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FEDERAL RESERVE BANK *of* NEW YORK

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Abstract

We propose a new approach to assessing the anchoring of inflation expectations using "strategic surveys." Namely, we measure households' revisions in long-run inflation expectations after they are presented with different economic scenarios. A key advantage of this approach is that it provides a causal interpretation in terms of how inflation events affect long-run inflation expectations. We implement the method in the summer of 2019 and the spring-summer of 2021 when the anchoring of long-run inflation expectations was in question. We find that the risk of unanchoring of expectations was reasonably low in both periods, and that long-run inflation expectations were essentially as well anchored in August 2021 as in July 2019, before the COVID-19 pandemic.

Key words: inflation, expectations, anchoring, strategic surveys

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1. Introduction

Long-run inflation expectations that are consistent with an (implicit or explicit) central bank's inflation objective are viewed as one measure of successful monetary policy. In the United States, the Federal Open Market Committee (FOMC) judges that "longer-term inflation expectations that are well anchored at 2 percent foster price stability and moderate long-term interest rates and enhance the Committee's ability to promote maximum employment in the face of significant economic disturbances."[1] Hence, references to "anchoring" are frequently found in speeches, statements, and other forms of FOMC communications.[2] In particular, the potential un-anchoring of inflation expectations often emerges as a topic of concern during spells of unusually low inflation (like the one experienced in the United States during most of 2010's) or unusually high inflation (such as in 2021). But the practical question remains of how to measure the risk that long-run inflation expectations may become unmoored. Kumar et al. (2015) argue that the literature does not provide a clear definition of anchored inflation expectations, and thus there is no unique way of measuring the extent of anchoring. Indeed, the literature has used a range of metrics that do not necessarily yield consistent findings. In this paper, we propose a new approach to assess inflation expectations anchoring based on "strategic surveys" and implement it during two periods of heightened concerns about the potential un-anchoring of inflation expectations: the summer of 2019 and the spring-summer of 2021.

Strategic surveys (Ameriks et al., 2011) are experimental methods that enable causal identification by generating controlled exogenous variation. Respondents participate in various thought experiments describing different environments that may be hard to observe in practice. The survey responses are then used to identify cleanly a phenomenon of interest. As detailed in

[1] "Statement on Longer-Run Goals and Monetary Policy Strategy" (federalreserve.gov).
[2] See e.g. Bernanke (2007) and more recently, Clarida (2019a,b), Powell (2021) and Williams (2021).

Section 2, such methods have been applied in a wide range of economic settings. In this paper, three strategic surveys are designed to identify the extent to which long-term inflation expectations are sensitive to shocks or surprises to *past* or *future* inflation: In the backward-looking "inflation shock" experiment, respondents are asked to think about scenarios with *past* inflation being higher or lower than it actually was over the past 3 or 10 years; In the forward-looking "inflation surprise" experiment respondents are asked to consider inflation surprises, that is, situations in which *future* near- or medium-term inflation turns out to be higher or lower than they currently expect; Finally, the "joint inflation & unemployment surprise" experiment presents respondents with different hypothetical combinations of *inflation and unemployment* surprises over the next 12 months, where surprises are again defined relative to what they currently expect.

This approach has four main advantages. First, it speaks directly to the extent to which longer-term inflation expectations risk becoming unmoored due to prolonged spells of persistently high or low inflation. Second, because it employs a series of thought experiments specifically designed to generate controlled exogenous variation, it provides a causal interpretation. Third, it enables one to study the sensitivity of longer-term inflation expectations to changes in the environment that may occur infrequently in the real world, such as sizable and persistent positive or negative inflation shocks or surprises. Fourth, it can be implemented at any time at relatively low cost, providing real-time readings of potential inflation expectations un-anchoring.

We use three special modules of the Federal Reserve Bank of New York's Survey of Consumers Expectations (SCE) to implement this approach during two periods of heightened concern about inflation expectation anchoring, conducted in July 2019, April 2021, and August 2021. The longer-run inflation objective was set at 2 percent of the personal consumption expenditure (PCE) price index, consistent with the goal established by the FOMC in 2012 to

formalize the price stability objective of the dual mandate.[3] In the event, inflation consistently undershot this objective for most of the following nine years. In 2019, the policy debate became centered on whether the prolonged period of inflation undershooting could unmoor long-term inflation expectations on the downside (see e.g. Williams 2020). The opposite concern arose in 2021 when supply disruptions and large shifts in consumer demand associated with the Covid-19 pandemic caused extraordinarily large movements in relative prices and elevated inflation. The question asked by many at the time was whether the surge in inflation experienced in the second and third quarter of 2021 risked un-anchoring long-term inflation expectations on the upside.[4]

Our results indicate that the risk of expectations un-anchoring as captured by our measures was reasonably low in both periods, and that long-run inflation expectations were essentially as well anchored in August 2021 as in July 2019, before the onset of the pandemic. To support these conclusions, we start off by looking at changes over time in the distribution of short- and longer-term expectations. Here we find that the distribution of 5-year ahead inflation expectations changed little between 2019 and 2021, in sharp contrast with a significant shift to the right of the distribution of 1-year ahead inflation expectations over the same period.

We then turn to the results of our strategic experiments. In the backward-looking experiment we find that the sensitivity of longer-term inflation expectations to hypothetical past inflation shocks is similar in 2019 and 2021. In every survey, the average magnitude of revisions is relatively modest, compared to the large and protracted nature of the shocks described in the hypothetical scenarios. We also uncover interesting asymmetries: In the 2019 backward-looking experiment, long-run inflation expectations were more sensitive to negative inflation shocks than

[3] "Statement on Longer-Run Goals and Monetary Policy Strategy," adopted effective January 24, 2012 and last amended in August 2020 following the FOMC's Review of Monetary Policy Strategy, Tools, and Communications.
[4] See e.g. this news story from October 2021 about Larry Summers' views on inflation and inflation expectations: https://www.bloomberg.com/news/articles/2021-10-25/larry-summers-takes-inflation-debate-with-yellen-to-twitter.

to positive inflation shocks. The asymmetry reverses in the 2021 experiments, with larger revisions in the positive inflation treatments than in the negative ones. The asymmetries are consistent with the shifting pattern of realized inflation, where elevated readings in the spring and summer of 2021 replaced the persistent under-shooting of inflation that was concerning in 2019.

The direction and magnitude of the average treatment effects vary with the sign and the duration of the hypothetical inflation shocks: respondents on average revise their longer-term inflation expectations downward in the negative shock treatments and revise upward in the positive shock treatments. Furthermore, the average size of revisions is larger when the scenarios depict shocks of longer duration. The two forward-looking experiments yield similar results in terms of the size and direction of revisions in 5-year ahead inflation expectations in response to near-term inflation and/or unemployment surprises.

Finally, across all three surveys and all experiments, we find that a sizable share of participants—ranging between about 30% to 50%—respond as if they had perfectly anchored inflation expectations, in the sense that their long-run inflation beliefs are unresponsive to persistent inflation shocks or surprises. The share of non-revisers remains stable over time, even after the extraordinary economic dislocations caused by the pandemic. This result lends additional support to the conclusion that longer-term inflation expectations remained as well-anchored in April and August 2021 as they were in July 2019.

The rest of the paper is organized as follows. Section 2 reviews the literature on inflation expectations anchoring and introduces the strategic survey approach. Section 3 describes the three special modules of the SCE on which our analysis is based and compares reported short- and long-run expectations across the three survey waves. The experimental design of our strategic surveys is detailed in section 4 and empirical results are presented in section 5. Section 6 concludes.

2. Related Literature

2.1 Existing measures of inflation anchoring

The literature has considered a range of measures of anchoring of inflation expectations. These metrics can be broadly classified into two categories, corresponding to "level" anchoring and "shock" anchoring (Ball and Mazumder 2011, see Kumar et al. 2015 for a formalization of anchoring metrics). The first category captures the extent to which economic agents' beliefs about long-run inflation remain within some range of the central bank's inflation target. Thus, if inflation beliefs are well anchored, then *mean or median* expectations should be aligned with the target, and *absolute deviations* from the target should be small. Furthermore, agents' inflation expectations should be tightly distributed around the central bank's target, thereby indicating little *disagreement* across respondents. Similarly, a respondent whose expectations are well anchored should express little forecast *uncertainty* about inflation in the long run.

The second category is meant to capture the extent to which long-run inflation expectations respond to shocks. In particular, when expectations are well-anchored one would expect an agent's *forecast revisions* of long-run inflation expectations to be small. In addition, if expectations are well-anchored, there should be relatively low *co-movement* between revisions in long-run expectations and corresponding revisions in short-run expectations (Kumar et al. 2015, Dräger and Lamla 2018), and revisions in long-run inflation expectations should not be overly sensitive to *short-term inflation forecast errors* (see Carvalho et al. 2021).

Studies of inflation expectations anchoring employ various combinations of level and shock anchoring metrics and use different types of data. Some papers use data from surveys of consumers, professional forecasters or businesses, while others use market-based measures. The geographic coverage of these studies is quite broad, spanning advanced and emerging economies.

A number of studies find that long-run expectations were well anchored in several countries before the Covid-19 pandemic. Ball and Mazumder (2011), Dräger and Lamla (2018) find that pre-pandemic, inflation expectations in the U.S. had generally become better anchored over time. Similarly, Bems et al. (2021) find improved anchoring in 45 countries between the early 1990's through 2017. Moessner and Takats (2020), find that inflation expectations have remained well-anchored in advanced economies between 1996 and 2019, even after the global financial crisis.

Other studies have identified situations where long-run inflation expectations were not well-anchored or became un-anchored. Kumar et al. (2015) find that long-run inflation expectations of firms in New Zealand are not well-anchored. Binder (2017) finds a lack of anchoring in the U.S. but notes that level anchoring has improved over time. Busetti et al. (2017), Dovern and Kenny (2020) and Möhrle (2020) find evidence of deteriorating anchoring to the downside in the euro area following the global financial crisis. Galati et al. (2021) find that Dutch consumers' long term euro area inflation expectations may have become un-anchored to the upside during the pandemic. Finally, Candia et al. (2021a,b) find a positive correlation between revisions in short-run inflation expectations and revision in long-run inflation expectations, consistent with a lack of anchoring.

2.2 Strategic Surveys

To introduce strategic surveys, Ameriks et al. (2011) write "We employ a series of hypothetical questions as essential aids in the identification process. These 'strategic' survey questions represent natural thought experiments concerning behavior in contingencies selected for their high information content." These thought experiments are designed to generate controlled exogenous variation in order to cleanly identify a parameter of interest.

The object of interest for the researcher may vary. For instance, Barsky et al. (1997) use data from a strategic survey to identify the degree of risk aversion. They do so by measuring how much

one needs to be compensated to take income risk. By asking respondents to make hypothetical financial decisions at two different points in time, one now and the other close to the end of life, Ameriks et al. (2011) are able to disentangle two hypotheses, the "bequest motive" and the "public care aversion," that had been proposed to explain why few people purchase private annuities. Ameriks et al. (2020a) use a strategic survey designed to separate supply and demand side forces to identify the willingness to work of older Americans. Fuster and Zafar (2021) use a strategic survey to identify the separate effects of mortgage rates, down payment constraints, and exogenous wealth shocks on housing demand. In our setting, we design strategic questions to identify the causal effect of the duration and the magnitude of inflation shocks or surprises on long-run inflation expectations. Thus, our approach belongs to the class of shock anchoring measures.

