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Abstract

We study the effects of forward guidance with an approach that combines theory with experimental estimates of counterfactual expectation adjustments. Guided by the model, we conduct experiments with representative samples of the US population to study how households adjust their expectations in response to changes in the Fed's projections about future interest rates. Respondents significantly downward-adjust their inflation expectations in response to learning about an increase in the Fed's projection about the federal funds rate three years in the future, and they expect inflation to respond most strongly immediately after the announcement. By contrast, respondents do not adjust their nominal income expectations. Our model-based estimates highlight a small average consumption response to forward guidance due to opposing effects from intertemporal substitution and changes in expected real income.

JEL Classification: D12, D14, D83, D84, E32, G11
Keywords: Expectation Formation, Information, Updating.

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1 Introduction

Forward guidance has become commonly used by central banks around the world. According to macroeconomic models forward guidance is a powerful policy tool, especially at the zero lower bound (Eggertsson and Woodford, 2003). These models show that a recovery can be accelerated if the central bank commits from the outset to keep interest rates at the zero lower bound for an additional period of time beyond what current economic conditions justify. However, several authors have argued that the magnitude of the effects of forward guidance in a workhorse New Keynesian model seems implausibly large, especially if the announcement is about policy rates far in the future (Carlstrom et al., 2015; Del Negro et al., 2012).

According to different macroeconomic theories, expectations play a fundamental role in shaping the effectiveness of forward guidance. Current state of the art models make particular theoretical assumptions about the expectation formation process in order to study the effects of forward guidance on consumption. For example, papers have proposed anticipated future credit constraints (McKay et al., 2016), inattention (Wiederholt, 2015), a lack of common knowledge (Angeletos and Lian, 2018), level-k thinking (Farhi and Werning, 2019), finite reflection (García-Schmidt and Woodford, 2019), or myopia (Gabaix, 2020) as reasons for the muted effects of forward guidance. Modelling expectation formation in response to forward guidance is challenging, especially in a setting with heterogeneous agents with limited cognitive abilities, which may in addition hold different subjective models of the macroeconomy (Andre et al., 2021).

In this paper, we propose a novel approach to identify the effects of forward guidance using a model that is agnostic about the way in which economic agents form expectations, but instead leverages experimental estimates of the expectation adjustments in response to forward guidance.[1] To capture respondents' subjective beliefs about the the effects of

[1] In a recent commentary, Monika Piazzesi calls for the use of subjective beliefs measured in surveys as an input in theoretical models (Brunnermeier et al., 2021). For an introduction to this "temporary equilibrium with measured expectations" approach see Piazzesi and Schneider (2016). Applications include Landvoigt et al. (2015) and Leombroni et al. (2020).

forward guidance in a clean way, we employ hypothetical vignettes with different projections of future interest rates, whose design is guided by a parsimonious theoretical framework.

The main idea can be illustrated with a simple example. Many macroeconomic models imply equations of the form

$$Y = \gamma E\left[X\left(Z\right)\right], \tag{1}$$

where Y is an outcome variable (e.g. consumption), X is an endogenous variable (e.g. permanent income), and Z is a structural shock (e.g. a policy shock). Furthermore, γ is a coefficient and E is the subjective expectation of the agent. The marginal effect of the structural shock on the outcome variable is

$$\frac{\partial Y}{\partial Z} = \gamma \frac{\partial E\left[X\left(Z\right)\right]}{\partial Z}.$$

To compute the derivative $\frac{\partial E[X(Z)]}{\partial Z}$, one usually makes assumptions about expectation formation. The most common assumption is that the agent has full information rational expectations (i.e. the agent knows the realization of the shock Z and is right about the effect of Z on X). The alternative is to assume that the agent has incomplete information about the realization of Z (e.g. due to inattention) or distorted beliefs about the effect of Z on X (e.g. due to level-k thinking or some other deviation from rational expectations). In this paper, we take a different route. We elicit directly the expectation $E\left[X\left(Z\right)\right]$ for alternative policies and can thereby compute the effect of the shock Z on the outcome variable Y without making assumptions about expectation formation.

The specific macroeconomic model that we build on is a New Keynesian model with heterogeneous agents. The assumptions about preferences, budget constraints, asset structure and borrowing constraints are similar to the assumptions in McKay et al. (2016). The expectation side of the model is new. Rather than making theoretical assumptions about expectation formation, we feed experimentally estimated adjustments of all those expectations appearing in the consumption functions into the model. For example, consider a

household who is currently not borrowing constrained and holds the belief that it will not be borrowing constrained in the future. The log-linearized consumption function of this type of household has the following form. Current consumption is a linear function of three terms: the expectation of the discounted sum of current and future real income, the expectation of the discounted sum of current and future real interest rates, and the expectation of end-of-previous-period real bond holdings (Angeletos and Lian, 2018). This is an example of equation (1) but with multiple terms on the right-hand side of the equation. In the survey, we elicit all expectations that appear on the right-hand side of this consumption function for a baseline policy and an alternative policy. Substituting the difference in expectations across policies into the consumption function we can assess the effect on consumption of implementing one policy instead of another policy. As part of the survey, we also elicit a household's subjective probability of being borrowing constrained in the future and whether the household is currently borrowing constrained. This allows us to substitute the expectation difference into the consumption function that is adequate for this type of household. Aggregating across households yields the aggregate consumption response on impact of the announcement that the central bank has decided to move from the baseline policy to the alternative policy.

Informed by the model, we empirically study how households adjust their policy rate, inflation and income expectations in response to changes in the Fed's projection about the future federal funds rate. To do so we leverage hypothetical vignettes, which provide us with tight control over our respondents' information sets. The vignettes make sure that all respondents observe the change in the Fed projection, fix beliefs about the source of the shock, and provide information on the current Federal Funds rate.[2] In our experiments, respondents first complete a hypothetical scenario in which they are asked to imagine that at the next Fed meeting the projected federal funds rate for the year 2023 remains constant at 0.1 percent. They are then asked about their expectations about the future development

[2]By contrast, expectation adjustments around Fed announcements as measured in observational data are more difficult to interpret, as households' information sets are typically unobserved. In particular, it is unclear which fraction of households have heard at all of a Fed announcement, and which fraction of households have heard about the source of a policy change.

of the federal funds rate, the inflation rate, and their nominal household income under the scenario of an unchanged Fed projection. Second, respondents are asked to think about an alternative hypothetical scenario, in which the projected federal funds rate for the year 2023 increases from 0.1 percent to 0.5 percent at the next Fed meeting. We vary across respondents whether the change in the federal funds rate is due to a change in the Fed's outlook on the broader economy, is due to a change in the composition of the Fed committee, or is not attributed to any specific reason. We then elicit our respondents' expectations about the future development of the federal funds rate, the inflation rate as well as their income under this alternative hypothetical scenario of a change in the Fed's projection. Moreover, we collect a rich set of additional variables to measure households' attention to Fed announcements and their expectations about future credit constraints. Finally, we designed a dedicated survey module to identify hand-to-mouth consumers (Kaplan et al., 2014), whose behavior does not respond to expectations adjustments.

We first present the reduced form results from our experiments. First, we confirm that the increase in the Fed's projection about the future interest rate substantially increases respondents' expectations about the federal funds rate. While respondents upward adjust their federal funds rate expectations for 2021 by 0.05 percentage points ($p < 0.01$), and for 2022 by 0.08 percentage points ($p < 0.01$), the effect peaks for the expected rate in 2023, with an increase by 0.19 percentage points ($p < 0.01$), and then reverts back to close to zero in 2026 and 2030, consistent with the long-term projections remaining unchanged across the scenarios. The increase by 0.19 percentage points corresponds to approximately 50 percent of the difference in Fed projections across scenarios. This in turn suggests that respondents attach positive probability to a state where the Fed will ex-post not increase the future federal funds rate as projected. Second, we document substantial downward adjustments of inflation expectations in response to the increase in the projected federal funds rate in 2023. Expectations decrease most strongly for inflation on impact in 2021, and less strongly for the later time-periods. The effect size of the inflation expectation adjustment in 2021 of 0.25 percentage points ($p < 0.01$) is sizable compared to the first stage adjustment of the federal funds rate. Third, there is a muted average response of

nominal income expectations over all relevant time horizons. Together, the significant effects on inflation expectations and the muted response of nominal income expectations imply that the Fed announcement increases respondents' expected real income. Finally, using an additional experiment, we show that neither expectations about future credit constraints nor expectations about the nominal value of respondents' home change in response to the change in the Fed projection.

Our respondents' expectation adjustment does not systematically vary depending on whether the source of the change in the Fed's projection is described to be (i) endogenous to current economics conditions, (ii) exogenous to current conditions, or (iii) exogenous to current conditions and also reflected in stock market movements, or whether (iv) we provide no reason for the change in the projection. The similar expectations adjustments across arms highlight the robustness of our main findings, and showcase that households do not form their expectations as posited by a large class of theoretical models, which would predict sharp differences in expectation adjustment depending on whether a policy change is endogenous or exogenous.

Both the result that households do not adjust their nominal income expectations and the finding that expectation adjustments do not depend on the reason for the policy change highlight the value of an approach that feeds measured expectations into models and makes no theoretical assumptions about the expectation formation process.

We next turn to the model-based consumption responses, which we obtain from directly feeding the estimated expectation adjustments of the relevant behavior types into the theoretical model. Thus, we calculate the effects of adjustments in the Fed's projection on consumption based on how non-hand-to-mouth households actually adjust their expectations in response to changes in the Fed's projection. Assuming an intertemporal elasticity of substitution of $\frac{1}{2}$, our estimates imply a consumption decrease among non-hand-to-mouth households who are certain that they will not be credit constrained in the future by 0.39 percentage points ($p < 0.05$). This overall effect masks opposing effects working through intertemporal substitution, lowering consumption by 0.82 percentage points ($p < 0.01$), and higher expected real income, increasing consumption by approxi-

mately 0.43 percentage points ($p < 0.10$). Our results are robust to varying assumptions about the rate at which expectation adjustments converge to zero beyond the horizons we measure in our survey. We also study the consumption response among non-hand-to-mouth households attaching positive probability to future credit constraints focusing on two corner cases – i) that they behave as if they expected no constraints, and ii) that they behave as if they were certain to be constrained in the next period. While in case i) their consumption would increase by 0.54 percent, in case ii) their consumption would be unchanged.

Focusing on case ii) for this group of households, we calculate a direct effect of the change in the Fed's projection due to expectation adjustment on overall consumption in the economy of -0.19 percent. Any additional effect on consumption depends on assumptions about how quickly the reduction in consumption due to the expectation adjustment is reflected in changes in income.

We contribute to a literature assessing the effects of forward guidance (Eggertsson and Woodford, 2003), as well as a series of papers analyzing potential mechanisms that could explain small effects of forward guidance (Del Negro et al., 2012). McKay et al. (2016) provide a theoretical framework highlighting that anticipated future credit constraints imply a more muted consumption response to changes in forward guidance. Angeletos and Lian (2018) show that without the common knowledge assumption, forward guidance has less powerful effects than in standard theories. Gabaix (2020) models agents' partial myopia toward distant atypical events using a new microfounded "cognitive discounting" parameter, which substantially limits the effectiveness of forward guidance. Wiederholt (2015) studies the effects of forward guidance when expectations adjust sluggishly and are dispersed. We offer a new approach to assess the effectiveness of forward guidance that combines a parsimonious model with survey-based estimates of expectation adjustments, while making no theoretical assumptions on the way expectations are formed. Our findings suggest that changes in forward guidance lead to changes in expected inflation with flat nominal income expectations, which may result in a more muted consumption response than implied by canonical models (Eggertsson and Woodford,

2003) due to opposing effects working through intertemporal substitution and changes in expected real income. In addition, the inflation expectation adjustments in the survey are smaller compared to those in canonical models.

Our approach also has a range of desirable features for policy-makers. First, our approach predicts the effects of policy changes based on current expectation adjustments, current hand to mouth-status, current perceived probability of becoming credit constrained in the future and current attention to monetary policy across the population. Thus, our approach captures rich state-dependence in the consumption response to policy changes. This should allow to more precisely predict effects of policy changes on behavior than models that are calibrated based on historical data. Second, our rich background questions allow to quantify the role of different channels in the pass-through of changes in communication to economic behavior, such as the role of hand-to-mouth behavior or inattention among fractions of the population. Third, the flexibility of our approach enables practitioners to vary the way in which announcements are communicated. This in turn opens a possibility for policymakers to use such surveys to predict effects of different policy options on economic behavior before committee meetings.

We also contribute to a literature studying households' expectation formation in the context of monetary policy (Coibion et al., 2020b; D'Acunto et al., 2021; Link et al., 2020).[3] For instance, Coibion et al. (2019) examine how households' inflation expectations respond to the provision of different pieces of information about monetary policy in the US. Coibion et al. (2020a) use large-scale surveys to examine how information about inflation and policy rates at different horizons affects household expectations. Andre et al. (2021) characterize a large degree of heterogeneity in people's subjective models of the macroeconomy with a particular focus on the associations that come to people's minds when thinking about macroeconomic shocks. Our paper differs from this literature in

[3]Our work also relates to a growing empirical literature studying the way households form expectations about macroeconomic variables (Armona et al., 2019; Bachmann et al., 2015; Bailey et al., 2018; Cavallo et al., 2017; Coibion et al., 2018; Fuster et al., 2020; Kuchler and Zafar, 2019; Roth and Wohlfart, 2020; Roth et al., 2021). For a review of the broader literature on information provision experiments, see Haaland et al. (2021).

three main ways: first, our measurement of expectations and behavioral types is directly guided by the insights of a simple macroeconomic model. This allows us to directly identify the elasticities of expectations and fractions of behavioral types that are relevant in the model. Second, we directly use our estimated elasticities of expectations as inputs in our model to quantify the impact of monetary policy on consumption. Finally, we shed new light on the importance of beliefs about the sources of changes in the Fed projection. Our estimates thereby allow us to characterize whether respondents' expectation formation process depends on whether they perceive a policy change as "endogenous" or "exogenous". Our findings suggest that, in contrast to canonical models, the reasons for policy changes play a minor role in households' expectation adjustments.

Our paper proceeds as follows. Section 2 presents a model of consumption responses to monetary policy announcements. Section 3 provides an overview of our survey design. In Section 4 we discuss reduced-form evidence from our main experiment and the robustness experiment. In Section 5 we present the model-implied consumption responses. Section 6 concludes.

2 Theoretical framework

This section presents a model of how households adjust their consumption in response to policy announcements on future interest rates. The assumptions about preferences, budget constraints and borrowing constraints are similar to the assumptions in McKay et al. (2016). In Section 5, we use this model together with our experimentally estimated expectation adjustments to predict consumption responses to forward guidance.

2.1 Assumptions

The economy is populated by a unit continuum of households, indexed by $i \in [0,1]$, with preferences given by

$$E_{i,t}\left[\sum_{s=t}^{\infty}\beta^{s-t}\left(\frac{C_{i,s}^{1-\gamma}}{1-\gamma}-v_i\left(N_{i,s}\right)\right)\right], \tag{2}$$

where $C_{i,s}$ is consumption of household i at time s and $N_{i,s}$ is labor supply of household i at time s. The disutility of labor function $v_i : \mathbb{R}_+ \to \mathbb{R}$ is twice continuously differentiable, strictly increasing, and convex, and may differ across households. The preference parameters satisfy $\beta \in (0,1)$ and $\gamma > 0$.

Households can save, or borrow up to a borrowing limit. Households can save by holding a positive amount of a liquid asset (e.g., a nominal government bond) with gross nominal interest rate R_t between periods t and $t+1$. Households can borrow by holding a negative amount of the liquid asset with gross nominal interest rate R_t^{debt} between periods t and $t+1$. For now, we assume that $R_t = R_t^{debt}$.

There are firms in the economy that generate profit. Households therefore have dividend income. For now, we assume that households cannot trade their stakes in the firms.

The flow budget constraint of household i in period t reads

$$P_t C_{i,t} + B_{i,t} = R_{t-1}B_{i,t-1} + W_{i,t}N_{i,t} + D_{i,t} - T_{i,t}, \tag{3}$$

where $P_t C_{i,t}$ is the consumption expenditure of household i in period t, P_t is the consumer price index in period t, and $B_{i,t}$ are the household's holdings of the liquid asset between periods t and $t+1$. Turning to the right-hand side of the flow budget constraint, $W_{i,t}N_{i,t}$ is labor income, $D_{i,t}$ is dividend income, and $T_{i,t}$ are tax payments of household i in period t. The wage rate and the dividend income may differ across households. The tax payment can be any function of income and wealth, so long as it does not affect the consumption Euler equation.

The borrowing constraint of household i in period t reads

$$B_{i,t} \geq -L_{i,t} \tag{4}$$

where the borrowing limit $L_{i,t}$ may differ across households, can depend on the entire history of the economy, and is taken as given by household i. A special case is a borrowing limit of zero in every period and every state of the world.

The expectation operator in equation (2) is assumed to satisfy linearity and the law of iterated expectations. Formally, for any two random variables X and Y,

$$E_{i,t}\left[X + Y\right] = E_{i,t}\left[X\right] + E_{i,t}\left[Y\right], \tag{5}$$

and

$$\forall s > t : E_{i,t}\left[E_{i,s}\left[X\right]\right] = E_{i,t}\left[X\right]. \tag{6}$$

Furthermore, we assume that for any binary random variable Z

$$E_{i,t}[X] = \theta_{i,t} E_{i,t}[X|Z = 1] + (1 - \theta_{i,t}) E_{i,t}[X|Z = 0], \tag{7}$$

where $\theta_{i,t}$ denotes household i's period-t subjective probability of the event $Z = 1$. We make no other assumptions about the expectation operator.

We assume that in period t, each household chooses consumption $C_{i,t}$ so as to maximize its objective (2) subject to its budget constraint (3) and its borrowing constraint (4), given its subjective beliefs about the future paths of all relevant variables.

2.2 Terminology

Note that in period t, each household belongs to exactly one of the following three groups:

- Group 1: The household's borrowing constraint is binding in period t.
- Group 2: The household's borrowing constraint is not binding in period t, and the

household believes that the borrowing constraint will not be binding in the future.

- Group 3: The household's borrowing constraint is not binding in period t, and the household believes that the borrowing constraint is binding in the future with strictly positive probability.

