact on inflation expectations, which will tend to make future consolidation necessary purely on account of public finances.

Interplay between fiscal and monetary policy important for future inflation

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13 By contrast, tail risks are more likely to be underestimated in the ECB's SPF as the survey participants tend to enter a probability of zero for intervals with just a small probability.
14 Owing to the lack of unambiguity when determining a density distribution for five to ten years, it is not possible to derive a forward rate in the same way as for inflation-indexed bonds and inflation swaps.
15 One example would be the attempt to achieve higher inflation targets in order to lower the real value of government debt. Market participants can learn how to see through such a strategy and how to react accordingly with interest rate premiums. This is shown in, for example, M U Krause and S Moyen, Public debt and changing inflation targets, Deutsche Bundesbank Discussion Paper, No 06/2013.

The long-run relationship between public deficits and inflation in various economic models

The notion that high budget deficits in the public sector can drive inflation higher over a medium or long-term horizon has been demonstrated by a number of theoretical models used in economic research circles.[1] The different research papers all have one idea in common – that it is not public deficits by themselves but the interaction between fiscal and monetary policy which dictates whether public deficits exert an inflationary influence.

The concept underlying the models covering this topic can be illustrated with the aid of the following simplified government budget restraint

$$\frac{B_t}{P_t} = \sum_{j=0}^{\infty} \beta^j E_t \left(s_{t+j} + \frac{\Delta M_{t+j}}{P_{t+j}} \right),$$

where B_t represents nominal outstanding government debt, P_t the current price level, s_t (real) government primary surpluses,[2] ΔM_t denotes seignorage, ie government earnings from the issuance of money, and β represents the discount factor. The equation states that the real value of outstanding debt must be commensurate with the present value of the government's expected net revenue. This line of thought eliminates the possibility of the government becoming insolvent and thus being unable to repay its debt. In a conventional regime – one in which monetary policy controls inflation (and thus seignorage is determined) – it is up to fiscal policy to ensure that the real debt level is stabilised by future primary surpluses s_t, which it can do either by raising taxes or reducing government spending in the future. This is known as monetary dominance. However, a situation in which fiscal policymakers are either unwilling or unable to generate the necessary future primary

surpluses – or economic agents do not expect this to happen – is dubbed a regime of fiscal dominance, assuming that monetary policy ensures the solvency of the government. The method used to map fiscal dominance varies from one model to the next, depending on which market is assumed to be the one which determines the price level. If the price level is only determined in the money market, it is ultimately monetary policy which dictates the price and inflation level. Should fiscal policymakers decide to continue to run primary deficits, spending will need to be funded through additional borrowing. If neither monetary nor fiscal policy relents initially, debt will grow faster than the economy. Leaving aside the possibility of sovereign default, this means that in the long run, monetary policy will have to generate higher seignorage profits after all. At the end of the day, this implies higher inflation rates going forward and – because economic agents are aware of this – it already drives up inflation expectations at the current juncture. If the price level is not necessarily determined in the money market, the current price level – assuming a given level of future primary surpluses and seignorage profits – adapts to ensure that future real primary balances and seignorage profits cover the current real debt level. For instance, inflation might conceivably rise be-

1 See E Leeper (1991), Equilibria under 'active' and 'passive' monetary and fiscal policies, Journal of Monetary Economics, 27(1), pp 129-147; T Sargent and N Wallace (1981), Some unpleasant monetarist arithmetic, Federal Reserve Bank of Minneapolis Quarterly Review, 5, pp 1-17; as well as C Sims (1994), A simple model for study of the determination of the price level and the interaction of monetary and fiscal policy, Economic Theory, 4(3), pp 381-399.
2 Primary surpluses are defined as the excess of revenue over expenditure, disregarding both interest expenditure and seignorage revenue.

cause holders of nominal government debt securities, perceiving themselves to be wealthier, increase their spending, but the higher inflation is not dampened by those economic agents whose tax burden will be higher in the future. This second scenario is also referred to in the literature as the "fiscal theory of the price level".[3]

Regardless of their individual design, all these models agree that it is the interaction between monetary and fiscal policy which is crucial for price stability. Ultimately, sound fiscal policymaking is a key prerequisite for monetary policy to serve its purpose of safeguarding price stability. Conversely, this would suggest that monetary policymakers are deprived of any means of controlling inflation in a fiscal dominance regime. Under these circumstances, higher public deficits go hand in hand with higher inflation rates over the long term.

