SURVEYING BUSINESS UNCERTAINTY

David Altig
Jose Maria Barrero
Nicholas Bloom
Steven J. Davis
Brent H. Meyer
Nicholas Parker

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David Altig, Jose Maria Barrero, Nicholas Bloom, Steven J. Davis, Brent H. Meyer, and Nicholas
Parker
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ABSTRACT

We develop a new monthly panel survey of business executives and a new question design that
elicits subjective probability distributions over own-firm outcomes at a one-year look-ahead
horizon. Our Survey of Business Uncertainty (SBU) began in 2014 and now covers 1,500 firms
drawn from all 50 states, every major industry in the nonfarm private sector, and a full range of
firm sizes. We use SBU data to measure expected future outcomes for the growth of sales,
employment, and investment for each firm and the uncertainty surrounding those expectations.
Mean expectations are highly predictive of realized growth rates in the firm-level data, and
subjective uncertainty is highly predictive of absolute forecast errors. We also use the SBU data to
produce a Business Expectations Index (first moment) and a Business Uncertainty Index (second
moment) for the U.S. economy. In Granger causality tests, the Business Expectations Index has
statistically significant predictive power for a range of prominent business cycle indicators. The
SBU also includes special questions that elicit additional information, including the perceived
effects of specific government policy developments on the firm's decisions and outcomes.

David Altig
Federal Reserve Bank of Atlanta
1000 Peachtree St. NE
Atlanta, GA 30309
Dave.Altig@atl.frb.org

Jose Maria Barrero
Economics Department
579 Serra Mall
Stanford University
Stanford CA 94305
barsanjmb@gmail.com

Nicholas Bloom
Stanford University
Department of Economics
579 Serra Mall
Stanford, CA 94305-6072
and NBER
nbloom@stanford.edu

Steven J. Davis
Booth School of Business
The University of Chicago
5807 South Woodlawn Avenue
Chicago, IL 60637
and NBER
Steven.Davis@ChicagoBooth.edu

Brent H. Meyer
Federal Reserve Bank of Atlanta
brent.meyer@atl.frb.org

Nicholas Parker
Federal Reserve Bank of Atlanta
nicholas.parker@atl.frb.org

Introduction

Uncertainty is a fundamental fact of economic life. Businesses and households grapple with uncertainty in forming plans and making decisions. The extent and nature of uncertainties change over time, sometimes gradually and sometimes abruptly, altering the outlook for decision makers and affecting their choices. Recent history offers some vivid examples: the 9/11 terrorist attacks, the Global Financial Crisis, banking and sovereign debt crises in the Eurozone, the June 2016 Brexit referendum with its still-uncertain resolution, and a dramatic escalation of trade policy tensions under the Trump Administration. These examples underscore the need for sound, flexible measures of uncertainty, so that we can better understand and model the relationship of perceived uncertainty to economic decisions, outcomes, and performance.

We would like to track the uncertainty that agents perceive in their external environments and the uncertainty they perceive about own future outcomes, e.g., a firm's future employment. A standard approach maintains rational expectations and some form of stationarity, so that past conditional volatility can serve as the basis for inferences about uncertainty over future outcomes. Examples include Bloom (2009), Fernández-Villaverde et al. (2011), Jurado, Ludvigson, and Ng (2015), and Colacito et al. (2018). Another approach treats the dispersion in point forecasts as a proxy for uncertainty (e.g., Bachman, Elstner and Sims, 2013). Scotti (2016) uses surprises in economic data releases to proxy for uncertainty. Yet another approach relies on newspapers and other text sources to construct uncertainty measures, as in Baker, Bloom, and Davis (2016), Hassan et al. (2017) and Handley and Li (2018). Datta et al. (2017) offer an extensive overview of various approaches, with a focus on measuring uncertainty in the external environment.

While valuable, these approaches may not adequately capture the subjective uncertainty that agents perceive, which presumably is what drives their decisions. There is a now-large body

of evidence that subjective expectations deviate systematically from the expectations implied by rational expectations with full use of available information.[1] In addition, many of the most prominent empirical proxies for uncertainty pertain to distinct theoretical concepts and differ in their statistical properties (Kozeniauskas et al., 2018). These observations argue for a measurement approach that gets directly at the uncertainty agents perceive without invoking assumptions about rationality, information, and stationarity.

We – a group of researchers at the Atlanta Fed, Chicago Booth and Stanford – set out in 2013 to develop and field a new survey instrument to measure the perceived uncertainty of senior decision makers in U.S. firms. In doing so, we built on earlier work that elicits subjective beliefs from households, as in Dominitz and Manski (1997) and Manski (2004).[2] We spent about a year on initial field testing of various question designs, conducting cognitive interviews, and creating the Survey of Business Uncertainty (SBU). Since 2014, the SBU has collected subjective probability distributions over own-firm future outcomes from a panel of business executives on a monthly basis. The panel has grown over time and now covers about 1,500 firms, drawn from all 50 states, every major industry in the nonfarm private sector, and a wide range of firm sizes.

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[1] Examples include Coibion and Gorodnichenko (2012, 2015) for professional forecasters, Malmendier and Tate (2005), Ben-David, Graham, and Harvey (2013), Gennaioli, Ma and Shleifer (2016) and Barrero (2018) for firm managers, Barber and Odean (2001), Bailey et al. (2011), Puetz and Ruenzi (2011) and Akepanidtaworn et al. (2018) for investors and mutual fund managers, and Roszypal and Schlaffmann (2017) for consumers.

[2] Manski (2004) is an early advocate of measuring subjective expectations by asking survey respondents to assign probabilities to pre-specified outcomes. Most of this work surveys households and consumers. The University of Michigan Survey of Consumers (http://www.sca.isr.umich.edu/) has long asked households to assign probabilities to binary outcomes defined over family income, job loss, inflation, and more. The New York Fed's Survey of Consumer Expectations (https://www.newyorkfed.org/microeconomics/sce) includes questions with a similar structure and questions that elicit probabilities over multiple pre-specified outcomes, e.g., bins defined by inflation rate intervals.

Our core questions elicit five-point subjective probability distributions over each firm's own future sales growth, employment, and capital expenditures. The look-ahead horizon is four quarters or twelve months, depending on the outcome variable. Survey respondents freely select support points and assign probabilities to each one. This approach affords great flexibility for the respondent, allowing for high or low expected growth, uncertain or predictable outlooks, and negative or positive skew in the distribution over future outcomes. It also avoids anchoring, because our question format specifies neither location nor spread of the support points.

Using the subjective probability distributions, we measure expected future outcomes and the uncertainty surrounding those outcomes for each firm. Since the SBU has a panel structure and includes questions about past and current outcomes, we can readily compare firm-level subjective forecast distributions to realized outcomes. As we show, mean growth rate forecasts are highly predictive of realized growth rates. More impressive and more to the point, subjective uncertainty is highly predictive of absolute forecast errors in the firm-level data. This result assures us that the SBU yields informative measures of the uncertainty that business executives perceive about their firms' own-future outcomes.[3]

We also use the firm-level data to measure the average subjective expectations of growth rates in employment, sales and capital expenditures and the corresponding average subjective uncertainty levels. By combining these measures, we produce a monthly Business Expectations Index (first moment) and a monthly Business Uncertainty Index (second moment). We began publishing them in November 2018 at www.frbatlanta.org/research/surveys/business-uncertainty, and both series are published by the time series data provider Haver Analytics

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[3] Barrero (2018) more fully examines the relationship between subjective probability distributions and realized outcomes in the firm-level SBU data. Bloom et al. (2017) examine the relationship in data from a U.S. Census Bureau survey that adapts the SBU question design to manufacturing plants.

(http://www.haver.com). Despite a short time series thus far, Granger causality tests reveal that the Business Expectations Index and the underlying topic-specific measures have statistically significant predictive content for a range of prominent business cycle indicators.

The SBU differs from earlier surveys of beliefs and expectations in key respects: an innovative question design for eliciting subjective probability distributions, a focus on outcomes at the respondent's own firm, a monthly sampling frequency, and broad coverage of the U.S. nonfarm private sector. Core questions about own past, current and future sales, employment and capital expenditures go to field every month. Special questions each month elicit (a) subjective probability distributions over other firm-level or aggregate outcomes, (b) information about the firm's characteristics or information processes, or (c) the perceived effects of specific economic and policy developments on the firm's own outcomes. In February 2018, for example, we asked whether the 2017 Tax Cut and Jobs Act caused firms to revise their capital investment plans for 2018 and 2019 and, if so, in which direction and by how much. In January 2019, we posed questions about the past and prospective effects of trade policy developments on investment. By aggregating over the firm-level responses to these questions, we obtain survey-based estimates for the causal effects of policy developments. See, for example, Altig et al. (2019).

Several other surveys collect data on the expectations and beliefs of business decision makers. For example, the Duke University CFO Survey elicits perceptions of aggregate uncertainty in the form of 80 percent confidence intervals for future S&P 500 returns and, more recently, for U.S. GDP growth. See Ben-David, Graham, and Harvey (2013) and cfosurvey.org. Surveys in Germany and Japan collect data on the expectations of firm-level variables. See Bachmann and Elstner (2015), Massenot and Pettinichi (2018), Tanaka et al. (2019) and Chen et al. (2019). While these surveys do not elicit subjective probability distributions, the ifo Business

Tendency Survey collects data on the best- and worst-case sales growth scenarios of German firms (Bachman et al., 2018). The closest forerunner to the SBU is the Bank of Italy's Survey on Investment in Manufacturing, which has elicited subjective probability distributions at an annual frequency for decades (Guiso and Parigi, 1999). The SBU is also closely related to the Atlanta Fed's monthly Business Inflation Expectations (BIE) Survey, which focuses on inflation expectations of firms in the Sixth Federal Reserve District (Florida, Georgia, Alabama, and parts of Tennessee, Mississippi, and Louisiana). We conducted our initial field testing of SBU questions as part of the BIE's special question series.

Although a young survey, the SBU approach to eliciting subjective probability distributions from business managers has already been adopted in several other surveys with large-scale institutional backing. The U.S. Census Bureau put questions with the SBU design to about 50,000 manufacturing plants as part of the Management and Organizational Practices Survey (Bloom et al., 2017). Since August 2016, the Bank of England and University of Nottingham have fielded a monthly U.K. Decision Maker Panel Survey that follows the SBU closely, and which has proved especially useful in assessing business expectations and uncertainty related to Brexit (Bloom et al., 2018). The British Office for National Statistics put questions that follow the SBU design to about 25,000 firms in 2017 as part of the new U.K. Management and Expectations Survey (Awano et al., 2018). Statistical agencies in Japan have also developed and fielded surveys of business managers that incorporate the SBU question design for eliciting subjective probability distributions over own-firm and aggregate outcomes.[4]

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[4] The Social Research Institute of Japan put three-point versions of the SBU questions to managers at about 13,600 manufacturing plants in 2017 and is now planning a second wave. Japan's Research Institute of Economy, Trade and Industry used the SBU question design in a 2017 survey to elicit subjective probability distributions over own-firm and aggregate outcomes. These Japanese surveys are not yet the subject of a working paper in circulation, to the best of our knowledge.

Section 1 below describes the steps we took to develop the SBU and our approach to measuring the subjective uncertainty of business executives. We describe our field tests and explain how and why we settled on a question design that lets respondents freely select support points and probability values. Our testing strategy and results may be of independent interest to survey design experts and to others engaged in developing surveys that elicit beliefs, expectations and perceptions. Section 2 discusses the SBU sample frame and our procedures for recruiting survey participants. Section 3 explains how we use the raw survey data to measure expectations and uncertainty at the firm level. Section 4 assesses our firm-level measures by comparing them to realized outcomes. Section 5 considers activity-weighted average measures of business expectations and uncertainty. Finally, Section 6 shows that respondents convey information about subjective uncertianty mainly by their choice of support point locations. Letting respondents freely select support point locations is a key innovation in the SBU question design.

1. Developing the Survey of Business Uncertainty

A. Survey Objectives

Consider a discrete probability distribution over, say, the future employment growth rates of a firm. Suppose the distribution has N support points, $\{EGr_i\}_{i=1}^N$, with associated probabilities $\{p_i\}_{i=1}^N$. We aim to elicit such a probability distribution from survey respondents. We can then calculate the respondent's (mean) expectation of future employment growth rates as $\sum_{i=1,2,\ldots,N} p_i \cdot EGr_i$ and his or her subjective uncertainty as the standard deviation,

$$\sqrt{\sum_{i=1,2,\ldots,N} p_i \left(EGr_i - Mean(EGr) \right)^2}$$

where the summation inside the radical is the variance of the subjective distribution.

