Unanticipated and Backward-Looking: Deflations and the Behavior of Inflation Expectations*

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We analyze the behavior of inflation expectations during periods of deflation using a large cross-country data set of professional forecasters' expectations. We find that deflation episodes are largely unanticipated by forecasters and feature much larger forecast errors than periods of high inflation rates. Furthermore, inflation expectations become more backward-looking during deflations, especially among forecasters that are pessimistic about growth. The results have implications for a risk-management approach to monetary policy when an economy faces very low inflation.

JEL Codes: E31, E58.

1. Introduction

The widespread shift to an unusually low inflation environment after the Great Financial Crisis (GFC) of 2008–09, and Japan's earlier experience, brought policymakers' concerns about deflation back to the fore. A downward drift in inflation expectations and deflation

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risks were an important rationale for the introduction of unconventional monetary policy in the euro area (e.g., Draghi 2015). And as central banks globally were again easing policy over the course of 2019, observers were making reference to deflation risks as one factor (e.g., Summers 2019). Earlier, avoiding deflation was a significant driver behind the accommodative U.S. monetary policy stance of the early 2000s, in line with a "robust optimal" approach to monetary policy to avoid very bad outcomes (e.g., Giannoni 2007).

Perhaps surprisingly, given concerns about deflation, empirical research has so far not focused on the behavior of inflation expectations during periods of falling prices.[1] Yet, expectations matter for wage and price setting and therefore for any second-round effects from falling prices. The behavior of expectations is thus likely to affect both the depth and duration of deflation (see, e.g., Fuhrer 2017, Nishizaki, Sekine, and Ueno 2014, and Williams 2009). Benhabib, Schmitt-Grohe, and Uribe (2002) show how non-fundamental revisions to expectations can contribute to the occurrence of liquidity traps. Some policy proposals for escaping a liquidity trap aim to generate expectations of higher inflation so that the real ex ante interest rate falls (e.g., Krugman 1998; Svensson 2001). Relatedly, Mertens and Williams (2018) argue that inflation expectations can become anchored at a level below the central bank's inflation target if the economy is expected to spend a significant amount of time at the zero lower bound.

In this paper, we analyze the behavior of inflation expectations during deflations. To this aim, we use surveys of professional forecasters from Consensus Economics from 1990 onwards for 42 advanced and emerging market economies. The global nature of the data set is highly relevant, as deflations have not been limited to advanced economies—30 of the 47 deflationary episodes identified in our data set occur in emerging market economies (EMEs), mostly in Asia and Central and Eastern Europe.

We first document that deflation episodes are largely unanticipated by forecasters, even at short forecasting horizons. Considering all one-year-ahead inflation forecasts made before a deflation episode yields a large median overprediction of close to 2 percentage points.

[1] Our companion paper, Banerjee and Mehrotra (2021), which focuses on inflation forecast disagreement, is an exception.

This contrasts with a median forecast error—an underprediction—of around 0.6 percentage point prior to episodes of high inflation, and close-to-zero forecast errors during times of moderate positive inflation rates. Thus, our results concur with the evidence in Ahearne et al. (2002) regarding the unanticipated nature of Japan's deflation in the 1990s, but apply for a much larger set of economies and time periods.

We then formally examine the effect of deflations on inflation expectations, using data for a large panel of forecasters. We start by examining the degree of backward-lookingness of one-year-ahead inflation expectations during deflations. This short forecast horizon is related to the frequency with which most prices and wages are adjusted and may therefore provide a timely measure of the risk that expectations could become unmoored. Our panel regressions, based on a similar specification as in Ehrmann (2015), suggest that deflations lead to increased backward-lookingness of expectations, compared with other time periods. The dependence of inflation expectations on past inflation outcomes rises by close to 50 percent during deflations compared with other periods. Notably, while estimations that do not control for deflations suggest that periods of low positive inflation rates—those with inflation rates below 1 percent—also appear to be associated with greater backward-lookingness, this finding is not robust to controlling for deflation episodes explicitly in the estimation. Thus, our results suggest that it becomes significantly more difficult to get inflation back to target when an economy is already experiencing deflation. We also show that an alternative methodology yields results that are highly similar in nature: impulse responses from local projections indicate that short-term inflation expectations become more sensitive to actual inflation in a deflationary environment.

Next, we analyze the behavior of expectations during deflations using five-year-ahead forecasts. We apply these longer-term measures of expectations to examine the anchoring of inflation expectations in two ways. First, using the same approach as for short-term expectations, we analyze whether deflations render the five-year-ahead inflation expectations backward-looking. Second, applying regressions similar to Buono and Formai (2018) and Lyziak and Paloviita (2017), we analyze whether long-term measures of inflation expectations become more sensitive to changes in short-term expectations. Notably, both tests suggest that inflation expectations become unanchored during periods when prices are falling. This stands in stark contrast to periods of high inflation, as well as to those of low positive inflation (below 1 percent), for which we do not find evidence of unanchoring.

Our results also highlight significant heterogeneity in the expectations behavior across individual forecasters during deflations. Using forecaster-level data on short-term inflation expectations, we show that significant backward-lookingness in inflation expectations during deflations obtains especially in the sample of forecasters who are pessimistic about the short-term growth prospects of the economy. By contrast, there is less backward-lookingness in expectations for the sample of more optimistic forecasters. Moreover, during periods of moderately positive inflation rates, we find the degree of backward-lookingness to be highly similar between optimistic and pessimistic forecasters.

Our results—in particular, the changing behavior of expectations once the economy hits deflation—have implications for a risk management approach of monetary policy (see, e.g., Greenspan 2004). As it becomes increasingly difficult to return inflation to target once prices are falling, it may be prudent to preemptively react to deflation risks. In addition, optimal policy under adaptive expectations implies a stronger policy response than under rational expectations (e.g., Gaspar, Smets, and Vestin 2006).

Our paper is related to different strands of literature. It adds to the vast and expanding literature that uses surveys to analyze the behavior of inflation expectations (see, e.g., Faust and Wright 2013, Kozicki and Tinsley 2012, Mehrotra and Yetman 2018, and the references therein). Similar to our paper, various studies have analyzed the relationship between surveys of inflation expectations and inflation outcomes to examine the anchoring of expectations (e.g., Ehrmann 2015, Levin, Natalucci, and Piger 2004, Lyziak and Paloviita 2017). However, to our knowledge, no empirical study has previously focused explicitly on the behavior of inflation expectations during deflations in a large sample of countries. While the empirical approach in our paper is similar to Ehrmann (2015), we make additional contributions by highlighting the role of heterogeneity across forecasters in explaining increased backward-lookingness of forecasters; analyze the behavior of both short-term and longer-term (five-year-ahead) forecasts; and focus the analysis on deflation periods which have so far been under-researched in the literature.

The paper also contributes to empirical research on the behavior of inflation expectations during the post-GFC period. Coibion and Gorodnichenko (2015) suggest that rising inflation expectations can account for the missing disinflation during the Great Recession. Ehrmann (2015) analyzes the anchoring of expectations when inflation is below the central bank's target, while International Monetary Fund (IMF) (2016) evaluates changes in anchoring both over time and conditional on monetary policy. The Bank of Japan (2016) evaluates the behavior of various measures of inflation expectations after the introduction of quantitative and qualitative monetary easing (QQE) in April 2013. Natoli and Sigalotti (2018) propose novel techniques based on the distribution of financial market data to examine the anchoring of inflation expectations during the post-GFC period. And Kenny and Dovern (2017) use data from surveys of professional forecasters to analyze how the distribution of long-run inflation expectations has changed in the euro area after the GFC.

The paper also relates to studies on the macroeconomic record of deflations. While the experience from the Great Depression suggests that deflations have highly adverse implications for economic activity, the more benign deflations during the latter part of the 19th century provide less evidence of negative feedback loops between deflation and output (see Bordo and Filardo 2005 and Borio et al. 2015). On the other hand, Eichengreen, Park, and Shin (2017), using producer price inflation, find stronger evidence of damaging effects of deflation on growth. Burdekin and Siklos (2010) and Smith (2006) provide overviews of the empirical evidence relating to deflation, and Fisher (1933) introduces the phenomenon of debt deflation.

Finally, the paper relates to empirical studies that consider the importance of inflation dynamics in the risk-management approach for monetary policy. Kilian and Manganelli (2008) provide evidence that the Federal Reserve under Greenspan's chairmanship was responding to changes in the balance of risks in inflation and output growth, rather than changes in the conditional means of these variables. Similarly, Gnabo and Moccero (2015) find that risks to the inflation outlook were an important consideration for U.S. monetary policy in the Greenspan era, while Andrade, Ghysels, and Idier (2015) document that the Fed's policy rate is affected by right-tail inflation risks, measured from distributions of survey expectations.

