Unit Cost Expectations and Uncertainty: Firms' Perspectives on Inflation*

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November 3, 2022

Abstract

We propose a novel survey-based measure of nominal marginal cost expectations held by business decision makers to track building inflationary pressures and augment the existing set of inflation expectations data policymakers frequently monitor. Unlike other surveys of firms or households that elicit "aggregate" expectations, we focus on idiosyncratic costs that firms are well-aware of, plan for, and matter for price setting. We document five key findings. First, once aggregated, firms' unit cost realizations closely comove with U.S. inflation statistics. Second, in aggregate, firms' unit cost expectations significantly outperform households' inflation expectations and are at least as accurate as the expectations of professional forecasters in out-of-sample forecasting exercises. Third, utilizing a novel, flexible technique to parametrically estimate firms' unit cost uncertainty, we find that up until early 2020, the evolution of firms' views was similar to other survey and market-based measures of inflation uncertainty. Fourth, utilizing special questions, we find evidence that information treatments about aggregate inflation and policymakers' forecasts do little to alter firms' unit cost expectations. And, lastly, we show that unit costs, at the firm level, are an important determinant of their own price setting behavior.

JEL Classification: E6, E31, E52, L2

Keywords: Inflation Expectations, Probability Distributions, Bimodality, Randomized Controlled Trials, Uncertainty, Unit Cost Expectations

*This draft is substantially revised from the last draft of the working paper. Nicholas Parker participated in past drafts and we thank him for his contribution. A special thanks to Brian Prescott and Antar Diallo for providing excellent research assistance. We thank the Federal Reserve Bank of Atlanta for its ongoing support of the Economic Survey Research Center (ESRC) and the Business Inflation Expectations (BIE) Survey. We remain heavily indebted to Mike Bryan for founding the BIE. We thank Jose Maria Barrero (discussant), Carola Binder (discussant), Oli Coibion (discussant), Ewa Stanisawska (discussant), Bernie Andrade, Nick Bloom, Wojtek Charemza, Jon Willis, and participants at the Philadelphia Fed Conference on "Real-Time Data Analysis, Methods, and Applications," 21st IWH-CIREQ-GW Macroeconometric Workshop, 23rd Federal Forecasters Conference, ESCoE Conference on Economic Measurement, 41st International Symposium on Forecasting, IAAE Conference, CEBRA Conference, 35th CIRET Conference, ICEA Conference on Inflation, 49th OeNB Conference on "The Return of Inflation," Cleveland Fed/ECB Conference on "Inflation: Drivers and Dynamics," Stanford Workshop on "The Macroeconomics of Uncertainty and Volatility," and seminars at Federal Reserve Board, Penn State University, George Washington University, Renmin University of China, and University College Dublin for helpful comments. Any opinions and conclusions expressed herein are those of the authors and do not necessarily represent the views of the Federal Reserve Bank of Atlanta. All results have been reviewed to ensure that no confidential information was disclosed.

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"*Price stability is that state in which expected changes in the general price level do not effectively alter business or household decisions.*"
–Federal Reserve Chairman Alan Greenspan, July 1996, FOMC Meeting[1]

1 Introduction

Inflation expectations play a central role in many macroeconomic models. For monetary policymakers, monitoring and understanding the public's inflation expectations are crucial to achieving their policy goals. However, much of the literature on survey measures of inflation expectations reveals that the public has trouble holding well-formed expectations that conform to economists' notions of aggregate inflation. For households, expectations suffer from demographic differences (Bryan and Venkatu, 2001), are persistently biased relative to actual inflation (Thomas, 1999), are dispersed (Mankiw et al., 2004), reflect personal expenditure bundles (Cavallo et al., 2017) or salient price changes (D'Acunto et al., 2021), and contain respondents that may not fully comprehend the question at hand (Bruine de Bruin et al., 2010). In eliciting quantitative aggregate inflation expectations from firms, Coibion et al. (2018) and Candia et al. (2021) find many of these issues are present among business decision makers as well. In short, the existing literature points toward the existence of informational or processing impediments in the aggregate inflation expectations of the public, especially in the U.S. These impediments cast doubt on the ability for monetary policymakers to fully trust these expectations. As former Federal Reserve Chairman Alan Greenspan's quote implies, during (or following) times of low, stable inflation, inattention may be a feature of price stability. Unfortunately, that also implies tracking survey measures of aggregate inflation expectations in a stable inflation environment is an exercise fraught with many challenges and suggests alternative approaches to eliciting forward-looking information on costs and price growth that both matter for respondents and connect up to the concept of aggregate inflation that policymakers care about can be particularly fruitful.

In this paper, we explore an alternative approach by eliciting from business decision-makers their own-firm unit cost expectations and then aggregating these responses up. We utilize the Federal Reserve Bank of Atlanta's Business Inflation Expectations (BIE) Survey, which has been continuously collecting subjective probability distributions over own-firm future unit costs from a panel of business executives (CFOs, CEOs, and business owners) monthly since October 2011. The BIE is unique across several dimensions, choosing to focus on firms' own anticipated unit costs rather than an aggregate inflation expectation to gauge the expectations of business decision makers that matter for their price-setting behavior. In addition to its unique focus, the BIE elicits firm-level expectations in a probabilistic format.

We forward the notion popularized by Mackowiak and Wiederholt (2009) and Coibion et al.

[1] https://www.federalreserve.gov/monetarypolicy/files/FOMC19960703meeting.pdf

(2018) that firms pay much more attention in all states of the world (i.e. high and low inflation environments) to their own, potentially idiosyncratic, business conditions. That focus on own-firm (or own-household) conditions implies a degree of inattention toward aggregates that creates challenges for interpreting measures of aggregate inflation expectations across both high and low-inflation environments. Our approach offers a unique solution to inattention to aggregate conditions, one we show is highly connected to aggregate inflation statistics that monetary policymakers care about. We demonstrate the usefulness of this bottom-up approach to eliciting expectations regarding the nominal trajectory of the economy in comparison to current well-known survey measures of inflation expectations. Unlike survey measures of aggregate inflation expectations elicited from firms (Coibion et al., 2018) or households (Thomas, 1999), firms' unit cost expectations are tightly correlated with the inflation expectations of professionals and can be used to forecast the evolution of aggregate U.S. inflation statistics.

In addition to eliciting expectations of own-firm unit cost expectations, we also gather information about own-firm unit cost growth over the past year. Both unit cost realizations and expectations differ significantly across industry in means, volatility, and time-series behavior. However, once aggregated, firms' unit cost realizations covary strongly with official U.S. inflation statistics (i.e. CPI, PCE price index, and GDP deflator). Our interpretation of this finding is two-fold. First, much like Altig et al. (2022) it demonstrates the value of aggregating own-firm quantities to make inference about the aggregate economy. Second, it provides further support for "unit costs" as a concept that is intimately related to nominal price pressures in the economy.

In out-of-sample forecasting exercises, we find that businesses' unit cost expectations significantly outperform the aggregate inflation expectations of households and are roughly as accurate as the expectations of professional forecasters. Also, the timeseries evolution of unit cost expectations tends to co-move strongly with the inflation expectations of professional forecasters. Firms' unit cost expectations are essentially unrelated with households' inflation expectations at least in low, stable inflation environments.

We elicit unit cost expectations in a probabilistic format, following Manski (2004), and utilize a novel, flexible technique to parametrically estimate a given firm's unit cost uncertainty. We adopt the bimodal asymmetric power normal (BAPN) distribution proposed by Bolfarine et al. (2018) that allows us simultaneously to handle open intervals at the end points and instances of bimodality (respondents assigning positive probabilities to non-adjacent bins). Utilizing the BAPN allows us to calculate the variance, hence the unit cost uncertainty, held by each firm in our panel at successive point in time. Aggregating across firms in each month yields a measure of firms' unit cost uncertainty. We compare firms' unit cost uncertainty to other survey and market-based measures of aggregate inflation uncertainty and find that up until early 2020 (the onset of the pandemic), all the measures we considered followed a similar (declining) evolution over the prior decade. Since the onset of the pandemic, however, firms' unit cost uncertainty has performed differently than other

measures.

Through unique randomized controlled trials posed to respondents in special questions, we find evidence that information treatments about aggregate inflation and policymakers' forecasts do little to alter firms' unit cost expectations or uncertainty. In separate experiments, spaced exactly one year apart, we provide firms with information on the projections (first-moment) and attendant uncertainty (second-moment) from the FOMC's Summary of Economic Projections.

Firms report that unit costs matter more than aggregate inflation or the Consumer Price Index (CPI) for pricing and business decisions, even during the highest, broadest-based inflationary environment the U.S. has witnessed since the early 1980s. Firm-level panel data are consistent with that notion. We find that unit cost realizations and expectations are related to realized and expected price changes. Firms' forecast error over unit costs is close to zero, on average. And, firms that operate in highly cyclical or volatile cost environments tend to be more uncertain ex ante and have larger absolute forecast errors, ex post.

One clear implication from our results is that even when firms are inattentive to aggregate conditions, eliciting firm-specific (idiosyncratic) information related to the inflation process and aggregating across firms provides useful insight about the inflation process. The theoretical and empirical literature on rational inattention and information rigidities such as Sims (2003), Woodford (2003), Mackowiak and Wiederholt (2009), Kumar et al. (2015), Bachmann et al. (2015) and Afrouzi (2020) suggest the aggregate inflation expectations of agents in the economy (firms in this case) are not well-formed or meaningfully connected to their decisions. Rational inattention appears to be a feature of low, stable inflation environments like the U.S. has enjoyed from the mid-1990s until very recently. Mackowiak and Wiederholt (2009), in particular, develop a model where firms face a trade-off between paying attention to firm-specific or aggregate conditions and, in calibrating their model of rational inattention to micro pricing data, find evidence that prices react much more swiftly and forcefully to idiosyncratic shocks. Our findings can be seen as supporting their theoretical framework. Particularly relevant to our work is a recent paper by Chen et al. (2021). They find information rigidities are much more prevalent in Japanese firms' forecasts of macro variables than their own-firm unit costs. Bachmann et al. (2015), using the University of Michigan Survey of Consumers, note that idiosyncratic determinants of household spending decisions matter for economic decision making but, aggregate inflation expectations are either "reported truthfully, but do not matter for spending decisions, or they are reported inaccurately, because there are unimportant to households."

Indeed, studies like Coibion et al. (2018) on New Zealand firms or Candia et al. (2021) on a panel of U.S. CEO's, document the pervasiveness of aggregate inflation inattention in surveys of firms. Cavallo et al. (2017), through a series of survey experiments investigating rational inattention among households, suggest that if central banks wanted to affect household expectations, they should disseminate information about the price changes of specific products salient in the minds

of households. And, D'Acunto et al. (2021) show a clear, strong relationship between consumers' grocery store expenditures and their individual expectations for aggregate inflation.

As highlighted above, the literature on survey-based measures of aggregate inflation expectations builds a strong case that inattention to the macroeconomic environment or the primacy of salient relative prices create interpretation challenges that make these measures less useful to policymakers and economists. One potential solution to this problem put forth by Coibion et al. (2020a) is to lower the cost of information on inflation by improving central bank communication. Our results suggest another alternative. Survey firms on economic quantities that they care about and are connected to the aggregate phenomena that central bankers endeavor to monitor. Our work can be seen as the first firm-level survey to attempt to provide such information despite the challenges of inattention to aggregate inflation or official price statistics.

Interesting work out of Cleveland Fed, detailed by Hajdini et al. (2022), follows our approach to eliciting useful, respondent-specific information that connects up to inflation on the household side by first eliciting expectations about anticipated price changes of own-household consumption baskets and then asking households what increase in nominal income they need to keep their standard of living constant. This *indirect* measure of consumer inflation expectations, which has only existed since February 2021, covaries meaningfully with local-area CPI inflation.

Eliciting own-firm quantities to make inference about the aggregate economy or overall business activity is the direction that many firm-level studies of agent perceptions and expectations are heading. For example, Bachmann et al. (2021) and Altig et al. (2022) elicit business expectations and uncertainty on own-firm quantities (i.e. sales revenue and employment growth) to make inferences for the aggregate economy. This is among the broader set literature that uses firm-level survey to study properties of agent perceptions and expectations. Notable examples also include Enders et al. (2019), Ma et al. (2020), Barrero (2022), Chen et al. (2021) and Fiori and Scoccianti (2021).

Our paper also contributes to the growing literature that uses probability forecasts to elicit agent perceptions and expectations. This literature is related to density forecasts made by professional forecasters in the surveys conducted by the Philadelphia Fed and European Central Bank; see, e.g. Engelberg et al. (2009) and Rich and Tracy (2010). New York Fed's Survey of Consumer Expectations adopts a similar methodology in eliciting a household's distribution of inflation beliefs and Armantier et al. (2013) provide a comprehensive review of this initiative. Our density forecasts take a similar form by assigning probabilities to pre-specified bins as is the case for professional forecasters and households. To our knowledge, the BIE survey is the first monthly survey of businesses in the United States that elicits probabilistic expectations.

The rest of the paper proceeds as follows. Section 2 describes the Atlanta Fed's Business Inflation Expectations Survey and motivates the usage of unit cost expectations to glean information about future aggregate inflation. Section 3 describes our approach to parametric estimation of firm-

level unit cost beliefs and their associated uncertainty using the bimodal asymmetric power normal distribution in fitting probability forecasts. Section 4 compares aggregated unit cost expectations to well-known surveys of aggregate expectations and measures of inflation uncertainty. In this section we run simple out-of-sample forecasting exercises relative to an ARMA(1,1) benchmark for a variety of aggregate inflation statistics. We also provide a short overview of the dynamics of our measure relative to other survey measures of inflation expectations during the COVID-19 pandemic. Section 5 further motivates the use of unit cost as a relevant variable for firm-level pricing decisions and includes results from randomized controlled trials that provide information treatments about aggregate inflation and policymakers' forecasts. Section 6 concludes. Additional tables and figures are relegated to an online appendix.

2 Eliciting Unit Cost Expectations

2.1 The Business Inflation Expectations Survey

For this study, we utilize the Atlanta Fed's Business Inflation Expectations (BIE) Survey. The BIE is an online panel survey of roughly 500 CFOs, CEOs, and business owners of firms headquartered within the 6th Federal Reserve District in the southeastern United States.[2] The BIE has fielded monthly since October 2011. For this paper, we use data from October 2011 through August 2022, a total of 131 successive monthly waves (just over 1 full decade worth of data). Nearly 75 percent of the panel consists of C-suite executives and business owners; see Figure A.1. Another roughly 20 percent of respondents carry titles like "Controller", "Director of Finance", and "Director of Forecasting". Given the forward-looking probabilistic nature of the BIE's main question of interest, it is important to reach decision makers within a firm engaged in strategic operations and planning for the future of the firm.

Panel coverage includes firms in every major industry in the private nonfarm sector and a full range of firm sizes (provided that the firm is an employer). The Atlanta Fed engages in a purposive sampling methodology in finding and recruiting new panel members, oversampling firms with 100 employees or more and from cyclically-sensitive industries (manufacturing, construction, retail, etc.), yet still attempting to maintain an industry and size composition that is broadly reflective of the national economy at the two-digit North American Industry Classification System (NAICS) level.

Table 1 reports the industry and size characteristics of the BIE survey panel. Relative to the physical count of establishments in the U.S. – according to the Census Bureau's Statistics of U.S. Businesses – the BIE panel is underweighting small firms.[3] Yet, despite their large share of

[2]Specifically, the 6th Federal Reserve District's footprint consists of Alabama, Florida, and Georgia, the eastern two-thirds of Tennessee, 38 parishes of southern Louisiana, and 43 counties of southern Mississippi.

[3]With the exception of the Census Bureau, practical probability sampling of firms in the United States is largely

establishments, small firms account for roughly 1/4 of annual payroll in the U.S., whereas firms with 500 or more employees are a much smaller fraction of U.S. establishments but account for the lion's share of employment and payroll. The composition of the BIE panel is broadly reflective of the U.S. economy with the exception of manufacturing, which due to its capital-intensive nature is a small share of establishments and employment, but accounts for a relatively large share of value-added output in the U.S. It is also worth noting that the 6th Federal Reserve district closely mirrors the composition of U.S. businesses in terms of firm size and industrial mix.[4]

Importantly, the BIE survey is a relatively short and simple survey for business decision makers to complete. The core questionnaire consists of just six questions and takes roughly 3-5 minutes to complete.[5] Brevity is quite important, as Candia et al. (2021) highlight, which does limit the scope of the survey and the variety of questions we are able to ask on an ongoing basis. We view the simplicity and brevity of the questionnaire as crucial elements to maintaining our relatively high response rate (see Figure A.2) and retention rate (see Figure A.3).[6] As Figure A.2 shows, the response rates have stayed steady around 40 percent for the past 6 years. Our response rates compare favorably to other, voluntary surveys of businesses. For example, Coibion et al. (2018), in surveying New Zealand firms achieved a response rate of 20 percent in their first wave.[7] The BIE survey does have a high attachment rate, as the typical respondent stays with the panel between 1 and 2 years. Less than 5 percent of respondents fail to complete one survey once they agree to join the panel. And, we have two respondents that have stayed with the panel since its inception – completing every month survey we have fielded.

Our main question of interest from the BIE survey is the probabilistic 1-year ahead unit cost expectation question (see Figure 1 for the screenshot of how the question appears to respondents). The response quality to this question appears to be relatively high. Out of 25,376 observations there are just 507 cases (2.0 percent) where the probabilities did not sum to 100 percent. We also find only 220 instances of respondents assigning 20 percent to each bin.

The BIE elicits probabilistic unit cost expectations by asking firms to assign probabilities to pre-specified intervals (bins) for anticipated unit cost growth over the year ahead. This approach

unfeasible, as business database providers such as Dunn and Bradstreet have difficulty capturing small firms and startups.

[4]One potential criticism of the BIE panel is that it only represents firms headquartered in the Southeast U.S. We address this criticism in two ways. First, many firms headquartered in the U.S. have national or international sales footprints or exposure beyond the Southeast U.S. through supply chains. See Appendix B for a more direct response. The aggregated unit cost expectations and measured uncertainty from the BIE panel are highly correlated with those from the Survey of Business Uncertainty, which is a larger, national panel of U.S. firms' expectations and uncertainty.

[5]The question wording and response options can be found in Appendix D. We include the core questionnaire, quarterly rotating questions, and special questions used in this paper.

[6]An AAPOR response rate 2 calculation is the second most restrictive (out of 6 levels) way to calculate response rates. It does include partial responses. For an overview or AAPOR response rates see: https://www.aapor.org/Education-Resources/For-Researchers/Poll-Survey-FAQ/Response-Rates-An-Overview.aspx

[7]There are myriad reasons for response rates to differ including survey mode, quality of contact information, and method of first contact. See Lessler and Kalsbeek (1992) for a fulsome discussion of nonresponse error.

follows Manski (2004), Engelberg et al. (2009) and Armantier et al. (2013). These probability distributions provide richer detail than point forecasts on the uncertainty with which respondents hold expectations. Despite some efforts to quantify qualitative responses, such as the approach outlined in Mankiw et al. (2004), it is difficult to extract quantitative measures of expectations. In contrast, the subjective probability distributions in the BIE survey enable us to directly measure expected unit costs and attending uncertainty for each firm.

2.2 Why Unit Costs?

As we noted at the outset, the current literature on households' and firms' aggregate inflation expectations clearly highlights the existence of numerous informational and processing impediments that cast doubt on the reliability of these measures during low inflation periods. Our decision to track firms' unit cost expectations was motivated by a variety of factors including macroeconomic theory, the aforementioned issues the public seems to have in holding well-formed aggregate inflation expectations, and, importantly, by conversations with businesses themselves.

The Atlanta Fed conducted cognitive interviews with businesses in early development of the BIE survey that led us to conclude that firms' pricing decisions generally begin with their expectation of future costs.[8] Indeed, that prices depend on costs is far from controversial.[9] The new Keynesian Phillips curve has firms set price as a markup over their nominal marginal cost and adjust prices based on expected future marginal costs (Calvo, 1983; Clarida et al., 1999).

One impediment to this approach is firms' understanding of the term "marginal costs." Alan Blinder, in his landmark 1994 study, notes: "This turned out to be a tricky question because the term marginal cost is not in the lexicons of most business people...For purpose of the survey, we translated 'marginal cost' into 'variable costs of producing additional units'. " In specific questions, Blinder (1994) shortens that to "variable costs per unit." In the BIE questionnaire, we employ more parsimonious phrasing of "variable costs per unit," shortening that to "unit costs." In eliciting unit cost expectations, we are eliciting firms' views of the future growth in nonlabor and labor costs per unit of the year ahead, hence, firms' expected future nominal marginal costs.

On a fundamental level, the micro-foundations of the New Keynesian model only require individual firms, denoted by f, set prices as a markup μ_f, over their own *nominal* marginal costs $MC_{f,t}$. Without frictions that would delay a firm's ability to adjust prices, a given firm's pricing decision is represented by

$$P_{f,t} = \mu_f MC_{f,t}. \tag{1}$$

[8] The setup of the survey also allows us to monitor cost expectations and changes in margin pressures as independent decision points in the price decisions by firms.

[9] We chose to elicit unit cost expectations rather than future selling prices for multiple reasons including: maintaining the brevity of the survey, price stickiness, and other motivations for price changes that may be unconnected to expectations over the future nominal environment.

Taking the logs of equation (1) and assuming a constant elasticity of demand, equation (1) becomes:

$$lnP_{f,t} = \gamma_f + lnMC_{f,t}, \tag{2}$$

where γ_f is the log of the firm-specific (constant) markup over nominal marginal costs.

To make the above more tractable and allow for price-setting frictions of the Calvo (1983)-type – where only a subset of firms can adjust prices in a given period, equation (2) becomes dependent on firms' expectations. Firms will consider the (nearly) optimal price today, taking into consideration expected changes in nominal marginal costs between today and an opportunity to adjust price in the future (with some attendant positive probability). As noted by Carlsson and Nordstrom Skans (2012), the popular Calvo economy representation of equation (2) can be expressed as:

$$lnP_{f,t} = \gamma_f + (1 - \beta\theta)E_t \sum_{k=0}^{\infty} (\beta\theta)^k lnMC_{f,t+k}, \tag{3}$$

where β is a discount factor and θ is the probability that a firm will be allowed to engage in a price adjustment. In the Calvo case, a firm sets prices based on a markup over the weighted average of the discounted stream of nominal marginal costs, where the weight of the kth term reflects the probability of being stuck with the reset price ($P_{f,t}$) over the next k periods.

From the perspective of individual firms, pricing decisions in the New Keynesian framework are based on expectations of their own future nominal marginal costs. This exposition does not preclude firms from holding expectations about some notion of aggregate inflation measure as an input into firms' formulation of their own nominal marginal cost expectations. Indeed, that process is akin to Afrouzi (2020), where firms with multiple competitors have a greater likelihood of holding an inflation expectation closer to what economists consider "aggregate" inflation. However, as appears to be the case with rationally inattentive firms in a low inflation environment, the micro-foundations of the New Keynesian framework do not necessitate that firms hold an aggregate inflation expectation. One important consideration that led us to survey firms' unit cost expectations is that should a firm hold an aggregate inflation expectation it is likely to be nested in their own unit cost expectations.[10]

Perhaps as importantly, firms themselves indicate that unit costs are an important input into their price setting behavior, much more so than aggregate inflation concepts or metrics. In separate special questions we elicited firms' views of the importance of unit costs, aggregate inflation, or a

[10]Other potential considerations in our question design would include attempting to, in aggregate, tease out the nominal inflation expectations component and the real marginal cost component of unit cost expectations. We leave for future research. That said, the empirical performance of the aggregated unit cost expectations provides empirical support for the observed flatness of the Phillips curve. See Kiley (2015) for an overview or a 2018 speech by Chairman Powell addressing, "Monetary Policy and Risk Management at a Time of Low Inflation and Low Unemployment." https://www.federalreserve.gov/econresdata/notes/feds-notes/2015/low-inflation-in-the-united-states-a-summary-of-recent-research-20151123.html

price statistic such as the CPI.

For example, in September 2015, we asked,

> "On a scale of 1 to 5, with 1 being "no influence," please indicate what level of influence, if any, your expectation regarding the [economy's overall rate of inflation] or [unit costs] has (have) on your pricing decisions?"

The panel was split at random with half of the respondents receiving the "economy's overall rate of inflation" and the other half receiving "unit costs."

And, in January 2015, we posed the following,

> "On a scale of 1 to 5, with 1 being "no influence," please indicate what level of influence, if any, price statistics such as the Consumer Price Index have on your business decisions?"

The results, shown in Figure 2 indicate only a small minority of firms we sampled view the Consumer Price Index or the "economy's overall rate of inflation" as having a significant influence on their firm's business and pricing decisions. These results are consistent with the literature on rational inattention. Firms operating in, what was at the time a low, stable inflation environment viewed unit costs as a more informative input into their pricing decisions than aggregate inflation or the CPI.

We repeated these exercises again in the current, high-inflation environment. As Figure 2 shows, In January 2015, when headline CPI inflation was running at 1.7 percent over the past 6 years, more than 50 percent of firms said that changes in CPI had no or very little influence on their business decisions. As expected, this percentage declined from 2015 to 2022, amid a surge in inflationary pressures. Still, even in the high inflation environment in May 2022, with headline inflation at 40-year highs, one third of business executives still think aggregate inflation, as measured by the CPI, does not really matter for their business decisions, and just 12 percent of firms attach a significant influence to CPI inflation.

Related to concerns over relevancy and the potential for social desirability bias, Kim and Binder (forthcoming) find significant panel conditioning effects for both household and firm inflation expectations. Respondents' inflation forecasts and attendant uncertainty decline with the number of previous responses, suggesting what they call "learning-through-survey" effects.[11] Yet, when it comes to households' own-earnings expectations, this effect does not exist. One interpretation is that aggregate inflation is a concept that holds little relevance in the minds of respondents, yet out of a desire to appear informed, these respondents appear to be educating themselves on the topic. Just as panel conditioning appears to be nonexistent for a relevant concept like households'

[11] They also find evidence that repeated respondents in a panel of CEOs carry nearly 1/2 percent point lower aggregate inflation expectations.

own-earnings, we do not find a conditioning effect in the BIE when asking firms for their own unit cost expectations (see Figure A.4). Lack of survey tenure effects in the BIE gives us further confidence in the suitability of eliciting own-firm unit costs.

Business decision makers also directly indicate they focus keenly on costs, planning for and forecasting potential cost changes. In March 2015, roughly 94 percent of respondents indicated they plan for or forecast unit cost changes, with the 71 percent noting a planning frequency between daily and quarterly (see Figure A.5).

In sum, firms appear to hold differing notions of unit cost and aggregate inflation expectations in both high and low inflation environments. Moreover, as suggested by Mackowiak and Wiederholt (2009) and others, businesses focus on their own-firm quantities rather than aggregate developments in their decision-making processes.

3 Analyzing the Probability Forecasts

Two issues arise in using firm's subjective distributions. First, the 5-bin approach we use to eliciting firms' unit-cost expectations leave histograms with open intervals at both ends. We close these open intervals by using the same width of the middle intervals (following Manski (2004)). Second, many firms assign probabilities to one or two intervals, implying very small degrees of freedom. This concern prompts us to consider reconstructing the histograms by simulating observations. Specifically, we generate 1,000 samples uniformly within each interval, with supports equal to the range of the interval and the sample size being proportional to the probability assigned to each interval. The histograms of the reconstructed data sets are indistinguishable from the originals.