Of course, we don't know how respondents conceptualize future possibilities. They may think in terms of fewer or more support points, or in terms of a continuous distribution. We also don't have a priori knowledge about the shape of the subjective distribution. These facts argue for a question design that gives flexibility to the respondent. In this regard, note that $N=5$ implies nine degrees of freedom, more than enough to approximate common parametric distributions. It also accommodates symmetric and asymmetric, single- and multi-mode, thin and fat-tailed distributions. These considerations prompted us to consider values for N as large as five.

Several other considerations figured in our thinking about the SBU question design. First, we require questions that respondents can comprehend and answer without undue burden. Much of our field testing and early analysis of survey responses focused on comprehension, as we discuss below. Face-to-face cognitive interviews with small groups of SBU panel members (4-6 respondents per group) also helped us assess comprehension. Second, business executives place a high value on their time. Thus, we aimed for a short survey instrument with an average response time of about five minutes. To help meet this goal, our sample design involves splitting the panel into two or three groups, each of which rotates through the full set of core questions every two or three months.[5] As of May 2019, one group receives the employment questions in any given month, one group receives the sales questions, and one group receives the investment questions. Each group also receives one or more special questions each month. Third, the SBU is a web-based, self-administered survey, which requires question designs that elicit answers without intervention by an enumerator or other survey representative.

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[5] The number of groups has fluctuated between two and six since we launched the SBU in mid-2014. See Table 1 for details. For much of this time, we split the panel into two groups, one of which received questions about employment and sales and the other about unit costs and capital investment in any given month. Currently the panel is split into three groups, receiving questions on employment, sales, or capital expenditures.

B. Field Testing Question Designs

Table 1 summarizes a series of question designs that we fielded and evaluated, initially as part of the BIE's special question series and later in a new panel of firms for the SBU.

<u>October 2013: Initial question formulations</u>

We began fielding trial questions in October 2013, comparing two designs for eliciting information about the firm's subjective distribution over its future sales growth rate. Figure 1 displays screen shots. We randomly assigned each question design to half the participants.

- The first design asked respondents to select the best, middle and worst-case percentage changes in the firm's sales over the next twelve months. A drop-down menu for each case let respondents choose among values ranging from -10 to +25 in one-point increments. Pop-up boxes instructed respondents to select a "best case" corresponding to the top ten percent of possible outcomes, a "worst case" corresponding to the bottom ten percent, and a "middle case" corresponding to a value the firm would use for planning purposes.

- The second design asked respondents to assign probabilities to five pre-set interval bins for the possible percentage change in sales over the next year. The bins ranged from "less than -1 percent" at the bottom end to "more than 5 percent" at the top end.

The first design resembles that of the Duke CFO Survey question about future stock market returns, and the second is closer to that of the Bank of Italy's Survey on Investment in Manufacturing. These two long-running surveys of business mangers offered a natural starting point for thinking about SBU question design. We were particularly interested in two issues: First, whether the two designs yield similar inferences about mean expectations and uncertainty, and second, the adequacy of the intervals in the five-bin design.

Using the October 2013 responses, we constructed subjective distributions and compared four moment statistics.[6] The first design yielded a higher mean expectation than the second design (4.2 and 1.9 percent, respectively, for the expected sales growth rate), greater dispersion in expected sales growth rates (standard deviations of 5.9 and 1.7 percent), higher subjective uncertainty (average standard deviation values of 3.6 and 1.4 percent), and more dispersion in subjective uncertainty (standard deviations of 2.1 and 0.8 percent). For each moment, we reject the null hypothesis of equality across the two question designs at a p-value under 0.001. Clearly, the two question designs yield quite different inferences about firm-level forecast distributions.

Each question design also has potentially serious weaknesses for our purposes. The first design allows for only three support points, which affords a rather coarse characterization of the subjective probability distribution. Moreover, the pre-set outcome range in the drop-down menu may inject anchoring effects that distort the responses. Regarding the second design, a large body of literature shows that (a) businesses differ greatly in their realized growth rates and (b) much of the mass in the realized growth rate distribution lies outside the lowest and highest values (-1 percent and 5 percent) specified in the question. See, for example, the literature review in Davis and Haltiwanger (1999). Taken together, (a) and (b) imply that it is infeasible to pre-specify a modest number of support points or bins that allow all firms to characterize their subjective forecast distributions in a reasonably granular manner. This observation argues strongly in favor of letting respondents select the support points. Our survey responses to the second question design suggest another reason as well. In particular, the typical respondent assigned a probability of about 30 or 40 percent to the middle bin (1.1 to 3 percent sales growth) and 10 to 20 percent to the outer

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[6] The first design yields a three-point discrete distribution with probability 0.1 for the "worst" case, 0.8 for the "middle" case and 0.1 for the "best." For the second design, we applied the user-selected probability to the interval midpoint. We used 6% and -2% for the top and bottom intervals, respectively.

bins. This pattern is worrisome in light of empirical regularities (a) and (b). It suggests that the question design leads respondents to put too much mass in our pre-set middle bin. This response pattern fits the "middle means typical" heuristic, a well-known source of response distortion in the survey design literature (e.g., Tourangeau, Couper, and Conrad, 2004).

November 2013: Alternative interval bins

We retained the first question design in November 2013 but made it clearer that the worst, middle and best cases correspond to support points with pre-set probabilities of 0.1, 0.8 and 0.1. We tried a variant of the second design with much wider interval bins, as shown in Figure 2. The wider bins more closely align with the range of outcomes elicited by the first question design in October 2013 and better reflect the heterogeneity in observed firm-level growth rates.

The November 2013 results showed that the spread of the bin intervals in the second design matter greatly. In particular, the moment statistics generated by the second question design in November 2013 are much closer to the ones generated by the first design in either month. For example, the second design yielded an average expected growth rate of 5.1 percent and average uncertainty statistic of 5.8 percent in the November survey. Moreover, the same firms responded quite differently to the October and November variants of the second question design. Among firms that received and answered the second question in both months, the average expected growth rate jumped from 1.7 to 5.1 percent, and the average subjective standard deviation jumped from 1.1 to 4.5 percent. In sharp contrast, among the firms that received and answered the first question in both months, the average expected growth rate was nearly identical (3.3 and 3.2 percent), and the average subjective standard deviation was similar at 3.4 percent in October and 3.0 percent in November. Finally, among firms that got the second design in October and the first design in

November, the moment statistics differ between months very similarly to how they differ across the two designs in October.

The foregoing discussion underscores two advantages of letting respondents select the location of support points. First, it allows for a parsimonious question format (as in the first design) while still accommodating enormous cross-firm heterogeneity in the central tendency and dispersion of growth rates. Second, it avoids anchoring and types of response distortions that might be introduced by pre-specifying support points or interval bins.

December 2013: Testing three-point versus five-bin designs on unit cost questions

In December 2013, we modified the questions to refer to unit cost growth over the next 12 months. Figure 3 shows screen shots. Again, the two question designs yielded systematic differences in the moment statistics. Although the between-design discrepancies in December 2013 for unit cost growth were smaller than the ones for sales cost growth in October 2013, the results reinforced our concerns about the pitfalls in pre-specifying the support points or bins.

January 2014: Freeing up the probabilities

In January 2014, we began testing designs that let respondents freely select probabilities *and* support points. We used a three-point distribution and returned to sales growth. We modified the questionnaire to refer to scenarios for "low", "medium", and "high" growth. Figure 4 shows screenshots.

With this design, respondents reported statistically significantly higher subjective uncertainty and—particularly—greater heterogeneity in both forecasts and subjective uncertainty concerning sales growth over the next 12 months. Letting respondents provide their own probabilities typically yielded more weight on the "high" and "low" scenarios – closer to 20 or 25 percent than the 10 percent specified in the October and November variants of this question.

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Respondents also assigned a broad range of probabilities to "high" and "low" scenarios, typically from 5 to 30 percent but in extreme cases as low as zero or as high as 80 or 85 percent. By contrast, the three support point values they selected were similar to the ones they gave in October and November. We did not remind respondents that probabilities should add up to 100 percent. Indeed, 20 percent submitted probability vectors that did not add up to 100.

The January 2014 experiment led us to conclude that letting respondents select support points and probabilities is feasible and allows them to express idiosyncratic features of their subjective probability distributions. From a research standpoint, this question design means our survey questions can capture heterogeneity in expectations and uncertainty in the cross-section of firms as well as over time.

February 2014: Testing a question about employment

In February 2014 we essentially replicated the experiment from January, but this time asking BIE respondents to provide a three-point subjective probability distribution for their firm's employment 12 months in the future. We first asked them for the firm's current number of employees (including part-time). Then we asked them to provide three-point outcomes for the level of employment ("low", "middle", and "high") twelve months into the future, and then assign a probability to each of those three outcomes. See Figure 5 for a screenshot.

We found the February test to be broadly successful in capturing beliefs about future employment levels. Similar to our prior tests of questions about sales growth and unit cost growth, the employment levels question had a low rate of item nonresponse, respondents gave monotonic outcomes across the "low", "medium", and "high" cases, and 98 percent of their probability assignments summed to 100 percent.

March 2014: Repeating the three-point, three-probability sales question from January 2014

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The March 2014 BIE special question included a repeat of the January 2014 question, namely asking respondents for "low", "middle", and "high" scenarios for sales growth over the next year and subsequently ask them to assign a probability to each of these scenarios. (See Figure 6 for a screenshot.) We confirmed the suitability of the question and found responses to be broadly consistent with those from January. Additionally, we found some preliminary evidence that the mean respondent changed the positioning of the support points more than the probability vector. In Section 6 below, we show that the positioning of the support points accounts for much of the variation in subjective uncertainty both cross-sectionally and across time using a larger sample from the SBU proper.

April-May 2014: Testing five-point, five-probability versions of the sales and employment questions

We decided to test a five-point version of the sales question in April 2014 (again as a special question in the BIE survey), looking to see if we could capture more extreme scenarios by the addition of a "highest" and a "lowest" scenario at the tails of the elicited sales growth distribution. (Figure 7 shows a screenshot of this version of the question.) We found this test to be successful, with many respondents assigning more extreme outcomes and lower probabilities—on the order of 10 percent—to the extreme outcomes.

In May 2014 we tested a five-point version of the employment question from February 2014. The screenshot for this test, again implemented among BIE respondents, is shown in Figure 8. Once more, we found this test to be successful, with respondents assigning low probabilities to the outermost "highest" and "lowest" scenarios and associating those outcomes with more extreme outcomes.

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<u>June 2014: Testing a three-point version of the sales question, plus asking for extreme scenarios</u>

In June 2014 we returned to the three-point sales question from January and March and considered how responses changed if we asked for "best" and "worst" tail scenarios in addition to the three-point distribution, without asking for associated probabilities for those tail scenarios. Figure 9 shows a screenshot of this test.

The responses to the three-point question in this experiment yielded forecasts and subjective uncertainty over future sales that had a similar mean and dispersion as those from January and March. We interpreted this consistency between January, March, and June responses as a sign of the reliability of our methodology.

June 2014 was the last time we tested questions as part of the BIE special question series.

<u>July 2014: First tests on SBU panel</u>

From July 2014 on, we conducted survey testing on a new panel of firms recruited specifically for the Survey of Business Uncertainty (described in more detail in Section 2 below on Panel Characteristics and Recruitment). Following the A/B testing strategy employed previously, we split the sample randomly and sent three-point or five-point versions of the questions, now covering three topics: employment, sales growth, and prices. See Figure 10 for screenshots of these questions.

In the inaugural SBU survey, we found that respondents were willing and able to provide monotonic scenarios across the five support points for the outcomes, that probability vectors nearly always summed up to 100 percent, and that the distributions of respondents' implied subjective expectations and uncertainty resembled those of the three-point questions we tested in previous months. Additionally, as we first found in the April 2014 test, the five-point questions gave respondents additional flexibility to express their perception of outcomes farther out on the tails.

As a consequence of these findings we decided to focus on our five-point question design going forward.

<u>Summer and Early Fall 2014: Cognitive interviews and further development of questions</u>

During summer 2014, the team conducted cognitive interviews with 7 members of the BIE panel to assess their understanding of the questions that constituted the new SBU survey. Most interviewees found the questions to be interesting, worthwhile, and user-friendly. Much of the feedback they provided was quite industry-specific and thus not particularly actionable since we wanted our survey to work for firms throughout the private business sector.

One useful finding from the interviews concerned the way we were asking respondents to select the five potential support point outcomes ("lowest" to "highest"). Up to that point, we had been using drop-down boxes with one-unit increments. For example, the bottom box would correspond to -20 percent (or lower) sales growth over the next year, the next to -19, the following one -18 percent, and so forth. Many respondents asked the increments to be finer in order to increase precision.

Additionally, we found that the drop-down boxes could be problematic. This was especially true for sales, where we had made the range in the drop-down box very large (from less than -24 percent in the lowest case to more than +35 percent in the highest). Some respondents confused the minus with a dash and thus ended up selecting the wrong outcome. In light of these comments and observations, we moved to an open-text question format, allowing respondents to enter the values each of the support point outcomes freely for all questions. We tested that question design in August 2014, which was the same as in July except for the replacement of the drop-down boxes with open text boxes.