Strategic surveys are closely related to other approaches, such as, for example, the so-called "vignettes" studies in which hypothetical situations are described in some detail (see e.g. Andre et al. 2021). Recent examples of similar approaches include Beshears et al. (2014), Jappelli and Pistaferri (2014), Fuster and Zafar (2016), Armona et al. (2018), Fuster et al. (2020), Ameriks et al. (2020b), Christelis et al. (2019), Roth et al. (2021).[5]

Strategic surveys present several appealing features. First, because they use scenarios aimed at generating controlled exogenous variation, the associated within-person variation in responses have a causal interpretation. Second, they allow the researcher to identify the object of interest without confounding factors: for example, the strategic surveys of Ameriks et al. (2020a) allow them to estimate the willingness to work of older Americans without confounding a desire to work with perceived job opportunities. Third, they enable researchers to present respondents with hypothetical situations that are tailored to the research question of interest and may be impossible

[5] Our approach is also related to recent work involving the use of elicited choice probabilities in stated choice experiments to causally estimate preferences (Blass et al. 2010, Wiswall and Zafar 2018, Kosar et al. 2020).

to replicate with naturally occurring data. We exploit these features in our application to inflation expectations anchoring and discuss further their advantages and limitations in section 4.

3. Data

The SCE is a monthly, internet-based survey produced by the Federal Reserve Bank of New York since June 2013. It is a 12-month rotating panel (respondents are asked to take the survey for 12 months) of roughly 1,300 nationally representative U.S. household heads. The main goal of the survey is to collect consumers' expectations on both macroeconomic variables (such as inflation, home price changes, unemployment, credit availability) and individual future outcomes (such as wage growth, the likelihood of losing or finding a job, household income and spending growth). The survey also collects a rich array of socio-demographic characteristics from each respondent.

The SCE consists of a core monthly survey, with the same set of questions asked each month, and "special surveys" conducted on an ad-hoc basis to address timely questions. We focus here on three special surveys fielded in July 2019 (999 respondents), April 2021 (1,024 respondents), and August 2021 (2,209 respondents). Respondents in these special surveys are former SCE panelists who had previously rotated out of the 12-month panel. Note that 674 respondents completed *both* the July 2019 and August 2021 surveys, while 807 respondents completed *both* the April and August 2021 surveys. This allows for a direct within-person comparison across surveys.[6]

As explained below, the backward-looking *inflation shock* experiment was conducted in all three surveys. The forward-looking *inflation surprise* experiment was conducted in April and

[6] Armantier et al. (2017) and Binder and Kim (2020) discuss the issue of "panel conditioning" or learning in inflation expectations surveys that are repeated over time. While we cannot rule out panel conditioning, we think it is unlikely to affect our results substantially for a number of reasons. First, most of the panel conditioning effects identified in these papers occur in the first few months of participation in a panel. So, it should not affect much our experienced respondents. Second, our special surveys were widely spaced apart, and respondents were not aware they would be invited back for any subsequent surveys. Hence, respondents had no incentive to learn about future inflation between surveys. Third, as explained below, we focus on within-person variation in treatment responses. So, it is not obvious any level bias associated with previous survey participation would also affect differences in treatment responses.

August 2021 and the *joint inflation & unemployment surprise* experiment was conducted only in the August 2021 survey. Thus, we are able to compare the anchoring measures from the *inflation shock* and *inflation surprise* experiments at different point in times.

In each of the three surveys we elicited consumers' short- and long-run inflation expectations. To measure short-run inflation expectations, we asked respondents "*What do you expect the rate of [inflation/deflation] to be over the next 12 months?"* To measure long-run inflation expectations, we asked respondents the same question, but we replaced "*Over the next 12 months*" with "*Over the 12-month period between* M+48 *and* M+60," where M is the month in which the respondent takes the survey. So, for instance, a respondent taking the survey in August 2021 was asked about inflation "*Over the 12-month period between August 2025 and August 2026.*" [7,8]

Before moving to the strategic survey, we compare reported short- and long-run expectations across the three surveys. Table 1 shows the median point prediction in each survey at the two horizons. We see an increase in the median 1-year ahead inflation expectations between July 2019 and April 2021 (from 2.92% to 3.24%), followed by a sharp rise (from 3.24% to 4.84%) in the four months between the April and August 2021 surveys. These differences are all statistically significant at the 1% level (see Table A1).[9] In August 2021, respondents were asked for the reason(s) that led to this sharp increase. Overwhelmingly, they mentioned it was driven primarily by their own experience with higher prices during the previous months.

[7] The SCE questionnaire design builds on an extensive feasibility study conducted from 2006 to 2013 (see van der Klaauw et al. 2008, Armantier et al. 2013, 2017). The SCE core module also elicits a density forecast for inflation. In the strategic surveys we focus on point predictions: Because we need to elicit revisions in inflation expectations several times during the experiment, eliciting density forecasts would be too lengthy and cognitively demanding.

[8] Inflation expectations data from the SCE have been used to address both policy and research questions. For instance, Armantier et al. (2015) find that survey respondents tend to act on their reported inflation beliefs in a manner consistent with theory. Armantier et al. (2016) show that respondents update their inflation expectations sensibly upon receipt of new information. See also Crump et al. (2021) and Armantier et al. (2021) for recent use of SCE inflation data.

[9] Tables and Figures with a number preceded by the letter "A" can be found in Appendix. We focus on medians in Table 1 because survey inflation expectations typically include outliers. As shown in Table A2 using (raw or trimmed) means confirms that expectations have risen substantially more at the one- than at the five-year horizon across surveys.

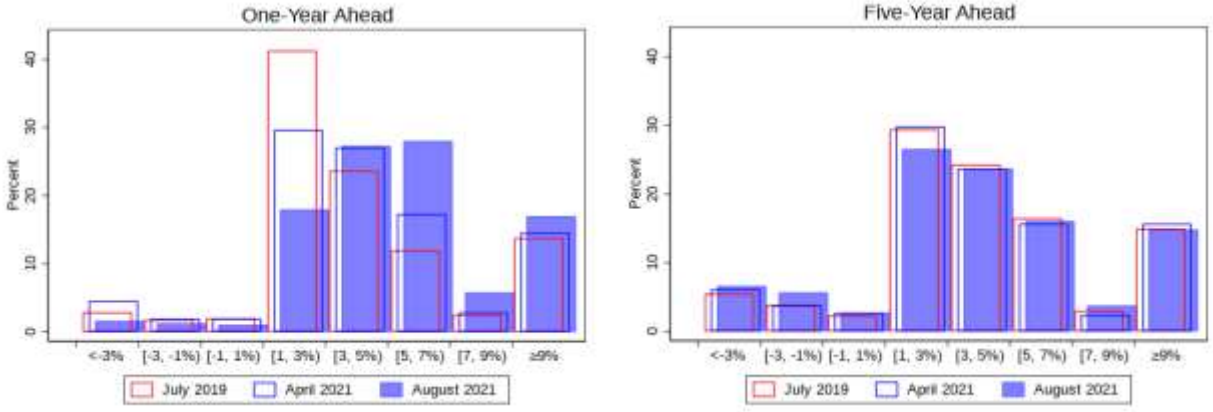
Table 1: Median Short-Run and Long-Run Inflation Expectations

	July 2019 (N=999)		**April 2021** (N=1024)		**August 2021** (N=2209)	
	Horizon	Median Point Prediction	Horizon	Median Point Prediction	Horizon	Median Point Prediction
1 year ahead	Jul 19-20	2.92%	Apr 21-22	3.24%	Aug 21-22	4.84%
5 year ahead	Jul 23-24	3.00%	Apr 25-26	3.00%	Aug 25-26	3.16%

The medians reported are interpolated medians computed using the iquantile module (Cox 2009) in Stata.

In sharp contrast, Table 1 indicates that the median 5-year ahead inflation point prediction remained unchanged at 3.00% between July 2019 and April 2021 and increased only modestly (and statistically insignificantly) between April and August 2021 (to 3.16%). Thus, it appears that the surge in realized inflation that occurred in the first half of 2021 had only a modest impact on the long-run inflation expectation the median U.S. consumer reported in August 2021.

Figure 1: Distributions of Short-Run and Long-Run Inflation Expectations



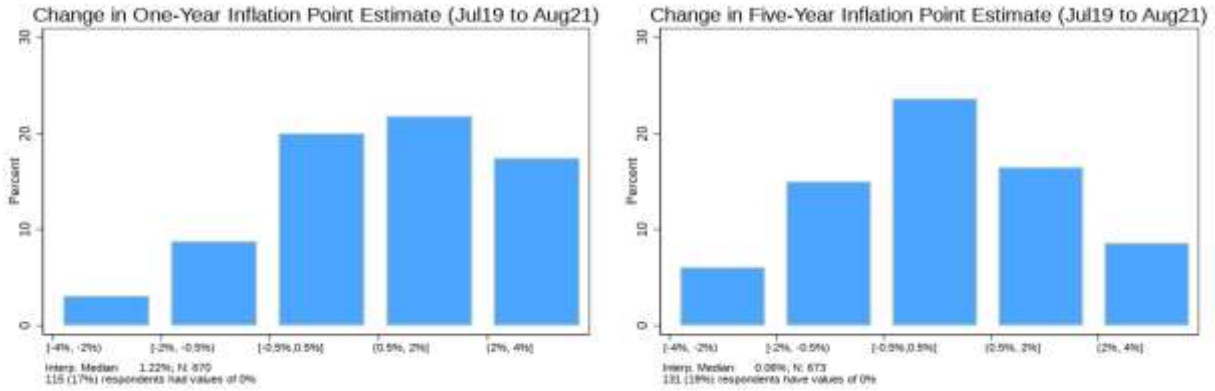
Having compared central tendencies across surveys, we now compare the entire distribution of inflation expectations across respondents. Figure 1 shows the proportion of respondents who report inflation point predictions in different bins, focusing on the region between -3% inflation (or 3% deflation) and 9% inflation. The left panel is for 1-year ahead inflation expectations, while the right panel is for 5-year ahead. The red hollow bars are for the July 2019 survey, the blue hollow bars for the April 2021 survey, and the blue solid bars for the August 2021 survey.

Starting with the distribution of 1-year inflation expectations in the left panel of Figure 1, we

can see a clear shift to the right, that is toward higher inflation values, between 2019 and 2021.[10] In particular, the proportion of respondents who expect inflation a year from now to be between 1% and 3% dropped significantly from 41% in July 2019 to 18% in August 2021. Meanwhile, the proportion of respondents who expect inflation a year from now to be between 5% and 7% more than doubled (from 12% to 28%) during the same period (a statistically significant increase).

In sharp contrast, the distributions of 5-year ahead inflation expectations in the right panel of Figure 1 remained remarkably similar across the three surveys. Although we see small differences in the proportion of respondents who expect inflation 5 years ahead to be between 1% and 3%, no clear pattern emerges.[11] Thus, our survey results suggest that the entire distribution of long-run inflation expectations remained mostly unchanged between 2019 and 2021.[12]

Figure 2: Distribution of Change in Inflation Point Predictions Among Respondents who Completed both the July 2019 and August 2021 Surveys



Does this imply that respondents did not revise their long-run inflation expectations at all during the past 2 years? To answer this question, we focus on the 674 respondents who completed both the July 2019 and August 2021 surveys. Figure 2 shows the distribution of individual changes in 1- and 5-year ahead inflation point predictions between the two surveys. We can see that the

[10] Figure A1, showing the same distributions as in Figure 1 winsorized at -5% and 20%, confirms there is little movement in the tails of the distributions—especially at the five-year-ahead horizon.
[11] Kolmogorov-Smirnov tests reject the null hypothesis that the distributions of short-run inflation expectations are the same across the three surveys, but they fail to reject the same null hypothesis for long-run inflation expectations.
[12] These patterns are confirmed when focusing only on repeat respondents (see Figure A2).

distribution of changes in 1-year ahead inflation expectations is skewed to the right, reflecting a statistically significant increase in 1-year ahead inflation expectations among repeat respondents (see Table A3). In contrast, the distribution of changes in 5-year ahead inflation expectations is remarkably symmetric, with 19% of repeat respondents reporting *exactly* the same long-run inflation expectations two years apart, and an almost equal number of respondents revising their long-run inflation expectations upward and downward.[13] The latter may reflect noise or rounding errors, as is often the case with inflation surveys that elicit point predictions, but they may also reflect the unprecedented events consumers experienced over this period.