However, the model results are quite a controversial topic and there is a lively academic debate about whether the findings are consistent with reality. While the relationship between public deficits and inflations in developed economies is disputed, emerging market economies – all of which exhibit higher inflation rates – have already been the subject of empirical research which has found that deficits positively influence inflation and inflation expectations.[4]

Against this backdrop, a more recent study[5] investigates the long-run relationship between public deficits and inflation in the USA across a relatively long period (from 1900 until 2011), focusing primarily on potential variations in this relationship over time. The researchers estimate a vector-autoregression model with time-varying parameters and stochastic volatilities. Specifically, the paper explores the relationship between inflation and primary deficits over

government debt.[6] The ratio of primary deficits to government debt can be interpreted directly as the change in outstanding government liabilities to creditors, and it is influenced primarily by fiscal policy itself over the long term. Besides these variables, the model incorporates monetary growth and real economic growth as well as a short-term interest rate to take account of any interactions with these variables. The time-varying long-run relationship between primary deficits over government debt and inflation is quantified following the estimate with the aid of a spectral analysis. The key finding is depicted by the solid black line in the chart on page 75.

This outcome illustrates that, with the exception of a brief spell following the First World War and in the years surrounding the Great Depression, there was a clearly positive long-run relationship between the two variables up until roughly 1980. It is also evident that the long-run relationship did not follow a clear-cut trend in the first half of the past century, which contrasts with the broadly upward tendency observed in the period immediately following the Second World War. The long-run relationship between public deficits and inflation suddenly diminished after 1979 and has remained insignificantly different from zero ever since. Another interesting observation is that the strongest long-run relationships

3 See C Sims (1994), A simple model for study of the determination of the price level and the interaction of monetary and fiscal policy, op cit.
4 See L Catão and M Terrones (2005), Fiscal deficits and inflation, Journal of Monetary Economics, 52(3), pp 529-554.
5 See M Kliem, A Kriwoluzky and S Sarferaz (2014), On the low-frequency relationship between public deficits and inflation, mimeo. Revised version by M Kliem, A Kriwoluzky and S Sarferaz, On the low-frequency relationship between public deficits and inflation, Deutsche Bundesbank Discussion Paper, No 12/2013.
6 See C Sims (2011), Stepping on a rake: The role of fiscal policy in the inflation of the 1970s, European Economic Review, 55, (1), pp 48-56.

Long-run relationship between public deficits and inflation in the USA*

Quarterly data
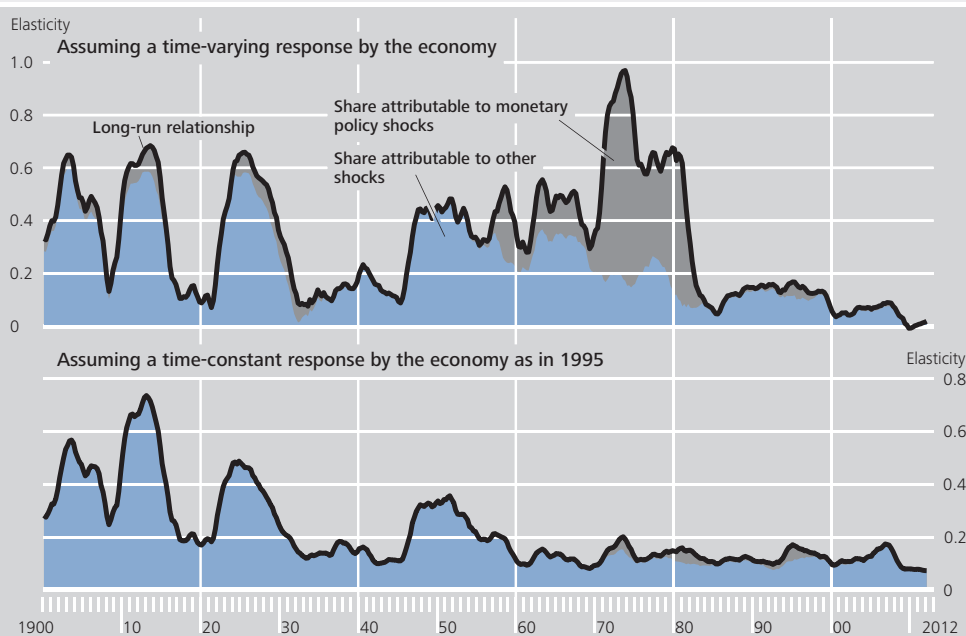
* The long-run relationship denotes the elasticity of the long-term inflation trend to changes in the long-term trend exhibited by primary deficits over government debt in a model with time-varying coefficients. A decomposition of such elasticity into structural shocks can be found in L Gambetti and J Galí (2009), On the Sources of the Great Moderation, American Economic Journal: Macroeconomics, 1, pp 26-57.