In early fall 2014 we also changed the format of the sales questionnaire to mimic that of employment, namely asking for the current level of sales in dollars and asking for five potential sales levels one year ahead. We had been using this approach for the questions on employment levels because it was harder for us to preset the support point outcomes in the presence of vast heterogeneity in the number of employees across firms. We additionally changed the wording in the sales question to refer to quarterly values, given that sales are a flow rather than a stock variable and are often tracked quarterly. See Figure 11 for a look at the new sales question.

During the August test we also tested questions on unit costs (which we had previously tested in December 2013), capital investment (designed analogously to those for sales) and new questions about profit margins. In September we conducted tests that were very similar to those of August, also trying out questions on average prices.[7]

October 2014: Initial version of the SBU operates regularly

In October 2014 we settled on the first stable version of the SBU questionnaire (at the time known as the "Decision Maker Survey"). Since then, the survey has been administered monthly out of the Atlanta Fed with monthly response rates averaging roughly 40 percent, resulting in about 300 responses per month. Up until October 2015 we divided the panel into three subgroups, each answering questions about two topics in a given month, with topics including employment, sales, capex, unit costs, average prices, and profit margins. From November 2015 to August 2016 we used six sub-groups, each answering questions about two of the six topics.

September 2016 to April 2019

We made a major change to the SBU in September 2016, at which time we eliminated the questions on average prices and profit margins. Based on feedback from our respondents these

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[7] See Appendix Figure 1 for the wording of the prices and profit margins questions. In subsequent rounds of the survey we eliminated the questions on these two topics and they are not part of our main analyses.

were the questions that created the most confusion. Eliminating these two topics also allowed us to split the sample into just two groups, greatly increasing the number of responses per topic per month. Starting in September 2016, the monthly SBU form thus contained two of the four topics in the following combinations: Average Unit Cost/Capital Expenditures (CC), and Sales Revenue/Number of Employees (SE). We sorted our panel respondents randomly into two subgroups. In a given month group A receives the Sales Revenue/Number of Employees (SE) questionnaire and vice versa for group B. See Figure 12 for screenshots of these questionnaires.

In September 2016 we also changed the sales question back to asking about sales *growth rates* looking ahead over the next four quarters, rather than sales *levels* four quarters ahead. Figure 12 reflects this change, in contrast with Figure 11. Our rationale for the change was that many respondents made mistakes in entering the dollar value of sales four quarters into the future. Some common mistakes included giving an annual rather than quarterly value for the firm's current or future sales level or failing to keep units consistent. In some cases, respondents reported current sales in units of dollars and future values in thousands or millions of dollars, at other times using different units across months. By asking for sales growth rates we created fewer opportunities for respondents to make such mistakes.

Future changes: May 2019 onwards

As of writing we are in the process of implementing a new round of changes to the SBU questionnaire. In May 2019 we plan to eliminate the unit cost growth questions given our limited ability to track actual changes in unit costs and due to feedback from our respondents concerning that question. Several respondents have cited difficulty answering questions about unit costs. Service firms, in particular, cite confusion regarding this question, often saying that unit costs are more relevant for manufacturing. We therefore plan to concentrate on subjective probability

distributions for future employment, sales, and capital expenditures, asking about only one of these topics in a given month. These changes will expand the number of respondents receiving questions about a given topic in a given month. Having a rotating panel of three questions rotated monthly will also mean that a given firm will answer questions about a given topic at a quarterly frequency.

Finally, in this new wave of changes, we intend to ask firms systematically about the level of the stock of capital (i.e. property, plant and equipment) they hold in addition to asking them our usual questions about current, past, and future investment (i.e. capital expenditure flows).

2. Panel Characteristics and Recruitment

The SBU's panel of respondents consists of firms from throughout the United States economy. With the exception of agriculture and government, our panel includes firms from every sector and a broad range of sizes (in terms of number of employees), from owner-operated firms to large publicly-traded companies.

A team of research assistants at the Atlanta Fed identifies and recruits new panel members using lists of eligible firms purchased from Dunn & Bradstreet, a supplier of business information and research. The composition of firm types in these lists is determined only by sectoral contribution to US Gross Domestic Product. The team randomly selects potential recruits from a contact list, focusing on contacts in senior finance or executive roles. Since our goal is to use the survey to create indices that aggregate business expectations and uncertainty, the team oversamples firms with more than 100 and 500 employees. See Figure 13 for more details on how the composition of our survey panel compares with the rest of the US economy in terms of firm size, sector, age, region. Figure 13e also shows the share of firms and share of employment in our sample belonging to publicly-traded firms, as self-reported answers to special questions fielded in

February and March 2019. (These figures are replicated in the Appendix of Barrero (2018), the first academic paper to focus primarily on data from the SBU.) Table 3 shows summary statistics about key firm characteristics in our sample, as do sub-figures 13f through 13h.

Panel Recruitment Process

Our team of recruiters at the Atlanta Fed contacts potential respondents via telephone, explaining the nature of the survey, its purpose, and informs them that individual survey responses are confidential. If the contact agrees to join the survey, the recruiter records his or her email address, where we deliver the personalized link to the survey instrument each month. We verify that the email address is valid by sending a confirmation that they have joined the SBU panel.

During the period covering June 2014 to June 2018, approximately 42 percent of potential contacts reached via telephone agreed to join the panel. Among those who joined, 62 percent responded at least once. In any given month about 43 percent of all continuing panel members responded to the survey.[8]

The recruiting team deduplicates lists of contacts that we subsequently purchase, preventing us from re-recruiting previously listed firms. To maintain the survey's sample size over time, we constantly recruit new firms to join the panel and replace those who stop responding. Our aim is to maintain a sample size of about 300 responses per month.

Data Preparation

In a typical month, we email our respondents an individual link to the survey instrument on the Monday of the second full week of the month. We collect responses during the next two workweeks, so data collection ends on the Friday of the third full week of the month. The Monday following the end of the survey collection, we download and store all responses in a folder that

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[8] These response rates refer to the period between September 2016 (when we made the most recent major change to the survey) and October 2018.

contains all prior monthly data files. Then we run programs to combine all monthly files into an aggregate file and perform a series of automated cleaning procedures on the raw survey data. This cleaning program includes the following processes:

1. Rescaling of subjective probabilities: On occasion, respondents provide subjective probabilities that do not add up to 100 percent. We rescale probability vectors that add to between 95 and 105 percent to make them add up to 100 percent. We disregard responses whose probability vectors add up to a number outside the 95-105 percent range. Typically, this filter eliminates very few of the responses in a given month.

2. Adjustment of estimates and probabilities given in reverse order: In rare instances, some respondents provide their range of estimates in reverse order, starting with their "highest case" value in the "lowest case" scenario. We reverse these estimates and their associated probabilities to conform to the typical response pattern of lowest to highest.

Once the automated cleaning processes are completed, we perform a manual review of all large firms (firms with 1000 employees or more). We check a large firm's current month responses for consistency with its historical responses. If responses are found to be inconsistent, we conduct a review of publicly available information, including news reports, public filings, etc. If a review of publicly available information is inconclusive, we consider contacting the respondent for clarification. We focus on larger firms for the manual audit because of their greater weight on the aggregate indices produced from the SBU survey.

3. Measuring Subjective Expectations and Uncertainty with the SBU Microdata

Computing Moments of Subjective Probability Distributions

We use the raw subjective probability distributions from survey responses to compute subjective expectations (i.e. forecasts) and uncertainty over the future growth rates of employment and sales. For investment, we focus on expectations and uncertainty about the firm's investment rate, namely the ratio of capital expenditures to its capital stock (i.e. I/K).[9] In this section, we outline the full details of these computations for employment growth and leave the details for the other topics in Appendix A. Table 2 shows summary statistics on the probabilities and outcomes associated with each of the five points in respondents' probability distributions for each topic. Table 3 shows summary statistics on our measured expectations, uncertainty, and realized outcomes as well as some basic firm-level characteristics.

For each respondent in month t we obtain from the survey data:[10]

- The firm's current employment: $CEmp_t$

- A vector of employment outcomes, 12 months hence: $FEmp_i, i = 1,2,3,4,5$

- A vector of probabilities associated with those employment outcomes: $p_i, i = 1,2,3,4,5$

First we compute the implied employment growth[11] rate associated with each outcome i:

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[9] As of April 2019 we have not regularly asked firms to report their capital stock. In a series of special questions during September and October 2017 as well as February and March 2019 we asked them to report the book value of their property plant and equipment. Based on these responses, we construct measures of our respondent firm's capital stock throughout the sample. See Appendix B for details. Starting in May 2019 we intend to ask firms to report their capital stock every few months, when they receive the capital expenditures questionnaire.

[10] We drop firm-level subscripts in this section to keep notation light, but we perform all calculations at the level of firm-by-survey wave.

[11] Following standard practice in the literature on business-level dynamics we always compute the growth rate of variable x from t to $t + 1$ using the following formula: $g_t = 2 \cdot \frac{x_{t+1} - x_t}{x_{t+1} + x_t}$.

- $EGr_i = 2 \cdot \frac{FEmp_{it} - CEmp_t}{FEmp_{it} + CEmp_t}$

We then compute the subjective first and second moments implied by the subjective distribution:

- The respondent's subjective forecast for growth over the next year, namely the expectation implied by their five-point, five-probability discrete distribution:

$$Mean(EGr) = \sum_{i=1,2,3,4,5} p_i \cdot EGr_i$$

- The respondent's subjective uncertainty, namely the standard deviation implied by their five-point, five-probability discrete distribution:

$$Var(EGr) = \sum_{i=1,2,3,4,5} p_i (EGr_i - Mean(EGr))^2$$

$$SD(EGr) = \sqrt{Var(Egr)}$$

Obtaining and Cleaning Forecast Errors

We obtain forecast errors by exploiting the SBU's panel structure. When responses are available, we measure the firm's actual employment growth between months t and $t + 12$ as:

$$Realized(EGr) = 2 * \frac{CEmp_{t+12} - CEmp_t}{CEmp_{t+12} + CEmp_t}.$$

If for some reason we do not have a value for $CEmp_{t+12}$ (e.g. because the respondent failed to answer that particular survey), we use $CEmp_{t+11}$ and adjust the realized growth rate by a factor of 12/11. If $CEmp_{t+11}$ is also not available, we use $CEmp_{t+13}$ and adjust the realized growth rate by a factor of 12/13. If we still cannot compute the realized growth rate, we use $CEmp_{t+10}$ and $CEmp_{t+14}$ analogously.[12]

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[12] As of April 2019, respondents answer questions about a given topic every two months, so typically we record realized employment 12, 10, or 14 months after a forecast. Prior to September 2019, the format of

Once we have obtained the realized growth rate, we compute the forecast error for a firm responding in month t as:

$$ForecastError(EGr) = Mean(EGr) - Realized(EGr).$$

We manually review the responses of firms with extremely large forecast errors for employment and sales growth rates. In particular, we review responses when the absolute difference between forecast and realized growth rates is greater than unity, i.e. if $|ForecastError| > 1$. We use the firm's history of responses about current sales and employment to correct obvious mistakes. Common mistakes include missing or added zeros and reporting an annual rather than a quarterly sales figure. If we cannot find an obvious mistake, we flag these observations as potential errors, typically excluding them from analyses of forecast error behavior.

4. Assessing the Performance of Subjective Moments

In this section we show that firm expectations and uncertainty as captured by the SBU's five-point probability distribution are strong predictors of realized outcomes. Our sample for this section includes all SBU survey waves from October 2014 to February 2019. These results build on some of the analysis in Barrero (2018), which also uses SBU microdata.

Expectations measured using the SBU's five-point subjective probability distributions are strong predictors of ex-post employment growth. Figure 14 shows a bin-scatter of 50 quantiles of employment growth forecasts for the next 12 months, $Mean(EGr)$, collected in month t on the horizonal axis. The vertical axis plots actual employment growth over the ensuing 12 months, $Realized(EGr)$. We can see a tight positive relationship between employment growth forecasts

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the SBU was less stable so we do have a few cases for which we observe realized employment 11 or 13 months after a forecast. The same applied for realized sales and investment.

and realized employment growth. The OLS coefficient for the slope is 0.688 (0.073), so lower than (and statistically distinct) from one, but this appears to be at least partly a result of classical measurement error in the independent variable. Indeed, an IV regression that uses the "middle" support point scenario for employment growth as an instrument for the firm's employment growth forecast has a coefficient of 0.904 (0.090) and is no longer statistically different from one. We find qualitatively the same results if we repeat this exercise using forecasts for future sales growth or future investment rates.

