



# Inflation, deflation, and uncertainty: What drives euro-area option-implied inflation expectations, and are they still anchored in the sovereign debt crisis? ☆



Michael Scharnagl<sup>\*</sup>, Jelena Stapf

Deutsche Bundesbank, Wilhelm-Epstein-Str. 11, D-60431 Frankfurt, Germany

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## ABSTRACT

We tackle two questions in this paper: In the sovereign debt crisis, what moves the euro-area inflation outlook, and has the firm anchoring of medium to long-term inflation expectations been affected? We try to answer these questions by looking at option-implied probability density functions of future inflation. Deriving densities from a new data set on options on the euro-area harmonised index of consumer prices (excluding tobacco) provides us with the full distribution of inflation expectations, including uncertainty and asymmetry of market participants' beliefs about the inflation outlook. The daily data set allows us to analyse the effects of monetary policy announcements and macro news in a time-varying event study framework despite the short sample period from 2009 to 2013. Due to renewed fears of deflation, we compare option-implied and statistical density functions to gain insight into deflation risk. Inflation expectations show a decreasing mean but growing uncertainty, especially since the intensification of the sovereign debt crisis in mid-2011. Around the same time, the influence of monetary policy announcements on inflation expectations across all horizons diminished. Tail events such as deflation, although still contained, have become more probable. The impact of macroeconomic news on inflation probabilities has overall decreased and shifted towards countries more affected by the crisis. This paper's results regarding the anchoring of inflation expectations are twofold: The mean and low sensitivity to actual news speak for anchored inflation expectations, whereas the growing uncertainty reveals market participants' concerns about possible extreme inflation or deflation outcomes in the future.

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## 1. Introduction

Inflation expectations are important for gauging the effectiveness and credibility of monetary policy. The anchoring of inflation expectations includes not only the containment of the mean or level of expectations but also low uncertainty about future realisations of inflation rates, and only marginal reactions of long-term inflation expectations to news. The rationale for the first anchoring definition, i.e. to contain inflation expectations within a certain range, is straightforward. Secondly, a high variation of inflation expectations covers the risk of sudden expectation swings towards extreme outcomes. Then, if long-term inflation expectations are way above target, people will have an inherent distrust in the central bank's ability to keep overall inflation in control

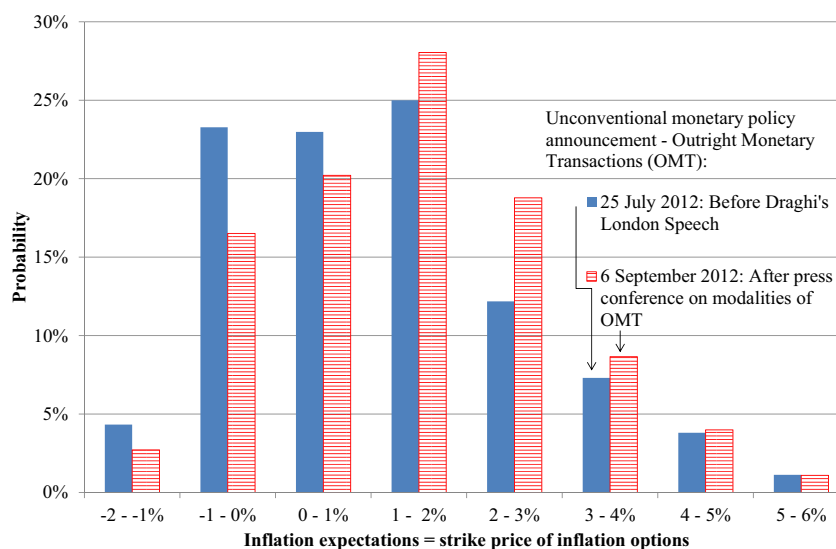
and will eventually try to link their long-run income streams to actual inflation rates to circumvent real income depressions. Ultimately this could end in an inflation spiral with negative effects on the allocation of capital and goods and on overall growth. The same could apply to deflationary outcomes. Thirdly, a muted reaction of long-term inflation expectations to macroeconomic news can be seen as an indicator of a firm belief among market participants in the central bank's ability to effectively maintain price stability in the long run.

We will cover especially the latter two aspects of anchoring, uncertainty and reaction to news by first deriving risk-neutral implied probability density functions from a new data set on options on euro-area inflation rates. Full distributions allow us to observe different zones of inflation expectations, i.e. inflation, deflation, extreme inflation and extreme deflation. In addition, we can look at variance and skewness as measures of uncertainty and asymmetry of market participants' expectations about future realisations of inflation rates. Fig. 1 shows the histogram of the option-implied probability distribution of expected inflation rates over the next five years for a range of strike prices at two certain points in time. The probability that market participants attach to a certain future inflation rate span, e.g. from 0 to 1%, determines the height of the corresponding bar. Any change in a bar signals a change in the distribution function

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\* Corresponding author.