To sum up, the results provide prima facie evidence that in August 2021 consumers' five-year ahead inflation expectations were as well anchored as they were two years prior, before the start of the pandemic. Nevertheless, the large proportion of repeat respondents that revised their long-run inflation expectations between 2019 and 2021 may reflect some un-anchoring. To get a better sense of the risk of un-anchoring in 2019 and 2021, we now turn to our new experimental approach.

4. The Design of the Strategic Surveys

Our objective is to address the following question: Could prolonged spells of unusually high or low inflation risk un-anchoring long-term inflation expectations? To do so, we design a strategic survey and conduct three experiments. The backward-looking *inflation shock* experiment aims at measuring the sensitivity of long-run inflation expectations to persistent past inflation shocks. The forward-looking *inflation surprise* experiment measures how 5-year ahead inflation expectations respond to *future* (near- and medium-term) inflation surprises. Finally, in the forward-looking *joint*

[13] We reject the null hypothesis that the mean change is zero for 1-year ahead expectations, but not for 5-year ahead expectations. Although downward revisions may seem surprising in the high-inflation environment respondents experienced in the summer of 2021, we note that they were consistent with the risk reported by a few commentators that longer-running structural factors behind the declines in inflation in pre-pandemic years, could have resumed once supply disruptions and the large relative price movements induced by the pandemic had run their course.

inflation & unemployment surprise experiment we measure how sensitive long-run inflation expectations are to joint surprises in near-term inflation *and* unemployment.

We start by describing the backward-looking *inflation shock* experiment. The timing is the following. To start, the respondent's *baseline* long-term inflation expectation (here 5-year ahead expectations) is elicited. Then, the respondent takes part in four consecutive treatments, each consisting of two steps. In the first step, the respondent is asked to consider a scenario. For instance, the respondent is told: "*What if in* ***each of the past three years*** *inflation had been* ***lower*** *than it actually was* ***by 1 percent*** *each year*." In the second step, the respondent's *conditional* long-term expectation is elicited. In August 2021 for instance, respondents are asked: "***Under this scenario****, would the rate of inflation you expect for the 12-month period between* ***August 2025 and August 2026*** *be different than the [X] percent you just reported?*" A follow-up question then elicits a quantitative measure of the change in her expectation, if any.

We conduct what is known as a "2 by 2," "within subject" experiment. There are two treatment variables: the sign and the duration of the inflation shock. The sign of the inflation shock is either positive (i.e., inflation is 1 percent higher) or negative (i.e., inflation is 1 percent lower). The duration of the shock is either "short" (i.e., the shock lasts for each of the past 3 years) or "long" (i.e., the shock lasts for each of the past 10 years). Finally, as discussed earlier, the same respondent is exposed to each of the four treatments, so that treatment effects can be identified at the individual level, thereby controlling for unobserved heterogeneity.[14] Importantly, the advantage of this experimental approach is to enable the identification of causal effects, namely, how the direction and the duration of the inflation shocks causally change long-run inflation expectations.

The other two experiments have a similar design, but respondents are asked to consider

[14] Respondents see the four treatments in the same order. Thus, we cannot rule out order effects. However, the ranking of treatments effects changes across surveys (see below) which suggests that order effects do not play a big role.

different scenarios. In the forward-looking *inflation surprise* experiment, respondents are presented with scenarios of the form "*What if the rate of inflation* ***over the next 12 months*** *turns out to be* ***1% higher than you [currently expect]****?*" *or* "*What if the rate of inflation turns out to be* ***1% higher*** *than you* ***[currently expect] in each of the next 3 years?***" In the 2 by 2 design, the sign of the inflation surprise is either "1% higher" or "1% lower," and the duration is either "over the next 12 months" or "in each of the next 3 years." Observe that a baseline has to be elicited for each duration in this experiment, i.e. respondents are asked to report their 5-year ahead inflation expectations under two scenarios in which inflation over the next 12 months and in each of the next 3 years is "***exactly as you expect***."

In the forward-looking *joint inflation & unemployment surprise* experiment, respondents are asked to consider scenarios of the form "*Imagine that the rate of inflation* ***over the next 12 months*** *turns out to be* ***1% higher than you [currently expect]****, and the* ***unemployment rate 12 months from now*** *turns out to be* ***1% lower than you [currently expect].***" In this experiment the horizon of the surprise is fixed at 1 year. The 2 by 2 design is obtained by varying the sign of the inflation and the sign of the unemployment surprises to either "1% higher" or "1% lower." As in the forward-looking *inflation surprise* experiment, a baseline expectation has to be elicited, i.e. we ask respondents to report their 5-year ahead inflation expectations under the scenario in which inflation *and* the unemployment rate over the next 12 months are "***exactly as you expect***."

Several features distinguish our approach from the related shock anchoring metrics discussed in Section 2. First, it enables one to evaluate the risk of inflation expectations un-anchoring for a given person and at a given point in time. As such, it is not affected by time-varying unobserved factors that may affect other measures based on panel regressions with individual-level data. Second, the experiments are conducted in a controlled environment. In particular, we control the size and duration of the shocks and are able to present scenarios that have never occurred before.

Third, the scenarios can be tailored to the situation of particular policy or academic interest. For instance, compared to other measures of anchoring, our approach perhaps captures most directly the question often posed by policy makers: Do prolonged spells of high or low inflation risk de-anchoring long-run inflation expectations? Fourth, as mentioned earlier, because of the "2 by 2" and "within-subject" design specifically aimed at generating controlled exogenous variation, the revisions in beliefs we record have a causal interpretation at the individual level.

These features make our approach appealing in addressing our research question. Nevertheless, strategic surveys have limitations. As is always the case when measuring (unobservable) beliefs, we cannot fully control what the respondents have in mind when they report their expectations. In particular, we cannot be sure that the respondents are able to immerse themselves fully in each scenario, and we do not know the extent to which they think other variables are changing with inflation in each scenario. That said, these caveats are common to all treatments and thus cannot explain differences across treatments. Furthermore, as noted in Section 2, a growing literature shows that strategic surveys are informative to understand contingent behavior in environments that are difficult to study with naturally occurring data. As we will see below, responses in our experiments and in particular differences in revisions across treatments appear to be meaningful.

5. Experimental Results

5.1 Backward-looking experiment

We first report the results of the backward-looking *inflation shock* experiment. Figure 3 describes the distributions of revisions in the 2 by 2 treatments (by sign and duration of the inflation shock), for all three surveys. In each plot, blue bars represent the share of respondents who do not revise their 5-year inflation expectations following that treatment. Green bars represent respondents who revise their expectations upward, with darker shades representing larger revisions. Similarly, red

bars represent respondents who revise their expectations downward, with darker shades again representing larger revisions. The average revisions by treatment for all three special surveys are shown in Table 2. For example, in July 2019 and looking at the treatment with inflation lower by 1% for 3 years, Figure 3 indicates that almost 40% of respondents did not revise their expectations, while Table 2 shows that the average revision in this treatment was -0.35 percentage point.

Table 2: Average Treatment Effects in Backward Scenario Experiments

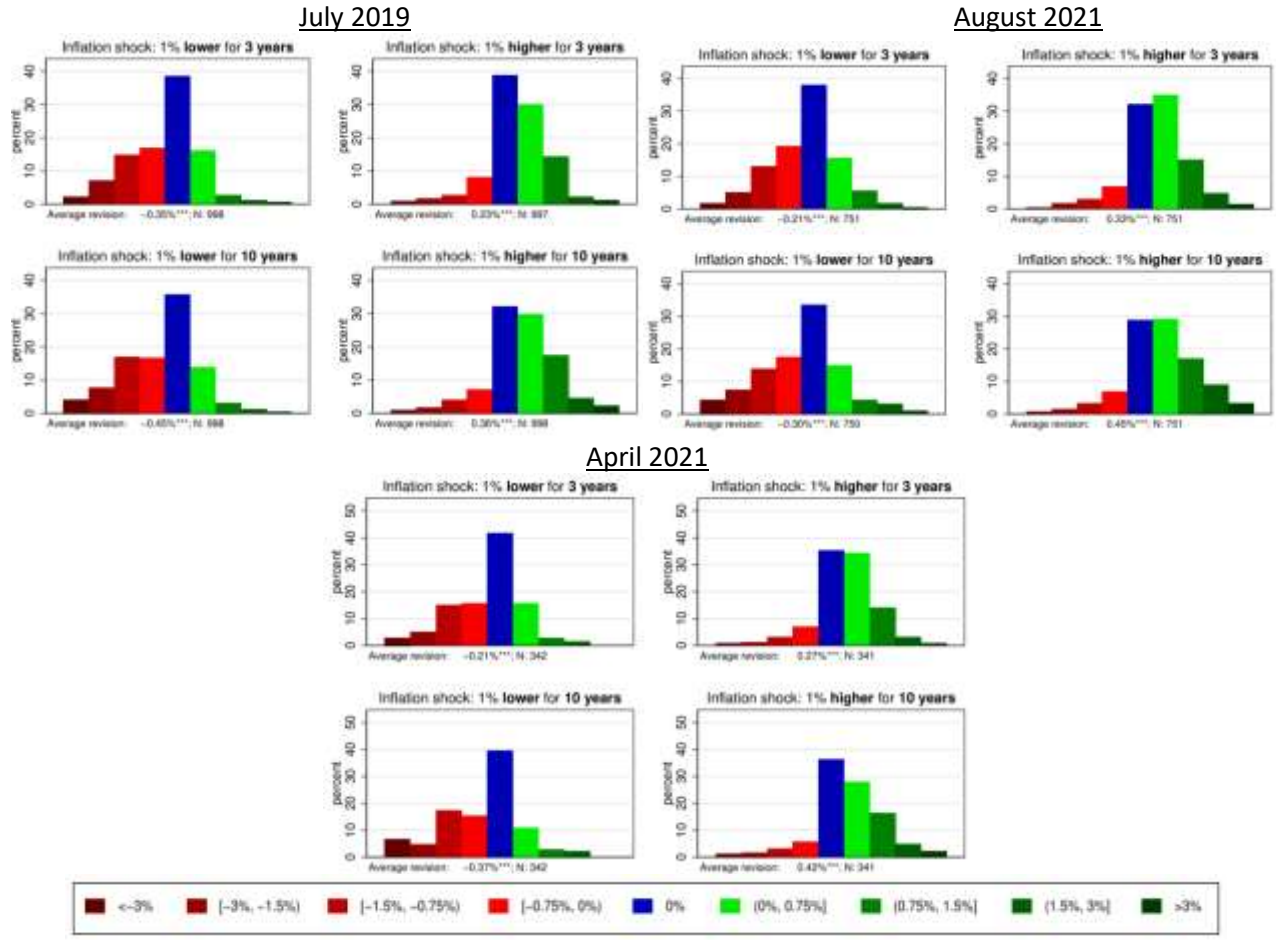
		July 2019 (N=1000)		**April 2021** (N=342)		**August 2021** (N=751)	
		Sign of inflation shock		Sign of inflation shock		Sign of inflation shock	
		1% Lower	1% Higher	1% Lower	1% Higher	1% Lower	1% Higher
Duration of inflation shock	Past 3 years	-0.35 (0.03)	0.23 (0.03)	-0.21 (0.05)	0.27 (0.04)	-0.21 (0.04)	0.33 (0.03)
	Past 10 years	-0.45 (0.03)	0.36 (0.03)	-0.37 (0.06)	0.42 (0.05)	-0.30 (0.04)	0.45 (0.04)

The average treatment effects are in percentage points. Standard errors in parentheses.