This paper is structured as follows. The next section describes the data and discusses the identification of deflation episodes in our sample. Section 3 presents stylized facts about the behavior of expectations around deflations. This is followed in Section 4 by a formal investigation of how deflation affects both short- and longer-term inflation expectations. Section 5 analyzes possible reasons behind the forecast behavior and Section 6 discusses policy implications. Finally, concluding comments are provided in Section 7.

2. Data and Identification of Deflationary Episodes

We use surveys of professional forecasters from Consensus Economics. These data are available for a relatively long history and are collected in a comparable fashion across a large number of countries, both advanced and emerging. Having a global data set is essential for the analysis, given the large number of deflation episodes in emerging market economies. Regarding the favorable forecasting performance of subjective expectations, Faust and Wright (2013) find that survey measures of inflation expectations tend to improve the forecasts that come from a large number of different forecasting models.

At the same time, we acknowledge the limitation of using surveys of professional forecasters, as the expectations of firms and households—the price and wage setters—would arguably be more economically relevant. Moreover, the inflation expectations behavior of firms and households has been shown to deviate systematically from that of professional forecasters (see, e.g., Coibion et al. 2020). However, while there are recent studies examining firms' and households' expectations behavior in individual economies (e.g., Coibion, Gorodnichenko, and Kumar 2018; D'Acunto et al. 2021), comparable data are not available for a large number of economies, in particular EMEs.

Each month, Consensus Economics polls a panel of experts from public and private economic institutions, mostly investment banks and research institutions, about their predictions for the main macroeconomic variables for the current and next calendar year.

Given that the fixed-event nature of the forecasts—expectations of inflation during a calendar year—implies a changing forecast horizon between different months, we transform the fixed-event forecasts to one-year-ahead forecasts by computing a weighted average of current and next-year forecasts. This approach has been widely used in the literature (see, e.g., Dovern, Fritsche, and Slacalek 2012; Siklos 2013). With h as the forecast horizon, the 12-month-ahead forecast is computed as

$$\hat{\pi}_{t+12|t} = \frac{h}{12}\hat{\pi}_{t+h|t} + \frac{12-h}{12}\hat{\pi}_{t+12+h|t}, \tag{1}$$

where $\frac{h}{12}$ and $\frac{12-h}{12}$ denote the weights, i.e., the shares of current and next-year forecasts in the forecast period.

For some countries in the sample, longer-term survey forecasts are also available. The longer-term surveys are conducted and published twice a year. The data are not available at the forecaster level, as only the mean forecasts are published. We use these forecasts in parts of the analysis.

Our data cover 42 economies, 12 advanced and 30 emerging. The length of the data set depends on the availability of inflation forecast data. For advanced economies, the data start earliest in 1990, yielding a maximum of 319 monthly observations per country (see Table A.1 in the appendix for details). For emerging markets, the starting dates vary by region. For most countries in emerging Asia, the data start in late 1994; for Latin America in 2001; and for Central and Eastern Europe in 2007. The number of forecasters varies both across countries and within the same country across time. The average number of forecasters in the country-specific samples varies from 8 in Lithuania to 30 in the United Kingdom; in the full sample, the average number of forecasters per country is 15.

Our inflation data are for headline consumer price inflation (CPI, year on year).[2] While developments in core inflation would also be interesting, expectations data are not widely available for this measure. Moreover, for some EMEs where volatile components such as food comprise a large share of the consumption basket, developments

[2] A partial exception is the United Kingdom, where inflation refers to retail price (RPIX) inflation until 2004 and CPI inflation thereafter.

in core inflation may be less relevant than those in headline inflation (eg., Anand, Prasad, and Zhang 2015).

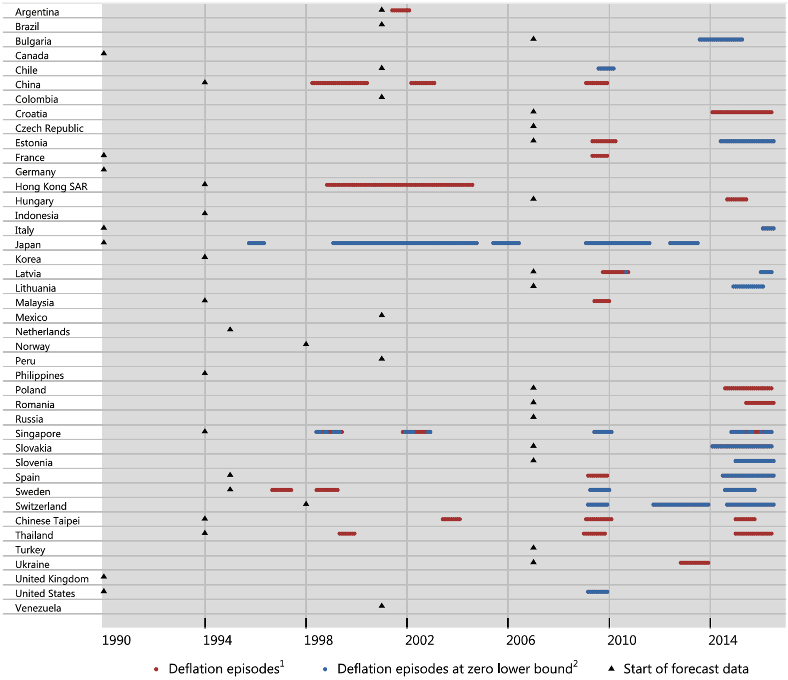
We focus on deflation episodes characterized by negative headline inflation rates (year on year) for at least six consecutive months. Furthermore, a country is regarded as exiting the deflation episode only in the third consecutive month of positive inflation rates that follow deflation. This classification ensures that very short bouts of negative inflation rates do not count as individual deflation episodes. Moreover, it avoids longer deflation periods being classified as several shorter ones, if they are interrupted only by one or two months of positive inflation rates.

The 47 deflation episodes identified in our sample are shown in Figure 1. Three periods with greater occurrence of deflations stand out. First, various Asian economies experienced deflation around the time of the Asian financial crisis: Hong Kong SAR, mainland China, Chinese Taipei, Singapore, and Thailand. Japan also experienced a long spell of deflation as its domestic banking crisis occurred. The second, more global, bout of deflations took place during the GFC. The third relatively widespread period of falling prices occurred in 2014–15, affecting many European countries but also some emerging economies in Asia. Over time, deflations were increasingly associated with near-zero interest rates (blue lines in Figure 1).

Overall, the deflation periods are relatively widely dispersed across countries, as in 16 countries deflation episodes occurred only once. Seventeen deflation episodes took place in advanced economies and 30 in emerging markets, while 11 occurred in countries that were part (or later became part) of the euro area. Hong Kong SAR experienced the lowest inflation outcome within a single deflation episode in the sample (−6.1 percent). On average the minimum inflation outcome across all the different deflation episodes was −1.7 percent. Table A.2 in the appendix shows details of the identified deflations, including their length and the minimum inflation outcomes and levels of expectations during these time periods.

In order to compare the behavior of expectations during deflations with other inflation environments, we construct two other dummy variables. First, we consider periods of high inflation, defining an economy to have high inflation if the headline inflation rate is above 4 percent for at least six consecutive months. Furthermore,

Figure 1. Deflation Episodes



Note: [1]Negative headline consumer price inflation (CPI, year on year) for at least six consecutive months. A deflation episode ends if subsequently at least three consecutive months of positive inflation rates occur. [2]Deflation episodes occurring when policy rates are at or below 0.5 percent. If policy rate data are not available, money market interest rate data are used.

the country only exits a high-inflation episode in the third consecutive month of inflation rates below 4 percent. The high-inflation episodes using this definition are documented in Figure A.1 in the appendix. For many EMEs—in particular, in Latin America but also in other emerging economy regions—such periods cover large parts of the sample.

Moreover, in order to examine whether there are differences between low (mostly positive) inflation and deflation, we use a 1 percent inflation threshold to similarly classify episodes of low inflation. Finally, we omit as outliers all observations with inflation rates exceeding 10 percent and/or policy rates above 100 percent.

3. Descriptive Evidence of Expectations around Deflations

We find that deflations are largely unanticipated by professional forecasters. The first row of Table 1 shows median forecast errors associated with different inflation environments. It considers all forecasts (median expectation across forecasters for country c) made one year before a particular inflation environment prevailed. Thus, for deflations, the forecasts may have been made one year before a deflation episode started or, in the case of longer deflations, the economy may already have been experiencing deflation when the forecast was made. The median forecast error associated with deflations, defined as realization less forecast, is close to 2 percentage points (−1.9 percent; an overprediction). This stands in contrast with high inflations (threshold of 4 percent; see Section 2) where the median forecast error is only 0.6 percentage point (an underprediction). For low inflations which, with the threshold of 1 percent, are a superset of the deflation episodes, the forecast error is −1.3 percentage points. Thus, forecasters seem to be able to better anticipate future inflation trends during periods of higher inflation. For all other periods, which correspond to moderate positive inflation rates, the forecast error is close to zero.