More crucial to our goal in this paper, we find our measures of subjective uncertainty based on the SBU's data and methodology are highly predictive of the magnitude of ex-post forecast errors. Figure 15 shows a bin-scatter, now with 50 quantiles of subjective uncertainty about employment growth looking 12 months hence from month t, $SD(EGr)$, on the horizontal axis. The vertical axis shows absolute forecast errors for employment growth between t and $t + 12$, $|ForecastError(EGr)|$. Again, there is a tight, positive relationship, indicating that our measures of subjective uncertainty based on the SBU's five-point, five-probability questionnaires capture the degree to which firms are (un)able to predict their future employment growth accurately. This result is particularly encouraging for our main goal in developing the SBU, namely, to develop measures of subjective uncertainty. The pattern in Figure 15 thus confirms that our measures are highly correlated with an ex-post objective measure of uncertainty, namely the magnitude in the unpredictable component of employment growth. Earlier work, notably Jurado, Ludvigson, and Ng (2015), use this sort of ex-post measure to quantify uncertainty. Our contribution is to show that businesses' subjective probability assessments can predict some of these ex-post measures and therefore justify their use in measuring economic uncertainty.

In Appendix Figure 2 and Appendix Figure 3 we also show that subjective uncertainty is negatively correlated with firm size and age, although not with age after controlling for size. We find these relationships reassuring, given long-standing results that larger, older firms experience lower dispersion and volatility than do younger, smaller firms (e.g., see Davis et al., 2006). The fact that our subjective uncertainty measures correlate with size and age is therefore a good indication that our measured subjective uncertainty captures well-known features of the cross-sectional variation in uncertainty.

5. Indices of Business Expectations and Uncertainty for the US Economy

In this section, we describe how we build our indices of business expectations and business uncertainty for the US economy using data from the SBU. First, we generate topic-specific expectations and uncertainty indices for employment growth, sales growth, and investment, shown in Figure 16.[13] Then we aggregate the topic specific indices into overall business expectations and business uncertainty indices. Below we describe in full detail how we construct our topic-specific and overall business expectations (first-moment) and uncertainty (second-moment) indices from our panel of subjective probability distributions. The procedures for expectations and uncertainty are analogous other than for a couple of details.

<u>Business Expectations Indices</u>

We begin by constructing monthly, activity-weighted, expectations (i.e. first-moment) indices for employment growth, sales growth, and investment rates, looking 12 months ahead for

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[13] Figure 16 shows the topic-specific indices in their natural units. As of July 2019 we plan to post standardized versions (mean and variance 100) of the topic-specific indices while also sharing the underlying mean and variance of the raw series for interested researchers.

employment and four quarters ahead for sales and investment.[14] For illustration, the index for employment takes a value in month t equal to the activity-weighted average of subjective expectations about employment growth rates looking 12 months hence, $Mean(EGr)$, averaging across all firms responding to the employment question that month. We winsorize $Mean(EGr)$ at the 1st and 99th percentiles before averaging across firms to diminish the influence of outliers. In month t, we weight firm i's subjective mean growth rate by the firm's month t employment, $CEmp_{it}$. If that data is unavailable, we use $CEmp_{it-1}$, $CEmp_{it+1}$, $CEmp_{it-2}$, $CEmp_{it+2}$, $CEmp_{it-3}$, or $CEmp_{it+3}$, in that order of preference. We top-code these weights at 500 to diminish the influence of outliers among very large firms.

We construct indices for sales growth and investment rates analogously.[15] To make our investment index comparable conceptually to our employment <u>growth</u> and sales <u>growth</u> indices, we use firms' expectations of the <u>change</u> in their investment rate, looking four quarters ahead, relative to current investment. Namely, we build our investment index by averaging firms' expectation of their investment rate four quarters in the future *less* their current investment rate (see Appendix A4 for more details, and Appendix B for details on how we measure firms' capital stocks). As with the employment growth expectations index, we use top-coded employment values to weight the firm-level expectations for future sales growth and investment rates.

After aggregating individual responses into our three topic-specific expectations indices, we smooth these series. Our smoothing procedure exploits the fact that for survey months prior to

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[14] In earlier versions of our indices we also constructed series on unit costs and included them as part of our overall business expectations and business uncertainty indices. In April 2019, when we decided to eliminate the unit cost question from the SBU, we re-built our indices historically without including the unit cost series.

[15] We find that our raw sales index changes its mean and volatility exactly when we changed the sales questionnaire to ask for growth rates rather than sales levels in September 2016. To address this, we currently normalize the pre-September 2016 data so as to give it the same mean and standard deviation as the portion of the series covering September 2016 to December 2018, inclusive.

September 2016 we have about 50 responses per topic per month and since September 2016 about 150 responses per topic per month. To generate a series with an approximately constant number of underlying observations each month (and thus a relatively stable sampling error) we smooth as follows:

- For months since November 2016 we use a three-month lagged moving average.

- For months up to and including August 2016 we use a nine-month lagged moving average.

- In the September and October 2016 data we use a seven-month and five-month lagged moving average, respectively, accounting for the transition to the new sample size per topic and month.

We aggregate the three topic-specific indices for employment growth, sales growth, and investment into an overall business expectations index. First we standardize each of the indices to give them a mean and a variance of 100 (i.e. standard deviation of 10) during the 48 months covering January 2015 to December 2018, inclusive. We hold the base period fixed to keep historical values of our indices constant as we add more months of data. By standardizing, we ensure that the contribution of each of the topic-specific indices to the overall index does not mechanically depend on the magnitude of the natural units for that topic. After standardizing, we compute the overall business expectations index in month t as the arithmetic average of the three standardized topic-specific indices in month t. Finally, we re-standardize the overall index to have mean and variance of 100 (i.e. standard deviation of 10) during the base period covering January 2015 and December 2018, inclusive.

Business Uncertainty Index

Construction of our business uncertainty Index closely follows that of our business expectations index. We first build a monthly activity-weighted uncertainty (second-moment) index for employment growth, sales growth, and investment looking ahead over the next year. The month t index of 12 months ahead subjective uncertainty for employment growth is the activity–weighted mean of $SD(EGr)$ across firms responding in month t. We winsorize $SD(EGr)$ at the 1st and 99th percentiles before averaging across firms to diminish the influence of outliers. In month t, we weight firm i's subjective uncertainty by the firm's month–t employment, $CEmp_{it}$. If unavailable, we use $CEmp_{it-1}$, $CEmp_{it+1}$, $CEmp_{it-2}$, $CEmp_{it+2}$, $CEmp_{it-3}$, or $CEmp_{it+3}$, in that order of preference. We top–code these weights at 500 to avoid the index being dominated by very large firms (which could increase measurement error due to overweighting a small number of respondees). We construct the indices for sales growth and investment analogously, as with our expectations indices.[16] For investment we focus now on firms' subjective uncertainty about their investment rate four quarters ahead.[17] In all cases, we use top-coded employment values to weight firm-level uncertainty when we aggregate across firms.

As with our expectations indices, we smooth the topic-specific indices for employment growth and sales growth uncertainty to adjust for the smaller number of responses in the pre-September 2016 sample, using the same smoothing scheme described above.

To aggregate the three topics into our business uncertainty index, we standardize each of the topic-specific uncertainty indices to give them a mean and a variance of 100 (standard deviation of 10) during the period covering January 2015 to December 2018, inclusive. Then, we compute

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[16] We give our sales growth uncertainty index in months prior to September 2016 the mean and standard deviation of the index during September 2016 to December 2018, inclusive, as with the sales growth expectations index.

[17] Subtracting current investment is no longer necessary since that would just wash out when computing the subjective (conditional) standard deviation across scenarios for the firm's future investment rate.

the overall index in month t as the equally weighted average of the three standardized topic specific indices in month t. Finally, we re-standardize our overall business uncertainty index to give it both mean and variance of 100 (standard deviation of 10) during the period between January 2015 and December 2018, inclusive.

Assessing the Performance of Our Business Expectations and Uncertainty Indices

Figure 17 assesses the performance our overall business expectations index by plotting it against other aggregate series that capture developments in the state of the US economy. Figure 17a shows our business expectations index alongside a smoothed series of S&P 500 returns. We compute the S&P return to month t from the middle of month $t - 1$ to the middle of month t to better match the timing of our survey, which goes to the field during the second full week of each calendar month and collects responses until the end of the third full week of the month.

We can see a weak positive relationship between developments in the stock market and our index. As of early 2019 the link between the two appears particularly weak, with bigger swings in the market during late 2018 and early 2019 than in our index. Figure 17b shows an alternative plot of the *change in our business expectations index* against the same series of S&P 500 returns. The correlation between the series is now much higher, at 0.37. Finally, Figure 17c shows that our index has a very high correlation with the most recent growth rate of the Federal Reserve's monthly Industrial Production Index. Our respondents seem to be particularly optimistic in months during which industrial production grows by more relative to other months.

In Table 4 we explore the relationship between the SBU expectations indices (the overall index as well as the topic-specific employment growth, sales growth, and investment indices) over a sample starting in January 2015. We conduct granger causality tests in a VAR framework,

reporting the p-values in Table 4.[18] While the sample is admittedly small, the results suggest the SBU first moment indices have predictive power for a set of well-known macroeconomic variables typically used in policy analysis. The overall SBU Business Expectations Index *granger-causes* Industrial Production, the ISM's Composite Purchasing Managers Index, and the Federal Reserve Bank of Chicago's National Activity Index. All three of these series are often used to provide a monthly signal of quarterly GDP growth. The SBU employment and investment expectations indices also appear to have significant predictive information in general, while sales growth expectations tends to be *granger-caused* by a variety of macro aggregates.[19]

Figure 18 benchmarks our business uncertainty Index against some common proxies for uncertainty in the US economy. In Figure 18a we plot our index against a smoothed version of the 1-year VIX, with both series exhibiting something of a downward trend since 2015 and a recent uptick towards the end of 2018 just as concerns about trade, the recent government shutdown, and future economic developments kick in and then somewhat subside as we go farther into 2019. We made a conscious choice to use the 1-year VIX, a volatility index published by the CBOE using the methodology of the VIX on options that expire within one year, rather than the usual, 30-day VIX. The reason is the forward-looking horizon covered by the 1-year VIX aligns closely with that of our survey questions, yielding a more direct comparison of two measures of uncertainty over the next year.

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[18] Appendix Figure 4 graphs the timeseries of the SBU Expectations Index vs 6 different macroeconomic variables.

[19] Granger-causality tests have been shown to be sensitive to the number of included lags, as in Thornton and Batten (1985). We chose the optimal lag length for each bivariate VAR using either the Schwarz or Hannan-Quinn Information Criterion over a maximum lag length window of 12 months. The 12-month maximum window was chosen *a priori* given the year-ahead construction of our indices. In Appendix Table 1 we allow for selection criterion over a shorter window of 6 months.

In Figures 18b and 18c we show how our index performs against measures of forecaster disagreement regarding GDP in the current quarter and four quarters ahead. Our index behaves most similarly to forecaster disagreement about current GDP, but still exhibits certain similarities with disagreement about GDP four quarters ahead, particularly the uptick in late 2018 which subsides in early 2019. Overall, we believe these comparisons show our indices contain information that is also part of traditional uncertainty proxies, while providing new insights about business uncertainty due to their tight link to micro-level subjective uncertainty.

Survey Tenure Effects and Our Uncertainty Index

One potential concern regarding our business uncertainty Index concerns whether the downward trend in the index apparent in Figure 18 is a result of survey tenure effects. This is particularly concerning given that the trend is likely responsible for much of the correlation between our index and other measures of uncertainty like the one-year VIX during our sample period. To examine this concern, we look to the SBU microdata and regress the natural logarithm of subjective uncertainty about employment growth, sales growth, and investment one year hence on survey tenure. The results of these regressions are shown in Table 5. In Table 5a we define tenure as the number of previous responses, while in 5b we define tenure by the number of months since the firm's first response to the survey. In both cases we compare this regression with or without date fixed effects and find that higher survey tenure is not significantly associated with lower uncertainty, in particular when we include those date fixed effects. Namely, the downward trend in our business uncertainty index is a feature of responses that come later in terms of calendar time rather than due to higher average survey tenure in recent months.

We corroborate that survey tenure effects are not driving the downward trend in our business uncertainty index in Figure 19, in which we estimate a less parametric version of column

(2) of Table 5a. We regress subjective uncertainty about employment over the next twelve months on a full set of indicators for the previous number of responses, controlling for date fixed effects. We find none of the point estimates are statistically significant and do not appear to become more positive or negative for higher previous numbers of responses, corroborating our conclusion from Table 5. In unreported results we run the same exercise for survey tenure in terms of the number of months since the firm's first response to the SBU and find a similar pattern.

