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Abstract

This paper studies how inflation beliefs reported in the New York Fed's Survey of Consumer Expectations have evolved since the start of the COVID-19 pandemic. We find that household inflation expectations responded slowly and mostly at the short-term horizon. In contrast, the data reveal immediate and unprecedented increases in individual inflation uncertainty and in inflation disagreement across respondents. We find evidence of a strong polarization in inflation beliefs and we show differences across demographic groups. Finally, we document a strong link, consistent with precautionary saving, between inflation uncertainty and how respondents used the stimulus checks they received as part of the 2020 CARES Act.

Key words: inflation expectations, inflation uncertainty and disagreement, COVID-19 pandemic

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1. Introduction

In macroeconomic models, inflation expectations drive a wide range of decisions including consumption, saving, borrowing, wage bargaining, and thus have a direct impact on realized inflation. Inflation expectations therefore represent a key variable, closely monitored by policy makers. At the onset of an economic crisis, when an immediate policy response has to be designed, inflationary risks typically are not a first order concern. Nevertheless, monitoring how inflation expectations change during a crisis is important to anticipate how effective the transmission of monetary and fiscal policy interventions to the real economy can be. For instance, theory predicts that (all else equal) households should shift consumption from the future into the present if they expect inflation to be high in the future. Further, inflation beliefs should be monitored to ensure they remain consistent with long-term monetary policy objectives. In particular, if inflation expectations start drifting away from the central bank's implicit or explicit objective, they could become permanently "un-anchored" which may prevent a central bank from achieving its objectives of stable prices and maximum employment.[2] Similarly, inflation could become unmoored if the public starts disagreeing about the expected future path of inflation or if agents become more uncertain about what inflation will be in the future. In this paper, we use the New York Fed's Survey of Consumer Expectations (SCE hereafter) to study how the Covid-19 pandemic has affected U.S. households' inflation beliefs, including inflation expectations, uncertainty and disagreement.

The economic crisis associated with the Covid-19 pandemic has been exceptional in many regards. First, it started as a health crisis rather than a financial or economic crisis, and it generated an unusual set of disruptions (e.g. stay-at-home mandates, temporary business closures, a part of the workforce being infected). Second, the impact of the pandemic on the economy was extremely sudden and brutal. Notably, within a span of four weeks starting in the second half of March 2020, a record 22 million U.S. workers filed for unemployment. In comparison, the financial crisis of 2007 was slow moving, and its impact on the real economy did not fully materialize for several months. Third, the Covid-19 crisis has been characterized (at least at the time of this writing) by high uncertainty as to its duration and its medium and long-term impact on the economy. In particular, various commentators have mentioned the possibility of a V, U, L or even K shape

[2] On August 27, 2020, the Federal Reserve moved to a "flexible form of average inflation targeting" according to which it "will seek to achieve inflation that averages 2 percent over time. Therefore, following periods when inflation has been running below 2 percent, appropriate monetary policy will likely aim to achieve inflation moderately above 2 percent for some time." The policy change did not alter the importance of keeping inflation expectations well-anchored: "Well-anchored inflation expectations are critical for giving the Fed the latitude to support employment when necessary without destabilizing inflation" (Powell 2020 https://www.federalreserve.gov/newsevents/speech/powell20200827a.htm)

recovery (Guerrieri et al. 2020). Finally, the Covid-19 crisis sparked rapid and strong monetary and fiscal responses by policy makers. Notably, within days after the World Health Organization (WHO hereafter) officially declared the Covid-19 outbreak to be a pandemic, the Federal Reserve (the Fed hereafter), in a surprise move, lowered its target rate to the effective lower bound on March 15, while the CARES Act was signed into law on March 27 to provide over $2 trillion in stimulus to small businesses and lower to middle-income households.

Because of these unique features, it has been difficult initially to predict whether Covid-19 would have an inflationary or a deflationary effect (Cochrane 2020, Binder 2020). On the one hand, weak consumer demand (e.g. for travel, entertainment, or leisure and hospitality) and a prolonged economic slowdown may be expected to put downward pressure on inflation. Evidence of this effect was immediately visible: The month-over-month core Consumer Price Index fell 0.1%, 0.4% and 0.1% in March, April and May 2020, respectively. The drop in March was only the 10th time since 1957 that core prices had ever registered a decline. On the other hand, some may expect supply chain disruptions, the rising levels of government debt and the unprecedented expansion of the Fed's balance sheet to put upward pressure on future inflation. Further, it has been suggested that households tend to associate deteriorating economic outcomes with higher future inflation (Kamdar 2019, Candia, Coibion, and Gorodnichenko 2020). These opposing forces may have an impact not only on aggregate inflation expectations, but also on the level of inflation disagreement between individuals, as well as the degree of uncertainty one may express about the future path of inflation.

The SCE is ideally suited to study how Covid-19 affected the public's inflation beliefs. First, the SCE is a well-established monthly survey, designed to be representative of U.S. household heads, and the wording of its inflation expectations questions has been rigorously tested (Bruine de Bruin et al. 2011a, 2011b, 2012). Second, the fact that the SCE has been collecting data well before the pandemic (i.e. since June 2013) enables us to conduct a *before-after* comparison. Third, SCE data are collected continuously within a month, which allows us to explore how inflation expectations responded after specific health-related events (e.g. the WHO pandemic declaration), or after monetary and fiscal policy announcements (e.g. the signature of the CARES Act on March 27). Fourth, because the SCE is a rotating panel, we can identify changes in inflation beliefs over time *within* respondents, thereby ensuring that results are not driven by changes in the composition of the respondents' sample. Fourth, while surveys with a longer history (such as the Michigan Survey of Consumers) collect only point predictions for inflation, the SCE elicits each respondent's entire distribution of belief, thereby providing a measure of individual inflation uncertainty. Hence, the SCE provides a unique opportunity to understand how inflation uncertainty changes during an economic crisis. Fifth, the SCE collects data on realizations and expectations

about economic outcomes at the household and aggregate levels. In addition, special questions are fielded on an ad-hoc basis to address timely questions. In particular, SCE respondents were asked questions specific to the Covid-19 pandemic, including how they used stimulus checks they may have received as part of the 2020 CARES Act. These data allow us to illustrate how changes in inflation expectations and uncertainty during the pandemic affected households' broader actual behavior.

Our analysis shows that households' average inflation expectations responded to the Covid-19 outbreak slowly and mostly at the short-term horizon. In contrast, the data reveal immediate and unprecedented increases in inflation uncertainty and disagreement. The apparent muted response in average inflation expectations at the onset of the pandemic, however, is slightly misleading. Indeed, we document a sharp polarization in inflation beliefs with a substantial proportion of respondents initially believing that the pandemic was going to produce high inflation, and another group of respondents believing that the pandemic was going to yield low inflation or even deflation. We also identify substantial heterogeneity in inflation expectations and uncertainty across demographic groups before the pandemic. However, we find little evidence that the outbreak of Covid-19 either exacerbated or diminished this heterogeneity. Finally, we document that, consistent with precautionary saving, an increase in a household's inflation uncertainty during the pandemic was associated with a significant increase in the share of the stimulus checks (received as part of the 20020 CARES Act) the household saved.

The paper is structured as follows. The related literature is summarized in section 2. Section 3 describes the SCE and the measures of inflation expectations, disagreement and uncertainty we study in the paper. In section 4, 5 and 6, we document how the Covid-19 pandemic affected each of these measures. We offer an additional perspective in section 7 based on the evolution of the aggregate belief distribution and on changes in the probability respondents assign to extreme inflation outcomes. We explore in section 8 possible heterogeneity in these different measures across demographic groups before and after the start of the outbreak of Covid-19. In section 9, we contrast how inflation beliefs changed during the pandemic with the experience of the Great Recession of 2007-2009. The association between changes in inflation beliefs and uses of the 2020 Economic Impact Payments is investigated in section 10. Section 11 concludes.

2. Related Literature

This paper belongs to the rapidly expanding literature that uses surveys to study how economic expectations, and in particular inflation expectations, have responded to the shock produced by the Covid-19 pandemic. Early studies in the U.S. include Binder (2020) who used Amazon

Mechanical Turk to conduct a survey on March 5 and 6, 2020 (i.e. before the virus spread widely and before social distancing measures were put into place). Binder (2020) documents that greater concerns about Covid-19 were initially associated with higher inflation expectations. Dietrich, et al. (2020) report on daily surveys they conducted in the second half of March 2020. Although the median respondent reported that the pandemic should have an inflationary effect, Dietrich et al. (2020) find that short-term inflation expectations actually declined slightly in their surveys. Similarly, Coibion, Gorodnichenko and Weber (2020) compare two surveys conducted in January and April 2020 and find a decrease in year-ahead inflation expectations and an increase in short-term inflation uncertainty. Using the next wave of the same quarterly survey, Candia et al. (2020) report that households' inflation expectations had subsequently increased in July 2020. The authors argue that this result is consistent with consumers associating a worsening economy with higher future inflation.

Two papers focus on the inflation expectations of U.S. firms during Covid-19 and report conflicting results. Candia et al. (2020) suggest that, similar to households, firms see the pandemic as an inflationary supply shock. In contrast, Meyer, Prescott and Sheng (2020) report that, similar to market participants and professional forecasters, firms have responded to Covid-19 by lowering their one-year-ahead inflation expectations as they see the pandemic as a demand shock. Further, Meyer et al. (2020) find that, as of June 2020, firms' longer-run inflation expectations have changed little throughout the pandemic and remained reasonably well anchored.

Our paper complements this literature in several ways. First, having access to a rotating panel of daily expectations for a period that extends before and after the outbreak of Covid-19 allows us to provide a unique perspective on the evolution of inflation beliefs in response to the pandemic. Second, we focus on changes to the *entire distribution* of inflation beliefs, that is inflation expectations, uncertainty, disagreement and the probability assigned to extreme inflation outcomes. Third, we use the demographic characteristics collected in the SCE to assess the extent to which the Covid-19 shock had a heterogenous impact on households' inflation beliefs.

In addition to shedding light on how inflation expectations, disagreement and uncertainty have changed due to Covid-19, this paper also contributes more broadly to the literature on inflation expectations formation during an economic crisis. How individuals form and update their inflation beliefs has been the focus of several studies over the last decade (see e.g. Coibion, Gorodnichenko and Kamdar 2018 for a review). However, only a handful of papers have studied how households update their inflation beliefs in times of crisis. In particular, Galati, Poelhekke and Zhou (2011) document an increase in inflation expectations during the 2007-2009 Great Recession, while Gerlach, Hördahl and Moessner (2011) or Trehan and Zorilla (2012) find that this effect vanished quickly once the recession subsided. Several questions, however, still remain unanswered. In

particular, how do inflation uncertainty and disagreement change during a crisis? Are these adjustments in beliefs long lasting or short lived? Do the inflation beliefs of specific demographic groups respond homogenously to a crisis? Are the revisions in beliefs (if any) associated with changes in behavior? This study provides new evidence that helps answer some of these important questions.

We also contribute to the long empirical literature on precautionary savings (for recent reviews see Lugilde, Bande and Riveiro 2019, or Baiardi, Magnani and Menegatti 2020). In particular, Ben-David et al. (2018) used data from the SCE to show that consumers who report higher forecast uncertainty (about inflation, national home price changes and wage growth) tend to have more cautious consumption, investment, and borrowing behaviors. We build on this earlier work in two distinct ways. First, we exploit the panel dimension of the SCE to control for potential unobserved individual and time-invariant effects (e.g. time preference) that may otherwise act as confounding factors. Second, we focus on a singular event by investigating how inflation uncertainty is linked to the way consumers used the Economic Impact Payments (referred below as "stimulus checks") that were issued as part of the 2020 CARES Act.