Table 1 also documents forecast errors by types of deflation. To do this, we divide the deflations into those that last longer than the sample average; those that are deeper than sample average; and those where prices fall at a faster rate than sample average (where speed is defined as deepness of deflation divided by its duration). Forecast errors are particularly large for deflations that saw greater price declines (median of −3.1 percentage points; second row of Table 1) and those that featured faster price declines (−4.2 percentage points). By contrast, longer deflations tend to have lower forecast errors, possibly because forecasters have more time to adjust their expectations downwards (see also row 3 of Table 1).

We then consider similar evidence for longer-term, five-year-ahead, expectations. These surveys, conducted and published twice a year, are available during 28 of the 47 deflations identified in Figure 1 (see also Table A.2). Not surprisingly, deflations are completely unanticipated by this measure, with a median overprediction of 2.5 percentage points for forecasts made five years prior to all months

Table 1. Short-Term Forecasts for Inflation and Growth before and during Different Inflation Environments

	One-Year-Ahead Inflation Forecast Errors Prior to Different Inflation Environments			
	High Inflation	**Low Inflation**	**Deflation**	**Other**
Median Forecast Error, % Pts.	0.628 [0.518, 0.726]	–1.318 [–1.381, –1.254]	–1.916 [–2.059, –1.795]	–0.113 [–0.150, –0.084]
Obs.	1,642	1,868	792	4,108
	One-Year-Ahead Inflation Forecast Errors Prior to Different Types of Deflations			
	Longer Deflations	**Deflations with Greater Price Declines**	**Deflations with Faster Price Declines**	
Median Forecast Error, % Pts.	–1.567 [–1.699, –1.440]	–3.130 [–3.371, –2.738]	–4.150 [–4.429, –3.855]	
Obs.	457	303	165	
	One-Year-Ahead Inflation Forecasts Made during Different Environments			
	High Inflation	**Low Inflation**	**Deflation**	**Other**
Median Forecast, %	5.100 [5.000, 5.225]	0.917 [0.894, 0.953]	0.480 [0.418, 0.515]	2.400 [2.367, 2.424]
Obs.	1,848	1,898	800	4,317

(*continued*)

Table 1. (Continued)

	One-Year-Ahead Inflation Forecasts Made during Different Types of Deflations			
	Longer Deflations	**Deflations with Greater Price Declines**	**Deflations with Faster Price Declines**	
Median Forecast, %	0.331 [0.250, 0.434]	0.368 [0.286, 0.500]	0.661 [0.569, 0.780]	
Obs.	457	311	173	
	One-Year-Ahead GDP Growth Forecasts Made during Different Environments			
	High Inflation	**Low Inflation**	**Deflation**	**Other**
Median Forecast, %	4.417 [4.267, 4.543]	1.838 [1.780, 1.900]	1.385 [1.257, 1.493]	2.808 [2.775, 2.850]
Obs.	1,847	1,898	800	4,317

Note: 90 percent confidence intervals are in brackets. Forecast error is defined as realization minus forecast. Forecasts are computed as the median expectation across forecasters at each point in time, for country *c*. The table shows the forecasts and forecast errors as medians over the months associated with the different inflation environments.

an economy spends in deflation (first row of Table 2). Again, deflations with faster price declines feature the highest absolute forecast errors, with overpredictions of 3 percentage points (second row of Table 2).

The difficulty in anticipating deflations remains if we consider short-term forecasts at the tails of the forecast distribution. Even for the "pessimistic" forecasts, i.e., those at the 10th percentile of the forecast distribution, the median one-year-ahead forecast error associated with deflations amounts to −1.5 percentage points. For the "optimistic" forecasts, i.e., those at the 90th percentile, these short-term forecasts are off the mark by −2.4 percentage points.

Consistent with evidence of the unanticipated nature of deflations, only 3 percent of the median one-year-ahead forecasts in the data set are negative. This compares with a higher share of negative inflation outcomes in the sample, at 11 percent. However, in cases where the one-year-ahead forecasts do fall into negative territory, expectations of future GDP growth also adjust downwards—the median one-year-ahead GDP growth forecast is at 0.9 percent when forecasters expect negative inflation rates, compared with a median forecast of 2.9 percent during other periods. This suggests that professional forecasters associate deflations with adverse growth outcomes.

Once deflation actually hits, professional forecasters adjust their short-term expectations downwards. The median one-year-ahead inflation forecast formed during months when an economy is already experiencing deflation amounts to 0.5 percent (third row of Table 1). This contrasts with median forecasts of 0.9 percent made during low-inflation episodes, 5.1 percent during high-inflation episodes, and 2.4 percent during all other times. Inflation expectations are lower for longer deflations, as well as those that feature greater price declines (0.3–0.4 percent; fourth row).

The downward adjustment in inflation forecasts is also reflected in GDP growth forecasts. The median one-year-ahead GDP growth forecast during deflations amounts to 1.4 percent, compared with 1.8 percent during low-inflation episodes, 4.4 percent during high-inflation episodes, and 2.8 percent during all other times (see fifth row of Table 1).

In addition to short-term expectations, the five-year-ahead expectations also adjust downward when the price level is declining.

Table 2. Five-Year-Ahead Forecasts for Inflation before and during Different Inflation Environments

	Five-Year-Ahead Inflation Forecast Errors Prior to Different Inflation Environments			
	High Inflation	**Low Inflation**	**Deflation**	**Other**
Median Forecast Error, % Pts.	1.665 [1.427, 2.080]	−1.855 [−1.957, −1.735]	−2.516 [−2.697, −2.300]	−0.090 [−0.209, −0.007]
Obs.	153	149	53	334
	Five-Year-Ahead Inflation Forecast Errors Prior to Different Deflation Environments			
	Longer Deflations	**Deflations with Greater Price Declines**	**Deflations with Faster Price Declines**	
Median Forecast Error, % Pts.	−2.574 [−2.889, −2.294]	−2.690 [−3.691, −2.293]	−3.049 [−3.759, −2.683]	
Obs.	29	14	13	

(*continued*)

Table 2. (Continued)

	Five-Year-Ahead Inflation Forecasts Made during Different Environments			
	High Inflation	**Low Inflation**	**Deflation**	**Other**
Median Forecast, %	3.9 [3.6, 4.2]	1.9 [1.9, 2]	1.85 [1.7, 2.1]	2.3 [2.3, 2.4]
Obs.	192	204	76	489
	Five-Year-Ahead Inflation Forecasts Made during Different Deflation Environments			
	Longer Deflations	**Deflations with Greater Price Declines**	**Deflations with Faster Price Declines**	
Median Forecast, %	1.7 [1.332, 1.868]	2.3 [1.7, 3]	2.6 [2.2, 2.844]	
Obs.	47	25	15	

Note: 90 percent confidence intervals are in brackets. Forecast error is defined as realization minus forecast. Forecasts are the mean expectation across forecasters (as reported by Consensus) at each point in time, for country *c*. The table shows the forecasts and forecast errors as medians over the months associated with the different inflation environments.

The long-term expectations move down by close to 0.5 percentage point during deflations, compared with periods of moderate positive inflation (Table 2, third row). This downward movement is notable, given the well-documented inertia in long-run survey measures of inflation.[3] Yet, the five-year-forecasts in our sample never reach negative territory, and they only dip below 1 percent during 1.3 percent of the observations in our sample—all corresponding to Japan's deflation and occurring at various dates between 2001 and 2012.

Notably, the short-term inflation and GDP growth forecasts become significantly more volatile once the economy is in deflation: the standard deviation (normalized by the mean) of the one-year-ahead median inflation forecast is 3.8 during deflations, compared with 0.8 during all periods. For GDP growth, the corresponding figures are 1.3 and 0.7, respectively. The increase in volatility potentially reflects greater uncertainty about future macroeconomic conditions during deflations.

4. Estimation Results

Beyond the previous informal evidence, do we observe changes in the behavior of survey forecasts when an economy is experiencing deflation? In what follows, we formally analyze the degree to which expectations depend on past inflation and compare it across different inflation environments. A similar approach to evaluate backward-lookingness has been used in various studies; see, e.g., Blanchard (2016), Ehrmann (2015), Levin, Natalucci, and Piger (2004), and Lyziak and Paloviita (2017).