6. How Respondents Communicate Information about Subjective Distributions

In this section, we consider whether respondents' positioning of support point outcomes or how they choose to distribute probabilities across the five outcomes scenarios accounts for more of the cross-sectional and time-series variation in subjective uncertainty we find in the SBU. To do this, we compare four measures of uncertainty constructed using our SBU data. Recall that we measure uncertainty as respondents' subjective standard deviation for employment growth over the next 12 months, sales growth over the next four quarters, and for their firm's investment rate (I/K) four quarters ahead. For each topic this requires us to compute the standard deviation implied by respondents' chosen probabilities and outcomes across five potential scenarios $\{p_i, g_i\}$, $i = 1,2,3,4,5$. (Look back at Section 4 for details on how we compute subjective uncertainty for employment growth, and Appendix A for all of our topics). Our results in this section focus on employment growth, but in unreported results, we find the same patterns hold for sales growth and investment.

The four measures of uncertainty we consider are:

1. <u>True Subjective Uncertainty:</u> uses each respondent's own probabilities and support points $\{p_i, g_i\}$, $i = 1,2,3,4,5$. This is the measure of uncertainty we have been using up to now.

2. <u>Free Support Points, Mean Probabilities:</u> uses the mean probability vector across all responses for that topic (e.g. employment growth over the next 12 months) and the respondent's own support point outcome scenarios $\{\bar{p}_i, g_i\}$ $i = 1,2,3,4,5$, where $\bar{p}_i = \sum_{j=1}^{N} p_{ij}/N$. Here, i indexes the five scenarios and j indexes responses, pooling across all SBU waves.

3. <u>Free Probabilities, Mean Support Points:</u> uses the respondent's own probability vector and the mean vector of support points for the outcomes across all responses for that topic $\{p_i, \bar{g}_i\}$, $i = 1,2,3,4,5$ where $\bar{g}_i = \sum_{j=1}^{N} g_{ij}/N$. Again, i indexes the five scenarios and j indexes responses, pooling across all SBU waves.

4. <u>Lowest-highest based Measure:</u> uses the mean probability vector, the respondent's own lowest, middle, and highest support points, and interpolates for the "low" (2nd) and "high" (4th) support points: $\{\bar{p}_i\ i = 1,2,3,4,5,\ g_l,\ l = 1,3,5, \tilde{g}_2 = \frac{g_1+g_3}{2}, \tilde{g}_4 = \frac{g_3+g_5}{2}\}$. Now i and l index the five scenarios and j indexes responses, pooling across all SBU waves.

Figure 20a shows which of the above measures of uncertainty capture more or less of the variation in our baseline "True Subjective Uncertainty," looking at the pooled cross section that includes all SBU waves. We plot 100 quantiles of log(True Subjective Uncertainty) for employment growth on the horizontal axis against the average log(Uncertainty) corresponding to each quantile under the "Free Support Points, Mean Probabilities," "Free Probabilities, Mean Support Points", and "Lowest-highest based" measures on the vertical axis.

Our plots of the "Free Support Points, Mean Probabilities" and "Lowest-highest based" measures of uncertainty are nearly identical. The plots also lie quite close to the 45-degree line, indicating that they capture most of the variation in "True Subjective Uncertainty." Instead, the plot of uncertainty based on the 3rd measure, "Free Probabilities, Mean Support Points" is nearly flat, varying very little with our baseline measure of uncertainty. This result suggests that respondents' placement of the five support points—and particularly the middle, lowest, and highest points—accounts for most of the cross-sectional variation in uncertainty we see in the SBU. Using the mean probability vector rather than the vector chosen by the respondent does not appear to materially change our measure of uncertainty. The opposite is true for the placement of the support points.

In Figure 20b we further show how our different measures of uncertainty relate to our respondents' absolute forecast errors, repeating the exercise from Figure 15. Again, we find that our "Free Support Points, Mean Probabilities", and "Lowest-highest based" measures of uncertainty have high predictive power for respondents' ex-post absolute forecast errors for employment growth, as we previously found with our baseline uncertainty measure. The "Free Probabilities, Mean Support Points" measure performs poorly, capturing little of the cross-sectional variation in uncertainty.

In Figure 20c we assess the time series performance of employment growth uncertainty indices based on each of our alternative uncertainty measures. Each of these indices is constructed by applying the procedure we outline in Section 5 to one of the four measures of uncertainty we defined above (e.g. "True Subjective Uncertainty" versus "Free Support Points, Mean Probabilities"). Plotting the four series together we find that the "Free Probabilities Mean Support Points" index is again the clear outlier, both in terms of its overall level and its variability during

the sample period. The "Free Support Points, Mean Probabilities" and "Lowest-highest based" measures behave much more closely to the baseline uncertainty measure, in particular in terms of their variability. There is some difference in the level of uncertainty across each of these measures, which suggests that there is still cardinal information about uncertainty when we look at the outcome and probability vectors *together*. Nonetheless, most of the variation in uncertainty across time can be accounted for by how our respondents assign outcomes across the five support points rather than by how they distribute the probability mass.

Though not reported here, we find the same key results from a series of exercises like those in Figure 20 focusing on subjective expectations. Namely, we find that the placement of support points across outcome scenarios matters more than the distribution of probabilities when accounting for cross-sectional variation in expectations, the predictive power of expectations for future growth, and for time-series variation in expectations.

Concluding Remarks

We develop a new methodology to measure subjective uncertainty at the firm level by eliciting five-point discrete subjective probability distributions about businesses' own future outcomes. This paper describes the series of tests that we used to develop our Survey of Business Uncertainty, which has been fielded monthly to about 1,500 firms from across all sectors and regions of the US economy since 2014, resulting in a survey sample that is broadly representative of the US private non-farm sector. We show how we compute subjective forecasts (i.e. expectations) and subjective uncertainty from our raw survey data and validate these survey-based measures in the cross section of microdata. Finally, we build indices of business expectations and uncertainty for the US

economy and show that they track benchmark series that capture first- and second-moment developments in the US economy.

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Table 1: Summary of Tests for Developing the Survey of Business Uncertainty

Panel	Date	Variable(s)	Abbreviated description	Description
BIE Survey Panel – Special Question Series	Oct–13	sales levels	A/B test. three–estimate and five-binned range versions.	Participants were randomly assigned to one of two groups. Group 1 received a question eliciting the "best," "most likely," and "worst" case change in sales levels over the next 12 months. A drop–down box was provided with estimates ranging from –15% to 30%. Group 2 received a question asking respondents to assign a likelihood to five potential percentage sales level change ranges (from "less than –1%" to "more than 5%") over the next 12 months.
	Nov–13	sales levels	A/B test.	Participants were randomly assigned to one of two groups. Group 1 received a question eliciting the "best," "most likely," and "worst" case change in sales levels over the next twelve months. For each estimate a drop–down box was provided with options ranging from –15% to 30%. A note indicating "best" and "worst" case scenarios should be associated with a 10% chance of occurrence was included. Group 2 received a question asking respondents to assign a likelihood to five potential percentage sales level change ranges (ranging from "less than –5%" to "more than 25%") over the next 12 months.
	Dec–13	unit costs	A/B test	Participants were randomly assigned to one of two groups. Group 1 received a question eliciting the "best," "middle," and "worst" case percentage change in unit costs over the next 12 months. Group 2 received a question asking respondents to assign a likelihood to five potential percentage unit cost change ranges (from "less than –1%" to "more than 5%") over the next 12 months.
	Jan–14	sales levels	three estimates	Participants received a two–part question. Part one elicited the expected "low," "middle," and "high" case changes in sales levels over the next twelve months. Part two asked respondents to assign a likelihood of occurrence for each of the three scenarios.
	Feb–14	number of employees	three estimates	Participants received a two–part question. Part one elicited the expected "low," "middle," and "high" case number of employees twelve months ahead. Part two asked respondents to assign a likelihood of occurrence for each of the three scenarios.
	Mar–14	sales levels	three estimates	Repeat of the January 2014 question.
	Apr–14	sales levels	five estimates	The same question as in January and March 2014 with the addition of a "worst case" and "best case" scenario for a total of five response categories.
	May–14	number of employees	five estimates	The same question as in February 2014 with the addition of a "worst case" and "best case" scenario for a total of five response categories.
	Jun–14	sales levels	three estimates with a best case/worst case follow–up	Repeat of the January 2014 question with a follow–up question asking for the "best case" and "worst case" scenarios without a likelihood assignment.

Panel	Date	No. of Groups	Variable(s)	Notes	Description
Survey of Business Uncertainty Panel	Jul–14	2	number of employees, average price, sales revenue	A/B Test – 5 estimate and 3 estimate versions with drop down boxes for estimates and open text boxes for likelihoods	Participants were randomly assigned to one of two groups. In each group, respondents received a two–part question for each variable. Grop 1: Part one elicited the "high," "medium," and "low" case change in each variable over the next 12 months. Part two asked respondents to assign a likelihood to each of these scenarios. Group 2: Same format as Group 1 with two additional scenarios eliciting the "lowest case" and "highest case."
	Aug–14	2	sales revenue, average price, number of employees, unit cost, capital investment, profit margin	five estimates with drop down box for estimates and open text box for likelihoods	Participants received a two–part question for each variable. Part one elicited the "highest," "high," "medium," "low," and "lowest" case change in each variable over the next 12 months. Part two asked respondents to assign a likelihood to each of these scenarios.
	Sep–14	2	sales revenue, average prices, unit cost, capital investment	five estimates with open text boxes for estimates and likelihoods	Participants received a two–part question for each variable. Part one elicited the "highest," "high," "medium," "low," and "lowest" case change in each variable over the next 12 months. Part two asked respondents to assign a likelihood to each of these scenarios.
	Oct–14 to Jan–15	3	sales revenue, average price, number of employees, unit cost, capital investment, profit margin	five estimates with open text boxes for estimates and likelihoods	Participants received a two–part question for each variable. Part one elicited the "highest," "high," "medium," "low," and "lowest" case change in each variable over the next 12 months. Part two asked respondents to assign a likelihood to each of these scenarios.
	Feb–15 to Oct–15	3	sales revenue, average price, number of employees, unit cost, capital investment, profit margin	five estimates with open text boxes for estimates and likelihoods	Participants received a two–part question for each variable. Part one elicited the "highest," "high," "medium," "low," and "lowest" case change in each variable over the next 12 months. Part two asked respondents to assign a likelihood to each of these scenarios.
	Nov–15 to Jan–16	6	sales revenue, average price, number of employees, unit cost, capital investment, profit margin	five estimates with open text boxes for estimates and likelihoods	Participants received a two–part question for each variable. Part one elicited the "highest," "high," "middle," "low," and "lowest" case change in each variable over the next 12 months. Part two asked respondents to assign a likelihood to each of these scenarios.
	Feb–16 to Aug–16	6	sales revenue, average price, number of employees, unit cost, capital investment, profit margin	five estimates with open text boxes for estimates and likelihoods	Participants received a two–part question for each variable. Part one elicited the "highest," "high," "middle," "low," and "lowest" value for each variable over the next 12 months. Part two asked respondents to assign a likelihood to each of these scenarios.
	Sep–16 to Present	2	sales revenue, average unit cost, capital expenditures, number of employees	five estimates with open text boxes for estimates and likelihoods	Participants received a two–part question for each variable. Part one elicited the "highest," "high," "middle," "low," and "lowest" value for each variable over the next 12 months. Part two asked respondents to assign a likelihood to each of these scenarios.

Table 2: SBU Subjective Probability Distributions, Summary Statistics

	Outcomes by Support Point Scenario							
Scenario	Employment Growth, Next 12 Months		Sales Growth, Next 4 Quarters		Investment Rate, 4 Quarters Ahead		Unit Cost Growth, Next 12 Months	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	-0.105	0.168	-0.045	0.128	0.049	0.154	-0.002	0.042
2	-0.048	0.110	-0.001	0.094	0.076	0.222	0.016	0.033
3	0.015	0.076	0.044	0.080	0.114	0.314	0.035	0.038
4	0.066	0.093	0.082	0.091	0.156	0.416	0.055	0.049
5	0.114	0.121	0.123	0.117	0.218	0.550	0.076	0.066
N	6,149		6,252		5,585		6,058	

	Probabilities by Support Point Scenario (%)							
Scenario	Employment Growth, Next 12 Months		Sales Growth, Next 4 Quarters		Investment Rate, 4 Quarters Ahead		Unit Cost Growth, Next 4 Quarters	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	10.883	9.364	12.369	11.405	12.670	11.976	13.436	13.841
2	18.301	9.314	18.509	9.012	18.734	9.201	19.774	10.325
3	41.412	17.630	38.184	15.735	38.407	16.048	38.066	17.011
4	19.215	10.987	19.992	10.530	19.346	10.569	18.574	10.287
5	9.566	6.894	10.405	7.149	10.318	7.268	9.763	6.861
N	6,149		6,252		5,585		6,058	

Notes: This table shows (top) the mean and standard deviation of the outcome associated with each of the five support points in respondents' subjective probability distributions for future employment growth, sales growth, investment rate, and unit cost growth at their firm; (bottom) the mean and standard deviation of the probabilities respondents assign to the five support points in the SBU for each topic. The sample for this table includes all SBU responses between 10/2014 and 3/2019, restricting attention to subjective distributions for which we can construct an expectation. All variables are winsorized at the 1st and 99th percentiles.