We estimate the mean and variance of each firm's density forecast both parametrically and non-parametrically. For nonparametric estimation, we assume that the probability is concentrated at the midpoint of each interval. Following Giordani and Söderlind (2003) and Engelberg et al. (2009), we fit normal and beta distributions to the histograms. Compared to nonparametric estimation, fitting these two distributions enables sharper empirical analysis, but imposes assumptions about the shapes of the histograms – in particular, that they are unimodal. While the assumption of unimodality is not problematic in SPF density forecasts, some firms in the BIE survey assign positive probabilities to non-adjacent bins.

To accommodate the bimodality, we adopt the bimodal asymmetric power normal (BAPN) distribution, proposed by Bolfarine et al. (2018). Let ϕ be the probability density function of standard normal distribution, and Φ be its cumulative distribution function. The density of the BAPN model is given by

$$h(x) = 2\gamma c_\gamma \phi(x)\Phi(|x|)^{\gamma-1}\Phi(\lambda x), \tag{4}$$

for $x \in \mathbf{R}$ with $c_\gamma = \frac{2^{(\gamma-1)}}{2^\gamma - 1}$, $\gamma > 0$ and $\lambda \in \mathbf{R}$. The distribution is bimodal if $\gamma > 1$, with larger γ

denoting greater separation between modes. λ controls the amount of skewness, with left skewness for $\lambda > 0$. Note that, as $|\lambda|$ increases, bimodality becomes less pronounced. The BAPN model, denoted by $BAPN(\gamma, \lambda)$, nests two other popular distributions, with $BAPN(1, 0)$ being standard normal and $BAPN(1, \lambda)$ being skew normal distribution. A desirable feature of the BAPN model is its non-singular information matrix that guarantees large sample properties of the maximum likelihood estimators.[12]

Bimodality appears to be somewhat unique to business expectations. Professional forecaster expectations from the SPF do not exhibit any material bimodality; see Binder et al. (2022). Approximately 2 percent of firms' subjective probabilistic year-ahead unit cost distributions exhibit bimodality (Table 2).[13] Instances of bimodality in the BIE exist across every major private industrial sector, although they are slightly more prevalent in durable and nondurable manufacturing sectors, and in "other" services. We contacted a small subsample (10-15 respondents) regarding the bimodality they expressed in their probabilistic unit cost expectations. Nearly every respondent was able to articulate a scenario-based reason for reporting anticipated bimodality. It also appears that, in this small handful of responses, bimodality was meant to convey some sort of conditionality to their forecasts (i.e. "If transportation costs rise by X, then my costs will likely be Y"). Not only do these instances of bimodality justify the BAPN estimator, but the responses to follow-up interviews indicate that respondents are putting thought into their responses around unit costs (and that unit costs are a meaningful concept followed closely by business decision makers). Also, as shown in Table A.1, nonparametrically calculating unit cost uncertainty systematically underestimates uncertainty relative to a parametric approach.

Therefore, in all subsequent analysis, we fit the BAPN model to histograms – with $\gamma > 1$ to capture the bimodality and $0 < \gamma \leq 1$ to capture the unimodality. We use the mean and variance of the BAPN distribution as the first- and second-moment of inflation expectations at the firm level, and compare these parametric estimates to nonparametric counterparts when appropriate.

Panel (a) in Figure 3 compares bin-scatters for the parametric mean of the 5-bin probabilistic distribution of a given firm's 1-year ahead unit cost growth to a given firm's ex post perceived unit cost growth over the past year. The unit cost expectations are on the horizontal axis and the vertical axis plots unit cost growth over the ensuing 12 month time period. The bin-scatters show a tight positive relationship between firm's unit cost forecasts and their realized unit cost growth over that 12 month period. Using the parametric method, we see that the mean error (i.e. unit

[12] As an illustration, we make comparisons between BAPN, normal and beta model fitting in Appendix C; see Figures C.1–C.3. For histograms being moderately bimodal and strongly bimodal, the BAPN provides the best fit when compared with normal and beta models. This visual inspection is further collaborated by descriptive measures and formal tests, such as Bayesian Information Criterion, Mean Squared Error between the fitted and the empirical cumulative distribution function, and the Kolmogorov-Smirnov test having the fitted model as the null model against the two-sided alternative; see Table C.1.

[13] The Census Bureau's 2015 Management and Organizational Practices Survey (MOPS) collected five-point forecast distributions over own future shipments, employment, and capital and materials expenditures for 35,000 U.S. manufacturing plants. About 18.2 percent of probability distributions are bimodal; see Table 2 in Bloom et al. (2020).

cost growth at time t minus expected cost growth at $t-12$) is slightly negative.[14] Firms, especially larger ones, over this period have been a bit too pessimistic with their unit cost expectations.

Panel (b) in Figure 3 shows that the more uncertain a given firm is about their future unit costs – that is, the higher the variance of their subjective probability distribution – the larger their absolute forecast errors tend to be. In other words, firms tend to *know what they don't know*. Furthermore, firms that are highly cyclical or volatile industries (manufacturing, construction, mining and finance) tend to have larger absolute forecast errors.

4 Unit Costs Provide a Useful Lens into Inflation Developments

In this section, we show that aggregating own-firm unit cost realizations and expectations yields useful information about inflation developments in the U.S. Firms' unit costs realizations – unit cost growth over the previous year – comove closely with aggregate U.S. inflation statistics. In comparison to other well-known surveys of inflation expectations, we find that firms' unit cost expectations significantly outperform the inflation expectations of households and are about as accurate as the expectations of professional forecasters in out-of-sample forecasting exercises. While others such as Kumar et al. (2015) highlight that firms' aggregate inflation expectations more closely resemble those of households, the timeseries behavior of aggregated unit cost expectations behaves similarly to that of professional forecasters. We also exploit the probabilistic nature of the BIE's unit cost expectations question to compare firms' subjective uncertainty over unit costs with other survey and market-based measures of inflation uncertainty.

4.1 Unit Cost Realizations and Overall Inflation

Firms' realized unit cost growth over the previous year varies across industry and firm size (see Figure 4).[15] This heterogeneity across- and within-industries can reflect differing conditions due to idiosyncratic, industry-level, or economy-wide differences (see Table A.1). Over the October 2011 through August 2022, construction costs outpaced costs in the financial services and insurance industry. Unit costs in the mining and utilities sector fluctuate with prices in energy markets. And, starting in the first quarter of 2021, amid intensifying supply chain disruption and shortages of qualified labor, unit costs for nearly every broad-industry grouping have risen sharply.

Despite this observed heterogeneity, aggregating up year-over-year unit cost growth across all firms in the panel each month and weighting by industry's share of overall gross output, yields an index of firms' unit cost growth that closely mirrors overall inflation. Figure 5 plots the timeseries of firms' year-over-year unit cost growth along with the year-over-year growth rate in the GDP deflator

[14] The forecast error averaged across firms is -0.18 from the parametric method and -0.17 from the nonparametric method.

[15] Importantly, this heterogeneity across and within industries extends to firms' unit cost expectations as well. See Figure A.6.

produced by the Bureau of Economic Analysis. The GDP deflator is the broadest measure of inflation as it tracks price changes of all goods and services newly produced in the U.S.[16] Firms' unit cost growth covaries quite closely with changes in the GDP deflator, carrying a correlation coefficient of 0.97 using quarterly data from 2011Q4 through 2022Q3. The tightness of this relationship is exaggerated by exceedingly sharp increases in measured inflation rates and unit cost growth over the past two quarters. Still, prior to the onset of the pandemic, the correlation between firms' unit cost growth and the GDP deflator was still quite strong (correlation coefficient of 0.8). This strong relationship is reassuring from our point of view. To reiterate, we are simply eliciting firms' views on their own unit costs and taking an GDP-by-industry weighted-average. Yet, this aggregate measure of unit cost realizations closely tracks official U.S. inflation statistics. Firms clearly see the concept of "inflation" through the lens of unit cost developments. The fact that changes in firms' unit costs are closely related to the changes in prices we observe through aggregate inflation statistics provides validity to our approach of aggregating up own-firm information.

4.2 Comparing Unit Cost Expectations with Other Survey Measures of Inflation Expectations

We compare aggregated 1-year ahead unit cost expectations from firms in the BIE panel to well-known and long-standing survey measures of inflation expectations. The BIE's unit cost expectations measure is calculated as the industry-weighted average expected value from individual firms' 1-year ahead subjective probability distributions. Quarterly estimates are calculated by averaging over the three months in a given quarter. For household expectations, we use 1-year ahead price expectations from the University of Michigan's Survey of Consumers. And, for professional forecasters, we use the Blue Chip Panel of Economic Forecasters for monthly frequencies and the Philadelphia Fed's Survey of Professional Forecasters for quarterly comparisons.

Table 3 reports the pairwise correlations between inflation expectation measures along with the statistical significance.[17] We report these correlations over two sample periods. The first begins in 2011Q4 and ends in 2019Q4. The second panel includes the developments during the COVID-19 pandemic (through 2022Q2), a tumultuous period for inflation that included sharp pandemic-induced price changes (induced by widespread supply chain disruption, lack of labor availability, and the reopening of the economy).[18] The table highlights two key points. First, firms'

[16] For purposes of comparison to the BIE panel, which includes firms operating in the business-to-business space, the GDP deflator is a more appropriate comparison metric than a measure of consumer price growth like the CPI or PCE price index. Still, firm's unit costs also covary highly with the PCE price index (correlation of 0.96) and the core PCE price index (0.97), calculated on a quarterly basis with data from 2011Q4 until 2022Q3.

[17] Table A.2 shows that these correlations hold on a monthly time frequency as well and using a different set of professional forecasters' inflation expectations. And, Figure A.7 shows the time-series comovement of firm, household, and professional expectations on a monthly frequency. The results are similar.

[18] The sharp increases in all measures of survey inflation expectations beginning in 2021Q2 exaggerate the correlation between all these measures. See Meyer et al. (2022b) for a more fulsome discussion.

unit cost expectations are highly correlated with the forecasts of professional forecasters, especially the SPF's forecasts for the GDP deflator. This finding suggests firms' aggregated views over future costs contain a similar signal about the year-ahead inflationary pressures that professional forecasters anticipate over both low- and high- inflation environments. Second, as inflation rates rose sharply starting in early 2021, all expectations measures increased markedly, consistent with increased attention paid to aggregate conditions on the part of households. In addition, Figure 6 provides a timeseries visual of how tightly the BIE measure co-moves with the expectations of professionals. Despite the very tight pre-COVID relationship, during the later part of 2020 the BIE 1-year ahead measure rose sharply, much more quickly and to a higher level than the SPF forecasts. This corresponds with a time-period where professional forecasters, many policymakers, and other economists were viewing the incoming inflation information "transitory." Whereas, firms' views, conditioned on, perhaps, a clearer view of the supply disruption and shipping bottlenecks saw these factors as being more persistent(Meyer et al., 2022b). Divergence between professional forecasters views and those of businesses operating in this volatile, high-inflation time-period highlights the importance of gathering firm-level unit cost expectations.

Conversely, the BIE measure is uncorrelated with households' inflation expectations during the pre-COVID period, yet the correlation increases markedly following the onset of the COVID pandemic (see Figure A.7). Once inflationary pressures broadened out and became significant across much of the consumers' market-basket, households' inflation expectations became much more highly correlated with firms' unit cost expectations. This finding is similar to Coibion et al. (2018), who use the disconnect between a firm's cost expectations and aggregate inflation expectations in low inflation countries to argue for rational inattention.

Monetary policymakers pay a lot of attention to inflation expectations. In a 2007 speech, then Chairman Ben Bernanke noted, "Undoubtedly, the state of inflation expectations greatly influences actual inflation and thus the central bank's ability to achieve price stability."[19] Thomas (1999) and Ang et al. (2007) find that survey measures of inflation expectations generally outperform timeseries benchmarks in forecasting inflation. Recent work by Verbrugge and Zaman (2021) was the first to include the BIE's unit cost expectations in tests of in-sample fit and forecasting performance, finding that the BIE measure performs about as well as professional forecasters. Our own analysis demonstrates the usefulness of the BIE's unit cost expectations in out-of-sample forecasting exercises.

We compare the forecasting performance of aggregated unit cost expectations to the median and mean 1-year ahead inflation expectations from the University of Michigan Survey of Consumers (MSC), the Blue Chip panel of forecasters median 1-year ahead inflation forecasts, and the Philadelphia Fed's median 1-year ahead inflation forecasts.[20] As is the case with many (pseudo)

[19]Inflation Expectations and Inflation Forecasting. Speech by Chairman Bernanke on July 10, 2007. https://www.federalreserve.gov/newsevents/speech/bernanke20070710a.htm

[20]In general, most references to survey measures of inflation expectations of household and professional forecasters

out-of-sample forecasting exercises, we employ an ARMA(1,1) benchmark to anchor our comparisons (Stock and Watson, 2007).

We investigate relative forecasting performance on both a monthly and quarterly frequency. Our out-of-sample forecasting horizon is 1-year ahead and the sample runs from late 2011 until the third quarter of 2022. Different from many studies, we extend these analyses by including disaggregate subgroupings of the BIE and MSC data. For the BIE's firm-level expectations we include 4 industrial subgroupings 1-digit NAICS supersectors.[21] For households, we include subgroups of inflation expectations by income, motivated by Binder (2015). Also, given that in the BIE, firms are asked to provide their views over their own future unit costs and households are asked for their "prices in general" expectation, we compare forecasting performance for a variety of often used inflation statistics (CPI, core CPI, PCE, core PCE, and, on a quarterly frequency we include the GDP deflator).

Tables 4 and 5 report the out-of-sample root mean squared errors (RMSE) and mean absolute errors (MAE) relative to an ARMA(1,1) benchmark at the monthly and quarterly frequency, respectively.[22] They also report forecasting performance for the pre-COVID timeperiod (through the end of 2019) and the full sample (which evaluates forecasts through mid-to-late 2022). The top row of each panel of these tables report the actual RMSE and MAE from the timeseries benchmark, and subsequent rows report the relative performance of the survey-based measures. A numerical value in these cells lower than 1 indicates more accurate forecasting performance and an asterisk symbol indicates statistically different performance using the Diebold and Mariano (1995) test statistic.

Starting with Panel A in both Tables 4 and 5, firms' aggregated unit cost expectations significantly outperform the ARMA(1,1) benchmark for a variety of inflation metrics including CPI, core CPI and GDP deflator on both a monthly and quarterly frequency over the pre-COVID time period. When PCE or core PCE inflation is the object of interest, the BIE measure tends to perform at least as well as the ARMA(1,1) benchmark, but carries RMSEs and MAEs that are typically 40% of that of households. One potential explanation for the differences in forecasting performance when predicting a PCE-based metric relative to a CPI-based inflation metric may be the inclusion of nonmarket based components for health care and financial service prices that carry a large weight in the PCE-based measures (and a much higher weight after excluding food and energy prices).[23]

utilize median expectations rather than the mean. For the BIE, the mean and median are nearly perfectly correlated and using either measure of central tendency would yield quantitatively similar results.

[21]The BIE supersectors are defined as follows: (1) Construction, mining and utilities, and real estate, rental and leasing; (2) Durable and non-durable goods manufacturing; (3) Retail and wholesale trade and transportation and warehousing; (4) Educational services, finance and insurance, healthcare and social assistance, information, leisure and hospitality, other services except government, and professional and business services.

[22]We generate ARMA(1, 1) forecasts using all available data each period. For example, when forecasting CPI for October 2012, our estimation sample is March 1947 to October 2011. We then forecast 12 months ahead and use the average of those forecasts as our point estimate. The same procedure is done for the quarterly frequency data. The estimation sample is updated recursively each month with the initialization being the price index's earliest observation. We generate forecasts of this type for the periods spanning October 2012 to August 2022.

[23]Roughly 20 percent of the PCE price index contain these nonmarket-based prices. The GDP deflator includes

Firms' unit cost expectations over the pre-COVID period carry a similar forecasting performance as that of professional forecasters, which is not surprising given how tightly these timeseries comove from the inception of the BIE survey through the beginning stages of the pandemic.

When folding in the pandemic period (panel B of both tables), firms' and professional forecasters' expectations perform about as well as the simple benchmark model in terms of RMSE (which harshly penalized large forecast errors). However, in terms of mean absolute error, both firms' and professional forecasters' expectations still carry lower values than the benchmark model. Firms' relative MAEs are also slightly lower than that of professionals, indicating the relative deterioration in firms' forecasting performance over this volatile, high-inflation time period was lesser than that of professional forecasters. While this is a nuanced point, our interpretation is that while both firms and professional forecasters saw the onset of pandemic as, on net, a demand shock (see Meyer et al. (2022a)), firms adjusted more quickly to the high (and persistent) inflation environment brought on by ample fiscal stimulus and widespread, severe supply chain disruption in 2021.

The combined weight of the evidence presented in this section suggests that eliciting own-firm unit cost expectations and aggregating them up is a useful exercise. In low inflation environments, firms' unit cost expectations mirror those of professional forecasters, are uncorrelated with household measures of inflation expectations, and forecast future inflation more accurately than households. However, when inflation is high and salient in the minds of households, the expectations of firms, households, and professionals covary strongly. Yet, we also saw during 2021 and through early 2022, firms' inflation expectations rose much more quickly than professionals' forecasts, suggesting that information yielded from firms' unit cost expectations contains a unique signal about the evolution of inflation over the year ahead that warrants monitoring.

4.3 Comparing Firms' Unit Cost Uncertainty to Other Measures of Inflation Uncertainty

While the usefulness of gathering and monitoring firms' unit cost expectations should already be clear on the basis of firms' first-moment expectations, the BIE survey also offers unique insight into how uncertain firms' view of their future cost environment will be. Using the parametric estimate of firms' own unit cost uncertainty calculated in Section 3, we take the weighted average across panelists to create a measure of aggregate unit cost uncertainty. We compare this proxy to available measures of inflation uncertainty from households and financial markets. Specifically, we compare to 1-year ahead inflation uncertainty from the New York Fed's Survey of Consumer Expectations. We also compare firms' unit cost uncertainty to the inflation uncertainty embedded in the implied volatility in the prices of inflation swaptions.[24]

these prices as well, but they receive a much lower weight given the broad-based nature of this price index.

[24]Market-based inflation uncertainty is estimated from a closed-form model and assumes changes in log prices are normally distributed. Estimation is performed jointly for 1 and 3 year maturities using caps with 1%-6% strikes and

Figure 7 plots a comparison of these measures. A few interesting patterns emerge from this (admittedly visual) analysis. First, prior to the onset of COVID-19, all these measures indicate a lessening of uncertainly (a tightening up in the subjective probability distributions for firms and households) over the previous business cycle.[25] In other words, firms, households, and market-participants saw the uncertainty attached to their cost or inflation outlooks as waning in the years following the Great Recession. The pre-COVID correlation between the BIE unit cost uncertainty and option-implied inflation uncertainty is 0.64. Firms' unit cost uncertainty is also highly correlated with the NY Fed's inflation uncertainty from households. However, since the onset of the COVID-19 pandemic, these measures of uncertainty have diverged.

4.4 Inflation Expectations and Uncertainty Since the Onset of COVID-19

The onset of the COVID-19 pandemic in early 2020 has ushered in a quite disruptive and disparate economic period for firms and households. The pandemic itself, attendant measures to control the virus (including shutdowns), and massive policy responses embody elements of both an aggregate demand shock and an aggregate supply shock. As highlighted by Meyer et al. (2022a), in the early months of the pandemic, firms, on net, saw COVID-19 as largely a demand shock – lowering their unit cost expectations, actual and expected prices and wages, and was a large negative hit to sales revenue (for most firms). In these early months, both firms' unit cost expectations and the inflation expectations of professionals fell sharply, with the BIE measure falling to a series low by April 2020. During this period, the disconnect between firms' (and professionals') expectations and the expectations of households widened considerably. Households' inflation expectations jumped markedly at the onset of the pandemic, despite an observed stark decline in measured inflation, alongside a sharp increase in the prices of grocery store items (which, over the first 4 months of the pandemic comprised the entirety of the upper tail of the CPI price change distribution). Meyer et al. (2022a) highlight that households may have disproportionately responded to sharp increases in these salient grocery store items rather than expressing a belief that aggregate inflation would rise (a finding also consistent with D'Acunto et al. (2021)).

However, as the pandemic wore on, global supply chain disruption and shipping bottlenecks grew more and more severe. As these disruptions, along with a growing disruption to labor supply, grew more widespread and increased in intensity, Meyer et al. (2022b) repeatedly elicited firms' views on the impact these supply issues were having on business activity. They extended and fielded a set of special questions utilized by the Census Bureau's Small Business Pulse Survey,[26] designed

floors with -2% to 3% strikes. We are grateful to Brian Robertson at the Atlanta Fed for providing these estimates to us.

[25] In the firm-level data, we can trace the decline in uncertainty to a tightening up in the upper tail of firms' subjective probability distributions beginning in 2012. In short, firms slowly began to assign less and less probability mass in the upper two bins of the discrete distribution.

[26] https://www.census.gov/data/experimental-data-products/small-business-pulse-survey.html

to measure the breath and intensity of the supply-side disruptions in business activity. They find that the dramatic rise in firms' year-ahead unit cost expectations largely reflects the level of supply chain and labor disruption experienced. These results are related to Cavallo and Kryvtsov (2021), who study the recent supply chain disruption from a different angle, using high-frequency data on product shortages and stockouts to document their association with cost shocks and temporary inflationary pressure.

Another interesting development during the COVID-19 pandemic has been the evolution of firms' unit cost uncertainty relative to other measures. As shown in Figure 7, households' inflation uncertainty rose quite dramatically, while firms' unit cost uncertainty remained relatively low. While a fulsome investigation of these differences is outside the scope of this paper, one tentative takeaway is that firms appear to have been fairly confident about the likely impact of the pandemic on their future unit costs. During the course of the pandemic firms' view flipped from anticipating low unit cost outcomes to increasingly higher outcomes, leaving unit cost uncertainty largely unchanged. Interestingly, these stark shifts in views are mirrored by market participants.[27] Inflation densities for CPI inflation derived from caps and floors show that the probability of inflation over a 5-year horizon averaging below 1 percent shot up to roughly 80 percent at the onset of the pandemic, while the probability of seeing above 3 percent inflation was nearly zero. As of the end of October 2021, the situation has flipped, with market participants assigning an 80 percent likelihood to inflation over 3 percent and near zero to inflation below 1 percent over the next 5 years.[28]

One additional aspect of firms' subjective probabilistic expectations that we can track is skewness. Figure 8 plots two simple measures of skewness, averaging across firms in the panel. The first is simply the weight assigned to the highest bin (unit costs up greater than 5%) minus unit costs decreasing more than a percentage point. The second is the difference between the highest two bins and the lowest two bins. Figure 8 elucidates how the typical firm's projections for future unit cost have evolved over the course of the pandemic. Entering into the pandemic, after years of low, stable inflation, these unit cost risk indicators reveal that balance of risks were weighted to the downside (as more weight was assigned to the lowest two bins in the five bin distribution). In April and May of 2020, the typical firm had assigned a nearly 15 percent likelihood that their costs were going to decline by more than 1 percent over the year ahead and just an 8 percent likelihood of unit costs increasing greater than 5 percent. However, firms quickly reversed course, placing more and more weight in the upper two bins. By April 2022, firms were assigning more than one-third of the weight to unit costs persisting above 5 percent increases over the year head and just 2 percentage points of weight to a sharp decrease in unit costs. These are striking shifts in the balance of risks to firms' cost outlook. By the end of our sample, upside cost risks had far outweighed the potential for perceived downside risks over the year ahead. These unit cost risk measures also help

[27] https://www.minneapolisfed.org/banking/current-and-historical-market--based-probabilities

[28] These sharp changes in expectations, leaving overall uncertainty unchanged may be related to overconfidence, which appears to be a feature of firms' expectations (Barrero, 2022; Altig et al., 2022).

provide context for the BIE's unit cost uncertainty metrics, which have fallen during the course of the pandemic. Essentially, firms, en masse, have reacted strongly to the persistent disruption and elevated cost environment over the past two years.

While a fulsome exploration of the pandemic-era period is interesting but beyond the scope of the paper, it does warrant attention as it highlights the usefulness of gathering firm-level insights on the evolution of cost and cost expectations during the only true inflation shock the U.S. has experienced since the Great Inflation (1965-1982).

5 Unit Costs Matter for Firms

5.1 Unit Costs and Pricing: Firm-level Evidence

For unit cost expectations to be an important determinant of future inflation, these expectations must feed through into expectations and realizations for price changes. Surveying firms regarding price change expectations can be complicated by nominal frictions (i.e. price stickiness). For example, over the course of 2019 and into 2020 a battery of special questions were posed to the BIE panel that included a question eliciting firms' recent (3-month) price changes for the product/product line or service responsible for the largest share of the firm's revenue (a "representative" price). This question was fielded once per quarter over a four quarter period and out of the resulting 1,112 usable responses, 367 or 1/3 were zero (indicating the potential presence of nominal frictions). This is consistent with studies such as Bils and Klenow (2004) and Klenow and Kryvtsov (2008) that suggest firms typically change their selling price less often than once a quarter (excluding temporary sale prices, the typical frequency of price change rises to nearly once a year). In surveys, this price stickiness is first documented by Blinder (1991).

Firms' unit cost expectations are related to their representative price change expectations. We aggregate the responses to special questions on the year-ahead price expectations of firms and relate them to year-ahead unit cost expectations.[29] Table 6 shows the results of simple OLS regressions of year-ahead price change expectations (for the given month) against firms' unit cost expectations and trailing year-over-year unit cost realizations. Figure A.8 shows a binscatter of the results from specification (9) in Table 6.

As indicated by the regression results and binscatter, firms' year-ahead unit cost expectations covary strongly with year-ahead price expectations across all eight periods, despite changes in

[29]In June 2013, the BIE elicited probabilistic year-ahead expectations of firms' average prices using the same format as the core BIE unit cost expectations question. In February 2019, the BIE elicited probabilistic year-ahead "representative" price change expectations using the same format as in the Survey of Business Uncertainty (see Altig et al. (2022)). And, in December 2020, April 2021, July 2021, and November 2021 firms were asked to provide their point estimates for the percentage change in the product/product line or service responsible for the largest share of revenue. Given changes in question wording and formatting, we normalize the price responses in the following analysis. Detailed wording for these special questions can be found in Appendix D. And, a full list of all special question can be found here: https://www.frbatlanta.org/research/inflationproject/bie/special-questions

wording and question formatting. As suggested by the empirical investigation of unit costs and price changes of Carlsson and Nordstrom Skans (2012), expectations of future unit costs appear to play a role in firms' price formation strategies. However, this relationship is not one-for-one (likely due to aforementioned impediments to continuous price adjustments).

In a separate analytical exercise, utilizing the series of special questions elicited over the course of January 2019 through January 2020, we find little evidence that firms' year-ahead ex ante aggregate inflation expectations are related to their ex post year-over-year price changes. Table 7 shows the simple correlations between firms' realized price changes over the past year, aggregate (CPI-based) inflation expectations (elicited in January 2019), firms' year-ahead expected price changes as of February 2019, lagged unit cost expectations, and firms' unit cost growth over the past year. In stark contrast to firms' year-ahead price expectations, firms' expectations for aggregate (CPI) inflation are uncorrelated with reported price changes in the cross section. This result conforms to the notion that aggregate inflation expectations are not central to firms' price-setting behavior in low inflation environments. In addition, as they reported to direct questions on the usefulness of aggregate inflation (see Figure 2), firms appear to pay more attention to their own idiosyncratic conditions.