4.1 Short-Term Forecasts during Deflations

We commence with one-year-ahead inflation expectations. While these are short term in nature and likely affected by current transitory shocks affecting the economy, they could provide timely measures of potential changes in the degree of anchoring. Changes

[3]For example, in the case of Canada, the five-year-ahead forecast for inflation remained unchanged at 2.0 from October 2005 to October 2008, and then again from October 2009 to October 2012.

in short-term inflation expectations may well spill over to those at longer horizons, as Buono and Formai (2018) and Lyziak and Paloviita (2017) document for the euro area, potentially affecting the credibility of monetary policy. Moreover, for the setting of monetary policy, the most relevant horizon is arguably related to the frequency with which most prices and wages are adjusted, and hence has an important impact on inflation dynamics. Indeed, Fuhrer (2017) finds that short-term expectations play a quantitatively important role for actual inflation outcomes in estimated Phillips curves for Japan and the United States.

We consider a panel fixed effects regression of the type

$$E_{i,t}\left(\pi_{c,t+12}\right) = \alpha_i + \beta_1 \pi_{c,t-1} + \beta_2 D^{infl}_{c,t-1} + \beta_3 D^{infl}_{c,t-1} \pi_{c,t-1} + \varepsilon_{i,t}, \tag{2}$$

where $E_{i,t}\left(\pi_{c,t+12}\right)$ denotes the one-year-ahead inflation expectation by forecaster i for country c, formed in period t. $\pi_{c,t-1}$ is lagged inflation. $D^{infl}_{c,t-1}$ is a dummy variable capturing a particular inflation environment; we define individual dummy variables for episodes of deflation, low inflation, or high inflation (see Section 2). These dummy variables are interacted with lagged inflation to infer whether there is evidence of increased backward-lookingness during the different inflation environments, compared with other periods.[4] α_i denote forecaster fixed effects. All data sources are given in Table A.3 in the appendix.

The dummy variables and actual inflation interacted with them are lagged so as to match the timing of the information set based on which expectations are formed. Forecasters will generally have access to some information about the previous month's inflation outcome (and whether the economy was in deflation/high inflation) at the time they submit the expectations to Consensus Economics but not for the current month. As an example, consider Germany, where forecasters would receive information about the January 2021 CPI inflation outcome in the flash inflation release by Destatis on January 28, 2021. They would then submit their inflation expectations for

[4]Such analysis is related to research that examines potential non-linearities in the Phillips curve; see, e.g., Doser et al. (2017).

Table 3. One-Year-Ahead Inflation Expectations and Deflation

Variable	(1)	(2)	(3)	(4)
$\pi_{c,t-1}$	0.525***	0.496***	0.478***	0.479***
	(0.00939)	(0.0102)	(0.0142)	(0.0138)
$D^{defl}_{c,t-1}$		0.0458		0.0395
		(0.107)		(0.110)
$D^{High\ Infl}_{c,t-1}$		–0.0403	–0.0938	–0.101
		(0.0758)	(0.0801)	(0.0803)
$D^{defl}_{c,t-1}\pi_{c,t-1}$		0.239**		0.372***
		(0.101)		(0.0949)
$D^{High\ Infl}_{c,t-1}\pi_{c,t-1}$		0.0198	0.0374*	0.0375*
		(0.0170)	(0.0192)	(0.0194)
$D^{Low\ Infl}_{c,t-1}$			–0.165***	–0.0698**
			(0.0308)	(0.0296)
$D^{Low\ Infl}_{c,t-1}\pi_{c,t-1}$			0.107***	–0.119***
			(0.0404)	(0.0201)
Obs.	124,252	124,252	124,252	124,252
R-squared	0.766	0.767	0.767	0.767

Note: Dependent variable is the expectation by an individual forecaster for one-year-ahead inflation. Robust standard errors clustered by forecaster in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent level, respectively. All models include forecaster fixed effects.

the current and next calendar year to the February Consensus Economics publication on the survey date of February 8, 2021, which is before the February flash release.

Equation (2) is estimated by ordinary least squares using forecaster-level data, yielding over 124,000 observations for the full sample. We use heteroskedasticity-consistent standard errors clustered by forecaster, allowing the residuals to be correlated within the same forecaster over time.

The estimates in Table 3 show that deflations render inflation expectations more backward-looking. Column 1 indicates that one-year-ahead inflation expectations are generally backward-looking in our sample—the coefficient on the lagged inflation term is 0.525 with a standard error of 0.009. This is consistent with the short-term nature of the one-year-ahead expectations. Column 2 adds dummy variables for deflation and high-inflation periods, together with interaction terms of lagged inflation with deflation and high-inflation dummy variables, respectively. The estimates in column 2 suggest that deflations are associated with more backward-looking inflation expectations, as shown by an economically and statistically significant coefficient estimate on the interaction term between deflation and lagged inflation. The sum of the backward-looking terms amounts to $0.496 + 0.239 = 0.735$—this implies that the dependence of expectations on past inflation increases by around 50 percent during deflations, compared with normal periods. By contrast, a similar increase in backward-lookingness is not observed for high-inflation periods.

We also analyze whether longer, deeper, or faster deflations (see Section 3) have different implications for inflation expectations. To do this, we include the same interaction variable between lagged inflation and the deflation dummy as in the baseline model, together with an additional interaction variable between lagged inflation and a deflation dummy for longer/deeper/faster deflations, respectively. Table A.4 in the appendix shows that the additional interaction variables for faster and deeper deflations enter with positive and statistically significant coefficients, suggesting that such deflations feature greater backward-lookingness. However, the additional interaction variable for longer deflations enters with a negative and statistically significant coefficient. This could arise, as forecasters have time to re-adjust their expectations during longer deflations. Indeed, Table 1 showed that forecast errors associated with longer deflations are lower than those that occur when price declines are of shorter duration. In all models, the baseline interaction term between all deflations and lagged inflation remains positive and statistically significant.

An important issue is whether the results are indeed driven by deflations, or whether they reflect the effect of low inflation on inflation expectations more broadly. For example, Ehrmann (2015) finds that expectations become more backward-looking when inflation is below the central bank's target. As our sample includes a wide range of economies with various different monetary policy regimes, we use our low-inflation dummy variables to investigate this (using a positive 1 percent inflation threshold; see Section 2). Including the interaction variable associated with low inflations in column 3 of Table 3 indeed suggests that low inflations are associated with more backward-looking expectations, with a coefficient estimate roughly half of that observed for deflations in column 2. However, this finding is not robust to the inclusion of the deflation dummy variables in the estimation—column 4 shows that when the different inflation environments are considered jointly, deflations alone appear to render inflation expectations more backward-looking in a way that is economically significant.[5]

One may argue that a 4 percent inflation threshold is too low for economies with a history of higher inflation and/or higher inflation targets and this may result in biased estimates of backward-lookingness in periods when inflation is neither high nor low. To address this concern, Table A.5 in the appendix presents results with a country-specific high-inflation threshold, defined as inflation above the mean of the country-specific sample. In these regressions, the results for backward-lookingness during deflations are similar to the baseline estimates. However, the interaction term between high inflation and lagged inflation is more statistically significant. At the same time, the high-inflation dummy variable gets a statistically significant negative sign, suggesting some "mean reversion" in expectations when an economy is experiencing higher inflation rates.[6]

Overall, the finding of greater backward-lookingness in expectations concurs with other evidence. For instance, the Bank of Japan (2016) finds a significant adaptive component of inflation expectations in the Japanese economy. The study attributes this feature in expectations formation to the prolonged deflation such that expectations have not been anchored at 2 percent. Similarly, Banca d'Italia (2017) reports that wage contracts in Italy have been increasingly linked to past rather than forecast inflation, which could make it more difficult to return inflation to target.

4.2 Evidence from Local Projection Regressions

Similar results related to the relationship between inflation outcomes and expectations are obtained with an alternative methodology. In

[5]This finding is robust to considering a dummy variable for low inflations that excludes periods when the price level is falling. The results are available upon request.

[6]The results for deflations are also robust to considering 5 percent or 6 percent as alternative high-inflation thresholds. At the same time, the high-inflation dummy and the associated interaction variables lose significance when 6 percent high-inflation thresholds are considered.

particular, impulse responses computed from local projection regressions suggest that expectations respond more strongly to changes in inflation outcomes in negative inflation environments.