Table 3: SBU Summary Statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) p10	(5) p25	(5) p50	(7) p75	(8) p90
Employment Growth Forecast, Next 12 Months	6,150	0.009	0.083	-0.049	-0.011	0.007	0.034	0.079
Employment Growth Uncertainty, Next 12 Months	6,153	0.057	0.063	0.014	0.022	0.037	0.064	0.113
Realized Employment Growth, Next 12 Months	3,061	0.026	0.165	-0.133	-0.043	0.015	0.087	0.198
Sales Growth Forecast, Next 4 Quarters	6,252	0.041	0.083	-0.018	0.011	0.035	0.068	0.120
Sales Growth Uncertainty, Next 4 Quarters	6,253	0.045	0.049	0.010	0.016	0.029	0.054	0.099
Realized Sales Growth, Next 4 Quarters	2,429	0.052	0.277	-0.253	-0.058	0.049	0.182	0.356
Expected Investment Rate (I/K) 4 Quarters Ahead	5,582	0.121	0.342	0.005	0.013	0.035	0.088	0.240
Expected Change in Investment Rate (I/K) , Now to 4 Quarters Ahead	5,574	0.018	0.149	-0.038	-0.004	0.002	0.021	0.094
Uncertainty about Investment Rate (I/K), 4 Quarters Ahead	5,582	0.042	0.104	0.002	0.005	0.013	0.033	0.087
Realized Investment Rate (I/K), 4 Quarters Ahead	5,922	0.092	0.245	0.001	0.008	0.025	0.070	0.200
Unit Cost Growth Forecast, Next 12 Months	6,058	0.035	0.039	0.002	0.015	0.028	0.044	0.070
Unit Cost Growth Uncertainty, Next 12 Months	6,058	0.021	0.021	0.006	0.009	0.013	0.024	0.044
Current Sales ($M)	6,423	36.212	106.700	0.902	2.870	7.500	22.000	75.500
Employment	14,712	408.723	999.336	22	63	145	295	735
Employment Growth, Past 12 Months (Reported)	6,492	0.021	0.122	-0.095	-0.018	0.018	0.069	0.143

Notes: This table shows summary statistics from our main variables of interest, namely the subjective forecasts (expectations) and uncertainty we compute from our survey's five-point discrete subjective probability distributions. Data come from all SBU survey waves between 10/2014 and 3/2019. All variables are winsorized at the 1st and 99th percentiles.

Table 4. Granger-Causality Tests for our Expectations Indices

Macro Series	Overall Expectations Index			Employment Growth Expectations Index			Investment Expectations Index			Sales Growth Expectations Index		
	SBU granger-causes X	X granger-causes SBU	# lags in VAR	SBU granger-causes X	X granger-causes SBU	# lags in VAR	SBU granger-causes X	X granger-causes SBU	# lags in VAR	SBU granger-causes X	X granger-causes SBU	# lags in VAR
Industrial Production	**0.05**	**0.00**	3	0.21	0.07	3	**0.00**	**0.00**	11	**0.03**	**0.02**	3
Private Nonfarm Payrolls (BLS)	0.52	**0.02**	3	0.46	0.86	1	0.10	**0.02**	1	0.26	**0.00**	3
Private Nonfarm Payrolls (ADP)	0.28	0.07	3	0.66	0.66	1	**0.00**	**0.00**	12	0.47	**0.04**	3
Macroadvisers Monthly GDP	0.09	**0.03**	2	0.30	0.18	1	**0.00**	**0.00**	9	0.79	**0.00**	3
ISM Composite Index	**0.00**	0.25	3	**0.00**	**0.00**	12	**0.00**	**0.00**	11	0.28	**0.04**	3
FRB Chicago National Activity Index	**0.02**	**0.01**	3	**0.00**	**0.00**	12	**0.00**	**0.00**	10	**0.03**	**0.05**	3
Real Manu. & Trade Sales	0.08	**0.00**	3	**0.00**	**0.00**	12	**0.00**	**0.00**	12	0.10	0.07	3
Real Pers. Cons. Expenditures	0.35	**0.00**	4	**0.00**	**0.00**	12	**0.00**	**0.00**	10	0.77	0.17	3
NFIB Optimism Index	0.09	0.41	2	**0.01**	0.14	1	0.78	0.07	1	0.50	0.40	3

Notes: Bold p-values indicates statistical significance at the 5% level. Sample period January 2015 through March 2019. All macroeconomic data series transformed using the same procedure used to construct the SBU indexes. Granger-causality tests performed on first-differenced timeseries with optimal lag lengths chosen by BIC (Hannan-Quinn information criterion used if BIC finds zero lags). Max lag length = 12. **Sources:** Federal Reserve Board; Bureau of Economic Analysis; Bureau of Labor Statistics; Macroeconomic Advisers; Institute for Supply Management; Federal Reserve Bank of Chicago; National Federation of Independent Business

Table 5 Uncertainty and Survey Tenure
5a. Number of Previous Responses

	(1)	(2)	(3)	(4)	(5)	(6)
			log(Subjective Uncertainty) about:			
Dependent Variable	Employment Growth, Next 12 Months		Sales Growth, Next 4 Quarters		Investment Rate 4 Quarters Ahead	
No. of Previous Responses	-0.003	-0.002	-0.012***	0.000	-0.003	-0.005
	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)	(0.006)
Date Fixed Effects		Y		Y		Y
Observations	6,159	6,159	6,249	6,249	5,582	5,582
R-squared	0.002	0.010	0.024	0.208	0.000	0.011

Notes: We regress the natural logarithm of subjective uncertainty about employment over the next 12 months, sales growth over the next four quarters, and the firm's investment rate (capital expenditures/captial stock) against the number of previous survey responses. Data are from the SBU covering all survey waves between 10/2014 and 3/2019. Robust standard errors in parentheses, clustered by firm. *** p<0.01, ** p<0.05, * p<0.1

5b. Months Since 1st Response

	(1)	(2)	(3)	(4)	(5)	(6)
			log(Subjective Uncertainty) about:			
Dependent Variable	Employment Growth, Next 12 Months		Sales Growth, Next 4 Quarters		Investment Rate in 4 Quarters Ahead	
Months Since 1st Response	-0.003**	-0.003	-0.011***	0.000	-0.001	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
Date Fixed Effects		Y		Y		Y
Observations	6,159	6,159	6,249	6,249	5,582	5,582
R-squared	0.003	0.011	0.026	0.208	0.000	0.010

Notes: We regress the natural logarithm of subjective uncertainty about employment over the next 12 months, sales growth over the next four quarters, and the firm's investment rate (capital expenditures/capital stock) four quarters ahead, against the number of months elapsed since the firm's first survey response. Data are from the SBU covering all survey waves between 10/2014 and 3/2019. Robust standard errors in parentheses, clustered by firm. *** p<0.01, ** p<0.05, * p<0.1

Figure 1: October 2013 Trial Questions

Notes: This figure shows screenshots from our first trial at eliciting subjective probabilities for future sales growth in October 2013. We performed an A/B test, giving half of the Atlanta Fed's BIE panel the three-point question above and the other half the bottom question.

Figure 2: November 2013 Trial Questions

Notes: This figure shows screenshots from our November 2013 test, again attempting to elicit subjective probabilities for future sales growth. We again performed an A/B test, giving half of the Atlanta Fed's BIE panel the three-point question above and the other half the bottom question.

Figure 3: December 2013 Trial Questions

Notes: This figure shows screenshots from our December 2013 test, now attempting to elicit subjective probabilities for future unit cost growth. We again performed an A/B test, giving half of the Atlanta Fed's BIE panel the five-bin question above and the other half the bottom question with three support points.

Figure 4: January 2014 Trial Question

Notes: This figure shows screenshots from our January 2014 test question, again eliciting subjective probabilities for future sales growth. We sent the same question to all of the Atlanta Fed's BIE panel of respondents. This new question has two parts: the top asks firms to provide numerical outcomes for their "low", "medium", and "high" outcomes and the bottom asks for probabilities.

Figure 5: February 2014 Trial Question

Notes: This figure shows screenshots from our February 2014 test question, now eliciting subjective probability distributions for future employment. We sent the same question to all of the Atlanta Fed's BIE panel of respondents. This new question has three parts: first it asks for current employment levels, then asks for numerical outcomes for the "low", "medium", and "high" outcomes, and finally the bottom asks for probabilities for those outcomes.

Figure 6: March 2014 Trial Question

Notes: This figure shows screenshots from our March 2014 test question, which repeated the January 2014 experiment and elicited subjective probabilities for future sales growth. We sent the same question to all of the Atlanta Fed's BIE panel of respondents.

Figure 7: April 2014 Trial Question

Notes: This figure shows screenshots from our April 2014 test question, which extended our January and March 2014 experiments to a five-point format, again eliciting subjective probabilities for future sales growth. We sent the same question to all of the Atlanta Fed's BIE panel of respondents.

Figure 8: May 2014 Trial Question

Notes: This figure shows screenshots from our May 2014 test question, which extended our February 2014 test for eliciting subjective probabilities for future employment levels, now using a five-point format. We sent the same question to all of the Atlanta Fed's BIE panel of respondents.

Figure 9: June 2014 Trial Question

Notes: This figure shows screenshots from our June 2014 test question, which replicated the question from January and March 2014, using a three-point design to elicit subjective probabilities for future sales growth levels. Then we additionally asked respondents for estimates of their "worst" and "best" case scenarios. We sent the same question to all of the Atlanta Fed's BIE panel of respondents.

Figure 10: July 2014 Questions
(Asking for five vs. three support points)

Notes: This figure shows screenshots from our July 2014 test questions, in which we A/B tested three- and five-support point designs to elicit subjective probability distributions about employment, prices and sales. July 2014 was the first month in which we tested our questions on a newly-recruited panel of firms for the SBU specifically. We randomly split the panel into two sub-groups, with the first group assigned the three-point question and the second assigned the five-point question.

10a. Employment Questions

Please provide the approximate NUMBER OF EMPLOYEES (including part-time) your firm may employ 12 months from now for each of the following scenarios.

The LOWEST CASE number of employees at my firm 12 months from now would be:	12
The LOW CASE number of employees at my firm 12 months from now would be:	114
The MEDIUM CASE number of employees at my firm 12 months from now would be:	200
The HIGH CASE number of employees at my firm 12 months from now would be:	300
The HIGHEST CASE number of employees at my firm 12 months from now would be:	400

Please assign a percentage likelihood of realizing the NUMBER OF EMPLOYEES you selected above. (Values should sum to 100%)

LOWEST CASE: The likelihood of my firm employing 12 people 12 months from now is:	%
LOW CASE: The likelihood of my firm employing 114 people 12 months from now is:	%
MEDIUM CASE: The likelihood of my firm employing 200 people 12 months from now is:	%
HIGH CASE: The likelihood of my firm employing 300 people 12 months from now is:	%
HIGHEST CASE: The likelihood of my firm employing 400 people 12 months from now is:	%
Total	%

Projecting ahead over the next twelve months, please provide the approximate low case, medium case, and high case NUMBER OF EMPLOYEES (including part-time) you may have.

The LOW CASE number of employees my firm may have 12 months from now would be:	250
The MEDIUM CASE number of employees my firm may have 12 months from now would be:	300
The HIGH CASE number of employees my firm may have 12 months from now would be:	400

Please assign a percentage likelihood to the low case, medium case, and high case NUMBER OF EMPLOYEES you selected above. *(Responses should sum to 100)*

LOW CASE: The likelihood of my firm employing 250 employees 12 months from now is:	0 %
MEDIUM CASE: The likelihood of my firm employing 300 employees 12 months from now is:	0 %
HIGH CASE: The likelihood of my firm employing 400 employees 12 months from now is:	0 %
Total	0 %

10b. Prices

Projecting ahead over the next twelve months, for each of the following scenarios please provide an approximate percentage change in the AVERAGE PRICE you charge:

The LOWEST CASE change in the average price my firm charges would be:	0%
The LOW CASE change in the average price my firm charges would be:	1%
The MEDIUM CASE change in the average price my firm charges would be:	2%
The HIGH CASE change in the average price my firm charges would be:	3%
The HIGHEST CASE change in the average price my firm charges would be:	4%

Please assign a percentage likelihood to the percentage AVERAGE PRICE changes you selected above. (Values should sum to 100%)

LOWEST CASE: The likelihood of realizing about a 0% change in average price would be	%
LOW CASE: The likelihood of realizing about a 1% change in average price would be	%
MEDIUM CASE: The likelihood of realizing about a 2% change in average price would be	%
HIGH CASE: The likelihood of realizing about a 3% change in average price would be	%
HIGHEST CASE: The likelihood of realizing about a 4% change in average price would be	%
Total	%

Projecting ahead over the next twelve months, please provide the approximate low case, medium case, and high case percentage change in the AVERAGE PRICE you charge.

