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Do Household Expectations Help Predict Inflation?

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January 2023

ABSTRACT:

We examine whether changes in the distribution of household inflation expectations contain information on future inflation. We first discuss recent shifts in micro data from the US, UK, Germany, and Canada. We then zoom in on the US to explore econometrically whether distributional characteristics help predict future inflation. We find that that the shape of the distribution of household expectations does indeed help predict one-year-ahead CPI inflation. For example, higher moments of household expectations' distributions add predictive power beyond and above the mean. Remarkably, qualitatively, these results hold when including market-based measures and four moments of the distribution of professional forecasts.

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WORKING PAPERS

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[1] The authors would like to thank Bank of Canada and Bundesbank for kindly sharing the detailed data from their surveys, Ricardo Reis for kindly providing codes to use his 2021 method to construct densities, and Anu Verma for excellent research assistance. We also thank Sheheryar Malik, Roland Meeks and participants at the conference on “Inflation – Issues and Challenges” organized by the Guld Monetary Council and Qatar Central Bank for useful discussions and comments. All errors remaining are our own.

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I. Introduction

The recent sharp rise in inflation around the world has ignited academic and policy interest in measures of inflation expectations, including expectations of households and firms. Inflation expectations are likely to play a key role in driving inflation dynamics. However, in the full information rational expectations (FIRE) models dominating in the profession until recently, there are no differences in expectations across agents since everyone is supposed to know the “true” model of the economy. The academic literature has increasingly been recognizing that this assumption is far from reality (see e.g. Chen, Gornycka, and Zdarek 2022 and d’Accunto et el. 2022). For example, there is considerable dispersion of inflation expectations across households and firms. Even professional forecasts display dispersions and deviation from FIRE (Coibon and Gorodnichenko 2015). These different expectations influence consumption, saving, production, pricing decisions and wage bargaining, and thereby shape the overall inflation process. A better understanding of the drivers and economic significance of the inflation expectations of different groups is therefore high on the academic agenda. Moreover, closer monitoring of the expectations of different actors may also be important for forecasting purposes.

This paper focuses on household expectations. Household expectations have not been studied widely and are interesting as they often differ significantly from the expectations of professional forecasters and markets. In addition, they tend to be characterized by a relatively wide dispersion of expectations among households themselves. The diversity of views across households might be the result of different groups of households being exposed to different goods in their daily lives or having different sources of information than professional forecasters or market participants (D’Acunto et al., 2022). Possibly, differences in the thresholds across individuals for paying attention to price developments may also play a role, due to different cognitive resources or marginal values of obtaining accurate information about inflation (Bracha and Tang 2022).

Recent studies also show that household inflation expectations matter for consumption and saving decisions (D’Acunto et al. (2022), Andrade et al. (2020), Duca-Radu et al., 2021), and for households’ financing and home-ownership decisions (Botsch and Malmendier, 2021; Malmendier and Nagel, 2016; Malmendier and Wellsjo, 2020). It has further been shown that household expectations display similar characteristics as expectations of small- and medium-sized enterprises (Coibion et al., 2019; Candida and others, 2021). As such, they are a proxy for inflation expectations that inform investment, hiring, and price-setting decisions of smaller firms.

While *median* household expectations have been often been found to have somewhat less predictive power than inflation expectations of other actors (e.g., Verbrugge and Zaman, 2021), recent research suggests that changes in the distributions of household expectations matter. Distributional changes are not only important drivers of current inflation (Meeks and Monti, 2022), but there is also reason to believe that they provide important signals about future inflation. For instance, discussing inflationary periods in different countries, Reis (2021) points out that changes in the variance and skewness of household inflation expectations have often been leading changes in inflation.

In our paper, we take a more systematic approach to examine whether changes in the distribution of household inflation expectations do indeed contain information on future inflation. For this purpose, we work with micro data from Canada, Germany the United Kingdom (UK) and the United States (US). We first document recent developments of distribution of one-year-ahead household inflation expectations in these four counties. We focus on one-year expectations, since these have been shown to matter for wage setting and Phillips Curve estimations (Glick, Leduc and Pepper 2022; Werning, (2022), Faust and Weight (2013), and Alvarez et al, 2022). Moreover, since expectations had been anchored for the last decades in advanced economies, there is not much variation over time in longer-term expectations.

We then zoom in on the US to explore econometrically whether distributional characteristics help predict inflation. Specifically, we test whether distributional characteristics of household inflation expectations add information beyond and above that contained in the means/medians of household expectations, market-based measures, and the distributions of professional forecasters' expectations. To this end, we estimate a simple inflation forecasting model, regressing one-year-ahead inflation on current inflation and different characteristics of the distribution of one-year-ahead household inflation expectations, as well as medians of professional forecasts and market-based measures. First, using a Functional Principal Component Analysis (FPCA), we identify the principal components making up the distribution of household inflation expectations. An important advantage of this approach is that it can capture most of the cross-sectional variation using only a few components. A disadvantage of the approach is that it is not straightforward to interpret these components and assign an economic meaning. To allow for a better interpretation, we next proceed to estimate a similar forecasting equation with the first four moments as explanatory variables. Finally, to dissect even further which movements in the distributions of household inflation expectations are indicative for future inflation developments, we fit a bimodal normal distribution on the data and compute first and second moments.

We find [that the distributions of one-year expectations have shifted rightward everywhere, with more and more households expecting higher inflation outcomes. In each of the countries, the median household expects higher inflation one year into the future, and a significant share of households are expecting inflation greater than 10 percent one year out]. In Germany, the UK, and the US, new peaks in the right-hand side of the distribution have emerged or become much more pronounced.

In our regression analysis, we find that that the shape of the distribution of household expectations does indeed help predict one-year-ahead CPI inflation. Specifically, in the FPCA analysis, scores (measuring the extent to which a curve is described by the respective functional principal component) help predict inflation above and beyond the mean expectation. Similarly, higher moments of household expectations' distributions add predictive power beyond and above the mean. Remarkably, qualitatively, these results continue to hold when including market-based measures and four moments of the distribution of professional forecasts.

II. Recent Shifts in the Distribution of Household Inflation Expectations in Four Countries

In the first part of this paper, we will take a closer look at developments over the past three years in the distributions of one-year-ahead household inflation expectations for Canada, Germany, the UK and the US. We construct distribution densities for the inflation expectations data for each of these countries and document how distributions have shifted as actual headline inflation rose.

A. Data Description

We use detailed microdata from the household inflation expectations surveys for the four countries of interest. For the US and the UK this data is publicly available from the Michigan Survey and the Bank of England's Inflation Attitude Survey, respectively. For Germany and Canada we use data that we received directly from the Deutsche Bundesbank and the Bank of Canada for the purposes of this study. For the US, UK, and Germany, we construct the distributions using the method used in Reis (2021), For the Canadian data this is not possible, as the Bank of Canada provides only data on the percentiles of inflation expectations, on which we fit a skewed-t distribution instead.

US data

We use monthly data on one-year-ahead household inflation expectations from the Survey of Consumers conducted by the University of Michigan. The survey is based on a rotating panel and every edition includes a minimum of 600 interviews. Data is available from January 1978. The survey question consists of two parts. The first part asks: "During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?" And the second part asks: "By about what percentage do you expect prices to go (up/down) on the average, during the next 12 months?" For the first question, responds can choose between "Higher", "Stay the same", "Lower", and "Don't Know (DK)." For the second question, respondents are expected to provide a percentage value, or answer "Don't Know." For the purpose of our study, we generally focus on answers to the second question. Answers to the first question are only taken into account when adjusting our distributions for so-called "Don't Know How Much Ups" and "Don't Know How Much Down" (i.e., someone that expects inflation to go up or down, but does not know by how much).

For the construction of densities, we follow the method used by Reis (2021), which bins data with a lower bound of -5 and an upper bound of 20. The frequencies are taken from the published tables from the Survey website to which we assign the mid-point of the inflation bins. Missing data points ("NA" and "DK whether up or down") are excluded from the dataset, while "DK how much up" answers—which have been relatively common and always more than "DK how much down"—are distributed in the binned data across all response codes in the same proportions as cases with complete information. Thereafter, also following Reis, we fit a kernel density function of bandwidth 1.3 using the midpoints of the point estimates and the frequencies.

UK data

The quarterly Bank of England/Ipsos Inflation Attitudes Survey (previously known as Bank of England/Kantar Inflation Attitudes Survey[1]) has been conducted since 2001. Each quarter, a minimum of 2000 respondents are interviewed, chosen using a random location sample. Questions for one-year ahead and five-year ahead inflation expectations are, first: "How much would you expect prices in the shops generally to change over the next twelve months?" and second: "And how about the longer term, say in five years' time? How much would you expect prices in the shops generally to change over a year then?" The respondents do not provide point estimates but are asked to choose from several ranges (e.g., up by 1 percent or less, up by 1 percent but less than 2 percent etc.). In 2008 the survey changed an important aspect of their question on next year inflation expectations. Prior to the change, the highest inflation expectations range respondents could choose from was

[1] Prior to February 2022 Kantar conducted the survey, since February 2022 Ipsos has been conducting the survey permanently switching to an online format.

"up by 5 percent or more"; since the change respondents get a follow-up question in that case, with the highest possible range being "up by 10 percent or more". In 2022, a third follow-up question was included if a respondent chooses "up by 10 percent or more", with the highest option being "up by 15 percent or more." As in the US case, we focus on the answers to the second question.