To show this, we consider local projection regressions of the type[7]

$$\pi^e_{c,t+h} - \pi^e_{c,t-1} = \alpha_c + \beta_1 \Delta\pi_{c,t} + \beta_2 \pi^e_{c,t-1} + e_{c,t}, \qquad (3)$$

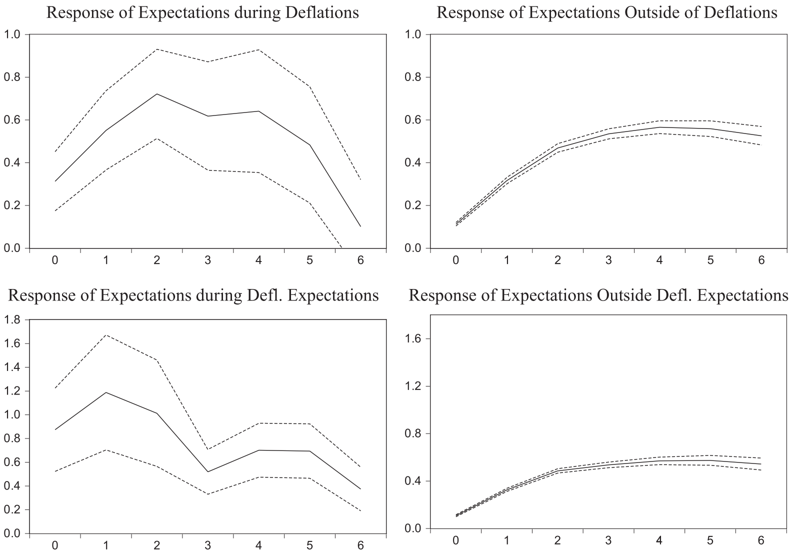
where $\pi^e_{c,t+h}$ is the one-year-ahead inflation expectation (median across forecasters for country c, formed in period $t+h$); $\pi^e_{c,t-1}$ is the initial level of one-year-ahead inflation expectation (formed in period $t-1$); $\Delta\pi_{c,t}$ denotes the change in actual inflation between period t and $t-1$; and $e_{c,t}$ is the error term. We consider impulse responses between zero and six months from the inflation increase, given that the shortest deflation episode in our sample lasts for six months.

Figure 2, upper row, shows that the response of one-year-ahead expectations to 1 percentage point increases in inflation is higher in a deflationary environment. A 1 percentage point change in actual inflation leads, after one month, to a 0.55 percentage point change in inflation expectations in the same direction during deflations, whereas the change in expectations is 0.3 point during other periods. The peak effect on expectations is also higher during deflations, although the 90 percent confidence bands are considerably wide, reflecting the much smaller estimation samples when deflationary periods are considered. The results suggest that survey expectations respond more strongly to inflation outcomes in the deflation subsamples than during other periods.

We also apply an alternative way of identifying the deflationary episodes by considering the level of expected inflation. We consider periods where, instead of actual inflation, the median one-year-ahead inflation expectation is below zero, resulting in a still smaller subsample than in the case where actual inflation is negative. The lower row of Figure 2 displays the impulse responses, highlighting that expectations respond significantly more to movements in actual inflation during periods when forecasters expect negative inflation. When one month has passed from a change in inflation by 1 percentage point, one-year-ahead inflation expectations change by

[7] See Jordà (2005).

Figure 2. Impulse Responses to 1 Percentage Point Increases in Inflation Outcomes



Note: Based on local projection regressions; in percentage points. The upper row shows the responses of one-year-ahead inflation expectations to 1 percentage point increases in actual inflation during (left) and outside (right) deflations. The lower row shows the responses of inflation expectations during periods when one-year-ahead expectations are below (left) or above (right) zero. The x-axis shows the number of months that have passed from the inflation increase. Dashed lines are 90 percent confidence intervals.

1.2 percentage point in the same direction when forecasters expect deflation, and by 0.3 percentage point during other periods. The corresponding peak responses over six months are 1.2 and 0.6 percentage points, respectively, again suggesting greater sensitivity of expectations to movements in actual inflation during deflationary periods.

4.3 Evidence from Longer-Term Forecasts

We then investigate the anchoring of expectations during deflations using five-year-ahead forecasts. As our first test of anchoring, we examine whether deflations result in more backward-looking longer-term expectations. To do this, we replace one-year-ahead forecasts in

Table 4. Five-Year-Ahead Inflation Expectations and Deflation

Variable	(1)	(2)	(3)	(4)
$\pi_{c,t-1}$	0.0820**	0.0521***	0.0585**	0.0582**
	(0.0336)	(0.0158)	(0.0245)	(0.0245)
$D^{defl}_{c,t-1}$		–0.0221		–0.0588
		(0.0976)		(0.103)
$D^{High\ Infl}_{c,t-1}$		–0.293	–0.272	–0.279
		(0.328)	(0.314)	(0.316)
$D^{defl}_{c,t-1}\pi_{c,t-1}$		0.0796		0.164**
		(0.0474)		(0.0678)
$D^{High\ Infl}_{c,t-1}\pi_{c,t-1}$		0.0705	0.0637	0.0646
		(0.0758)	(0.0725)	(0.0728)
$D^{Low\ Infl}_{c,t-1}$			–0.0168	0.0495
			(0.0644)	(0.0671)
$D^{Low\ Infl}_{c,t-1}\pi_{c,t-1}$			0.0352	–0.0903
			(0.0481)	(0.0648)
Obs.	880	880	880	880
R-squared	0.871	0.872	0.872	0.872

Note: Dependent variable is the mean expectation across forecasters for five-year-ahead inflation. Robust standard errors clustered by country in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent level, respectively. All models include country fixed effects.

Equation (2) (forecaster-level data) with their five-year-ahead equivalent (country-level data). As only the mean long-run expectation across forecasters is available at each point in time, the forecaster fixed effects are replaced by country fixed effects. The results are shown in Table 4.

We find that deflations are associated with more backward-looking expectations behavior even when the long-term forecasts are considered. First, we observe some backward-lookingness for the five-year-ahead expectations when the entire sample period is included (column 1 in Table 4). Not surprisingly, the coefficient estimate is much smaller than in the case of one-year-ahead expectations (0.082 in Table 4 versus 0.525 in Table 3). However, the increase in the dependence of longer-term expectations on past inflation is very large for deflations—in column 4, where all the different inflation environments are included, the coefficient estimate on the interaction term between deflation and lagged inflation is around three times as high as that on lagged inflation alone. Thus, we observe changes in expectations behavior even for the (relatively inertial) longer-term survey expectations, such that it becomes more difficult to get inflation back to target.

A second test of anchoring of inflation expectations is the dependence of long-term expectations on short-term expectations. If long-run expectations are well anchored, they should not respond to movements in short-term inflation expectations. For this test, we use both five-year and one-year-ahead forecasts, the former as the dependent variable in Equation (2) and the latter replacing lagged inflation in the right-hand side of the same equation. Given that only the mean five-year-ahead forecasts are published, we also use mean forecasts for the one-year-ahead expectations.

The results, shown in Table 5, provide further evidence about the unanchoring of survey expectations during deflations. Column 1 suggests that long-run survey expectations are related to short-run survey expectations in the whole sample, with a statistically significant coefficient estimate of 0.219. Adding interaction variables for high inflation and deflation periods with short-term inflation expectations in column 2, we find that the coefficient on the interaction variable associated with deflations is economically and statistically highly significant. The estimate of 0.240 in column 2 suggests that deflations are associated with greater dependence of long-run survey expectations on short-run expectations, with an effect that is 40 percent higher in magnitude than in normal periods. The significance of deflations remains when low inflations are included in the estimation (column 4). Finally, no similar evidence of unanchoring is obtained for the high inflation periods, concurring with the evidence in Table 4.

5. Reasons for Forecast Behavior

Why do expectations become more backward-looking during deflations? In this section we examine a number of potential explanations, including beliefs about the macroeconomic situation during deflations, a more persistent inflation process during deflationary episodes, and constraints on monetary policy.

Table 5. Sensitivity of Long-Run Inflation Expectations to Short-Term Expectations

Variable	(1)	(2)	(3)	(4)
$\pi^e_{c,t-1}$	0.219***	0.172***	0.203***	0.206***
	(0.0557)	(0.0328)	(0.0460)	(0.0476)
$D^{defl}_{c,t-1}$		–0.0402		–0.0822
		(0.111)		(0.0766)
$D^{High\ Infl}_{c,t-1}$		–0.751*	–0.676	–0.666
		(0.402)	(0.431)	(0.437)
$D^{defl}_{c,t-1}\pi^e_{c,t-1}$		0.240**		0.247**
		(0.105)		(0.104)
$D^{High\ Infl}_{c,t-1}\pi^e_{c,t-1}$		0.175	0.149	0.147
		(0.112)	(0.123)	(0.125)
$D^{Low\ Infl}_{c,t-1}$			0.0516	0.148
			(0.153)	(0.127)
$D^{Low\ Infl}_{c,t-1}\pi^e_{c,t-1}$			0.0678	–0.0442
			(0.0959)	(0.0787)
Obs.	879	879	879	879
R-squared	0.889	0.896	0.895	0.896

Note: Dependent variable is the five-year-ahead forecast (mean across forecasters). π^e denotes the one-year-ahead inflation forecast. Robust standard errors clustered by country in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent level, respectively. All models include country fixed effects.