Finally, our paper is related to the literature that studies empirically the link between inflation beliefs and behavior. While most of this literature focuses on the relationship between inflation expectations and households' economic behavior (e.g. Armantier et al. 2015, Crump et al. 2015, D'Acunto, Hoang, and Weber 2018, Coibion et al. 2019, Candia et al. 2020), a few papers have investigated the role of inflation uncertainty. This includes Binder (2017), who finds that consumers with higher inflation uncertainty are more reluctant to purchase durable goods, which is consistent with a precautionary savings channel. Armantier et al. (2015) report experimental evidence showing that, consistent with expected utility theory, people make investment decisions based on their inflation expectation and uncertainty. Finally, Ben-David et al. (2019) show that higher inflation uncertainty is associated with more caution in households' consumption, investment and borrowing behaviors. Our paper complements this literature by exploring the role played by inflation uncertainty in the way consumers used the Economic Impact Payments (aka stimulus checks) that were issued in the spring of 2020 as part of the CARES Act.

3. The Data

The Survey of Consumer Expectations (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 consecutive months) of roughly 1,300 nationally representative U.S. household heads. The main objective of the survey is to collect expectations (both point

predictions and density forecasts) for a wide range of economic outcomes (e.g. inflation, income, spending, household finance, employment and housing). Data from the SCE have been used widely to address both policy and research questions.[3]

The SCE elicits different measures of inflation beliefs.[4] This study focuses on short and medium-term inflation density forecasts. The short-term horizon corresponds to the year ahead rate of inflation ("*Over the next 12 months*"), while the medium-term horizon corresponds to the three-year ahead one-year rate of inflation ("*Over the 12-month period between* M+24 *and* M+36," where M is the month in which the respondent takes the survey). For instance, a respondent taking the survey in March 2020 is asked about inflation "*Over the 12-month period between March 2022 and March 2023*." For each horizon, SCE respondents are asked to report their density forecasts using a menu of pre-specified bins. More specifically, a respondent is asked to state the percent chance that the rate of inflation at the given horizon will be within each of the following intervals: (-12% or less], [-12%,-8%], [-8%,-4%],[-4%,-2%], [-2%,0%], [0%,2%], [2%,4%], [4%,8%], [8%,12%], [12% or more). A visible running sum gives respondents the ability to verify that their answers add to 100%.

The density forecasts are used to calculate the three inflation measures we focus on in this paper: the *individual inflation density mean*, the *individual inflation uncertainty* and the *inflation disagreement across respondents*. Following Engelberg, Manski and Williams (2009), a generalized beta distribution is fitted to each respondent's density forecast. The mean of a respondent's fitted distribution is the *individual inflation density mean*, while the interquartile range of a respondent's distribution is used as a measure of the respondent's *individual inflation uncertainty*. Finally, we use the interquartile range of the distribution of *individual inflation density means* as a measure of the *inflation disagreement across respondents* during that period.[5]

We study how these three inflation measures have evolved almost in real time during the pandemic using daily responses. As explained in Armantier et al. (2017), SCE respondents are invited to complete the survey on different dates spread out throughout the month in order to capture consumers' expectations uniformly over time. For each inflation measure, we construct figures showing daily predictions of a local linear regression. To quantify precisely the effect of the pandemic, we also carry out regression analyses in which we estimate how the various inflation

[3] See e.g. Armantier et al. (2015, 2016, 2020a), Armona et al. (2018), or Crump et al. (2020).
[4] In the paper, we distinguish an individual's *inflation belief*, which is characterized by a probability distribution, from his/her *inflation expectation* which is the mean of this distribution.
[5] An older literature in economics used to consider inflation disagreement to be a proxy for inflation uncertainty. As pointed out by Zarnowitz and Lambros (1987) or Manski (2004) among others, there is no theoretical nor empirical support for this practice. It is now widely recognized that the two measures are different and provide distinct information about the distribution of inflation beliefs.

beliefs' measures changed before and after the outbreak of Covid-19. To identify possible changes *during* the pandemic, we also partition the post-pandemic data in 5 periods:

- The *pre-pandemic declaration* period starts on January 1, 2020 and ends on March 10, the day before the WHO pandemic declaration.
- The *initial* period starts on March 11 and ends on March 26, the day before the CARES Act was signed into law.
- The *lockdown* period is between March 27 and May 15, when most U.S. states were under some form of social distancing restrictions.
- The *reopening* period goes from May 16 to June 30 when most states lifted or reduced social distancing restrictions.
- Finally, the *resurgence in cases* period is from July 1 to August 31, 2020, when the number of Covid-19 cases in the U.S. spiked.[6]

There are potential issues to consider when interpreting shifts in inflation measures as the causal impact of the pandemic. First, other factors could have affected inflation beliefs simultaneously. The Covid-19 pandemic, however, was relatively sudden, and its impact on the economy was massive. Thus, confounding factors appear to be highly unlikely to have played a significant role.

Second, to identify precisely the impact of a pandemic that stretches over several months, one must control for possible seasonality effects in inflation beliefs. Because the SCE has been conducted since June 2013, we can address this concern by estimating regressions with several years of data and controlling for month-of-year fixed effects.

Third, one must be cognizant of possible pre-pandemic trends in the data. While there are many ways to control for such pre-trends, we do so in two ways. First, we restrict the sample period to recent history, i.e. from January 1, 2017 to August 31, 2020. As we shall see, the data exhibit little to no visible pre-trend in the three years between January 2017 and December 2019. Second, to control for any recent shifts in inflation measures, we add a *Post-2019* dummy variable equal to 1 for any data collected on or after January 1, 2019. The five pandemic period dummies described above can then be interpreted as shifts relative to the *Post-2019* dummy.

Fourth, the pandemic outbreak may have affected the composition of SCE respondents over time. While we find no evidence of changes in the SCE sample composition with respect to respondents' observable characteristics, we cannot rule out completely that participation in the survey was affected by the pandemic. To address this issue, we exploit the unique rotating panel

[6] Many European countries and U.S. states experienced a new surge in Covid-19 cases in the fall of 2020. We do not consider this latest wave of outbreaks in this paper.

structure of the SCE and include individual fixed effects in the regressions that use individual-level observations. Further, we control for each respondent's SCE experience (i.e. how many SCE surveys they completed) using twelve dummy variables (one for each month of participation) so as to control for possible learning or "panel conditioning" effects.

Finally, identifying a precise start date for the Covid-19 crisis is challenging. While there is no objective way to do so, March 11, 2020, the day Covid-19 was officially declared a pandemic by the WHO, seems like a natural choice. We acknowledge, however, that the virus had been identified since at least December 2019. To test whether Covid-19 affected our three inflation measures before it was declared a pandemic, we also include in the regression a *pre-pandemic declaration* dummy variable for the period between January 1, 2020 and March 10.

4. Individual inflation density means

We plot in Figure 1 the daily inflation density means at the one- and three-year horizons as predicted by a local linear regression. To control for the undue influence of outliers we trim the data symmetrically on a weekly basis.[7] The figure in the top panel focuses on the period around the Covid-19 pandemic, from December 15, 2019 to August 31, 2020. The figure in the bottom panel covers a longer time period, from January 1, 2014 to August 31, 2020. In the top panel, we also draw vertical bars to mark the different pandemic periods we consider, as well as some of the key dates in the development of the pandemic.

[Figure 1]

Five points are worth noting on Figure 1. First, there is no clear evidence of a pre-trend prior to the Covid-19 outbreak. The bottom panel of Figure 1 shows that, with the exception of a few short episodes, short- and medium-term inflation expectations have been fairly stable since 2016. Second, the Covid-19 outbreak had no clear impact on inflation expectations at both horizons before the pandemic declaration on March 11, and a relatively modest impact during what we called the *initial* period (March 11 to March 26). These results are consistent with the early analyses of Dietrich et al. (2020) or Coibion et al. (2020). Third, short-term and, to a lesser extent, medium-term inflation expectations, have been generally above their 2019 averages after the

[7] Trimming inflation expectations to remove outliers is common in practice (see e.g. Coibion, Gorodnichenko and Kumar 2018). In the paper, we trim inflation expectations and uncertainty differently for the figures and for the regressions. Because the figures show daily estimates, they are quite sensitive to outliers. Hence, to avoid large daily jumps caused by the undue influence of outliers, we trim the bottom and top 10% of the data each week for the figures. In contrast, the inflation expectations and uncertainty are trimmed only at the top and bottom 2% each week for the regressions we use to establish the statistical significance of our results. Note however that the results presented below are robust to alternative trimming thresholds (including no trimming), and to the use of winsorizing (instead of trimming) methods.

pandemic declaration on March 11, 2020. Fourth, inflation expectations have been unusually volatile during the pandemic as indicated by the large upward and downward swings in the top panel of Figure 1. Fifth, neither of the early policy interventions, i.e. the Federal Reserve surprise rate cut on March 15 or the signature of the CARES Act on March 27, appeared to have had a substantial or a lasting effect on average inflation density means.

[Table 1]

To confirm these observations statistically and to measure the exact impact of the pandemic, we regress individual inflation density means at both horizons on the five pandemic period dummies, controlling for individual, seasonal, survey experience and pre-trend effects. The results reported in column 1 of Table 1 confirm the absence of a significant pandemic effect on short-term inflation expectations during both the *pre-pandemic* period (January 1, 2020 to March 10) and *initial* period (March 11 to March 26). Table 1 also indicates that after March 27 (the start of the *lockdown* period), short-term inflation expectations became significantly higher than they were prior to the pandemic, consistent with the findings of Candia et al. (2020). The magnitude of the effect (between 42 and 66 basis points), although substantial, is not unprecedented as can be seen in the top panel of Figure 1. Turning now to column 2 of Table 1, we can see that while the pandemic had a positive impact on medium-term inflation expectations throughout the pandemic, the effect is only significant at the 5% level during the *lockdown* period when the average inflation density mean increased by 46 basis points.

Summing up, we find that inflation expectations at both horizons did not immediately respond to the pandemic outbreak, and that subsequently, only short-term inflation expectations experienced a sustained increase.

5. Individual inflation uncertainty

We plot in Figure 2 the daily individual inflation uncertainty measures at both horizons. Unlike inflation expectations, inflation uncertainty exhibited a sharp, immediate and monotonic increase right around the date of the WHO pandemic declaration (see the top panel of Figure 2). In fact, one-year ahead inflation uncertainty reached levels in March not seen since the inception of the SCE (see the bottom panel of Figure 2). After remaining elevated throughout the spring, inflation uncertainty at both horizons briefly returned to levels close to their 2019 averages by the end of the *reopening* period (i.e. by the end of June 2020), but then sharply increased again over the summer as the U.S. was experiencing a resurgence in new Covid-19 cases.

[Figure 2]

Figure 2 reveals another interesting pattern. As can be seen in the bottom panel, uncertainty has been historically higher for three-year ahead inflation than for one-year inflation, reflecting the fact that predicting inflation further in the future may be more difficult. In contrast, the top panel of Figure 2 shows that uncertainty was uncharacteristically higher for one-year ahead inflation than for three-year ahead inflation throughout the pandemic. This pattern suggests that respondents have been more uncertain about predicting the economic consequences of the pandemic in the short-term than in the medium-term.

The regression coefficients in columns 3 and 4 of Table 1 confirm the immediate, large (at least 1.0 and 0.75 percentage point at the one- and three-year ahead horizons, respectively) and sustained increase in inflation uncertainty at both horizons. In fact, we cannot reject the null hypothesis that the time dummy parameters in each of columns 3 and 4 are jointly equal across the four post-March 11 pandemic periods.

To sum up, in contrast with inflation expectations, we find that the pandemic led to an immediate and substantial increase in inflation uncertainty, especially at the short-term horizon. This result has important policy implications. Indeed, Kumar et al. (2015) consider high inflation uncertainty about long-term inflation to be one of the metrics indicating un-anchored inflation expectations. Thus, even if, on average, inflation expectations (i.e. density means) have changed little during the pandemic, a sustained increase in medium-term inflation uncertainty could be a sign of inflation un-anchoring by households.