The construction of densities for the UK data also follows the Reis method. As the largest bucket in the UK dataset is "10 percent or more," we have assumed an upper bound of 15 percent and a mid-point of 12 percent for the last bucket. Further, we allocated deflation expectations in the category "down, i.e., smaller or equal 0 percent" in a similar way as in the Michigan survey and used -2 percent as the mid-point.

German data

The relatively new Survey on Consumer Expectations of the Deutsche Bundesbank has been conducted on a monthly basis since April 2020, preceded by a brief pilot period from April to June 2019. Approximately 2000 households are asked to respond in each wave, with some respondents being asked to respond in multiple waves. The survey, inter alia, inquiries about one-year ahead inflation expectations. Similar to the US and UK setups, the survey enquires about inflation expectations in two stages. First, it asks whether respondents "think inflation or deflation is more likely over the next twelve months." Then, depending on the answer, the next question asks to assess the rate of inflation/deflation over the next twelve months. Again, we are interested in the answers to the second question.

German bins are composed in similar way as the US bins and Reis' method was again used to construct the distributions.[2]

Canadian data

The Canadian Survey of Consumer Expectations has been conducted by the Bank of Canada as a quarterly survey since 2014 to measure expectations of Canadian consumers. It surveys about 2000 households in a rotating panel conducted online. As in the German, US and UK surveys, it uses a two-part question set-up, whereby the first part of the question inquires whether the respondent expects inflation or deflation at the respective horizon and the second part asks for the percentage value ("What do you expect the rate of [inflation/deflation] to be over the next 12 months? Please give your best guess."

The Bank of Canada did not share individual responses with us but provided percentiles of point forecasts. Based on these percentiles we fit a skewed t-distribution following Azzalini and Capitanio (2003).

[2] Non-integer values that lie outside the Michigan Survey buckets (e.g.: between 2-3%), are rounded up or down to the nearest integer.

B. Recent Shifts in Distributions of Household Inflation Expectations

The data described in the previous section allows us to examine shifts in the distributions of household inflation expectations. Figure 1 shows the densities of the point forecasts of one-year-ahead inflation in households for the four countries at four different points in time since 2019, with the most recent available observations graphed as red solid lines. In the US, we have data up to October 2022, in the UK the latest available quarter is 2022Q3, in Germany the most recent month is September 2022, and Canadian data are available until [Q2 2022].

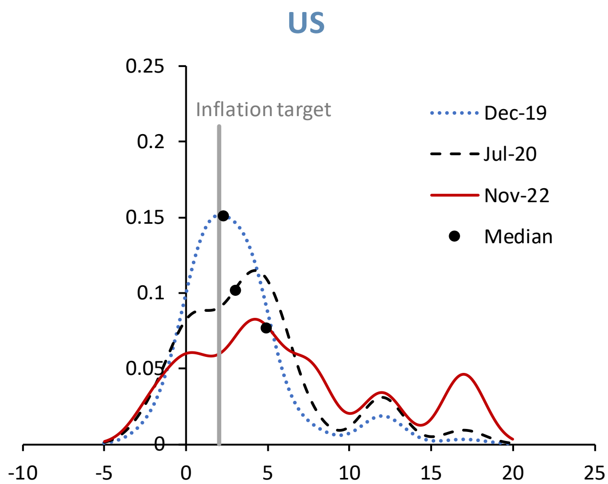
From the charts, it is clear that considerable shifts in household expectations are underway. The distributions have shifted rightward in all four countries, with more and more households expecting higher inflation outcomes. In each of the countries, the median household expects higher inflation one year in the future, and a significant share of households are expecting inflation greater than 10 percent one year out.

The most striking change in the distribution is a change in the skewness of the distribution, with a significant fattening of the right tail. In the US, the UK, and in Germany, the distributions have also become more clearly bi- or trimodal, with the second highest mode situated at the 10-15 percent point in the UK and Germany, and even at the 15-20 percent point in the US, suggesting that an increasing share of households expects very high inflation outcomes. While median expectations in the US and the UK remain considerably below mid-2022 inflation values, the median household in Germany expects close to 10 percent inflation one year out.

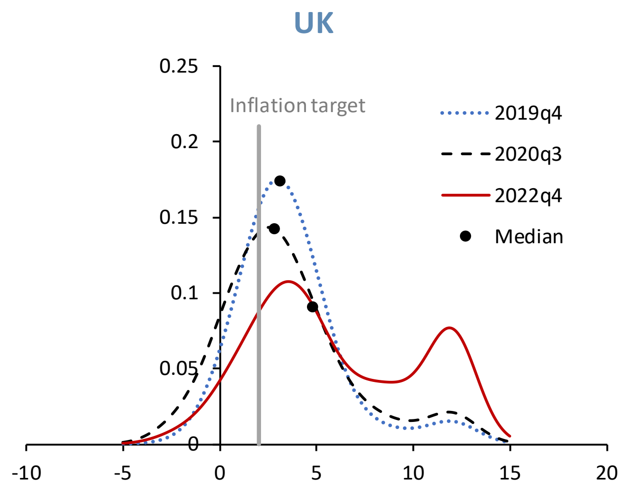
Given the short horizons of these expectations and the recent developments in actual inflation, these results may not be surprising. They simply indicate that households are aware of the trend in actual inflation, and that they do not expect it to (fully) reverse in a 12-month timespan. That would seem reasonable and is not necessarily indicative of a de-anchoring of longer-term expectations (indeed, expectations at the 5-year horizon have shifted much less than one-year expectations).

However, one-year expectations have been shown to matter for wage negotiations and Phillips Curve estimation and it is plausible that they have an impact on shorter-term inflation dynamics and thereby influence future inflation outcomes. To test whether one-year household inflation expectations contain information about future inflation, in the next section we will explore the predictive power of short-term expectations.

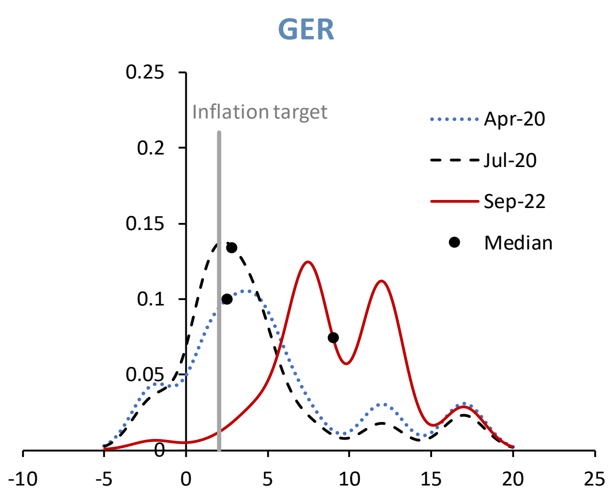
Figure 1. One-year Expectations in the US, UK, Germany, and Canada



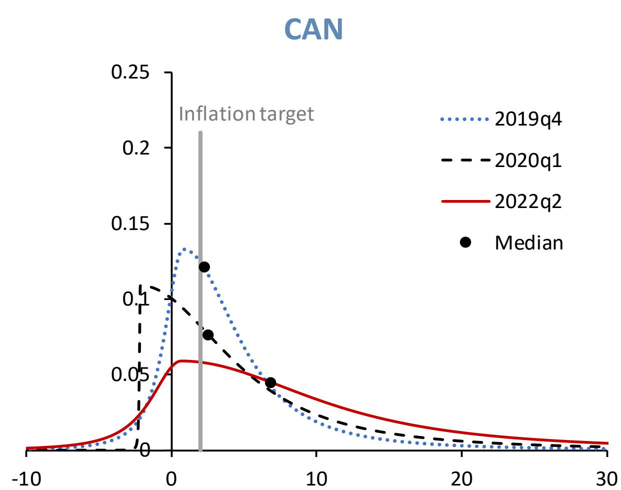
Sources: The University of Michigan's Survey of Consumers and authors' calculations, IMF staff calculations.
Note: The charts fit kernel densities to households' inflation forecasts, using methodology similar to Reis (2021).



Sources: Bank of England Inflation Attitudes Survey and authors' calculations.
Note: The charts fit kernel densities to households' inflation forecasts, using methodology similar to Reis (2021).



Sources: Bundesbank Survey on Consumer Expectations and authors' calculations.
Note: The charts fit kernel densities to households' inflation forecasts, using methodology similar to Reis (2021).



Sources: Canadian Survey of Consumer Expectations and authors' calculations.
Note: The charts fit a skewed t-distribution based on percentiles of point forecasts.

III. The Predictive Power of Distributions of Household Inflation Expectations in the US

To test econometrically whether the distributions of one-year inflation expectations of households contain information about future inflation, we will focus on the US as it is the only country for which long time series microdata are available. Specifically, we test whether characteristics of the distributions of household inflation expectations contain information about inflation over and above (i) the information that is contained in the means of household expectations, and (ii) over market-based measures and the distributions of professional forecasters' expectations. To this end, we estimate a relatively simple inflation forecasting model, regressing one-year-ahead inflation on current inflation, on different characteristics of the distribution of one-year-ahead household inflation expectations, and on medians of professional forecasts and market-based measures.