Following the literature, we will refer to households in group 1 as "hand-to-mouth" households. We distinguish between these three groups because households in different groups have different consumption functions, which we turn to next.

2.3 Consumption functions

The consumption of a household in group 1 (i.e., the consumption of a hand-to-mouth household) is given by the flow budget constraint and the binding borrowing constraint

$$C_{i,t} = \frac{1}{P_t}\left(R_{t-1}B_{i,t-1} + W_{i,t}N_{i,t} + D_{i,t} - T_{i,t} + L_{i,t}\right). \tag{8}$$

The household consumes all liquid wealth, all after-tax income, as well as all available credit.

The consumption function of a household in group 2 can be derived from the present value budget constraint in real terms

$$\sum_{s=t}^{\infty} Q_{t,s}C_{i,s} = \frac{R_{t-1}}{\Pi_t}\tilde{B}_{i,t-1} + \sum_{s=t}^{\infty} Q_{t,s}\left(\tilde{W}_{i,s}N_{i,s} + \tilde{D}_{i,s} - \tilde{T}_{i,s}\right),$$

where $\tilde{B}_{i,t-1} \equiv \frac{B_{i,t-1}}{P_{t-1}}$, $\tilde{W}_{i,s} \equiv \frac{W_{i,s}}{P_s}$, $\tilde{D}_{i,s} \equiv \frac{D_{i,s}}{P_s}$, $\tilde{T}_{i,s} \equiv \frac{T_{i,s}}{P_s}$, $Q_{t,t} \equiv 1$, and $Q_{t,s} \equiv \prod_{k=1}^{s}\left(\frac{R_{t+k-1}}{\Pi_{t+k}}\right)^{-1}$, the consumption Euler equation in period t

$$C_{i,t}^{-\gamma} = E_{i,t}\left[\beta\frac{R_t}{\Pi_{t+1}}C_{i,t+1}^{-\gamma}\right],$$

and the period-t belief that the consumption Euler equation will also hold with equality

in future periods $s > t$

$$E_{i,t}\left[C_{i,s}^{-\gamma}\right] = E_{i,t}\left[E_{i,s}\left[\beta\frac{R_s}{\Pi_{s+1}}C_{i,s+1}^{-\gamma}\right]\right].$$

Log-linearizing the last three equations around the steady state of the non-stochastic version of the economy (where households may be ex-ante different and therefore may have different initial wealth levels $\tilde{B}_i$, different labor income $\tilde{W}_i N_i$, different dividend income $\tilde{D}_i$, and different tax payments $\tilde{T}_i$) and rearranging yields

$$\begin{aligned} c_{i,t} = & \frac{1}{\frac{\tilde{C}_i}{\tilde{Y}_i}}(1-\beta)\,E_{i,t}\left[\sum_{s=t}^{\infty}\beta^{s-t}\tilde{y}_{i,s}\right] \\ & + \left[\left(\frac{1}{\beta}-1\right)\frac{\tilde{B}_i}{\tilde{Y}_i}\frac{1}{\frac{\tilde{C}_i}{\tilde{Y}_i}} - \frac{1}{\gamma}\right]\beta E_{i,t}\left[\sum_{s=t}^{\infty}\beta^{s-t}\left(r_s - \pi_{s+1}\right)\right] \\ & + \left(\frac{1}{\beta}-1\right)\frac{\tilde{B}_i}{\tilde{Y}_i}\frac{1}{\frac{\tilde{C}_i}{\tilde{Y}_i}}E_{i,t}\left[r_{t-1} - \pi_t + \tilde{b}_{i,t-1}\right]. \end{aligned} \tag{9}$$

Here $\tilde{Y}_{i,t}$ denotes real labor income plus real dividend income minus real tax payments

$$\tilde{Y}_{i,t} \equiv \tilde{W}_{i,t}N_{i,t} + \tilde{D}_{i,t} - \tilde{T}_{i,t},$$

and lower-case letters denote log-deviations from the steady state of the non-stochastic version of the economy (e.g., $c_{i,t} = ln\left(C_{i,t}\right) - ln\left(C_i\right)$ and $\tilde{y}_{i,t} = ln\left(\tilde{Y}_{i,t}\right) - ln\left(\tilde{Y}_i\right)$).[4] Consumption of a household who is not borrowing constrained in period t and does not expect to be borrowing constrained in the future depends on three expectations: permanent non-interest income (the first term in equation (9)), the income and substitution effect linked to expected real interest rates (the second term in equation (9)), and the perceived beginning-of-period real liquid wealth (the third term in equation (9)).

[4]The definition of the variable $\tilde{b}_{i,t-1}$ is $\tilde{b}_{i,t-1} = ln\left(\tilde{B}_{i,t-1}\right) - ln\left(\tilde{B}_i\right)$ if $\tilde{B}_i > 0$, $\tilde{b}_{i,t-1} = ln\left(\left|\tilde{B}_{i,t-1}\right|\right) - ln\left(\left|\tilde{B}_i\right|\right)$ if $\tilde{B}_i < 0$, and $\tilde{b}_{i,t-1} = 0$ if $\tilde{B}_i = 0$.

Combining the two interest income terms and the non-interest income term yields

$$
\begin{aligned}
c_{i,t} = & \frac{\frac{1}{\frac{C_i}{\tilde{Y}_i}}(1-\beta) E_{i,t}\left[\sum_{s=t}^{\infty}\beta^{s-t}\left(\frac{1}{\beta}\frac{\tilde{B}_i}{\tilde{Y}_i}(r_{s-1}-\pi_s)+\tilde{y}_{i,s}\right)\right]}{} \\
& -\frac{1}{\gamma}\beta E_{i,t}\left[\sum_{s=t}^{\infty}\beta^{s-t}(r_s-\pi_{s+1})\right] \\
& +\frac{1}{\frac{C_i}{\tilde{Y}_i}}(1-\beta)\frac{1}{\beta}\frac{\tilde{B}_i}{\tilde{Y}_i}E_{i,t}\left[\tilde{b}_{i,t-1}\right].
\end{aligned} \tag{10}
$$

The consumption of a household who is not borrowing constrained in period t and does not expect to be borrowing constrained in the future depends on permanent income, the intertemporal substitution term, and the perceived end-of-previous-period real liquid wealth.

Turning to the effect of policy announcements on consumption, let $\triangle c_{i,t} = c_{i,t}^{Policy1} - c_{i,t}^{Policy2}$ denote the difference between consumption under policy announcement 1 and consumption under policy announcement 2 and let $\triangle E_{i,t}[X] = E_{i,t}^{Policy1}[X] - E_{i,t}^{Policy2}[X]$ denote the difference between the expectation of variable X under policy announcement 1 and the expectation of the same variable under policy announcement 2. Equation (10) implies that

$$
\begin{aligned}
\triangle c_{i,t} = & \frac{\frac{1}{\frac{C_i}{\tilde{Y}_i}}(1-\beta) \triangle E_{i,t}\left[\sum_{s=t}^{\infty}\beta^{s-t}\left(\frac{1}{\beta}\frac{\tilde{B}_i}{\tilde{Y}_i}(r_{s-1}-\pi_s)+\tilde{y}_{i,s}\right)\right]}{} \\
& -\frac{1}{\gamma}\beta \triangle E_{i,t}\left[\sum_{s=t}^{\infty}\beta^{s-t}(r_s-\pi_{s+1})\right] \\
& +\frac{1}{\frac{C_i}{\tilde{Y}_i}}(1-\beta)\frac{1}{\beta}\frac{\tilde{B}_i}{\tilde{Y}_i}\triangle E_{i,t}\left[\tilde{b}_{i,t-1}\right].
\end{aligned} \tag{11}
$$

For a household in group 2, differences in consumption across policy announcements are determined by differences in expectations across policy announcements. The key idea of this paper is to elicit these differences in expectations with a survey and to compute the effect of policy announcements on consumption from equation (11).

The consumption function of a household in group 3 looks different because of the positive subjective probability of being borrowing constrained in the future. Since the borrowing constraint of a household in group 3 is not binding in period t, the household's

consumption Euler equation holds with equality in period t

$$C_{i,t}^{-\gamma} = E_{i,t}\left[\beta \frac{R_t}{\Pi_{t+1}} C_{i,t+1}^{-\gamma}\right].$$

Let $\theta_{i,t}$ denote household i's subjective probability in period t of being borrowing constrained in period $t+1$. Using this notation, one can write the consumption Euler equation in period t as

$$C_{i,t}^{-\gamma} = \theta_{i,t} E_{i,t}^{b}\left[\beta \frac{R_t}{\Pi_{t+1}} C_{i,t+1}^{-\gamma}\right] + (1-\theta_{i,t})\, E_{i,t}^{n}\left[\beta \frac{R_t}{\Pi_{t+1}} C_{i,t+1}^{-\gamma}\right],$$

where $E_{i,t}^{b}$ denotes the expectation conditioning on a binding borrowing constraint in period $t+1$, while $E_{i,t}^{n}$ denotes the expectation conditioning on a non-binding borrowing constraint in period $t+1$.

Consumption in the case of a binding borrowing constraint in period $t+1$ is given by the flow budget constraint and the consumption function of a group 1 household

$$C_{i,t+1} = \frac{R_t}{\Pi_{t+1}}\left(\frac{R_{t-1}}{\Pi_t}\tilde{B}_{i,t-1} + \tilde{Y}_{i,t} - C_{i,t}\right) + \tilde{Y}_{i,t+1} + \tilde{L}_{i,t+1}.$$

See equations (3) and (8). Log-linearizing the last two equations around the steady state of the non-stochastic version of the economy and combining these two equations yields

$$c_{i,t} = -\frac{1}{\gamma} E_{i,t}\left[r_t - \pi_{t+1}\right] + \theta_{i,t} E_{i,t}^{b}\left[x_{i,t+1} - \frac{1}{\beta} c_{i,t}\right] + (1-\theta_{i,t})\, E_{i,t}^{n}\left[c_{i,t+1}\right],$$

with

$$x_{i,t+1} \equiv \frac{\frac{\tilde{B}_i}{C_i}}{\beta^2}\left(r_t - \pi_{t+1} + r_{t-1} - \pi_t + \tilde{b}_{i,t-1}\right) + \frac{\frac{\tilde{Y}_i - C_i}{C_i}}{\beta}\left(r_t - \pi_{t+1}\right) + \frac{\tilde{Y}_i}{C_i}\left(\frac{1}{\beta}\tilde{y}_{i,t} + \tilde{y}_{i,t+1}\right) + \frac{\tilde{L}_i}{C_i}\tilde{l}_{i,t+1}.$$

To illustrate the implications of beliefs about future binding borrowing constraints for current consumption, consider the limit as $\theta_{i,t}$ converges to one, that is, the household

believes that the borrowing constraint (4) will very likely be binding in the next period. The last two equations then imply

$$\begin{aligned} c_{i,t} = & \frac{1}{\frac{\bar{C}_i}{\bar{Y}_i}} \frac{1}{1+\beta} E_{i,t} \left[\sum_{s=t}^{t+1} \beta^{s-t} \left(\frac{1}{\beta} \frac{\tilde{B}_i}{\bar{Y}_i} \left(r_{s-1} - \pi_s \right) + \tilde{y}_{i,s} \right) \right] \\ & - \frac{1}{\gamma} \frac{\beta}{1+\beta} E_{i,t} \left[r_t - \pi_{t+1} \right] \\ & + \frac{1}{\frac{\bar{C}_i}{\bar{Y}_i}} \frac{1}{1+\beta} E_{i,t} \left[\frac{1}{\beta} \frac{\tilde{B}_i}{\bar{Y}_i} \tilde{b}_{i,t-1} + \beta \frac{\tilde{L}_i}{\bar{Y}_i} \tilde{l}_{i,t+1} \right]. \end{aligned} \tag{12}$$

Comparing equation (12) to equation (10) shows that the anticipation of a binding borrowing constraint in the next period has several implications. First, the relevant definition of "permanent" income becomes the expected average income up to and including the period in which the borrowing constraint becomes binding. Second, the intertemporal substitution term depends only on the expected real interest rate up to the period in which the borrowing constraint becomes binding. Third, the expectation of the future real value of the borrowing limit affects current consumption.

The effect of the policy announcement on consumption then equals

$$\begin{aligned} \triangle c_{i,t} = & \frac{1}{\frac{\bar{C}_i}{\bar{Y}_i}} \frac{1}{1+\beta} \triangle E_{i,t} \left[\sum_{s=t}^{t+1} \beta^{s-t} \left(\frac{1}{\beta} \frac{\tilde{B}_i}{\bar{Y}_i} \left(r_{s-1} - \pi_s \right) + \tilde{y}_{i,s} \right) \right] \\ & - \frac{1}{\gamma} \frac{\beta}{1+\beta} \triangle E_{i,t} \left[r_t - \pi_{t+1} \right] \\ & + \frac{1}{\frac{\bar{C}_i}{\bar{Y}_i}} \frac{1}{1+\beta} \triangle E_{i,t} \left[\frac{1}{\beta} \frac{\tilde{B}_i}{\bar{Y}_i} \tilde{b}_{i,t-1} + \beta \frac{\tilde{L}_i}{\bar{Y}_i} \tilde{l}_{i,t+1} \right], \end{aligned} \tag{13}$$

where $\triangle c_{i,t}$ is the difference between consumption under policy announcement 1 and consumption under policy announcement 2 and $\triangle E_{i,t} [X]$ is the difference between the expectation of variable X under policy announcement 1 and the expectation of the same variable under policy announcement 2.

For households in group 2 and households in group 3, differences in consumption across policy announcements are determined by differences in expectations across policy announcements. However, the consumption function of a household in group 2 differs from the consumption function of a household in group 3. The key idea of the paper is

to elicit differences in expectations across policy announcements for an individual household with a survey and to compute the effect of the policy announcement on the consumption of the household from the consumption function of this type of household.

3 Experimental design and data

In this section we present our main experimental design and our data. The full experimental instructions are provided in Appendix B.1.

3.1 Samples

For our main survey we collect a sample of 2,218 respondents that is representative of the US population in terms of education, gender, age, region, and household net income. The survey was conducted as an online survey shortly before the regular FOMC meeting on March 16/17 2021 in collaboration with the panel data provider Luc.id, which is commonly used in economic research (Haaland et al., 2021).

3.2 Experimental design: Main survey

3.2.1 Combining theory and empirics

According to our model, expectations about the federal funds rate, the inflation rate, and household income are the key expectations that should shape the consumption response to changes in Fed projections. In our survey, we elicit the response of exactly these expectations over different relevant forecast horizons. Moreover, we include tailored questions to measure current hand-to-mouth status, attention to Fed announcements, and the perceived probability of becoming credit constrained, which all matter for households' spending responses in the model.

3.2.2 Demographics, introduction and definitions

In the beginning of our survey, we elicit a basic set of demographic characteristics. Then, we provide our respondents with basic definitions of the inflation rate as well as the federal funds rate. In particular, we explain to our respondents that the Federal Reserve (Fed) controls the federal funds rate and that besides choosing the current rate, the Fed publishes projections of where this interest rate will be in the coming years. We then fix beliefs about the current level of the federal funds rate (0.1 percent) as well as the projection by the Fed according to which the rate will still be 0.1 percent at the end of 2023.

3.2.3 Baseline scenario

Respondents are then asked to imagine the following hypothetical scenario:

> Please imagine that at the next meeting of the Fed on March 16/17 2021, the Fed announces that the current federal funds rate will remain unchanged at 0.1 percent. Moreover, the Fed announces that its projection about the future federal funds rate at the end of 2023 remains unchanged at 0.1 percent.

We then elicit the respondents' own expectations under this hypothetical scenario[5], such as their expectations about the future federal funds rate at the end of the years 2021, 2022, 2023, 2026 and 2030, and their expectations about annual inflation in 2021, 2022 and 2023, as well as their average expected inflation rate for the years 2024-2026. We also elicit our respondent's expectations about their average annual household income in nominal dollar terms in 2021, 2022-2023, as well as 2024-2026.

[5]To make it clear to respondents that we are interested in their expectations conditional on learning about the Fed announcement we explicitly ask them about their expectations "if they learned about the Fed's announcement".

3.2.4 Alternative scenario

Respondents are then asked to imagine an alternative scenario about the Fed's projections. Specifically, respondents receive the following set of instructions:

> We will now ask you to consider the following alternative hypothetical scenario. Please imagine that at their next meeting on March 16/17 2021, the Fed announces that the current federal funds rate will remain unchanged at 0.1 percent. However, the Fed announces that its projection about the future federal funds rate at the end of 2023 increases from 0.1 percent to 0.5 percent. Note: The Fed's longer-run projection about the federal funds rate remains unchanged.

We then re-elicit respondents' own expectations regarding the federal funds rate, the inflation rate, and their net household income under this alternative hypothetical scenario using the same time horizons as in the baseline scenario.

3.2.5 Beliefs about the source of the change in the Fed projection

To probe the robustness of our findings, we cross-randomize respondents into four different groups receiving different messages on the source of the change in the Fed projection: In the "no-reason" group, respondents are not provided with a reason for why the projection changes. In the "endogenous" group, respondents are told that the change in the projection is due to a change in the Fed's outlook on the broader development of the economy. In the "exogenous" group, participants are told that the change in the Fed's projection occurred because the composition of the committee changed before the meeting. Moreover, respondents in the "exogenous" group are additionally told that the change in the projection is not due to a change in the Fed's outlook on the broader development of the economy. In the "exogenous-stock" group respondents receive the same instructions as respondents in the "exogenous" group, but are additionally told that in response to the Fed announcement, the S&P 500 stock market index falls by one percent. This last treat-

ment arm allows us to study whether our findings differ when we provide additional information that might be important for households' learning about Fed announcements in the real world.

3.2.6 Measuring inattention

A key variable in the consumption response to Fed announcements is the fraction of households that are inattentive to such announcements, and may therefore not adjust their consumption in response to such events. To quantify the fraction of inattentive households, we ask our respondents to think of announcements by the Federal Reserve in general. We then ask them how long it would typically take until they hear of a Fed announcement on a scale ranging from "less than seven days" to "typically I would never hear of such an announcement". Similarly, we measure people's attention to stock market movements in response to Fed announcements.