It appears plausible that, in an unusual economic environment, forecasters are increasingly getting their cues from actual inflation outcomes. However, such behavior does not appear to be uniform across forecasters. Indeed, diving deeper into the forecaster-level data, we observe significant heterogeneity in forecast behavior during deflations.[8] In particular, we find that significant backward-lookingness in inflation expectations during deflations obtains especially in the sample of forecasters who are more pessimistic about the short-term growth prospects of the economy. Table 6 splits the sample of forecasters into those whose GDP forecasts are below and

[8]This analysis is only pursued for the one-year-ahead expectations, as only the mean forecasts are published for the longer-term (e.g., five-year-ahead) expectations.

Table 6. Heterogeneity among Forecasters Based on GDP Growth Expectations

Variable	Below-Median GDP Forecast (1)	Below-Median GDP Forecast (2)	Above-Median GDP Forecast (3)	Above-Median GDP Forecast (4)
$\pi_{c,t-1}$	0.486***	0.471***	0.493***	0.470***
	(0.0150)	(0.0194)	(0.0101)	(0.0133)
$D_{c,t-1}^{defl}$	0.154	0.143	–0.0469	–0.0463
	(0.174)	(0.179)	(0.0827)	(0.0842)
$D_{c,t-1}^{High\ Infl}$	0.0814	0.0306	–0.114	–0.188**
	(0.106)	(0.111)	(0.0911)	(0.0956)
$D_{c,t-1}^{defl}\pi_{c,t-1}$	0.356**	0.486***	0.129	0.260***
	(0.169)	(0.157)	(0.0845)	(0.0815)
$D_{c,t-1}^{High\ Infl}\pi_{c,t-1}$	–0.00249	0.0119	0.0348*	0.0571**
	(0.0225)	(0.0255)	(0.0201)	(0.0224)
$D_{c,t-1}^{Low\ Infl}$		–0.0543		–0.0941***
		(0.0392)		(0.0312)
$D_{c,t-1}^{Low\ Infl}\pi_{c,t-1}$		–0.118***		–0.111***
		(0.0290)		(0.0220)
Obs.	56,927	56,927	59,751	59,751
R-squared	0.736	0.736	0.833	0.833

Note: Dependent variable is the expectation by an individual forecaster for one-year-ahead inflation. Columns 1 and 2 show inflation expectations behavior for forecasters who predict below-median GDP growth; columns 3 and 4 show results for forecasters who predict above-median GDP growth. Robust standard errors clustered by country in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent level, respectively. All models include forecaster fixed effects.

above the median across forecasters, respectively (computed separately for each country). In the more parsimonious specification, increased backward-lookingness obtains only for those forecasters who have lower GDP growth expectations (column 1). For those with a more optimistic outlook on activity (column 3), inflation expectations do not become more backward-looking in a statistically significant way during deflations. By contrast, during periods of moderate positive inflation, the degree of backward-lookingness is highly similar among pessimists and optimists.

Similar evidence obtains in a model that also includes the dummy variable on low inflation. In this case, while also the more optimistic forecasters seem to display greater backward-lookingness, the coefficient estimate on the interaction variable between deflation and lagged inflation is higher (0.49 versus 0.26) for the more pessimistic forecasters (columns 2 and 4 in Table 6). Thus, anchoring of near-term inflation expectations appears to weaken especially for forecasters who expect lower GDP growth. Again, for periods of moderate inflation, backward-lookingness is similar for both pessimists and optimists.

The point inflation forecasts for the two groups of forecasters are also different during deflations. For the median pessimistic forecaster, the one-year-ahead inflation expectation formed during deflations is 0.28 percent, compared with 0.58 percent for an optimistic forecaster. By contrast, both the relative and absolute differences between forecasters are much smaller outside of deflations, with one-year-ahead inflation forecasts at 2.47 percent for pessimists and 2.56 percent for optimists.

Such evidence on forecast heterogeneity, particularly during adverse time periods, is consistent with other literature. Andrade et al. (2019) document, using forecast data from the Federal Reserve's forward guidance in 2011–12, that the same announcement on maintaining future interest rates low led to highly contrasting interpretations across professional forecasters. The optimists interpreted forward guidance as a promise of a future accommodative monetary policy stance and therefore better macroeconomic conditions, whereas the pessimists regarded it as signaling worse future macroeconomic outcomes. Similarly, Banerjee and Mehrotra (2021) show that deflations are associated with an economically and statistically significant rise in forecast disagreement across professional inflation forecasters. By contrast, disagreement about future inflation appears lowest when inflation rates are close to 2 percent—a common inflation target. Bachmann, Berg, and Sims (2015) report that the sign of the relationship between readiness to purchase durable goods and inflation expectations differs across households, with a positive relationship documented only for a small fraction of households that are "good" forecasters. Moreover, the prevailing negative relationship between durables spending attitudes and inflation expectations becomes stronger at the zero lower bound.

Relatedly, evidence about the macroeconomic implications of deflations is far from conclusive, potentially contributing to the divergent views across forecasters. Borio et al. (2015) document that, the Great Depression aside, the historical link between output growth and consumer price deflation is weak, and Bordo and Filardo (2005) highlight the mostly benign deflation record of the 19th century. By contrast, Eichengreen, Park, and Shin (2017), using producer price inflation, find stronger evidence of damaging effects of deflation on growth. Davis (2015) finds that expectations of deflation led to lower durable consumption in the United States during the Great Depression; similar evidence is provided for Japan's deflation experience in Hori and Shimizutani (2005).

Besides pessimistic perceptions about the economic implications of deflations, there are other possible factors driving greater forecast persistence. One possibility is that inflation outcomes themselves could be more persistent during deflations. Then, greater backward-lookingness could merely reflect this change in the inflation process rather than any other change in the behavior of expectations per se. However, we do not find evidence of increased inflation persistence during deflations: estimating a simple AR(1) model for inflation with country-level panel data for the deflation episodes leads to an autoregressive coefficient at the first lag of 0.787 (standard error of 0.050).[9] Considering the entire sample instead, the coefficient is 0.943 (standard error of 0.010). Thus, inflation actually appears somewhat less persistent during deflations.

Another factor potentially affecting the behavior of expectations during deflations is the possibility that conventional interest rate policy is constrained. Forecast dynamics and the macroeconomic implications of deflations may be expected to be more adverse if monetary policy is perceived to lack the tools to return inflation to target. In order to examine to what extent interest rates close to zero are affecting the results, we exclude periods with policy interest rates at levels of 0.5 percent or below from the estimations that use near-term inflation expectations. The results are shown in Table A.6 in the appendix.

We find that greater backward-lookingness in expectations during deflations does not hinge on the zero interest rate floor. When periods of near-zero interest rates are excluded, the point estimate

[9] These models include country fixed effects, and the standard errors are clustered by country.

on the interaction variable between lagged inflation and the deflation dummy actually increases in absolute terms. The sum of the backward-looking terms during deflations, when zero lower bound (ZLB) periods are excluded, is close to one (column 4 of Table A.6 in the appendix). This suggests that the fall in expectations during deflations does not arise due to perceived lack of potency of monetary policy.

6. Implications for Policy from More Backward-Looking Expectations during Deflation

Higher backward-lookingness in expectations also has implications for optimal monetary policy. Consider, for instance, the differences for optimal policy between rational expectations and expectations formed through adaptive learning. In the latter case, the private sector forms its inflation expectations based on the past behavior of inflation, updating their beliefs as the available data change. Gaspar, Smets, and Vestin (2006) show that under this environment, optimal policy responds in a persistent manner to cost-push shocks, allowing to stabilize inflation expectations in this way.[10] The higher is the perceived inflation persistence by the private sector, the stronger and more persistent the optimal response. Thus, if expectations are increasingly adaptive as the inflation rate falls, a stronger policy response would be called for when negative cost-push shocks push inflation down from already low levels. In Evans, Guse, and Honkapohja (2008) that features the ZLB, the possibility of a deflationary spiral arises around the lower inflation equilibrium under learning, requiring a strong fiscal and monetary response to guarantee a lower bound on inflation.

The fact that significant backward-lookingness in inflation expectations during deflations is driven by forecasters who are also pessimistic about the short-term growth prospects may have implications for monetary and fiscal coordination in such states. In particular, during deflationary episodes, there may be a role for fiscal

[10]The authors show that this decreases inflation persistence and volatility at little cost in terms of output volatility. See also Gaspar, Smets, and Vestin (2011), who note that departures from rational expectations raise the potential for instability, increasing the importance of managing inflation expectations.

stimulus to boost short-term growth and thus minimize pessimistic beliefs about near-term growth prospects (Nakata and Schmidt 2022). This in turn may help anchor inflation expectations (Evans and Honkapohja 2010).