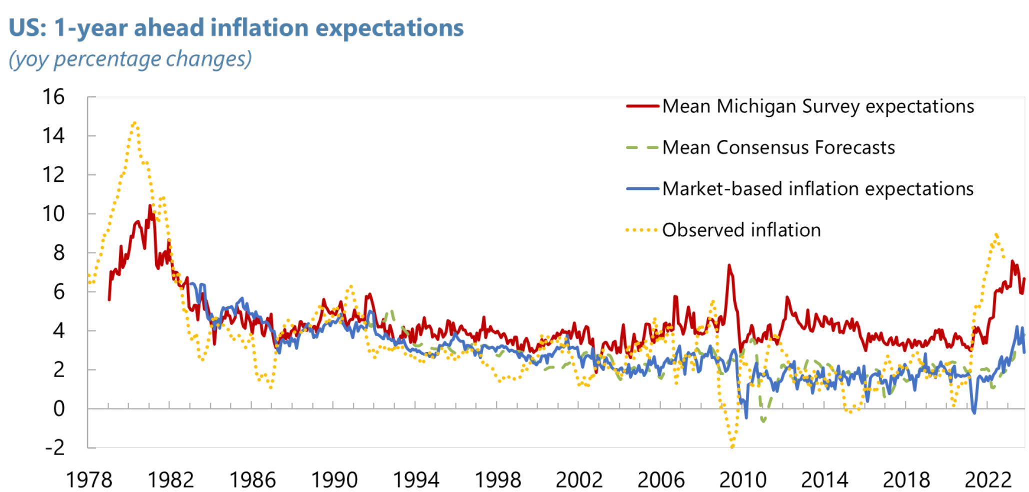
Data Description

For household inflation expectations, we again use the monthly data on one-year-ahead expectations from the Michigan Survey. We use data from January 1978 to October 2022 and construct densities as described in Section II.

For the expectations of professional forecasters, we use monthly data based on surveys by Consensus Forecasts. Consensus Forecasts does not provide one-year-ahead forecasts, but only forecasts for inflation in the current year and next year. We therefore construct a weighted average of the two with weights depending on the month of the year, which we use as proxy for the one-year-ahead forecast. Based on this data, we construct the first four moments of the distribution of professional forecasters.

For market-implied expectations, we use monthly data on market-based inflation expectations provided by the Cleveland Fed. These estimates are derived from Treasury yields, inflation data, inflation swaps, and survey-based measures of inflation expectations. Further details on the estimation procedure and data can be found on the Cleveland Fed website.

Figure 2. Expectations of Households, Professional Forecasters, and Markets Compared



Sources: US Bureau of Labor Statistics, Survey of Consumers - University of Michigan, Consensus Forecasts, Federal Reserve Bank of Cleveland, Datastream, IMF staff calculations.
Last observation: November 2022 for Michigan survey, Consensus Forecasts and market-based inflation expectations; October 2022 for observed inflation.

Finally, we use monthly data on year-on-year US CPI inflation. Figure 2 plots the data over the full sample. From the chart it is immediately apparent that there is a high correlation between actual inflation and mean household expectations, mean professionals' expectations, and market-based expectations—as one might have expected. However, there are also some systematic differences. In particular, the average household tends to structurally expect higher inflation than professional forecaster and markets, a feature that has been well documented in the literature.

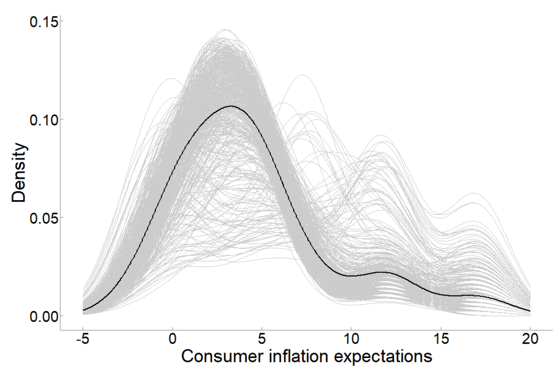
While such differences in and of themselves could contain complementary information about future inflation developments, in the remainder of the paper we seek to exploit the possible additional information that is contained in shifts in the whole *distribution* of household expectations. To test whether shifts in the distribution of household expectations contain information about future inflation over and above that of other measures of expectation we will use three alternative approached to describe the distribution of household expectations: scores models, moments models, and mixed distribution models.

A. Scores Models

Functional Principal Components Analysis

First, we use Functional Principal Components Analysis (FPCA) to describe the shape of the monthly distributions of household inflation expectations. FPCA allows to describe highly complex functions by a minimal number of components.[3] Figure 3 shows density functions fitted on US households' one-year ahead expectations data from January 1978 to October 2022, with each grey line representing one month, and the black line depicting the average across all months. In most months, the distributions depict a mode close to-, but above the FED's 2-percent inflation target, often complemented by two smaller modes at higher levels of expected inflation, clustering around multiples of 5. Note that FPCA can be based either on the original distributions or on the distributions after centering them around their cross-sectional mean. Here we will report results based on the uncentered distributions. An analysis based on the centered distributions is provided in Annex 1.

Figure 3. Distributions of Households' One-year Expectations

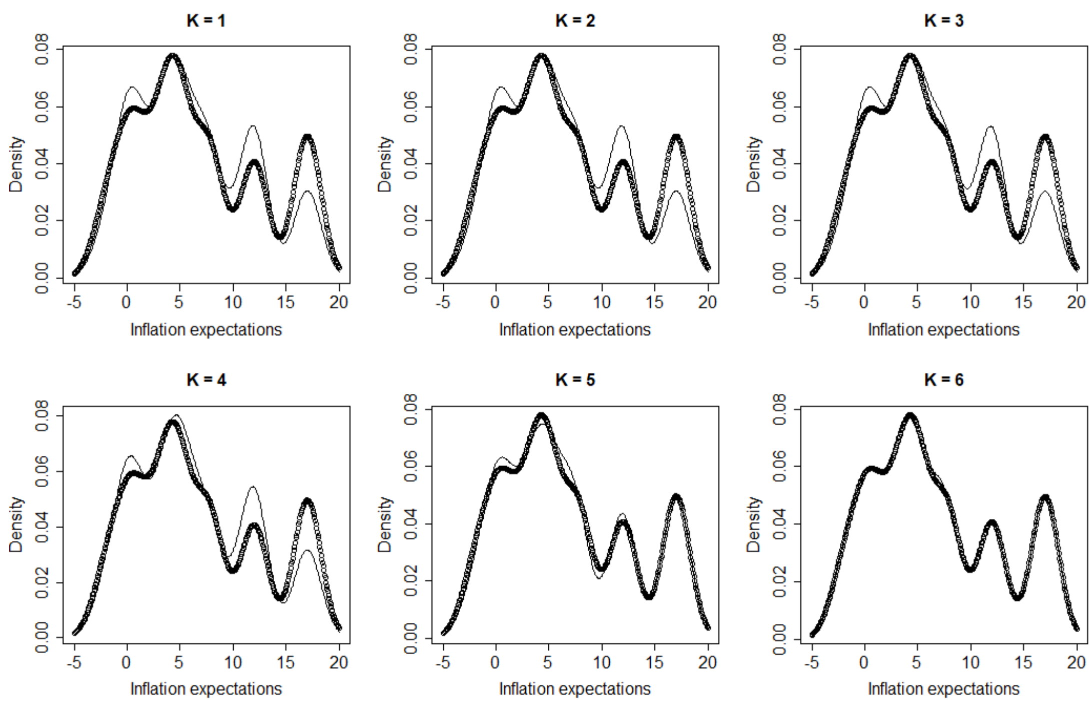


Source: Survey of Consumers – University of Michigan, and authors' calculations.
Notes: Kernel densities based on US households' one-year expectations.

[3] See Meeks and Monti (2022) and Chang et al. (2022) for a comprehensive mathematical exposition of FPCA in the context of household inflation expectations. Like Principal Component Analysis (PCA), FPCA is a technique to reduce the dimensionality of data while minimizing the loss of information contained in the data. While PCA deals with vectors, i.e., a multivariate set-up, FPCA is applied to functional data. The basic idea is to find the principal components that explain the largest part of variation in the data.

Using FPCA, we find that three components explain around 94 percent of variation of the distribution, and four components can explain around 97 percent. Figure 4 depicts the approximation (in black dotted lines) and actual distribution (in black solid lines) for a given number of basis functions in October 2022. Adding more components reduces the approximation error, with an approximation that uses only six basis functions already providing a very good approximation for the distribution in that particular month. The scree plot, depicted on the left-hand side of Figure 5, gives an idea of the goodness of the approximation over the whole sample. Since further components only add a marginal increase in the explained variation, we will report results for regressions that use three and four principal components as explanatory variables.