The sign and direction of revisions appear sensible: Table 2 shows that, across all three surveys, the average revision is always negative in the negative shock treatments and positive in the positive shock treatments. These treatment effects are all statistically significantly different from zero (see Table A4). Among those who revise, most revise their expectations downward (upward) in the negative (positive) shock treatments. For instance, Figure 3 shows that in July 2019, slightly more than 40% of respondents revised downward in the negative shock treatments, and about half revised upward in the positive shock treatments. The same pattern holds in the 2021 experiments.

Furthermore, the average magnitude (in absolute value) of the treatment effect increases monotonically in the *duration* of the shock. Table 2 indicates that the average (absolute) revision is always larger in each of the 10-year treatments than in the 3-year treatments. These differences are again statistically significant (see Table A4). Thus, respondents' revisions appear consistent with what one would expect given each of the contingencies depicted in the various treatments, and the evidence suggests that respondents paid attention and took the experiment seriously.

Figure 3: Distribution of Revisions by Treatments



Turning now to the topic of the risk of un-anchoring, Table 2 shows that the magnitude (in absolute value) of average revisions ranges from 0.21 to 0.45 percentage point across treatments and surveys. We argue that these are modest revisions considering that the inflation "shocks" in each treatment (one percent higher or lower inflation for each of the past 3 or 10 years) are large and protracted by historical standards. Furthermore, note that the average magnitude of revisions remains quite stable between the experiment conducted in 2019 and those conducted in 2021, despite the tremendous movements in relative prices associated with the Covid-19 pandemic and related shutdowns, re-openings and supply disruptions.

The share of non-revisers in each of the experiments is also notable. Across treatments and surveys, 29% to 42% of respondents act as if they had perfectly anchored inflation expectations,

in the sense that their long-term inflation beliefs are completely unresponsive to persistent inflation shocks (see Figures 3 and A2). The modal revision in all four treatments and all three surveys is in fact zero. Importantly, we can see in Figure 3 that the share of "perfectly anchored" respondents remains remarkably stable between July 2019 and August 2021.[15] We also note that, except for the positive shock treatments in April 2021, the proportion of "perfectly anchored" respondents is always lower in the 10-year treatments than in the 3-year treatments, consistent with expectations.

We find an asymmetry in the responses to the positive vs. negative treatments, which reverses direction between 2019 and 2021. As shown in Table 2, in the 2019 experiment the absolute value of the average treatment effect is larger in the negative shock treatments than in the positive ones. That is, the downward revisions in the 3 and 10-year negative shock treatments (-0.35 and -0.45 percentage points on average) are significantly larger (see Table A4) in absolute size than the upward revisions in the corresponding positive shock treatments (0.23 and 0.36 percentage points on average). The greater sensitivity to negative shocks appears sensible as it may reflect the persistent undershooting of inflation relative to the central bank's target over most of the 2010's. The asymmetry also lends support to the concerns policy makers expressed at the time about the impact of a persistent undershooting of the inflation target. Although this asymmetry is relevant and should not be ignored, we note that the size of the treatment effects in the negative shock treatments remains relatively modest, which suggests that this undershooting did not induce a serious risk of un-anchoring to the downside in July 2019.

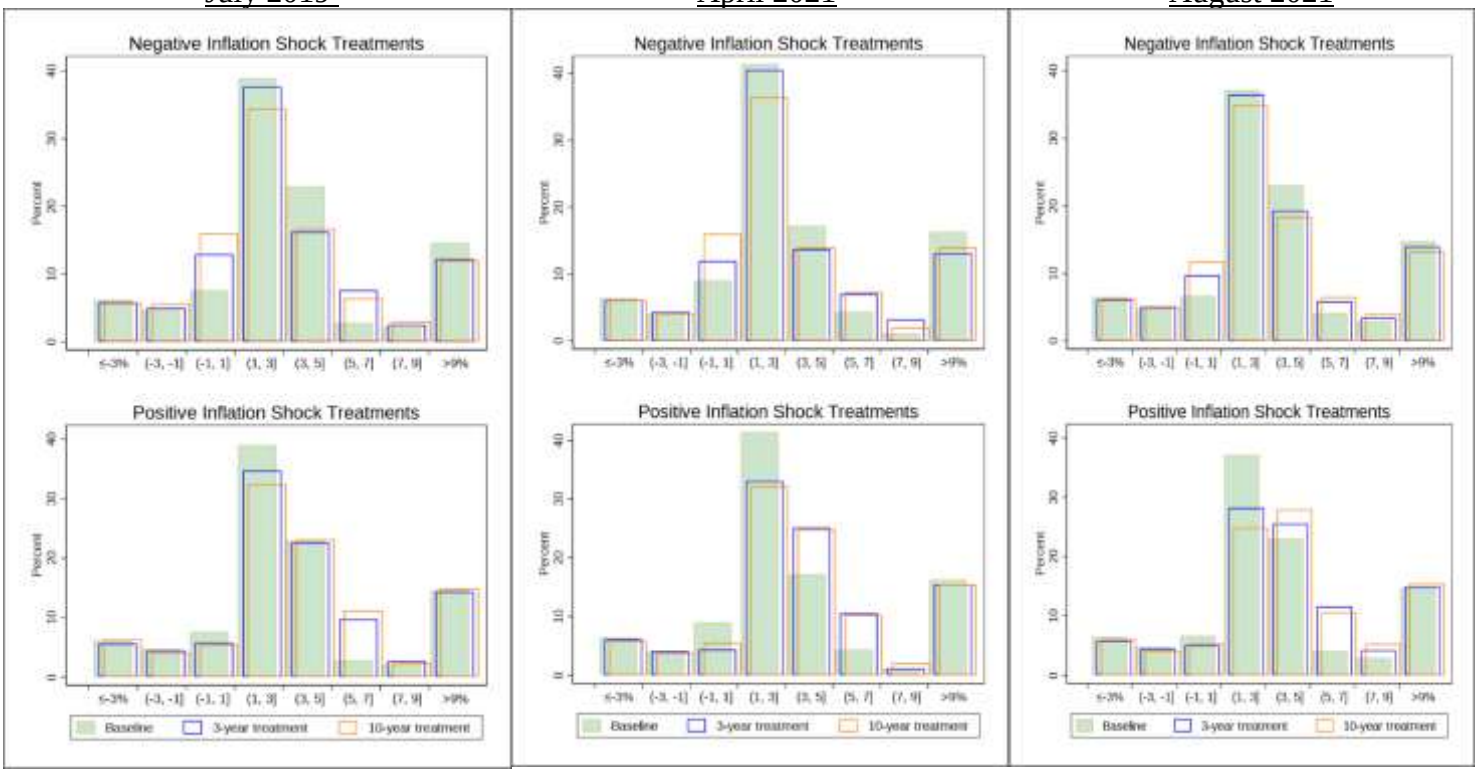
The asymmetry reverses in the two experiments conducted in 2021, with average revisions

[15] One may be concerned that a zero revision may reflect inertia, fatigue or a lack of effort in answering the questions. We find no evidence to support this hypothesis. In particular, non-revisers took essentially as much time to complete the survey as non-revisers. Furthermore, the proportion of non-revisers did not increase in the latter part of the survey. Finally, the share of non-revisers responds to the type of treatment effect considered. For instance, when eliciting the impact of inflation shocks on expectations about future changes in earnings in a different strategic survey, we find up to 75% of non-revisers. These results suggest that zero revision answers are informative.

larger (in absolute size) in the two positive shock treatments than in the negative ones (see the two rightmost panels of Table 2).[16] This finding again likely reflects the elevated inflation readings during spring and summer 2021, and concerns raised in the media as well as by policymakers (see e.g. Clarida 2021 or Powell 2021).[17] Given the modest size and stability of the average treatment effects in the two surveys conducted in 2021, the evidence presented here points to a relatively modest risk of un-anchoring of longer-term inflation expectations, as of August 2021.

Figure 4: Distribution of 5-Year Ahead Inflation Expectations

July 2019 April 2021 August 2021



To get a different perspective on how the experimental treatments affect expectations, we plot in Figure 4 the distribution of 5-year ahead inflation expectations before and after the respondents are treated. In each panel, the solid bars represent the baseline (pre-treatment) distribution of

[16] As Table A4 indicates, the differences between upward and downward revisions are statistically significant in the August 2021 experiment but not in the April 2021 experiment.

[17] The "availability heuristic" could explain why the asymmetry reverses between 2019 and 2021. Under this hypothesis, people react more strongly to a treatment if the information provided in a scenario triggers recent memory consistent with that scenario. For instance, people may have responded more to the positive inflation shock treatments in 2021 than in 2019 because that scenario was closer to the news of high inflation that were prevalent at the time.

inflation beliefs, the blue hollow bars represent the distribution of beliefs after each of the 3-year treatments, while the orange hollow bars depict belief distributions after the 10-year treatments.

The figure reinforces the main message of the analysis so far: in all three surveys, the distribution of long-run inflation expectations shifts to the right in response to the positive inflation shocks and shifts to the left in response to the negative inflation shocks (consistent with the patterns of revisions documented above). In the 2021 surveys, the rightward shift in response to the positive shock treatments is more evident than the leftward shift in response to the negative treatments—consistent with the asymmetry in revisions discussed earlier[18]. For instance, in the 3-year positive shock treatment conducted in August 2021, more people move from the (1,3] to the (3,7] region, than from (1,3] to the (-3,1] region.[19] Nevertheless, the modal belief remains in the (1, 3] inflation bin across surveys and all but one treatment: The only exception is the scenario with inflation 1% higher than it actually was over the past 10 years in the August 2021 experiment, where the modal response shifts to the (3, 5] bin. This movement could represent a potential warning sign, should the surge in inflation experienced in spring and summer 2021 persist for a long period of time.

5.2 Analysis based on repeat respondents

Next, we investigate whether and to what extent revisions in the backward-looking inflation shock experiment differ across the three surveys by focusing on the 547 "repeat respondents" who took part in both the July 2019 and the August 2021 surveys. This feature allows for a direct within-person comparison and enables us to test whether the same individuals changed their revisions significantly over time. Table 3 reports average treatment effects for these repeat respondents.[20]

[18] Gorodnichenko and Sergeyev (2021) find zero to act as a lower bound in revising down inflation expectations, resulting in a posterior distribution with a mass at zero and little mass below it. In our setting, the posterior distributions in Figure 4 instead show a nontrivial share (around 11-12%) of respondents with revised forecasts of deflation, and we find little bunching at zero (less than 2% of respondents).

[19] Specifically, the share of point predictions in the (1,3] region declines by 9 percentage points, the share in the (3,7] region rises by 12 percentage points and the share in the (-3,1] region declines by 2 percentage points.

[20] Sampling weights are used everywhere except in Table 3 because it is unclear whether one should use the July 2019

Table 3: Average Treatment Effects Among the 547 who Completed the Backward Inflation Experiment both in July 2019 and August 2021

		July 2019		August 2021	
		Sign of inflation shock		Sign of inflation shock	
		1% Lower	1% Higher	1% Lower	1% Higher
Duration of inflation shock	3-year	-0.30 (0.04)	0.24 (0.03)	-0.17 (0.04)	0.35 (0.04)
	10-year	-0.45 (0.04)	0.40 (0.04)	-0.26 (0.05)	0.50 (0.05)

The average treatment effects are in percentage points. Standard errors shown in parentheses.

The main takeaways are very similar to those discussed above for all respondents. The sign and direction of revisions make intuitive sense, the magnitude of the average treatment effects is modest and increases with the duration of the inflation shock. The comparison of responses in July 2019 and August 2021 confirms the reversal of the asymmetry described earlier, with significantly stronger revisions in the positive than in the negative inflation shock treatments in August 2021, whereas the opposite is true in July 2019. For example, in August 2021 the average treatment effect in the 3-year positive inflation shock treatment was 0.35 percentage point, compared to -0.17 percentage point in the 3-year negative inflation shock scenario. In July 2019, the corresponding treatment effects were 0.24 and -0.30 percentage points, respectively.[21]

5.3 Heterogeneity in revisions

Do survey respondents revise their long-run inflation expectations differently? To address this question, we look at heterogeneity in individual treatment effects along various demographic characteristics. To simplify, we focus on data from the August 2021 backward-looking *inflation shock* experiment.[22] Table 4 reports the results of three sets of regressions. Column 1 regresses the respondents' baseline (pre-treatment) 5-year ahead inflation expectations on a broad set of

or August 2021 weight for a repeat respondent. The results, however, are qualitatively similar in all cases.