3.2.7 Identifying hand-to-mouth consumers

In our model, only non-hand-to-mouth households will adjust their consumption in response to changes in expectations. Therefore, it is critical for us to identify hand-to-mouth consumers (Kaplan et al., 2014). Following the approach in Kaplan et al. (2014), we use a series of questions on balance sheet variables to identify liquidity constraints. Specifically, we ask respondents about their household's liquid wealth in the last days before the main earner's last income receipt as well as their total revolving credit card debt and overall combined credit limit for all credit cards owned by the household.

3.2.8 Anticipated credit constraints

Another key variable in our model is households' perceived likelihood of becoming credit constrained in the future (McKay et al., 2016). To measure anticipated credit constraints we ask our respondents about the probability that their household will be in a situation where it would like to borrow more money on its credit cards, but would be unable to

do so. We elicit the probability of being credit constrained at some point until the end of 2021, at some point until the end of 2022, or at some point until the end of 2026.

3.2.9 Additional characteristics

Finally, we elicit an additional set of characteristics, including respondents' numeracy, their risk and time preferences, their perceived exposure to macroeconomic fluctuations as well as their household's savings rate in 2020.

3.2.10 Discussion of the design

Our design leverages differences in predictions across two alternative hypothetical scenarios – i.e. within-subject variation – to identify the effects of changes in projections of the federal funds rate. We believe that within-subject variation is particularly suited for our purposes for several reasons: First, our within-design helps us to control for individual-level fixed effects, and thus strengthens our statistical power, and deals with individual-specific measurement error. Second, it allows us to characterize the distribution of treatment effects at the individual level. Third, in our within-design it is salient to respondents that there is a change in the Fed's projections. Since in our model we are interested in expectation formation among households if they are attentive to Fed announcements, our design thus matches the theory closely. Our design provides us with estimates of how individuals would adjust their expectations if they heard about the change in the Fed's projections, regardless of whether they are usually attentive to Fed announcements. Setting equal to zero the consumption responses of households who self-report to be usually inattentive to Fed announcements, we obtain an estimate of the consumption stimulus due to forward guidance when only attentive households adjust their expectations.

One alternative approach to study the consumption response to Fed announcements would be to directly elicit respondents' beliefs about their household spending under both the baseline and the alternative scenario. Compared to our approach of measuring

expectation adjustments and feeding those into a model, this alternative approach has several disadvantages.

First, if one elicits directly respondents' beliefs about their household spending under the baseline and the alternative policy scenario, it will be difficult to interpret the responses since it is not clear what the respondents "hold fixed". Would the responses reflect how much their consumption would change if monetary policy was the *only* thing that changed? Or how much their consumption would change after everybody else had also changed their consumption, leading to a change in output, income and inflation in the economy? By eliciting directly respondents' beliefs about the effects of the policy on aggregate outcomes such as inflation and individual outcomes such as their after-tax income we circumvent this problem.

Moreover, according to standard theory, the consumption of group 2 and group 3 households not only depends on the beliefs measured in our survey, but it depends on nothing else than these beliefs. That is, the expectations changes in equations (11) and (13) are sufficient statistics for the consumption changes in equations (11) and (13). This also means that all general equilibrium effects on the consumption of group 2 and group 3 households operate through these expectations.

Over time agents might receive additional information and change their consumption because they revise these beliefs, so what we measure is the response of consumption to the policy announcement on impact of the announcement.

Second, self-reported data on household spending is known to be subject to a high level of measurement error, even for recall of past spending levels (Ahmed et al., 2006; Battistin, 2003; Bound et al., 2001; Browning et al., 2003). In the context of self-reported expectations of future spending, Galashin et al. (2021) document a very noisy relationship between spending plans and realized spending as measured in credit card data. By contrast, our approach highlights the consumption response to empirically estimated expectation adjustments as it is implied by standard models.

Third, another advantage of measuring expectation adjustments as an input for model-implied consumption changes is that we can vary other inputs, such as the degree of at-

tention to Fed announcements or the degree of liquidity constraints, and examine how such changes affect predicted consumption responses.

3.3 Sample restrictions and summary statistics

3.3.1 Sample restrictions

We drop respondents in the top and bottom percentiles of response time, as very short or very long response times may indicate inattention to our survey, reducing the sample size from 2,218 to 2,175 for the main survey.

Point forecasts of macroeconomic variables elicited in household surveys are known to often include extreme outliers, which may reflect typos or inattention to the survey questions. Even if extreme outliers reflect true beliefs, they could be driving predicted consumption responses according to our model, which features averages taken over individual survey responses, which are sensitive to outliers. We deal with this concern by excluding outliers in elicited point forecasts.

Since our model is calibrated using individual-level data (see Section 5), we require a sample for which all relevant expectations variables are available. Specifically, we exclude responses predicting a federal funds rate higher than 10 percent for any horizon (corresponding to the 97th or 98th percentile in the main survey depending on the horizon), responses predicting an inflation rate higher than 10 percent for any horizon (97th or 98th percentile), and responses predicting cumulative income growth of less than -70 percent or higher than 200 percent for any horizon (first and 98th or 99th percentile). In addition, we set to missing those who predict extreme differences in beliefs across the two hypothetical scenarios, as such extreme differences likely indicate typos. Specifically, we set to missing those predicting absolute effects on the federal funds rate and on the inflation rate of more than 5 percentage points or absolute effects on cumulative income growth of more than 50 percentage points. Again, these cutoffs mostly correspond to the bottom first or second or top 98th or 99th percentiles across variables and horizons.

Even though these steps are not restrictive individually, and even though there is

strong overlap of groups containing outliers across survey questions, our focus on a common sample implies that these procedures result in dropping 14.8 percent of responses in the main survey. None of our reduced-form results and our model-based estimates are sensitive to the exact cutoffs used, and our reduced-form results are very similar if we use all available non-outlier observations for each forecast and horizon instead of focusing on the smaller common sample. Throughout, we obtain similar results if we winsorize outliers instead.

3.3.2 Summary statistics

Table A.1 Panel A shows summary statistics of the remaining sample of 1,854 respondents for the main survey, including benchmarks from the 2019 American Community Survey. Our sample closely resembles the population according to the targeted variables gender, age, education, income and region even after our sample restrictions. Moreover, the table indicates that our sample is broadly balanced across the survey arms providing different explanations for the hypothetical change in the Fed's projections.

4 Reduced-form evidence

4.1 Descriptive results

We first provide descriptive evidence on the distributions of hand-to-mouth status, anticipated probabilities of becoming credit constrained, and attention to Fed announcements in our data.

Hand-to-mouth status We classify hand-to-mouth households using a similar procedure as Kaplan et al. (2014). Among those who report to have carried over positive credit card debt from the last billing cycle (27.3 percent), we classify those as hand-to-mouth who carried over credit card debt of more than 80% of their combined limit on all cards (8.41 of the full sample). Among those who report not to have carried over any credit

card debt, we classify those as hand-to-mouth who report liquid wealth holdings before the last income receipt of the main earner of less than their monthly household net income (18.4 percent). Together, this procedure yields a fraction of 26.8 percent hand-to-mouth households, which is very close to previous findings (Kaplan et al., 2014).[6]

Anticipated credit constraints The anticipated probability of becoming credit constrained plays a key role for the consumption response to Fed announcements among non-hand-to-mouth households according to our model. Figure 1 displays the distributions of the perceived percent chance of becoming credit constrained over different horizons among non-hand-to-mouth households in our sample. The figure highlights that a majority (60.5 percent) attach zero probability to becoming credit constrained at any point until the end of 2026.

Inattention to Fed announcements Figure 2 provides histograms of non-hand-to-mouth respondents' self-reported time until they typically hear about Fed announcements (Panel A) or the stock market reaction to such announcements (Panel B). 81 percent of respondents report that it typically takes at most four weeks until they learn about Fed announcements. The fraction is somewhat higher (86 percent) for the self-reported time until respondents hear of stock market movements in response to Fed announcements, in line with the idea that households may be more attentive to stock market movements than to Fed announcements, e.g. due to higher news coverage. Finally, Table A.2 provides an overview of the numbers of respondents in different cells according to their hand-to-mouth status, their perceived chance of becoming credit constrained and their attention to Fed announcements. Attention to Fed announcements is substantially higher among non-hand-to-mouth households, in line with the idea that these households' decisions depend on their expectations about the future, such as the expected real interest rate.

[6]In the model only households with a binding borrowing constraint are "hand-to-mouth", but in the empirical implementation we also assume that households at the zero kink are "hand-to-mouth" and thus do not respond to expectations.

4.2 Reduced-form results from the vignettes

According to our model, the consumption of hand-to-mouth households does not depend on their expectations, for given labor income and given hand-to-mouth status. Only the expectation adjustment of non-hand-to-mouth households should matter for the direct consumption effects of forward guidance. Therefore, we focus on the expectation adjustments of the 1,357 households that are classified as non-hand-to-mouth (73% of our final sample). Our results for expectations are qualitatively similar if we instead use the full sample. We measure the effect of the change in the Fed's projections on a respondent's expectations as the difference between a respondent's reported expectations under the "rise" and under the "baseline" scenario.

Table 1 illustrates the results for the first stage. It confirms that respondents substantially update their federal funds rate expectations when going from the baseline to the rise scenario. While the average federal funds rate expectations increase by 0.05 percentage points for 2021 ($p < 0.01$) and by 0.08 percentage points for 2022 ($p < 0.01$), the effect peaks for 2023 with an increase by 0.19 percentage points ($p < 0.01$), and then reverts back to close to zero in 2026 and 2030, consistent with the fact that the Fed's longer-run projection does not change across the scenarios. The increase by 0.19 percentage points corresponds to approximately 50 percent of the difference in Fed projections across scenarios. This in turn suggests that respondents attach positive probability to a state where the Fed will ex-post not increase the future federal funds rate as projected.[7]

Columns 1-4 of Table 2 highlight substantial downward adjustments in average inflation expectations in response to the increase in the projected federal funds rate in 2023. Inflation expectations decrease by 0.25 percentage points for 2021 ($p < 0.01$), by 0.18 percentage points for 2022 ($p < 0.01$), and somewhat less strongly for the later time periods. The size of the adjustment of inflation expectations is substantial compared to the first-stage adjustment of expectations about the federal funds rate. Moreover, these findings highlight that households expect most of the changes in inflation to occur early on after

[7] Another potential reason for the less than one-to-one pass-through of projections to expectations is that a fraction of respondents may be inattentive to our survey and may just quickly click through the questions.

the announcement, while effects are less pronounced for 2023, when the effect on the federal funds rate expectations is highest. The substantial effects on federal funds rate and inflation expectations already suggest an important role of the intertemporal substitution mechanism in households' consumption responses.

Columns 5-7 of Table 2 display results on nominal income expectations. The table reveals a very muted average response of income expectations over all relevant time horizons. These effects are very precisely estimated and the minimum detectable effect sizes for a power of 80% and a significance threshold of 5% are below 1 percentage point. This suggests a limited relevance of adjustments of nominal income expectations.

Table 3 displays results on real income expectations. Consistent with the fall in inflation expectations and the muted response of nominal income expectations, we observe a significant *increase* in real income expectations for some horizons. Expectations about cumulative real income growth increase by 0.52 percentage points for the years 2022-2023 ($p < 0.01$), and by 0.60 percentage points for the years 2024-2026 ($p < 0.01$). These reduced-form results already suggest reductions in consumption due to intertemporal substitution may be partially offset by positive effects on real income expectations.

Robustness to different beliefs about the shocks To probe the robustness of our findings, we varied the source of the change in the Fed's increased projection for the year 2023. Panel B of Tables 1-3 highlight that households' expectation adjustment does not systematically vary depending on whether the source of the change is described to be (i) endogenous to current economic conditions, (ii) exogenous to current conditions, or (iii) exogenous to current conditions and also reflected in stock market movements, or whether (iv) no reason for the change is given. The lack of differences across the different sources of the shock underscores the robustness of our main findings, and showcases that households do not form their expectations as posited by a large class of theoretical models, which would predict sharp differences in expectation adjustments depending on whether a policy change is endogenous or exogenous.

Robustness to sample definition In some of our projections of consumption responses in Section 5 we assume that only households that report to typically hear about Fed announcements within four weeks adjust their consumption. Appendix Tables A.4-A.6 display reduced-form results on expectation adjustments restricting the sample to non-hand-to-mouth households who are attentive to Fed announcements. Although there are some small quantitative differences compared to the baseline results focusing on all non-hand-to-mouth households, the patterns are overall very similar.

4.3 Robustness experiment

We conducted an additional robustness experiment (n=392) in March 2021 in collaboration with Luc.id with a sample representative of the US population in terms of education, gender, age, region, and household net income.[8] Our design is identical to our main experiment except that we elicit different expectations in the hypothetical scenarios. In the robustness experiment, we elicit expectations about the future federal funds rate, the probability that the household will be borrowing-constrained in the future, and the value of the household's main residence under the baseline scenario of a constant Fed projection and under the alternative scenario of a rise in the projected Fed funds rate.[9]

We use our robustness experiment to examine whether non-hand-to-mouth households update their expectations about future credit constraints and the value of their main residence in response to changes in Fed projections. These expectations play an important role in the effects of forward guidance according to influential models (Kaplan et al., 2018; McKay et al., 2016). Table A.3 in the online appendix shows similar first stage effects on expectations about the federal fund rate in the robustness experiment as in the main

[8]We apply the same sample restrictions as in the main survey to our initial sample of 478 respondents in the robustness survey. This results in dropping 8 respondents in the top and bottom percentiles of response time, and dropping 78 respondents providing outlier responses. We define outliers according to respondents' predicted federal funds rate as in the main survey (described in Section 3.3.1), and according to whether they predict home price growth less than -90 or greater than 900 percent, or absolute differences in expected home price growth across scenarios of more than 150 percent. See Table A.1 Panel B for summary statistics and tests of balance across arms for the robustness survey.

[9]In Appendix B.2, we provide the full set of instructions.

survey. Table 4 shows that neither respondents' perceived likelihood of becoming credit constrained nor their home price expectations change in response to the change in the Fed projection. The estimated effects are close to zero, and relatively precisely estimated given the high statistical power in our within-design.

5 Consumption counterfactuals with measured expectations

In this Section, we feed the measured expectations adjustments from Section 4 into our model outlined in Section 2, and discuss the implied consumption changes in response to the Fed announcement.

Expected path of federal funds rate, inflation and income The survey elicits each household's expected path for the federal funds rate, the inflation rate, and own income under the baseline policy announcement and under the alternative policy announcement.

Let $E_{i,t}[r_s]$ denote household i's expectation in period t of the federal funds rate in period s. Let $\triangle E_{i,t}[r_s] = E^a_{i,t}[r_s] - E^b_{i,t}[r_s]$ denote the difference between the expectation under the alternative policy announcement and the expectation under the baseline policy announcement. The survey elicits each household's expectation in quarter t=2021:Q1 of the federal funds rate at the end of five years (2021, 2022, 2023, 2026, and 2030) under the two policy announcements. Hence, from the survey, one can directly compute $\triangle E_{i,t}\left[r_{2021:Q4}\right]$, $\triangle E_{i,t}\left[r_{2022:Q4}\right]$, $\triangle E_{i,t}\left[r_{2023:Q4}\right]$, $\triangle E_{i,t}\left[r_{2026:Q4}\right]$, and $\triangle E_{i,t}\left[r_{2030:Q4}\right]$. We interpolate the answers for those quarters s that we do not ask about with the following

formula:

$$\triangle E_{i,t}\left[r_s\right] = \begin{cases} 0 & s = t, t+1, t+2 \\ \triangle E_{i,t}\left[r_{2021:Q4}\right] & s = t+3, \ldots, t+6 \\ \triangle E_{i,t}\left[r_{2022:Q4}\right] & s = t+7, \ldots, t+10 \\ \triangle E_{i,t}\left[r_{2023:Q4}\right] & s = t+11, \ldots, t+22 \\ \triangle E_{i,t}\left[r_{2026:Q4}\right] & s = t+23, \ldots, t+38 \\ \rho^{s-(t+39)} \triangle E_{i,t}\left[r_{2030:Q4}\right] & s \geq t+39 \end{cases}. \tag{14}$$

This formula contains two assumptions. First, the difference in the expectation under the two policy announcements starts in the quarter for which it is expressed for the first time. Second, the effect of the announcement in 2021:Q1 on the expected federal funds rate in quarter s converges to zero at rate ρ from quarter 2030:Q4 onwards.

Turning to inflation, let $E_{i,t}\left[\pi_s\right]$ denote household i's expectation in period t of the inflation rate in period s. Let $\triangle E_{i,t}\left[\pi_s\right] = E^a_{i,t}\left[\pi_s\right] - E^b_{i,t}\left[\pi_s\right]$ denote the difference between the expectation under the alternative policy announcement and the expectation under the baseline policy announcement. The survey elicits each household's expectation in quarter t=2021:Q1 of the annual inflation rate over the year 2021, over the year 2022, over the year 2023, and over the period 2024-2026. We compute the expected quarterly inflation rates with the following formula:

$$\triangle E_{i,t}\left[\pi_s\right] = \begin{cases} \frac{1}{4}\triangle E_{i,t}\left[\pi_{2021}\right] & s = t, \ldots, t+3 \\ \frac{1}{4}\triangle E_{i,t}\left[\pi_{2022}\right] & s = t+4, \ldots, t+7 \\ \frac{1}{4}\triangle E_{i,t}\left[\pi_{2023}\right] & s = t+8, \ldots, t+11 \\ \frac{1}{4}\triangle E_{i,t}\left[\bar{\pi}_{2024-2026}\right] & s = t+12, \ldots, t+23 \\ \rho^{s-(t+23)}\frac{1}{4}\triangle E_{i,t}\left[\bar{\pi}_{2024-2026}\right] & s \geq t+24 \end{cases}. \tag{15}$$

This formula also contains two assumptions. First, the household expects the price level

to grow at a constant rate within a year and within the period 2024-2026. The expected quarterly inflation rate thus equals (1/4) times the expected annual inflation rate. Second, the effect of the policy announcement in quarter t=2021:Q1 on the expected inflation rate in quarter s converges to zero at rate ρ from quarter 2026:Q4 onwards.