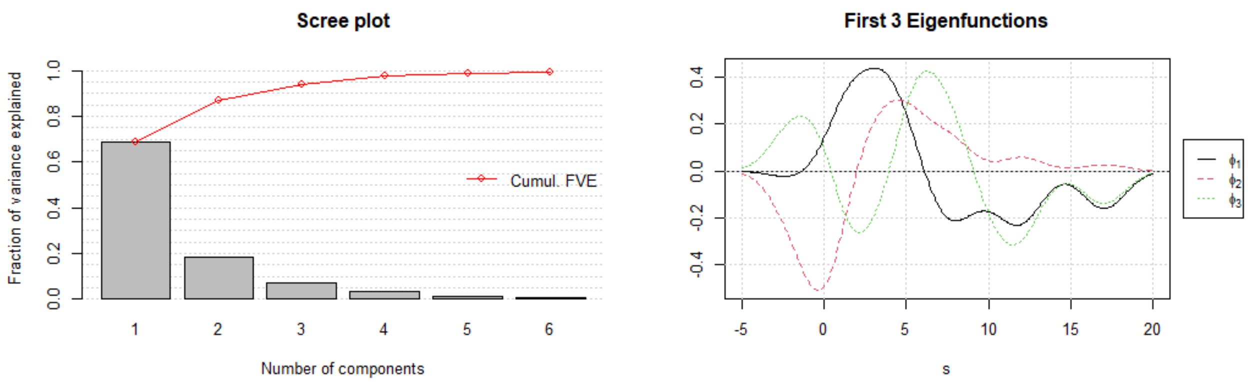
Figure 4. Approximation of Distribution for a Given Number of Principal Components, October 2022



Source: Survey of Consumers – University of Michigan, and authors' calculations.
Notes: Approximation (black dotted line) and actual distribution (black solid line) for a given number of principal components in October 2022.

While FPCA can approximate highly complex functions with a very limited number of principal components, this often comes at the cost of the interpretation of the principal components themselves not being straightforward. Indeed, interpretation of each of the first three principal components depicted on the right-hand side of Figure 5 requires considering their impact on the shape of the distribution *relative to the across-months mean distribution,* shown on the left-hand side of the figure. Based on this analysis, we call the first principal component 'agreement' because it increases mass in the middle ranges, while it decreases mass at the lower and higher ends. It explains about 69 percent of total variation. The second component decreases mass for lower expectations and increases mass for higher expectations, thus reducing skewness of the distribution. This 'negative skew' component explains close to 18 percent of total variation. The third component adds mass around -1, but also at higher expectations around 7 percent, while it decreases mass for intermediate expectations and very high expectations. This 'uncertainty' component explains about seven percent of total variation.

Figure 5. Proportion of Variance Explained by FPCA and First Three Principal Components



Source: Survey of Consumers – University of Michigan, and authors' calculations.
Notes: Left hand side: The scree plot depicts proportion of the variance which is explained for a given number of principal components. Right hand side: The eigenfunctions represent the principal components. Their shape is indicative about what part of the shape of the household expectation distribution they represent.

Empirical models

We now examine if the shape of the distribution of households' inflation expectations has informational content for short-term inflation dynamics. To this end, we specify a simple inflation forecasting model that regresses inflation twelve months ahead on a constant, current inflation 'scores' describing the distribution (for robustness we use both 3 and 4 scores)

$$\pi_{t+12} = c + \alpha\pi_t + \sum_{k=1}^{K} \beta_k s_{k,t}^{uncent} + \varepsilon_t \quad (1)$$

where π_t is inflation in period t, c is a constant, α and β_k are coefficients to be estimated, $s_{k,t}^{uncent}$ are scores obtained from the FPCA based on uncentered distributions, and ε_t is the error term.

The shape of the distribution of expectations is informative of future inflation, independently of whether we use three of four scores. The regression results are summarized in Table 1. The first two columns show coefficient estimates for the whole period, based on the FPCA scores. For the specification including the first three scores, we find that coefficients of the first and the third score are statistically significant, while for the specification including the first four scores, we get significant coefficients for scores one, three, and four. That is, the shape of the distribution of household inflation expectation is indeed informative about future inflation. Since inflation fluctuates over the sample, with high-inflation periods at the beginning and the end of the sample, we test for breakpoints in the sample using the sequential breakpoint test described in Liu, Wu, and Zidek (1997)).[4] Applying this test, we find that there are three different regimes, with two high-inflation regimes at the beginning and the end of the sample. Interestingly, the models perform best in the high inflation periods: for the regime with the highest-inflation (at the beginning of the sample), the adjusted R squared is highest. The next highest adjusted R squared we find for the most recent period, while empirical models fitted on subperiod in-between are less successful in explaining one-year-ahead inflation.

[4] As a robustness check, we use the Bai and Perron (2003) sequential break test, which finds five different regimes. However, the results are robust to using these regimes – the two high-inflation regimes at the beginning and at the end of the sample have the highest adjusted R-squared, and more distributional characteristics of household expectations are significant in these regimes. See Annex III.

Table 1. Scores Model Based on Different Subsamples

	Inflation t+12							
Sample	**1979M1-2022M10**		**1979M1-1991M7**		**1991M8-2015M8**		**2015M9-2022M10**	
Constant	2.81 ***	2.75 ***	4.52 ***	4.54 ***	1.46 ***	1.37 ***	3.40 ***	3.39 ***
Inflation	0.21 -	0.23 *	-0.11 -	-0.05 -	0.17 -	0.18 -	0.63 ***	0.61 ***
Score1	-22.34 ***	-21.77 ***	-34.38 ***	-27.92 ***	18.26 ***	17.98 ***	-21.58 **	-20.87 **
Score2	7.81 -	7.62 -	37.36 ***	34.06 ***	-5.68 -	-7.20 *	-4.81 -	-2.49 -
Score3	-15.83 *	-15.34 *	-19.48 ***	-35.99 ***	13.86 -	6.38 -	51.64 **	62.56 **
Score4		26.91 ***		27.86 ***		-16.11 -		17.30 -
N	526	526	151	151	289	289	86	86
Adj. R-squared	0.60	0.62	0.84	0.85	0.17	0.17	0.73	0.73

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Notes: Scores are based on FPCA performed on uncentered distributions. Subsamples are obtained from breakpoint tests on the specification including four scores. *** = significant at 0.01 level, **=significant at 0.05 level, *=significant at 0.1 level. Errors are Newey-West.

Because our results from the breakpoint test hint at the existence of different regimes differentiated by inflation levels, we include a dummy indicating high-inflation periods in the following (see Table 2). We test specifications with a dummy for months with inflation larger than three percent, and a dummy for months with inflation larger than four percent. Inclusion of dummies seems to slightly improve the fit over the whole sample.

Table 2. Scores Model Augmented by High-Inflation Dummies

	Inflation t+12					
Model	**No dummy**		**Inflation>3 dummy**		**Inflation >4 dummy**	
Constant	2.81 ***	2.75 ***	2.02 ***	2.01 ***	1.88 ***	1.74 ***
Inflation	0.21 -	0.23 *	0.31 **	0.42 ***	0.26 **	0.42 ***
Mean						
Score1	-22.34 ***	-21.77 ***	-0.17 -	-4.66 -	3.95 -	-1.22 -
Score2	7.81 -	7.62 -	-0.89 -	-0.35 -	-3.99 -	-3.69 -
Score3	-15.83 *	-15.34 *	23.37 **	21.87 *	21.60 **	18.50 *
Score4		26.91 ***		6.39 -		10.51 -
Dummy*mean						
Dummy*score1			-21.58 ***	-6.12 -	-30.07 ***	-8.69 -
Dummy*score2			19.51 **	18.25 **	33.62 ***	33.76 ***
Dummy*score3			-40.40 **	-65.58 ***	-38.97 ***	-74.06 ***
Dummy*score4				61.25 ***		62.62 **
Adj. R-squared	0.60	0.62	0.63	0.69	0.65	0.70

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Notes: Scores are based on FPCA performed on uncentered distributions. Subsamples are obtained from breakpoint tests on the specification including four scores. *** = significant at 0.01 level, **=significant at 0.05 level, *=significant at 0.1 level. Errors are Newey-West. The sample period is 1979m1-2022m10.

We proceed to analyze whether changes in the distribution of household inflation expectations can add informational value on next year's inflation *beyond* information contained in expectations by professional forecasters and financial markets. Since the survey data from Consensus Forecasts are only available since October 1989, we have to restrict our sample for this 'horse race' exercise to this shorter time period. Unfortunately, excluding the pre-1989 period generally implies the loss of a lot of variation over the sample, which leads to a significantly lower adjusted R-squared and significance (Table 3). We therefore also include results for the horse race performed on the most recent period, as identified by previous breakpoint tests, excluding the low-variation intermediate period. The results show that changes in household expectation distribution do indeed add value beyond information contained in market-based and professional forecasts, especially when considering the most recent period.

We report results for all empirical exercises based on centered distributions in the Annex and show that results are robust to the centering.

Table 3. Horse Race with Professional Forecasters and Market Expectations

	Inflation t+12							
Sample	1991M10-2022M10				2015M9-2022M10			
Constant	1.67 ***	1.68 ***	1.72 **	2.19 ***	3.40 ***	3.39 ***	3.06 ***	3.79 ***
Inflation	0.30 **	0.30 **	0.32 -	0.26 -	0.63 ***	0.61 ***	0.53 ***	0.54 ***
Households score 1	5.88 -	6.10 -	6.63 -	4.30 -	-21.58 **	-20.87 **	-22.45 **	-19.90 **
Households score 2	-2.84 -	-2.27 -	-2.32 -	-5.19 -	-4.81 -	-2.49 -	-4.02 -	-5.38 -
Households score 3	18.77 -	21.97 -	22.87 -	15.17 -	51.64 **	62.56 **	64.36 **	65.19 **
Households score 4		5.36 -	5.82 -	-3.58 -		17.30 -	17.24 -	10.94 -
Market-based			-0.05 -	0.05 -			0.34 -	0.44 -
Professionals				-0.23 -				-0.54 *
N	373	373	373	373	86	86	86	86
Adj. R-squared	0.06	0.06	0.06	0.03	0.73	0.73	0.73	0.74

Sources: Survey of Consumers - University of Michigan and authors' calculations, Consensus Forecasts, Cleveland Fed market-based expectations.
Notes: Scores are based on FPCA performed on uncentered distributions.. *** = significant at 0.01 level, **=significant at 0.05 level, *=significant at 0.1 level. Errors are Newey-West.