[21] Figures A3 and A4 plot the distribution of within-person changes in revisions for a given treatment, between July 2019 and August 2021 and between April and August 2021. The modal repeat respondent (about 1 in 4) reported the same revisions across pairs of surveys. This suggests a remarkable degree of stability in the sensitivity of long-run inflation expectations over time. The distribution of changes in revisions is quite dispersed in all treatments, with patterns generally consistent with the shift in asymmetry between 2019 and 2021 documented earlier.

[22] Table A5 reports results from similar regressions for the August 2021 forward-looking *inflation surprise* scenario.

demographic characteristics. The next set of columns, 2 through 5, reports results from regressions of individual revisions in each treatment on the same set of attributes and the respondent's baseline 5-year ahead inflation expectation. Finally, columns 6 through 9 report estimates from probit regressions, in which the dependent variable is a dummy variable equal to 1 if the respondent is "perfectly anchored," i.e. did *not* revise her inflation expectation in response to a given treatment.

Table 4: Heterogeneity in Revisions and Propensity to Not Revise in August 2021 Backward Experiment

	5-year Ahead Point Prediction OLS Regression	Individual Revisions in 5-year Ahead Inflation Expectations OLS regression				Propensity to be a Non-Reviser (i.e. Revision=0) Probit Marginal Effects			
Treatment	—	3 Year 1% Lower	10 year 1% lower	3 Year 1% Higher	10 year 1% Higher	3 Year 1% Lower	10 year 1% lower	3 Year 1% Higher	10 year 1% Higher
5-year ahead point Prediction	—	-0.012*** (0.004)	-0.022*** (0.005)	-0.001 (0.004)	0.004 (0.005)	-0.002 (0.002)	-0.005** (0.002)	-0.004* (0.002)	-0.004* (0.002)
Age 40-60	0.504 (0.482)	0.074 (0.092)	-0.019 (0.117)	0.035 (0.088)	0.091 (0.106)	0.089* (0.050)	0.062 (0.049)	-0.025 (0.047)	-0.025 (0.047)
Age 60+	0.780 (0.511)	0.138 (0.098)	0.019 (0.124)	0.144 (0.094)	0.079 (0.113)	0.114** (0.053)	0.099* (0.052)	-0.015 (0.050)	0.014 (0.049)
Income 40k-	1.631*** (0.555)	0.184* (0.102)	0.113 (0.129)	0.057 (0.097)	-0.080 (0.117)	-0.036 (0.055)	-0.022 (0.052)	0.051 (0.052)	0.025 (0.049)
Income 75k+	-0.092 (0.448)	0.042 (0.086)	-0.095 (0.109)	0.151* (0.082)	0.067 (0.098)	0.020 (0.046)	-0.053 (0.044)	0.019 (0.044)	-0.106** (0.043)
Male	-0.133 (0.379)	0.123* (0.071)	0.125 (0.090)	0.023 (0.068)	0.038 (0.082)	0.031 (0.038)	0.043 (0.037)	-0.006 (0.037)	-0.052 (0.035)
Renter	1.419*** (0.485)	-0.009 (0.092)	0.053 (0.116)	0.058 (0.087)	-0.058 (0.105)	0.053 (0.049)	0.042 (0.047)	-0.005 (0.047)	0.002 (0.045)
College	-0.949** (0.403)	0.001 (0.074)	-0.044 (0.094)	-0.089 (0.071)	-0.053 (0.085)	-0.042 (0.040)	0.007 (0.039)	-0.041 (0.038)	-0.050 (0.037)
Not White	2.098*** (0.525)	-0.028 (0.096)	0.053 (0.121)	0.037 (0.091)	-0.069 (0.110)	0.014 (0.051)	-0.023 (0.050)	0.075 (0.048)	0.025 (0.047)
High Financial Literacy	-1.751*** (0.466)	-0.334*** (0.088)	-0.229** (0.111)	0.098 (0.084)	0.127 (0.101)	0.062 (0.047)	-0.063 (0.045)	-0.041 (0.045)	-0.046 (0.042)
Intercept	4.923*** (0.684)	-0.094 (0.135)	-0.053 (0.171)	0.154 (0.129)	0.348** (0.155)	—	—	—	—
Dep. Var Mean	4.280	-0.200	-0.300	0.360	0.510	—	—	—	—
Observations	2,139	730	730	730	730	730	730	730	730
R2	0.049	0.045	0.039	0.012	0.012				

Note: *p<0.1; **p<0.05; ***p<0.01

Column 1 shows a significant heterogeneity in consumers' long-run inflation expectations. College educated individuals and those with high financial literacy tend to report significantly lower long-run inflation expectations.[23] Lower-income, renters and non-white respondents are associated with

[23] The measure of financial literacy is adapted from Lusardi (2007). Here is an illustration of the type of questions we asked to elicit financial literacy: "If you have $100 in a savings account, the interest rate is 10% per year and you never withdraw money or interest payments, how much will you have in the account after: one year? two years?"

higher expectations, on average. These results are consistent with a vast literature that finds substantial heterogeneity in *short-term* inflation expectations, pointing to the consistency of this heterogeneity at both short- and long-term horizons.[24] In contrast, columns 2 through 9 reveal no consistent pattern of heterogeneity in terms of both individual treatment effects and the propensity to be "perfectly anchored." In particular, it is not the case that in response to the different treatments, specific groups consistently make larger revisions, are more responsive, or more likely to be perfectly anchored. Thus, our conclusions on the sensitivity of long-run inflation expectations to persistent inflation shocks appear to be broad-based across demographic groups.

5.4 Forward-looking experiments

Finally, we discuss the results of the two forward-looking experiments described in Section 4.[25] We first turn to the *inflation surprise* experiment, which was fielded in both April and August 2021. We report average treatment effects in the top panel of Table 5 (see Figure A5 for the distributions of revisions and Table A6 for tests of statistical significance).

Table 5: Revisions in 5-Year Ahead Inflation Expectations in Forward Experiments

		April 2021		**August 2021**	
		Sign of inflation surprise		Sign of inflation surprise	
		1% Lower	1% Higher	1% Lower	1% Higher
Duration of inflation surprise*	Next year	-0.14 (0.04)	0.25 (0.04)	-0.01 (0.02)	0.29 (0.02)
	Each of next 3 years	-0.12 (0.03)	0.31 (0.04)	-0.04 (0.02)	0.33 (0.02)
Sign of unemployment surprise†	1% Lower			-0.15% (0.02)	0.13% (0.02)
	1% Higher			-0.01% (0.02)	0.22% (0.03)

The average treatment effects are in percentage points.
***** Forward Inflation Surprise Experiment. The median 5-year ahead inflation expectation conditional on inflation over the next year (respectively next 3 years) being as expected was 2.92% and 3.04% (respectively 2.25% and 3.02%) in April and August 2021, respectively.
† Joint Inflation & Unemployment Surprise Experiment. The median 5-year ahead inflation expectation conditional on inflation and unemployment over the next year being as expected was 3.44%.

Respondents who answer correctly at least 4 out of the 5 questions we ask are classified as "high numeracy."

[24] Armantier et al. (2021) also find substantial heterogeneity along demographic lines in both short- and medium-term inflation expectations, which remains mostly unchanged after the onset of the Covid-19 pandemic.

[25] In the August 2021 survey, 487 participants undertook first the backward-looking *inflation shock* followed by the forward-looking *joint inflation & unemployment surprise* experiment. However, because respondents took the inflation shock experiment first, there is no risk of cross-experiment contamination in the results presented so far.

The findings are qualitatively similar to those of the backward-looking *inflation shock* experiment. Table 5 shows that the average revision is always negative in the negative surprise treatments and positive in the positive surprise treatments. Treatment effects also display a similar (albeit somewhat weaker) monotonicity in the duration of the treatments as in the backward-looking experiments. The average magnitude of revisions, in absolute value, is larger in the 3-year surprise treatment than in the 1-year surprise treatment, with the only exception of the April 2021 negative surprise treatment. The asymmetry uncovered in the backward-looking *inflation shock* experiment is also present here, with larger average revisions in the positive inflation surprise treatments than in the negative ones. Finally, a comparison of Tables 2 and 5 indicates that the magnitude of average treatment effects is similar and modest in the backward- and forward-looking experiments, for a comparable duration (3 years) of the inflation shock or surprise. In April and August 2021, the average revision was 0.31 and 0.33 percentage points (ppt) in the positive inflation surprise scenario, as compared to 0.27 and 0.33 ppt in the backward-looking experiment.

Finally, we turn to the forward-looking *joint inflation & unemployment surprise* experiment. The results of this experiment, summarized in the bottom panels of Table 5, are broadly consistent with those of the other experiments.[26] The magnitude of revisions remains modest, and the share of "perfectly anchored" individuals remains stable at roughly 40% across treatments. Average treatment effects in the two scenarios with positive inflation surprises are (weakly) larger than in the ones with negative inflation surprises, in line with the asymmetry uncovered in the other experiments. Looking across rows in Table 5, the average revision in 5-year ahead inflation expectations points to slightly higher expected inflation in the higher unemployment scenarios (-

[26] In the bottom-right panel of Table 5, note that the scenario in the top-right (bottom-left) cell could be interpreted as deriving from a stronger (weaker) than expected positive demand shock, and the scenario in the top-left (bottom-right) cell could be interpreted as coming from a weaker (stronger) than expected negative supply shock. Also, respondents rated the scenario "inflation 1% higher and unemployment 1% lower than expected" as the most likely to occur.

0.01 and 0.22 ppt) than in the lower unemployment scenarios (-0.15 and 0.13 ppt). This result is consistent with evidence in the literature that households tend to have a stagflationary view of inflation, associating higher inflation with negative economic outcomes (Ehrmann et al. 2017, Kamdar 2019). Alternatively, our survey respondents may have internalized more accommodative monetary and fiscal policy in scenarios with higher unemployment, all else equal.

5.5 Benchmarking our treatment effects

The results we just reported indicate that the response of five-year-ahead inflation expectations to a 1% inflation shock or surprise ranges between 0.01 and 0.45 percentage point (ppt) on average across surveys and experiments. To gauge whether the magnitude of these results is consistent with other measures, we now consider two possible benchmarks for our treatment effects.

First, we measure the sensitivity of individual revisions in longer-term inflation expectations to individual short-term forecast errors, defined here as realized CPI inflation minus one-year-ahead inflation expectations expressed a year earlier. Armantier et al. (2022) conduct this exercise using individual SCE data and find the sensitivity of revisions in three-year-ahead inflation expectations to inflation surprises to be 0.5 ppt in 2019 and 0.2 ppt in 2021.

Second, we consider the ratio of changes in five-year-ahead expectations to changes in one-year-ahead expectations between the July 2019 and the August 2021 special surveys. This measure of pass-through is 0.24 ppt for respondents who took both special surveys, and 0.2 ppt in the Michigan survey over the same period. In a related exercise, we regress individual changes in five-year-ahead expectations on individual changes in one-year-ahead expectations, again for repeat respondents in the July 2019 and August 2021 surveys, which produces a statistically significant pass-through coefficient of 0.18 ppt. Hence, the different benchmarks we calculated are all generally consistent with the magnitude of the treatment effects we identified in the paper.

5.6 Comparison of different anchoring measures

As discussed in Section 2, our approach is one of several measures that have been proposed to measure inflation expectations anchoring. How comparable are these measures? To address this question, we compare anchoring measures defined at the aggregate and at the individual level.