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between the two variables were measured between the mid-1960s and the end of the 1970s – a period in which deficits were not exceptionally high.

A historical decomposition of the long-run relationship between public deficits and inflation can offer deeper insights into these observations. Assuming a recursive identification, the authors calculate which structural exogenous shocks are behind this outcome. The grey areas in the above chart illustrate that the bulk of the increase between 1960 and 1980 was primarily attributable to monetary policy. This era of US monetary policy has often been described as not being independent of fiscal policy, which is consistent with this outcome.[7] This independence was only restored at the turn of the 1980s, Paul Volcker's appointment generally being regarded as a turning point in US monetary policymaking.[8]

It is therefore reasonable to assume that a change in monetary policy has played a crucial role in creating, and destroying, the long-run relationship between public deficits and inflation. The authors conducted counterfactual analysis to rule out the possibility that both events only occurred as a result of specific shocks during the 1970s – the oil price shocks, say, or the collapse of the Bretton Woods system. Counterfactual analysis assumes that the economic model's endogenous reaction to structural exogenous shocks remained stable across the entire time period and that only the structural shocks changed over time. The above chart exemplifies how the long-run relationship between public deficits and inflation would have turned out if the economy had responded to structural shocks across the

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7 See Meltzer (2010), A history of the Federal Reserve, University of Chicago Press.
8 See Meltzer (2010), A history of the Federal Reserve, op cit.

entire time period as it had done in 1995. The outcome of the analysis illustrates that the disappearance of the long-run relationship between post-1980 public deficits and inflation was indeed attributable to a change in US monetary policy and its interaction with fiscal policy. Regardless of the structural shocks prior to 1980, a long-run relationship between the variables would not have been evident if the monetary policy stance adopted in the 1980s and 1990s had already been in place before 1980. The research also indicates that if monetary and fiscal policy interacted today as it had done in the 1970s, then a long-run relationship between the variables would come to light.

All in all, the empirical findings for the USA show how important the interaction between monetary and fiscal policy is for the long-run relationship between inflation and public deficits. It can generally be concluded that stable and sustainable public finances are a key factor underpinning a stability-oriented monetary policy. The latter is frequently pressurised to put its stability objective aside whenever there is a growing belief that the sustainability of public finances is coming under threat. This might trigger an undesired upturn in inflation expectations, hampering monetary policy-making further still. Given that neither high inflation as a means of safeguarding sovereign solvency nor a sovereign default are a desirable macroeconomic outcome, a sustainable fiscal policy which is geared to ensuring robust public finances is a crucial prerequisite for keeping the economy on a steady growth path.

Conclusions

Anchoring of inflation expectations requires a sound fiscal policy in the long run

The global economic crisis of the past few years has presented considerable challenges for monetary policy. A great number of years have passed since the global economy was faced with a crisis on a similar scale, which makes it difficult to apply the lessons learnt back then to the situation today. However, it has become evident that the shock which was initially triggered by problems in isolated markets and which later spilt over to the financial system, together with a number of other weaknesses that came to light as a result, placed a considerable strain on the real economy. The crisis also made it more difficult for central banks to fulfil their function as the relationships between inflation and certain benchmarks, such as the output gap and the natural rate of unemployment, have changed or have become even more uncertain. Communication with the general public also became more complicated as a result. This was compounded by the fact that central banks implemented a number of new instruments in some cases as the traditional interest rate policy reached its limits. The effectiveness of these new instruments remains largely untested, however. Against this backdrop, it is remarkable that the rates of price change did not deviate more seriously from their target rates. There is much to suggest that the central banks have gained enough credibility in the past as a result of their stability-oriented policies and were therefore successful in anchoring the inflation expectations, which also helped them to contain the deviations of the actual inflation rates from the target rate within reasonable limits. This credibility is due, not least, to the successes achieved in ensuring price stability and an institutional framework which has enabled central banks to pursue their stability policies in an unrestricted manner. Looking ahead, it will remain crucial for central banks to maintain this credibility.