In-sample RMSEs

To assess the ability of the different regression models to predict inflation *in sample*, we will now compare actual inflation with predicted inflation by using root mean squared errors (RMSEs). In this exercise, the estimation of the regression models is based on the entire sample period and predicted values also are based on the entire sample. Table 4 shows the resulting RMSEs for the regression models using scores, without dummy and with a dummy indicating inflation greater than four percent. Comparing models within each "group" of models (no dummy group versus inflation-greater-than-four-percent dummy), we find that including more scores reduces the in-sample RMSEs. That is, the better the distribution of household inflation expectations is accounted for, the closer is predicted inflation to actual inflation. Comparing models across groups, the results show that including the dummy slightly lowers RMSEs. In Annex 1, we report additional results for the regression model based on centered scores and with a dummy for inflation greater than three percent. In these configurations, too, including more scores lowers RMSEs.

Table 4. In-sample RMSEs

No Score	Score 1	Scores 1 and 2	Scores 1, 2, and 3	Scores 1, 2, 3, and 4	No Score	Score 1	Scores 1 and 2	Scores 1, 2, and 3	Scores 1, 2, 3, and 4
No dummy					*Dummy: Inflation > 4*				
1.91	1.80	1.78	1.76	1.71	1.91	1.75	1.67	1.64	1.52

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Note: The sample period is 1979m1-2022m10.

Out-of-sample RSMEs

While the previous results already suggest that including the distribution of household expectations will improve forecasts, to test the robustness of the results, we complement the in-sample results by conducting an out-of-sample analysis. For the purpose of this exercise, the respective regression model is estimated based on a sample excluding the most recent data points. RMSEs are computed comparing these most recent data points with inflation predicted by the model based on the sample that excludes them. Out-of-sample RMSEs are usually higher than their in-sample counterparts, because the data points they are computed on have not been included in the estimation of regression parameters.

Including distributional characteristics improves out-of-sample forecasting power somewhat. Table [5] reports RMSEs for three and five year out-of-sample forecasting performance. That is, the regression models are estimated based on the sample excluding the last three (five) years. Predicted values are then computed based on these regression models and compared with actual inflation in the last three (five) years. Again, we also conduct this exercise including a dummy for high inflation. As expected, out-of-sample RMSEs are significantly higher than their in-sample counterparts. Not controlling for high inflation, there is a decline in the out-of-sample RMSE when including Score 2 in addition to Score 2. Including further scores increase RMSEs. However, when including a dummy for high inflation periods, including scores beyond score 1 does not improve RMSEs. including further scores does not increase out-of-sample forecasting power. The additional results in the Annex show that this is robust to using a different dummy or basing the model on the centered scores.

Table 5. Out-of-sample RMSEs, Full Sample

	Score 1	**Scores 1 and 2**	**Scores 1, 2, and 3**	**Scores 1, 2, 3, and 4**	**Score 1**	**Scores 1 and 2**	**Scores 1, 2, and 3**	**Scores 1, 2, 3, and 4**
	No dummy				*Dummy: Inflation > 4*			
3 years	2.88	2.82	2.89	3.13	2.99	2.99	2.94	3.02
5 years	2.26	2.22	2.27	2.57	2.35	2.37	2.33	2.39

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Note: The sample period is 1979m1-2022m10.

The lack of predictive power of higher scores over the whole period stem from the fact that both the last three and last five years include the most recent high inflation episode, which might not be predicted well by models estimated largely based on a long low-inflation period. To test this hypothesis, we perform three-year out-of-sample forecasting exercises excluding all data points from 2019 onwards. That is, we estimate the scores model based on the 1978m1-2015m12 sample and compare RMSEs of predicted inflation and actual inflation for 2016m1-2018m12 in Table 6. For the model without the dummy, including the first three scores lowers the RMSEs relative to including just one score, but including also the fourth one increases it. For the model including a dummy, however, including more scores consistently decreases RMSEs, except for score 4.

Table 6. Three-year Out-of-sample RMSEs, Restricted Sample

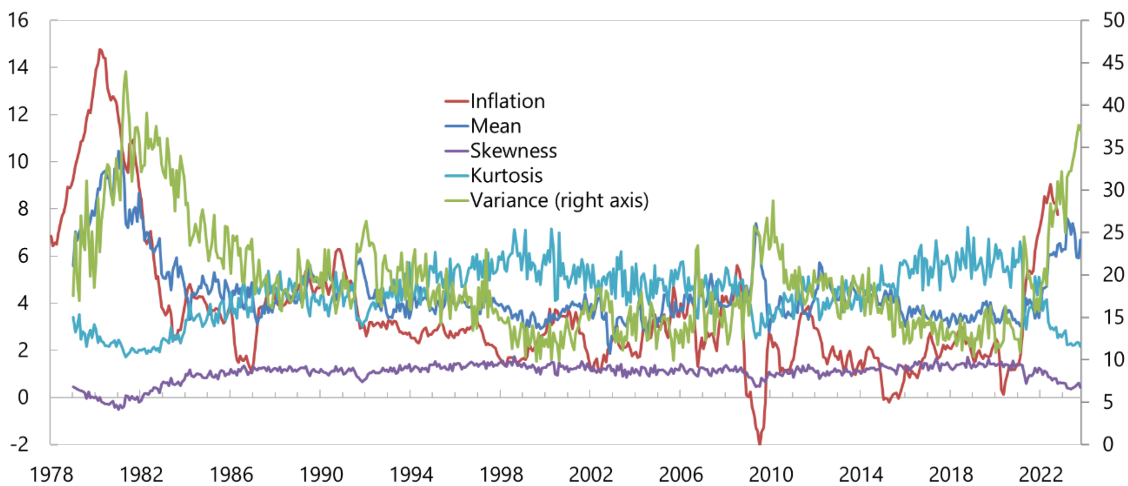
	Score 1	**Scores 1 and 2**	**Scores 1, 2, and 3**	**Scores 1, 2, 3, and 4**
No Dummy	0.62	0.72	0.50	1.12
Dummy: Inflation > 4	0.54	0.45	0.44	0.41

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Note: The sample period is 1979m1-2019m12.

B. Moments Models

In the previous section we have shown that changes in the distribution of household inflation expectations contain important information about future inflation. However, due to the difficult interpretation of principal components, the economic mechanisms behind these results remain obscure. To shed more light on the economics, we perform a similar simple forecasting exercise with moments instead of scores as explanatory variables. The more intuitive interpretation of the moments, however, comes at the cost of a less accurate approximation of highly complex distribution functions.

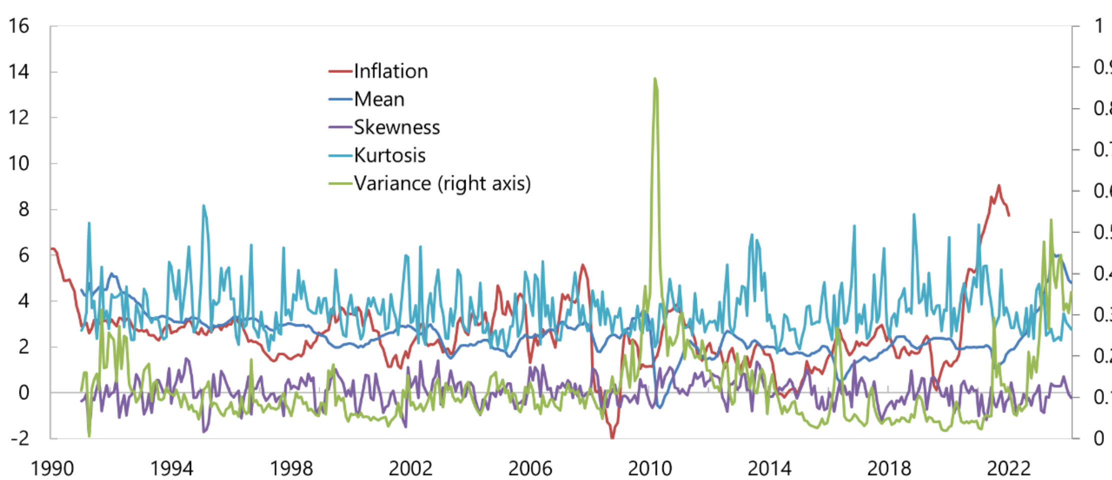
Figure 6. Mean, Variance, Skewness, and Kurtosis of US Household Expectations, and Inflation



Sources: US Bureau of Labor Statistics, Survey of Consumers - University of Michigan and IMF staff calculations.
Note: The plot depicts inflation in month t and moments in month t-12 to reflect the relationship analyzed in the regressions.

Unlike the corresponding time series for the households, at first glance the moments of professionals' expectations do not seem correlated with inflation over time (Figure 7). A possible exception is the year 2022. This could indicate that there is not much information contained in cross-sectional distributions, a hypothesis that we will test in another horse race exercise.

Figure 7. Mean, Variance, Skewness, and Kurtosis of Professionals' Expectations, and Inflation



Sources: Consensus Forecasts and IMF staff calculations.
Note: The plot depicts inflation in month t and moments in month t-12 to reflect the relationship analyzed in the regressions.