The LOW CASE change in the average price my firm charges would be:	0%
The MEDIUM CASE change in the average price my firm charges would be:	5%
The HIGH CASE change in the average price my firm charges would be:	7%

Please assign a percentage likelihood to the low case, medium case, and high case percentage AVERAGE PRICE changes you selected above. (Values should sum to 100%)

LOW CASE: The likelihood of my firm realizing about a 0% change in its average price would be	%
MEDIUM CASE: The likelihood of my firm realizing about a 5% change in its average price would be	%
HIGH CASE: The likelihood of my firm realizing about a 7% change in its average price would be	%
Total	%

10c. Sales Growth

Projecting ahead <u>over the next twelve months</u>, for each of the following scenarios please provide an approximate percentage change in your firm's SALES REVENUE:

The LOWEST CASE change in my firm's sales levels would be:	0% ▼
The LOW CASE change in my firm's sales levels would be:	1% ▼
The MEDIUM CASE change in my firm's sales levels would be:	2% ▼
The HIGH CASE change in my firm's sales levels would be:	3% ▼
The HIGHEST CASE change in my firm's sales levels would be:	4% ▼

Projecting ahead <u>over the next twelve months</u>, please provide the approximate low case, medium case, and high case percentage change in your firm's SALES REVENUE.

The LOW CASE change in my firm's revenue would be:	0% ▼
The MEDIUM CASE change in my firm's revenue would be:	2% ▼
The HIGH CASE change in my firm's revenue would be:	4% ▼

Please assign a percentage likelihood to the percentage SALES REVENUE changes you selected above. (Values should sum to 100%)

LOWEST CASE: The likelihood of realizing about a 0% change in sales levels would be	%
LOW CASE: The likelihood of realizing about a 1% change in sales levels would be	%
MEDIUM CASE: The likelihood of realizing about a 2% change in sales levels would be	%
HIGH CASE: The likelihood of realizing about a 3% change in sales levels would be	%
HIGHEST CASE: The likelihood of realizing about a 4% change in sales levels would be	%
Total	%

Please assign a percentage likelihood to the low case, medium case, and high case percentage changes in your firm's SALES REVENUE you selected above. (Values should sum to 100%)

LOW CASE: The likelihood of my firm realizing about a 0% change in revenue	%
MEDIUM CASE: The likelihood of my firm realizing about a 2% change in revenue	%
HIGH CASE: The likelihood of my firm realizing about a 4% change in revenue	%
Total	%

Figure 11: New Sales Question During SBU 1st Generation (August 2014 - August 2016)

Figure 12: Full SBU Questionnaires
September 2016 – present
12a. Sales/Employment (SE) Questionnaire

SBU Survey of Business Uncertainty

FEDERAL RESERVE BANK of ATLANTA   CHICAGO BOOTH   Stanford University

Looking _ahead_, from now to four quarters from now, what approximate percentage **SALES REVENUE** growth rate would you assign to each of the following scenarios?

The LOWEST percentage sales revenue growth rate would be about:	-2	%
A LOW percentage sales revenue growth rate would be about:	-1	%
A MIDDLE percentage sales revenue growth rate would be about:	0	%
A HIGH percentage sales revenue growth rate would be about:	1	%
The HIGHEST percentage sales revenue growth rate would be about:	2	%

SBU Survey of Business Uncertainty

FEDERAL RESERVE BANK of ATLANTA   CHICAGO BOOTH   Stanford University

Please assign a percentage likelihood to the **SALES REVENUE** growth rates you entered. (Values should sum to 100%)

LOWEST: The likelihood of realizing a **-2%** sales revenue growth rate would be:	0	%
LOW: The likelihood of realizing a **-1%** sales revenue growth rate would be:	0	%
MIDDLE: The likelihood of realizing a **0%** sales revenue growth rate would be:	0	%
HIGH: The likelihood of realizing a **1%** sales revenue growth rate would be:	0	%
HIGHEST: The likelihood of realizing a **2%** sales revenue growth rate would be:	0	%
Total	0	%

SBU Survey of Business Uncertainty

FEDERAL RESERVE BANK of ATLANTA   CHICAGO BOOTH   Stanford University

Currently, what is your **NUMBER OF EMPLOYEES** (including part-time)?

Looking back, 12 months ago, what was your **NUMBER OF EMPLOYEES** (including part-time)?

Looking ahead, 12 months from now, what **NUMBER OF EMPLOYEES** (including part-time) would you assign to each of the following scenarios?

The LOWEST number of employees would be about:	48
A LOW number of employees would be about:	49
A MIDDLE number of employees would be about:	50
A HIGH number of employees would be about:	51
The HIGHEST number of employees would be about:	52

Back - 4 of 7   Next - 6 of 7

Please assign a percentage likelihood to the **NUMBER OF EMPLOYEES** you entered above. (Values should sum to 100%)

LOWEST CASE: The likelihood of employing about **48** people 12 months from now would be:	0	%
LOW CASE: The likelihood of employing about **49** people 12 months from now would be:	0	%
MEDIUM CASE: The likelihood of employing about **50** people 12 months from now would be:	0	%
HIGH CASE: The likelihood of employing about **51** people 12 months from now would be:	0	%
HIGHEST CASE: The likelihood of employing about **52** people 12 months from now would be:	0	%
Total	0	%

Back - 5 of 7   Next - 7 of 7

12b. Capital Expenditures/Costs (CC) Questionnaire

Looking <u>back</u>, from 12 months ago to now, what was the approximate percentage change in your **AVERAGE UNIT COST** considering all of your products and services?

[　　　] %

Next - 2 of 7

SBU Survey of Business Uncertainty

FEDERAL RESERVE BANK of ATLANTA   CHICAGO BOOTH   Stanford University

Looking ahead, from now to 12 months from now, what approximate percentage change in your **AVERAGE UNIT COST** would you assign to each of the following scenarios?

The LOWEST percentage change in average unit cost would be about:	__ %
A LOW percentage change in average unit cost would be about:	__ %
A MIDDLE percentage change in average unit cost would be about:	__ %
A HIGH percentage change in average unit cost would be about:	__ %
The HIGHEST percentage change in average unit cost would be about:	__ %

SBU Survey of Business Uncertainty

FEDERAL RESERVE BANK of ATLANTA   CHICAGO BOOTH   Stanford University

Please assign a percentage likelihood to the **AVERAGE UNIT COST** changes you entered. (Values should sum to 100%)

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

SBU Survey of Business Uncertainty

FEDERAL RESERVE BANK of ATLANTA   CHICAGO BOOTH   Stanford University

For the current quarter, what would you estimate the total dollar value of your **CAPITAL INVESTMENT** expenditures will be?

$ _____

Looking back, four quarters ago, what was the approximate dollar value of your **CAPITAL INVESTMENT** expenditures?

$ _____

Figure 13: SBU Panel Descriptives
13a. Firm Size Distribution vs. US Economy
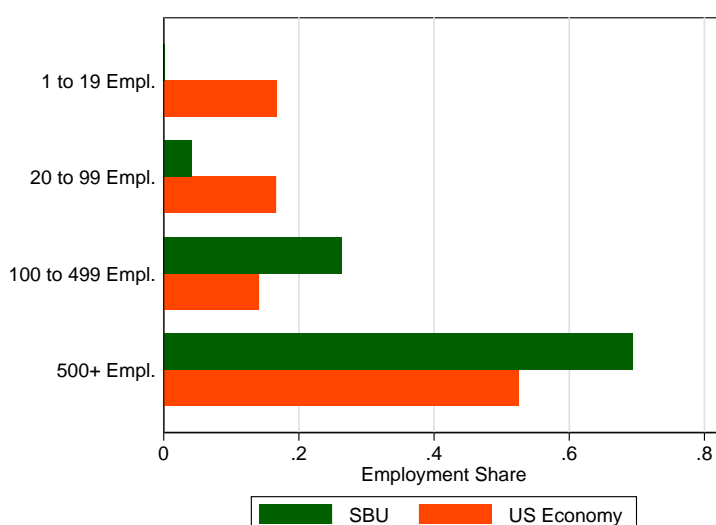
Notes: This figure shows the share of employment accounted for by firms each of the five employment categories shown on the vertical axis, 1) across all responses in the SBU from 10/2014 to 3/2019, and 2) in the US Census Bureau's 2015 Statistics on US Businesses. An observation in the SBU is a response for which we can construct a subjective probability distribution for one of employment, sales, investment, or unit cost growth looking one year ahead.

13b. Industry Affiliation vs. US Economy
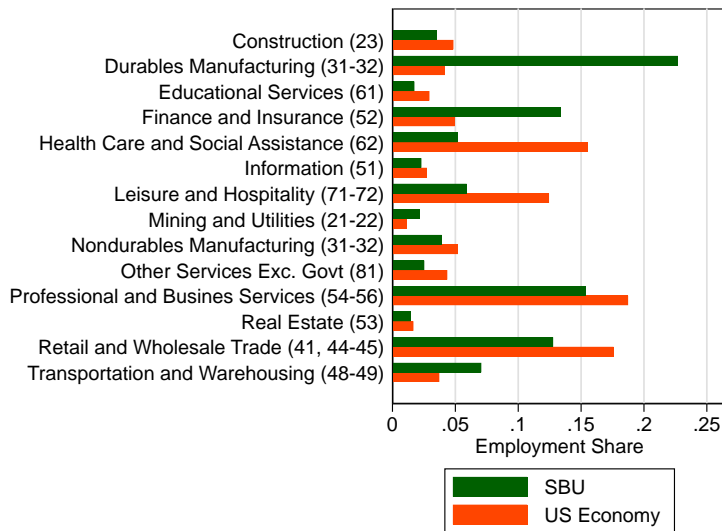
Notes: This figure shows the share of employment accounted for by firms each of the industry categories shown on the vertical axis, 1) across all responses in the SBU from 10/2014 to 3/2019, and 2) in the US Census Bureau's 2015 Statistics on US Businesses. An observati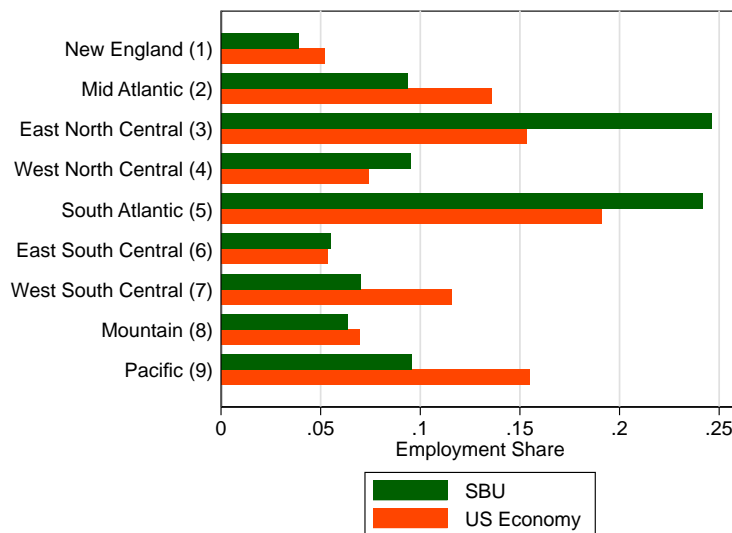on in the SBU is a response for which we can construct a subjective probability distribution for one of employment, sales, investment, or unit cost growth looking one year ahead.

13c. Geographical Distribution vs. US Economy

Notes: This figure shows the share of employment accounted for by firms each region (i.e. Census Division) shown on the vertical axis, 1) across all responses in the SBU from 10/2014 to 3/2019, and 2) in the US Census Bureau's 2015 Statistics on US Businesses. An observation in the SBU is a response for which we can construct a subjective probability distribution for one of employment, sales, investment, or unit cost growth looking one year ahead.
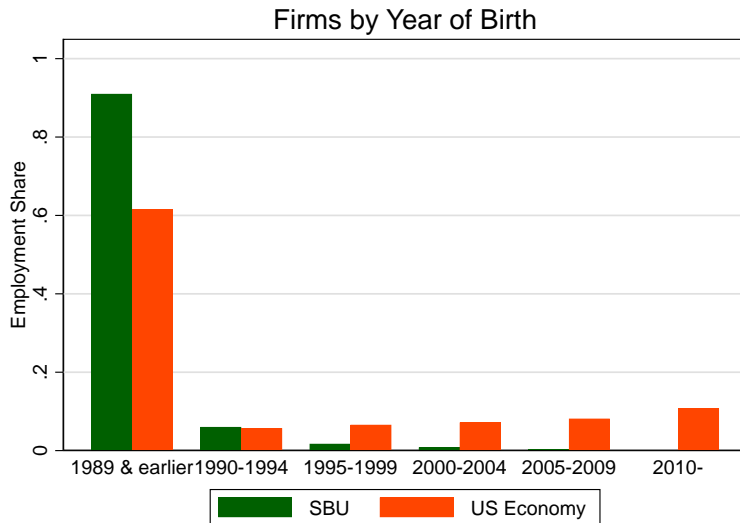
13d. Age Distribution vs. US Economy

**Firms by Year of Birth**

Notes: This figure shows the share of employment accounted for by firms born in the years shown on the horizontal axis, 1) across all responses in the SBU from 10/2014 to 3/2019, and 2) in the US Census Bureau's 2015 Business Dynamics Statistics. An observation in the SBU is a response for which we can construct a subjective probability distribution for one of employment, sales, investment, or unit cost growth looking one year ahead.