E-mail addresses: [michael.scharnagl@bundesbank.de](mailto:michael.scharnagl@bundesbank.de) (M. Scharnagl), [jelena.stapf@bundesbank.de](mailto:jelena.stapf@bundesbank.de) (J. Stapf).



**Fig. 1.** Histogram of probability distribution. Reaction of option-implied probability distribution of expected inflation rates for the five-year horizon to an unconventional monetary policy announcement.

of inflation expectations as well. For example, the announcement of possible unlimited albeit conditional sovereign bond purchases of debt-troubled euro-area countries in concordance with the definition of the modalities of the purchase programme has increased the mean but, more importantly shifted the skewness of inflation expectations to the right in the summer of 2012. Furthermore we will analyse reactions of inflation expectations to macroeconomic and monetary policy news during the last five years and the change in reactions since the intensification of the sovereign debt crisis in a time-varying event study framework. Due to the possibly devastating outcome in terms of economic growth, our special focus will be on deflation risk.

Overall the mean of inflation expectations as measured by inflation options decreased over the last five years for all time horizons (see Fig. 2). However, uncertainty about the future realisation of inflation rates soared among market participants, especially since the intensification of the sovereign debt crisis in mid-2011. Around the same time, the influence of monetary policy announcements measured as high-frequency changes in long-term interest rates diminished. We reconcile both developments with a surge in disagreement over the influence of monetary policy on future inflation outcomes, especially extreme outcomes such as deflation or high inflation rates. The probability of deflation also increased in 2011, albeit from a low level. Measures of heterogeneity within the euro area, such as differences in bond yields or inflation rates among euro-area member states, are identified as drivers of deflationary outcomes. With respect to macroeconomic news on inflation expectations, the influence of surprises about countries more in the focus of the sovereign debt crisis, such as Italy, increased.

The remainder of the paper is organised as follows. The next section describes the data used and gives information on the inflation option market. The influence of macro news and monetary policy announcements on different inflation expectation zones, i.e. inflation, deflation, extreme inflation and extreme deflation, is explored in Section 3. We then analyse the anchoring of inflation expectations with respect to uncertainty of the inflation outlook and with respect to time-varying effects of inflation on news in concordance with the intensification of the sovereign debt crisis. Deflation probabilities, adjustments for overestimating tail risk due to the risk neutrality assumption, and drivers of deflation risk are subsumed in Section 5. Section 6 features robustness checks, and Section 7 concludes.

## 2. Inflation options, monetary policy announcements, and macro news

Many monetary authorities routinely use information that is embedded in financial asset prices in order to formulate and implement better monetary policy. Especially derivative markets provide a rich source of information for gauging market sentiment. Due to their forward-looking nature, forwards and option prices mirror market perceptions about underlying asset prices in the future. Information encapsulated in forwards can be derived from cash market instruments, and option prices do reveal genuinely new information about underlying price processes.

Yields on inflation-indexed bonds cover – by subtracting them from nominal yields of bonds of comparable quality and maturity – a broad measure of inflation compensation. Secondly, the fixed leg of inflation swaps gives an assessment of the level of inflation expectations of market participants as well. See e.g. Schulz and Stapf (2014) for a detailed description of both markets and their interrelationship. However, neither measure is able to show the level of uncertainty since distribution functions of expected inflation rates cannot be recovered from this type of instrument. Some surveys show the dispersion among individual respondents. The Survey of Professional Forecasters (SPF) conducted by the ECB shows, in addition, the distribution of probabilities of different future inflation rates and can therefore be used to replicate aggregate uncertainty measures (Bowles et al. (2007)). However, their low frequency – quarterly for the SPF – makes it difficult to analyse the influence of news on a timely basis.

We use European call and put options on the euro-area harmonised index of consumer prices ex tobacco (HICPxT), derive implied densities, and look at the distribution of inflation expectations on a daily basis. The HICP covers a broad range of final consumer expenditure for all types of households. It therefore seeks to provide a timely and relevant picture of inflation. It is calculated as a Laspeyres-type price index and measures the prices of a fixed expenditure pattern. Excluding tobacco as an administered price, the HICPxT dates back to the first issue of an inflation-linked government bond of a euro-area country, in France in 1998. It has become the standard reference index for all inflation-linked market instruments in the euro area. We explore how market participants believe inflation rates could evolve over time by using options with different time horizons. Having an interest in gauging the influence of economic developments and monetary policy

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