6. Inflation disagreement across respondents

We plot in Figure 3 daily measures of inflation disagreement across respondents for the short and medium-term horizons. The patterns in the top panel of Figure 3 are relatively similar to those observed for inflation uncertainty in the top panel of Figure 2. Inflation disagreement increased sharply through the month of March, especially at the one-year horizon. In fact, the bottom panel of Figure 3 indicates that disagreement at the one-year ahead horizon quickly reached levels not seen since the inception of the SCE. After peaking toward the end of May 2020, inflation disagreement at both horizons gradually subsided, but remained elevated compared to their 2019 averages, especially at the one-year horizon. Figure 3 also shows that disagreement has been larger for short-term inflation than for medium-term inflation since the start of the pandemic. This is in contrast with the historical trends, which show that respondents usually disagree more about the path of inflation in the medium- than in the short-term (see the bottom panel of Figure 3).

[Figure 3]

The estimation results reported in columns 5 and 6 of Table 1 confirm the large and statistically significant increases in inflation disagreement at both horizons during the pandemic. The magnitude of the estimated shifts in inflation disagreement are quite sizable, especially for short-term inflation. The effect corresponds to an increase of around 1.4 standard deviations of inflation disagreement (during our sample period) at the one-year horizon, and 0.9 standard deviation at the three-year horizon.

To summarize, the Covid-19 crisis has been characterized by high levels of inflation disagreement across respondents, especially at the one-year horizon. Similar to the increase in inflation uncertainty, this finding potentially raises policy concerns because elevated inflation disagreement about long-term inflation is another metric suggesting the possible un-anchoring of inflation expectations (see Kumar et al. 2015).[8]

7. A different perspective on inflation beliefs

7.1 The distribution of inflation beliefs

Using the same local regression approach we used to construct previous figures, we plot in Figure 4 the predicted probability mass that respondents assign to different inflation buckets when they report their density forecasts. We start with the top panel showing the daily one-year ahead *aggregate density forecast*, that is the average (across respondents) distribution of one-year ahead inflation. Note that Figure 4 captures how both inflation disagreement and inflation uncertainty have varied over time during the pandemic. Indeed, the aggregate density forecast is affected by any change in the location (e.g. density mean) or in the dispersion (e.g. interquartile range) of the respondents' individual inflation distribution. During the month of March, the probability mass assigned to the two buckets around the Federal Reserve's inflation target (i.e. [0%,2%] and [2%,4%]) fell precipitously. In contrast, the average respondent assigned a much higher likelihood to extreme inflation outcomes over the next year, i.e. deflation and the possibility that inflation will be greater than 4%. In particular, the perceived chance of deflation one-year ahead roughly doubled between the end of February and the end of March. After peaking in the first week of April, the likelihood given to deflation in the next year gradually returned to pre-Covid-19 levels. In contrast, the mass assigned to high inflation remained elevated until the end of August 2020.

[8] Inflation disagreement could also affect macroeconomic outcomes. Ehling et al. (2018) find that separate from the impact of expected inflation, disagreement in inflation expectations raises real and nominal yields and their volatilities, and that this effect is distinct from the impact of expected inflation. In their model, inflation disagreement affects yields because it leads to heterogeneity in consumption and investment decisions.

As indicated in the first four columns of Table 2, the patterns just described are all confirmed statistically with a regression analysis.

[Figure 4]

Turning now to the bottom panel of Figure 4, we can see that the aggregate three-year ahead density forecast exhibits relatively similar patterns as the one just described for year-ahead inflation, except that the magnitude of the changes during the pandemic are substantially more muted for medium-term expectations. Nevertheless, as indicated in the last four columns of Table 2, most of the changes are also statistically significant for three-year ahead inflation.

[Table 2]

To sum up, SCE respondents initially expressed more uncertainty about short and medium-term inflation by assigning higher likelihoods to both low and high inflation outcomes. Such a change in the aggregate density forecast again may signal potential un-anchoring of inflation expectations (Grishchenko, Mouabbi, and Renne 2019). As the crisis progressed, deflation expectations subsided while the perceived risk of high inflation remained elevated. The patterns just described are more pronounced for short-term than for medium-term inflation expectations. The higher likelihood assigned to extreme inflation outcomes during the pandemic is consistent with the increase in inflation uncertainty documented in section 5. Further, the fact that only the probability of deflation returned close to pre-pandemic levels contributes to explaining the increase in average inflation expectations during the latter part of the pandemic we identified in section 4.

7.2 The distribution of individual density means

To understand better how inflation disagreement across respondents has evolved during the pandemic, we plot in Figure 5 the daily distribution of individual inflation density means. We start with the top panel, which focuses on year ahead inflation expectations. The proportion of respondents who expect there will be deflation in the next year (i.e. with a density mean below zero) jumped from less than 10% at the end of February 2020 to more than 20% a month later. After peaking in early April, this proportion abated slowly back to its pre-pandemic level. The proportion of respondents who expect short-term inflation to be higher than 4% initially followed a similar pattern: It increased sharply, from 22% at the end of February to almost 45% by the end of March. However, the proportion of respondents who expect high inflation did not decline over time and remained higher than its pre-pandemic average until the end of our sample period. Finally, in part by construction, the proportion of respondents with inflation expectations in the two buckets around the Fed's inflation target (i.e. 0% to 2%, and 2% to 4%) followed an opposite pattern during the crisis (i.e. a sharp decline followed by a slow and incomplete return to normal levels). The

bottom panel of Figure 5 shows that the distribution of three-year ahead inflation density means experienced similar, although substantially more muted, patterns during the pandemic. The regression results reported in Table 3 confirm that the changes in the density means distributions during the pandemic period are indeed statistically significant.

[Figure 5]

[Table 3]

To summarize, respondents became substantially more polarized in their inflation expectations when the pandemic started, especially at the short-term horizon. Consistent with the hypothesis of Candia et al. (2020) under which households see the pandemic primarily as a supply shock, a substantial proportion of respondents believed that the pandemic was going to produce high inflation. However, another group of respondents initially believed that the pandemic was going to yield low inflation or even deflation. Although this polarization subsided somewhat by the end of August 2020, it remained elevated. Further, inflation polarization was less pronounced for medium-term inflation than for short-term inflation.

These results show that the increase in inflation disagreement we identified in section 5 is not explained by a simple one-sided shift by some respondents toward (e.g.) higher inflation expectations as suggested by Candia et al. (2020). Instead, the increase in disagreement reflects growing inflation polarization during the pandemic: A higher proportion of respondents moved simultaneously to both tails of the density mean distribution. The increase in inflation polarization also sheds light on why inflation expectations remained little changed on average during a large part of the pandemic.

8. Heterogeneity analysis

In this section, we start by investigating how the different individual inflation belief measures we have studied in Sections 4 to 7 differ across demographic groups before the Covid-19 crisis started. Then, we explore the extent to which the pandemic had a heterogenous impact on the inflation beliefs expressed by specific demographic groups. To do so, we exploit the rich array of socio-demographic variables collected in the SCE which include the respondent's age, gender, race, education, household income, and family composition (i.e. whether or not the household includes children). In addition, we include a measure of the respondent's financial literacy and numeracy skills (adapted from Lusardi 2007).[9]

[9] 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?". See Bruine de Bruin et al. (2010) for further details on our

8.1 Heterogeneity in inflation beliefs before the Covid-19 crisis

To identify the heterogeneity in inflation beliefs that may have existed just before the Covid-19 crisis started, we restrict the sample to SCE waves between January 1, 2017 and December 31, 2019. We then regress our individual inflation measures on demographic variables, controlling for month-of-the-year and survey-tenure fixed effects as in previous regressions. The results are reported in Table 4.

[Table 4]

We start in columns 1 and 5 with one-year and three-year ahead inflation density means, respectively. Consistent with Souleles (2004), Pfajfar and Santoro (2009), Bruine de Bruin et al. (2010), D'Acunto et al. (2019) and Armantier et al. (2020a), we find that age, gender and income are significantly correlated with inflation expectations at both horizons. Namely, we find that women and household heads above age 40 tend to have higher inflation expectations. Conversely, having a relatively high household income (above $60,000) tends to be associated with lower inflation expectations.

Inflation uncertainty is increasingly studied in the literature but, so far, only a few papers have explored the extent to which inflation uncertainty differs across demographic groups (Bruine de Bruin et al. 2011b, Ben-David et al. 2019, Armantier et al. 2020a). The individual density forecasts elicited in the SCE give us a unique opportunity to fill this gap. Consistent with Armantier et al. (2020a), we find several dimensions of heterogeneity that apply to both short- and medium-term inflation uncertainty (see columns 2 and 6 of Table 4). In particular, women and respondents with children appear significantly more uncertain about inflation. In contrast, respondents who identify as white, those with a college degree, high numeracy or a relatively high household income tend to be less uncertain. Note that the significance and the magnitude of these effects are remarkably similar for one-year ahead and three-year ahead inflation uncertainty.

We similarly analyze the heterogeneity in the probability assigned to extreme inflation outcomes at both horizons. To the best of our knowledge, such an analysis is new to the literature. Starting with the results for the short-term horizon in columns 3 and 4 of Table 4, we see that older respondents assign a higher probability to high inflation (above 4%), and a lower probability to deflation. This result is consistent with the inflation learning model of Malmendier and Nagel (2016), who argue that past personal experiences with high inflation (e.g. during the 1970s) lead older agents to have persistently higher inflation expectations. Respondents who self-identify as white, those with a college degree, high numeracy or a relatively high household income have

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

more moderate inflation beliefs as they put significantly less weights on both high inflation and deflation. In contrast, we find that women have more diffuse inflation beliefs as they put more weight both on high inflation and on deflation. Here again, the patterns are remarkably similar for beliefs about inflation at the three-year horizon (columns 7 and 8).

8.2 The effect of the Covid-19 crisis on the heterogeneity in inflation beliefs

We have just documented substantial heterogeneity in inflation beliefs before the pandemic started. Did Covid-19 exacerbate or diminish this heterogeneity, or did differences across demographic groups remain unchanged during the pandemic? To address this question and avoid small sample size issues, we now collapse our four pandemic periods into one. Based on the results in sections 4 to 6, where we found that Covid-19 affected inflation beliefs mostly after it was declared a pandemic, we define a *Pandemic* dummy equal to 1 for data collected between March 11 and August 31, 2020. We then regress the different inflation beliefs measures on the *Post-2019* and *Pandemic* dummies, each interacted with individual covariates, while also controlling for month of the year and survey tenure effects (consistent with the specifications in previous sections).[10] The heterogeneity of the impact of the Covid-19 crisis is then identified by the coefficients associated with the interaction between individual covariates and the *Pandemic* dummy.

[Table 5]

The results reported in column 1 of Table 5 reveal that the impact of the crisis on year-ahead inflation expectations has been relatively homogenous across demographic characteristics, except for education. Namely, holding other individual characteristics constant, we find that the year ahead inflation expectations of respondents with a college degree were significantly smaller (by 0.56 percentage points) during the pandemic. This result suggests that the Covid-19 crisis created some heterogeneity in short-term inflation expectations by education level that did not exist before the pandemic (as shown in column 1 of Table 4). Further, columns 3 and 4 of Table 5 indicate that, relative to other respondents, the short-term inflation beliefs of college graduates shifted significantly downward after the start of the pandemic, with a significantly lower mass assigned to high inflation and a significantly higher mass assigned to deflation. Note also in column 4 that respondents with high numeracy assigned a significantly higher weight to year-ahead deflation once the pandemic started. There are at least two, non-mutually exclusive, explanations for these results. First, college graduates and high numeracy respondents may be more informed about the expectations of markets participants and professional forecasters, who all predicted a sharp decline

[10] The results presented below remain virtually unchanged if we add a separate time dummy for the pre-pandemic period (i.e. a dummy for the period between January 1st and March 10, 2020), or if the *Pandemic* dummy is set equal to 1 for data collected between January 1st (instead of March 11) and August 31st, 2020.

in future inflation when the pandemic started.[11] Second, unlike other households who may associate Covid-19 to an inflationary supply shock (as suggested by Candia et al. 2020), college graduates and high numeracy respondents may see pandemic largely as a deflationary demand shock. Other than education, however, it is interesting to note that Covid-19 did not exacerbate nor reduce any of the substantial heterogeneity we identified along other socio-demographic dimensions for year-ahead inflation expectations before the pandemic started.