Turning to own nominal income, let $E_{i,t}\left[y_{i,s}\right] = E_{i,t}\left[\frac{Y_{i,s}-Y_{i,t-1}}{Y_{i,t-1}}\right]$ denote household i's expectation in period t of the percentage difference between own nominal income in period s and own nominal income in period $t-1$. Assuming that households know their own past nominal income, we have $E_{i,t}\left[y_{i,s}\right] = \frac{E_{i,t}\left[Y_{i,s}\right]-Y_{i,t-1}}{Y_{i,t-1}}$. Let $\triangle E_{i,t}\left[y_{i,s}\right] = E^{a}_{i,t}\left[y_{i,s}\right] - E^{b}_{i,t}\left[y_{i,s}\right]$ denote the difference between the expectation under the alternative policy announcement and the expectation under the baseline policy announcement. The survey elicits each household's expectation in quarter t=2021:Q1 of own nominal income in the year 2021, average own nominal income in the years 2022-2023, and average own income in the years 2024-2026 under the two policy announcements. Hence, from the survey, one can directly compute $\triangle E_{i,t}\left[y_{i,2021}\right] = \frac{\triangle E_{i,t}\left[Y_{i,2021}\right]}{Y_{i,2020}}$, $\triangle E_{i,t}\left[\bar{y}_{i,2022-2023}\right] = \frac{\triangle E_{i,t}\left[\bar{Y}_{i,2022-2023}\right]}{Y_{i,2020}}$, and $\triangle E_{i,t}\left[\bar{y}_{i,2024-2026}\right] = \frac{\triangle E_{i,t}\left[\bar{Y}_{i,2024-2026}\right]}{Y_{i,2020}}$. To arrive at expectations of quarterly own nominal income, we use the following formula:

$$\triangle E_{i,t}\left[y_{i,s}\right] = \begin{cases} \triangle E_{i,t}\left[y_{i,2021}\right] & s = t,\ldots,t+3 \\ \triangle E_{i,t}\left[\bar{y}_{i,2022-2023}\right] & s = t+4,\ldots,t+11 \\ \triangle E_{i,t}\left[\bar{y}_{i,2024-2026}\right] & s = t+12,\ldots,t+23 \\ \rho^{s-(t+23)}\triangle E_{i,t}\left[\bar{y}_{i,2024-2026}\right] & s \geq t+24 \end{cases}. \tag{16}$$

This formula contains two assumptions. First, if the household expects *annual* nominal income in 2021 to be x% higher in the year 2021 than in the year 2020, then the household expects *quarterly* nominal income to be x% higher in each quarter of the year. Second, the effect of the policy announcement in quarter t=2021:Q1 on the expected own nominal income in quarter s converges to zero at rate ρ from quarter 2026:Q4 onwards.

Finally, the expectation of own real income is determined by the expectation of own

nominal income and the expectation of the rate of inflation

$$E_{i,t}\left[\tilde{y}_{i,s}\right] = E_{i,t}\left[y_{i,s}\right] - \sum_{k=t}^{s} E_{i,t}\left[\pi_k\right],$$

where $E_{i,t}\left[\tilde{y}_{i,s}\right]$ is the expectation of household i in period t=2021:Q1 of the percentage difference between own real income in quarter s and own real income per quarter in 2020. The last equation implies

$$\triangle E_{i,t}\left[\tilde{y}_{i,s}\right] = \triangle E_{i,t}\left[y_{i,s}\right] - \sum_{k=t}^{s} \triangle E_{i,t}\left[\pi_k\right], \tag{17}$$

where $\triangle E_{i,t}\left[\tilde{y}_{i,s}\right]$ is the difference between the real income expectation under the alternative policy announcement and the real income expectation under the baseline policy announcement.

Consumption response of non-hand-to-mouth anticipating no constraints For a non-hand-to-mouth, attentive household who does not expect to be borrowing constrained in the future, the impact of the policy announcement on consumption then equals

$$\begin{aligned} \triangle c_{i,t} = & \frac{1}{\frac{C_i}{Y_i}}\left(1-\beta\right)\sum_{s=t}^{\infty}\beta^{s-t}\triangle E_{i,t}\left[\tilde{y}_{i,s}\right] \\ & -\frac{1}{\gamma}\beta\sum_{s=t}^{\infty}\beta^{s-t}\left(\triangle E_{i,t}\left[r_s\right] - \triangle E_{i,t}\left[\pi_{s+1}\right]\right) \\ & +\frac{1}{\frac{C_i}{Y_i}}\left(1-\beta\right)\frac{1}{\beta}\frac{\tilde{B}_i}{Y_i}\triangle E_{i,t}\left[\tilde{b}_{i,t-1}\right], \end{aligned} \tag{18}$$

if the household has positive liquid wealth ($\tilde{B}_j > 0$), and

$$\begin{aligned} \triangle c_{i,t} = & \frac{1}{\frac{C_i}{Y_i}}\left(1-\beta\right)\sum_{s=t}^{\infty}\beta^{s-t}\triangle E_{i,t}\left[\tilde{y}_{i,s}\right] \\ & -\frac{1}{\gamma}\beta\sum_{s=t}^{\infty}\beta^{s-t}\left(\triangle E_{i,t}\left[r_s\right] - \triangle E_{i,t}\left[\pi_{s+1}\right]\right) \\ & +\frac{1}{\frac{C_i}{Y_i}}\left(1-\beta\right)\frac{1}{\beta}\frac{\tilde{B}_i}{Y_i}\left(\triangle E_{i,t}\left[\tilde{b}_{i,t-1}\right] + \sum_{s=t}^{\infty}\beta^{s-t}\left(\triangle E_{i,t}\left[r_{s-1}\right] - \triangle E_{i,t}\left[\pi_s\right]\right)\right), \end{aligned} \tag{19}$$

if the household has negative liquid wealth ($\tilde{B}_j < 0$). The difference between these two equations is due to the fact that expected interest income is part of expected income for a household with positive liquid wealth, while expected interest payments are part of expected expenditure for a household with negative liquid wealth.

Table 5 shows the cross-sectional distribution of $\triangle c_{i,t}$ computed from the survey answers, assuming a quarterly discount rate of $\beta = 0.99$, an intertemporal elasticity of substitution of $\frac{1}{\gamma} = \frac{1}{2}$, and no effect of the policy announcement on the expectation of past real liquid wealth and of the past policy rate, $\triangle E_{i,t}\left[\tilde{b}_{i,t-1}\right] = 0$ and $\triangle E_{i,t}\left[r_{t-1}\right] = 0$. We assume that expectation adjustments beyond the measured horizons go to zero at rate $\rho = 0.9$. Moreover, we weight each respondent's consumption growth by the respondent's overall household spending in 2020.

Panel A of Table 5 shows the consumption response among non-hand-to-mouth households attaching a zero probability to becoming credit constrained at any point until the end of 2022, assuming that all of these households react to the Fed announcement. On average, our model calibrated using the survey-based expectation adjustments predicts a reduction of consumption by 0.39 percent ($p < 0.05$) in response to the hypothetical increase in the projected federal funds rate in 2023 from 0.1 to 0.5 percent. This average effect shrouds opposing effects of intertemporal substitution and changes in expected real income. While the intertemporal substitution mechanism lowers consumption by 0.82 percentage points ($p < 0.01$), the income effect channel increases consumption by approximately 0.43 percentage points ($p < 0.10$) and effects working through higher expected real interest payments reduce consumption by 0.001 percentage points ($p < 0.10$).

Panel B of Table 5 reports the average expectation adjustment assuming that the subset of respondents that self-report that they usually learn about Fed announcements only after four weeks or later (or never) would not adjust their expectations and spending at all. Under this assumption, consumption on average decreases by 0.42 percent ($p < 0.05$). While the intertemporal substitution mechanism lowers consumption by 0.69 percentage points ($p < 0.01$), the income effect channel increases consumption insignificantly by approximately 0.27 percentage points and effects working through real interest rate pay-

ments lead to an insignificant decrease by 0.001 percentage points. Thus, consistent with inattentive respondents not reacting to the announcement both the income and intertemporal substitution mechanism are smaller in absolute magnitude in Panel B. Yet, since these two mechanisms go into opposite directions, the overall consumption response is very similar across Panels A and B.

Table 6 highlights that our findings on the consumption adjustment of non-hand-to-mouth households attaching a zero probability to becoming credit constrained is very similar if we vary the rate ρ at which we assume expectation adjustments beyond the measured horizons to go to zero.

Consumption response of non-hand-to-mouth anticipating constraints For a non-hand-to-mouth, attentive household who expects to be borrowing constrained with probability one in the next period, the impact of the policy announcement on consumption equals

$$\begin{aligned}\triangle c_{i,t} = & \frac{1}{\frac{C_i}{\tilde{Y}_i}}\frac{1}{1+\beta}\left(\triangle E_{i,t}\left[\tilde{y}_{i,t}\right]+\beta\triangle E_{i,t}\left[\tilde{y}_{i,t+1}\right]\right) \\ & -\frac{1}{\gamma}\frac{\beta}{1+\beta}\left(\triangle E_{i,t}\left[r_t\right]-\triangle E_{i,t}\left[\pi_{t+1}\right]\right) \\ & +\frac{1}{\frac{C_i}{\tilde{Y}_i}}\frac{\beta}{1+\beta}\frac{\tilde{L}_i}{\tilde{Y}_i}\left(\triangle E_{i,t}\left[l_{i,t+1}\right]-\triangle E_{i,t}\left[\pi_{t+1}\right]\right) \\ & +\frac{1}{\frac{C_i}{\tilde{Y}_i}}\frac{1}{1+\beta}\frac{1}{\beta}\frac{\tilde{B}_i}{\tilde{Y}_i}\triangle E_{i,t}\left[\tilde{b}_{i,t-1}\right],\end{aligned} \tag{20}$$

if the household has positive liquid wealth ($\tilde{B}_j > 0$), and

$$\begin{aligned}\triangle c_{i,t} = & \frac{1}{\frac{C_i}{\tilde{Y}_i}}\frac{1}{1+\beta}\left(\triangle E_{i,t}\left[\tilde{y}_{i,t}\right]+\beta\triangle E_{i,t}\left[\tilde{y}_{i,t+1}\right]\right) \\ & -\frac{1}{\gamma}\frac{\beta}{1+\beta}\left(\triangle E_{i,t}\left[r_t\right]-\triangle E_{i,t}\left[\pi_{t+1}\right]\right) \\ & +\frac{1}{\frac{C_i}{\tilde{Y}_i}}\frac{\beta}{1+\beta}\frac{\tilde{L}_i}{\tilde{Y}_i}\left(\triangle E_{i,t}\left[l_{i,t+1}\right]-\triangle E_{i,t}\left[\pi_{t+1}\right]\right) \\ & +\frac{1}{\frac{C_i}{\tilde{Y}_i}}\frac{1}{1+\beta}\frac{1}{\beta}\frac{\tilde{B}_i}{\tilde{Y}_i}\left(\triangle E_{i,t}\left[\tilde{b}_{i,t-1}\right]+\sum_{s=t}^{t+1}\beta^{s-t}\left(\triangle E_{i,t}\left[r_{s-1}\right]-\triangle E_{i,t}\left[\pi_s\right]\right)\right),\end{aligned} \tag{21}$$

if the household has negative liquid wealth ($\tilde{B}_j < 0$). The only difference between these two equations is a small difference in the last term and is due to the fact that expected

interest income is part of expected income for a household with positive liquid wealth, while expected interest payments are part of expected expenditure for a household with negative liquid wealth.

Table 7 shows the cross-sectional distribution of $\triangle c_{i,t}$ computed from the survey answers, assuming a quarterly discount rate of $\beta = 0.99$, an intertemporal elasticity of substitution of $\frac{1}{\gamma} = \frac{1}{2}$, and no effect of the policy announcement on the expectation of past real liquid wealth and of the past policy rate, $\triangle E_{i,t}\left[\tilde{b}_{i,t-1}\right] = 0$ and $\triangle E_{i,t}\left[r_{t-1}\right] = 0$. In addition, we assume no differential effect of the two policy announcements on the expectation of the nominal borrowing limit, $\triangle E_{i,t}\left[l_{i,t+1}\right] = 0$, implying that deflationary expectations raise the expectation of the real value of the borrowing limit. We again weight each respondent's consumption growth by the respondent's overall household spending in 2020.

The table shows the consumption responses of non-hand-to-mouth households attaching a positive probability to becoming credit constrained until the end of 2022 for two corner cases. Panel A shows the consumption responses of these households if they behaved as if the probability of becoming credit constrained was zero. Panel B shows the consumption responses if they behaved as if the probability of becoming constrained was 100% already in $t + 1$ (using the derivations above). These two can be thought of as corner cases that should give a broad idea about where the overall consumption response of these households might be. Both panels assume that all households in this group adjust their expectations and consumption.

Panel A shows that if these households behaved as if they perceived a zero percent chance of being constrained, they would *increase* consumption by 0.54 percent ($p < 0.05$). The positive overall response is driven by large expected real income effects of 1.76 percent ($p < 0.01$) and somewhat smaller intertemporal substitution effects of -1.21 percent ($p < 0.01$). Panel B highlights that if these households behaved as if they knew with certainty that they will become credit constrained in the next period, they would reduce consumption by an insignificant 0.02 percent. The muted overall response masks intertemporal substitution effects of -0.02 percent ($p < 0.01$), insignificant real income ef-

fects of -0.11 percent, and effects working through higher expected interest payments on debt of 0.01 percent ($p < 0.01$), which are balanced by positive effects working through a higher expected real credit limit of 0.13 percent ($p < 0.01$).

Table A.7 highlights insignificant overall consumption increases by 0.31 percent or by 0.12 percent for the two corner cases if we assume that among the group of non-hand-to-mouth households anticipating credit constraints only those who report to typically learn about Fed announcements within four weeks or less react.

Overall direct consumption effects from expectations adjustments We can use the estimates for the groups of non-hand-to-mouth households attaching a zero probability to future credit constraints (48 percent of the sample) and of non-hand-to-mouth households perceiving a strictly positive probability of such constraints (25 percent of the sample) to obtain an estimate of the overall direct consumption effects from expectations adjustments in response to the policy announcement. For this exercise we assume that those predicting a positive probability of constraints behave as if they faced a 100 percent chance of constraints in the next period. The overall consumption response is given by the following formula:

$$\begin{aligned} \triangle \bar{c}_t = & \text{ Fraction HTM}_t \times 0 \\ & + \text{Fraction non-HTM 0\% constr.}_t \times \triangle \bar{c}_t^{unconstr} \\ & + \text{Fraction non-HTM >0\% constr.}_t \times \triangle \bar{c}_t^{constr} \end{aligned} \tag{22}$$

If all non-hand-to-mouth households react, the overall consumption response is given by:

$$\begin{aligned} \triangle \bar{c}_t = & \ 0.27 \times 0 \\ & + 0.48 \times (-0.394) \\ & + 0.25 \times (-0.021) \\ & = -0.194 \end{aligned} \tag{23}$$

If only those non-hand-to-mouth households who typically learn about Fed announce-

ments within four weeks react, the overall consumption response is given by:

$$\begin{aligned} \triangle \bar{c}_t &= 0.27 \times 0 \\ &+ 0.48 \times (-0.417) \\ &+ 0.25 \times (0.117) \\ &= -0.171 \end{aligned} \tag{24}$$

Thus the overall average consumption response due to the expectation adjustment in response to the increase in the projection about the 2023 federal funds rate will be -0.194 percent if all non-hand-to-mouth households react, and -0.171 if only those who are attentive to Fed announcements react.

Further discussion In addition to these effects working through expectation adjustments, there could be additional effects if households' incomes decrease in response to lower consumption due to the expectation adjustment. Such effects could affect the consumption response of non-hand-to-mouth households, and also lead to a consumption response among hand-to-mouth households. However, if the reduced consumption is mostly reflected in an increase in inventories and lower capacity utilization of capital and labor, such income effects will be small. Moreover, there could be additional adjustments in expectations, which have further effects on non-hand-to-mouth households' consumption. However, given that in the short-term no new data (e.g. on GDP) will become available, such additional expectation adjustments should only matter in the medium-term.

6 Conclusion

We study the effects of forward guidance combining a model with experimentally estimated adjustments of expectations. Informed by the model, we conduct experiments with representative samples of the US population to study how households adjust their expectations in response to changes in the Fed's projections about future interest rates.

Respondents significantly downward adjust their inflation expectations in response to learning about an increase in the Fed's projection about the federal funds rate three years in the future, and they expect inflation to respond most strongly immediately after the announcement. By contrast, respondents do not adjust their nominal income expectations. Our model-based estimates highlight a small average consumption response to forward guidance due to opposing effects from intertemporal substitution and changes in expected real income.

Our approach of calibrating theoretical models based on tailored survey-based adjustments of expectations has many potential applications. In particular, our approach would be well-suited to study the consumption response to other policies, such as fiscal policy measures that aim to change income expectations and which may also alter inflation expectations.