Results of regression models

We estimate simple models regressing one-year-ahead inflation on current inflation and the first three (four) moments of the distribution of household inflation expectations:

$$\pi_{t+12} = c + \alpha\pi_t + \sum_{k=1}^{K} \beta_k \, m_{k,t} + \varepsilon_t \quad (3)$$

where π_t is inflation in period t, c is a constant, α and β_k are coefficients to be estimated, $m_{k,t}$ are moments, and ε_t is the error term.

Skewness and kurtosis appear to be informative about future inflation. Regression results for the full period are reported in the first two columns of Table 7. The sign of the coefficient of variance is not positive, as expected e.g., from Reis (2021). However, coefficients of skewness and kurtosis are highly significant and have the expected signs. A decrease in skewness is a significant predictor of higher inflation a year later—that is, a fattening of the right tail of the distribution signals higher inflation a year later. Similarly, a higher kurtosis also signals higher future inflation.

The role of higher moments in predicting inflation seems to vary somewhat over time. We again test if the relationship changes over different subsamples identified by a breakpoint test. Interestingly, the breakpoints identified are very close (or even similar) to those identified in the scores regressions: We again find that the subsamples at the beginning and end of the sample have the most significant parameter estimates, with the highest adjusted R-squared. We therefore focus on these two subsamples in the remainder. Zooming in on the earliest subsample, we find highly statistically significant coefficient estimates (except for the kurtosis coefficient) and all signs as expected, except for the negative sign of the coefficient of the variance. Considering only the most recent period, we find a positive sign for the variance coefficient, which is also statistically highly significant. The mean coefficient is insignificant, but coefficients for skewness and kurtosis are highly significant and signs are as expected.

Table 7. Moments Model Based on Different Subsamples

	Inflation t+12							
Sample	**1979M1-2022M10**		**1979M1-1991M8**		**1991M9-2015M9**		**2015M10-2022M10**	
Constant	4.26 ***	1.11 -	9.97 ***	6.93 **	3.59 ***	6.08 ***	2.39 -	1.63 -
Inflation	0.33 **	0.23 *	0.13 -	0.07 -	0.19 *	0.23 **	0.37 **	0.36 **
Mean	0.65 *	0.63 *	0.92 ***	0.84 **	-0.57 **	-0.64 **	-0.40 -	-0.36 -
Variance	-0.11 ***	-0.02 -	-0.27 ***	-0.20 ***	-0.02 -	-0.09 -	0.33 ***	0.35 ***
Skewness	-2.54 ***	-4.33 ***	-4.35 ***	-5.79 ***	0.73 -	3.32 **	-2.86 ***	-3.61 -
Kurtosis		0.86 **		0.88 *		-0.88 **		0.25 -
N	526	526	152	152	289	289	85	85
Adj. R-squared	0.61	0.62	0.87	0.87	0.15	0.18	0.68	0.68

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Notes: Subsamples are based on breakpoint tests performed on regression using the first three moments as explanatory variables.

To get a better understanding of these different regimes, we again use high-inflation dummy variables (Table 8). In high-inflation periods, the sign of the mean coefficient and the sign of the skewness coefficient are as expected and the sign for the variance remains negative. However, for the low-inflation periods, the sign for variance turns positive while the mean turns negative. This result is robust to using other dummies such as for high/low variance or increasing/decreasing inflation.

Table 8. Moments Model with Different Dummies

	Inflation t+12					
Dummy	**No dummy**		**Dummy: Inflation > 4**		**Dummy: Inflation > 3**	
Constant	4.26 ***	1.11 -	3.84 ***	2.46 -	2.81 *	-0.16 -
Inflation	0.33 **	0.23 *	0.36 **	0.30 **	0.53 **	0.48 ***
Mean	0.65 *	0.63 *	-0.49 -	-0.36 -	-0.29 -	-0.08 -
Variance	-0.11 ***	-0.02 -	0.06 *	0.09 *	0.10 **	0.18 ***
Skewness	-2.54 ***	-4.33 ***	-0.95 -	-1.76 -	-1.39 *	-5.19 ***
Kurtosis		0.86 **		0.31 -		1.12 **
Dummy*mean			1.64 ***	1.20 -	1.19 ***	1.03 *
Dummy*variance			-0.28 ***	-0.24 **	-0.29 ***	-0.31 ***
Dummy*skewness			-1.35 **	-2.87 -	-0.45 -	2.74 -
Dummy*kurtosis				0.73 -		-0.54 -
Adj. R-squared	0.61	0.62	0.66	0.66	0.65	0.65

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Note: The sample is 1979m1-2022m10.

For the most recent period, moments of the household expectations distribution add information beyond what is contained in professionals' and market expectations. We perform the horse race exercise using moments of the distribution of household expectations as well as moments of the distribution of professional forecasters and market-based expectations. Because professional forecasters' expectations are only available from 1990, we again restrict our sample. Both the "household-only" moments model, as well as the models augmented by professionals' and markets perform poorly, as this period seems to lack sufficient variation in inflation and inflation expectations (similar to what we found previously). Focusing on the more recent period, however, changes in distribution of household inflation expectations do become informative for future inflation—over and above those of professional forecasters and market expectations.

Lastly, we explored whether changes in the distribution of household expectations have more predicting power at turning points—e.g., when there is a change from a low- to a high-inflation environment. However, we were unable to document any such a pattern—perhaps because there are too few turning points in our sample.

Table 9. Horse Race with Professional Forecasters and Market Expectations

	Inflation t+12							
Sample	**1991M10-2022M10**				**2015M10-2022M10**			
Constant	3.86 -	3.86 -	4.05 -	4.46 *	1.63 -	1.61 -	2.58 -	3.66 -
Inflation	0.33 ***	0.31 -	0.22 -	0.21 -	0.36 **	0.35 *	0.34 *	0.36 **
Households mean	-0.45 -	-0.45 -	-0.58 -	-0.64 *	-0.36 -	-0.38 -	-0.49 -	-0.57 -
Households variance	0.04 -	0.04 -	0.08 -	0.09 -	0.35 ***	0.35 **	0.36 ***	0.31 ***
Households skewness	1.06 -	1.03 -	0.45 -	0.61 -	-3.61 -	-3.66 -	-3.76 -	-4.15 **
Households kurtosis	-0.45 -	-0.46 -	-0.29 -	-0.42 -	0.25 -	0.26 -	0.28 -	0.19 -
Market-based		0.05 -	0.18 -	0.23 -		0.05 -	0.16 -	0.06 -
Professionals mean			-0.30 -	-0.39 -			-0.47 -	-0.59 *
Professionals variance				-1.59 -				1.16 -
Professionals skewness				-0.2572 -				-0.91 ***
Professionals kurtosis				0.13 -				0.29 *
N	373	373	373	373	85	85	85	85
Adj. R-squared	0.06	0.06	0.05	0.07	0.68	0.67	0.68	0.74

Sources: Survey of Consumers - University of Michigan, Consensus Forecasts, Cleveland Fed, and authors' calculations.

IV. Conclusion

In this paper, we have presented novel evidence on how changes in the distribution of household expectations can help predict future inflation. Our findings suggest that household expectations contain information that is complementary to the information contained in professional forecasts and market-based indicators. The evidence strengthens the notion that it is important for policymakers to keep a close eye on household expectations.

However, we see our analysis as only a first step toward a deeper exploration of this issue. For example, while we focused in our quantitative examination on the United States, similar investigations could usefully be carried out for other countries where long time series of the micro data are available. Moreover, while we were unable to detect significant changes in the role of household expectations around turning points (e.g. around changes from a low- to a high inflation regime), this issue deserves further investigation given the evidence on attention/inattention by households.

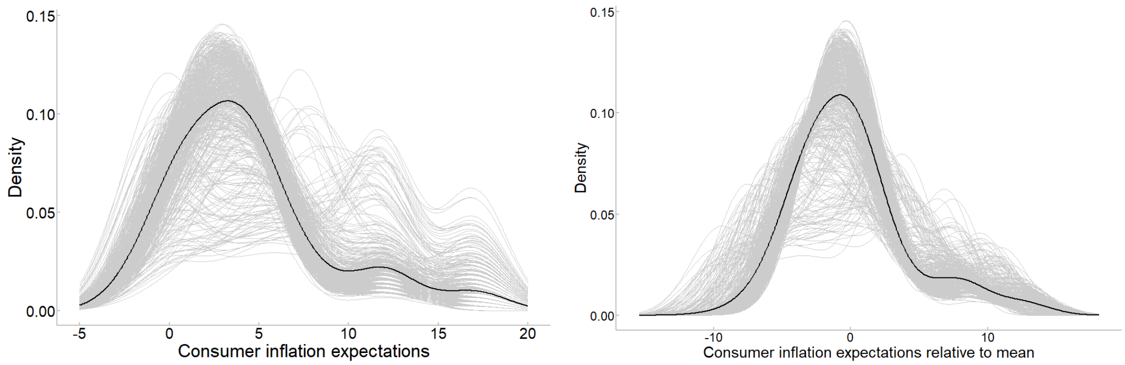
To dig even deeper into why the distributional shifts matter, we are working on a mixed distribution model, which models the distribution of household expectations as a mix of distributions from two populations and the shifts in the distribution as an increase in the disagreement between the two populations. The preliminary results indicate that an increase in the disagreement between two populations seems to be behind the shifts described earlier in the paper.