Similarly, the results in column 2 of Table 5 indicate that the Covid-19 crisis did not affect the heterogeneity in uncertainty about short-term inflation for any of the individual characteristics we analyze. This result is remarkable since we identified a sharp increase in uncertainty during the pandemic (Table 1) and substantial heterogeneity in uncertainty before the crisis (Table 4). Hence, it appears that the increase in short-term inflation uncertainty caused by Covid-19 was essentially uniform across demographic groups.

Columns 5 through 8 of Table 5 present the estimates of the heterogeneity in the effect of the Covid-19 crisis on three-year ahead inflation beliefs. The results in column 5 show that, all else equal, Covid-19 had a significantly smaller effect on three-year ahead inflation expectations for respondents with children, and a larger effect for respondents with a higher household income. Turning now to column 6 of Table 5, we see that the Covid-19 crisis exacerbated some of the heterogeneity in medium term inflation uncertainty that existed before the pandemic. In particular, women, who already tend to be more uncertain in normal times, responded to the pandemic with significantly more uncertainty. Conversely, the pandemic had a smaller impact on the medium-term uncertainty of older respondents, who already tend to be less uncertain.

To sum up, we find that there was substantial heterogeneity in inflation beliefs across demographic groups before the pandemic. However, except for a few notable demographic characteristics (e.g. education, gender), we find little evidence that the Covid-19 outbreak exacerbated or reduced this pre-existing heterogeneity. As discussed in the conclusion, these results may have implications for how central banks should communicate to the public (e.g. to lower disagreement or reduce uncertainty) in normal times and in times of crises.

9. Comparison with the 2008 crisis

As discussed in the introduction, the economic crisis that followed the Covid-19 outbreak has been unique along several dimensions. So, to what extent did inflation beliefs respond to the Covid-19 pandemic differently from the way they responded to previous economic crises? To address this

[11] See e.g. Federal Reserve Bank of St. Louis, 5-Year, 5-Year Forward Inflation Expectation Rate [T5YIFR], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/T5YIFR, October 8, 2020.

question, we now focus on the most recent economic crisis prior to the pandemic, namely the Great Recession of 2007-2009. As mentioned earlier, however, the SCE was officially launched in 2013.[12] Thus, to compare the two crises, we turn to a different survey, the Michigan Survey of Consumers (MSC hereafter).

There are a number of differences between the SCE and the MSC. First, MSC respondents are only asked to report a point prediction for future inflation, whereas the SCE also asks respondents to report a density forecast. Thus, we are unable to calculate an inflation uncertainty measure for the Great Recession. Second, the public data from the MSC do not have a timestamp. Hence, we can only calculate monthly averages for the MSC, not daily measures. Third, while both surveys capture expectations at the one-year horizon, the SCE elicits medium-term inflation beliefs (i.e. three-year ahead), whereas the MSC asks about a longer horizon, defined to respondents as "5 to 10 years from now."

With these differences in mind, we plot in Figure 6 the MSC median point forecast for each month between June 2007 and June 2010 on the left panel, and between December 2019 and August 2020 in the right panel. Two points are worth noting. First, the impact of both crises on long-term inflation expectations were muted. During the Great Recession, long-term inflation expectations only increased slightly and only for a few months after the failure of Bear Sterns in March 2008 (see left panel of Figure 6). Similarly, long-term inflation expectations increased only by a few basis points between March and August 2020 (see right panel of Figure 6). Second, short-term inflation expectations from the MSC have followed different patterns in the two crises. As indicated in the left panel of Figure 6, average short-term inflation expectations increased sharply (by roughly 2 percentage points) in the few months that followed the official start of the Great Recession (December 2007), they then declined over the summer 2008, before plunging after the bankruptcy of Lehman Brothers. In contrast, the right panel of Figure 6 shows that in the five months that followed the WHO pandemic declaration, short-term inflation expectations have increased by much less (by roughly 1 percentage point), and they have remained more stable from month-to-month until the end of our sample period. As the pandemic and its impact on the economy are still in progress at the time of writing this paper, it is clearly too early to state whether these initial differences in patterns will still be present once the pandemic is resolved.

[Figure 6]

[12] As documented in Bruine de Bruin et al. (2010), an experimental version of the SCE was conducted starting around the end of 2007. We refrain from using these data to compare the two crises because the wording of the questions and the sample of respondents were somewhat different from the one now used for the SCE. More importantly, data on inflation uncertainty in this experimental survey were only available after the Great Recession had started (i.e. after June 2008).

Figure 7 shows the monthly inflation disagreement measure in the MSC (i.e. the interquartile range of inflation point predictions across respondents) during the Great Recession (left panel) and during the Covid-19 pandemic (right panel). We can see that disagreement about short-term inflation increased sharply in the wake of two of the most prominent events of the Great Recession (the failure of Bear Sterns and the bankruptcy of Lehman Brothers), and only partially subsided over the next 18 months, remaining higher than their pre-recession levels even after the official conclusion of the Great Recession in July 2009. In contrast, disagreement about long-term inflation increased only very slightly during the Great Recession.

[Figure 7]

Relatively similar patterns have been observed since the start of the pandemic in the right panel of Figure 7. Short-term inflation disagreement rose sharply in the months that followed the WHO declaration, whereas long-term inflation disagreement changed little during the pandemic in the MSC. The latter result contrasts with our finding in section 6, that disagreement about medium-term inflation rose significantly during the pandemic in the SCE. This difference may be explained by several factors, including a difference in the horizons considered by respondents in the two surveys (three-year ahead in the SCE versus "5 to 10 years" in the MSC), and a difference in the individual inflation measures (the density mean in the SCE versus the point prediction in the MSC). Finally, it is interesting to note in Figure 7 that the magnitude of the increase in short-term inflation disagreement (from around 3 percentage points to almost 7 percentage points) has been roughly similar during the Great Recession and during the Covid-19 pandemic.

To sum up, the MSC provides evidence suggesting that inflation disagreement responded similarly to the Great Recession and the Covid-19 pandemic. Namely, disagreement increased early, sharply, but temporarily for short-term inflation, whereas it remained essentially stable for long-term inflation. In contrast, the increase in median inflation expectations at both horizons appears to have been more muted so far during the Covid-19 pandemic compared to during the Great Recession. This result may reflect the fact that Covid-19 is a singular crisis which has been difficult for households to categorize as either a supply or a demand shock.

10. Inflation uncertainty and precautionary saving

In this section, we illustrate the important role inflation uncertainty may play in the study of consumer behavior. To do so, we investigate the link between inflation uncertainty and how SCE respondents used the stimulus checks they received as part of the 2020 CARES Act. In particular, we examine whether, consistent with precautionary saving motives, those reporting increases in inflation uncertainty between February and June saved a larger share of their stimulus payments.

In a special module of the SCE that was fielded in June 2020, 89% of the respondents reported receiving a stimulus check. This is in line with the 159 million checks (or 82% out of an expected 194 million checks) that had been disbursed as of June 5.[13] These respondents were also asked what share of the stimulus checks they spent, saved, or used to pay down debt. The special module therefore gives us a unique opportunity to test the extent to which a shift in inflation expectations *and* in inflation uncertainty at the individual level affects a consumer's saving decision. Importantly, the panel dimension of the SCE enables us to look at the effect of *changes* in inflation beliefs on behavior, thus abstracting from level differences in uncertainty that may be related to unobservable characteristics of the respondents.

Of course, differences in demographic characteristics and many circumstances other than a change in inflation beliefs may have influenced the decision of how to use the stimulus payments, including whether the respondents or someone in their household lost their job or experienced a significant income shortfall. The June SCE special module allows us to condition on these circumstances, since in addition to information on how they used the stimulus payments, we asked respondents whether their household suffered a negative employment shock or experienced a drop in their household income between February and June.[14] We are also able to control for individuals' demographic characteristics, attitudes towards financial risks,[15] and year-ahead expectations regarding household income growth, which may also affect the way in which households allocate the stimulus payments they receive.

The regression results are reported in Table 6. The dependent variable is the share saved out of the stimulus checks, as reported in the June special module. Column 1 reports results for a specification which includes only the *change* (between February and June) in inflation expectations and in inflation uncertainty at the one-year-ahead horizon as covariates. Column 2 adds the same demographic variables we have used in Tables 4 and 5. Finally, column 3 adds our

[13] See House Committee on Ways and Means, "Economic Impact Payments Issued to Date," June 5, 2020, https://waysandmeans.house.gov/sites/democrats.waysandmeans.house.gov/files/documents/2020.06.04%20EIPs%20Issued%20as%20of%20June%204%20FINAL.pdf.

[14] A negative labor market shock is defined here as a dummy variable for having experienced a forced leave, furlough, or layoff since the onset of the pandemic. The drop in household income is also a dummy variable equal to 1 when the respondent report that her/his household income has declined between February and June 2020. Note that not all employment shocks imply a drop in income, given the $600 increase in weekly unemployment benefits under the CARES Act.

[15] Respondents are asked to assess their willingness to take risk regarding financial matters using a Likert scale ranging from 1 (not willing at all) to 7 (very willing). This instrument has been shown to produce meaningful measures of risk preferences. In particular, Dohmen et al. (2011) find that the risk tolerance reported on this scale is consistent with the risk preference elicited with a financially incentivized lottery-type experiment (Holt and Laury 2002) and correlates with actual (i.e. non-experimental) financial behavior.

measures of labor market shock and income drop, attitudes towards financial risk, and the expected change in household income (also at the one-year-ahead horizon).

[Table 6]

The results are robust across specifications and indicate that an increase in inflation uncertainty is associated with a statistically significant increase in the share saved out of the stimulus checks. In contrast, the coefficient estimates for the change in inflation expectations are statistically indistinguishable from zero. Observe however, that the negative sign of the point estimate is consistent with a standard consumption Euler equation, where, all else equal, an increase in inflation expectations is equivalent to a decline in the expected real rate of return and should therefore be associated with a decline in savings. In terms of magnitudes and looking across specifications, a one percentage point increase in inflation uncertainty is associated with about a 1.6 to 1.8 percentage points increase in the share saved, which are all economically significant effects.

Overall, the empirical results reported here indicate that an increase in inflation uncertainty is associated with a higher share saved out of a one-time transfer such as the one received by households through the CARES Act of 2020. This finding provides support for the theory of precautionary saving behavior, under which agents facing higher uncertainty about the future should save more today (see e.g. Carroll and Kimball 2008 for a review).

11. Conclusion

In this paper we examined the evolution of inflation beliefs of households during the Covid-19 pandemic. We find a relatively muted impact of the pandemic on average inflation expectations, with only short-term expectations showing a sustained and statistically significant increase. In contrast, we find that the pandemic led to an immediate and substantial increase in inflation uncertainty and disagreement at the medium-term horizon, and even more so at the short-term horizon. While qualitatively similar to the evolution of inflation expectations and disagreement observed during the Great Recession, the increase in inflation expectations appears to have been more muted so far during the Covid-19 pandemic.

When we consider individual heterogeneity in inflation beliefs, we find that the muted response in average inflation expectations masks substantial polarization in beliefs when the pandemic started, especially at the short-term horizon. A substantial share of households see the pandemic as inflationary, consistent with the pandemic representing a supply shock. However, in contrast to Candia et al. (2020) we find that other households, and in particular those college educated, initially expected the pandemic to lead to low inflation or even deflation. Such a view is more

closely aligned to that of firms, market participants and profession forecasters, who largely see the pandemic as a deflationary demand shock. The polarization in beliefs resulted in considerable thickening of both tails of the aggregate density forecast, as well as increases in the tails of the distribution of individual density means, both capturing a sharp rise in inflation disagreement. Although this polarization in beliefs subsided somewhat by the end of August 2020, it remained elevated. At the medium-term horizon we find inflation polarization to be less pronounced.