The results from our firm-level investigations of price changes are also consistent with the Mackowiak and Wiederholt (2009) rational inattention model. Firms in this model allocate almost all attention to idiosyncratic rather than aggregate conditions. As evidence of the dominance of idiosyncratic conditions, we decompose the variation in realized unit cost growth into its common (aggregate), sectoral, and idiosyncratic (firm-specific) components using the panel variance decomposition methods.[30] We find that the relative standard deviation of the sector-specific component is about 4 times as large as the aggregate component of unit cost growth. The relative variation of the idiosyncratic component is approximately 7 times that of the aggregate. These are similar to what Carlsson and Nordstrom Skans (2012) found using Swedish firm-level production data. Extending their work by applying this decomposition to firm-level unit cost expectations reveals a relative standard deviation of the sectoral component and the idiosyncratic component of 4 times and 9 times as large as the aggregate variation, respectively.

5.2 Informing Firms of the Policymakers' Views Does Not Change Firms' Unit Cost Expectations

Of key interest to monetary policymakers and economists alike is whether businesses respond to and incorporate information on the inflation projections and attendant uncertainty when forming their own expectations. Studies such as Coibion et al. (2018) and Coibion et al. (2020b) find

[30]The variance decomposition follows a two-stage panel regression strategy. First, the aggregate component is uncovered by regressing unit cost growth (unit cost expectations) on time dummies and clustering standard errors at the firm level. The second stage takes the residual series and separates it into sectoral (2-digit NAICS) component and an idiosyncratic component. The standard deviations of these components are available upon request.

mixed evidence that firms in a randomized controlled trial (RCT) setting incorporate information on the inflation expectations of professionals or the inflation projections (and goals) of monetary policymakers into firm's point estimates of inflation expectations. And, importantly, whether this new information provides a lasting, significant impact on key firm decisions, such as hiring plans. We advance these RCTs to study the impact of information about monetary policymakers' inflation expectations and the associated uncertainty on firms' own unit cost expectations and uncertainty.

In October 2020, we asked firms for their highest and lowest potential expectations for PCE inflation in 2021. In this experiment, we wanted to test whether giving business decision makers information on the *uncertainty* (in the form of confidence intervals) around monetary policymakers' projections influenced their inflation projections in October, and to see if this information impacted firms' own unit cost expectations over the year ahead a month later in November 2020. To make sure that the information we were supplying was about the second moment only, we provided both the control and the treatment groups with the median expectation for PCE inflation over calendar year 2021 from the FOMC's Summary of Economic Projections on September 15, 2020. For the treatment group we provided the 70 percent confidence interval around those projections based on the historical forecast errors of professionals (excerpted from the minutes of the September 2020 FOMC meeting).

Specifically, we asked

> "The median expectation of monetary policymakers for inflation over calendar year 2021 was 1.7 percent (as of September 15th). [Treatment: Based on forecasts over the past 20 years, there is a 70 percent chance that actual inflation will be in the range of 0.7 percent to 2.7 percent over calendar year 2021.] What is your best estimate for the highest and lowest potential rate of inflation over calendar year 2021?"

Panel A of Table 8 provides some simple descriptive statistics on firms' inflation expectations for 2021, separated by whether they received the uncertainty treatment. Two interesting facts emerge from Panel A. First, firms' lowest and highest potential inflation expectations for 2021 are higher, on average, than that of professionals. This finding, in the light of other literature on household and business inflation expectations, is not all that unusual. However, firms' spread between "highest possible" and "lowest possible" is fairly similar to the 70 percent confidence interval provided to the treatment group. And, perhaps more interesting, is that the control group had a nearly identical spread between their projections for the highest and lowest possible inflation in calendar year 2021.

There is another, rather important, aspect of these results that we need to point out. Table A.3 recreates Table 8 without excluding outliers. There were a handful of firms (four respondents in the treatment group and two in the control group) that, even after receiving policymakers' expectations for 2021 (and, for the treatment group a 70 percent confidence interval), responded with expectations for lowest or highest possible anticipated 2021 inflation in excess of 10 percent.

We find this interesting because it implies that these firms either hold expectations for aggregate inflation that are roughly an order of magnitude above that of monetary policymakers, they still don't understand the guidance, or, perhaps most likely, that the concept of aggregate inflation isn't meaningful enough for them to answer thoughtfully. Thus, the uncertainty information treatment had little impact on firms' aggregate inflation expectations and uncertainty for 2021.

In October 2021, one year after our first RCT, we performed a similar experiment that asked firms for their "annual rate of inflation" in 2022. The purpose of this RCT was to test whether giving business decision makers information on the monetary policymakers' first-moment expectations of inflation influenced their aggregate inflation projections and their own unit cost expectations. For the treatment group we provided the policymaker's inflation projections from the most recent FOMC's Summary of Economic Projections from the September 2021 meeting.

Specifically, we asked

> "[Treatment: The median expectation of monetary policymakers (as of September 22) for the annual rate of inflation over calendar year 2022 is 2.2 percent.] What do you think the annual rate of inflation will be over calendar year 2022?"

Note that the RCT in October 2021 is different from the one we performed a year ago in two aspects. First, the inflation environment changed rapidly. In the early months of the pandemic, firms, on net, saw COVID-19 as largely a demand shock – lowering their unit cost expectations. In contrast, as the pandemic wore on, global supply chain disruption and shipping bottlenecks made firms increase their unit cost expectations. Second, the information treatment is different. Firms were treated with information on the uncertainty (second moment) around monetary policymakers' inflation projections in October 2020, but, in October 2021, were treated with information on the median (first moment) inflation expectations of monetary policymakers.

Panel B of Table 8 reports the results from this new experiment. Despite the differences in two RCTs, the results are remarkably similar. The new information treatment had little impact on firms' aggregate inflation expectations. Taking advantage of the panel dimension of the BIE survey, we can compare the responses from three different groups of firms: those who were in the control group in 2020, those who were in the treatment group in 2020, and the rest of newly-added firms (who did not participate the experiment in 2020). For example, the firms who received the treatment in both 2020 and 2021 predicted a 3.8% aggregate inflation rate in 2022. Despite the small size of these groups, we are able to detect a statistically significant difference in the means. Cavallo et al. (2017) find the impact of informational treatments given to households to be short-lived. Here, we find similar (albeit suggestive, given the size of the groups) evidence. It appears that only the group that was repeatedly given policymakers' first-moment projections responded to treatment. One might be tempted to conclude that repeated communication on the part of monetary policymakers is needed to "break through the veil of inattention", as Candia et al. (2021)

put it. However, again consistent with Cavallo et al. (2017), much like consumers who chose to pay attention to specific prices at the supermarket, we find these treatments leave unit cost expectations and uncertainty unaltered.

To see this, we evaluate the informational treatments provided in October 2020 and October 2021 on subsequent (November 2020 and November 2021) unit cost expectations and uncertainty in a pooled regression. Table 9 reports the regression results. The coefficients on the treatment dummy variable are trivial in size and insignificant, suggesting that firms do not incorporate information about the forward trajectory of year-ahead aggregate inflation from policymakers in their projections for unit cost expectations and uncertainty over the year-ahead time horizon.

Firms themselves tell us that providing information about aggregate inflation through the projections of monetary policymakers does not heavily influence forecasts of unit costs and prices (see Figure 9 on influence of monetary policymakers' inflation projections). Only 1 percent of respondents suggested these inflation projections directly influenced their own-firm cost or price expectations. These results suggest that policymakers' views of the inflationary environment are not a material input into businesses' forecasts for unit costs or prices. In sum, U.S. firms operating in a low inflation environment appear to be rationally inattentive to aggregate inflation, and thus, policymakers' expectations for aggregate inflation do not alter firms' unit cost expectations and uncertainty.

6 Conclusion

The viewpoint espoused by Chairman Greenspan on price stability that opened this paper has direct implications for monetary policymakers attempting to measure the extent to which inflation expectations are "anchored." In particular, if firms do not pay attention to aggregate inflation in low-inflation environments (perhaps due to the lack of a perceived benefit to acquiring this information) or if aggregate inflation measures such as the CPI are not significant inputs into pricing decisions, then drawing inferences about the state of inflation expectations from firms' *aggregate* inflation expectations becomes challenging. Instead, we show that by asking business decision makers about important price-setting determinants they care about – in this case their own-firm unit costs – we can aggregate these firm-specific views into series that are closely related to the aggregate inflation dynamics central bankers care about. In this sense, our work is supportive of the notion forwarded in Mackowiak and Wiederholt (2009), Coibion et al. (2018), and others, that firms pay much more attention to idiosyncratic conditions. However, drawing on the lessons gleaned from survey work eliciting firm-level expectations (such as Altig et al. (2022)) we argue that firm-level unit cost expectations warrant inclusion into the existing suite of survey inflation expectations measures economists and policymakers use to monitor inflation developments.

We find that firms are well aware of, plan for, and form meaningful expectations for their own

unit costs. Using the Atlanta Fed's Business Inflation Expectations Survey, we aggregate own-firm probabilistic unit cost expectations. This measure is a useful predictor of future aggregate inflation – outperforming statistical benchmarks and household inflation expectations in out-of-sample forecasting exercises. And, own-firm unit cost realizations aggregate up into a series that comoves closely with official inflation statistics, further emphasizing the real-world connection between these survey responses and official (measured) inflation. Importantly, at the micro-level, we find unit cost realizations and expectations matter in price-setting behavior.

Firms' unit cost expectations do not resemble the inflation expectations of households. Instead, this measure is highly correlated with the inflation expectations of professional forecasters. Informing businesses about the aggregate inflation expectations and attendant uncertainty of policymakers' forecasts, via a series of randomized controlled trials, do little to alter firms' unit cost expectations.

Utilizing a novel, flexible technique to parametrically estimate firms' unit cost uncertainty, we find that up until early 2020, the evolution of firms' views was similar to other survey and market-based measures of inflation uncertainty. However, since early 2021, these measures have diverged, with household's inflation uncertainty rising sharply while firms' unit cost uncertainty has remained low despite a stark shift in first-moment expectations.

Chairman Powell, in an August 2022 address at the Jackson Hole Symposium, discussed the role inattention plays in aggregate inflation expectations. In particular, he noted,"*One useful insight into how actual inflation may affect expectations about its future path is based in the concept of "rational inattention." When inflation is low and stable, they are freer to focus their attention elsewhere.*"[31] This notion aligns with our perspective. In a low-inflation environment, households and firms appear to hold aggregate inflation expectations that are disconnected from the underlying inflation environment. During these low inflation periods, eliciting expectations from firms (or households) that they pay attention to and connect up to the aggregate inflation statistics that monetary policymakers endeavor to monitor is crucial. Aggregating up own-firm unit cost expectations does just this. Moreover, during the current high inflation environment, we show that unit cost expectations perform similarly to other measures that elicit aggregate inflation concepts, highlighting its durability as a useful measure of the inflation expectations of firms.

[31] https://www.federalreserve.gov/newsevents/speech/powell20220826a.htm

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Panel A: Representativeness by Firm Size

	BIE	United States			Sixth Federal Reserve District States		
		Establishments	Employment	Annual Payroll	Establishments	Employment	Annual Payroll
Small (1–99 employees)	50.9	78.0	33.0	26.7	77.2	31.2	26.5
Medium (100–499 employees)	27.4	4.9	14.1	13.6	4.4	12.7	12.5
Large (500+ employees)	21.6	17.1	52.9	59.7	18.4	56.2	61.0

Panel B: Representativeness by Industry

	BIE	United States			Sixth Federal Reserve District States			Private (Nonfarm) GDP
		Establishments	Employment	Annual Payroll	Establishments	Employment	Annual Payroll	
Construction	11.9	9.1	5.1	5.9	8.5	5.1	5.9	5.1
Manufacturing	18.0	3.7	9.1	10.2	3.0	8.0	9.4	18.8
Educational services	1.7	1.3	2.9	2.1	1.2	2.1	1.7	1.6
Finance and Insurance	11.9	6.1	5.0	9.6	6.5	4.4	7.5	9.5
Health care and social assistance	3.2	11.5	15.8	14.8	11.1	14.5	15.6	7.9
Information	1.3	2.0	2.7	5.3	1.8	2.2	3.7	5.8
Leisure and hospitality	3.0	11.1	12.8	5.3	10.1	13.5	6.0	4.7
Mining and utilities	2.0	0.6	1.0	1.8	0.5	0.8	1.5	3.3
Other services except government	2.8	9.8	4.3	2.7	9.4	4.2	2.7	2.3
Professional and business services	13.0	17.8	18.9	23.8	18.8	22.4	26.4	12.9
Real estate and rental and leasing	7.8	5.2	1.7	1.7	5.7	1.8	1.9	12.4
Retail and wholesale trade	18.4	18.8	17.0	13.1	20.3	17.2	13.4	12.2
Transportation and warehousing	5.0	3.0	3.8	3.6	3.0	4.0	4.4	4.1

Sources: Census Bureau Statistics of U.S. Businesses 2017; Bureau of Economic Analysis; Federal Reserve Bank of Atlanta's Business Inflation Expectations Survey.

Notes: This table reports the share of U.S. firms. The Atlanta Fed territory covers the Sixth Federal Reserve District, which includes Alabama, Florida, Georgia, and portions of Louisiana, Mississippi, and Tennessee.

Table 1: BIE Panel Representativeness

Panel A: Instances of Bimodality			
	Count	Unit Cost Expectation	Unit Cost Uncertainty
Bimodal distributions	387	1.94	5.749
Unimodal distributions	24989	2.056	2.136
Panel B: Distribution of Bimodality			
Sector	Count	Share of responses	
Goods-producing	152	2.04	
construction	33	8.53	
Durable manufacturing	53	13.70	
Nondurable manufacturing	64	16.54	
Mining and Utilities	2	0.52	
Service-providing	235	1.29	
Educational services	1	0.26	
Finance and Insurance	27	6.98	
Health Care & Social Assistance	20	5.17	
Information	13	3.36	
Leisure and Hospitality	4	1.03	
Retail and wholesale trade	83	21.45	
Transportation and Warehousing	6	1.55	
Professional and business services	26	6.72	
Real Estate & Rental, Leasing	30	7.75	
Other services (excluding government)	25	6.46	
Firm size			
Small (1-99)	186	48.06	
Medium (100-499)	155	40.05	
Large (500+)	46	11.89	

Source: Authors' calculations.

Table 2: Instances of Bimodality in Firms' 1-Year Ahead Unit Cost Expectations

Panel A: 2011Q4 – 2019Q4

Surveys	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) BIE	1.000						
(2) UM	-0.014	1.000					
(3) SPF CPI	0.550***	-0.380**	1.000				
(4) SPF PCE	0.464***	-0.085	0.723***	1.000			
(5) SPF PGDP	0.818***	-0.470***	0.809***	0.589***	1.000		
(6) SPF Core CPI	0.645***	-0.622***	0.780***	0.678***	0.799***	1.000	
(7) SPF Core PCE	0.590***	-0.4738***	0.742***	0.780***	0.790***	0.907***	1.000

Panel B: 2011Q4 – 2022Q2

Surveys	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) BIE	1.000						
(2) UM	0.894***	1.000					
(3) SPF CPI	0.877***	0.619***	1.000				
(4) SPF PCE	0.821***	0.628***	0.910***	1.000			
(5) SPF PGDP	0.926***	0.614***	0.946***	0.898***	1.000		
(6) SPF Core CPI	0.793***	0.392***	0.901***	0.900***	0.909***	1.000	
(7) SPF Core PCE	0.778***	0.419***	0.889***	0.930***	0.905***	0.967***	1.000

Note: The sample period for Panel A starts in 2011q4 and ends in 2019Q4 (right before the start of the pandemic). Panel B includes 10 additional quarters during the pandemic (through 2022q2). The comparisons use the mean BIE and the median measures for the University of Michigan's Survey of Consumers (UM) and Philadelphia Fed Survey of Professional Forecasters (SPF), as the medians are more widely cited in academic research, by policymakers, and in newswires. Using the mean UM and SPF measures does not qualitatively (or quantitatively) alter the results. Additionally, we use the highest frequency data available when estimating the correlation. This implies that the SPF comparisons use quarterly data while the comparison between the BIE and UM measures use monthly data. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 3: Time Series Correlations between One-year Ahead Inflation Expectations

Model	RMSE CPI	RMSE Core CPI	RMSE PCE	RMSE Core PCE	MAE CPI	MAE Core CPI	MAE PCE	MAE Core PCE
Panel A: Oct. 2012 – Dec. 2019								
Benchmark								
ARMA(1, 1)	1.48	1.05	1.24	0.87	1.24	0.39	0.87	0.59
Firms								
BIE	0.57**	0.55*	0.78	0.95	0.50**	0.53**	0.72	0.54*
BIE:Supersector 1	0.55**	0.60**	0.78	1.00	0.49**	0.55**	0.72	0.54*
BIE:Supersector 2	0.56**	1.00	0.77	1.00	0.55**	0.91	0.74	0.64*
BIE:Supersector 3	0.62**	0.75	0.85	1.17	0.55**	0.71	0.78	0.67
BIE:Supersector 4	0.58**	0.56**	0.80	0.97	0.50**	0.55*	0.71	0.53*
Consumers								
MSC:Mean	1.52***	3.73***	2.23***	4.89***	1.61***	4.10***	2.49***	3.23***
MSC:Median	1.10	2.24***	1.61***	3.24***	1.09	2.38***	1.72***	2.10***
MSC:Low income	2.18***	6.02***	3.16***	7.38***	2.30***	6.30***	3.46***	4.66***
MSC:Medium income	1.37***	3.35***	2.05***	4.49***	1.51***	3.78***	2.34***	3.01***
MSC:High income	1.10	2.42***	1.62***	3.36***	1.10	2.43***	1.74***	2.12***
Professional forecasters								
BCEI	0.60**	0.61***	0.88	1.30**	0.54*	0.56***	0.87	0.82
Panel B: Oct. 2012 – Sep. 2022								
Benchmark								
ARMA(1, 1)	1.93	1.14	1.41	0.94	1.59	0.73	1.12	0.59
Firms								
BIE	1.06	1.09	1.10	1.08	0.79	0.90	0.95	1.10
BIE:Supersector 1	1.02	1.04	1.06	1.05	0.77	0.89	0.93	1.10
BIE:Supersector 2	0.97	0.98	0.98	0.95	0.77	0.95	0.90	1.07
BIE:Supersector 3	1.04	1.05	1.08	1.07	0.81	0.93	0.96	1.17
BIE:Supersector 4	1.09	1.14	1.14	1.14	0.80	0.93	0.95	1.12
Consumers								
MSC:Mean	1.20	1.43	1.57	1.98	1.30*	2.04**	1.80**	2.93**
MSC:Median	1.07	1.08	1.27	1.42	1.05	1.46	1.42	2.07*
MSC:Low income	1.54	2.25	2.16*	3.01**	1.66*	3.08***	2.42**	4.28**
MSC:Medium income	1.10	1.36	1.47	1.90	1.21	1.98	1.71	2.83*
MSC:High income	1.01	1.08	1.23	1.42	0.98	1.42	1.36	2.05
Professional forecasters								
BCEI	1.11	1.16	1.18	1.20	0.83	0.95	1.07	1.38

Note: The forecast exercises compare the survey of agents expectations with an ARMA(1, 1) in forecasting month-over-month annualized inflation. We do this by comparing, for example, the BIE 1-year ahead unit cost expectation made in October 2011 to realized inflation in October 2012. The ARMA(1, 1) model is estimated using all data available for a given price index prior to September 2021. We generate year-ahead forecast for each month from October 2012 through September 2022 which are then taken as the benchmark values. The estimation sample is updated recursively each period with the initialization being the price index's earliest observation. The reported values, with the exception of the benchmark, are the ratio of the forecasts accuracy statistic to that of the benchmark. If the value is less than 1, then that survey was more accurate than the ARMA(1, 1). The exception is the benchmark value which is the raw accuracy statistic value. The Blue Chip Economic Indicators (BCEI) series reports the average forecast for CPI inflation specifically. We apply it to other measures of inflation since it is the only monthly frequency measure of professional expectations. With the exception of "MSC:Median", all reported Michigan Survey of Consumers (MSC) values are the mean. The BIE supersectors are defined as follows: (1) Construction, mining and utilities, and real estate, rental and leasing; (2) Durable and non-durable goods manufacturing; (3) Retail and wholesale trade and transportation and warehousing; (4) Educational services, finance and insurance, healthcare and social assistance, information, leisure and hospitality, other services except government, and professional and business services. The sample for Panel A runs from October 2012 through December 2019. Panel B includes data through the pandemic period (ending in September 2022). The stars in the table represent the significance of the Diebold-Mariano test for the forecast accuracy between the survey and the benchmark. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 4: Pseudo Out-of-sample Forecasting at the Monthly Frequency with ARMA(1, 1) Benchmark

Model	RMSE CPI	RMSE Core CPI	RMSE PCE	RMSE Core PCE	RMSE PGDP	MAE CPI	MAE Core CPI	MAE PCE	MAE Core PCE	MAE PGDP
Panel A: 2012q4 − 2019q4										
Benchmark										
ARMA(1, 1)	1.22	0.45	0.87	0.41	0.75	1.06	0.39	0.72	0.34	0.64
Firms										
BIE	0.66***	0.51**	0.92	0.91	0.74**	0.55***	0.48**	0.85	0.94	0.66***
BIE:Supersector 1	0.63***	0.47**	0.90	0.91	0.73*	0.53***	0.43**	0.84	0.89	0.64***
BIE:Supersector 2	0.64***	0.95	0.89	1.09	0.70*	0.62**	0.86	0.89	1.06	0.72**
BIE:Supersector 3	0.72**	0.70*	1.00	1.10	0.82	0.56***	0.66	0.92	1.10	0.74*
BIE:Supersector 4	0.67**	0.50**	0.94	0.92	0.77*	0.56***	0.50***	0.84	0.90	0.69**
Consumers										
MSC:Mean	1.82**	3.76***	2.67***	4.84***	2.67***	1.88***	4.08***	3.00***	5.66***	2.91***
MSC:Median	1.30*	2.26**	1.93**	3.20***	1.81**	1.26*	2.37**	2.07***	3.69***	1.87**
MSC:Low income	2.54***	5.88***	3.70***	7.10***	3.87***	2.69***	6.28***	4.17***	8.19***	4.24***
MSC:Medium income	1.63***	3.33***	2.44***	4.39***	2.42***	1.76***	3.75***	2.82***	5.28***	2.71***
MSC:High income	1.30	2.37**	1.93**	3.26***	1.81**	1.28	2.40**	2.09**	3.72***	1.92**
Professional forecasters										
BCEI	0.71*	–	–	–	0.67***	0.62**	–	–	–	0.62***
SPF	0.70**	0.61***	0.92	0.79***	0.72**	0.61**	0.62***	0.86	0.86***	0.66***
Panel B: 2012q4 − 2022q3										
Benchmark										
ARMA(1, 1)	1.82	1.13	1.36	0.94	1.32	1.43	0.73	1.00	0.57	0.96
Firms										
BIE	1.11	1.08	1.13	1.07	1.25	0.85	0.88	1.04	1.14	1.02
BIE:Supersector 1	1.07	1.03	1.09	1.03	1.21	0.82	0.84	1.02	1.13	0.99
BIE:Supersector 2	1.01	0.96	1.00	0.93	1.12	0.92	0.93	0.99	1.08	0.98
BIE:Supersector 3	1.09	1.05	1.11	1.06	1.22	0.88	0.91	1.06	1.19	1.04
BIE:Supersector 4	1.15	1.14	1.17	1.13	1.30	0.87	0.92	1.05	1.15	1.05
Consumers										
MSC:Mean	1.26	1.42	1.61	1.96	1.50	1.44	2.05*	2.01**	3.04**	1.91*
MSC:Median	1.12	1.07	1.30	1.40	1.27	1.15	1.46	1.58	2.17*	1.47
MSC:Low income	1.58	2.14	2.16	2.89*	2.01	1.81	3.02*	2.66*	4.43**	2.51**
MSC:Medium income	1.15	1.32	1.49	1.85	1.37	1.34	1.94	1.90	2.95*	1.78
MSC:High income	1.05	1.04	1.24	1.38	1.18	1.08	1.41	1.52	2.14	1.40
Professional forecasters										
BCEI	1.16	–	–	–	1.36	0.91	–	–	–	1.07
SPF	1.15	1.16	1.20	1.20	1.34	0.90	0.99	1.08	1.22	1.07

Note: The forecast exercises compare the survey of agents expectations with an ARMA(1, 1) in forecasting quarter-over-quarter annualized inflation. We do this by comparing, for example, the BIE 1-year ahead unit cost expectation made in 2011q4 to realized inflation in 2012q4. The ARMA(1, 1) model is estimated using all data available for a given price index prior to 2021q3. Therefore, the estimation sample start date varies depending on the price index and the end date is always the quarter we are generating the forecast for. We generate year-ahead forecast for each quarter from 2012q4 through 2021q3 which are then taken as the benchmark values. The estimation sample is updated recursively each period with the initialization being the price index's earliest observation. The reported values, with the exception of the benchmark, are the ratio of the forecasts accuracy statistic to that of the benchmark. If the value is less than 1, then that survey did better than the ARMA(1, 1). The exception is the benchmark value which is the raw accuracy statistic value. The Blue Chip Economic Indicators (BCEI) series reports the average forecast for CPI and PGDP inflation specifically. With the exception of "MSC:Median", all reported Michigan Survey of Consumers (MSC) values are the mean. The BIE supersectors are defined as follows: (1) Construction, mining and utilities, and real estate, rental and leasing; (2) Durable and non-durable goods manufacturing; (3) Retail and wholesale trade and transportation and warehousing; (4) Educational services, finance and insurance, healthcare and social assistance, information, leisure and hospitality, other services except government, and professional and business services. The sample for Panel A runs from 2012q4 through 2019q4. Panel B includes data through the pandemic period (ending in 2022q3). The stars in the table represent the significance of the Diebold-Mariano test for the forecast accuracy between the survey and the benchmark. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 5: Pseudo Out-of-sample Forecasting at the Quarterly Frequency

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Unit cost expectations	0.420***	0.253***	0.281***	0.129*	0.331***	0.238***	0.284***	0.197**	0.360***
	(0.109)	(0.084)	(0.055)	(0.074)	(0.064)	(0.053)	(0.045)	(0.061)	(0.028)
Unit cost growth	0.027	0.064	-0.021	0.012	-0.033	0.077*	0.024	(0.054)	0.083***
	(0.073)	(0.076)	(0.046)	(0.047)	(0.046)	(0.041)	(0.039)	(0.047)	(0.023)
Sales level	0.178*	0.022	-0.066	0.062	0.002	-0.034	-0.054	-0.005	0.043
	(0.096)	(0.124)	(0.065)	(0.060)	(0.060)	(0.068)	(0.062)	(0.063)	(0.030)
Sector FE	N	N	N	N	N	N	N	Y	
Period	Jun 2013	Feb 2019	Nov 2019	Dec 2020	Apr 2021	Jul 2021	Nov 2021	Mar 2022	Pooled
Observations	184	90	240	200	197	175	181	180	1,446
R^2	0.196	0.180	0.120	0.047	0.190	0.252	0.253	0.137	0.297

Source: FRBA Business Inflation Expectations (BIE) Survey.