7. Conclusion

In this paper, we have analyzed the behavior of inflation expectations during periods of deflation, using a large cross-country data set of Consensus forecasts. The global nature of the data is essential—out of the 47 deflation episodes identified in our sample, 30 occur in emerging market economies. We document that deflations are largely unanticipated by forecasters, even at short forecasting horizons. Thus, our results concur with the evidence in Ahearne et al. (2002) for Japan's deflation in the 1990s, but apply for a much larger sample of economies and time periods. In the econometric analysis, we first use one-year-ahead forecasts that could be relevant for actual wage and price setting, but also for providing timely signals that expectations risk becoming unmoored. Using these short-term forecasts, we show that the dependence of inflation expectations on past inflation outcomes rises by close to 50 percent during deflations, compared with other periods, implying that it becomes significantly more difficult to get inflation back to target when an economy is already experiencing deflation.

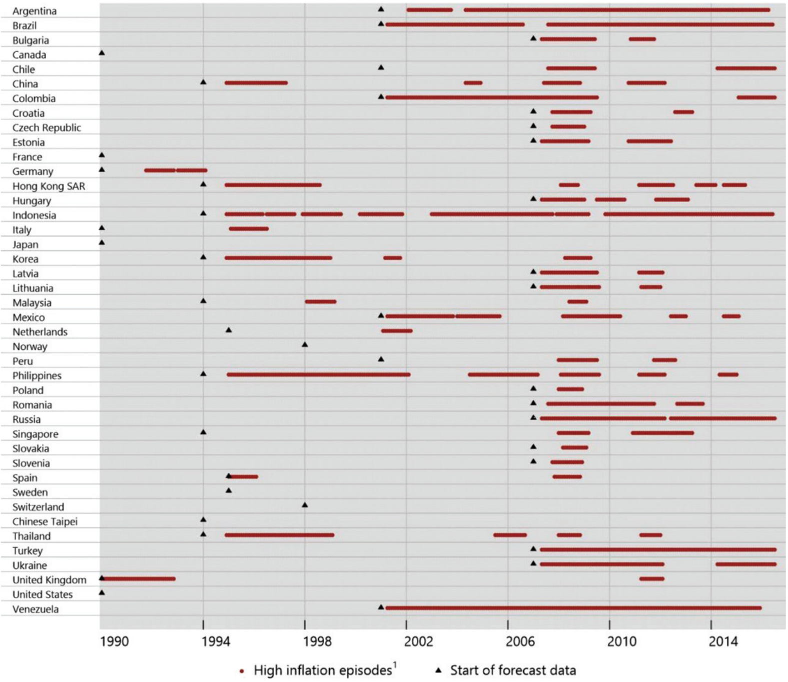
We additionally document that increased backward-lookingness in inflation expectations is driven by those forecasters who are more pessimistic about the short-term growth prospects. By contrast, inflation expectations of forecasters who are more optimistic about growth during deflations remain better anchored. In this way, deflations differ from other time periods that feature highly similar backward-lookingness across optimists and pessimists.

We also use longer-term, five-year-ahead, inflation expectations. We find that deflations are associated with greater backward-lookingness also in terms of the long-term expectations, as well as with greater dependence of long-term on short-term expectations. Both pieces of evidence are notable given the generally inertial nature of long-term survey expectations. They also differ from the results for other inflation environments and indicate that inflation expectations become unanchored during deflations.

Our results, in particular the changing behavior of expectations once the economy hits deflation, are supportive of a risk-management approach to monetary policy (see, e.g., Greenspan 2004). As it becomes increasingly difficult to return inflation to target once prices are falling and expectations have become more backward-looking, it may be prudent to preemptively react to deflation risks. Previous evidence for the United States suggests that the Federal Reserve may have already been responding to inflation in this manner (e.g., Kilian and Manganelli 2008). The global loosening of monetary policy in 2019 as inflation remained absent but trade tensions loomed large is also suggestive of a risk-management approach being applied in other economies.

Appendix

Figure A.1. High-Inflation Episodes



Note: [1]High-inflation periods are defined as at least six consecutive months of above 4 percent inflation rates. A high-inflation period ends if at least three consecutive periods with below 4 percent inflation rates occur.

Table A.1. Data Coverage

Economy	**Start**	**End**	**Number of Months**	**Number of Forecasters**			**Total Observations**
				Minimum	**Maximum**	**Average**	
Argentina	Apr. 01	Apr. 16	181	7	25	15.1	2,734
Bulgaria	May 07	Jun. 16	110	8	16	11.9	1,309
Brazil	Apr. 01	Jun. 16	183	13	27	18.0	3,303
Canada	Jan. 90	Jun. 16	318	11	20	15.2	4,847
Switzerland	Jun. 98	Jul. 16	218	6	17	13.3	2,891
Chile	Apr. 01	Jul. 16	184	11	23	17.0	3,122
China	Dec. 94	Jun. 16	259	11	24	17.9	4,624
Colombia	Apr. 01	Jul. 16	184	7	16	12.2	2,251
Czech Republic	May 07	Jun. 16	110	13	22	17.0	1,869
Germany	Jan. 90	Jul. 16	319	12	32	26.5	8,457
Estonia	May 07	Jul. 16	111	6	12	9.2	1,023
Spain	Jan. 95	Jul. 16	259	7	19	13.9	3,607
France	Jan. 90	Jul. 16	319	6	26	17.8	5,692
UK (CPI)	Jan. 05	Jun. 16	138	19	29	24.5	3,382
UK (RPI)	Jan. 90	Dec. 04	180	18	39	29.5	5,308
Hong Kong SAR	Dec. 94	Jun. 16	259	9	21	15.4	3,984
Croatia	May 07	Jun. 16	110	7	17	11.3	1,238
Hungary	May 07	Jun. 16	110	12	25	16.5	1,810
Indonesia	Dec. 94	Jul. 16	260	7	20	13.9	3,601
Italy	Jan. 90	Jul. 16	319	6	21	13.8	4,406

(*continued*)

Table A.1. (Continued)

Economy	Start	End	Number of Months	Number of Forecasters: Minimum	Number of Forecasters: Maximum	Number of Forecasters: Average	Total Observations
Japan	Jan. 90	Jun. 16	318	5	25	17.2	5,481
Korea	Dec. 94	Jul. 16	260	9	22	15.2	3,949
Lithuania	May 07	Jun. 16	110	6	12	8.0	883
Latvia	May 07	Jun. 16	110	7	14	9.5	1,043
Mexico	Apr. 01	Jul. 16	184	9	27	19.3	3,549
Malaysia	Dec. 94	Jun. 16	259	10	23	15.1	3,916
Netherlands	Jan. 95	Jul. 16	259	7	14	9.4	2,430
Norway	Jun. 98	Jun. 16	217	5	12	9.2	2,007
Peru	Apr. 01	Jul. 16	184	7	17	11.8	2,177
Philippines	Dec. 94	Jul. 16	260	12	21	15.4	1,526
Poland	May 07	Jun. 16	110	12	25	17.3	1,901
Romania	May 07	Jul. 16	111	7	19	12.4	1,374
Russia	May 07	Jul. 16	111	10	24	16.3	1,807
Sweden	Jan. 95	Jun. 16	258	6	18	13.4	3,470
Singapore	Dec. 94	Jun. 16	259	8	19	14.7	3,800
Slovenia	May 07	Jul. 16	111	7	16	10.6	1,179
Slovakia	May 07	Jun. 16	110	8	15	11.4	1,249
Thailand	Dec. 94	Jul. 16	260	8	22	13.9	3,623
Turkey	May 07	Jul. 16	111	9	21	15.2	1,683
Chinese Taipei	Dec. 94	Jul. 16	260	9	22	14.3	3,720
Ukraine	May 07	Jul. 16	111	8	19	14.4	1,599
United States	Jan. 90	Jun. 16	318	16	33	25.8	8,203
Venezuela	Apr. 01	Dec. 15	177	7	19	13.6	2,402