We also explored the extent to which inflation beliefs are heterogeneous across different demographic groups (i.e. age, gender, race, family composition, household income, education and financial literacy). While we identify substantial heterogeneity in inflation expectations, inflation uncertainty and in the probability assigned to extreme inflation outcomes, we find little evidence that the outbreak of Covid-19 exacerbated or reduced this pre-existing heterogeneity. These results suggest that while central banks may want to tailor their communication to specific demographic groups in normal times, (e.g. to lower disagreement or reduce uncertainty), they may not need to change their communication strategy differentially across groups during a crisis.

Overall, these results provide mixed evidence about the possible risk of inflation expectations un-anchoring due to Covid-19 (as of August 31, 2020). While the relatively muted response so far in medium-term inflation expectations is reassuring, the increases in medium term inflation uncertainty and disagreement could become concerning if they were to persist. So would the increase in polarization of beliefs, with the average probability assigned to high and very low inflation outcomes ---i.e., substantially above and below the Fed's inflation target, respectively--- simultaneously increasing during the Covid-19 crisis. If the public starts disagreeing about the expected future path of inflation or if agents become more uncertain about what inflation will be in the future, inflation expectations could become unmoored. Although the increases in inflation uncertainty, disagreement and polarization have receded somewhat during the summer, they remain relatively elevated. Based on a similar evolution of long-term inflation expectations and disagreement in the Michigan Survey of Consumers during the 2007-2009 Great Recession, one may expect these indicators of un-anchoring to subside further over time as the pandemic ends. Evidence from the SCE is consistent with this view of a dependence of the risk of un-anchoring of inflation expectations on the future path of the pandemic. The pattern observed during the pandemic suggests a strong co-movement with Covid-19 cases. Indeed, we found that medium-term inflation expectations and inflation uncertainty increased sharply during the *lockdown* and *resurgence* periods (when the number of new Covid-19 cases peaked in the U.S. during the spring and summer waves of the pandemic), while they returned to more moderate levels during the *reopening* period (when the number of new Covid-19 cases abated).

Our analysis also points to important behavioral responses to the observed changes in inflation

beliefs, and to the sharp rise in inflation uncertainty in particular. Consistent with precautionary savings behavior, we find that a one percent increase in inflation uncertainty is associated with a 1.6 to 1.8 percentage point increase in the share saved out of the stimulus checks distributed through the CARES Act of 2020. These results point to the broader role played by inflation uncertainty in affecting the impact of policy interventions meant to influence household spending, borrowing and investing, such as the stimulus checks. As uncertainty varies over time, so does the impact of interventions. For instance, our findings imply that the sharp rise in inflation uncertainty observed since the start of the pandemic may help explain the relatively low MPC out of stimulus checks, with an average of 29% used for consumption (Armantier et al. 2020).[16] They also suggest that the increase in uncertainty may have contributed to the sharp increase in the personal saving rate during the pandemic. At the same time, the large heterogeneity in inflation uncertainty that we unveiled implies that households will be differentially affected and respond differently to the economic impact payments.

Finally, our findings are also of broader relevance for monetary policy: to the extent that central bank communications (such as forward guidance) mitigate the public's uncertainty about future inflation outcomes, this may reduce precautionary saving and boost consumption by households. As such, this analysis would highlight a potential transmission channel for monetary policy.

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Table 1: Impact of Covid-19 Pandemic on Inflation Expectations, Uncertainty, and Disagreement

	Inflation expectations		Inflation uncertainty		Inflation disagreement	
	(1)	(2)	(3)	(4)	(5)	(6)
	1-yr	3-yr	1-yr	3-yr	1-yr	3-yr
Pre-pandemic	-0.11	0.05	-0.06	0.00	-0.26	0.00
	(0.14)	(0.15)	(0.13)	(0.13)	(0.18)	(0.21)
Initial period	0.33	0.17	1.02***	0.80***	2.51***	1.46**
	(0.30)	(0.26)	(0.20)	(0.19)	(0.69)	(0.61)
Lockdown	0.42*	0.46**	1.32***	0.94***	2.47***	1.01***
	(0.24)	(0.21)	(0.17)	(0.16)	(0.48)	(0.35)
Reopening	0.66***	0.27	1.19***	0.75***	2.21***	1.14***
	(0.24)	(0.23)	(0.19)	(0.17)	(0.33)	(0.29)
Resurgence	0.61***	0.38*	1.16***	0.92***	1.90***	0.81***
	(0.23)	(0.22)	(0.20)	(0.20)	(0.31)	(0.23)
N	53,250	53,320	53,036	53,150	1,286	1,287
R^2	0.53	0.54	0.69	0.69	0.18	0.05
Constant	X	X	X	X	X	X
Month-of-year FE	X	X	X	X	X	X
Post-2019 dummy	X	X	X	X	X	X
Individual FE	X	X	X	X		
Survey tenure FE	X	X	X	X		

Notes: The table shows the estimated impact of the COVID-19 pandemic on i) inflation density means at the one-year and three-year horizons (columns 1 and 2); ii) individual inflation uncertainty at the one-year and three-year horizons (columns 3 and 4); 3) inflation disagreement across respondents at the one-year and three-year horizons (columns 5 and 6). The sample consists of individual survey responses for columns 1 to 4 and daily data for columns 5 and 6 covering the period from January 1, 2017 through August 31, 2020. The pre-pandemic period is from January 1, 2020 through March 10, 2020. The initial period is from March 11, 2020 through March 26, 2020. The lockdown period is from March 27, 2020 through May 15, 2020. The reopening period is from May 16, 2020 through June 30, 2020. The resurgence period is from July 1, 2020 through August 31, 2020. The data are trimmed each week at the top and bottom 2% to remove outliers. Standard errors (in parentheses) are clustered at the individual level in columns 1 to 4, and robust in columns 5 and 6. $^{*}p < 0.1,^{**}p < 0.05,^{***}p < 0.01$

Table 2: Individual-level Reported Probability of Inflation within Stated Interval

	1-yr				3-yr			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$< 0\%$	$[0\%, 2\%]$	$[2\%, 4\%]$	$> 4\%$	$< 0\%$	$[0\%, 2\%]$	$[2\%, 4\%]$	$> 4\%$
Pre-pandemic	-0.14	2.52***	-0.75	-1.63	-0.80	1.78*	-0.61	-0.37
	(0.92)	(0.94)	(0.97)	(1.21)	(1.00)	(0.91)	(1.01)	(1.21)
Initial period	8.80***	-5.37***	-9.42***	5.99***	5.49***	-1.71	-6.74***	2.96*
	(1.68)	(1.32)	(1.35)	(1.89)	(1.44)	(1.35)	(1.40)	(1.76)
Lockdown	8.33***	-6.17***	-10.24***	8.08***	2.51**	-2.58*	-5.64***	5.71***
	(1.32)	(1.16)	(1.11)	(1.53)	(1.27)	(1.32)	(1.25)	(1.49)
Reopening	4.56***	-4.63***	-8.15***	8.22***	2.23	-1.99*	-4.52***	4.28***
	(1.51)	(1.25)	(1.24)	(1.68)	(1.40)	(1.18)	(1.35)	(1.62)
Resurgence	3.11**	-5.63***	-5.54***	8.05***	0.33	-3.62***	-1.94	5.24***
	(1.39)	(1.30)	(1.38)	(1.68)	(1.26)	(1.26)	(1.48)	(1.69)
N	54,946	54,946	54,946	54,946	55,082	55,082	55,082	55,082
R^2	0.55	0.51	0.46	0.58	0.52	0.49	0.44	0.56
Constant	X	X	X	X	X	X	X	X
Month-of-year FE	X	X	X	X	X	X	X	X
Post-2019 dummy	X	X	X	X	X	X	X	X
Individual FE	X	X	X	X	X	X	X	X
Survey tenure FE	X	X	X	X	X	X	X	X

Notes: The table shows the estimated impact of the COVID-19 pandemic on the probability assigned by individual respondents to different buckets for one-year and three-year inflation. The sample consists of individual survey responses covering the period from January 1, 2017 through August 31, 2020. The pre-pandemic period is from January 1, 2020 through March 10, 2020. The initial period is from March 11, 2020 through March 26, 2020. The lockdown period is from March 27, 2020 through May 15, 2020. The reopening period is from May 16, 2020 through June 30, 2020. The resurgence period is from July 1, 2020 through August 31, 2020. Standard errors (in parentheses) are clustered at the individual level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$

Table 3: Proportion of Respondents with Density Mean within Stated Interval

	1-yr				3-yr			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$< 0\%$	$[0\%, 2\%]$	$[2\%, 4\%]$	$> 4\%$	$< 0\%$	$[0\%, 2\%]$	$[2\%, 4\%]$	$> 4\%$
Pre-pandemic	0.32	4.08***	-0.98	-1.62	-0.53	4.66***	-0.14	-2.30
	(1.34)	(1.43)	(1.62)	(1.63)	(1.34)	(1.59)	(1.43)	(1.48)
Initial period	9.17***	-4.85**	-15.36***	9.03***	3.83*	0.07	-8.22***	4.08*
	(1.90)	(2.19)	(2.31)	(2.45)	(2.16)	(2.78)	(1.70)	(2.31)
Lockdown	8.80***	-7.51***	-13.56***	11.52***	2.81*	-1.12	-5.96***	4.13**
	(1.64)	(1.78)	(1.83)	(2.06)	(1.53)	(1.99)	(1.58)	(1.67)
Reopening	4.98***	-7.45***	-10.67***	12.45***	3.23*	-4.29**	-2.56	3.29*
	(1.52)	(1.80)	(1.84)	(2.14)	(1.67)	(1.89)	(1.97)	(1.96)
Resurgence	3.05**	-6.61***	-8.56***	11.28***	0.85	-3.20*	-1.79	4.43***
	(1.34)	(1.66)	(1.55)	(1.72)	(1.02)	(1.76)	(1.69)	(1.64)
N	1,286	1,286	1,286	1,286	1,287	1,287	1,287	1,287
R^2	0.08	0.06	0.12	0.10	0.02	0.04	0.02	0.03
Constant	X	X	X	X	X	X	X	X
Month-of-year FE	X	X	X	X	X	X	X	X
Post-2019 dummy	X	X	X	X	X	X	X	X

Notes: The table shows the estimated impact of the COVID-19 pandemic on the proportion of respondents with inflation density mean in different buckets for one-year and three-year inflation. The sample consists of individual survey responses covering the period from January 1, 2017 through August 31, 2020. The pre-pandemic period is from January 1, 2020 through March 10, 2020. The initial period is from March 11, 2020 through March 26, 2020. The lockdown period is from March 27, 2020 through May 15, 2020. The reopening period is from May 16, 2020 through June 30, 2020. The resurgence period is from July 1, 2020 through August 31, 2020. Standard errors (in parentheses) are robust. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$

Table 4: Heterogeneity in Inflation Beliefs before 2020

	1-yr				3-yr			
	(1) Inflation expectation	(2) Inflation uncertainty	(3) Probability infl. > 4	(4) Probability infl. < 0	(5) Inflation expectation	(6) Inflation uncertainty	(7) Probability infl. > 4	(8) Probability infl. < 0
Age > 40	0.51***	-0.33***	3.83***	-2.70***	0.55***	-0.30**	4.47***	-2.81***
	(0.10)	(0.12)	(0.91)	(0.70)	(0.11)	(0.12)	(0.92)	(0.73)
Female	0.48***	0.70***	6.17***	1.81***	0.36***	0.69***	4.90***	2.29***
	(0.10)	(0.12)	(0.92)	(0.69)	(0.11)	(0.12)	(0.91)	(0.71)
Has kids	-0.02	0.40***	0.25	1.66**	0.10	0.31**	0.17	1.47*
	(0.11)	(0.13)	(0.93)	(0.72)	(0.12)	(0.13)	(0.96)	(0.77)
White	-0.21	-1.78***	-4.91***	-3.71***	-0.12	-1.67***	-4.40***	-3.81***
	(0.14)	(0.19)	(1.14)	(0.91)	(0.15)	(0.18)	(1.13)	(0.92)
College	-0.10	-1.02***	-4.14***	-4.37***	-0.14	-0.98***	-3.57***	-4.08***
	(0.08)	(0.09)	(0.83)	(0.56)	(0.08)	(0.09)	(0.83)	(0.60)
Income $\geq$ \$60k	-0.30***	-1.18***	-5.71***	-3.44***	-0.31***	-1.18***	-5.21***	-3.03***
	(0.10)	(0.11)	(0.94)	(0.65)	(0.11)	(0.11)	(0.95)	(0.69)
High numeracy	0.04	-1.94***	-5.83***	-8.18***	0.10	-1.90***	-4.60***	-8.17***
	(0.12)	(0.15)	(1.06)	(0.83)	(0.13)	(0.15)	(1.06)	(0.87)
Constant	3.00***	7.77***	39.12***	28.14***	2.96***	7.75***	39.00***	29.54***
	(0.20)	(0.26)	(1.54)	(1.30)	(0.21)	(0.25)	(1.51)	(1.30)
N	45,271	45,037	46,640	46,640	45,316	45,131	46,756	46,756
R^2	0.01	0.20	0.06	0.08	0.01	0.19	0.04	0.06
Constant	X	X	X	X	X	X	X	X
Month-of-year FE	X	X	X	X	X	X	X	X
Survey tenure FE	X	X	X	X	X	X	X	X