Notes: In Columns (1) to (8), regressions are estimated via OLS of the form: $E_t p_{f,t+h} = \beta E_t uc_{f,t+1} + \theta uc_{f,t}^{perc} + \lambda s_{f,t} + \epsilon_{f,t}$, where $E_t p_{f,t+h}$ is year-ahead price change expectations (for a given month), $E_t uc_{f,t+1}$ is firms' unit cost expectations, $uc_{f,t}^{perc}$ is year-over-year unit cost realizations, and $s_{f,t}$ is sales level. Columns (1) through (8) use the responses to special questions on expected prices elicited in June 2013, February 2019, November 2019, December 2020, April 2021, July 2021, November 2021, and March 2022, respectively. Column (9) reports the result from a pooled regression across these eight special surveys. Given changes in question formatting, responses to all covariates except the discrete "Sales level" variable were normalized. For the period corresponding to February 2019, we only consider price expectations less than or equal to 10 percent. We then normalize the values reported. For periods after February 2019, the price expectations were also winsorized at the 5% and 95% levels prior to normalization. The "Sales level" variable is a qualitative core monthly question. We transform it into an indicator variable denoting whether a firm had sales levels that were higher than "normal" during the given month. Heteroskedasticity-robust standard errors are reported in parenthesis for Columns (1)–(8). Cluster-robust standard errors are reported in Column (9) and they are are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 6: Relationship Between Unit Cost Expectations and Price Change Expectations

Variables	(1)	(2)	(3)	(4)	(5)
(1) Realized Price Change	1.000				
(2) Aggregate Inflation Expectation	0.010	1.000			
(3) Expected Price Change	0.468***	0.046	1.000		
(4) Lagged Unit Cost Expectation	0.101	0.065	0.235**	1.000	
(5) Unit Cost Growth	0.171**	0.031	0.248**	0.307***	1.000

Source: FRBA Business Inflation Expectations (BIE) Survey.
Notes: (1) Realized price change is the winsorized (2.5%, 97.5%) and annualized 3-month price change realizations gathered from respondents quarterly from January 2019 to January 2020. (2) Aggregate Inflation is probabilistic 1-year ahead CPI expectations elicited in January 2019. (3) Expected price change is the probabilistic 1-year ahead price change expectations elicited in February 2019. (4) Lagged 1-year ahead unit cost expectations were gathered from respondents in January 2019. (5) Unit cost growth is the perceived unit cost growth over the past 12 months from the January 2020 survey. Pairwise correlations reported. ***, **, and * correspond to statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7: Realized Price Changes and Expectations: January 2019 to January 2020

Panel A: Forecasts for 2021 Aggregate Inflation				
	Mean	P25	P75	N
Treatment Group				
Lowest potential rate of inflation	1.22	1.00	1.50	101
Highest potential rate of inflation	3.07	2.50	3.50	101
Spread (highest - lowest)	1.85	1.00	2.00	101
Control Group				
Lowest potential rate of inflation	1.17	1.00	1.50	99
Highest potential rate of inflation	3.01	2.00	3.50	99
Spread (highest - lowest)	1.84	1.00	2.50	99
Panel B: Forecasts for 2022 Aggregate Inflation				
	Mean	P25	P75	N
October 2021 Treatment Group				
All firms	4.40	3.00	5.00	92
Existing firms that received the treatment in 2020	**3.77**	3.00	5.00	40
Existing firms in the control group in 2020	4.27	2.95	5.00	35
Newly added firms	6.14	3.70	6.25	17
October 2021 Control Group				
All firms	4.92	3.00	5.00	89
Existing firms that received the treatment in 2020	**5.12**	3.00	5.50	33
Existing firms in the control group in 2020	4.67	3.00	5.00	46
Newly added firms	5.42	3.25	7.50	10

Note: Results obtained via RCT special questions posed to the panel during October 2020 and October 2021. In October 2020, Treatment: [Based on forecasts over the past 20 years, there is a 70 percent chance that actual inflation will be in the range of 0.7 percent to 2.7 percent over calendar year 2021.] Question: What is your best estimate for the highest and lowest potential rate of inflation over calendar year 2021? 206 panelists responded to the BIE special questions in October 2020. Responses above 10% were excluded from these tables (4 from the treatment group and 2 from the control group). In October 2021, Treatment: [The median expectation of monetary policymakers (as of September 22) for the annual rate of inflation over calendar year 2022 is 2.2 percent.] Question: What do you think the annual rate of inflation will be over calendar year 2022? T-tests were performed on all control-treatment pairings above with the exception of "Newly added firms" due to the small sample size. We fail to reject the null hypothesis of equal expectations in all instances with one exception. The exception is firms that were treated in both periods. For these firms, we reject the null hypothesis of equal aggregate inflation expectations (highlighted in bold) at the 5% significance level.

Table 8: RCT: Impact of Monetary Policymakers' Inflation Projections on Firms' Aggregate Inflation Expectations

	Post-treat unit cost expectation	Post-treat unit cost uncertainty
Information treatment	0.068	-0.044
	(0.11)	(0.11)
Pre-treat unit cost expectation	0.808***	
	(0.03)	
Pre-treat unit cost uncertainty		0.776***
		(0.03)
Observations	327	327
R^2	0.660	0.684

Notes: This table reports the regression results of information treatments on own-firm unit cost expectations and uncertainty. The above results are obtained via the pooled OLS regression of post-treat unit cost expectation (or uncertainty) on information treatment and pre-treat unit cost expectation (or uncertainty). Post-treat unit cost expectations/uncertainty are obtained in November 2020 and November 2021. Information treatment is a dummy variable corresponding to whether or not a given firm received information treatment in October 2020 and October 2021. In October 2020, the treatment group received the following information: "Based on forecasts over the past 20 years, there is a 70 percent chance that actual inflation will be in the range of 0.7 percent to 2.7 percent over calendar year 2021." In October 2021, the treatment group received the following information: "The median expectation of monetary policymakers (as of September 22) for the annual rate of inflation over calendar year 2022 is 2.2 percent." Pre-treat unit cost expectations/uncertainty are obtained in October 2020 and October 2021 elicited prior to the information treatment in the questionnaire. In the reported regressions, we control for firm size and industry fixed effects, but the results without controls are quantitatively similar. Cluster-robust standard errors are reported and they are clustered at the firm level. *** denotes significance at the 1% level.

Table 9: RCT: Influence of Monetary Policymakers' Inflation Projections on Firms' Unit Cost Expectations and Uncertainty

Projecting ahead, to the best of your ability, please assign a percent likelihood to the following changes to UNIT COSTS over the next twelve months. (Values should sum to 100%)

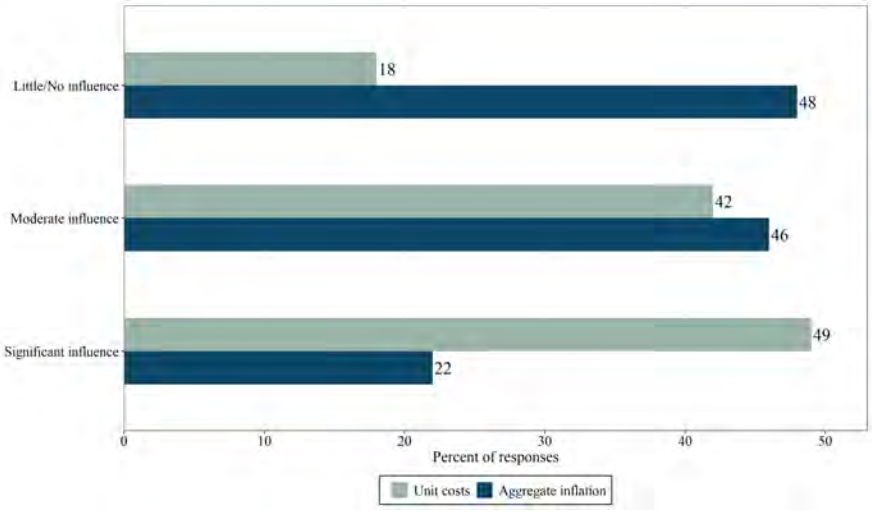
For example, if you think each of these is equally likely, you might answer 20% for each:

Unit costs down (less than -1%)	20
Unit costs about unchanged (-1% to 1%)	20
Unit costs up somewhat (1.1% to 3%)	20
Unit costs up significantly (3.1% to 5%)	20
Unit costs up very significantly (more than 5%)	20
Total	100

Unit costs down (less than -1%)	0	%
Unit costs about unchanged (-1% to 1%)	0	%
Unit costs up somewhat (1.1% to 3%)	0	%
Unit costs up significantly (3.1% to 5%)	0	%
Unit costs up very significantly (more than 5%)	0	%
Total	0	%

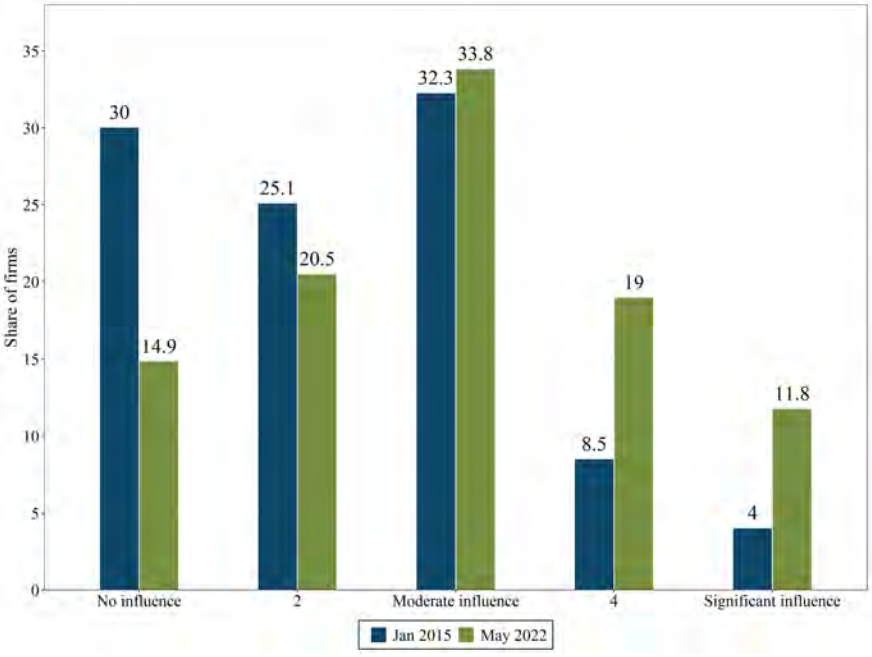
Source: FRBA Business Inflation Expectations (BIE) Survey.
Notes: The above figure is a screenshot of the actual current questionnaire fielded using Qualtrics. A sum of probabilities is calculated in real-time and shown in red if it does not sum to 100 percent. A respondent is not required to have probabilities sum to 100 percent before continuing on with the questionnaire. In practice, approximately 2 percent of responses to this question sum to something other than 100 percent.

Figure 1: BIE Survey Questionnaire: Probabilistic Unit Cost Expectations



(a) Influence of Inflation on Firms' Pricing Decisions

Source: FRBA Business Inflation Expectations (BIE) Survey, September 2015.
Notes: The above bar graph plots the results of a September 2015 special question. Question: On a scale from 1 to 5, with 1 being "no influence," please indicate what level of influence, if any, your expectation regarding [the economy's overall rate of inflation (given to panel A)] [your own unit costs (given to panel B)] has(have) on your pricing decisions? 1 - no influence; 2, 3- moderate influence, 4, 5-significant influence.

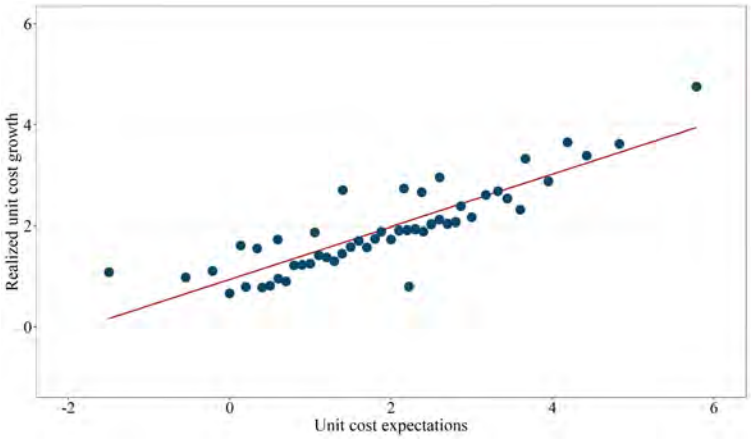


(b) Influence of Inflation on Business Decisions

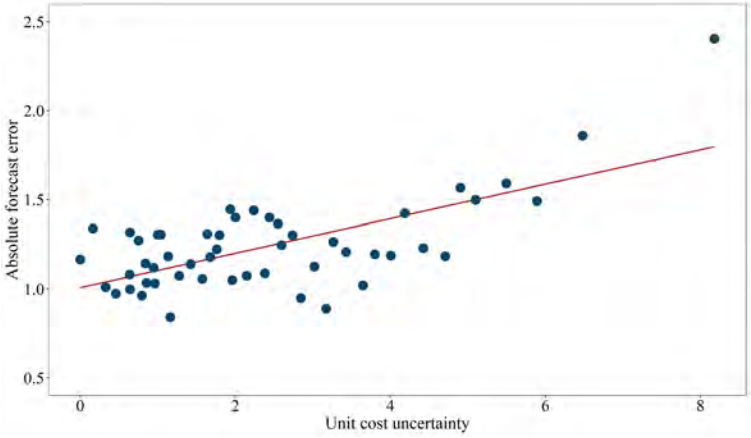
Source: FRBA Business Inflation Expectations (BIE) Survey, January 2015 and May 2022.
Notes: The above bar graph plots Likert scale responses to the following question which was asked in both a low and high inflation environment: "What level of influence do price indexes (like the Consumer Price Index, or CPI) have on your business decisions." Response options ranged from 1 (none) to 5 (significant).

Figure 2: Influence of Inflation on Business Decisions and Pricing Decisions

(a) Firm's Unit Cost Expectations vs. Realizations (Perceptions)

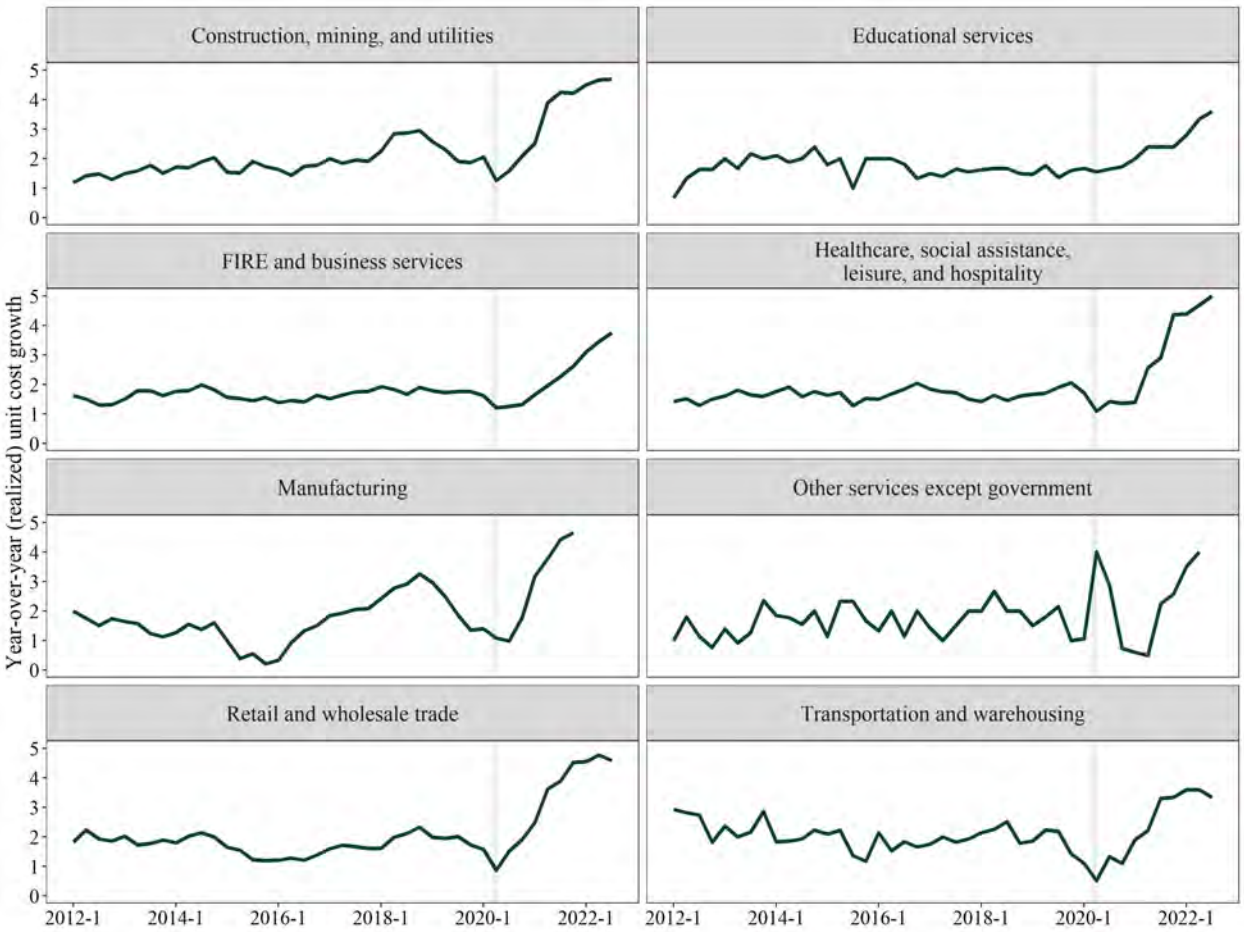


(b) Firm's Uncertainty vs. Absolute Forecast Errors



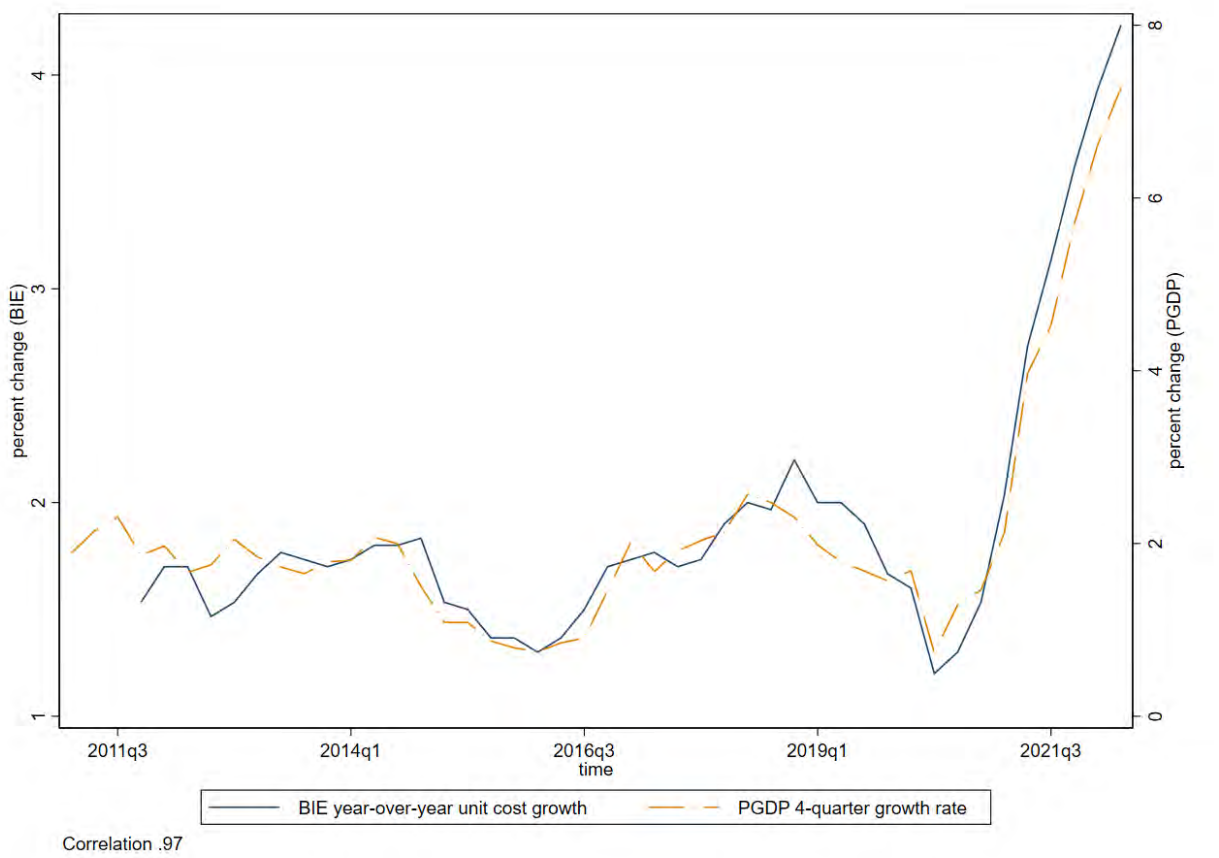
Source: FRBA Business Inflation Expectations (BIE) Survey
Note: The binscatters (51 bins) in panel (a) compare respondents' 1-year ahead unit cost expectations (lagged by 12 months) to their realized (perceived) year-over-year unit cost growth outcomes. For panel (a), the regression statistics are: $\beta = 0.546$, $R^2 = 0.158$, t-value $= 53.77$, and N $= 15359$. The binscatters (51 bins) in panel (b) compare respondents' 1-year ahead unit cost uncertainty (lagged by 12 months) to their realized absolute forecast errors (unit cost outcome minus 12-month lagged unit cost projection). For panel (b), the regression statistics are: $\beta = 0.092$, $R^2 = 0.018$, t-value $= 17.09$, and N $= 15359$.

Figure 3: Firms' Unit Cost Expectations, Uncertainty and Realizations



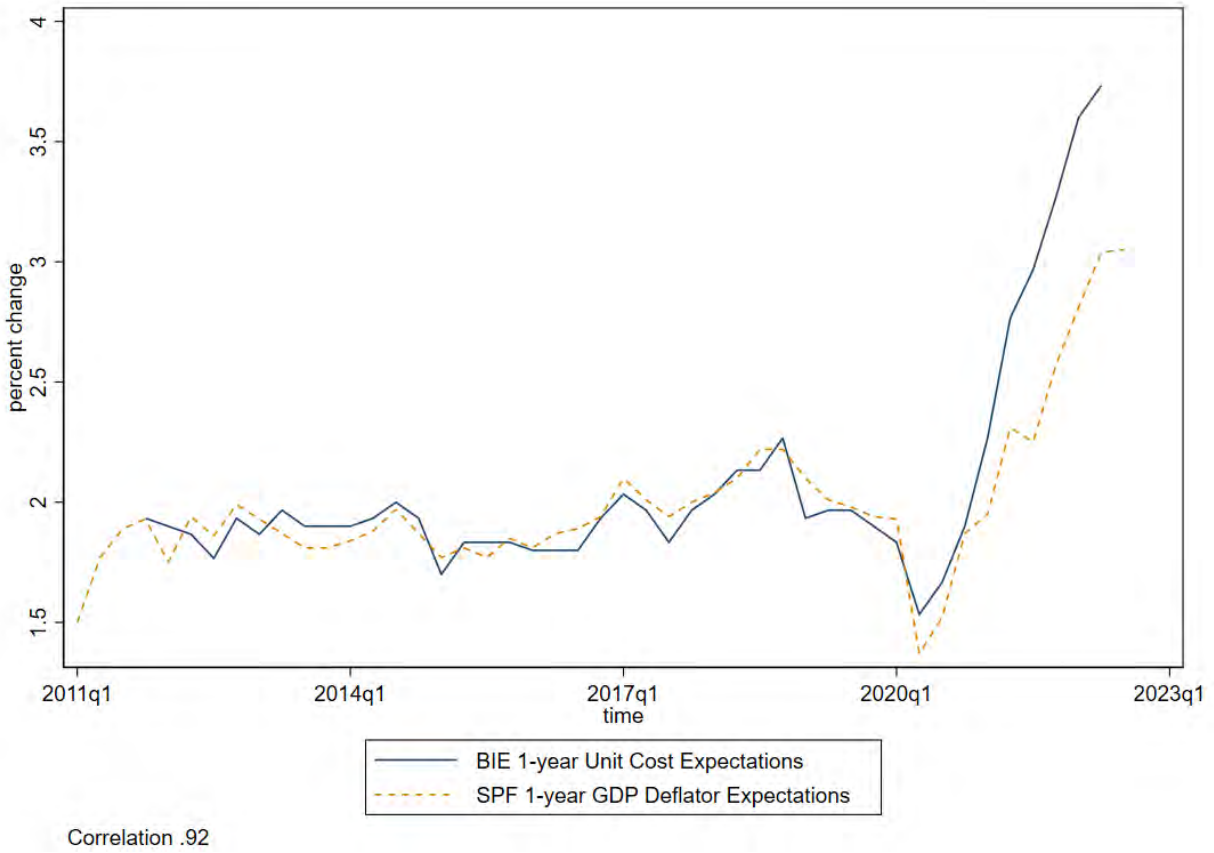
Source: FRBA Business Inflation Expectations (BIE) Survey.
Notes: The sample period is 2012q1 to 2022q2. The term "FIRE" refers to finance and insurance and real estate, rental and leasing firms.

Figure 4: Sectoral-level Year-over-year Unit Cost Growth



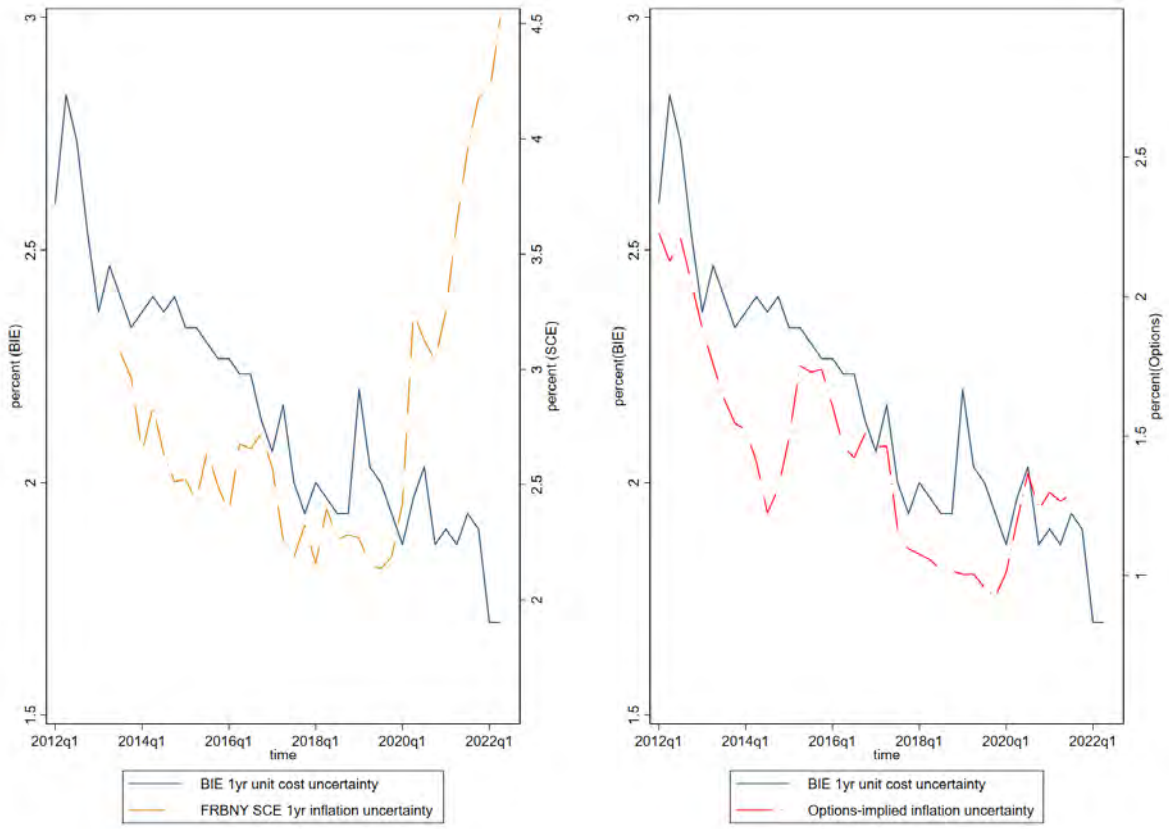
Sources: Bureau of Economic Analysis; FRBA Business Inflation Expectations (BIE) Survey.
Notes: The sample period begins in 2011q3 and ends in 2022q2. The BIE series are weighted by industry-share of GDP and quarterly averages are plotted. Given the nature of the panel, the most apt comparison is to the broadest notion of overall inflation (i.e. GDP price index). The BIE series is plotted on the left axis and the GDP Price Index is plotted on the right axis.