References

Ahmed, Naeem, Matthew Brzozowski, and Thomas F Crossley, "Measurement Errors in Recall Food Consumption Data," *Working Paper*, 2006. 3.2.10

Andre, Peter, Carlo Pizzinelli, Christopher Roth, and Johannes Wohlfart, "Subjective Models of the Macroeconomy: Evidence from Experts and Representative Samples," *Review of Economic Studies, forthcoming*, 2021. 1, 1

Angeletos, George-Marios and Chen Lian, "Forward Guidance Without Common Knowledge," *American Economic Review*, 2018, *108* (9), 2477–2512. 1, 1

Armona, Luis, Andreas Fuster, and Basit Zafar, "Home Price Expectations and Behaviour: Evidence from a Randomized Information Experiment," *The Review of Economic Studies*, 2019, *86* (4), 1371–1410. 3

Bachmann, Rüdiger, Tim O Berg, and Eric R Sims, "Inflation Expectations and Readiness to Spend: Cross-Sectional Evidence," *American Economic Journal: Economic Policy*, 2015, *7*, 1–35. 3

Bailey, Michael, Ruiqing Cao, Theresa Kuchler, and Johannes Stroebel, "The Economic Effects of Social Networks: Evidence from the Housing Market," *Journal of Political Economy*, 2018, *126* (6), 2224–2276. 3

Battistin, Erich, "Errors in Survey Reports of Consumption Expenditures," *Working Paper*, 2003. 3.2.10

Bound, John, Charles Brown, and Nancy Mathiowetz, "Measurement Error in Survey Data," in "Handbook of Econometrics," Vol. 5, Elsevier, 2001, pp. 3705–3843. 3.2.10

Browning, Martin, Thomas F Crossley, and Guglielmo Weber, "Asking Consumption Questions in General Purpose Surveys," *The Economic Journal*, 2003, *113* (491), F540–F567. 3.2.10

Brunnermeier, Markus, Emmanuel Farhi, Ralph SJ Koijen, Arvind Krishnamurthy, Sydney C Ludvigson, Hanno Lustig, Stefan Nagel, and Monika Piazzesi, "Perspectives on the Future of Asset Pricing," *The Review of Financial Studies*, 2021. 1

Carlstrom, Charles T, Timothy S Fuerst, and Matthias Paustian, "Inflation and Output in New Keynesian models with a Transient Interest Rate Peg," *Journal of Monetary Economics*, 2015, *76*, 230–243. 1

Cavallo, Alberto, Guillermo Cruces, and Ricardo Perez-Truglia, "Inflation Expectations, Learning and Supermarket Prices: Evidence from Field Experiments," *American Economic Journal: Macroeconomics*, 2017, *9* (3), 1–35. 3

Coibion, Olivier, Dimitris Georgarakos, Yuriy Gorodnichenko, and Michael Weber, "Forward Guidance and Household Expectations," *National Bureau of Economic Research Working Paper No. 26778*, 2020. 1

_ , Yuriy Gorodnichenko, and Michael Weber, "Monetary Policy Communications and their Effects on Household Inflation Expectations," *NBER Working Paper No. 25482*, 2019. 1

_ , _ , and Rupal Kamdar, "The Formation of Expectations, Inflation and the Phillips Curve," *Journal of Economic Literature*, 2018, *56* (4), 1447–91. 3

_ , _ , Saten Kumar, and Mathieu Pedemonte, "Inflation Expectations as a Policy Tool?," *Journal of International Economics*, 2020, p. 103297. 1

D'Acunto, Francesco, Daniel Hoang, Maritta Paloviita, and Michael Weber, "Human Frictions to the Transmission of Economic Policy," *Working Paper*, 2021. 1

Eggertsson, Gauti and Michael Woodford, "The Zero Bound on Interest Rates and Optimal Monetary Policy. Comments and Discussion," *Brookings Papers on Economic Activity*, 2003, *2003* (1), 212–233. 1, 1

Farhi, Emmanuel and Ivan Werning, "Monetary Policy, Bounded Rationality, and Incomplete Markets," *American Economic Review*, 2019, *109* (11), 3887–3928. 1

Fuster, Andreas, Ricardo Perez-Truglia, Mirko Wiederholt, and Basit Zafar, "Expectations with Endogenous Information Acquisition: An Experimental Investigation," *Review of Economics and Statistics*, 2020. 3

Gabaix, Xavier, "A Behavioral New-Keynesian Model," *American Economic Review*, 2020, *110* (8), 2271–2327. 1, 1

Galashin, Misha, Martin Kanz, and Ricardo Perez-Truglia, "Macroeconomic Expectations and Credit Card Spending," *Working Paper*, 2021. 3.2.10

García-Schmidt, Mariana and Michael Woodford, "Are Low Interest Rates Deflationary? A Paradox of Perfect-foresight Analysis," *American Economic Review*, 2019, *109* (1), 86–120. 1

Haaland, Ingar, Christopher Roth, and Johannes Wohlfart, "Designing Information Provision Experiments," *Journal of Economic Literature*, 2021. 3, 3.1

Kaplan, Greg, Benjamin Moll, and Giovanni L Violante, "Monetary Policy According to HANK," *American Economic Review*, 2018, *108* (3), 697–743. 4.3

_ , Giovanni L Violante, and Justin Weidner, "The Wealthy Hand-to-Mouth," *Brookings Papers on Economic Activity*, 2014, *2014* (1), 77–138. 1, 3.2.7, 4.1

Kuchler, Theresa and Basit Zafar, "Personal Experiences and Expectations about Aggregate Outcomes," *Journal of Finance*, 2019, *74* (5), 2491–2542. 3

Landvoigt, Tim, Monika Piazzesi, and Martin Schneider, "The Housing Market(s) of San Diego," *American Economic Review*, 2015, *105* (4), 1371–1407. 1

Leombroni, Matteo, Monika Piazzesi, Martin Schneider, and Ciaran Rogers, "Inflation and the Price of Real Assets," *Working Paper*, 2020. 1

Link, Sebastian, Andreas Peichl, Christopher Roth, and Johannes Wohlfart, "Information Frictions Among Firms and Households," *Available at SSRN 3739940*, 2020. 1

McKay, Alisdair, Emi Nakamura, and Jón Steinsson, "The Power of Forward Guidance Revisited," *American Economic Review*, 2016, *106* (10), 3133–58. 1, 1, 2, 3.2.8, 4.3

Negro, Marco Del, Marc P Giannoni, and Christina Patterson, "The Forward Guidance Puzzle," *FRB of New York Staff Report*, 2012, (574). 1, 1

Piazzesi, Monika and Martin Schneider, "Housing and Macroeconomics," *Handbook of Macroeconomics*, 2016, *2*, 1547–1640. 1

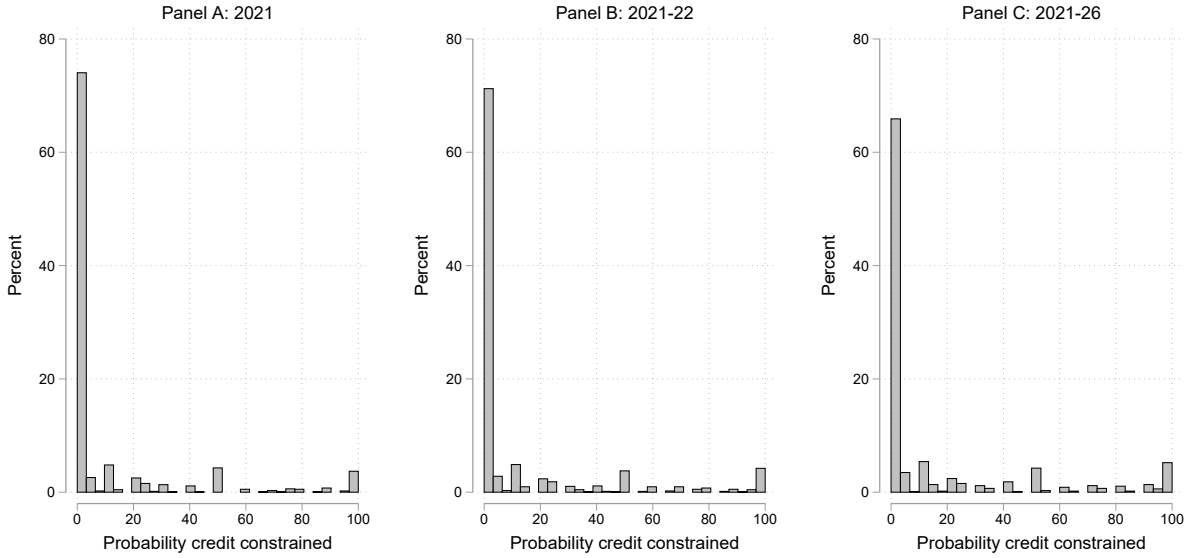
Roth, Christopher and Johannes Wohlfart, "How Do Expectations About the Macroeconomy Affect Personal Expectations and Behavior?," *Review of Economics and Statistics*, 2020, *102* (4), 731–748. 3

_ , Sonja Settele, and Johannes Wohlfart, "Risk Exposure and Acquisition of Macroeconomic Information," *American Economic Review: Insights*, 2021. 3

Wiederholt, Mirko, "Empirical Properties of Inflation Expectations and the Zero Lower Bound," *Working Paper*, 2015. 1, 1

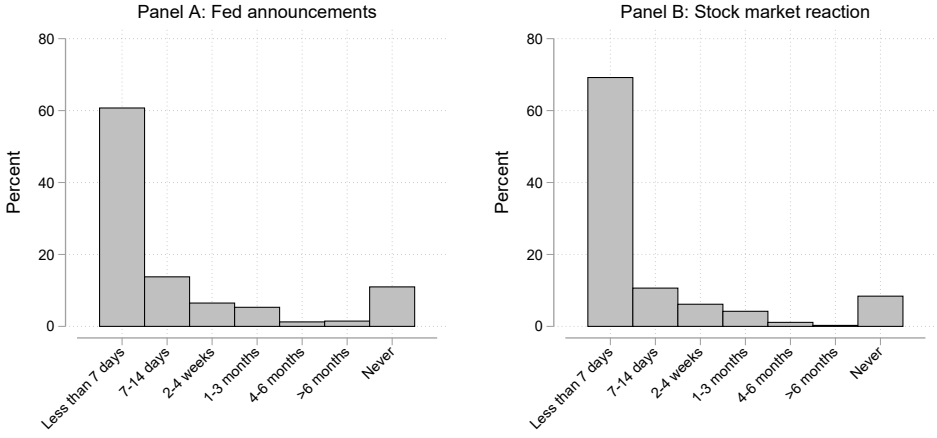
Main figures

Figure 1: Perceived probability of being credit constrained



Notes: This figure displays histograms of respondents' perceived probability of being credit constrained at any point in time over the indicated horizons. The sample is restricted to non-hand-to-mouth households.

Figure 2: Time until learned about Fed announcements or stock market reaction



Notes: This figure displays histograms of respondents' estimates of the time it typically takes until they hear about Fed announcements (Panel A) or the stock market reaction to such announcements (Panel B). The sample is restricted to non-hand-to-mouth households.

Main tables

Table 1: Reduced-form results: Adjustment of expectations about federal funds rate

	Δ Expected federal funds rate (percentage points)				
	(1) 2021	(2) 2022	(3) 2023	(4) 2026	(5) 2030
Panel A: Pooled					
Mean expectation adjustment	0.049***	0.076***	0.189***	0.032	0.001
	(0.012)	(0.014)	(0.018)	(0.024)	(0.027)
Panel B: By arm					
Change endogenous (a)	0.048**	0.093***	0.179***	0.079*	0.050
	(0.024)	(0.026)	(0.029)	(0.043)	(0.051)
Change no explanation (b)	0.016	0.034	0.148***	-0.009	0.005
	(0.021)	(0.023)	(0.034)	(0.043)	(0.049)
Change exogenous (c)	0.057***	0.092***	0.218***	0.073	0.072
	(0.022)	(0.028)	(0.040)	(0.049)	(0.054)
Change exogenous stocks (d)	0.072**	0.084***	0.210***	-0.016	-0.113*
	(0.030)	(0.032)	(0.042)	(0.053)	(0.062)
p-value(a=b)	0.318	0.089	0.479	0.151	0.532
p-value(b=c)	0.169	0.116	0.182	0.208	0.363
p-value(a=c)	0.765	0.967	0.439	0.926	0.767
p-value(c=d)	0.693	0.851	0.893	0.216	0.025
R-squared	0.01	0.02	0.07	0.00	0.01
SD expectation adjustment	0.45	0.51	0.68	0.87	1.01
Observations	1,357	1,357	1,357	1,357	1,357

Notes: This table shows the effect of the hypothetical increase in the Fed's projection of the future federal funds rate at the end of 2023 from 0.1 to 0.5 percent on respondent's own expectations about the federal funds rate at different horizons. Panel A shows results pooling across the four arms. Panel B shows results separately for each of the four arms providing respondents with different reasons for the change in the Fed's projections. Arm "Change endogenous" attributes the change in the Fed's projections to a change in the Fed's broader economic outlook. Arm "Change no explanation" does not give an explanation for the change in projections. Arm "Change exogenous" attributes the change in the Fed's projections to a change in the composition of the Fed's committee before the next meeting. Arm "Change exogenous stocks" features the same explanation as "Change exogenous" and in addition explains that the stock market drops by 1 percent in response to the Fed's projections. The sample is restricted to non-hand-to-mouth households. Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

Table 2: Reduced-form results: Adjustment of expectations about inflation and nominal income growth

	Δ Expected inflation rate (percentage points)				Δ Expected cumulative income growth (percentage points)		
	(1) 2021	(2) 2022	(3) 2023	(4) 2024-26	(5) 2021	(6) 2022-23	(7) 2024-26
Panel A: Pooled							
Mean expectation adjustment	-0.250***	-0.184***	-0.044	-0.139***	-0.057	0.062	-0.157
	(0.024)	(0.028)	(0.036)	(0.040)	(0.163)	(0.173)	(0.198)
Panel B: By arm							
Change endogenous (a)	-0.192***	-0.157***	-0.033	-0.076	0.287	0.438	0.373
	(0.044)	(0.052)	(0.073)	(0.077)	(0.318)	(0.363)	(0.434)
Change no explanation (b)	-0.333***	-0.249***	-0.120*	-0.178**	-0.758**	-0.785**	-0.998**
	(0.046)	(0.055)	(0.069)	(0.081)	(0.303)	(0.319)	(0.392)
Change exogenous (c)	-0.215***	-0.132**	-0.031	-0.196**	0.465	0.642*	0.173
	(0.047)	(0.058)	(0.078)	(0.082)	(0.352)	(0.343)	(0.396)
Change exogenous stocks (d)	-0.265***	-0.197***	0.001	-0.120	-0.229	-0.059	-0.222
	(0.053)	(0.059)	(0.069)	(0.078)	(0.324)	(0.343)	(0.352)
p-value(a=b)	0.028	0.224	0.389	0.360	0.018	0.011	0.019
p-value(b=c)	0.071	0.148	0.395	0.871	0.009	0.002	0.036
p-value(a=c)	0.726	0.756	0.986	0.283	0.707	0.683	0.733
p-value(c=d)	0.475	0.435	0.762	0.502	0.147	0.149	0.455
R-squared	0.08	0.03	0.00	0.01	0.01	0.01	0.01
SD expectation adjustment	0.88	1.03	1.33	1.46	5.99	6.36	7.30
Observations	1,357	1,357	1,357	1,357	1,357	1,357	1,357

Notes: This table shows the effect of the hypothetical increase in the Fed's projection of the future federal funds rate at the end of 2023 from 0.1 to 0.5 percent on respondent's expectations about inflation and the cumulative growth of nominal household net income compared to 2020 at different horizons. Panel A shows results pooling across the four arms. Panel B shows results separately for each of the four arms providing respondents with different reasons for the change in the Fed's projections. Arm "Change endogenous" attributes the change in the Fed's projections to a change in the Fed's broader economic outlook. Arm "Change no explanation" does not give an explanation for the change in projections. Arm "Change exogenous" attributes the change in the Fed's projections to a change in the composition of the Fed's committee before the next meeting. Arm "Change exogenous stocks" features the same explanation as "Change exogenous" and in addition explains that the stock market drops by 1 percent in response to the Fed's projections. The sample is restricted to non-hand-to-mouth households. Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

Table 3: Reduced-form results: Adjustment of expectations about real income growth

	Δ Expected cumulative real income growth (percentage points)		
	(1) 2021	(2) 2022-23	(3) 2024-26
Panel A: Pooled			
Mean expectation adjustment	0.193	0.518***	0.600**
	(0.164)	(0.183)	(0.248)
Panel B: By arm			
Change endogenous (a)	0.479	0.803**	0.906*
	(0.319)	(0.378)	(0.515)
Change no explanation (b)	-0.425	-0.144	0.058
	(0.309)	(0.342)	(0.514)
Change exogenous (c)	0.680*	1.004***	0.943*
	(0.356)	(0.378)	(0.502)
Change exogenous stocks (d)	0.036	0.403	0.479
	(0.329)	(0.355)	(0.455)
p-value(a=b)	0.042	0.064	0.244
p-value(b=c)	0.019	0.024	0.218
p-value(a=c)	0.674	0.706	0.958
p-value(c=d)	0.184	0.246	0.493
R-squared	0.01	0.01	0.01
SD expectation adjustment	6.06	6.72	9.15
Observations	1,357	1,357	1,357

Notes: This table shows the effect of the hypothetical increase in the Fed's projection of the future federal funds rate at the end of 2023 from 0.1 to 0.5 percent on respondent's expectations about the cumulative growth of real household net income compared to 2020 at different horizons. Expected real income growth is constructed from the respondents' expectations about nominal income growth and about inflation. Panel A shows results pooling across the four arms. Panel B shows results separately for each of the four arms providing respondents with different reasons for the change in the Fed's projections. Arm "Change endogenous" attributes the change in the Fed's projections to a change in the Fed's broader economic outlook. Arm "Change no explanation" does not give an explanation for the change in projections. Arm "Change exogenous" attributes the change in the Fed's projections to a change in the composition of the Fed's committee before the next meeting. Arm "Change exogenous stocks" features the same explanation as "Change exogenous" and in addition explains that the stock market drops by 1 percent in response to the Fed's projections. The sample is restricted to non-hand-to-mouth households. Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

Table 4: Robustness experiment: Adjustment of expectations about nominal home value growth and probability of being credit constrained

	Δ Expected probability credit constrained (percentage points)			Δ Expected cumulative home value growth (percentage points)
	(1) 2021	(2) 2021-22	(3) 2021-26	(4) 2023
Panel A: Pooled				
Mean expectation adjustment	0.025	0.516	0.240	0.284
	(0.659)	(0.811)	(0.527)	(1.217)
Panel B: By arm				
Change endogenous (a)	-0.372	0.006	-0.018	-0.958
	(0.746)	(1.005)	(0.568)	(2.342)
Change no explanation (b)	0.811	2.711	0.735	2.559
	(1.579)	(2.132)	(1.731)	(2.713)
Change exogenous (c)	-1.289	-1.094	-0.432	1.220
	(1.557)	(1.910)	(0.849)	(2.401)
Change exogenous stocks (d)	1.299	1.065	0.867	-1.561
	(1.097)	(1.065)	(0.997)	(2.292)
p-value(a=b)	0.499	0.252	0.680	0.327
p-value(b=c)	0.344	0.185	0.545	0.712
p-value(a=c)	0.596	0.611	0.686	0.517
p-value(c=d)	0.175	0.324	0.322	0.403
R-squared	0.01	0.01	0.00	0.01
SD expectation adjustment	11.38	14.00	9.09	21.01
Observations	298	298	298	298