Future research should also deepen our understanding about the role of household expectations in shaping the inflation process. How do different segments of the population react to changes in inflation expectations? What, if any, role do they play in wage negotiations? How are the consumption- and savings decisions of different parts of the population influenced by changes in inflation expectations? In sum, many important open questions remain, and it is our hope and expectation that future research efforts will help shed light on them.

Annex I. Robustness: Centered Distributions

This Annex reports results based on the FPCA performed on distributions centered their cross-sectional mean (see right-hand side of Figure A1, while the left-hand side shows the original distributions). The mean curve of the centered distribution has a lower variance and a shorter right tail compared to its uncentered counterpart.

Figure A1. Uncentered and Centered Distributions of Households' One-year Expectations



Source: Survey of Consumers – University of Michigan, and authors' calculations.
Notes: Left hand side: Kernel densities based on US households' one-year expectations. Right hand side: Kernel densities based on US households' one-year expectations *centered around the cross-sectional mean.* Grey lines indicate months January 1978 – October 2022, the black lines indicate the cross-months averages.

The FPCA can be performed on the uncentered or on the centered distributions. The only difference is that in the forecasting model based on the centered distributions, the mean should be included as an explanatory variable:

$$\pi_{t+12} = c + \alpha\pi_t + \sum_{k=1}^{K} \beta_k s_{k,t}^{cent} + \gamma\bar{\pi}_t^e + \varepsilon_t \quad (2)$$

where $s_{k,t}^{cent}$ are scores obtained from the FPCA based on centered distributions,[5] $\bar{\pi}_t^e$ is mean expected inflation in period t and γ is the corresponding coefficient to be estimated.

Regression results are summarized in Table A1. Empirical model (2), which includes the mean and scores based on the centered distributions, yields similar results as model (1) in the sense that coefficients of the mean, score 2, and score 3 are highly significant when estimated for the full period. Note that first principal component obtained from the uncentered FPCA is highly negatively correlated with the mean, so it is to be expected for the mean to have a positive significant coefficient. It also displays a similar pattern regarding the share of variation explained in the different sub-samples, with the highest R squared obtained for the earliest sub-sample, followed again by the most recent one and lower values for the intermediate period.

[5] The score measures to what extent a curve consists of the respective functional principal component.

Table A1. Scores Model Based on Different Subsamples, Centered Distributions

	Inflation t+12											
Sample	**1979M1-2022M5**		**1979M1-1991M7**		**1991M8-2000M1**		**2000M2-2008M10**		**2008M11-2016M3**		**2016M4-2022M10**	
Constant	-1.48 -	-2.31 **	-1.68 -	-1.40 -	3.54 ***	1.53 -	2.96 ***	4.04 ***	6.13 ***	2.10 -	2.46 -	-4.31 -
Inflation	0.15 -	0.25 *	-0.09 -	-0.18 -	0.03 -	0.07 -	-0.69 ***	-0.72 ***	0.02 -	0.07 -	0.33 **	0.55 ***
Mean	1.01 ***	1.11 ***	1.58 ***	1.61 ***	-0.21 -	0.22 -	0.21 -	0.03 -	-1.18 ***	-0.30 -	0.40 -	1.90 **
Score1	-6.24 *	-0.53 -	7.30 *	6.13 -	-10.76 **	-4.53 -	38.84 ***	27.58 ***	6.99 -	19.82 ***	-40.62 ***	-14.69 -
Score2	26.45 ***	25.29 ***	34.15 ***	35.80 ***	-4.34 -	2.12 -	-28.56 ***	-23.76 ***	-30.71 ***	-21.48 -	1.11 -	29.37 -
Score3		21.03 **		-10.60 -		16.80 **		-18.64 **		38.18 **		66.89 -
Adj. R-squ	0.63	0.64	0.86	0.86	0.38	0.41	0.53	0.54	0.26	0.30	0.71	0.74

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Notes: Scores are based on FPCA performed on uncentered distributions. Subsamples are obtained from breakpoint tests on the specification including the mean and three scores. *** = significant at 0.01 level, **=significant at 0.05 level, *=significant at 0.1 level. Errors are Newey-West.

Table A2 reports regression results including high-inflation dummies. Here, as for the model based on uncentered distributions, we cannot conclude that the differences between different regimes are driven by differences in the level of inflation.

Table A2. Scores Model Augmented by High-Inflation Dummies, Centered Distributions

	Inflation t+12					
Model	**No dummy**		**Inflation>3 dummy**		**Inflation>4 dummy**	
Constant	-1.48 -	-2.31 **	-2.46 *	-3.07 **	0.02 -	-1.65 -
Inflation	0.15 -	0.25 *	0.38 **	0.41 **	0.19 -	0.22 -
Mean	1.01 ***	1.11 ***	1.29 ***	1.32 ***	0.64 -	0.90 *
Score1	-6.24 *	-0.53 -	-27.51 ***	-14.83 *	-16.53 ***	2.83 -
Score2	26.45 ***	25.29 ***	46.40 ***	40.51 ***	28.21 **	22.84 *
Score3		21.03 **		21.97 -		38.25 ***
Score4						
Dummy*mean			-0.26 **	-0.20 -	0.26 **	0.26 **
Dummy*score1			33.17 ***	22.36 **	23.12 ***	7.28 -
Dummy*score2			-22.81 -	-19.19 -	13.31 -	10.79 -
Dummy*score3				-10.11 -		-41.27 **
Dummy*score4						
Adj. R-squared	0.63	0.64	0.65	0.66	0.66	0.67

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Notes: Scores are based on FPCA performed on uncentered distributions. Subsamples are similar to regressions using centered scores. *** = significant at 0.01 level, **=significant at 0.05 level, *=significant at 0.1 level. Errors are Newey-West. The sample period is 1979m1-2022m10.

Results on the horse race with market and professional forecasters' expectations are reported in Table A3. As for the horse race based on uncentered distributions, results are largely insignificant for the 1990M10-2022M10 period, but information contained in household expectation does add informational value beyond this contained in market and professional forecasters' expectations for the more recent period.

Table A3. Horse Race with Professional Forecasters and Market Expectations, Centered Distributions

	Inflation t+12							
Sample	**1990M10-2022M10**				**2015M1-2022M10**			
Constant	3.57 *	1.57 -	1.57 -	2.73 -	5.40 -	1.81 -	1.48 -	2.00 -
Inflation	0.33 **	0.35 ***	0.36 *	0.27 ***	0.68 ***	0.82 ***	0.71 ***	0.74 ***
Households mean	-0.43 -	0.01 -	0.01 -	-0.13 -	-0.51 -	0.27 -	0.24 -	0.36 -
Households score 1	-3.90 -	4.36 -	4.44 -	0.32 -	-55.85 ***	-41.93 *	-46.14 **	-43.61 **
Households score 2	-9.50 -	-5.15 -	-5.15 -	-5.59 -	12.27 -	28.05 -	30.14 -	35.62 *
Households score 3		20.85 -	20.98 -	17.47 -		38.07 -	38.90 -	49.22 -
Market-based			-0.01 -	0.11 -			0.47 -	0.64 -
Professionals				-0.26 -				-0.76 **
Adj. R-squared	0.06	0.07	0.08	0.05	0.64	0.65	0.65	0.66

Sources: Survey of Consumers - University of Michigan and authors' calculations, Consensus Forecasts, Cleveland Fed market-based expectations.

Notes: Scores are based on FPCA performed on uncentered distributions.. *** = significant at 0.01 level, **=significant at 0.05 level, *=significant at 0.1 level. Errors are Newey-West.

Annex II. Full Set of Results for RMSEs

Table A4. Full Set of Results for In-sample RMSEs

Centered scores models											
Only mean	Mean plus score 1	Mean plus scores 1 and 2	Mean plus scores 1, 2, and 3	Only mean	Mean plus score 1	Mean plus scores 1 and 2	Mean plus scores 1, 2, and 3	Only mean	Mean plus score 1	Mean plus scores 1 and 2	Mean plus scores 1, 2, and 3
No dummy				*Dummy: Inflation > 3*				*Dummy: Inflation > 4*			
1.81	1.81	1.69	1.66	1.79	1.77	1.64	1.63	1.80	1.79	1.61	1.58

Uncentered scores models											
Score 1	Scores 1 and 2	Scores 1, 2, and 3	Scores 1, 2, 3, and 4	Score 1	Scores 1 and 2	Scores 1, 2, and 3	Scores 1, 2, 3, and 4	Score 1	Scores 1 and 2	Scores 1, 2, and 3	Scores 1, 2, 3, and 4
No dummy				*Dummy: Inflation > 3*				*Dummy: Inflation > 4*			
1.80	1.78	1.76	1.71	1.78	1.73	1.69	1.55	1.75	1.67	1.64	1.52

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Note: The sample period is 1978m1-2022m10

Table A5. Full Set of Results for Out-of-sample RMSEs, Full Sample

	Centered scores models											
	Only mean	Mean plus score 1	Mean plus scores 1 and 2	Mean plus scores 1, 2, and 3	Only mean	Mean plus score 1	Mean plus scores 1 and 2	Mean plus scores 1, 2, and 3	Only mean	Mean plus score 1	Mean plus scores 1 and 2	Mean plus scores 1, 2, and 3
	No dummy				*Dummy: Inflation > 3*				*Dummy: Inflation > 4*			
3 years	2.92	3.04	3.22	3.22	2.94	2.94	3.11	3.14	2.89	2.97	3.37	3.26
5 years	2.29	2.39	2.55	2.52	2.31	2.34	2.45	2.47	2.26	2.34	2.64	2.56

	Uncentered scores models											
	Score 1	Scores 1 and 2	Scores 1, 2, and 3	Scores 1, 2, 3, and 4	Score 1	Scores 1 and 2	Scores 1, 2, and 3	Scores 1, 2, 3, and 4	Score 1	Scores 1 and 2	Scores 1, 2, and 3	Scores 1, 2, 3, and 4
	No dummy				*Dummy: Inflation > 3*				*Dummy: Inflation > 4*			
3 years	2.88	2.82	2.89	3.13	2.93	2.88	2.92	2.96	2.99	2.99	2.94	3.02
5 years	2.26	2.22	2.27	2.57	2.32	2.28	2.32	2.34	2.35	2.37	2.33	2.39

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Note: The sample period is 1978m1-2022m10.