For anchoring measures at the aggregate level, Armantier et al. (2022) find that, consistent with the results we just presented, different measures of "shock" anchoring (e.g. the sensitivity of revisions in longer-term expectations to short-term inflation surprises) suggest that longer-term inflation expectations were at least as well anchored in 2021 as they were in 2019. In contrast, some measures commonly associated with "level" anchoring point to three-year-ahead inflation expectations becoming less anchored in 2021, with a rise in average uncertainty, cross-sectional disagreement across respondents, and deviation from the 2% target (see Figures A6 to A8).

To compare evidence at the individual level, we use the data from our special surveys and calculate several anchoring measures used in the literature.[27] We report the correlations between these individual measures in Table A7. Two points are worth noting. First, while individual revisions in our experiment are highly and significantly correlated across treatments, they are only weakly correlated with other measures of anchoring.[28] Second, other measures of anchoring are unevenly correlated with each other, consistent with the finding at the aggregate level, and consistent with previous literature (as documented in Section 2).

Because inflation expectations anchoring is not a well-defined concept in the literature, various measures are used to assess the question empirically. Our analysis suggests that these different

[27] Namely the distance between a respondent's five-year-ahead inflation expectations and 2%; her five-year-ahead inflation uncertainty; her change in one- and five-year-ahead expectations between July 2019 and August 2021; and the ratio between these changes in expectations.

[28] However, when the correlations are significant they generally go in the expected direction. For instance, more positive revisions in the positive shock treatments (less negative revisions in the negative shock treatments) are associated with larger changes in individual inflation expectations or with inflation uncertainty.

approaches do not necessarily lead to the same conclusion, possibly because each measures a different form of anchoring. As mentioned earlier, our measure focuses on the risk of an un-anchoring of inflation expectations in response to periods of unusually high or low inflation.

6. Conclusion

The extent to which long-run inflation expectations are "well-anchored" is crucial for the conduct of monetary policy. The model of Orphanides and Williams (2005), among others, suggests that when long-run inflation expectations drift away from the central bank's target it becomes more difficult to achieve the Federal Reserve's dual mandate of stable prices and maximum employment, with adverse consequences in terms of welfare. Concerns about inflation expectations un-anchoring are often heightened after prolonged spells of especially low or high inflation (see e.g. Mertens and Williams 2019).

In this paper we propose a new approach to evaluate the risk that long-run inflation expectations may become un-anchored. Specifically, we propose using strategic surveys to estimate the sensitivity of 5-year ahead inflation expectations to different inflation shocks or surprises. We design three experiments in which respondents are presented with different scenarios about past inflation shocks, future inflation surprises, or future combinations of inflation and unemployment surprises. We use a 2 by 2, within-subject design in which the sign and duration of inflation shocks and surprises are varied exogenously. This approach allows us to evaluate the risk of un-anchoring at a given point in time, within-person, and in a controlled environment—tailoring the scenarios to the specific question of interest. Compared to other measures of anchoring, our approach captures most directly the question: Do prolonged spells of high or low inflation risk de-anchoring long-run inflation expectations? Furthermore, the flexibility of the approach allows its timely implementation whenever specific circumstances raise policymakers' concerns.

We implement our approach in three special modules of the Survey of Consumer Expectations, fielded in July 2019, April 2021 and August 2021. We find that the average treatment effects are sensible, their magnitude is modest relative to the size and protracted nature of the inflation shocks or surprises, and the share of respondents who behave as if "perfectly anchored" remains remarkably stable across treatments and surveys. Overall, the evidence suggests that the risk of un-anchoring seemed relatively low as of August 2021, and that long-run inflation expectations did not change substantially between July 2019 and August 2021, in spite of the extraordinary dislocations brought about by the Covid-19 pandemic.

Nevertheless, the rightward shift in the August 2021 posterior distribution of long-run inflation expectations in the positive inflation shock treatments, and the associated asymmetry in treatment effects—with a significantly larger response to positive than negative shocks in August 2021—suggest a relatively larger risk of un-anchoring to the upside. This risk may increase should the high inflation experienced in the spring-summer of 2021 remain elevated for an extended period of time. Furthermore, our findings are not directly informative about prolonged shocks larger than 1% in absolute value, so we cannot rule out possible nonlinearities in revisions that may lead to un-anchoring going forward. The extent to which our results extrapolate to different configurations of inflation shocks or surprises remains an open question which we leave to future research.

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Appendix

Table A1: Tests of Equality of Medians for Inflation Expectations

	Test of equality of 1-year ahead inflation expectations	Test of equality of 5-year ahead inflation expectations
July 2019 vs. April 2021	0.000	0.553
July 2019 vs. August 2021	0.000	0.659
April 2021 vs. August 2021	0.000	0.817
	Test of equality of 1- and 5-year ahead inflation expectations	
July 2019	0.036	
April 2021	0.000	
August 2021	0.000	

Note: The table shows p-values from Kruskal Wallis tests.

Table A2: Short-Run and Long-Run Inflation Expectations

	July 2019 (N=999)				**April 2021** (N=1024)				**August 2021** (N=2209)			
	Median	Mean	3% Trimmed Mean	10% Trimmed Mean	Median	Mean	3% Trimmed Mean	10% Trimmed Mean	Median	Mean	3% Trimmed Mean	10% Trimmed Mean
1-year ahead	2.92%	4.58% (0.29)	3.92% (0.13)	3.13% (0.07)	3.24%	5.15% (0.31)	4.13% (0.13)	3.60% (0.07)	4.84%	6.29% (0.18)	5.63% (0.09)	4.66% (0.05)
5-year ahead	3.00%	4.64% (0.26)	3.87% (0.14)	3.45% (0.08)	3.00%	4.65% (0.34)	4.17% (0.17)	3.38% (0.08)	3.16%	5.33% (0.23)	4.44% (0.11)	3.57% (0.06)

The medians reported are interpolated medians computed using the iquantile module (Cox 2009) in Stata. Standard errors in parentheses. Inflation expectations are respondents' point predictions. 3% Trimmed Mean results from trimming the top and bottom 3% of observations. 10% Trimmed Mean results from trimming the top and bottom 10% of observations.

Table A3: Tests of Equality of Medians for Inflation Expectations For Respondents who Completed both the July 2019 and August 2021 Surveys

	Test of equality of 1-year ahead inflation expectations	Test of equality of 5-year ahead inflation expectations
July 2019 vs August 2021	0.000	0.200
April 2021 vs August 2021	0.000	0.461

Note: The table shows p-values from Kruskal Wallis tests.

Table A4: Tests of Statistical Significance for Backward Experiments

	Significance of Average Treatment Effects (t-test p-value)			
	3 years & 1% lower	3 years & 1% higher	10 years & 1% lower	10 years & 1% higher
July 2019	0.000	0.000	0.000	0.000
April 2021	0.000	0.000	0.000	0.000
August 2021	0.000	0.000	0.000	0.000
	Within Survey Differences of Average Treatment Effects (paired t-test p-value)*			
	3 years treatments. 1% lower vs 1% higher	10 years treatments. 1% lower vs 1% higher	1% lower treatments. 3 years vs 10 years	1% higher treatments. 3 years vs 10 years
July 2019	0.002	0.041	0.003	0.000
April 2021	0.339	0.481	0.002	0.000
August 2021	0.025	0.012	0.013	0.000
	Between Surveys Differences of Average Treatment Effects (partial overlap t-test p-value)†			
	3 years & 1% lower	3 years & 1% higher	10 years & 1% lower	10 years & 1% higher
July 2019 vs. April 2021	0.012	0.387	0.247	0.354
July 2019 vs. August 2021	0.003	0.009	0.005	0.081
April 2021 vs. August 2021	0.915	0.208	0.321	0.677

***** The null hypothesis in these tests is H_0: { Average treatment effect in treatment X = - (Average treatment effect in treatment Y) }

† The test accounts for the fact that some respondents participated in two surveys.

Table A5: Heterogeneity in the Size of Revisions and Propensity to Not Revise in August 2021 Forward Inflation Surprise Experiment

	5-year Ahead Point Prediction OLS Regression	Individual Revisions in 5-year Ahead Inflation Expectations OLS regression				Propensity to be a Non-Reviser (i.e. Revision=0) Probit Marginal Effects			
Treatment	—	1 Year 1% Lower	3 year 1% lower	1 Year 1% Higher	3 year 1% Higher	1 Year 1% Lower	3 year 1% lower	1 Year 1% Higher	3 year 1% Higher
Conditional 5-year ahead point Prediction†	—	0.005* (0.003)	0.000 (0.003)	0.017*** (0.003)	0.018*** (0.003)	-0.005** (0.002)	-0.006*** (0.002)	-0.005*** (0.002)	-0.005*** (0.002)
Age 40-60	0.723 (0.683)	0.083 (0.055)	0.144*** (0.056)	-0.019 (0.057)	-0.063 (0.056)	-0.009 (0.043)	0.058 (0.043)	0.005 (0.043)	0.092** (0.043)
Age 60+	1.193* (0.719)	-0.035 (0.058)	-0.008 (0.059)	-0.096 (0.060)	-0.075 (0.059)	-0.013 (0.046)	0.055 (0.046)	0.041 (0.045)	0.095** (0.045)
Income 40k-	2.332*** (0.804)	0.085 (0.065)	-0.084 (0.066)	0.061 (0.068)	-0.019 (0.067)	0.097* (0.051)	0.006 (0.051)	0.053 (0.050)	-0.030 (0.050)
Income 75k+	0.514 (0.626)	0.032 (0.051)	-0.031 (0.051)	-0.025 (0.053)	0.008 (0.052)	-0.020 (0.040)	0.030 (0.039)	0.024 (0.039)	-0.005 (0.039)
Male	0.086 (0.536)	-0.035 (0.043)	-0.058 (0.044)	0.034 (0.045)	0.047 (0.044)	0.032 (0.034)	-0.020 (0.034)	0.007 (0.033)	-0.065 (0.033)
Renter	1.757** (0.683)	0.044 (0.055)	0.051 (0.056)	0.071 (0.058)	0.029 (0.057)	0.044 (0.043)	0.050 (0.043)	-0.065 (0.043)	-0.027 (0.042)
College	-1.346** (0.569)	-0.076* (0.046)	-0.097** (0.046)	0.004 (0.048)	-0.007 (0.047)	0.031 (0.036)	-0.071** (0.036)	0.018 (0.035)	-0.037 (0.035)
Not White	2.610*** (0.772)	-0.030 (0.063)	0.081 (0.063)	-0.069 (0.065)	-0.118* (0.064)	-0.012 (0.049)	0.014 (0.049)	0.001 (0.048)	0.077 (0.047)
High Financial Literacy	-1.318** (0.668)	0.094* (0.054)	-0.049 (0.054)	0.123** (0.056)	0.060 (0.055)	0.0154 (0.042)	0.001 (0.042)	-0.042 (0.041)	-0.067 (0.041)
Intercept	3.592*** (0.979)	-0.134* (0.080)	0.023 (0.080)	0.137* (0.083)	0.243*** (0.081)	—	—	—	—
Dep. Var Mean	3.900	-0.050	-0.070	0.280	0.310	—	—	—	—
Observations	966	966	966	966	966	966	966	966	966
R2	0.063	0.019	0.029	0.052	0.054	—	—	—	—

Note: *p<0.1; **p<0.05; ***p<0.01

† In the 1-year inflation surprise treatments (columns 3, 5, 7 and 9) the variable is equal to the respondent 5-year ahead point prediction conditional on "inflation over the next year being as expected." In the 3-year inflation surprise treatments (columns 4, 6, 8 and 10) the variable is equal to the respondent 5-year ahead point prediction conditional on "inflation in each of the next three years being as expected."