Figure 5: Firms' Realized Unit Cost Growth vs Actual Inflation



Sources: FRBA Business Inflation Expectations (BIE) Survey; FRBP Survey of Professional Forecasters
Notes: Data from 2011q3 through 2022q2. The SPF data is quarterly. For comparison, we plot the BIE using quarterly averages.

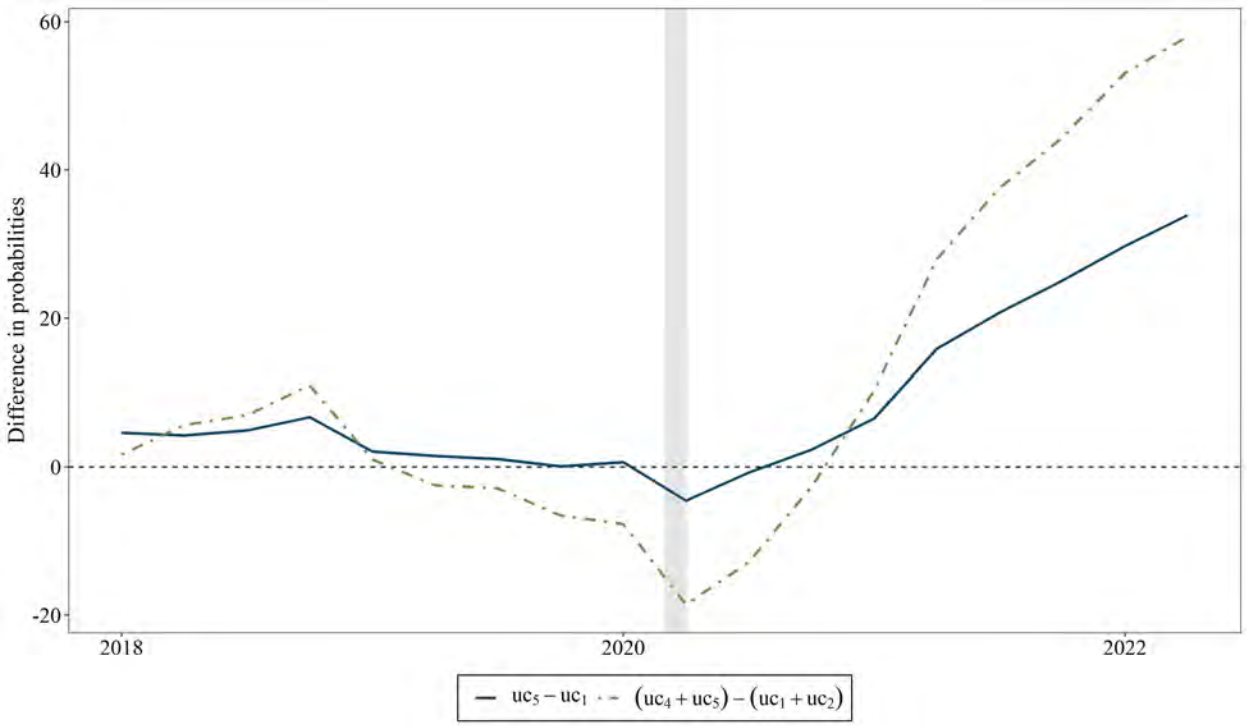
Figure 6: Year-Ahead Inflation Expectations of Firms and Professionals



Sources: FRBA Business Inflation Expectations (BIE) Survey; FRBNY Survey of Consumer Expectations (SCE); Bloomberg

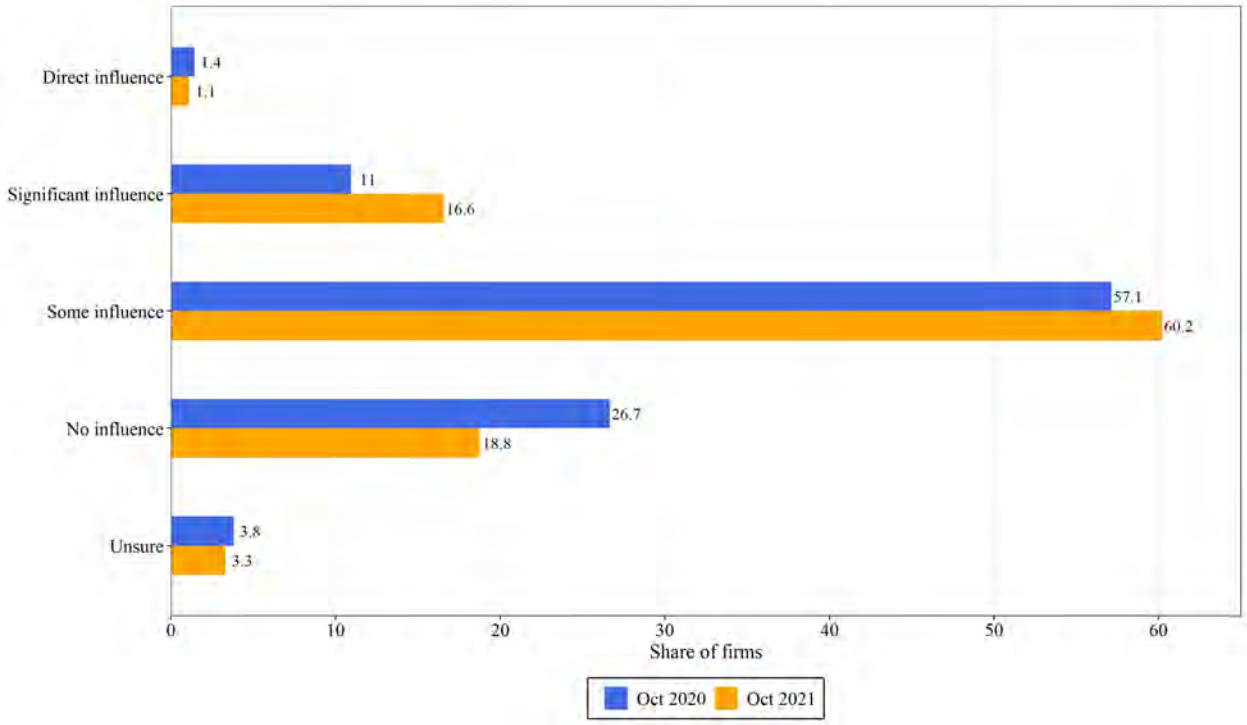
Note: For each graph above, the BIE series is plotted on the left-hand axis and the comparison series on the right.

Figure 7: Measures of Inflation Uncertainty



Sources: FRBA Business Inflation Expectations (BIE) Survey
Note: Data plotted from January 2018 through August 2022. Construction of these indexes is simple. For the solid line, it is the average weight respondents attach to the highest bin (increases of greater than 5 percent) minus the average weight attached to the lowest bin (down more than 1 percent). The dashed line is constructed similarly, taking the sum of the average weight in the upper two bins minus the sum of the weight in the lower two bins.

Figure 8: Measures of Inflation Risk



Sources: FRBA Business Inflation Expectations (BIE) Survey
Notes: The above bar graph plots the results of an October 2020 and 2021 special question. During both waves the respondents were asked the exact same question. Question: Which of the following best describes how useful, if at all, the inflation expectations of monetary policymakers are when forecasting potential changes to your own unit costs and/or prices?

Figure 9: Influence of Monetary Policymakers' Inflation Projections on Unit Costs and/or Prices Expectations

Online Appendix

Unit Cost Expectations and Uncertainty: Firms' Perspectives on Inflation

by Brent Meyer and Xuguang Simon Sheng

This online appendix contains four sections. In Appendix A we provide additional tables and graphs. In Appendix B we compare the Atlanta Fed's BIE Survey probabilistic binned response approach to a more flexible approach used by the Survey of Business Uncertainty. Appendix C illustrates fitting the bimodal asymmetric power normal distribution to three histograms, compared to fitting the normal and beta distribution. Finally, Appendix D provides the screenshot of additional questions posed to respondents in the BIE survey.

Appendix A Additional Tables and Graphs

Business Inflation Expectations Survey: Descriptive Statistics (Weighted Mean)							
	Unit cost expectations	Unit cost perceptions	Nonparam. uncertainty	Parame. uncertainty	Forecast error	Abs. forecast error	N
Overall BIE panel	2.143	2.003	2.112	2.447	0.037	1.255	16,744
	(0.011)	(0.014)	(0.014)	(0.013)	(0.014)	(0.01)	
By Firm Size							
Small (1-99 employees)	2.238	2.097	1.979	2.315	0.0314	1.148	7,192
	(0.017)	(0.021)	(0.020)	(0.020)	(0.019)	(0.013)	
Medium (100-499 employees)	2.154	1.984	2.340	2.669	0.0256	1.430	4,878
	(0.019)	(0.028)	(0.028)	(0.027)	(0.029)	(0.020)	
Large (500+ employees)	1.960	1.857	2.083	2.421	0.0593	1.244	4,674
	(0.018)	(0.024)	(0.026)	(0.026)	(0.025)	(0.017)	
By Nonfarm Private Industry (2-Digit NAICS)							
Construction	2.661	2.619	2.255	2.597	0.181	1.359	1,438
	(0.047)	(0.057)	(0.056)	(0.056)	(0.054)	(0.039)	
Durable goods manufacturing	2.229	2.140	2.229	2.564	0.017	1.688	1,791
	(0.037)	(0.054)	(0.037)	(0.037)	(0.056)	(0.038)	
Educational services	2.346	1.933	1.897	2.241	-0.16	0.928	476
	(0.044)	(0.041)	(0.072)	(0.072)	(0.061)	(0.044)	
Finance and insurance	1.523	1.157	1.915	2.254	-0.17	1.213	1,623
	(0.030)	(0.042)	(0.052)	(0.052)	(0.042)	(0.029)	
Health care and social assistance	2.094	1.877	2.605	2.949	-0.01	1.249	698
	(0.042)	(0.059)	(0.075)	(0.075)	(0.062)	(0.042)	
Information	2.823	2.759	1.840	2.175	0.164	1.017	474
	(0.066)	(0.080)	(0.082)	(0.083)	(0.063)	(0.043)	
Leisure and hospitality	2.233	2.031	1.579	1.911	-0.00	1.192	515
	(0.067)	(0.069)	(0.065)	(0.065)	(0.069)	(0.050)	
Mining and utilities	1.707	1.326	2.169	2.504	-0.34	1.099	448
	(0.055)	(0.070)	(0.064)	(0.064)	(0.068)	(0.048)	
Nondurable goods manufacturing	2.107	2.075	2.633	2.924	0.165	1.557	1,203
	(0.045)	(0.062)	(0.076)	(0.072)	(0.061)	(0.041)	
Other services except government	2.422	2.137	2.520	2.863	0.117	1.145	175
	(0.076)	(0.107)	(0.175)	(0.176)	(0.133)	(0.101)	
Professional and business services	2.437	2.184	2.175	2.514	-0.09	1.159	2114
	(0.030)	(0.040)	(0.038)	(0.038)	(0.036)	(0.025)	
Real estate and rental and lease	1.903	1.742	1.870	2.204	-0.01	1.138	1,629
	(0.030)	(0.034)	(0.040)	(0.040)	(0.038)	(0.026)	
Retail and wholesale trade	2.145	2.133	2.114	2.449	0.196	1.236	3,489
	(0.022)	(0.029)	(0.029)	(0.029)	(0.028)	(0.020)	
Transportation and warehousing	2.359	2.152	1.740	2.079	-0.08	1.141	671
	(0.044)	(0.053)	(0.065)	(0.065)	(0.061)	(0.044)	

Source: Authors' calculations.
Note: This sample begins in October 2011 and runs through August 2022 but restricts the observations to those for which we are able to calculate direct(t, t+12) forecast errors. The resulting 16,744 observations comprise approximately 64 percent of all useable observations (complete responses to the questionnaire). Responses are weighted by industry-share of GDP.

Table A.1: Descriptive Statistics

Panel A: 2011m10 – 2020m02					
Variables	(1)	(2)	(3)	(4)	(5)
(1) BIE 1yr	1.000				
(2) BlueChip 1yr CPI	0.149	1.000			
(3) BlueChip 1yr PGDP	0.691***	0.387***	1.000		
(4) UM 1yr	0.031	-0.491***	-0.304***	1.000	
(5) TIPS 5yr forward	0.164*	-0.486***	-0.228**	0.799***	1.000
Panel B: 2011m10 – 2022m08					
Variables	(1)	(2)	(3)	(4)	(5)
(1) BIE 1yr	1.000				
(2) BlueChip 1yr CPI	0.815***	1.000			
(3) BlueChip 1yr PGDP	0.882***	0.866***	1.000		
(4) UM 1yr	0.881***	0.702***	0.692***	1.000	
(5) TIPS 5yr forward	0.185**	0.080	0.144*	0.381***	1.000

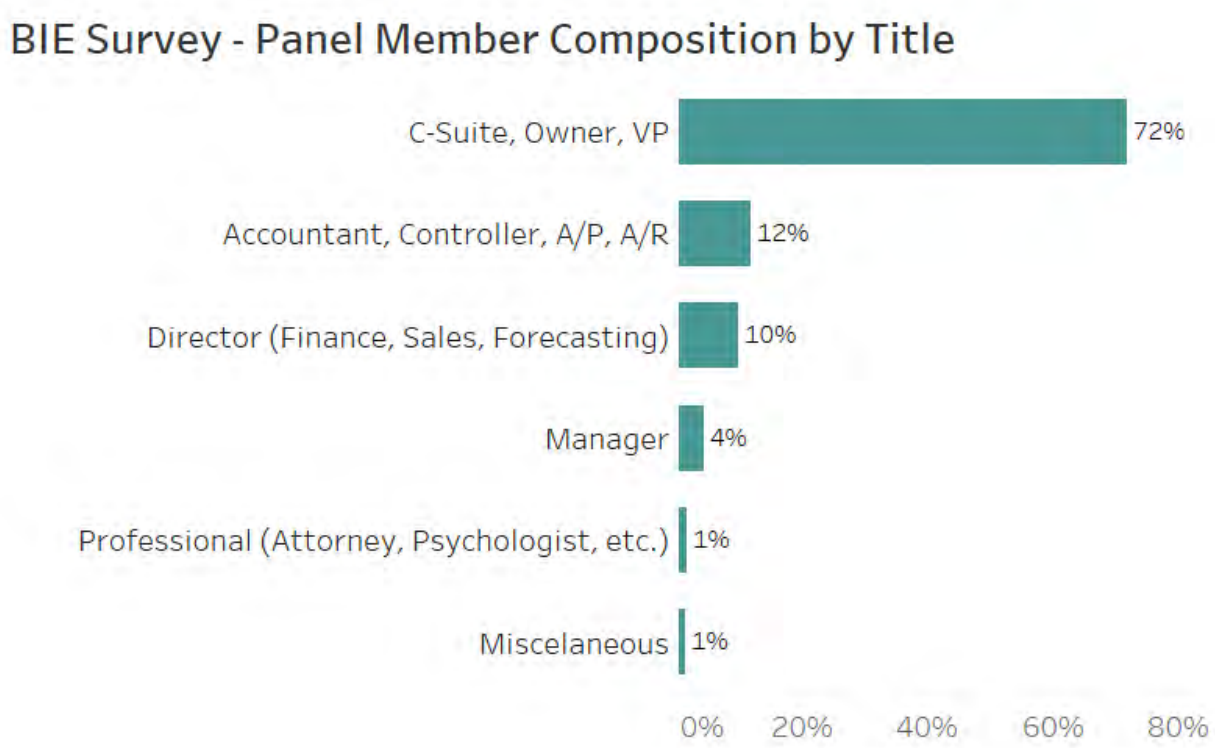
Sources: FRBA Business Inflation Expectations (BIE) Survey; Blue Chip Economist Panel; University of Michigan's Survey of Consumers; Haver Analytics
Notes: The sample starts in October 2011 and ends in August 2022. Panel A restricts the sample to the pre-COVID timeperiod. The comparisons use the mean BIE and the median measures for the University of Michigan's Survey of Consumers (UM). The Blue Chip 1-year ahead is calculated from consensus forecasts. TIPS breakeven and forward inflation rate calculated by Haver Analytics. *, **, *** denote significance at the 1%, 5%, and 10% levels, respectively.

Table A.2: Time Series Correlations between Monthly Inflation Expectations

Panel A: Lowest and Highest Forecasts for 2021 inflation				
	Mean	P25	P75	N
Treatment Group				
Lowest rate of potential inflation	1.77	1.00	2.00	105
Highest rate of potential inflation	4.37	2.50	3.50	105
Spread (highest - lowest)	2.60	1.00	2.00	105
Control Group				
Lowest rate of potential inflation	3.19	1.00	1.70	101
Highest rate of potential inflation	4.89	2.00	4.00	101
Spread (highest - lowest)	2.66	1.00	3.00	101
Panel B: Revisions to Expectations and Uncertainty				
	Mean	P25	P75	N
Treatment Group				
Difference in unit cost expectations (Nov - Oct)	0.14	-0.40	0.70	85
Difference in unit cost uncertainty (Nov - Oct)	-0.19	-0.60	0.32	85
Control Group				
Difference in unit cost expectations (Nov - Oct)	0.02	-0.40	0.20	82
Difference in unit cost uncertainty (Nov - Oct)	-0.03	-0.28	0.15	82

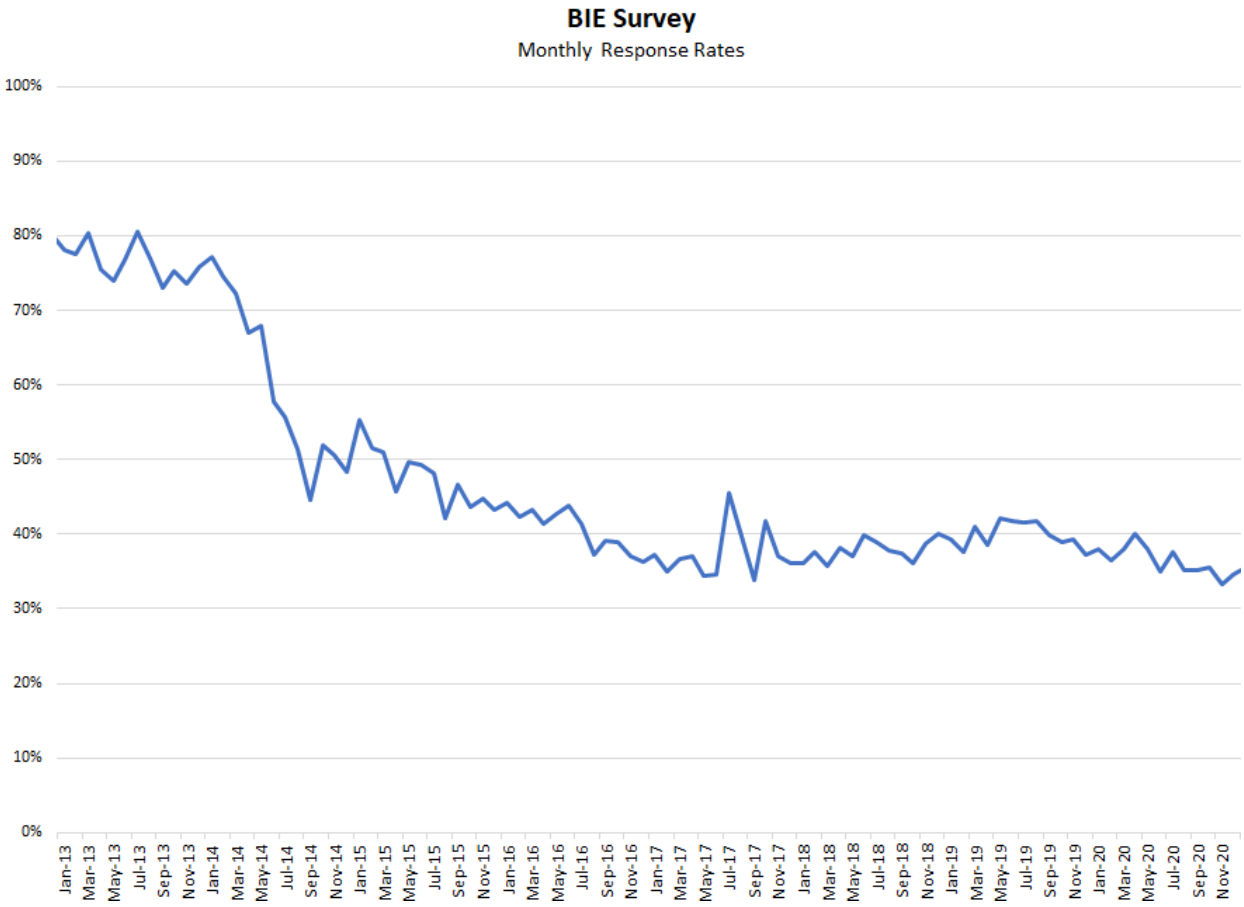
Source: FRBA Business Inflation Expectations (BIE) Survey
Notes: Results obtained via RCT special questions posed to the panel in October 2020. The median expectation of monetary policymakers for inflation over calendar year 2021 was 1.7 percent (as of September 15th, 2020). Treatment: [Based on forecasts over the past 20 years, there is a 70 percent change that actual inflation will be in the range of 0.7 percent to 2.7 percent over calendar year 2021.] Question: What is your best estimate for the highest and lowest potential rate of inflation over calendar year 2021? 206 panelists responded to the core BIE questionnaire in October 2020. T-tests fail to reject the hypothesis that the treatment group expected outcomes that were different from the control group.

Table A.3: RCT: Influence of Monetary Policymakers' Inflation Forecast Uncertainty on Unit Costs and/or Prices Expectations (With All Observations)



Source: FRBA Business Inflation Expectations (BIE) Survey
Notes: These shares are reflective of the existing panel as of December 2019. Titles are reported and confirmed during the recruiting process. Of "C-suite" respondents, we aim at garnering participation from CFOs in particular.

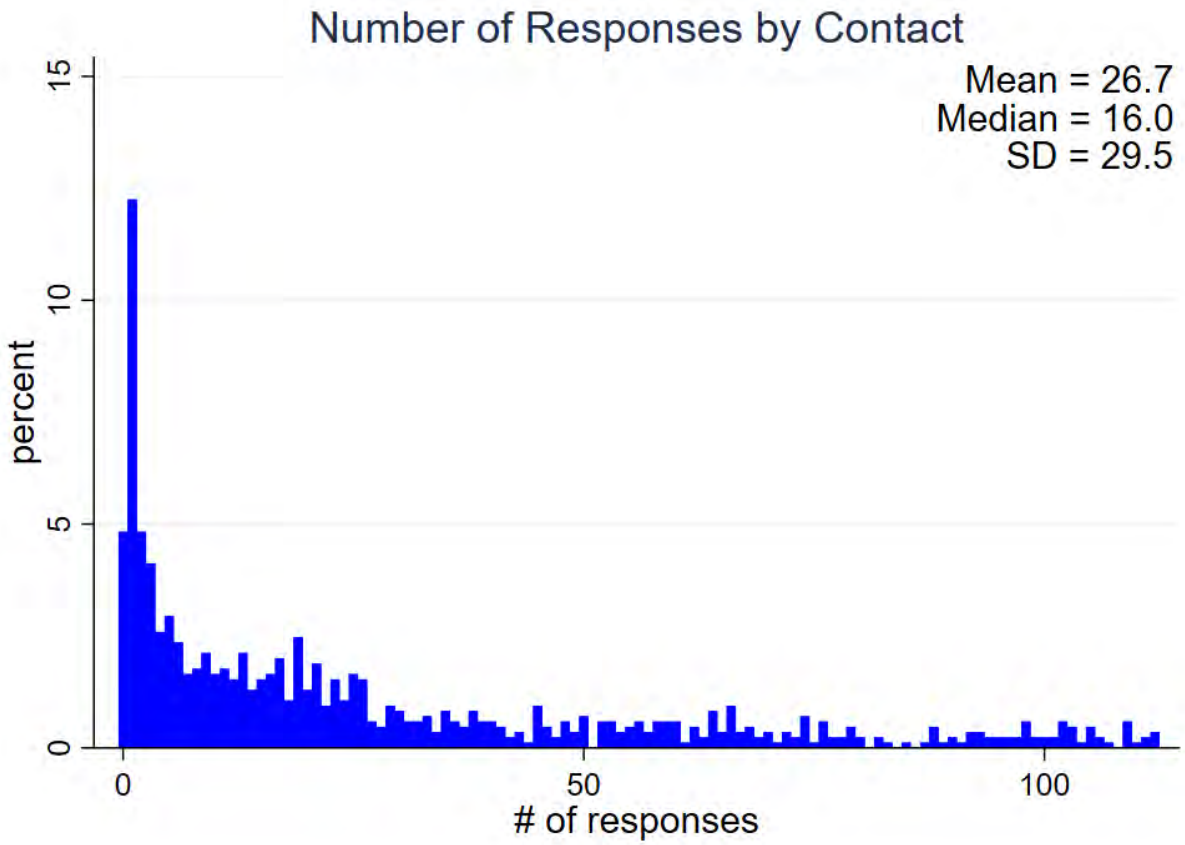
Figure A.1: BIE Panel Member Composition by Title



Source: FRBA Business Inflation Expectations (BIE) Survey

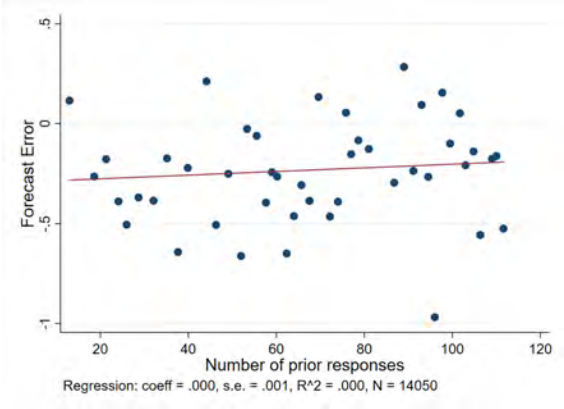
Notes: AAPOR Response Rate 2 Calculation = (partial and completed responses)/(number of survey invitations sent). See the American Association for Public Opinion Research 2016 Standard Definitions: Final Dispositions of Cases and Outcome Rates for Surveys. 9th edition. In late 2012, the BIE Survey transitioned to a web-hosted survey software. Prior to this transition, it was not possible to assess noncontact rates. Response rates from November 2012 to June 2014 were higher than average due to the culling of unresponsive panel members prior to the transition to a new survey platform.

Figure A.2: BIE Survey Monthly Response Rate

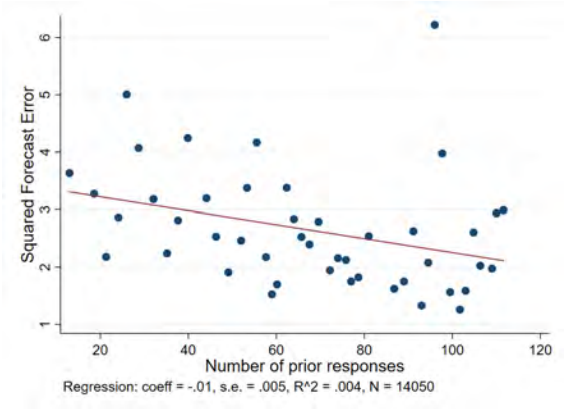


Source: FRBA Business Inflation Expectations (BIE) Survey
Notes: The above bar graph uses the complete history of the BIE from October 2011 through January 2021. A "complete" response means a respondent filled out the entire core questionnaire.