Notes: The table shows the estimated heterogeneity across demographic groups in one-year and three-year inflation expectations, uncertainty and the probability assigned to extreme inflation outcomes before the COVID-19 outbreak. The sample consists of individual survey responses covering the period from January 1, 2017 through December 31, 2019. Standard errors (in parentheses) are clustered at the individual level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$

Table 5: Effect of Covid-19 Pandemic on Heterogeneity in Inflation Beliefs

	1-yr				3-yr			
	(1) Inflation expectation	(2) Inflation uncertainty	(3) Probability infl. > 4	(4) Probability infl. < 0	(5) Inflation expectation	(6) Inflation uncertainty	(7) Probability infl. > 4	(8) Probability infl. < 0
Pandemic	0.52	0.82	4.38	-0.02	0.25	1.08**	3.21	-2.28
	(0.55)	(0.55)	(3.84)	(3.03)	(0.49)	(0.55)	(3.45)	(3.04)
Pandemic X Age > 40	0.23	-0.38	0.45	-0.42	0.22	-0.65**	0.63	-0.83
	(0.29)	(0.30)	(2.06)	(1.73)	(0.26)	(0.30)	(1.91)	(1.67)
Pandemic X Female	0.11	0.43	0.14	1.82	0.05	0.58**	-0.79	3.98**
	(0.29)	(0.27)	(2.08)	(1.59)	(0.26)	(0.26)	(1.95)	(1.57)
Pandemic X Has kids	-0.35	-0.07	-3.46	0.99	-0.68**	-0.10	-3.38	2.74
	(0.31)	(0.31)	(2.18)	(1.74)	(0.30)	(0.31)	(2.12)	(1.72)
Pandemic X White	0.16	-0.01	1.73	0.09	-0.38	-0.39	-0.78	2.03
	(0.43)	(0.40)	(2.95)	(2.20)	(0.39)	(0.41)	(2.74)	(2.11)
Pandemic X College	-0.58**	-0.07	-3.12	5.01***	-0.33	-0.30	-3.99**	1.15
	(0.24)	(0.24)	(1.91)	(1.49)	(0.21)	(0.25)	(1.82)	(1.41)
Pandemic X Income $\geq$ \$60k	0.10	0.09	2.56	0.37	0.61**	0.30	3.89*	-1.19
	(0.30)	(0.27)	(2.15)	(1.62)	(0.27)	(0.26)	(2.02)	(1.56)
Pandemic X High numeracy	-0.18	0.22	2.97	3.95**	0.03	0.05	2.54	2.86
	(0.36)	(0.33)	(2.50)	(1.88)	(0.32)	(0.32)	(2.36)	(1.89)
N	54,781	54,560	56,511	56,511	54,869	54,693	56,663	56,663
R^2	0.01	0.10	0.04	0.04	0.01	0.09	0.03	0.03
Constant	X	X	X	X	X	X	X	X
Month-of-year FE	X	X	X	X	X	X	X	X
Survey tenure FE	X	X	X	X	X	X	X	X
Post-2019 controls	X	X	X	X	X	X	X	X

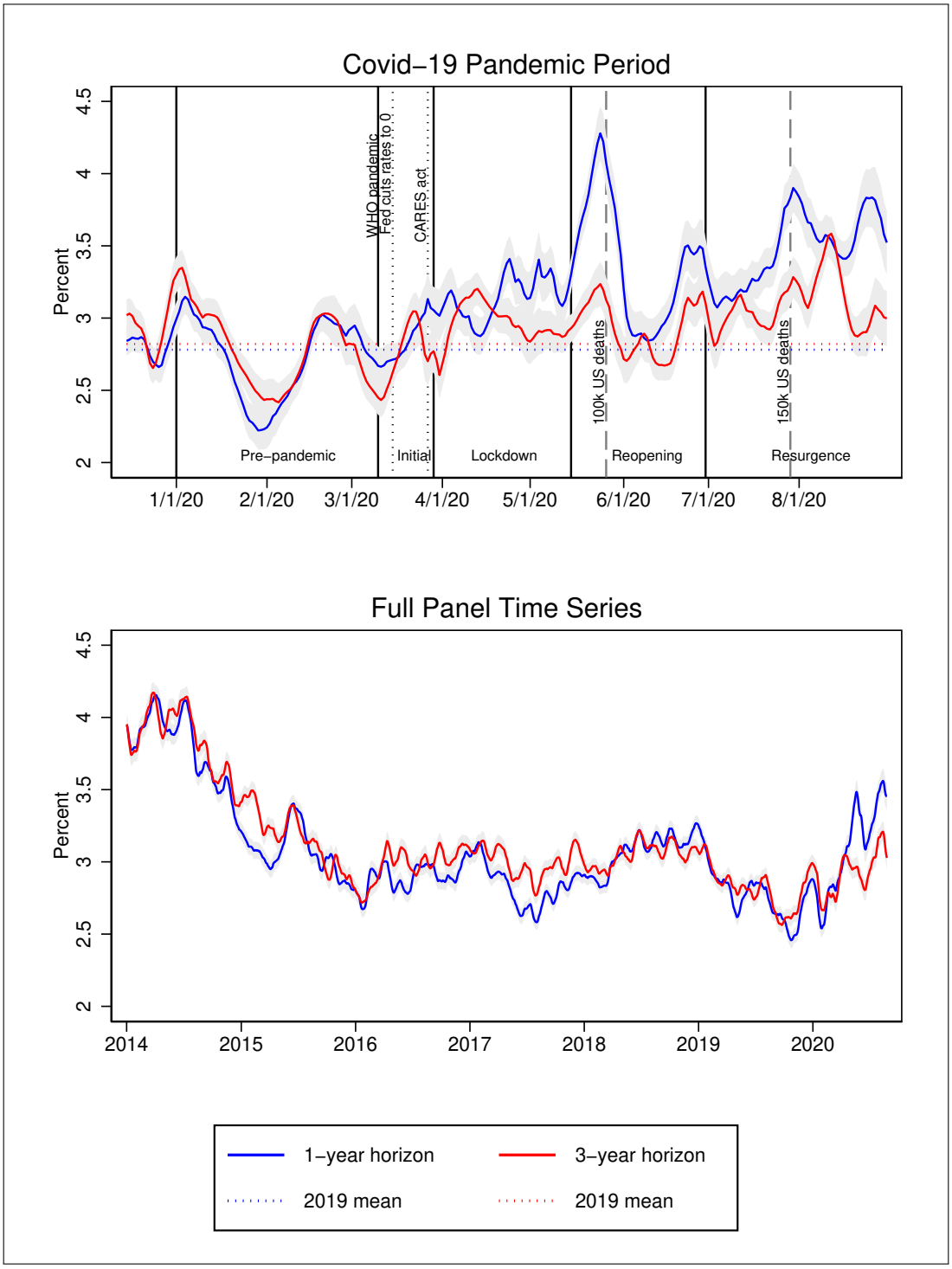
Notes: The table shows the estimated heterogeneity in response to the Covid-19 outbreak in one-year and three-year inflation expectations, uncertainty and the probability assigned to extreme inflation outcomes. The sample consists of individual survey responses covering the period from January 1, 2017 through August 31, 2020. The pandemic period is from March 11, 2020 through August 31, 2020. Standard errors (in parentheses) are clustered at the individual level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$

Table 6: Inflation Uncertainty and Precautionary Saving, Focusing on 2020 CARES Act Stimulus Check

	(1)	(2)	(3)
1-yr infl. expectation change	-0.49	-0.44	-0.28
	(0.46)	(0.45)	(0.45)
1-yr infl. uncertainty change	1.77***	1.55***	1.58***
	(0.57)	(0.58)	(0.58)
N	474	474	473
R^2	0.022	0.072	0.090
Demos		X	X
Other			X

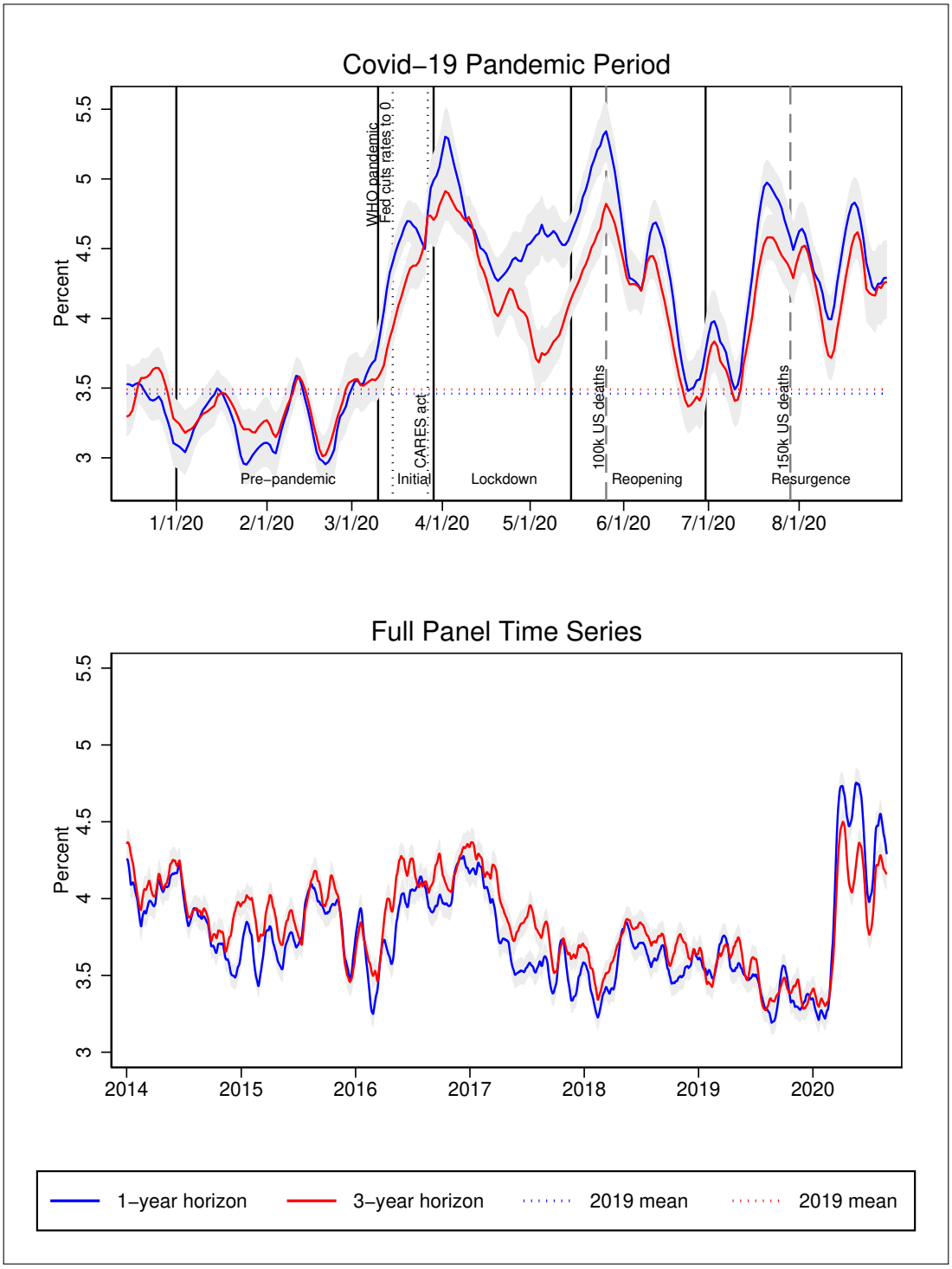
Notes: The dependent variable is the share saved out of the respondent's stimulus check, as reported in the June SCE special module. Column 1 reports results for a specification which includes as covariates only the change (between February and June) in inflation expectations and in inflation uncertainty at the one-year-ahead horizon. Column 2 adds the same demographic variables we have used in Tables 4 and 5. Finally, column 3 adds our measures of labor market shock and income drop, attitude towards financial risk, and the expected change in household income (also at the one-year-ahead horizon). A negative labor market shock is defined here as a dummy variable for having experienced a forced leave, furlough, or layoff since the onset of the pandemic. An income drop is defined here as a dummy variable for having experienced a decrease in household income from February to June. The sample consists of those who took both the February SCE monthly survey and the June SCE special module and reported receiving a stimulus check in June. Standard errors (in parentheses) are clustered at the individual level. $^{*}p < 0.1,^{**}p < 0.05,^{***}p < 0.01$