Table A6: Tests of Statistical Significance for Forward Experiments

Inflation Surprise Experiment				
	Significance of Average Treatment Effects (t-test p-value)			
	1 year & 1% lower	1 year & 1% higher	3 years & 1% lower	3 years & 1% higher
April 2021	0.000	0.000	0.000	0.000
August 2021	0.807	0.000	0.050	0.000
	Within Survey Differences of Average Treatment Effects (paired t-test p-value)*			
	1 year treatments. 1% lower vs 1% higher	3 years treatments. 1% lower vs 1% higher	1% lower treatments. 1 year vs 3 years	1% higher treatments. 1 years vs 3 years
April 2021	0.050	0.000	0.668	0.182
August 2021	0.000	0.000	0.127	0.083
	Between Surveys Differences of Average Treatment Effects (partial overlap t-test p-value)†			
	1 year & 1% lower	1 year & 1% higher	3 years & 1% lower	3 years & 1% higher
April 2021 vs. August 2021	0.002	0.357	0.038	0.759
Inflation & Unemployment Surprise Experiment				
	Significance of Average Treatment Effects (t-test p-value)			
	I 1% lower & U 1% lower	I 1% lower & U 1% higher	I 1% higher & U 1% lower	I 1% higher & U 1% higher
August 2021	0.000	0.735	0.000	0.000
	Within Survey Differences of Average Treatment Effects (paired t-test p-value)*			
	I 1% lower treatments. U 1% lower vs 1% higher	I 1% Higher treatments. U 1% lower vs 1% higher	U 1% lower treatments. I 1% lower vs 1% higher	U 1% Higher treatments. I 1% lower vs 1% higher
August 2021	0.000	0.000	0.516	0.000

***** The null hypothesis in these tests is H_0: { Average treatment effect in treatment X = - (Average treatment effect in treatment Y) }

† The test accounts for the fact that some respondents participated in two surveys.

Table A7: Spearman Correlations between Individual Level Anchoring Measures

August 2021 Backward-Looking Experiment

	3-year Lower	10-year Lower	3-year Higher	10-year Higher	| 5yr IE – 2% |	5yr IE Uncertainty	Δ 5yr IE / Δ 1yr IE	Δ 5yr IE	Δ 1yr IE
3-year Lower	1.00	-	-	-					
10-year Lower	0.65***	1.00	-	-					
3-year Higher	-0.15***	-0.16***	1.00	-					
10-year Higher	-0.19***	-0.23***	0.68***	1.00					
| 5yr IE – 2% |	0.11***	0.10***	-0.06*	-0.05	1.00	-	-	-	-
5yr IE Uncertainty	0.09**	0.07*	0.01	0.08**	0.50***	1.00	-	-	-
Δ 5yr IE / Δ 1yr IE	-0.06	-0.05	0.03	0.09*	0.14***	0.05	1.00	-	-
Δ 5yr IE	-0.04	-0.07	0.01	0.09**	0.17***	0.15***	0.34***	1.00	-
Δ 1yr IE	0.17***	0.08*	-0.05	-0.05	0.16***	0.14***	0.02	0.29***	1.00

Note: * p < 0.10, ** p < 0.05, *** p < 0.01

"3-year Lower" indicates the respondent's revision in the scenario with inflation 1% lower for 3 years ("3-year Higher" denotes the same in the scenario with inflation 1% higher).

"10-year Lower" indicates the respondent's revision in the scenario with inflation 1% lower for 10 years ("10-year Higher" denotes the same in the scenario with inflation 1% higher).

"| 5yr IE – 2% |" indicates the distance of the respondent's five-year-ahead inflation expectation from 2 percent.

"5yr IE Uncertainty" indicates the respondent's individual inflation uncertainty at the five-year-ahead horizon.

"Δ 5yr IE" denotes the change in the respondent's five-year-ahead inflation expectation between July 2019 and August 2021. "Δ 1yr IE" denotes the same at the one-year-ahead horizon.

"Δ 5yr IE / Δ 1yr IE" denotes the ratio of the change in five-year-ahead inflation expectation to the change in one-year-ahead inflation expectation between July 2019 and August 2021.

Figure A1: Distributions of Short-Run and Long-Run Inflation Expectations Winsorized at -5% and +20%

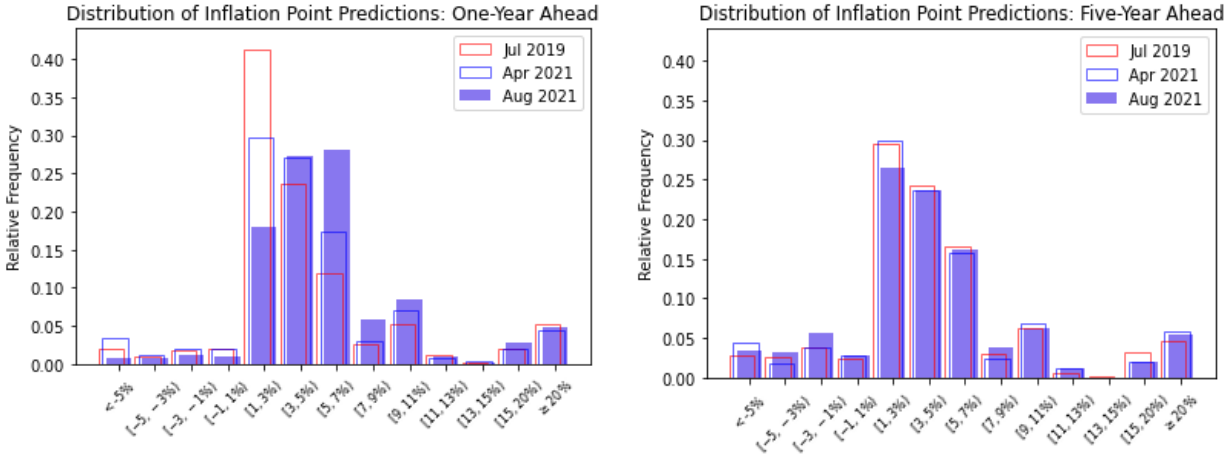


Figure A2: Distributions of Short-Run and Long-Run Inflation Expectations Among the 674 Repeat Respondents who Completed the July 2019 and August 2021 Surveys

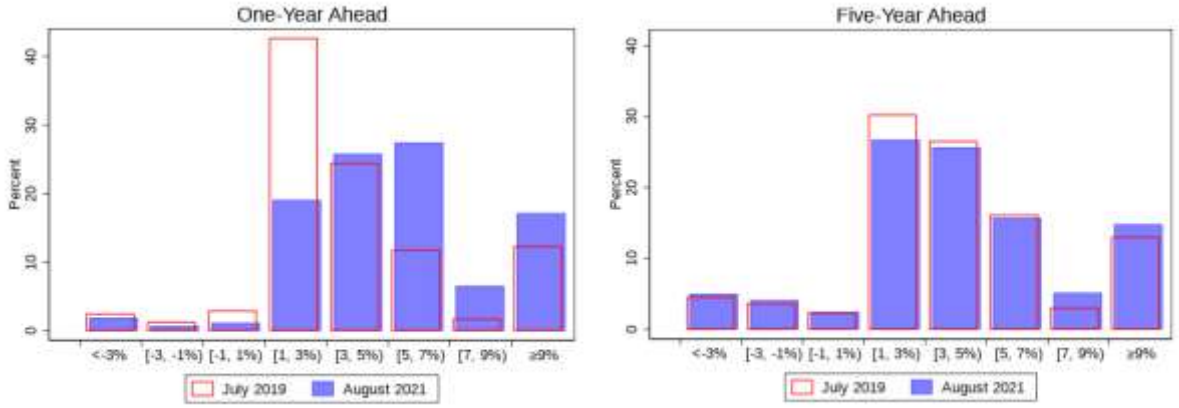


Figure A3: Change in Revision in each Treatment by the 547 Respondents who Completed the July 2019 and August 2021 Backward Experiments

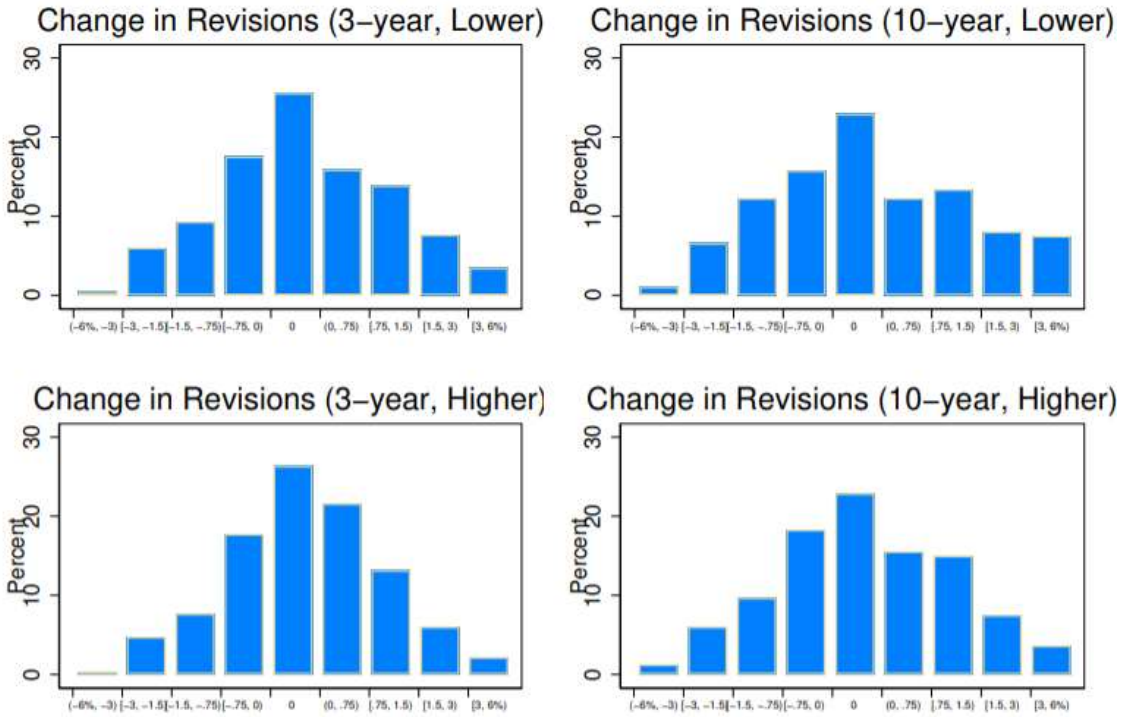


Figure A4: Change in Revision in each Treatment by the 264 Respondents who Completed the April and August 2021 Backward Experiments