Notes: This table shows the effect of the hypothetical increase in the Fed's projection of the future federal funds rate at the end of 2023 from 0.1 to 0.5 percent on respondent's expectations about the cumulative growth of the nominal value of their main residence until 2023 compared to 2020 and the probability of becoming credit constrained over different horizons. Panel A shows results pooling across the four arms. Panel B shows results separately for each of the four arms providing respondents with different reasons for the change in the Fed's projections. Arm "Change endogenous" attributes the change in the Fed's projections to a change in the Fed's broader economic outlook. Arm "Change no explanation" does not give an explanation for the change in projections. Arm "Change exogenous" attributes the change in the Fed's projections to a change in the composition of the Fed's committee before the next meeting. Arm "Change exogenous stocks" features the same explanation as "Change exogenous" and in addition explains that the stock market drops by 1 percent in response to the Fed's projections. The sample is restricted to non-hand-to-mouth households in the robustness experiment. Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

Table 5: Model-based results: Predicted consumption response to interest rate announcement among non-hand-to-mouth households with zero perceived chance of credit constraints

	Predicted consumption response (percent)							
	Mean	Median	SD	p10	p25	p75	p90	N
Panel A: All non-HTM react:								
Overall response among non-HTM	-0.394**	-0.55	4.41	-5.63	-2.29	1.79	5.29	895
	(0.179)							
- Real income effects	0.430*	-0.05	6.19	-6.49	-2.54	2.54	10.60	895
	(0.245)							
- Intertemporal substitution effects	-0.823***	-0.34	3.61	-6.28	-2.18	0.83	3.17	895
	(0.141)							
- Effects from interest payments	-0.001*	0.00	0.02	0.00	0.00	0.00	0.00	895
	(0.001)							
Panel B: Only attentive non-HTM react:								
Overall response among non-HTM	-0.417**	-0.06	4.06	-5.11	-2.01	1.19	4.51	895
	(0.168)							
- Real income effects	0.269	0.00	5.69	-5.86	-1.77	1.59	8.42	895
	(0.229)							
- Intertemporal substitution effects	-0.685***	-0.08	3.32	-5.59	-1.44	0.50	2.67	895
	(0.131)							
- Effects from interest payments	-0.001	0.00	0.02	0.00	0.00	0.00	0.00	895
	(0.001)							

Notes: This table shows the immediate consumption responses to the hypothetical increase in the Fed's projection of the future federal funds rate at the end of 2023 from 0.1 to 0.5 percent according to the model, which is calibrated using the survey-based changes in expectations. The table focuses on consumption responses of non-hand-to-mouth households with a zero perceived probability of being credit constrained at some point until the end of 2022. We assume effects on expectations to converge to zero at a quarterly rate $\rho = 0.9$ for horizons beyond those measured in the survey. In Panel A all of the included households are assumed to react. In Panel B only those included households who report that they typically learn about Fed announcements within four weeks (68 percent) are assumed to react, while the consumption response is set to zero among those included households that report that it typically takes longer than four weeks or that they typically never hear about Fed announcements (32 percent). Each of the three terms of the consumption response is winsorized at -15 percent and 15 percent. The overall consumption response is the sum of the winsorized individual terms. All statistics are weighted by the respondents' total household spending in 2020. Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

Table 6: Model-based results: Predicted consumption response to interest rate announcement among non-hand-to-mouth households with zero perceived chance of credit constraints: Different values of ρ

	Predicted consumption response (percent)							
	Mean	Median	SD	p10	p25	p75	p90	N
All non-HTM react:								
$\rho = 0.1$*:*								
Overall response among non-HTM	-0.416***	-0.60	3.80	-4.76	-2.08	1.40	4.35	895
	(0.153)							
- Real income effects	0.250	-0.07	5.50	-5.55	-2.15	2.14	8.51	895
	(0.217)							
- Intertemporal substitution effects	-0.666***	-0.33	3.07	-5.06	-1.91	0.75	2.79	895
	(0.120)							
$\rho = 0.5$*:*								
Overall response among non-HTM	-0.410***	-0.59	3.87	-4.88	-2.09	1.43	4.48	895
	(0.156)							
- Real income effects	0.273	-0.07	5.58	-5.66	-2.21	2.15	8.69	895
	(0.220)							
- Intertemporal substitution effects	-0.683***	-0.34	3.12	-5.16	-1.95	0.77	2.79	895
	(0.122)							
$\rho = 0.8$*:*								
Overall response among non-HTM	-0.399**	-0.55	4.09	-5.11	-2.21	1.55	5.01	895
	(0.165)							
- Real income effects	0.339	-0.09	5.83	-6.07	-2.42	2.37	9.47	895
	(0.230)							
- Intertemporal substitution effects	-0.738***	-0.33	3.30	-5.54	-1.95	0.81	2.90	895
	(0.129)							
$\rho = 0.9$*:*								
Overall response among non-HTM	-0.394**	-0.55	4.41	-5.63	-2.29	1.79	5.29	895
	(0.179)							
- Real income effects	0.430*	-0.05	6.19	-6.49	-2.54	2.54	10.60	895
	(0.245)							
- Intertemporal substitution effects	-0.823***	-0.34	3.61	-6.28	-2.18	0.83	3.17	895
	(0.141)							
$\rho = 0.95$*:*								
Overall response among non-HTM	-0.437**	-0.50	4.91	-6.19	-2.61	2.06	5.61	895
	(0.200)							
- Real income effects	0.538**	-0.06	6.72	-7.34	-2.75	3.01	12.52	895
	(0.267)							
- Intertemporal substitution effects	-0.973***	-0.36	4.21	-7.65	-2.38	0.97	3.58	895
	(0.163)							

Notes: This table shows the immediate consumption responses to the hypothetical increase in the Fed's projection of the future federal funds rate at the end of 2023 from 0.1 to 0.5 percent according to the model, which is calibrated using the survey-based changes in expectations. The table focuses on consumption responses of non-hand-to-mouth households with a zero perceived probability of being credit constrained at some point until the end of 2022. The table varies the quarterly rate ρ at which we assume effects on expectations to converge to zero for horizons beyond those measured in the survey. Throughout, all of the included households are assumed to react. Each of the three terms of the consumption response is winsorized at -15 percent and 15 percent. The overall consumption response is the sum of the winsorized individual terms. All statistics are weighted by the respondents' total household spending in 2020. Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

Table 7: Model-based results: Predicted consumption response to interest rate announcement among non-hand-to-mouth households with positive perceived chance of credit constraints (corner cases)

	Predicted consumption response (percent)							
	Mean	Median	SD	p10	p25	p75	p90	N
Panel A: Assume 0% ever constrained:								
Overall response	0.537**	0.01	4.83	-5.15	-1.88	3.50	6.32	462
	(0.254)							
- Real income effects	1.756***	0.02	6.84	-5.82	-1.63	5.67	12.90	462
	(0.361)							
- Intertemporal substitution effects	-1.216***	-0.21	4.39	-7.10	-3.42	0.77	3.62	462
	(0.233)							
- Effects from interest payments	-0.003	0.00	0.04	-0.00	0.00	0.00	0.00	462
	(0.002)							
Panel B: Assume 100% constrained in t+1:								
Overall response	-0.021	0.00	5.26	-4.70	-0.18	0.76	4.16	462
	(0.308)							
- Real income effects	-0.114	0.00	5.21	-4.78	-0.15	0.65	4.12	462
	(0.306)							
- Intertemporal substitution effects	-0.024***	0.00	0.06	-0.12	-0.06	0.00	0.02	462
	(0.003)							
- Effects from real credit limit	0.131***	0.00	0.70	-0.04	0.00	0.05	0.39	462
	(0.045)							
- Effects from interest payments	-0.014***	0.00	0.10	0.00	0.00	0.00	0.00	462
	(0.005)							

Notes: This table shows the immediate consumption responses to the hypothetical increase in the Fed's projection of the future federal funds rate at the end of 2023 from 0.1 to 0.5 percent according to the model, which is calibrated using the survey-based changes in expectations. The table focuses on consumption responses of non-hand-to-mouth households with a positive perceived probability of being credit constrained at some point until the end of 2022. We assume effects on expectations to converge to zero at a quarterly rate $\rho = 0.9$ for horizons beyond those measured in the survey. Panel A shows model-based predicted consumption responses if these households never expected to become credit constrained. Panel B shows model-based predicted consumption responses if these households perceived a 100% chance of becoming credit constrained in period t+1 (i.e. one quarter after the survey). In both panels, all of the included households are assumed to react, independently of their self-reported attention to Fed announcements. Each of the three terms of the consumption response (four terms in Panel B) is winsorized at -15 percent and 15 percent. The overall consumption response is the sum of the winsorized individual terms. All statistics are weighted by the respondents' total household spending in 2020. Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

Online Appendix: The Effects Of Forward Guidance: Theory with Measured Expectations [1]

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A Additional tables

Table A.1: Summary statistics and balance check

	ACS	Online Sample							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	2019 Mean	Full Sample Mean	Full Sample Median	Full Sample SD	Change endo-genous Mean	Change no expla-nation Mean	Change exo-genous Mean	Change exog. stocks Mean	p-value (5) = (6) = (7) = (8)
Panel A: Main experiment									
Female	0.51	0.51	1.00	0.50	0.48	0.54	0.51	0.50	0.426
Age	47.78	52.60	60.00	15.23	51.36	52.59	53.95	52.63	0.082
At least bachelor's degree	0.31	0.41	0.00	0.49	0.40	0.40	0.39	0.42	0.876
Log(Household net income)	11.06	11.06	11.13	0.81	11.13	11.03	11.00	11.09	0.239
Northeast	0.17	0.19	0.00	0.39	0.22	0.19	0.19	0.17	0.363
Midwest	0.21	0.28	0.00	0.45	0.24	0.30	0.29	0.28	0.180
South	0.38	0.31	0.00	0.46	0.31	0.30	0.29	0.34	0.460
West	0.24	0.22	0.00	0.41	0.23	0.20	0.23	0.21	0.647
Main earner employed		0.62	1.00	0.48	0.65	0.62	0.59	0.63	0.366
Log(Household liquid wealth)		9.61	9.77	2.85	9.59	9.54	9.67	9.64	0.913
Log(Household credit card debt)		2.14	0.00	3.62	2.16	2.12	2.08	2.19	0.969
Prob. credit constrained 2021-22		15.68	0.00	29.68	16.48	16.25	15.78	14.27	0.656
Observations		1,854	1,854	1,854	490	441	439	484	
Panel B: Robustness experiment									
Female	0.51	0.52	1.00	0.50	0.58	0.44	0.46	0.59	0.071
Age	47.78	51.60	50.00	15.79	50.98	52.56	51.47	51.54	0.927
At least bachelor's degree	0.31	0.31	0.00	0.47	0.33	0.32	0.34	0.26	0.585
Log(Household net income)	11.06	10.77	10.98	1.41	10.84	10.85	10.90	10.92	0.455
Northeast	0.17	0.20	0.00	0.40	0.16	0.21	0.23	0.19	0.603
Midwest	0.21	0.20	0.00	0.40	0.16	0.21	0.19	0.24	0.514
South	0.38	0.40	0.00	0.49	0.45	0.41	0.34	0.43	0.341
West	0.24	0.20	0.00	0.40	0.23	0.17	0.25	0.14	0.169
Main earner employed		0.56	1.00	0.50	0.61	0.54	0.55	0.54	0.707
Log(Household liquid wealth)		9.26	9.77	2.89	9.15	9.22	9.45	9.20	0.881
Log(Household credit card debt)		2.46	0.00	3.69	2.69	2.34	2.20	2.64	0.742
Observations		392	392	392	95	84	113	100	

Notes: This table shows summary statistics for the main experiment (Panel A) and for the robustness experiment (Panel B). The p-value in Column 9 refers to the null hypothesis that the means across the fours arms in Columns 5-8 are equal.

Table A.2: Numbers of respondents in different groups

	Number of respondents			
	Learn $\leq$4 weeks	Learn $>$4 weeks	Learn never	All
HTM at credit limit	101	12	43	156
HTM at zero kink	236	45	60	341
Non-HTM 0% chance constrained	742	42	111	895
Non-HTM $>$ 0% chance constrained	357	67	38	462
All	1,436	166	252	1,854

Notes: This table shows the numbers of respondents in different groups according to hand-to-mouth-status, the perceived probability of being credit constrained at some point until the end of 2022, and the time it typically takes until the respondent learns about Fed announcements.

Table A.3: Robustness experiment: Adjustment of expectations about federal funds rate

	Δ Expected federal funds rate (percentage points)				
	(1) 2021	(2) 2022	(3) 2023	(4) 2026	(5) 2030
Panel A: Pooled					
Mean expectation adjustment	0.064**	0.066*	0.176***	0.022	-0.024
	(0.027)	(0.033)	(0.037)	(0.049)	(0.059)
Panel B: By arm					
Change endogenous (a)	0.103	0.101	0.263**	0.188	0.231*
	(0.091)	(0.112)	(0.103)	(0.123)	(0.135)
Change no explanation (b)	0.032	0.004	0.134***	-0.041	-0.056
	(0.032)	(0.035)	(0.040)	(0.085)	(0.095)
Change exogenous (c)	0.052	0.039	0.092	-0.017	-0.066
	(0.044)	(0.051)	(0.068)	(0.093)	(0.102)
Change exogenous stocks (d)	0.069***	0.115***	0.226***	-0.037	-0.189
	(0.022)	(0.044)	(0.062)	(0.082)	(0.127)
p-value(a=b)	0.461	0.410	0.247	0.126	0.083
p-value(b=c)	0.700	0.572	0.594	0.846	0.943
p-value(a=c)	0.618	0.616	0.168	0.184	0.080
p-value(c=d)	0.732	0.260	0.147	0.871	0.452
R-squared	0.02	0.02	0.08	0.01	0.02
SD expectation adjustment	0.46	0.58	0.63	0.84	1.01
Observations	298	298	298	298	298

Notes: This table shows the effect of the hypothetical increase in the Fed's projection of the future federal funds rate at the end of 2023 from 0.1 to 0.5 percent on respondent's own expectations about the federal funds rate at different horizons. Panel A shows results pooling across the four arms. Panel B shows results separately for each of the four arms providing respondents with different reasons for the change in the Fed's projections. Arm "Change endogenous" attributes the change in the Fed's projections to a change in the Fed's broader economic outlook. Arm "Change no explanation" does not give an explanation for the change in projections. Arm "Change exogenous" attributes the change in the Fed's projections to a change in the composition of the Fed's committee before the next meeting. Arm "Change exogenous stocks" features the same explanation as "Change exogenous" and in addition explains that the stock market drops by 1 percent in response to the Fed's projections. The sample is restricted to non-hand-to-mouth households in the robustness experiment. Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

Table A.4: Reduced-form results among respondents that are attentive to Fed announcements: Adjustment of expectations about federal funds rate

	Δ Expected federal funds rate (percentage points)				
	(1) 2021	(2) 2022	(3) 2023	(4) 2026	(5) 2030
Panel A: Pooled					
Mean expectation adjustment	0.056***	0.078***	0.196***	0.040	0.023
	(0.013)	(0.015)	(0.021)	(0.026)	(0.030)
Panel B: By arm					
Change endogenous (a)	0.032	0.087***	0.158***	0.056	0.067
	(0.028)	(0.030)	(0.035)	(0.050)	(0.057)
Change no explanation (b)	0.024	0.033	0.155***	0.006	0.037
	(0.020)	(0.023)	(0.037)	(0.047)	(0.057)
Change exogenous (c)	0.069***	0.097***	0.234***	0.087*	0.082
	(0.023)	(0.030)	(0.045)	(0.051)	(0.056)
Change exogenous stocks (d)	0.097***	0.092***	0.236***	0.015	-0.083
	(0.030)	(0.035)	(0.047)	(0.056)	(0.066)
p-value(a=b)	0.811	0.155	0.954	0.472	0.706
p-value(b=c)	0.137	0.095	0.174	0.248	0.572
p-value(a=c)	0.300	0.815	0.179	0.668	0.854
p-value(c=d)	0.469	0.916	0.973	0.338	0.057
R-squared	0.02	0.03	0.08	0.00	0.01
SD expectation adjustment	0.43	0.50	0.69	0.86	0.99
Observations	1,099	1,099	1,099	1,099	1,099

Notes: This table shows the effect of the hypothetical increase in the Fed's projection of the future federal funds rate at the end of 2023 from 0.1 to 0.5 percent on respondent's own expectations about the federal funds rate at different horizons. Panel A shows results pooling across the four arms. Panel B shows results separately for each of the four arms providing respondents with different reasons for the change in the Fed's projections. Arm "Change endogenous" attributes the change in the Fed's projections to a change in the Fed's broader economic outlook. Arm "Change no explanation" does not give an explanation for the change in projections. Arm "Change exogenous" attributes the change in the Fed's projections to a change in the composition of the Fed's committee before the next meeting. Arm "Change exogenous stocks" features the same explanation as "Change exogenous" and in addition explains that the stock market drops by 1 percent in response to the Fed's projections. The sample is restricted to non-hand-to-mouth households who report that they typically learn about Fed announcements within four weeks or less. Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

Table A.5: Reduced-form results among respondents that are attentive to Fed announcements: Adjustment of expectations about inflation and nominal income growth

	Δ Expected inflation rate (percentage points)				Δ Expected cumulative income growth (percentage points)		
	(1) 2021	(2) 2022	(3) 2023	(4) 2024-26	(5) 2021	(6) 2022-23	(7) 2024-26
Panel A: Pooled							
Mean expectation adjustment	-0.205***	-0.137***	0.016	-0.084*	-0.012	0.130	-0.087
	(0.026)	(0.031)	(0.040)	(0.043)	(0.190)	(0.196)	(0.222)
Panel B: By arm							
Change endogenous (a)	-0.121**	-0.080	0.070	0.006	0.266	0.423	0.517
	(0.049)	(0.056)	(0.084)	(0.085)	(0.393)	(0.442)	(0.490)
Change no explanation (b)	-0.311***	-0.217***	-0.081	-0.120	-0.632*	-0.688**	-0.742*
	(0.051)	(0.062)	(0.076)	(0.090)	(0.341)	(0.344)	(0.442)
Change exogenous (c)	-0.169***	-0.086	0.027	-0.134	0.577	0.897**	0.261
	(0.050)	(0.062)	(0.083)	(0.086)	(0.415)	(0.393)	(0.461)
Change exogenous stocks (d)	-0.223***	-0.165***	0.041	-0.094	-0.247	-0.102	-0.393
	(0.056)	(0.064)	(0.076)	(0.084)	(0.367)	(0.374)	(0.381)
p-value(a=b)	0.008	0.102	0.182	0.307	0.084	0.048	0.057
p-value(b=c)	0.048	0.137	0.337	0.913	0.025	0.002	0.117
p-value(a=c)	0.497	0.937	0.715	0.245	0.586	0.423	0.704
p-value(c=d)	0.475	0.376	0.901	0.739	0.137	0.066	0.274
R-squared	0.06	0.02	0.00	0.00	0.01	0.01	0.00
SD expectation adjustment	0.86	1.02	1.32	1.43	6.31	6.51	7.37
Observations	1,099	1,099	1,099	1,099	1,099	1,099	1,099