Table A6. Full Set of Results for Out-of-sample RSMEs, Restricted Sample

	Centered scores models											
	Only mean	Mean plus score 1	Mean plus scores 1 and 2	Mean plus scores 1, 2, and 3	Only mean	Mean plus score 1	Mean plus scores 1 and 2	Mean plus scores 1, 2, and 3	Only mean	Mean plus score 1	Mean plus scores 1 and 2	Mean plus scores 1, 2, and 3
	No dummy				*Dummy: Inflation > 3*				*Dummy: Inflation > 4*			
1978m1-2018m12	0.57	0.52	0.65	0.46	0.51	0.67	0.51	0.53	0.55	0.57	0.47	0.44
1991m7-2018m12	0.61	0.75	0.75	0.54	0.56	0.45	0.45	0.42	0.50	0.55	0.55	0.44

	Uncentered scores models											
	Score 1	Scores 1 and 2	Scores 1, 2, and 3	Scores 1, 2, 3, and 4	Score 1	Scores 1 and 2	Scores 1, 2, and 3	Scores 1, 2, 3, and 4	Score 1	Scores 1 and 2	Scores 1, 2, and 3	Scores 1, 2, 3, and 4
	No dummy				*Dummy: Inflation > 3*				*Dummy: Inflation > 4*			
1978m1-2018m12	0.62	0.72	0.50	1.12	0.44	0.39	0.44	0.38	0.54	0.45	0.44	0.41
1991m7-2018m12	0.87	0.81	0.63	0.54	0.43	0.44	0.44	0.53	0.55	0.54	0.48	0.48

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Note: The sample period is 1978m1-2018m12.

Annex III. Subsamples Based on Bai-Perron Sequential Breakpoint Tests

Table A7. Scores Model Based on Different Subsamples

	Inflation t+12											
Sample	**1979M1-2022M10**		**1979M1-1991M7**		**1991M8-2000M1**		**2000M2-2008M10**		**2008M11-2016M4**		**2016M5-2022M10**	
Constant	2.81 ***	2.75 ***	4.52 ***	4.54 ***	2.76 ***	2.76 ***	4.83 ***	4.69 ***	1.30 ***	1.18 ***	3.67 ***	3.69 ***
Inflation	0.21 -	0.23 *	-0.11 -	-0.05 -	0.01 -	0.02 -	-0.67 ***	-0.69 ***	0.00 -	-0.05 -	0.53 ***	0.50 ***
Score1	-22.34 ***	-21.77 ***	-34.38 ***	-27.92 ***	-8.25 **	-8.19 *	-3.05 -	-1.84 -	12.82 ***	10.04 ***	-15.51 -	-14.89 -
Score2	7.81 -	7.62 -	37.36 ***	34.06 ***	-3.94 **	-4.19 **	13.78 ***	11.87 **	-13.95 **	-16.43 ***	4.33 -	7.18 -
Score3	-15.83 *	-15.34 *	-19.48 ***	-35.99 ***	5.80 -	3.04 -	-27.85 ***	-38.79 ***	12.82 -	-14.87 -	62.30 ***	73.42 ***
Score4		26.91 ***		27.86 ***		-8.70 -		-25.62 -		-55.34 ***		17.79 -
Adj. R-squared	0.60	0.62	0.84	0.85	0.38	0.38	0.43	0.44	0.29	0.38	0.75	0.75

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Notes: Scores are based on FPCA performed on uncentered distributions. Subsamples are obtained from breakpoint tests on the specification including four scores. *** = significant at 0.01 level, **=significant at 0.05 level, *=significant at 0.1 level. Errors are Newey-West.

Table A8. Horse Race with Professional Forecasters and Market Expectations

	Inflation t+12							
Sample	**1991M10-2022M10**				**2016M5-2022M10**			
Constant	1.67 ***	1.68 ***	1.72 **	2.19 ***	3.67 ***	3.69 ***	3.50 ***	4.33 ***
Inflation	0.30 **	0.30 **	0.32 -	0.26 -	0.53 ***	0.50 ***	0.46 ***	0.47 ***
Households score 1	5.88 -	6.10 -	6.63 -	4.30 -	-15.51 -	-14.89 -	-15.82 *	-12.57 -
Households score 2	-2.84 -	-2.27 -	-2.32 -	-5.19 -	4.33 -	7.18 -	6.05 -	4.12 -
Households score 3	18.77 -	21.97 -	22.87 -	15.17 -	62.30 ***	73.42 ***	73.62 ***	73.82 ***
Households score 4		5.36 -	5.82 -	-3.58 -		17.79 -	17.04 -	7.04 -
Market-based			-0.05 -	0.05 -			0.17 -	0.31 -
Professionals				-0.23 -				-0.62 *
Adj. R-squared	0.06	0.06	0.06	0.03	0.75	0.75	0.74	0.76

Sources: Survey of Consumers - University of Michigan and authors' calculations, Consensus Forecasts, Cleveland Fed market-based expectations.
Notes: Scores are based on FPCA performed on uncentered distributions.. *** = significant at 0.01 level, **=significant at 0.05 level, *=significant at 0.1 level. Errors are Newey-West.

Table A9. Moments Model Based on Different Subsamples

	Inflation t+12											
Sample	**1979M1-2022M10**		**1979M1-1991M7**		**1991M8-2000M1**		**2000M2-2008M10**		**2008M11-2016M3**		**2016M4-2022M10**	
Constant	4.26 ***	1.11 -	9.53 ***	6.82 *	3.06 ***	4.23 ***	1.69 -	4.88 ***	-0.19 -	6.39 **	2.77 -	0.83 -
Inflation	0.33 **	0.23 *	0.13 -	0.07 -	0.05 -	0.10 -	-0.60 **	-0.62 ***	-0.01 -	-0.02 -	0.28 -	0.23 -
Mean	0.65 *	0.63 *	0.97 ***	0.88 ***	-0.31 **	-0.37 **	1.20 ***	1.16 ***	-0.66 **	-0.76 **	-0.18 -	-0.06 -
Variance	-0.11 ***	-0.02 -	-0.27 ***	-0.20 ***	0.09 ***	0.05 -	-0.21 ***	-0.37 ***	0.12 ***	-0.03 -	0.29 **	0.33 **
Skewness	-2.54 ***	-4.33 ***	-4.17 ***	-5.53 ***	-0.71 -	0.22 -	1.24 **	7.20 ***	2.07 *	5.45 ***	-3.13 ***	-5.36 **
Kurtosis		0.86 **		0.81 -		-0.32 -		-1.58 ***		-1.67 ***		0.72 -
Adj. R-squared	0.61	0.62	0.87	0.87	0.36	0.36	0.39	0.50	0.31	0.37	0.69	0.69

Sources: Survey of Consumers - University of Michigan and authors' calculations.
Notes: Subsamples are based on breakpoint tests performed on regression using the first three moments as explanatory variables.

Table A10. Horse Race with Professional Forecasters and Market Expectations

	Inflation t+12							
Sample	**1991M10-2022M10**				**2016M4-2022M10**			
Constant	3.86 -	3.86 -	4.05 -	4.46 *	0.83 -	0.87 -	1.90 -	3.29 -
Inflation	0.33 ***	0.31 -	0.22 -	0.21 -	0.23 -	0.26 -	0.25 -	0.33 ***
Households mean	-0.45 -	-0.45 -	-0.58 -	-0.64 *	-0.06 -	0.00 -	-0.12 -	-0.37 -
Households variance	0.04 -	0.04 -	0.08 -	0.09 -	0.33 **	0.32 **	0.33 **	0.30 **
Households skewness	1.06 -	1.03 -	0.45 -	0.61 -	-5.36 **	-5.23 **	-5.47 **	-4.70 **
Households kurtosis	-0.45 -	-0.46 -	-0.29 -	-0.42 -	0.72 -	0.71 -	0.75 -	0.37 -
Market-based		0.05 -	0.18 -	0.23 -		-0.12 -	0.02 -	-0.02 -
Professionals mean			-0.30 -	-0.39 -			-0.50 -	-0.60 *
Professionals variance				-1.59 -				0.79 -
Professionals skewness				-0.257 -				-0.833 **
Professionals kurtosis				0.13 -				0.25 -
Adj. R-squared	0.06	0.06	0.05	0.07	0.69	0.68	0.69	0.73

Sources: Survey of Consumers - University of Michigan, Consensus Forecasts, Cleveland Fed, and authors' calculations.

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