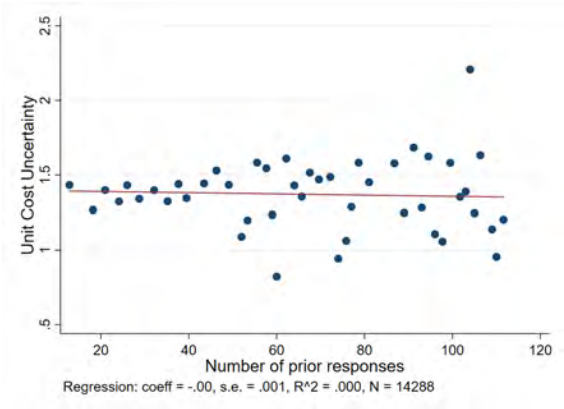
Figure A.3: Survey Retention: Number of Complete Responses by Panelist



(a) Forecast Error



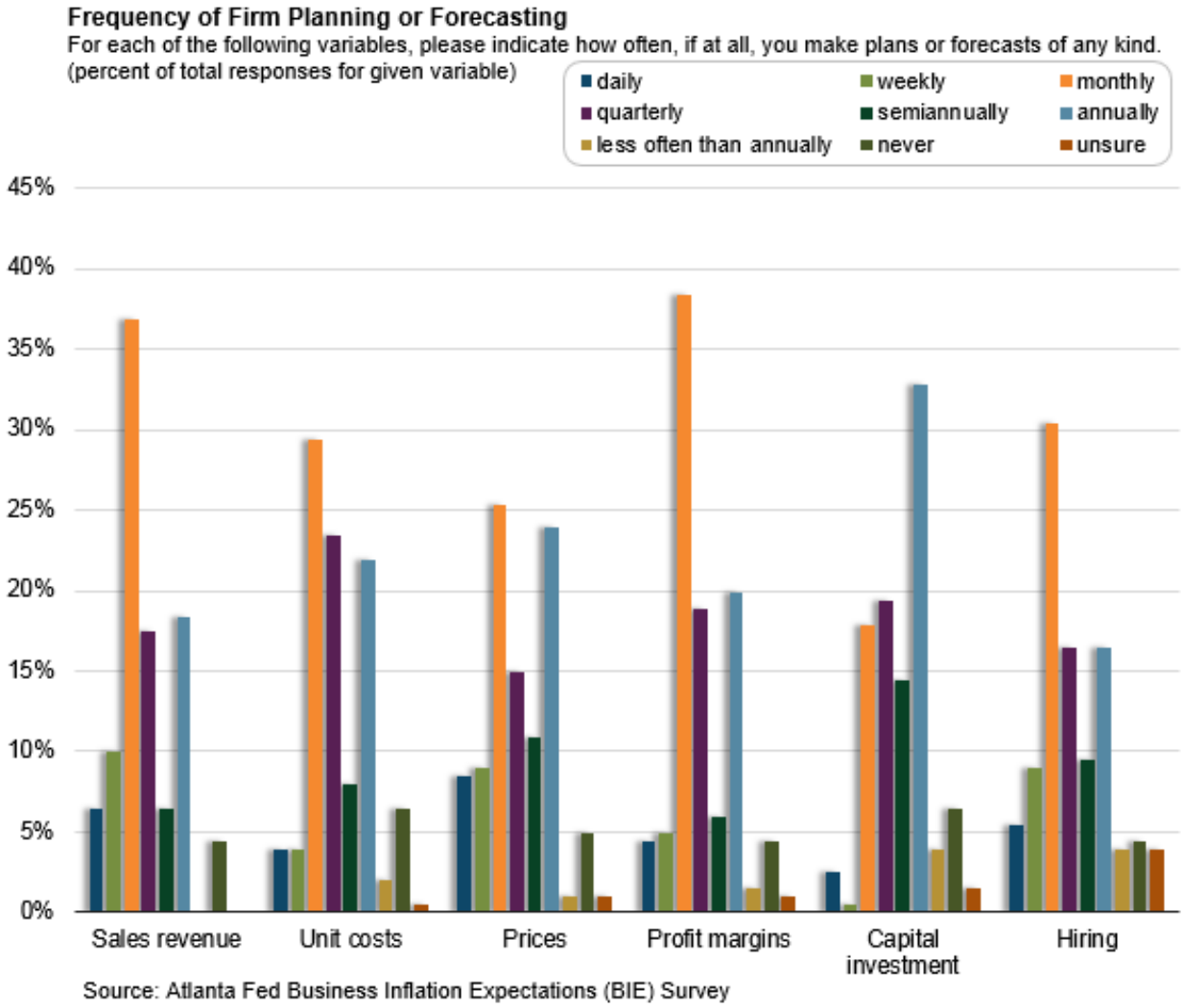
(b) Squared Forecast Error



(c) Unit Cost Uncertainty

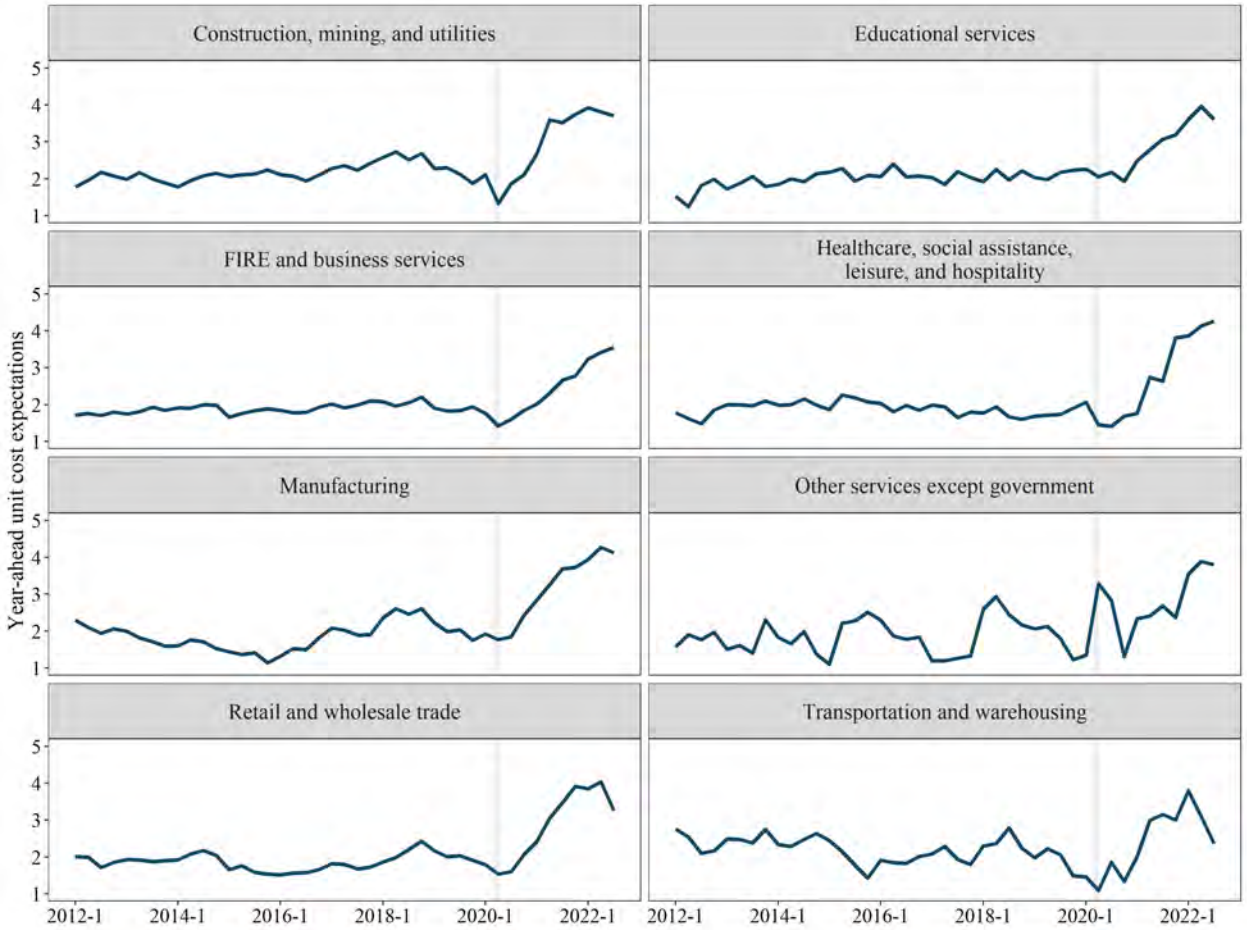
Source: FRBA Business Inflation Expectations (BIE) Survey
Notes: These binscatters (50 bins) compare respondents' (a) forecast error, (b) squared forecast error, and (c) uncertainty. Statistics below the figure correspond to the population OLS regression. Data are from October 2011 through January 2021.

Figure A.4: Tenure Effects



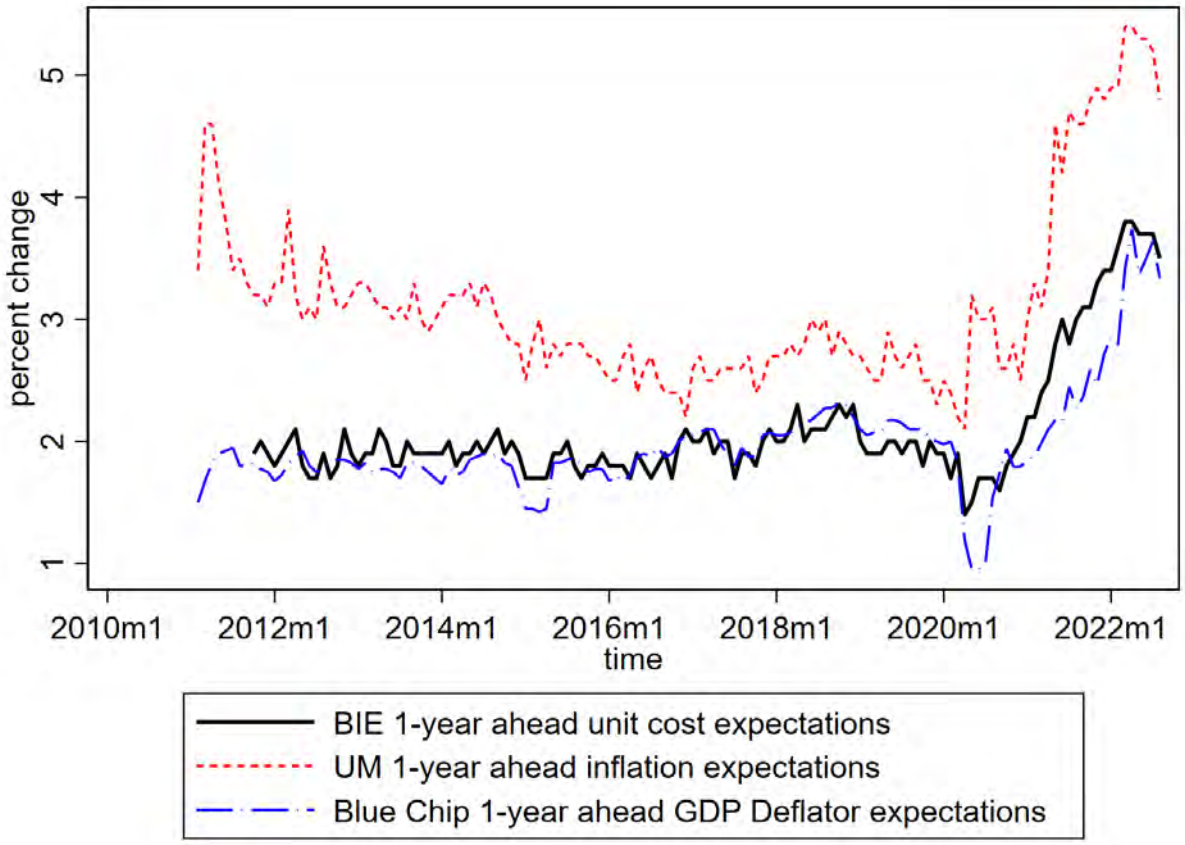
Source: FRBA Business Inflation Expectations (BIE) Survey
Note: Elicited from panelists as of March 2015.

Figure A.5: Firms Planning and Forecasting Frequencies



Source: FRBA Business Inflation Expectations (BIE) Survey.
Notes: The sample period is 2012q1 to 2022q2. The term "FIRE" refers to finance and insurance and real estate, rental and leasing firms.

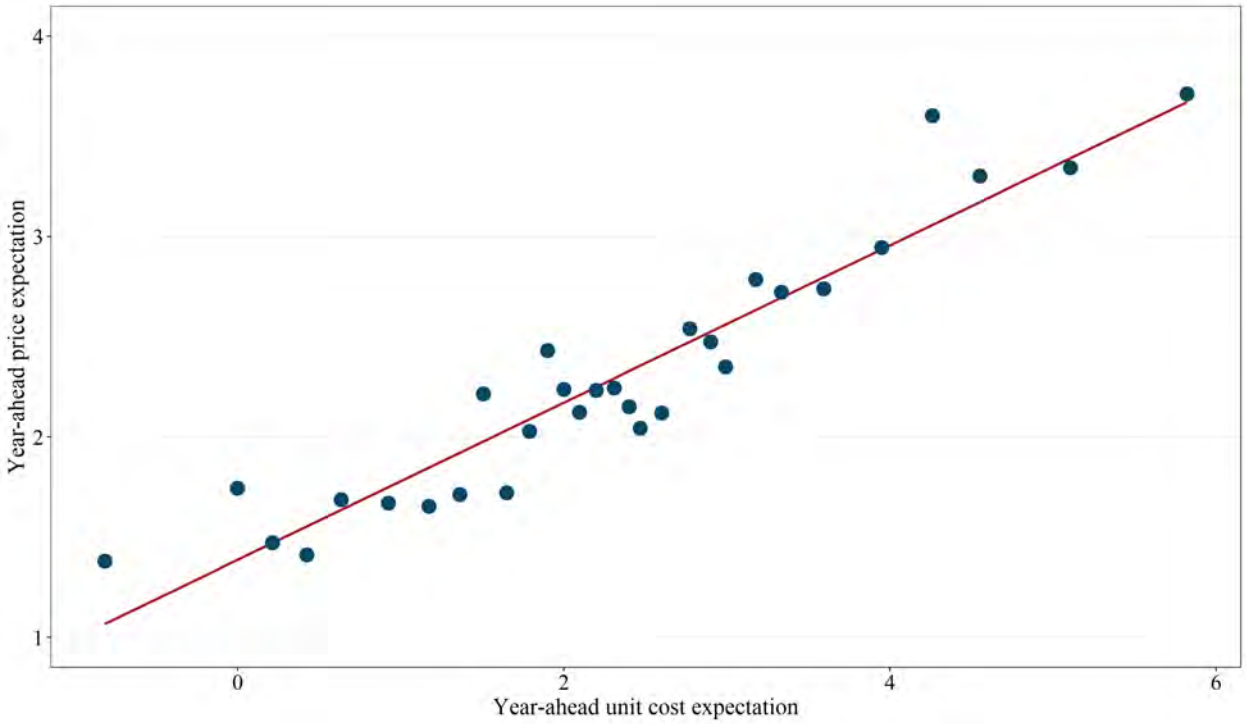
Figure A.6: Sectoral-level Year-ahead Unit Cost Expectations



Sources: Blue Chip Economist Panel; University of Michigan Survey of Consumers; FRBA Business Inflation Expectations (BIE) Survey

Note: The sample period goes from October 2011 through August 2022. The pre-COVID (Oct. 2011 through Feb. 2020) correlation between the BIE and UM is 0.03 and rises to 0.88 after including data from March 2020 through August 2022. The pre-COVID correlation between the BIE and Blue Chip is 0.66 and rises to 0.88 after including data from March 2020 through August 2022.

Figure A.7: Short-Run (1-year ahead) Survey Inflation Expectations (Monthly Frequency)



Source: FRBA Business Inflation Expectations (BIE) Survey.
Notes: The above binscatter (30 bins) compare respondents' 1-year ahead unit cost expectations to their 1-year ahead representative price expectations. Special questions on expected prices were elicited in June 2013, February 2019, November 2019, December 2020, April 2021, July 2021, and November 2021. Given changes in question formatting, responses were normalized and winsorized at the 2.5% and 97.5% levels.

Figure A.8: Unit Cost and Price Expectations

Appendix B Comparison of BIE to SBU

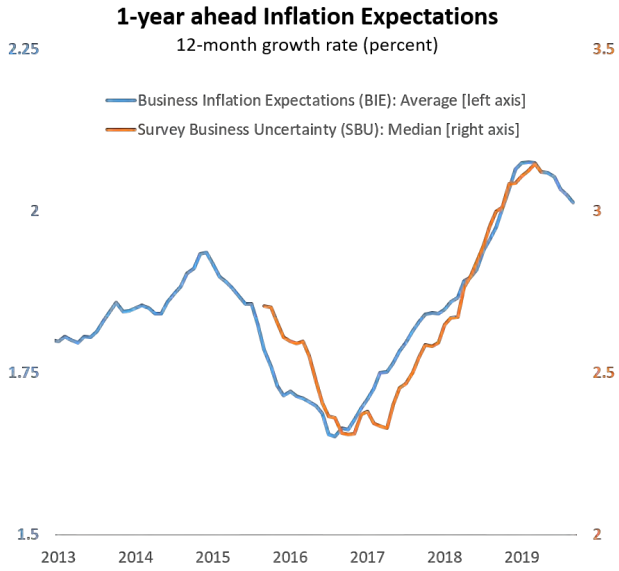
Two potential concerns arise in using the BIE survey. First, because the BIE only covers firms in the Southeast, it might not be nationally representative and the signal quality of the survey will likely suffer. Second, the question design itself – which is favored by Manski (2004) – is subject to framing bias. Because the quantitative suggestions for each bin width may be too narrow relative to the observed (perceived) distribution of actual unit cost expectations, the binned approach may potentially bias the results.

In an attempt to address both of these concerns, we compare the Atlanta Fed's BIE Survey probabilistic binned response approach to a more flexible approach used by the Survey of Business Uncertainty (SBU); see Altig et al. (2022) for details regarding this survey. The SBU is a national survey of businesses that draws from every major industry in the nonfarm private sector and covers a full range of firm sizes. From its inception in 2014 until April of 2019, the SBU elicited responses for 1-year ahead unit costs expectations from a very flexible probabilistic setup – first asking firms for 5 quantitative estimates (support points) ranging from "lowest" to "highest" for the possible outcomes of unit costs over the year ahead and then asking respondents to fill in the attendant probabilities that correspond to each one of those outcomes.[32]

Figure B.1 addresses, to a large extent the framing bias in the BIE relative to the SBU, as the mean for the aggregate time series for BIE unit costs expectations is roughly a full percentage point lower than its SBU counterpart. However, there appears to be a tradeoff between framing bias and inflation signal. Table B.1 shows the correlations between the BIE and SBU unit cost 1-year ahead expectations and uncertainty measures over various moving averages (1-, 3-, 6-, and 12-month growth rates). The BIE aggregate is a simple weighted average and the SBU aggregate is either a 2-percent winsorized (1-percent on each tail) weighted average or weighted median. All series are weighted by industry share of GDP.

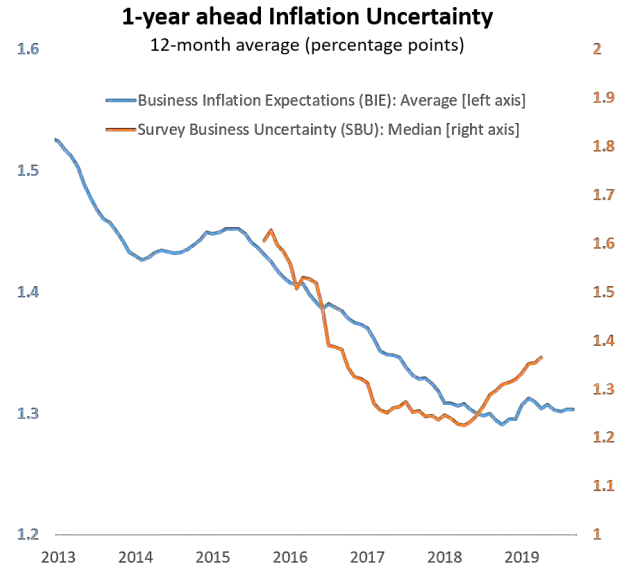
Table B.1 reveals that the BIE aggregate is more highly correlated with the SBU median than the mean and that correlations between the two surveys grows over time. This holds for both the first and second moments of these survey responses. The results suggest that while framing bias from a probabilistic binned approach may alter the level of the aggregate expectation and uncertainty, it comes with a positive tradeoff of a stronger signal-to-noise ratio.

[32]The SBU group, including researchers at Stanford University, the University of Chicago's Booth School, and the Federal Reserve Bank of Atlanta, jointly agreed to retire the unit-cost question in April 2019, in an effort to streamline the survey instrument and in large part due to the seeming redundancy between the BIE and SBU output for unit costs.



Sources: FRBA Business Inflation Expectations (BIE) Survey and Survey of Business Uncertainty (SBU).

(a) Inflation Expectations



(b) Inflation Uncertainty

Sources: FRBA Business Inflation Expectations (BIE) Survey and Survey of Business Uncertainty (SBU).
Notes: The BIE data are the smoothed average of the cross section of individual expected values. The SBU data are the smoothed median of the cross section of individual expected values. SBU data sample runs from October 2014 through April 2019. Both data series are weighted by industry-share of GDP.

Figure B.1: Comparison between BIE and SBU Unit Cost Expectations and Uncertainty

BIE 1-year Ahead Unit Cost Expectations		BIE 1-year Ahead Unit Cost Uncertainty	
1-month growth rates		**1-month averages**	
SBU: Median	0.68	SBU: Median	0.43
SBU: Winsorized Mean	0.26	SBU: Winsorized Mean	0.40
3-month growth rates		**3-month averages**	
SBU: Median	0.84	SBU: Median	0.66
SBU: Winsorized Mean	0.34	SBU: Winsorized Mean	0.57
6-month growth rates		**6-month averages**	
SBU: Median	0.90	SBU: Median	0.78
SBU: Winsorized Mean	0.42	SBU: Winsorized Mean	0.64
12-month growth rates		**12-month averages**	
SBU: Median	0.93	SBU: Median	0.81
SBU: Winsorized Mean	0.44	SBU: Winsorized Mean	0.71

Sources: FRBA Business Inflation Expectations (BIE) Survey and Survey of Business Uncertainty (SBU).
Notes: The Survey of Business Uncertainty (SBU) fielded probabilistic unit cost expectations questions from its inception until April 2019. The data period we analyze is from October 2014 through April 2019. The 3-, 6-, and 12-month samples begin in December 2014, March 2014, and September 2015, respectively. For more information on the SBU, see Altig et al. (2022)

Table B.1: Comparison between BIE and SBU Probabilistic Inflation Expectations

The higher correlation between the mean BIE measures and the median SBU measures suggests that there are some idiosyncratic responses to unit cost growth that are pushing the averages away from the median. This type of idiosyncratic volatility is bounded in the BIE survey (as a response of "unit costs up significantly" is coded as 6 percent). Also encouraging from the standpoint of the BIE survey is that time series smoothing leads to very high correlations (coefficients as high as 0.93 over 12-month windows) between the BIE and the SBU median. These results suggest that at the very least *directionally* the BIE survey is yielding actionable information on the inflation expectations and uncertainty of firms. Eliciting this information using a probabilistic binned response approach dampens the inflation and its volatility when compared to a much more flexible probabilistic question design. Perhaps as important is that, while the BIE is a regional survey, the inflation expectations signal is very similar to that we would take from a national surveying effort.

Appendix C Fitting the Bimodal Asymmetric Power Normal Distribution to Histograms

This appendix illustrates fitting the bimodal asymmetric power normal (BAPN) distribution to three histograms, compared to fitting the normal and beta distribution. Figures C.1 - C.3 display the histograms and the fitted curves. For unimodal histogram (case a), the beta model seems to be more appropriate than other models. For histograms being moderately bimodal (case b) and strongly bimodal (case c), the BAPN provides the best fit when compared with normal and beta models. This visual inspection is further collaborated by descriptive measures and formal tests, as discussed below.

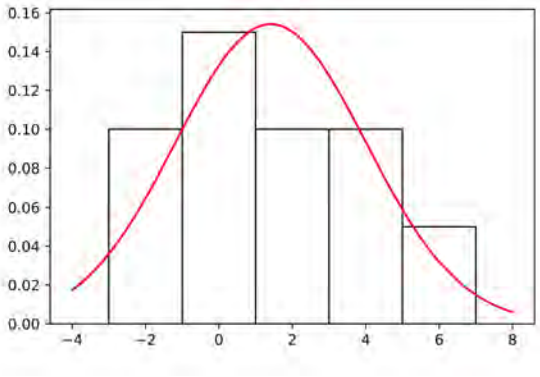
Following Andrade and Rathie (2016), we calculate three summary statistics in fitting parametric distributions to histograms. Bayesian Information Criterion (BIC) is obtained from the likelihood function when fitting each parametric distribution; see Table C.1. The second measure is the Mean Squared Error (MSE) between the fitted and the empirical cumulative distribution function. The third is the p-value from the Kolmogorov-Smirnov (KS) test having the fitted model as the null model against the two-sided alternative. For the unimodal histogram (case a), the beta model fits the data well according to BIC and KS test. For the two cases with bimodality, all statistics point strongly to the BAPN model: the lowest BIC and MSE, and the largest p-value for the KS test.

	Illustration 1			Illustration 2			Illustration 3		
	Beta	Normal	BAPN	Beta	Normal	BAPN	Beta	Normal	BAPN
BIC	4684	4774	4774	5525	4634	4569	3618	5072	3173
MSE	0.016	0.018	0.001	0.014	0.012	0.0001	0.086	0.089	0.0004
KS	0.11	<0.01	<0.01	0.04	<0.01	0.48	<0.01	<0.01	0.07

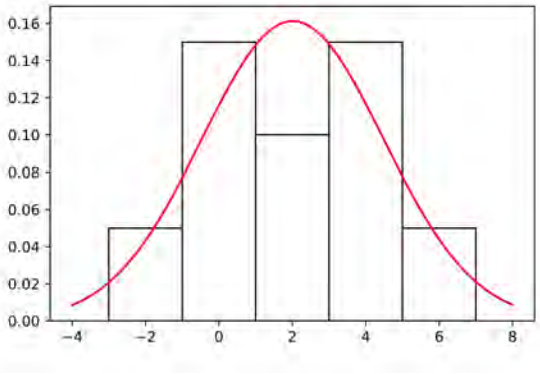
Note: This table reports the summary statistics in fitting parametric distributions to three examples illustrated in Figures C.1–C.3. BIC refers to Bayesian Information Criterion, calculated based on the likelihood function when fitting each parametric distribution. MSE is calculated as the Mean Squared Error between the fitted and the empirical cumulative distribution function. KS is the p-value calculated from the Kolmogorov-Smirnov test having the fitted model as the null model against the two-sided alternative. We fit normal distribution (Normal), generalized beta distribution with fixed support (Beta), and bimodal asymmetric power normal distribution (BAPN) to the reconstructed histograms.