Figure 1: Evolution of Individual Density Mean



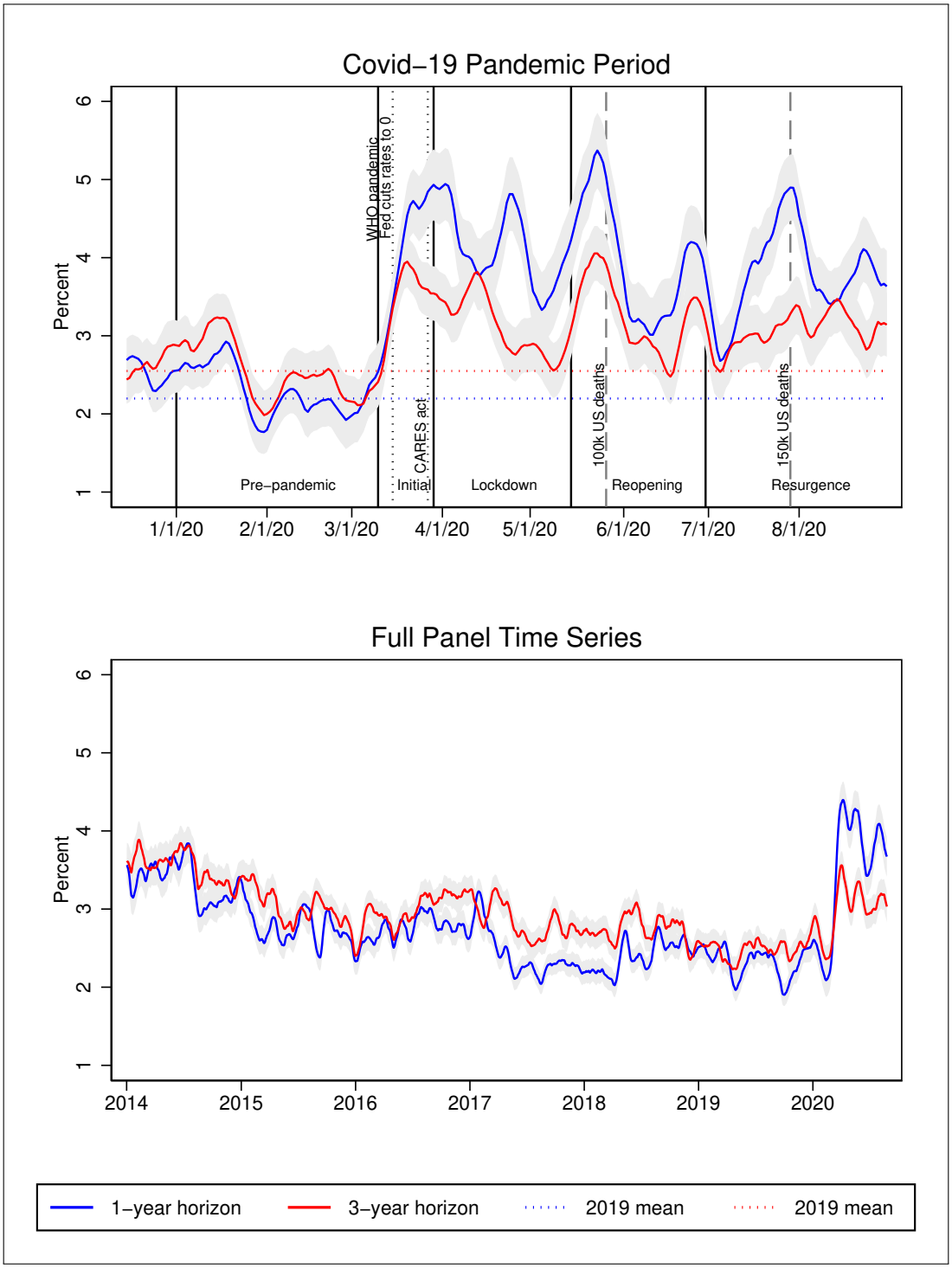
Notes: The figures in the two panels show daily inflation density means at the one-year and three-year horizons as predicted by a local linear regression using an Epanechnikov kernel with a bandwidth of 3 days for the figure in the top panel and with a bandwidth of 10 days for the figure in the bottom panel. The shaded areas indicate the 95% confidence interval for the daily local regression estimates. In each figure the data are trimmed each week at the top and bottom 10% to control for the undue influence of outliers. In the top panel figure, we denote with vertical bars the five pandemic periods we consider, as well as key dates in the development of the Covid-19 pandemic: health related events are marked by long dashed vertical bars, and policy related events are marked by dotted vertical lines.

Figure 2: Evolution of Individual Uncertainty



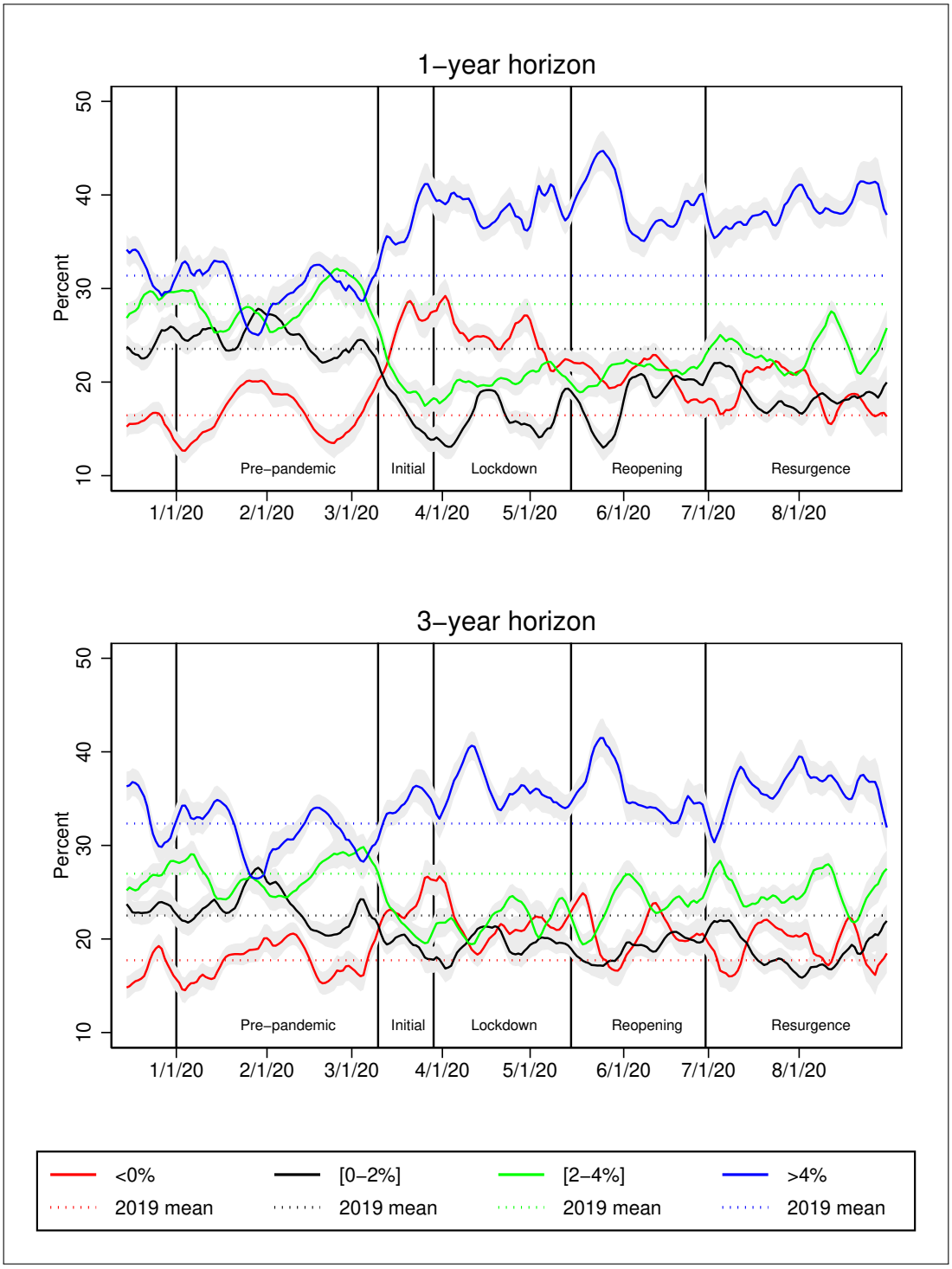
Notes: The figures in the two panels show daily individual inflation uncertainty (the interquartile range within an individual's density forecast distribution) at the one-year and three-year horizons as predicted by a local linear regression using an Epanechnikov kernel with a bandwidth of 3 days for the figure in the top panel and with a bandwidth of 10 days for the figure in the bottom panel. The shaded areas indicate the 95% confidence interval for the daily local regression estimates. In each figure the data are trimmed each week at the top and bottom 10% to control for the undue influence of outliers. In the top panel figure, we denote with vertical bars the five pandemic periods we consider, as well as key dates in the development of the Covid-19 pandemic: health related events are marked by long dashed vertical bars, and policy related events are marked by dotted vertical lines.