Notes: This table shows the effect of the hypothetical increase in the Fed's projection of the future federal funds rate at the end of 2023 from 0.1 to 0.5 percent on respondent's expectations about inflation and the cumulative growth of nominal household net income compared to 2020 at different horizons. Panel A shows results pooling across the four arms. Panel B shows results separately for each of the four arms providing respondents with different reasons for the change in the Fed's projections. Arm "Change endogenous" attributes the change in the Fed's projections to a change in the Fed's broader economic outlook. Arm "Change no explanation" does not give an explanation for the change in projections. Arm "Change exogenous" attributes the change in the Fed's projections to a change in the composition of the Fed's committee before the next meeting. Arm "Change exogenous stocks" features the same explanation as "Change exogenous" and in addition explains that the stock market drops by 1 percent in response to the Fed's projections. The sample is restricted to non-hand-to -mouth households who report that they typically learn about Fed announcements within four weeks or less. Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

Table A.6: Reduced-form results among respondents that are attentive to Fed announcements: Adjustment of expectations about real income growth

	Δ Expected cumulative real income growth (percentage points)		
	(1) 2021	(2) 2022-23	(3) 2024-26
Panel A: Pooled			
Mean expectation adjustment	0.193	0.463**	0.406
	(0.192)	(0.207)	(0.274)
Panel B: By arm			
Change endogenous (a)	0.387	0.589	0.635
	(0.394)	(0.459)	(0.568)
Change no explanation (b)	-0.322	-0.120	0.107
	(0.349)	(0.367)	(0.580)
Change exogenous (c)	0.746*	1.139***	0.757
	(0.421)	(0.433)	(0.556)
Change exogenous stocks (d)	-0.024	0.265	0.141
	(0.371)	(0.384)	(0.492)
p-value(a=b)	0.178	0.228	0.515
p-value(b=c)	0.051	0.027	0.418
p-value(a=c)	0.534	0.384	0.878
p-value(c=d)	0.170	0.131	0.407
R-squared	0.00	0.01	0.00
SD expectation adjustment	6.38	6.86	9.07
Observations	1,099	1,099	1,099

Notes: This table shows the effect of the hypothetical increase in the Fed's projection of the future federal funds rate at the end of 2023 from 0.1 to 0.5 percent on respondent's expectations about the cumulative growth of real household net income compared to 2020 at different horizons. Expected real income growth is constructed from the respondents' expectations about nominal income growth and about inflation. Panel A shows results pooling across the four arms. Panel B shows results separately for each of the four arms providing respondents with different reasons for the change in the Fed's projections. Arm "Change endogenous" attributes the change in the Fed's projections to a change in the Fed's broader economic outlook. Arm "Change no explanation" does not give an explanation for the change in projections. Arm "Change exogenous" attributes the change in the Fed's projections to a change in the composition of the Fed's committee before the next meeting. Arm "Change exogenous stocks" features the same explanation as "Change exogenous" and in addition explains that the stock market drops by 1 percent in response to the Fed's projections. The sample is restricted to non-hand-to-mouth households who report that they typically learn about Fed announcements within four weeks or less. Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

Table A.7: Model-based results: Predicted consumption response to interest rate announcement among non-hand-to-mouth households with positive perceived chance of credit constraints (corner cases): Only attentive households

	Predicted consumption response (percent)							
	Mean	Median	SD	p10	p25	p75	p90	N
Panel A: Assume 0% ever constrained:								
Overall response	0.314	0.00	4.39	-4.40	-1.30	2.01	5.53	462
	(0.230)							
- Real income effects	1.102***	0.00	5.99	-4.99	-0.68	3.13	10.97	462
	(0.309)							
- Intertemporal substitution effects	-0.786***	0.00	3.75	-6.07	-1.63	0.25	2.73	462
	(0.196)							
- Effects from interest payments	-0.001	0.00	0.03	-0.00	0.00	0.00	0.00	462
	(0.001)							
Panel B: Assume 100% constrained in t+1:								
Overall response	0.117	0.00	4.62	-3.59	0.00	0.42	3.12	462
	(0.276)							
- Real income effects	0.074	0.00	4.58	-3.34	0.00	0.36	1.92	462
	(0.274)							
- Intertemporal substitution effects	-0.016***	0.00	0.05	-0.11	-0.01	0.00	0.01	462
	(0.003)							
- Effects from real credit limit	0.069***	0.00	0.50	-0.02	0.00	0.01	0.20	462
	(0.025)							
- Effects from interest payments	-0.010**	0.00	0.09	0.00	0.00	0.00	0.00	462
	(0.004)							

Notes: This table shows the immediate consumption responses to the hypothetical increase in the Fed's projection of the future federal funds rate at the end of 2023 from 0.1 to 0.5 percent according to the model, which is calibrated using the survey-based changes in expectations. The table focuses on consumption responses of non-hand-to-mouth households with a positive perceived probability of being credit constrained at some point until the end of 2022. We assume effects on expectations to converge to zero at a quarterly rate $\rho = 0.9$ for horizons beyond those measured in the survey. Panel A shows model-based predicted consumption responses if these households never expected to become credit constrained. Panel B shows model-based predicted consumption responses if these households perceived a 100% chance of becoming credit constrained in period t+1 (i.e. one quarter after the survey). In both panels, only those included households who report that they typically learn about Fed announcements within four weeks (77 percent) are assumed to react, while the consumption response is set to zero among those included households that report that it typically takes longer than four weeks or that they typically never hear about Fed announcements (23 percent). Each of the three terms of the consumption response (four terms in Panel B) is winsorized at -15 percent and 15 percent. The overall consumption response is the sum of the winsorized individual terms. All statistics are weighted by the respondents' total household spending in 2020. Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

B Experimental instructions

B.1 Experimental instructions: Main experiment

B.1.1 Attention

The next question is about the following problem. In questionnaires like ours, sometimes there are participants who do not carefully read the questions and just quickly click through the survey. This means that there are a lot of random answers which compromise the results of research studies. **To show that you read our questions carefully, please choose both "Very strongly interested" and "Not at all interested" as your answer in the below question**

Given the above, how interested are you in politics?

- ☐ Very strongly interested
- ☐ Very interested
- ☐ A little bit interested
- ☐ Almost not interested
- ☐ Not at all interested

→

B.1.2 Demographics

In this survey we will ask you various times about things related to your **household**, such as the total income of your household. By household we mean all family members living with you in your main residence, but excluding roommates and renters.

Which of these describes you more accurately?

- ○ Male
- ○ Female

What is your age?

- ○ 18 - 24
- ○ 25 - 34
- ○ 35 - 44
- ○ 45 - 54
- ○ 55 - 64
- ○ 65 or older

In which region do you currently reside?

- ○ Northeast (CT, ME, MA, NH, RI, VT, NJ, NY,PA),
- ○ Midwest (IL, IN, MI, OH, WI, IA, KS, MN, MO, NE, ND, SD)
- ○ South (DE, DC, FL, GA,MD, NC, SC, VA, WV, AL, KY, MS, TN, AR, LA, OK, TX)
- ○ West (AZ, CO, ID, NM, MT, UT,NV, WY, AK, CA, HI, OR, WA)

What is the highest level of education you have completed?

- ○ 12th grade or less
- ○ Graduated high school or equivalent
- ○ Some college, no degree
- ○ Associate degree
- ○ Bachelor's degree
- ○ Post-graduate degree

What was your total household net income in **2020** in US dollars after taxes and deductions?

Note: Your household's total net income includes your household's total income from all sources, including e.g. labor income, financial income and income from transfers, net of taxes.

What was your total household net income in **2020** in US dollars after taxes and deductions?
Note: We would now ask you to enter an exact dollar amount which lies in the bracket specified above.

B.1.3 Definitions

About this study

This study is about your **beliefs about the future development of the US economy, as well as your own economic situation.** Your task will be to report your expectations about the future development of both the US economy and your personal economic situation under different hypothetical scenarios.

On the next page, we will provide you with a brief definition. Please read it carefully!

→

Definition

The **inflation rate** measures how much prices in the economy rise from year to year. It is defined as the yearly growth of the general level of prices of goods and services (Consumer Price Index). For instance, an inflation rate of 2% means that, on average, prices for goods and services rise by 2% over 12 months. That is, a typical bundle of goods and services that costs $1,000 at the beginning of a year costs $1,020 at the end of that year. If the inflation rate is negative, it is referred to as deflation. This means that goods and services become less expensive from one year to the next.

→

The main part of the survey begins when you press on the next button. Please try to **make your responses as accurate as possible**.

It is very important for the success of our research that you answer to the best of your knowledge and read the questions very carefully before answering.

→

The federal funds rate

The **federal funds rate** is the most important interest rate in the economy, and is frequently discussed in the news. The value of the rate influences how “costly” it is for banks to acquire money, thereby influencing interest rates on important financial products, such as savings accounts, consumer loans, mortgages, or loans to firms.

The **Federal Reserve (Fed)** controls the federal funds rate. Besides choosing the current rate, the Fed publishes **projections** of where this interest rate will be in the coming years.

We will now ask you about your own expectations under two different hypothetical scenarios about the Fed's projections on the future federal funds rate.

Currently, the federal funds rate stands at **0.1 percent**. According to the projection by the Fed, the rate will remain at **0.1 percent** until the end of **2023**.

→

B.1.4 Predictions in the baseline scenario

Baseline scenario: Projected federal funds rate stays constant

We now would like to ask you to imagine the following hypothetical scenario.

Please imagine that at the next meeting of the Fed on March 16/17 2021, the Fed announces that the **current** federal funds rate will remain **unchanged at 0.1 percent**.

Moreover, the Fed announces that its projection about the **future** federal funds rate at the **end of 2023** remains **unchanged at 0.1 percent**.

Note: Further, imagine that the Fed's projection of the federal funds rate at the end of 2030 remains **unchanged** at 2.5 percent.

Your predictions

Imagine that on March 18 2021, i.e. **on the day after the Fed meeting**, you learn about the Fed’s announcement. Imagine that we would then ask you about **your own expectations** regarding the federal funds rate, the inflation rate, and your net household income.

Under this hypothetical scenario, what would be **your own expectations** about the **future federal funds rate?**

Note: As an example, for an expected federal funds of 0.1%, please enter 0.1.

Federal funds rate at the end of **2021** (in %):
Federal funds rate at the end of **2022** (in %):
Federal funds rate at the end of **2023** (in %):
Federal funds rate at the end of **2026** (in %):
Federal funds rate at the end of **2030** (in %):

And what would be your expectations about **the future rate of inflation** under the hypothetical scenario if you learned about the Fed's announcement?

Note: As an example, if you think inflation will be 2%, please enter 2.

Reminder: Respond under the assumption that the Fed's projection of the end-2023 federal funds rate remains at 0.1 percent in their meeting on March 17, 2021.

Inflation over the year **2021** (in %):
Inflation over the year **2022** (in %):
Inflation over the year **2023** (in %):
Average annual inflation over the years **2024-2026** (in %):

And what would be your expectations about your **households' future total net income (after taxes and deductions)** under the hypothetical scenario if you learned about the Fed's announcement?

Reminder: Respond under the assumption that the Fed's projection of the end-2023 federal funds rate remains at 0.1 in their meeting on March 17, 2021.

Total household net income in the year **2021**:

Total household net income in the year **2021** (in $):
Note: We would now ask you to enter an exact dollar amount which lies in the bracket specified above.

Average yearly total household net income in the years **2022-2023**:

Average yearly total household net income in the years **2022-2023** (in $):
Note: We would now ask you to enter an exact dollar amount which lies in the bracket specified above.

Average yearly total household net income in the years **2024-2026**:

Average yearly total household net income in the years **2024-2026** (in $):
Note: We would now ask you to enter an exact dollar amount which lies in the bracket specified above.

→

B.1.5 Transition between baseline and rise scenario

Important!

On the next page, you will read a scenario that describes a change in the Fed's projections. We will ask you how the change in the Fed's projections would affect your expectations about the future federal funds rate, the US inflation rate and your household's income.

→

B.1.6 Between-subject variation in sources of change in the Fed Projection

Exogenous

Hypothetical scenario: Federal funds rate projection for 2023 increases

We will now ask you to consider the following alternative hypothetical scenario.

Please imagine that at their next meeting on March 16/17 2021, the Fed announces that the **current** federal funds rate will remain **unchanged at 0.1 percent**.

However, the Fed announces that its projection about the **future** federal funds rate at the **end of 2023 increases from 0.1 percent to 0.5 percent**.

The Fed explains that the change in the Fed's projection about the future federal funds rate occurred because the **composition** of the committee **changed** before the meeting on March 16-17 2021. In particular, some more "dovish" members, whose terms ended, left the Fed, and some more "hawkish" members joined the Fed. The change in the projection is **not** due to a change in the Fed's outlook on the broader development of the economy.

Note: Further, imagine that the Fed's projection of the federal funds rate at the end of 2030 remains **unchanged** at 2.5 percent.

Exogenous with stocks

Hypothetical scenario: Federal funds rate projection for 2023 increases

We will now ask you to consider the following alternative hypothetical scenario.

Please imagine that at their next meeting on March 16/17 2021, the Fed announces that the **current** federal funds rate will remain **unchanged at 0.1 percent**.

However, the Fed announces that its projection about the future federal funds rate at the end of 2023 increases from 0.1 percent to 0.5 percent.

The Fed explains that the change in the Fed's projection about the future federal funds rate occurred because the **composition** of the committee **changed** before the meeting on March 16-17 2021. In particular, some more "dovish" members, whose terms ended, left the Fed, and some more "hawkish" members joined the Fed. The change in the projection is **not** due to a change in the Fed's outlook on the broader development of the economy.

In response to the Fed annoucement, the **S&P 500 stock market index falls** by 1 percent.

Note: Further, imagine that the Fed's projection of the federal funds rate at the end of 2030 remains **unchanged** at 2.5 percent.

Endogenous

Hypothetical scenario: Federal funds rate projection for 2023 increases

We will now ask you to consider the following alternative hypothetical scenario. Please imagine that at their next meeting on March 16/17 2021, the Fed announces that the **current** federal funds rate will remain **unchanged at 0.1 percent**.

However, the Fed announces that its projection about the **future** federal funds rate at the **end of 2023 increases from 0.1 percent to 0.5 percent**.

The Fed explains that the change in the Fed's projection about the future federal funds rate is due to **a change** in the Fed's outlook on **the broader development of the economy**.

Note: Further, imagine that the Fed's projection of the federal funds rate at the end of 2030 remains **unchanged** at 2.5 percent.

No reason

Hypothetical scenario: Federal funds rate projection for 2023 increases

We will now ask you to consider the following alternative hypothetical scenario. Please imagine that at their next meeting on March 16/17 2021, the Fed announces that the **current** federal funds rate will remain **unchanged at 0.1 percent**.

However, the Fed announces that its projection about the **future** federal funds rate at the **end of 2023 increases from 0.1 percent to 0.5 percent**.

Note: Further, imagine that the Fed's projection of the federal funds rate at the end of 2030 remains **unchanged** at 2.5 percent.

B.1.7 Main predictions rise scenario

Your predictions

Imagine that on March 18, i.e. **on the day after the Fed meeting**, you learn about the Fed's announcement and the response of the S&P 500 stock market index. Imagine that we would then ask you about **your own expectations** regarding the federal funds rate, the inflation rate and your net household income.

Under the alternative hypothetical scenario (the Fed's projection of the end-2023 federal funds rate increases from 0.1 to 0.5 percent), what would be **your own expectations** about the **future federal funds rate?**

Federal funds rate at the end of **2021** (in %):
Federal funds rate at the end of **2022** (in %):
Federal funds rate at the end of **2023** (in %):
Federal funds rate at the end of **2026** (in %):
Federal funds rate at the end of **2030** (in %):

And what would be your expectations about **the future rate of inflation** under the alternative hypothetical scenario if you learned about the Fed's announcement?
Reminder: Respond under the assumption that the Fed's projection of the end-2023 federal funds rate increases from 0.1 to 0.5 percent in their meeting on March 17, 2021.

Inflation over the year **2021** (in %):
Inflation over the year **2022** (in %):
Inflation over the year **2023** (in %):
Average annual inflation over the years **2024-2026** (in %):

And what would be your expectations about your **households' future total net income (after taxes and deductions)** under the alternative hypothetical scenario if you learned about the Fed's announcement?
Reminder: Respond under the assumption that the Fed's projection of the end-2023 federal funds rate increases from 0.1 to 0.5 percent in their meeting on March 17, 2021.

Household net income in the year **2021**:

Household net income in the year **2021** (in $):
Note: We would now ask you to enter an exact dollar amount which lies in the bracket specified above.

Average yearly household net income in the years **2022-2023**:

Average yearly household net income in the years **2022-2023**: (in $):
Note: We would now ask you to enter an exact dollar amount which lies in the bracket specified above.

Average household net income in the years **2024-2026**:

Average yearly household net income in the years **2024-2026** (in $):
Note: We would now ask you to enter an exact dollar amount which lies in the bracket specified above.