Table C.1: Summary Statistics for Three Examples

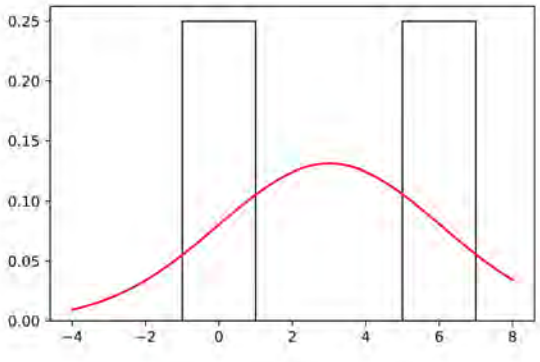
Therefore, in our analysis, we fit the BAPN model to histograms – with $\gamma > 1$ to capture the bimodality and $0 < \gamma \leq 1$ to capture the unimodality. We use the mean and variance of the BAPN distribution as the first- and second-moment of inflation expectations at the firm level, and compare these parametric estimates to nonparametric counterparts when appropriate.



(a) Illustration 1

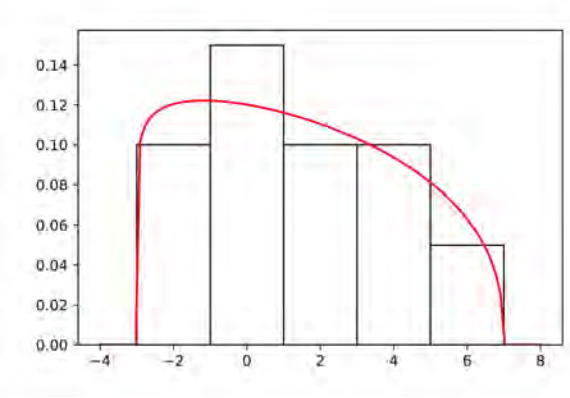


(b) Illustration 2

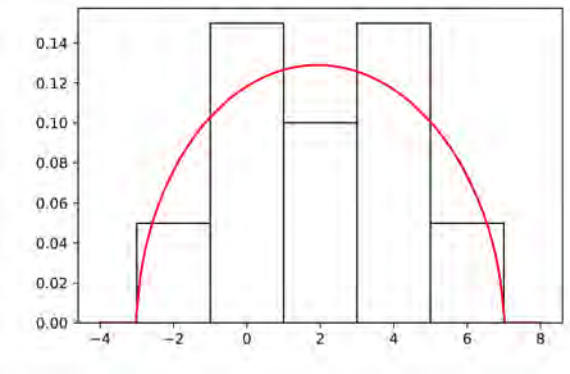


(c) Illustration 3

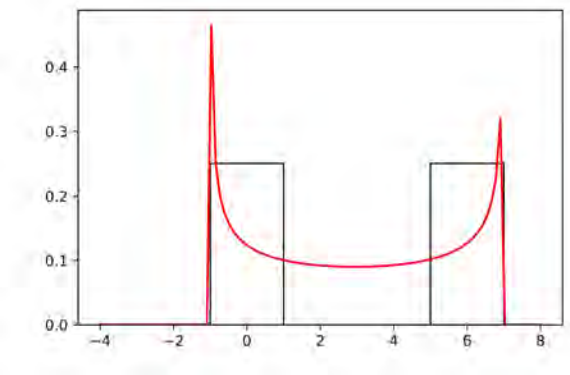
Figure C.1: Fitting Normal Distribution



(a) Illustration 1

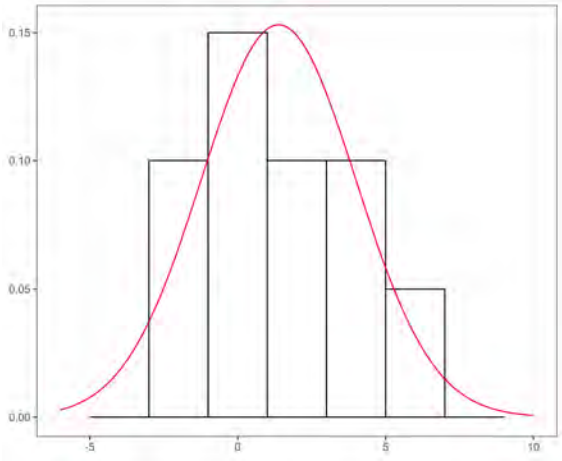


(b) Illustration 2

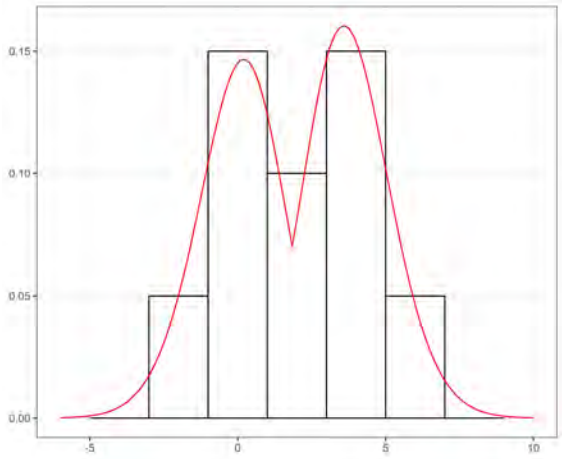


(c) Illustration 3

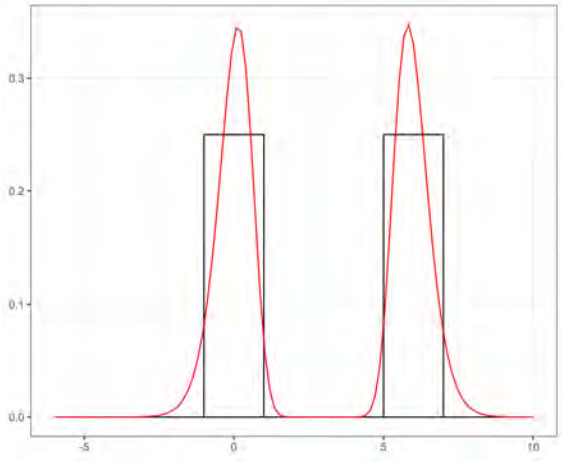
Figure C.2: Fitting Generalized Beta Distribution



(a) Illustration 1



(b) Illustration 2



(c) Illustration 3

Figure C.3: Fitting Bimodal Asymmetric Power Normal Distribution

Appendix D Business Inflation Expectations (BIE) survey questions

D.1 BIE core monthly questions

Question: How do your current SALES LEVELS compare with sales levels during what you consider to be "normal"times?
Response options:

- o Much less than normal
- o Somewhat less than normal
- o About normal
- o Somewhat greater than normal
- o Much greater than normal

Question: How do your current PROFIT MARGINS compare with "normal" times?
Response options:

- o Unit costs down (less than -1%)
- o Unit costs about unchanged (-1% to 1%)
- o Unit costs up somewhat (1.1% to 3%)
- o Unit costs up significantly (3.1% to 5%)
- o Unit costs up very significantly (more than 5%)

Question: Projecting ahead, to the best of your ability, please assign a percent likelihood to the following changes to UNIT COSTS over the next twelve months. (Values should sum to 100%)
For example, if you think each of these is equally likely, you might answer 20% for each:

20% Unit costs down (less than -1%)

20% Unit costs about unchanged (-1% to 1%)

20% Unit costs up somewhat (1.1% to 3%)

20% Unit costs up significantly (3.1% to 5%)

20% Unit costs up very significantly (more than 5%)

Response options:

☐% Unit costs down (less than -1%)

☐% Unit costs about unchanged (-1% to 1%)

☐% Unit costs up somewhat (1.1% to 3%)

☐% Unit costs up significantly (3.1% to 5%)

☐% Unit costs up very significantly (more than 5%)

D.2 BIE core quarterly questions

Question: Projecting ahead, to the best of your ability, please assign a percent likelihood to the following changes to UNIT COSTS per year, over the next five to 10 years. (Values should sum to 100%)
Response options:

☐% Unit costs down (less than -1%)

☐% Unit costs about unchanged (-1% to 1%)

☐% Unit costs up somewhat (1.1% to 3%)

☐% Unit costs up significantly (3.1% to 5%)

☐% Unit costs up very significantly (more than 5%)

Question: By roughly what percent are your firm's sales levels ABOVE "normal"?
Response options:

☐ Percent

Question: By roughly what percent are your firm's sales levels BELOW "normal"?
Response options:

☐ Percent

Question: You indicated that your sales levels are "about normal." By roughly what percent are your firm's sales levels above/below "normal", if at all?
Response options:

☐ Above/Below/Neither

☐ Percent

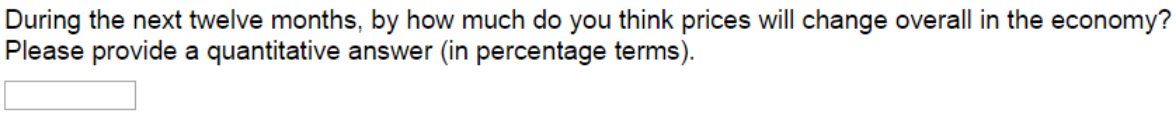
D.3 Special questions

Projecting ahead, over the next 12 months, please assign a percent likelihood to the following changes to the AVERAGE PRICE of the products and/or services you sell? *values should sum to 100%*

Average price down (less than -1%)	0 %
Average price about unchanged (-1% to 1%)	0 %
Average price up somewhat (1.1% to 3%)	0 %
Average price up significantly (3.1% to 5%)	0 %
Average price up very significantly (more than 5%)	0 %
Total	0 %

Sources: FRBA Business Inflation Expectations (BIE) Survey; June 2013.

Figure D.1: June 2013: Own-price expectations



Sources: FRBA Business Inflation Expectations (BIE) Survey; September 2014.

Figure D.2: September 2014: University of Michigan sequence with "prices overall in the economy"

On a scale from 1 to 5, with 5 being "very familiar", please choose the option that best describes your level of familiarity with the Consumer Price Index, commonly referred to as CPI.

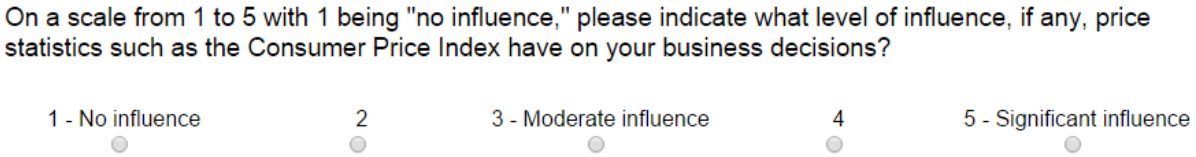
1 - Unfamiliar	2	3	4	5 - Very familiar
○	○	○	○	○

Please indicate what probabilities you would attach to the various possible percentage changes to the CORE (excluding food and energy) CONSUMER PRICE INDEX over the next 12 months. (Values should sum to 100%)

4 percent or more	0 %
3.5 to 3.9 percent	0 %
3.0 to 3.4 percent	0 %
2.5 to 2.9 percent	0 %
2.0 to 2.4 percent	0 %
1.5 to 1.9 percent	0 %
1.0 to 1.4 percent	0 %
0.5 to 0.9 percent	0 %
0 to 0.4 percent	0 %
Will decline	0 %
Total	0 %

Sources: FRBA Business Inflation Expectations (BIE) Survey; October 2014.

Figure D.3: October 2014: SPF's probabilistic core CPI question



Sources: FRBA Business Inflation Expectations (BIE) Survey; January 2015.

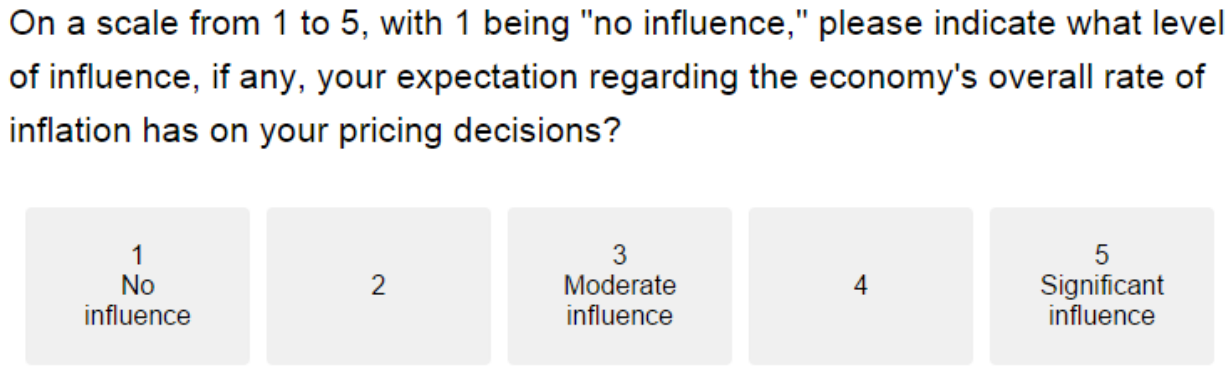
Figure D.4: January 2015: CPI's influence on pricing decisions

For each of the following variables, please indicate how often, if at all, you make plans or forecasts of any kind?

	daily	weekly	monthly	quarterly	semiannually	annually	less often than annually	never	Unsure
Sales Revenue	○	○	○	○	○	○	○	○	○
Unit Costs	○	○	○	○	○	○	○	○	○
Prices	○	○	○	○	○	○	○	○	○
Profit Margins	○	○	○	○	○	○	○	○	○
Capital Investment	○	○	○	○	○	○	○	○	○
Hiring	○	○	○	○	○	○	○	○	○

Sources: FRBA Business Inflation Expectations (BIE) Survey; March 2015.

Figure D.5: March 2015: Frequency of firm planning/forecasting activity



Sources: FRBA Business Inflation Expectations (BIE) Survey; September 2015.
Note: In September 2015, we split the panel at random, asking half for the influence of the "overall rate of inflation" on their pricing decisions and the other half was asked for the influence of "your own unit costs" have on pricing decisions.

Figure D.6: September 2015: Overall rate of inflation/Unit Costs' Influence on pricing decisions

Looking ahead, over the next 12 months, what aggregate rate of inflation, as measured by the Consumer Price Index, would you assign to each of the following scenarios?

The LOWEST aggregate rate of inflation would be about:	1 %
A LOW aggregate rate of inflation would be about:	2 %
A MIDDLE aggregate rate of inflation would be about:	3 %
A HIGH aggregate rate of inflation would be about:	4 %
The HIGHEST aggregate rate of inflation would be about:	5 %

Please assign a percentage likelihood to the potential aggregate rates of inflation you entered. (Values should sum to 100%)

LOWEST: The likelihood of realizing a **1%** aggregate rate of inflation rate would be:	10 %
LOW: The likelihood of realizing a **2%** aggregate rate of inflation rate would be:	20 %
MIDDLE: The likelihood of realizing a **3%** aggregate rate of inflation rate would be:	40 %
HIGH: The likelihood of realizing a **4%** aggregate rate of inflation rate would be:	20 %
HIGHEST: The likelihood of realizing a **5%** aggregate rate of inflation rate would be:	10 %
Total	100 %

Sources: FRBA Business Inflation Expectations (BIE) Survey; January 2019.

Figure D.7: January 2019: Aggregate Inflation Expectations

The LOWEST percentage change in my price would be about:	1 %
A LOW percentage change in my price would be about:	2 %
A MIDDLE percentage change in my price would be about:	3 %
A HIGH percentage change in my price would be about:	4 %
The HIGHEST percentage change in my price would be about:	5 %

Please assign a percentage likelihood to the percentage price changes you entered in the prior question. (Values should sum to 100%)

LOWEST: The likelihood of about a **1%** change in my price would be:	10 %
LOW: The likelihood of about a **2%** change in my price would be:	20 %
MIDDLE: The likelihood of about a **3%** change in my price would be:	40 %
HIGH: The likelihood of about a **4%** change in my price would be:	20 %
HIGHEST: The likelihood of about a **5%** change in my price would be:	10 %
Total	100 %

Sources: FRBA Business Inflation Expectations (BIE) Survey; February 2019.

Figure D.8: February 2019: Own-Price Expectations

By what percentage has your firm changed the price of the product/product line or service responsible for the largest share of sales revenue over the last 3 months?

[ ] %

By what percentage has your firm changed its total number of employees (full and part time) over the last 3 months?

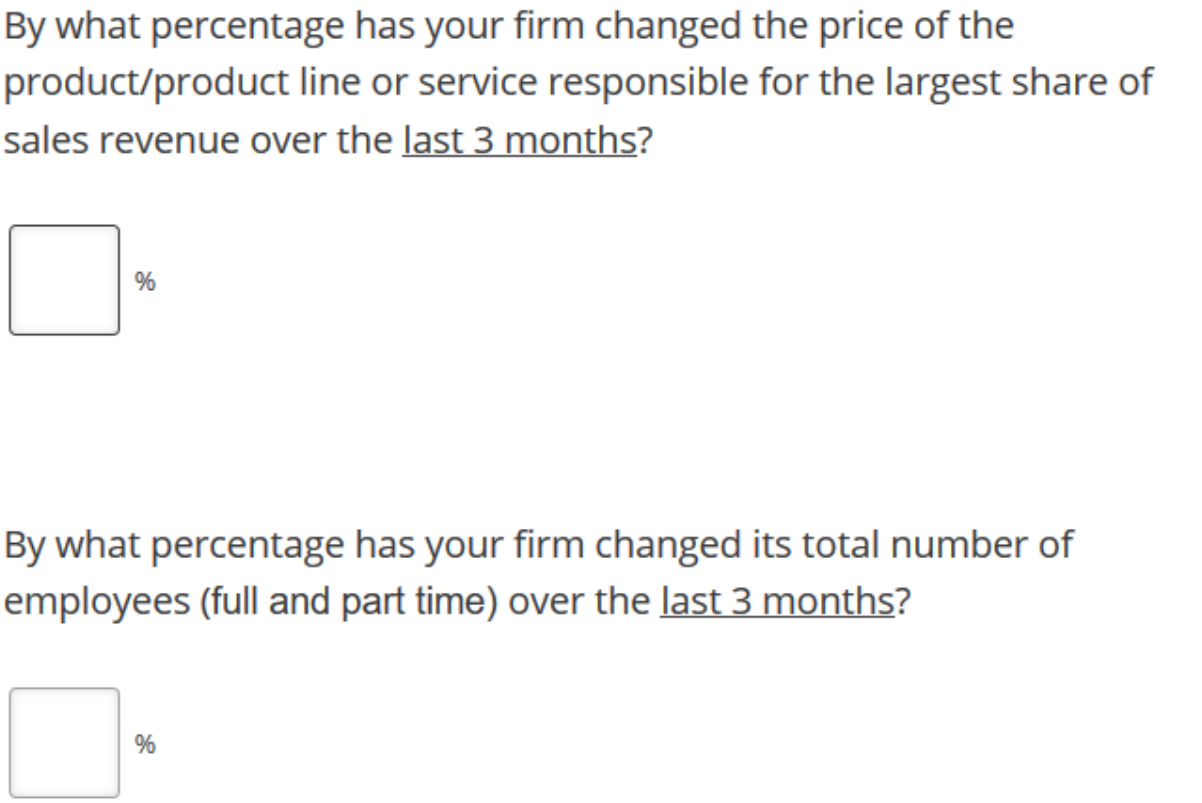
[ ] %

What do you think the aggregate rate of inflation, as measured by the Consumer Price Index, will be over the next 12 months?

[ ] %

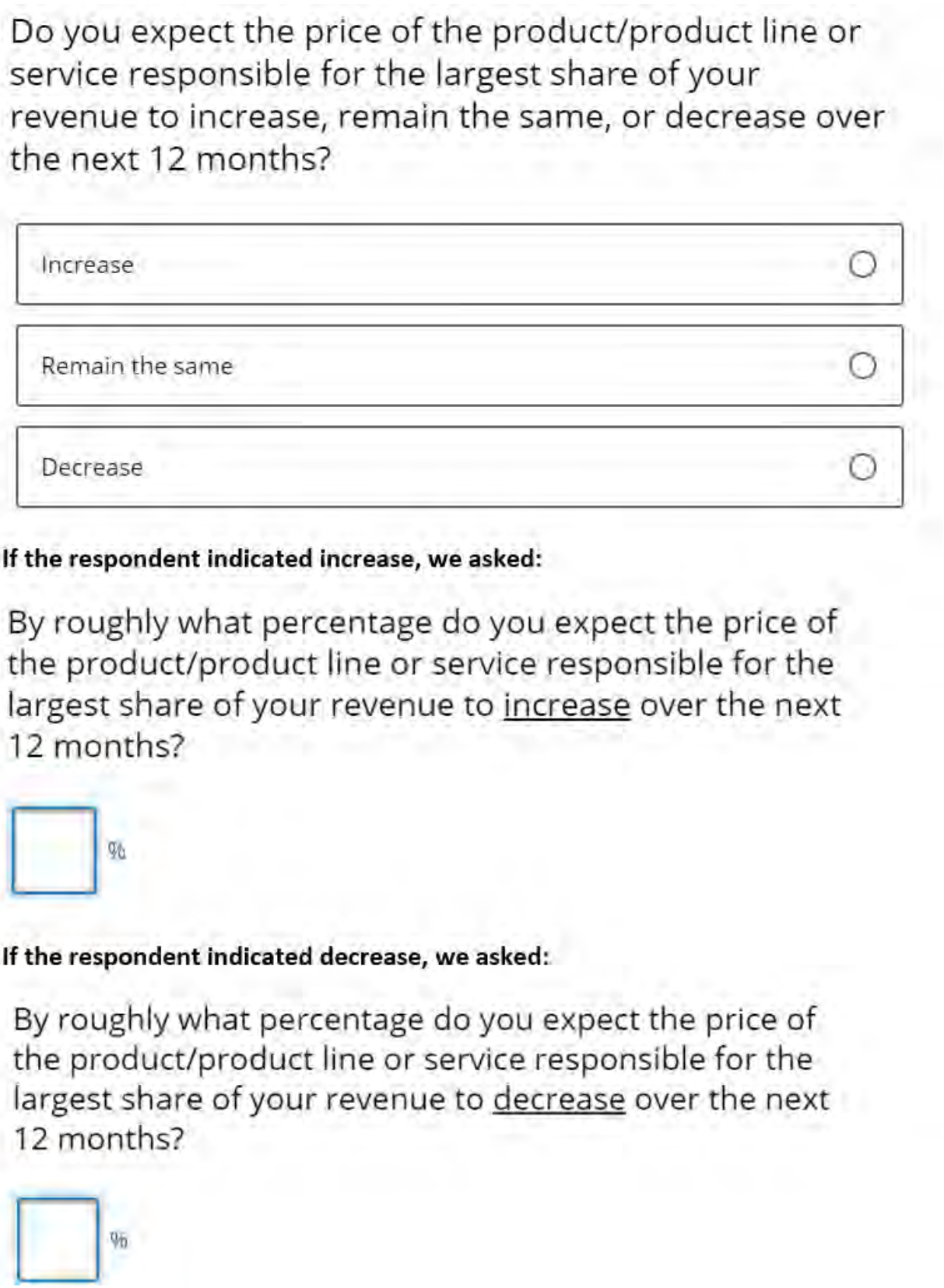
Sources: FRBA Business Inflation Expectations (BIE) Survey; April 2019.

Figure D.9: April 2019: Price and Aggregate Inflation Expectations



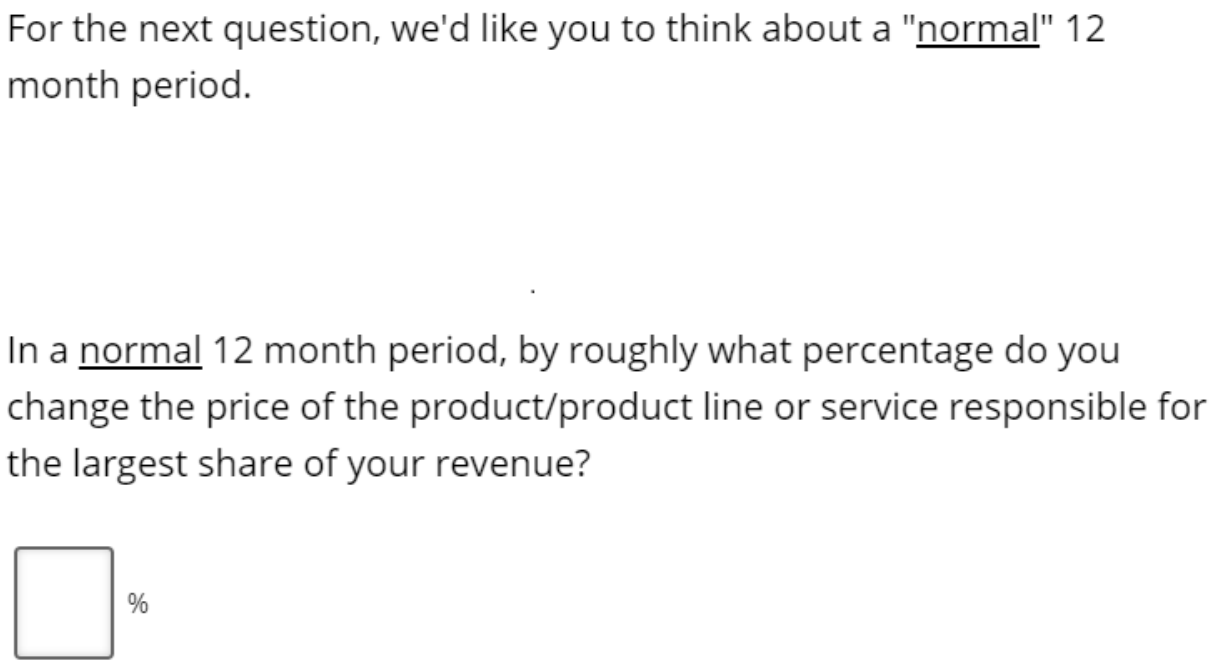
Sources: FRBA Business Inflation Expectations (BIE) Survey; July 2019, October 2019, and January 2020.

Figure D.10: July 2019, October 2019, and January 2020: Own-Price and Employment Expectations



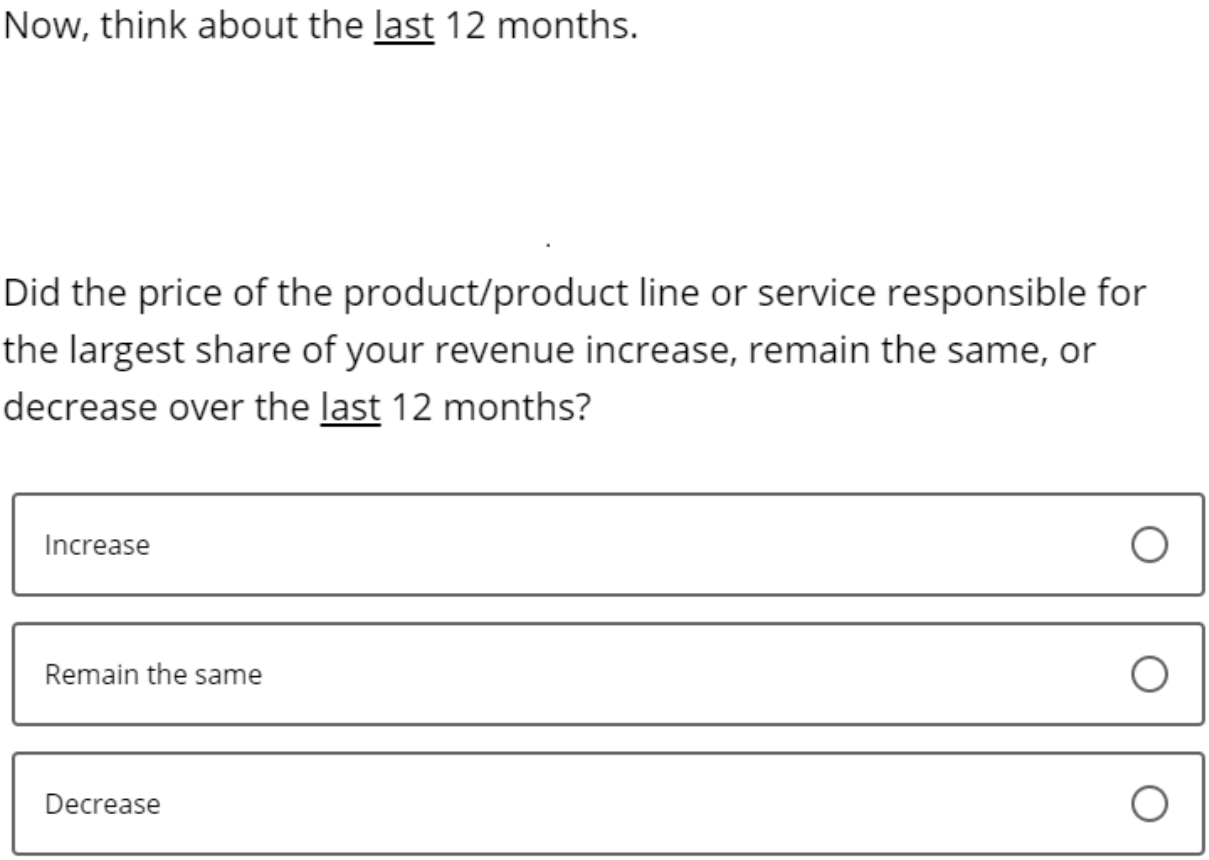
Sources: FRBA Business Inflation Expectations (BIE) Survey; November 2019.