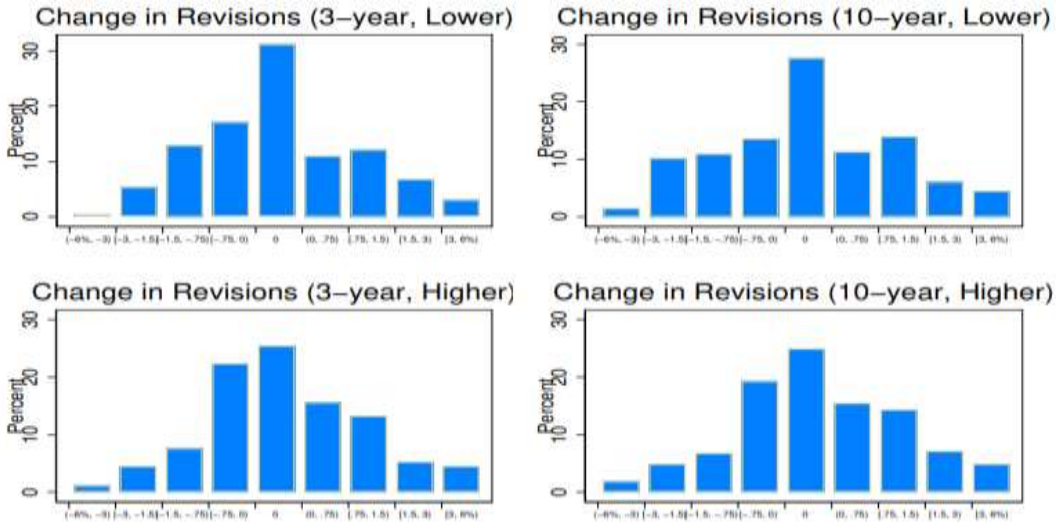


Figure A5: Distribution of Revisions by Treatments in Forward Experiments

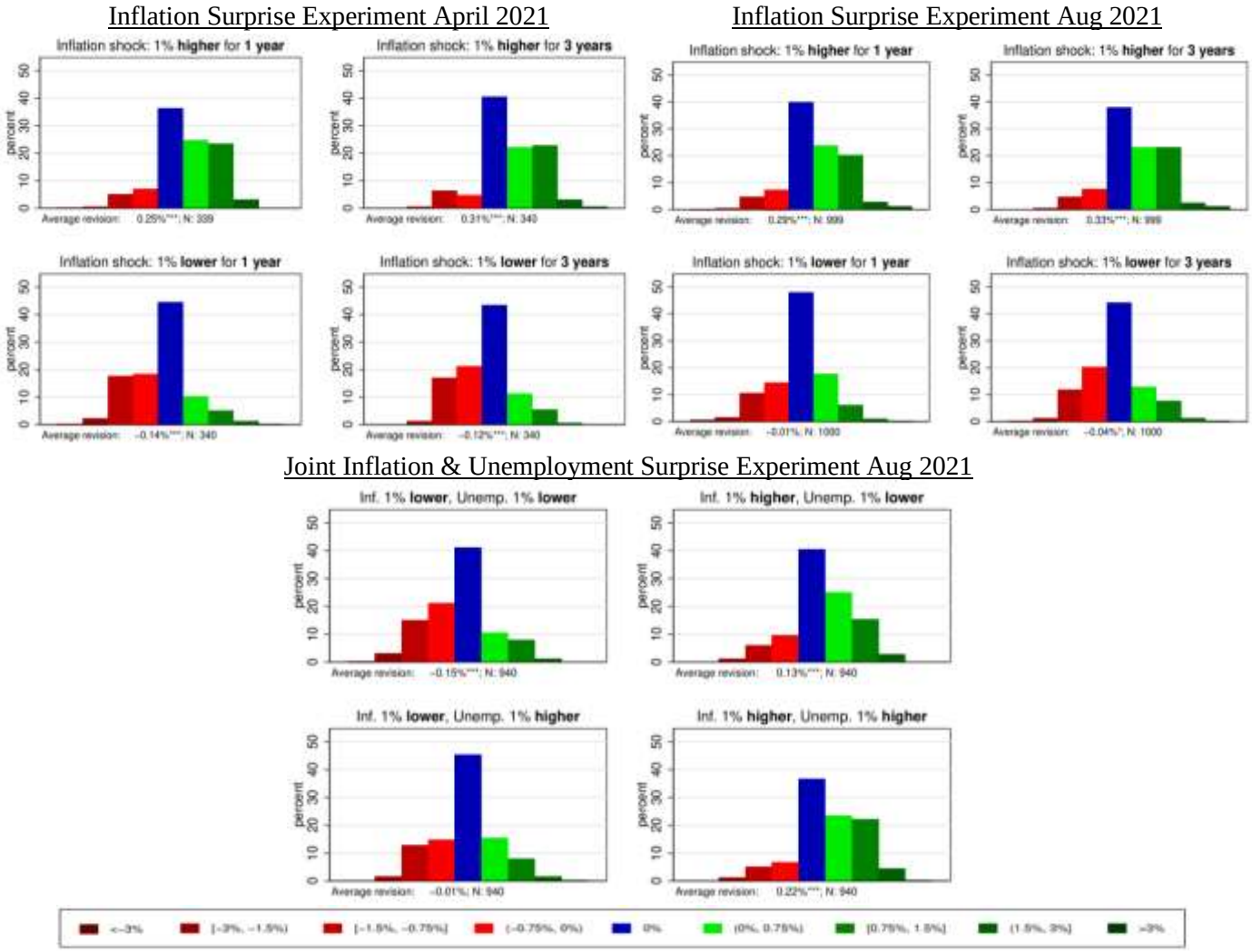
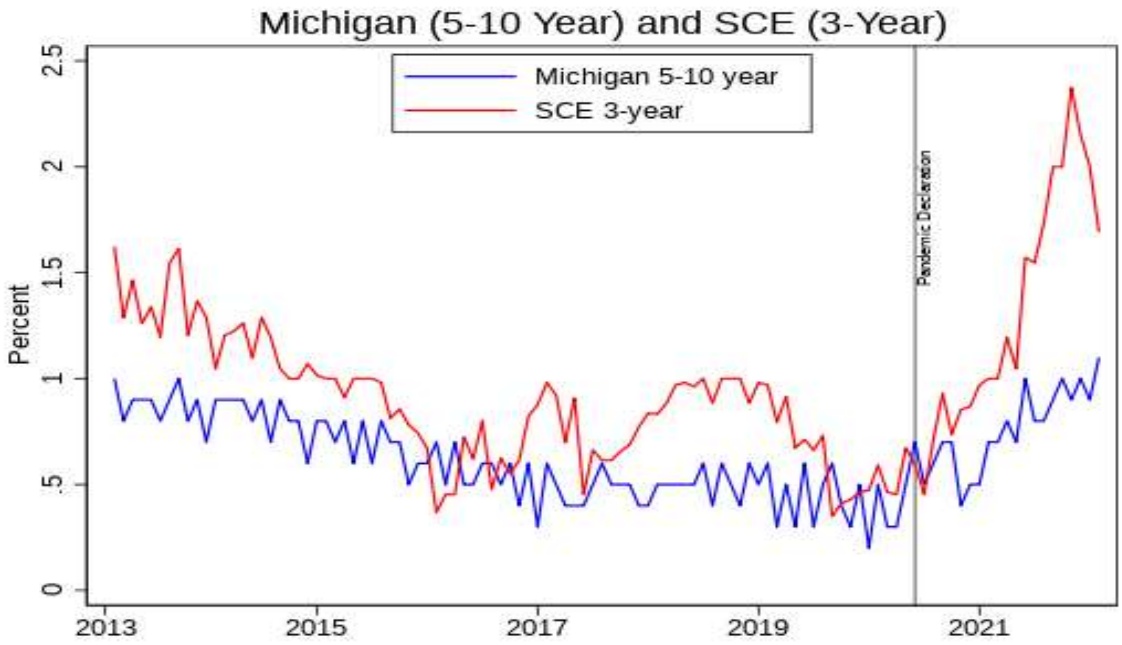
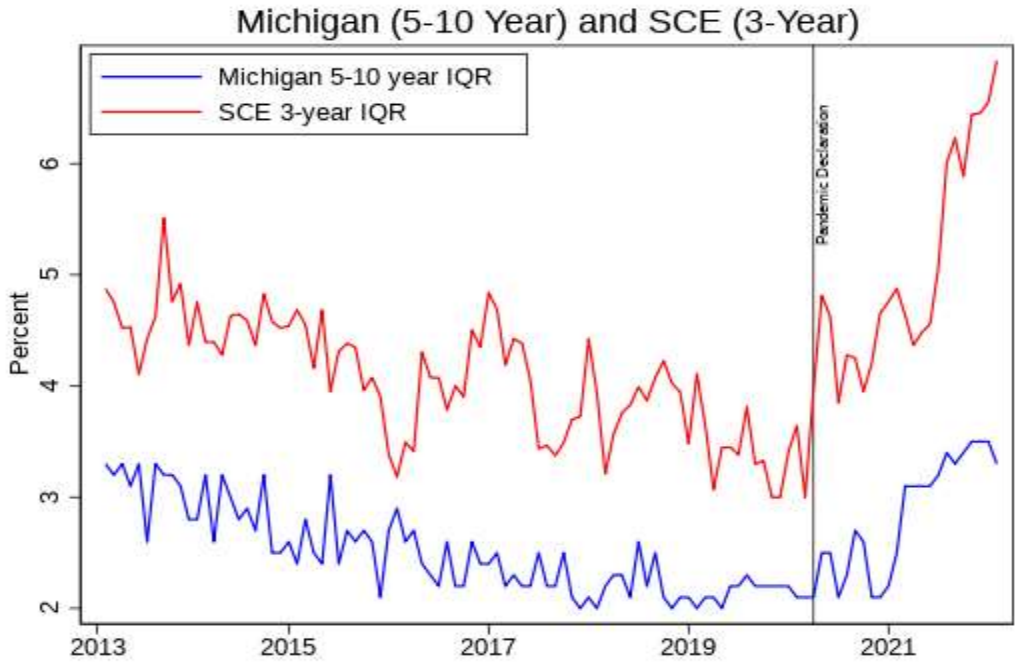


Figure A6: Distance of Inflation Expectations from 2%



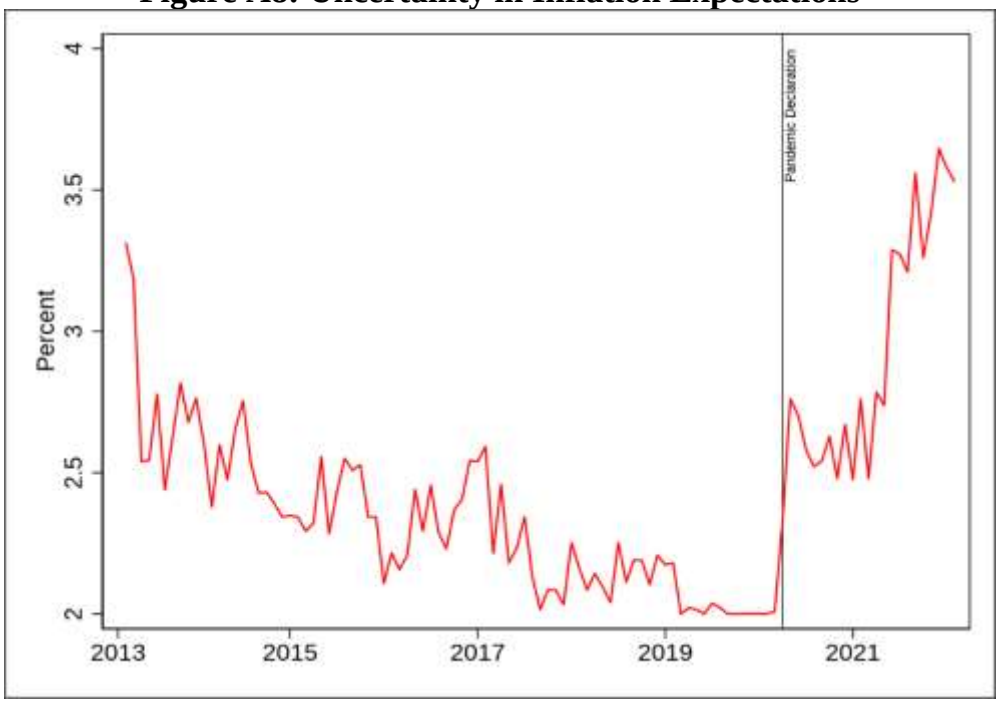
The distance is defined as the absolute difference between the cross-sectional median of inflation expectations and 2%. Inflation expectations in the SCE are defined as 3-year ahead density means. Inflation expectations in the MSC are defined as 5-10 year ahead point forecasts.

Figure A7: Disagreement in Inflation Expectations



Disagreement is defined as the cross-sectional interquartile range of the monthly distribution of individual expectations. Individual expectations in the SCE are defined as 3-year ahead density means. Individual expectations in the MSC are defined as 5-10 year ahead point forecasts.

Figure A8: Uncertainty in Inflation Expectations



Individual uncertainty is defined as the interquartile range of an individual's 3-year ahead density forecast. The figure shows the monthly median across respondents of individual uncertainty.