→

B.1.8 Inattention to Fed annoucements

Announcements by the Fed

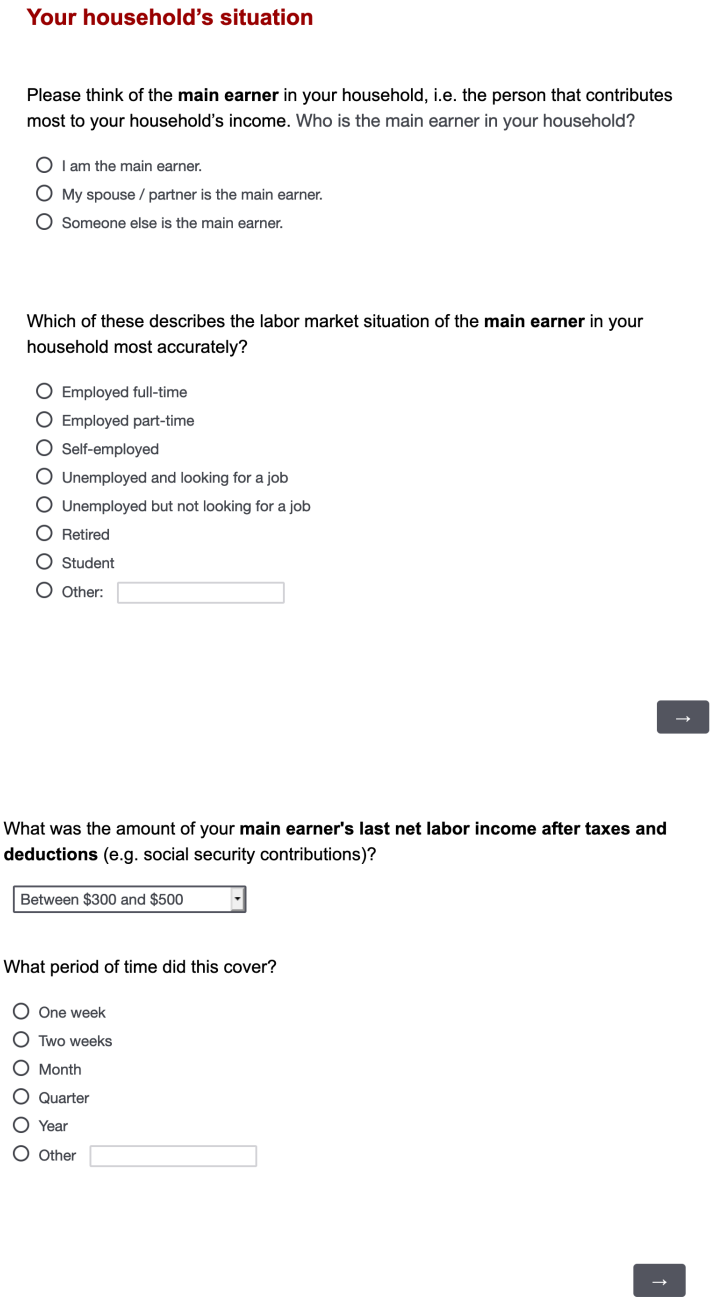
Now please think of **announcements by the Federal Reserve in general**. When the Fed makes an announcement, how long would you say does it typically take until you hear of such an announcement?

- ○ Less than seven days
- ○ Seven to 14 days
- ○ Two to four weeks
- ● One to three months
- ○ Four to six months
- ○ Longer than six months
- ○ Typically I would never hear of such an announcement.

Now please think of **movements of the stock market in response to announcements by the Federal Reserve**. When the stock market moves in response to a Fed announcement, how long would you say does it typically take until you hear of such a movement?

- ○ Less than seven days
- ○ Seven to 14 days
- ○ Two to four weeks
- ○ One to three months
- ○ Four to six months
- ○ Longer than six months
- ○ Typically I would never hear of such a movement.

B.1.9 Hand-to-mouth module



Your household's situation

Please think of the **main earner** in your household, i.e. the person that contributes most to your household's income. Who is the main earner in your household?

- ○ I am the main earner.
- ○ My spouse / partner is the main earner.
- ○ Someone else is the main earner.

Which of these describes the labor market situation of the **main earner** in your household most accurately?

- ○ Employed full-time
- ○ Employed part-time
- ○ Self-employed
- ○ Unemployed and looking for a job
- ○ Unemployed but not looking for a job
- ○ Retired
- ○ Student
- ○ Other:

→

What was the amount of your **main earner's last net labor income after taxes and deductions** (e.g. social security contributions)?

Between $300 and $500

What period of time did this cover?

- ○ One week
- ○ Two weeks
- ○ Month
- ○ Quarter
- ○ Year
- ○ Other

→

What were your household's holdings of **liquid wealth** on the **last days before** the **main earner** in your household received his or her **last income**? By liquid wealth we mean **cash, bank accounts or other easily accessible savings**, such as mutual funds, stocks and bonds that can be sold within a few days.

→

Did your household **pay** all its credit card bills in full **at the end of the last billing cycle**? That is, did your household start the new billing cycle with a **zero credit card balance** on all cards?

- ○ Yes
- ○ No

→

If you think of all credit cards your household owns, what is the **maximum combined amount your household could borrow** on credit cards (in $)?

For instance, let's say your household owns three credit cards. Then, the maximum combined amount your household could borrow on credit cards is the sum of the three credit limits.

→

What would you say is the probability that --- at any point in the next years -- your household will be in a situation where your household would like to **borrow more money** on its credit cards, but would be **unable** to do so (i.e. to be borrowing constrained)?

Probability of being borrowing constrained in **2021**:

Probability of being borrowing constrained in **2021** or **2022**:

Probability of being borrowing constrained at any point in time **until the end 2026**:

→

We now would like you to think about your households' **spending behavior in recent years**. Which of the following four types **describes your household most accurately**?

- ○ My household usually spends its entire income, and does not put aside any money to save or to pay back debt, but also does not increase debt through new borrowing.
- ○ My household usually does not spend its entire income, but puts aside some money to save or to pay back debt.
- ○ My household usually spends more than its income by increasing its debt through new borrowing.
- ○ My household usually spends more than its income by reducing its savings.

In case of an unexpected decline in income or increase in expenses, does your household have at least two months of income available in cash, bank accounts, or easily accessible funds?

- ○ Yes
- ○ No

→

B.1.10 Additional characteristics

Additional characteristics

In general, how willing or unwilling are you to **take risks**, using a scale from 0 to 10, where 0 means you are “completely unwilling to take risks” and 10 means you are “very willing to take risks.” You can also use any number between 0 and 10 to indicate where you fall on the scale.

0 - completely unwilling to take risks	1	2	3	4	5	6	7	8	9	10 - very willing to take risks
○	○	○	○	○	○	○	○	○	○	○

In comparison to others, are you a person who is generally willing to **give up something today** in order to **benefit from that in the future** or are you not willing to do so? Please use a scale from 0 to 10, where a 0 means you are “completely unwilling to give up something today” and a 10 means you are “very willing to give up something today”. You can also use any number between 0 and 10 to indicate where you fall on the scale.

0 - completely unwilling to give up something today	1	2	3	4	5	6	7	8	9	10 - very willing to give up something today
○	○	○	○	○	○	○	○	○	○	○

To what extent do you agree with the following statement?

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
A recession would adversely affect the financial situation of my household.	○	○	○	○	○	○	○

→

Next we would like to ask you three questions to see how people use numbers in everyday life. Please answer the following questions by filling in the blank.

Let's say you have $200 in a savings account. The account earns ten percent interest per year. Interest accrues at each anniversary of the account. If you never withdraw money or interest payments, how much will you have in the account at the end of two years (in $)?

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After one year, how much would you be able to buy with the money in this account?

- ○ More than today
- ○ Exactly the same
- ○ Less than today

Please tell me whether this statement is true or false: Buying a single company's stock usually provides a safer return than a stock mutual fund.

- ○ True
- ○ False

What was your household's **savings rate** in 2020 (in percent)?

Note: This refers to the fraction of your household's net income that your household put aside to save.
For instance, if your household spent 95 percent of its net income and saved 5 percent of its net income, then your household's savings rate was 5 percent.
If your household spent 10 percent more than its net income, then your household's savings rate was -10 percent.

→

Next we would like to ask you **which member** of your household has the **best overview** of the household's finances. By that we mean things such as income, savings and checking accounts, pensions, real estate. Who among the household members living in your household **knows the most** about the household's finances?

- ○ I know most about the household's finances.
- ○ My spouse knows most about the household's finances.
- ○ Someone else.

Does your household own or rent its current main residence?

- ○ Own
- ○ Rent
- ○ Other

What do you estimate is the current value of your household's total holdings of **stocks in publicly held corporations and stock mutual funds, including holdings in retirement accounts?**

- ○ Less than $1,000
- ○ Between $1,000 and $3,000
- ○ Between $3,000 and $5,000
- ○ Between $5,000 and $10,000
- ○ Between $10,000 and $15,000
- ○ Between $15,000 and $20,000
- ○ Between $20,000 and $30,000
- ○ Between $30,000 and $40,000
- ○ Between $40,000 and $50,000
- ○ Between $50,000 and $75,000
- ○ Between $75,000 and $100,000
- ○ Between $100,000 and $150,000
- ○ Between $150,000 and $200,000
- ○ Between $200,000 and $300,000
- ○ Between $300,000 and $500,000
- ○ Between $500,000 and $1,000,000
- ○ Between $1,000,000 and $2,000,000
- ○ More than $2,000,000

How many people usually live in your current primary residence, including yourself and those who are temporarily away, but excluding non-relatives like roommates or renters?

What was your household's total net income in **2019** in US dollars after taxes and deductions?

What was your household's total net income in **2019** in US dollars after taxes and deductions?
Note: We would now ask you to enter an exact dollar amount which lies in the bracket specified above.

→

We will now ask you some questions on how you are personally affected by the coronavirus pandemic.

What influence does the coronavirus crisis exert on the **economic situation** of your household?

- ○ Very negative influence
- ○ Negative influence
- ○ No influence
- ○ Positive influence
- ○ Very positive influence

Do you worry about your **health** or the health of other household members because of the coronvirus crisis?

- ○ No worries at all
- ○ Little worries
- ○ Moderate worries
- ○ Big worries
- ○ Very big worries

→

B.2 Experimental instructions: Robustness experiment

B.2.1 Predictions in the baseline scenario

Baseline scenario: Projected federal funds rate stays constant

We now would like to ask you to imagine the following hypothetical scenario.

Please imagine that at the next meeting of the Fed on March 16/17 2021, the Fed announces that the **current** federal funds rate will remain **unchanged at 0.1 percent**.

Moreover, the Fed announces that its projection about the **future** federal funds rate at the **end of 2023** remains **unchanged at 0.1 percent**.

Note: Further, imagine that the Fed's projection of the federal funds rate at the end of 2030 remains **unchanged** at 2.5 percent.

Your predictions

Imagine that on March 18 2021, i.e. **on the day after the Fed meeting**, you learn about the Fed's announcement. Imagine that we would then ask you about **your own expectations** regarding the federal funds rate, unemployment rate, your borrowing and the value of your residence.

Under this hypothetical scenario, what would be **your own expectations** about the **future federal funds rate?**

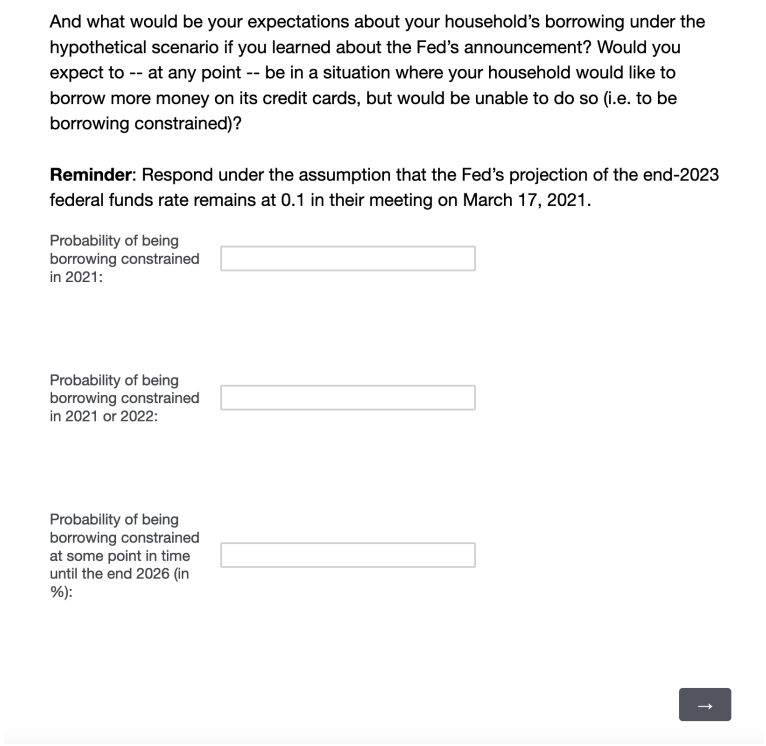
Note: As an example, for an expected federal funds of 0.1%, please enter 0.1.

Federal funds rate at the end of **2021** (in %):
Federal funds rate at the end of **2022** (in %):
Federal funds rate at the end of **2023** (in %):
Federal funds rate at the end of **2026** (in %):
Federal funds rate at the end of **2030** (in %):

Please think of your household's current main residence (which you may own or rent).

What would be your expectations about the **value** of this residence in the year **2023** under the hypothetical scenario if you learned about the Fed's announcement?
Reminder: Respond under the assumption that the Fed's projection of the end-2023 federal funds rate remaints at 0.1 in their meeting on March 17, 2021.

What would be your expectations about the **value** of this residence in the year **2023** under the hypothetical scenario if you learned about the Fed's announcement?
Note: We would now ask you to enter an exact dollar amount which lies in the bracket specified above.



B.2.2 Transition between baseline and rise scenario

Important!

On the next page, you will read a scenario that describes a change in the Fed's projections. We will ask you how the change in the Fed's projections would affect your expectations about the future federal funds rate, the value of your residence and your borrowing.

B.2.3 Between-subject variation in sources of change in the Fed Projection

Exogenous

Hypothetical scenario: Federal funds rate projection for 2023 increases

We will now ask you to consider the following alternative hypothetical scenario.

Please imagine that at their next meeting on March 16/17 2021, the Fed announces that the **current** federal funds rate will remain **unchanged at 0.1 percent**.

However, the Fed announces that its projection about the **future** federal funds rate at the **end of 2023 increases from 0.1 percent to 0.5 percent**.

The Fed explains that the change in the Fed's projection about the future federal funds rate occurred because the **composition** of the committee **changed** before the meeting on March 16-17 2021. In particular, some more "dovish" members, whose terms ended, left the Fed, and some more "hawkish" members joined the Fed. The change in the projection is **not** due to a change in the Fed's outlook on the broader development of the economy.

Note: Further, imagine that the Fed's projection of the federal funds rate at the end of 2030 remains **unchanged** at 2.5 percent.

Exogenous with stocks

Hypothetical scenario: Federal funds rate projection for 2023 increases

We will now ask you to consider the following alternative hypothetical scenario.

Please imagine that at their next meeting on March 16/17 2021, the Fed announces that the **current** federal funds rate will remain **unchanged at 0.1 percent**.

However, the Fed announces that its projection about the future federal funds rate at the end of 2023 increases from 0.1 percent to 0.5 percent.

The Fed explains that the change in the Fed's projection about the future federal funds rate occurred because the **composition** of the committee **changed** before the meeting on March 16-17 2021. In particular, some more "dovish" members, whose terms ended, left the Fed, and some more "hawkish" members joined the Fed. The change in the projection is **not** due to a change in the Fed's outlook on the broader development of the economy.

In response to the Fed annoucement, the **S&P 500 stock market index falls** by 1 percent.

Note: Further, imagine that the Fed's projection of the federal funds rate at the end of 2030 remains **unchanged** at 2.5 percent.

Endogenous

Hypothetical scenario: Federal funds rate projection for 2023 increases

We will now ask you to consider the following alternative hypothetical scenario. Please imagine that at their next meeting on March 16/17 2021, the Fed announces that the **current** federal funds rate will remain **unchanged at 0.1 percent**.

However, the Fed announces that its projection about the **future** federal funds rate at the **end of 2023 increases from 0.1 percent to 0.5 percent**.

The Fed explains that the change in the Fed's projection about the future federal funds rate is due to **a change** in the Fed's outlook on **the broader development of the economy**.

Note: Further, imagine that the Fed's projection of the federal funds rate at the end of 2030 remains **unchanged** at 2.5 percent.

No explanation

Hypothetical scenario: Federal funds rate projection for 2023 increases

We will now ask you to consider the following alternative hypothetical scenario. Please imagine that at their next meeting on March 16/17 2021, the Fed announces that the **current** federal funds rate will remain **unchanged at 0.1 percent**.

However, the Fed announces that its projection about the **future** federal funds rate at the **end of 2023 increases from 0.1 percent to 0.5 percent**.

Note: Further, imagine that the Fed's projection of the federal funds rate at the end of 2030 remains **unchanged** at 2.5 percent.

B.2.4 Predictions in the rise scenario

Your predictions

Imagine that on March 18, i.e. **on the day after the Fed meeting**, you learn about the Fed's announcement. Imagine that we would then ask you about **your own expectations** regarding the federal funds rate, your borrowing and the value of your residence.

Under the alternative hypothetical scenario (the Fed's projection of the end-2023 federal funds rate increases from 0.1 to 0.5 percent), what would be **your own expectations** about the **future federal funds rate?**

Federal funds rate at the end of **2021** (in %):
Federal funds rate at the end of **2022** (in %):
Federal funds rate at the end of **2023** (in %):
Federal funds rate at the end of **2026** (in %):
Federal funds rate at the end of **2030** (in %):

Please think of your household's current main residence (which you may own or rent).

What would be your expectations about the **value** of this residence in the year **2023** under the alternative hypothetical scenario if you learned about the Fed's announcement?

Reminder: Respond under the assumption that the Fed's projection of the end-2023 federal funds rate increases from 0.1 to 0.5 percent in their meeting on March 17, 2021.

What would be your expectations about the **value** of this residence in the year **2023** under the alternative hypothetical scenario if you learned about the Fed's announcement?

Note: We would now ask you to enter an exact dollar amount which lies in the bracket specified above.

And what would be your expectations about your household's borrowing under the hypothetical scenario if you learned about the Fed's announcement? Would you expect to -- at any point -- be in a situation where your household would like to borrow more money on its credit cards, but would be unable to do so (i.e. to be borrowing constrained)?

Reminder: Respond under the assumption that the Fed's projection of the end-2023 federal funds rate increases from 0.1 to 0.5 percent in their meeting on March 17, 2021.

Probability of being borrowing constrained in 2021:

Probability of being borrowing constrained in 2021 or 2022:

Probability of being borrowing constrained at some point in time until the end 2026 (in %):

→