Figure 3: Evolution of Inflation Disagreement



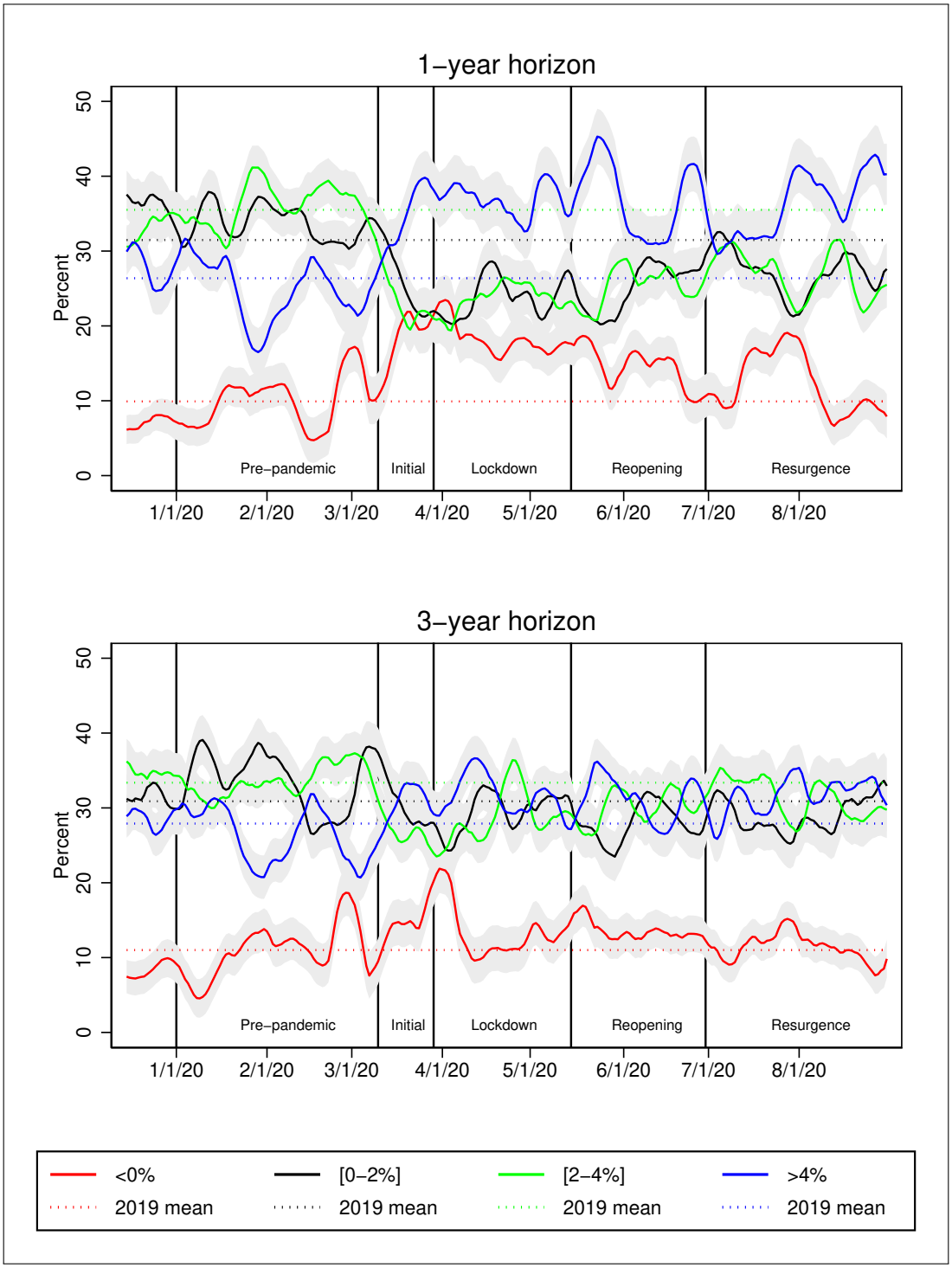
Notes: The figures in the two panels show daily inflation disagreement (the interquartile range of the distribution of density means across individuals within one day) at the one-year and three-year horizons as predicted by a local linear regression using an Epanechnikov kernel with a bandwidth of 3 days for the figure in the top panel and with a bandwidth of 10 days for the figure in the bottom panel. The shaded areas indicate the 95% confidence interval for the daily local regression estimates. In each figure the data are trimmed each week at the top and bottom 10% to control for the undue influence of outliers. In the top panel figure, we denote with vertical bars the five pandemic periods we consider, as well as key dates in the development of the Covid-19 pandemic: health related events are marked by long dashed vertical bars, and policy related events are marked by dotted vertical lines.

Figure 4: Individual Inflation Density Forecast



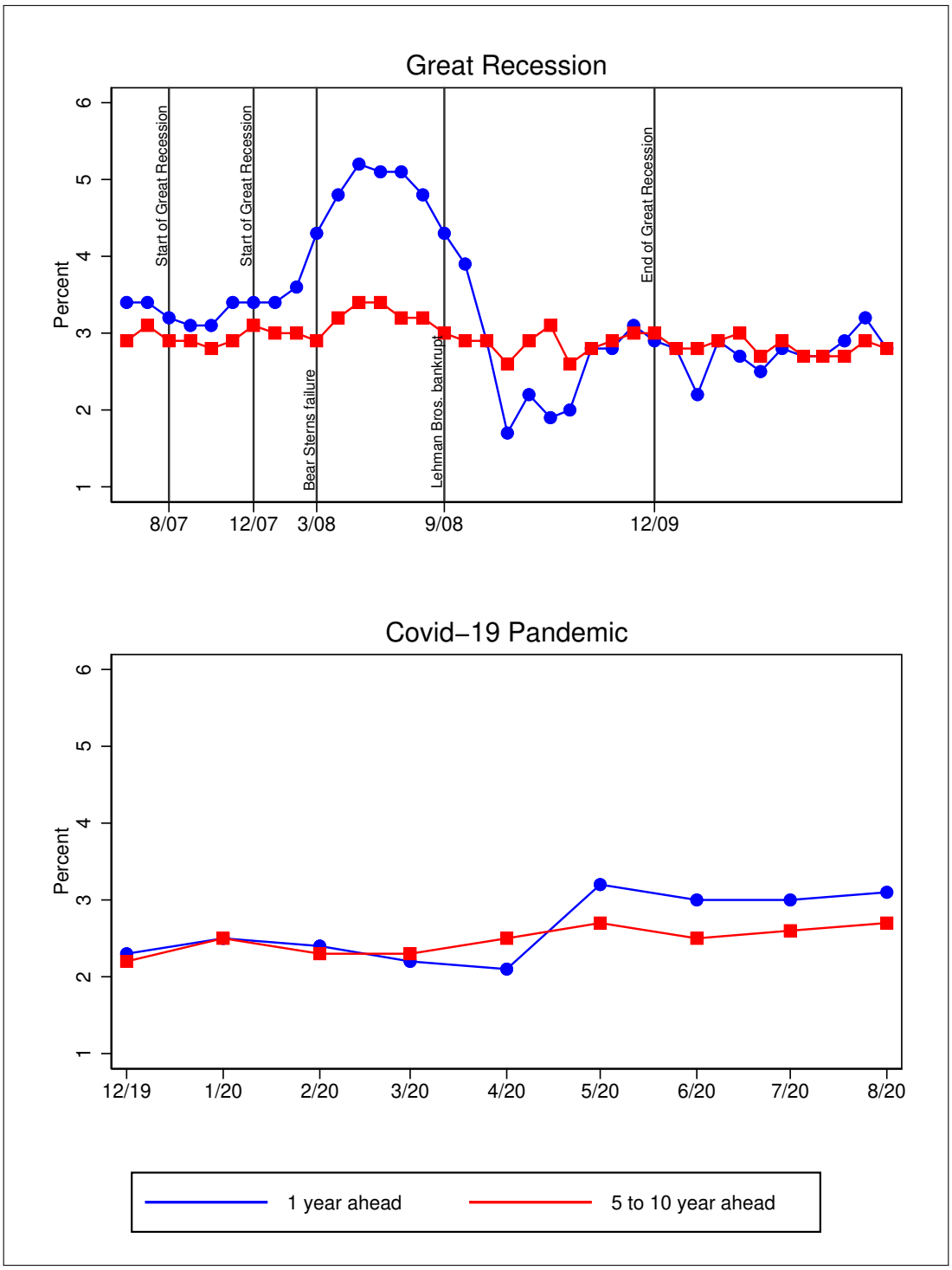
The figure shows the daily probability (in percent) that respondents assign to different inflation buckets at the one-year ahead (top panel) and three-year ahead (bottom panel) horizons as predicted by a local linear regression using an Epanechnikov kernel and a bandwidth of 3 days. We denote with vertical bars the five pandemic periods we consider.

Figure 5: Distribution of Individual Density Means



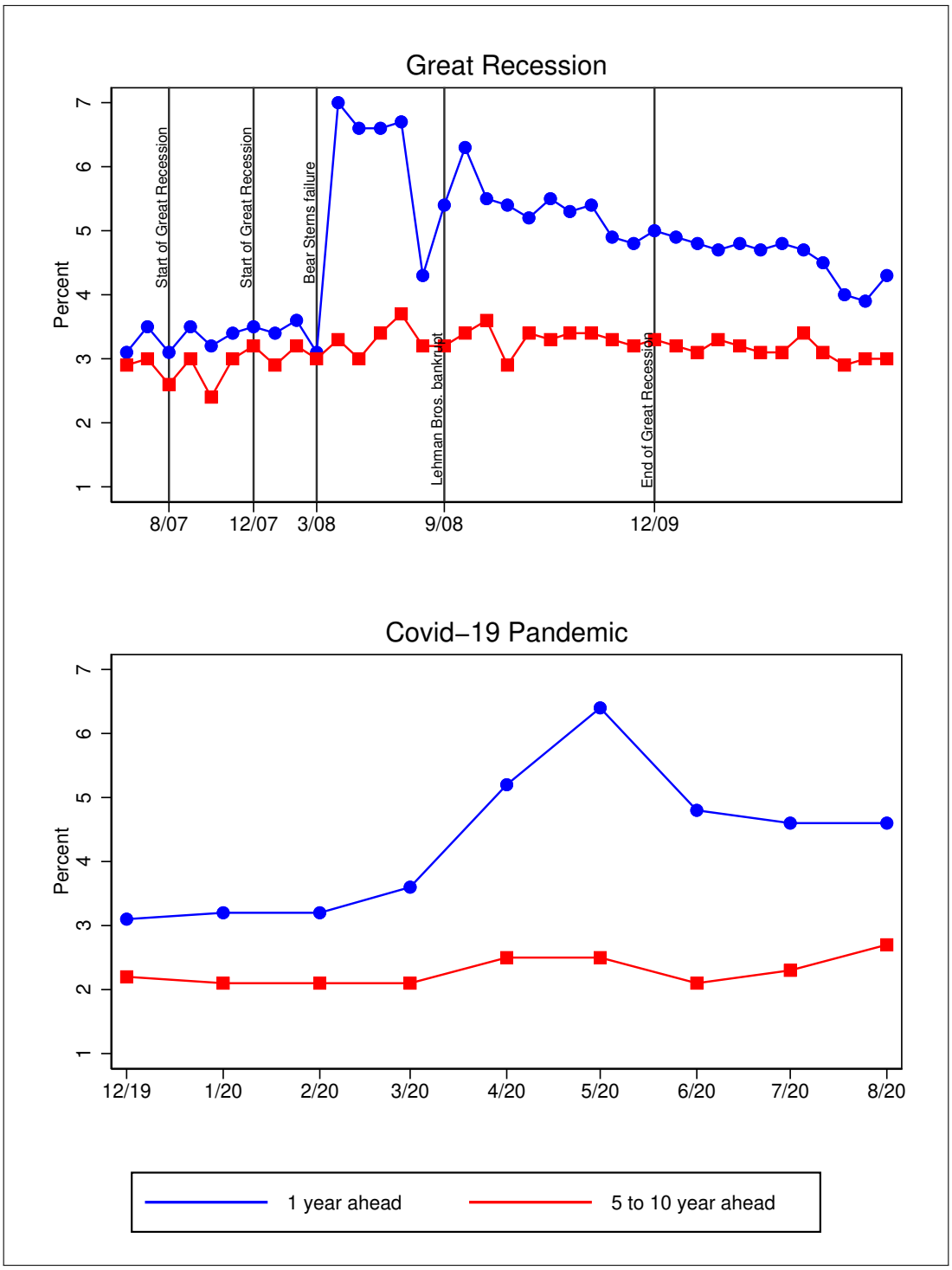
The figure shows the daily proportion of respondents with an individual density mean at the one-year (top panel) and three-year (bottom panel) horizons within certain buckets as predicted by a local linear regression using an Epanechnikov kernel and a bandwidth of 3 days. We denote with vertical bars the five pandemic periods we consider.

Figure 6: Median Inflation Point Prediction in the Michigan Survey of Consumers



Notes: The figures in the two panels show the median monthly inflation point prediction in the Michigan Survey of Consumers at the one-year and five-to-ten year horizons.

Figure 7: Median Inflation Disagreement in the Michigan Survey of Consumers



Notes: The figures in the two panels show the monthly inflation disagreement (the interquartile range of the distribution of point prediction within a month) in the Michigan Survey of Consumers at the one-year and five-to-ten year horizons.