Table A.2. Deflation Episodes

Economy	Start	End	Length (Months)	Minimum Current-Year Forecast	Minimum Next-Year Forecast	Minimum Five-Year-Ahead Forecast	Minimum Inflation Outcome
Argentina	Jun. 01	Feb. 02	9	–1.6	–0.9	1.5	–1.7
Chile	Aug. 09	Mar. 10	8	–1.3	2.7	3	–2.3
Bulgaria	Aug. 13	Apr. 15	21	–1.3	1.1	NA	–2.6
Estonia	May 09	Apr. 10	12	–0.8	–0.2	NA	–2.2
Estonia	Jun. 14	Jul. 16	26	–0.4	1.3	NA	–1.3
Croatia	Feb. 14	Jun. 16	29	–0.7	1.0	NA	–1.9
Hungary	Sep. 14	Jun. 15	10	–0.1	1.5	2.6	–1.4
Lithuania	Dec. 14	Feb. 16	15	–0.7	1.4	NA	–1.8
Latvia	Oct. 09	Oct. 10	13	–3.0	–3.1	NA	–4.2
Latvia	Jan. 16	Jun. 16	6	–0.1	1.7	NA	–0.8
Poland	Aug. 14	Jun. 16	23	–0.9	0.7	2.2	–1.3
Romania	Jun. 15	Jul. 16	14	–1.2	–0.2	NA	–3.5
Slovenia	Jan. 15	Jul. 16	19	–0.5	0.8	NA	–0.8
Slovakia	Feb. 14	Jun. 16	29	–0.3	0.9	NA	–0.8
Ukraine	Nov. 12	Dec. 13	14	–0.3	3.3	NA	–0.8
Switzerland	Mar. 09	Dec. 09	10	–0.5	0.6	1.4	–1.2
Switzerland	Oct. 11	Dec. 13	27	–0.6	–0.1	1.3	–1.1
Switzerland	Sep. 14	Jul. 16	23	–1.3	–0.3	1.3	–1.4
Spain	Mar. 09	Dec. 09	10	–0.3	1.3	2.2	–1.4
Spain	Jul. 14	Jul. 16	25	–1.1	0.5	1.8	–1.3
France	May 09	Dec. 09	8	0.1	1.1	2	–0.7
Italy	Feb. 16	Jul. 16	6	–0.1	0.9	1.7	–0.5
Japan	Oct. 95	May 96	8	0.0	0.2	NA	–0.7
Japan	Feb. 99	Oct. 04	69	–1.0	–0.9	0.3	–1.6
Japan	Jun. 05	Jun. 06	13	–0.2	0.1	1.3	–1.0

(*continued*)

Table A.2. (Continued)

Economy	Start	End	Length (Months)	Minimum Current-Year Forecast	Minimum Next-Year Forecast	Minimum Five-Year-Ahead Forecast	Minimum Inflation Outcome
Japan	Feb. 09	Aug. 11	31	–1.3	–1.0	0.7	–2.5
Japan	Jun. 12	Jul. 13	14	–0.2	–0.1	0.3	–0.9
Sweden	Sep. 96	Jun. 97	10	0.8	1.3	NA	–0.4
Sweden	Jun. 98	Apr. 99	11	0.3	0.6	NA	–1.2
Sweden	Apr. 09	Jan. 10	10	–0.4	0.8	1.9	–1.9
Sweden	Aug. 14	Oct. 15	15	–0.2	0.7	2.2	–0.4
United States	Mar. 09	Dec. 09	10	–1.0	1.6	2.2	–2.1
China	Apr. 98	Jun. 00	27	–1.3	1.2	3.9	–2.2
China	Mar. 02	Feb. 03	12	–0.8	0.3	1.7	–1.3
China	Feb. 09	Dec. 09	11	–0.7	1.4	3	–1.8
Hong Kong SAR	Nov. 98	Aug. 04	70	–3.6	–1.5	1.4	–6.1
Malaysia	Jun. 09	Jan. 10	8	0.6	2.0	3.3	–2.5
Singapore	Jun. 98	Jun. 99	13	–0.6	–0.5	NA	–1.5
Singapore	Nov. 01	Dec. 02	14	–0.4	1.1	1.9	–1.1
Singapore	Jun. 09	Feb. 10	9	–0.2	1.4	2.2	–0.9
Singapore	Nov. 14	Jun. 16	20	–0.5	0.5	1.9	–1.6
Thailand	May 99	Dec. 99	8	0.3	2.2	NA	–1.2
Thailand	Jan. 09	Nov. 09	11	–1.0	2.1	2.7	–4.4
Thailand	Jan. 15	Jun. 16	18	–0.8	1.4	2.5	–1.3
Chinese Taipei	Jun. 03	Feb. 04	9	–0.3	0.5	NA	–1.0
Chinese Taipei	Feb. 09	Feb. 10	13	–1.2	0.7	NA	–2.3
Chinese Taipei	Jan. 15	Oct. 15	10	–0.4	1.1	NA	–0.9

Note: See the definition of deflation episodes in Figure 1. The length of deflation episodes in this table includes the two consecutive months of positive inflation rates that potentially follow deflation. The minimum forecast refers to the lowest median forecast across forecasters (for five-year-ahead forecasts, minimum of mean forecasts; the latter as reported by Consensus). NA indicates that the forecast is not available.

Table A.3. Data Sources and Definitions

Variable	Source	Data Transformations
CPI Inflation	National Data	
Inflation Expectations	Consensus Economics	
GDP Growth Expectations	Consensus Economics	
Policy Interest Rate	Datastream; National Data	Where policy rates are not available, money market interest rates are used.

Table A.4. Degree of Backward-Lookingness, by Type of Deflation

Variable	(1)	(2)	(3)
$D^{defl}_{c,t-1}\pi_{c,t-1}$	0.664*** (0.194)		
$D^{longer\ defl}_{c,t-1}\pi_{c,t-1}$	–0.596*** (0.197)		
$D^{defl}_{c,t-1}\pi_{c,t-1}$		0.090*** (0.027)	
$D^{deeper\ defl}_{c,t-1}\pi_{c,t-1}$		0.408*** (0.139)	
$D^{defl}_{c,t-1}\pi_{c,t-1}$			0.136*** (0.034)
$D^{faster\ defl}_{c,t-1}\pi_{c,t-1}$			0.699*** (0.246)
Obs.	124,252	124,252	124,252
R-squared	0.770	0.768	0.771

Note: Dependent variable is the expectation by an individual forecaster for one-year-ahead inflation. Only the coefficients capturing backward-lookingness are displayed. Models are estimated separately with dummy variables for longer/deeper/faster deflations, respectively. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent level, respectively. All models include forecaster fixed effects.

Table A.5. One-Year-Ahead Inflation Expectations, Using a Country-Specific High-Inflation Threshold

Variable	**(1)**	**(2)**	**(3)**	**(4)**
$\pi_{c,t-1}$	0.525***	0.485***	0.466***	0.467***
	(0.00939)	(0.0260)	(0.0328)	(0.0316)
$D_{c,t-1}^{defl}$		0.0193		0.0321
		(0.0933)		(0.106)
$D_{c,t-1}^{High\ Infl}$		–0.118***	–0.196***	–0.163***
		(0.0288)	(0.0394)	(0.0343)
$D_{c,t-1}^{defl}\pi_{c,t-1}$		0.249**		0.356***
		(0.116)		(0.0976)
$D_{c,t-1}^{High\ Infl}\pi_{c,t-1}$		0.0424**	0.0613**	0.0557**
		(0.0184)	(0.0249)	(0.0229)
$D_{c,t-1}^{Low\ Infl}$			–0.208***	–0.106**
			(0.0385)	(0.0429)
$D_{c,t-1}^{Low\ Infl}\pi_{c,t-1}$			0.127**	–0.0928***
			(0.0584)	(0.0326)
Obs.	124,252	124,252	124,252	124,252
R-squared	0.766	0.767	0.767	0.768

Note: Dependent variable is the expectation by an individual forecaster for one-year-ahead inflation. The high-inflation dummy is constructed using a country-specific inflation threshold (average inflation in the country over the sample). Robust standard errors clustered by country in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent level, respectively. All models include forecaster fixed effects.

Table A.6. One-Year-Ahead Inflation Expectations, Excluding the ZLB

Variable	**(1)**	**(2)**	**(3)**	**(4)**
$\pi_{c,t-1}$	0.531***	0.492***	0.485***	0.486***
	(0.0112)	(0.0124)	(0.0166)	(0.0159)
$D_{c,t-1}^{defl}$		0.210		0.166
		(0.177)		(0.182)
$D_{c,t-1}^{High\ Infl}$		–0.0546	–0.0740	–0.0785
		(0.0832)	(0.0857)	(0.0870)
$D_{c,t-1}^{defl}\pi_{c,t-1}$		0.343**		0.542***
		(0.136)		(0.127)
$D_{c,t-1}^{High\ Infl}\pi_{c,t-1}$		0.359*	0.0413**	0.0413*
		(0.0190)	(0.0209)	(0.0212)
$D_{c,t-1}^{Low\ Infl}$			–0.116***	0.00658
			(0.0384)	(0.0354)
$D_{c,t-1}^{Low\ Infl}\pi_{c,t-1}$			0.116**	–0.196***
			(0.0523)	(0.0242)
Obs.	101,442	101,442	101,442	101,442
R-squared	0.745	0.746	0.745	0.747

Note: Dependent variable is the expectation by an individual forecaster for one-year-ahead inflation. Robust standard errors clustered by country in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent level, respectively. All models include forecaster fixed effects.

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