Figure D.11: November 2019: Own-Price Expectations



Sources: FRBA Business Inflation Expectations (BIE) Survey; December 2020, July 2021, and November 2021.
Note: We only elicited firms' "normal" price perceptions in December 2020.

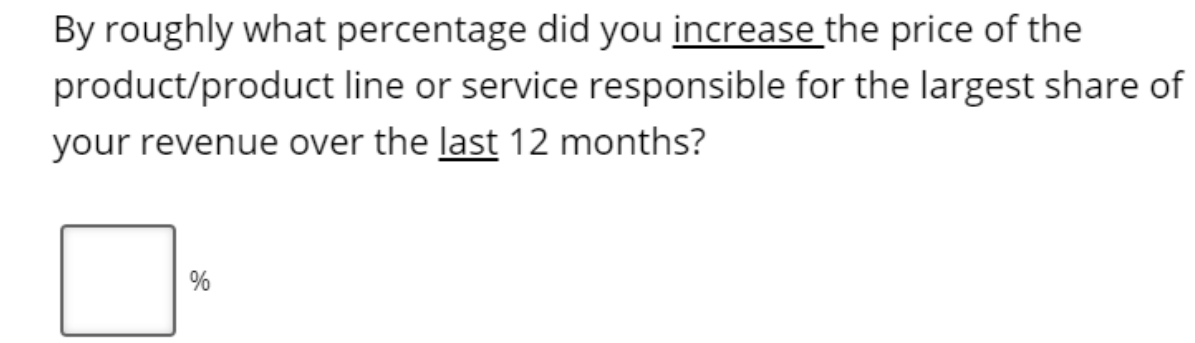
Figure D.12: December 2020, July 2021, and November 2021: Own-Price Realizations and Expectations (part 1)



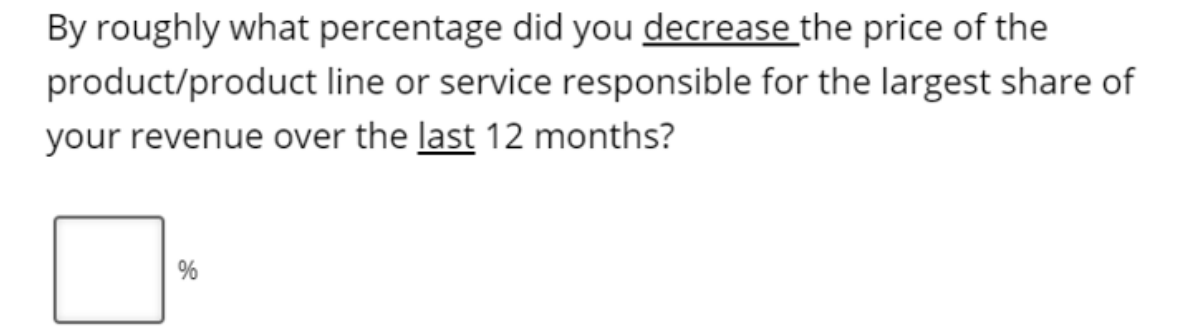
Sources: FRBA Business Inflation Expectations (BIE) Survey; December 2020, July 2021, and November 2021.
Note: We only elicited firms' "normal" price perceptions in December 2020.

Figure D.13: December 2020, July 2021, and November 2021: Own-Price Realizations and Expectations (part 2)

If the respondent indicated increase, we asked:

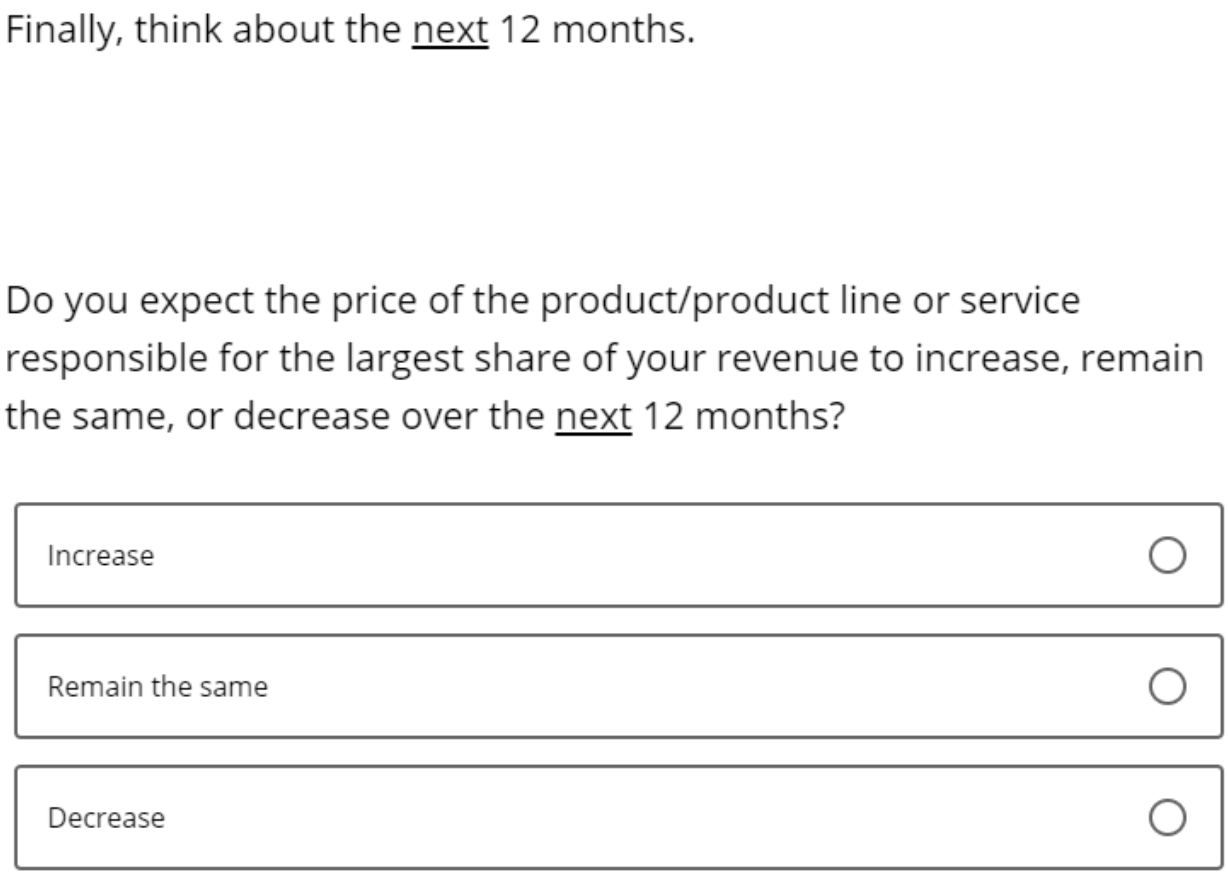


If the respondent indicated decrease, we asked:



Sources: FRBA Business Inflation Expectations (BIE) Survey; December 2020, July 2021, and November 2021.
Note: We only elicited firms' "normal" price perceptions in December 2020.

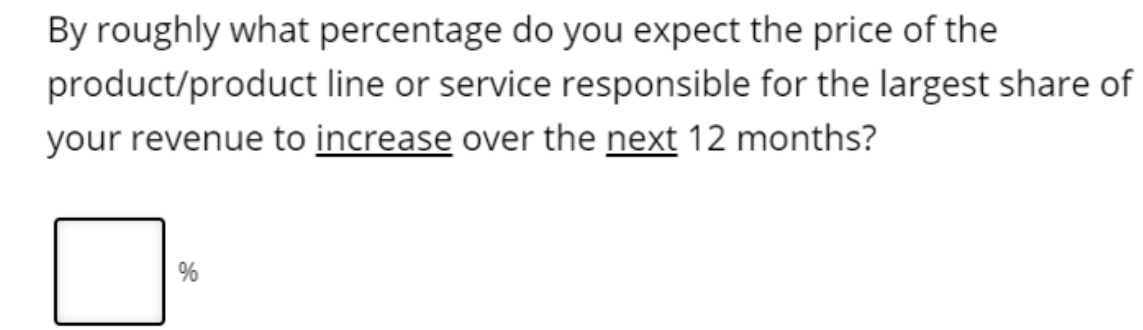
Figure D.14: December 2020, July 2021, and November 2021: Own-Price Realizations and Expectations (part 3)



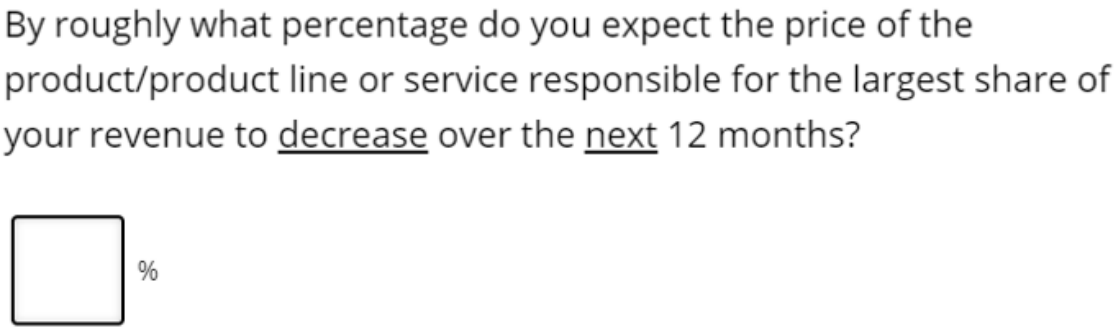
Sources: FRBA Business Inflation Expectations (BIE) Survey; December 2020, July 2021, and November 2021.
Note: We only elicited firms' "normal" price perceptions in December 2020.

Figure D.15: December 2020, July 2021, and November 2021: Own-Price Realizations and Expectations (part 4)

If the respondent indicated increase, we asked:

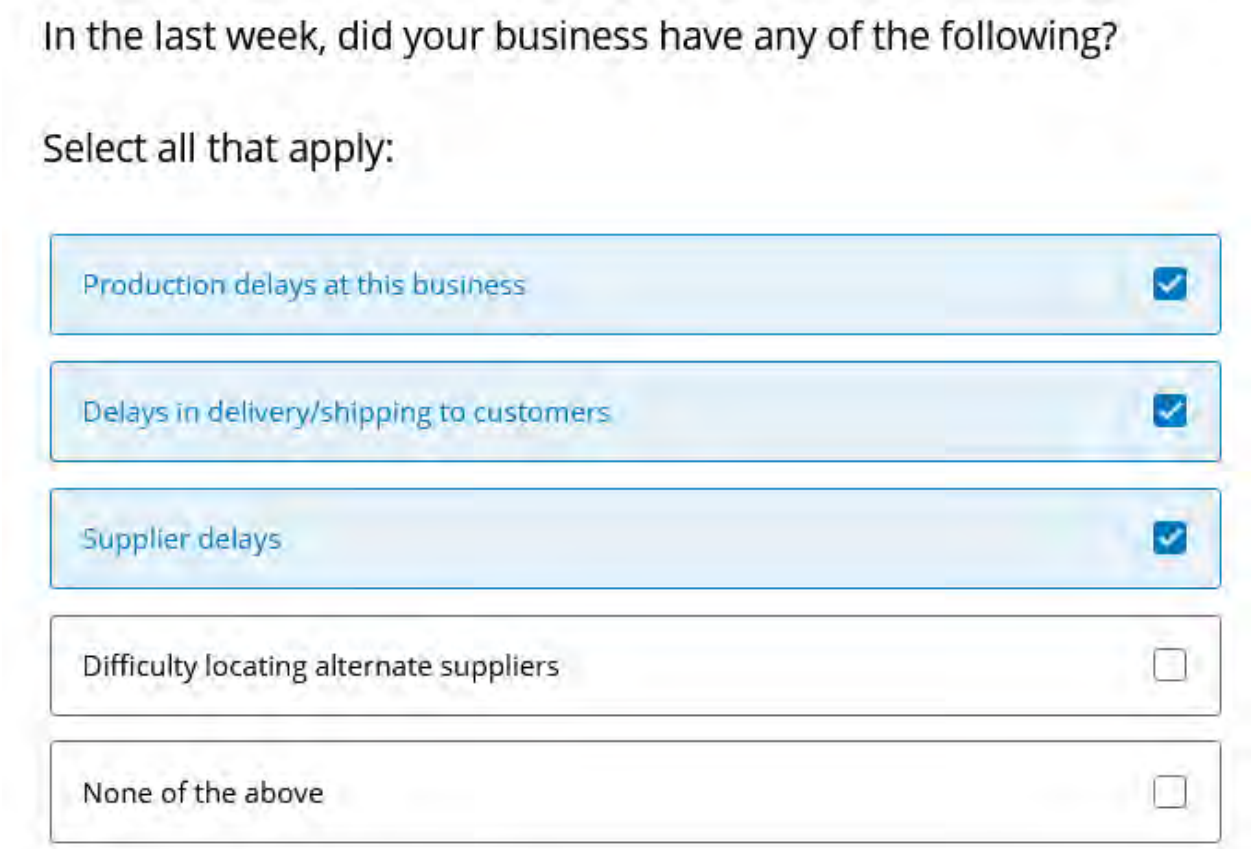


If the respondent indicated decrease, we asked:



Sources: FRBA Business Inflation Expectations (BIE) Survey; December 2020, July 2021, and November 2021.
Note: We only elicited firms' "normal" price perceptions in December 2020.

Figure D.16: December 2020, July 2021, and November 2021: Own-Price Realizations and Expectations (part 5)



Sources: FRBA Business Inflation Expectations (BIE) Survey; March, June, and August 2021.

Figure D.17: March, June, and August 2021: Supply Disruption and Labor Constraints (part 1)

If they answered yes, respondents received this follow-up:

How would you describe the impact of each disruption your business encountered?

	Little to none	Mild	Moderate	Severe
Supplier delays	◯	◯	◯	◯
Production delays at your business	◯	◯	◯	◯
Delays in deliver/shipping to customers	◯	◯	◯	◯

And were asked how long they anticipated the disruption to persist:

How long do you anticipate these disruptions will continue to impact your business?

	Less than a month	1-3 months	3-6 months	6-12 months	Longer than one year
Supplier delays	◯	◯	◯	◯	◯
Production delays at your business	◯	◯	◯	◯	◯
Delays in deliver/shipping to customers	◯	◯	◯	◯	◯

Sources: FRBA Business Inflation Expectations (BIE) Survey; March, June, and August 2021.

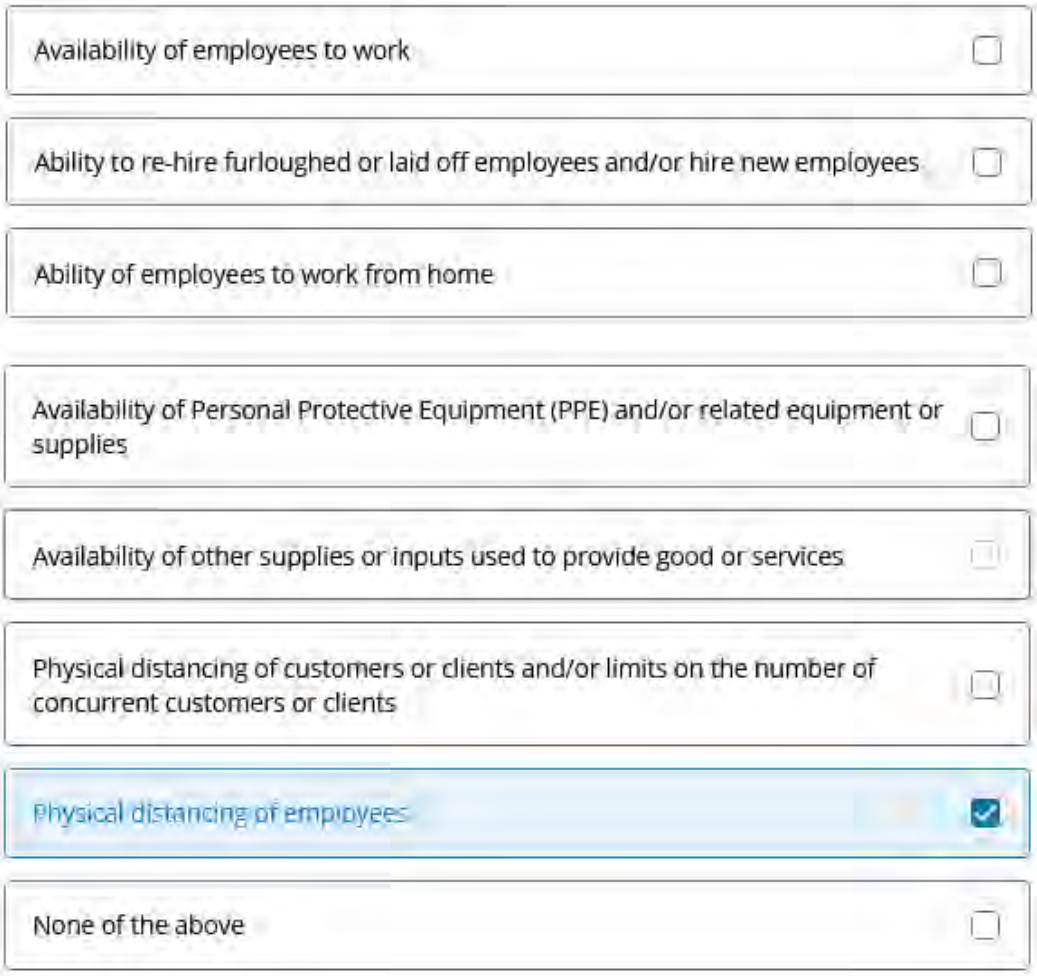
Figure D.18: March, June, and August 2021: Supply Disruption and Labor Constraints (part 2)

Respondents were also asked:

In the last week, was your business's operating capacity affected by any of the following?

Note: Operating capacity is the maximum amount of activity your business could conduct under realistic operating conditions.

Select all that apply:



Sources: FRBA Business Inflation Expectations (BIE) Survey; March, June, and August 2021.

Figure D.19: March, June, and August 2021: Supply Disruption and Labor Constraints (part 3)

If they answered yes, respondents received this follow-up:

How would you describe the impact on operating capacity of each disruption your business encountered?

	Little to none	Mild	Moderate	Severe
Physical distancing of employees	○	○	○	○

And were asked how long they anticipated the disruption to persist:

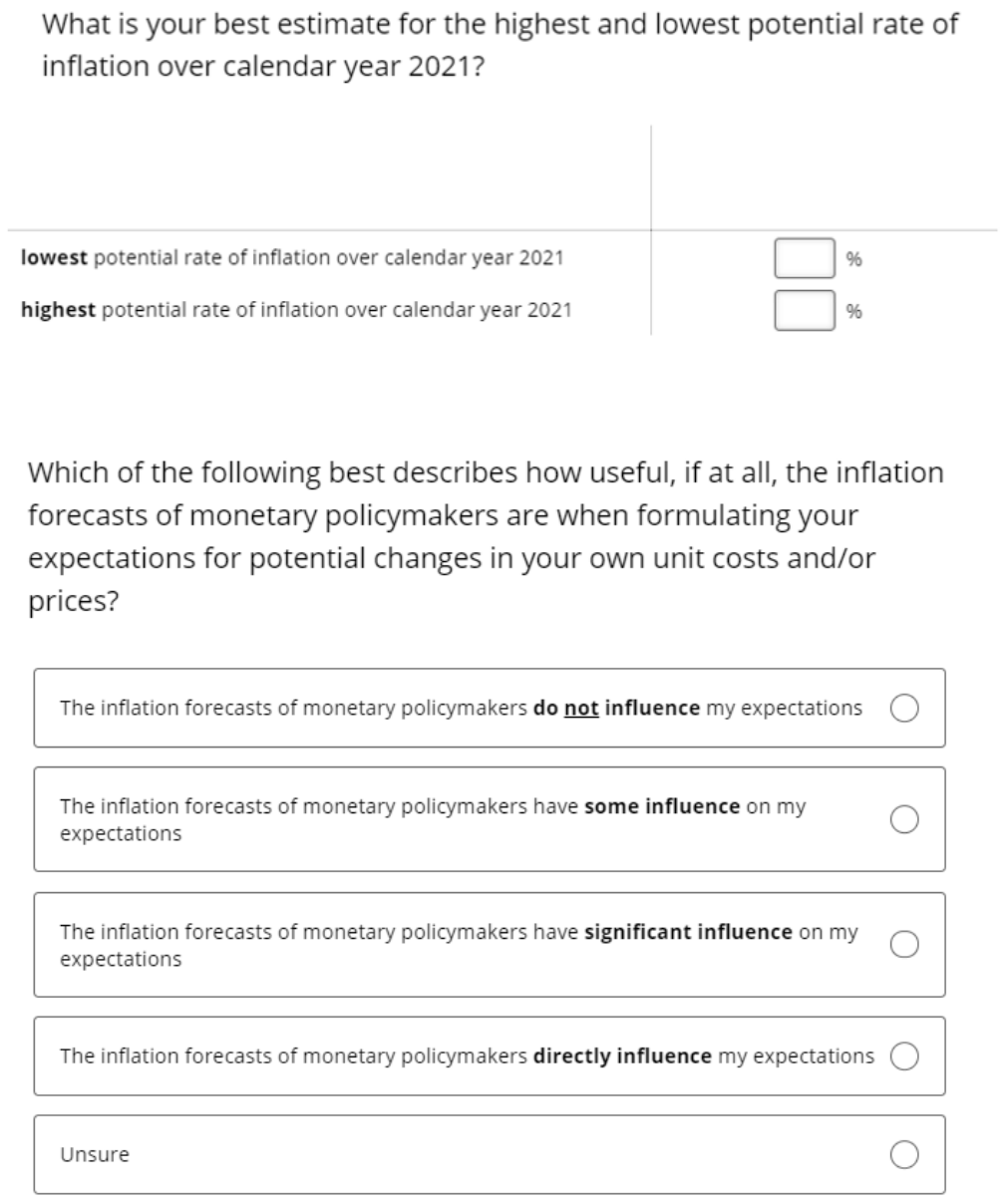
How long do you anticipate these disruptions will continue impact your business?

	Less than one month	1-3 months	3-6 months	6-12 months	Longer than one year
Physical distancing of employees	○	○	○	○	○

Sources: FRBA Business Inflation Expectations (BIE) Survey; March, June, and August 2021.

Figure D.20: March, June, and August 2021: Supply Disruption and Labor Constraints (part 4)

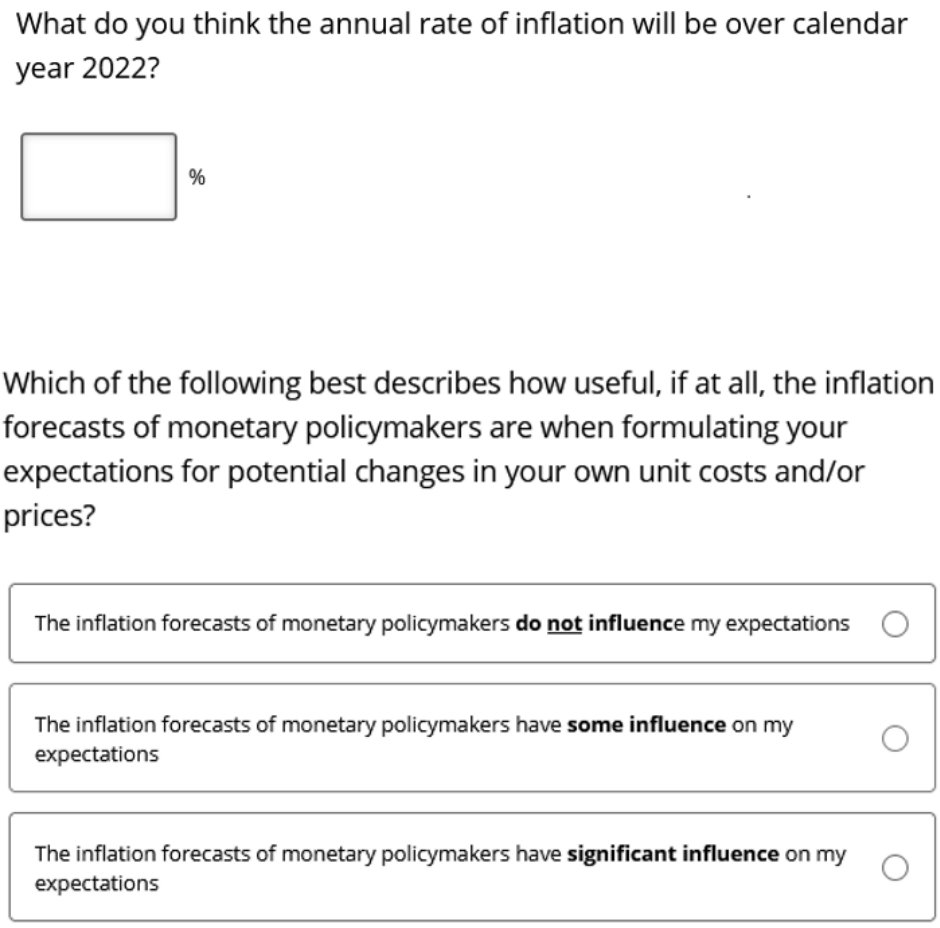
"The median expectation of monetary policymakers for inflation over calendar year 2021 was 1.7 percent (as of September 15th). [Treatment: Based on forecasts over the past 20 years, there is a 70 percent chance that actual inflation will be in the range of 0.7 percent to 2.7 percent over calendar year 2021.] "



Sources: FRBA Business Inflation Expectations (BIE) Survey; October 2020.

Figure D.21: October 2020: Randomized control trial (RCT) - Policymakers' views on uncertainty

"The median expectation of monetary policymakers (as of September 22) for the annual rate of inflation over calendar year 2022 is 2.2 percent."



Sources: FRBA Business Inflation Expectations (BIE) Survey; October 2021.

Figure D.22: October 2021: Randomized control trial (RCT) - Policymakers' views on inflation expectations