13e. Share Publicly-traded vs. Privately-held
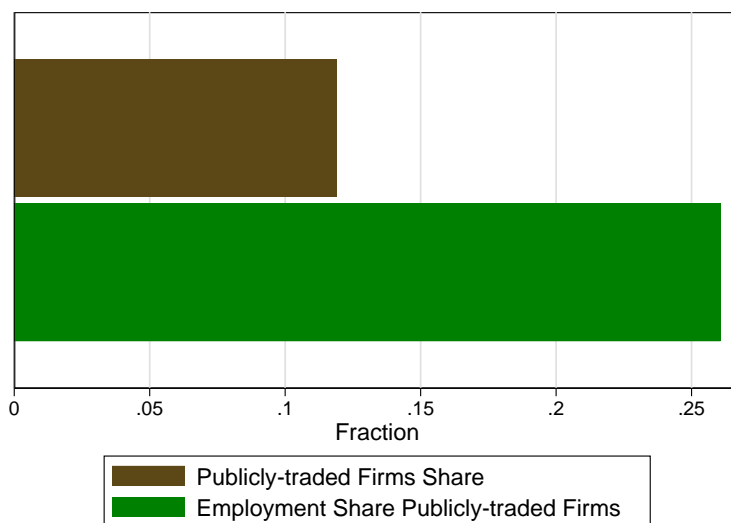
Notes: This figure shows the share of unique firms in the SBU and the share of employment among all SBU responses accounted for firms whose shares traded in a stock exchange or over-the-counter markets.*

 *We determine whether a firm is publicly-traded based on a special survey question from February and March 2019. If we do not have a response for whether a firm is publicly-traded or not we weight firm observations by the fitted probability of being publicly traded based on size and industry. The graph looks similar if we restrict attention to firms for which we know whether they are publicly-traded.

13f. Distribution of Reported Employment Growth Rates, Past 12 months

N = 6492. Mean = .021. SD = .122
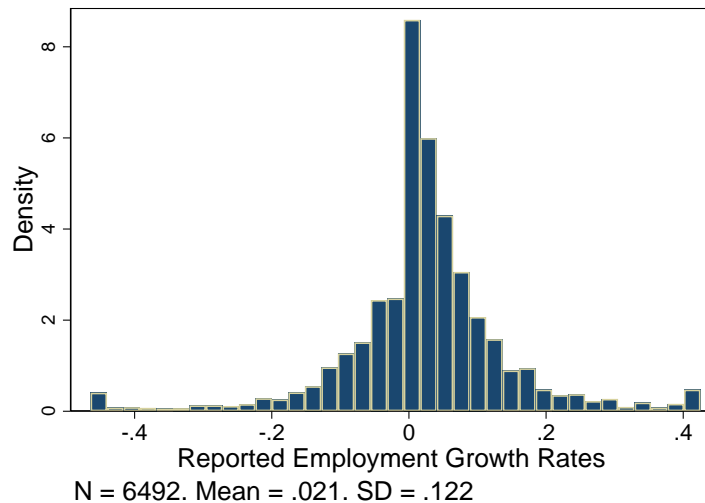
Notes: The histogram shows the empirical distribution of reported employment growth rates for the past 12 months in the Survey of Business Uncertainty. The sample includes all SBU responses between 10/2014 to 3/2019. We compute the firm's employment growth rate in the 12 months to t using the firm's reported employment in t and its answer to the question, *"Looking back, twelve months ago, what was your NUMBER OF EMPLOYEES (including part time)?".*
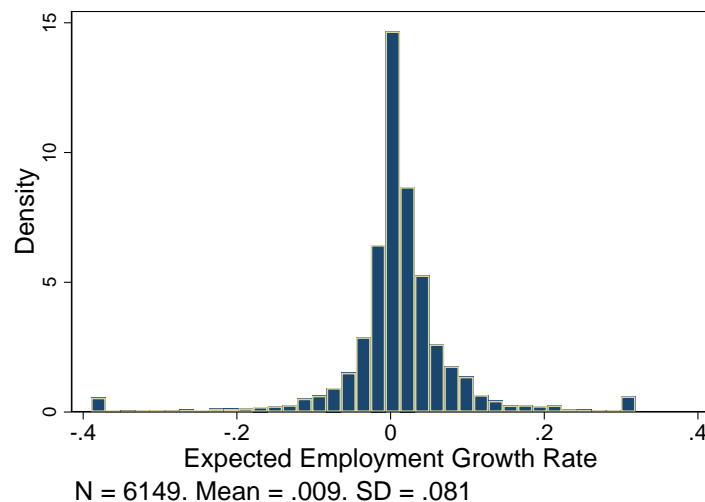
13g. Distribution of Employment Growth Expectations, Next 12 Months

N = 6149. Mean = .009. SD = .081

Notes: The histogram shows the empirical distribution of expected employment growth rates, looking ahead to the next 12 months. The sample includes all SBU responses between 10/2014 to 3/2019 for which we have a five-point subjective distribution over future employment growth rates. We compute these subjective mean growth rates as described in Section 3 of the main text.

13h. Distribution of Employment Growth Uncertainty, Next 12 Months

Density vs Subjective Uncertainty over Employment Growth

N = 6152. Mean = .056. SD = .063
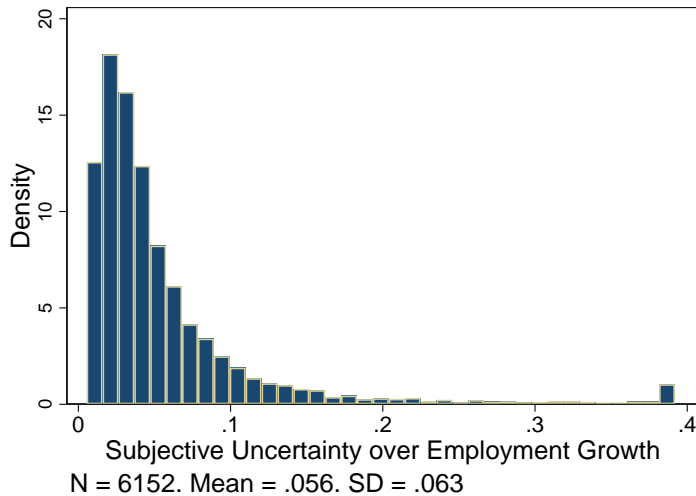
Notes: The histogram shows the empirical distribution of subjective uncertainty about employment growth, looking ahead to the next 12 months. The sample includes all SBU responses between 10/2014 to 3/2019 for which we have a five-point subjective distribution over future employment growth rates. We compute subjective uncertainty about employment growth as the standard deviation of the five-point subjective distribution. See Section 3 of the main text for details.

Figure 14: Subjective Forecasts (Expectations) Predict Realizations

Realized Employment Growth vs Employment Growth Forecasts

Coeff. = .688, S.E. = .073, R^2 = .108, N = 2922
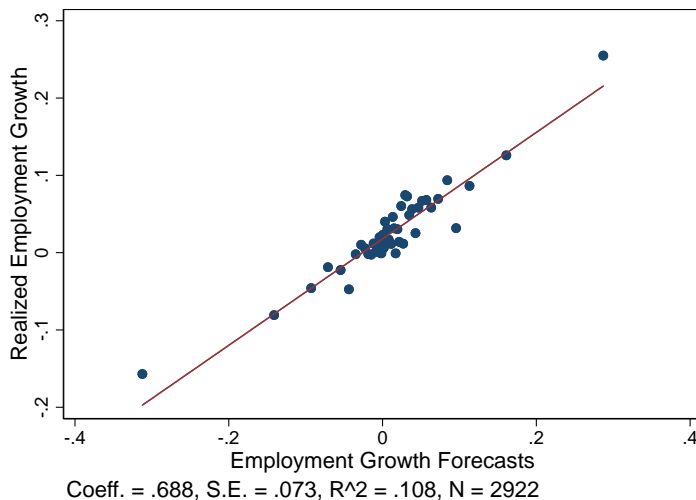
Notes: This figure shows a bin-scatter plot of employment growth forecasts for the next 12 months (i.e. expectations for employment growth from respondents' subjective probability distributions) on the horizontal axis against measured employment growth over the ensuing 12 months on the vertical axis. Statistics below the figure correspond to the population OLS regression. Data are from all waves of the SBU from 10/2014 to 3/2019.

Figure 15: Subjective Uncertainty Predicts Absolute Forecast Errors

Coeff. = .819, S.E. = .073, R^2 = .149, N = 2922
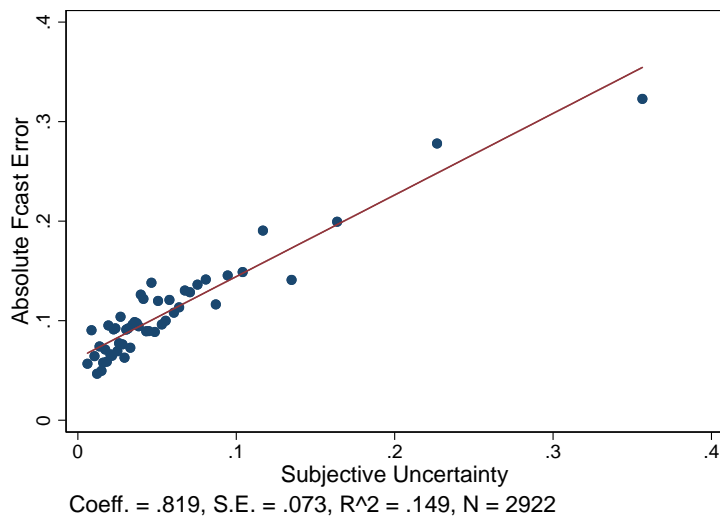
Notes: This figure shows a bin-scatter plot of subjective uncertainty over employment for the next 12 months (i.e. the SD employment growth according to respondents' subjective probability distributions) on the horizontal axis against the respondent's absolute forecast error for employment growth over the ensuing 12 months on the vertical axis. Statistics below the figure correspond to the population OLS regression. Data are from all waves of the SBU from 10/2014 to 3/2019.

Figure 16. Topic-specific Business Expectations and Uncertainty Indices
16a. Employment Growth
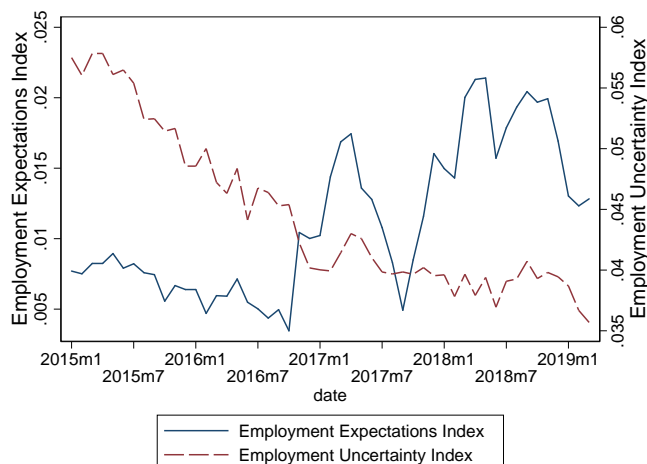
Notes: This figure shows our Business Expectations and Uncertainty Indices for Employment Growth over the next 12 months. Data are from the SBU and the sample period covers 1/2015 to 3/2019. We construct each index as the employment-weighted average across firms' subjective expectations and uncertainty for employment growth over the next 12 months. Then we smooth each series using a 3-month lagged moving average since 9/2016, with a 9-month lagged moving average prior to then.

16b. Sales Growth

Notes: This figure shows our Business Expectations and Uncertainty Indices for Sales Growth. Data are from the SBU and the sample period covers 1/2015 to 3/2019. We construct each index as the employment-weighted average across firms' subjective expectations and uncertainty for sales growth over the next 12 months. Then we smooth each series using a 3-month lagged moving average since 9/2016, with a 9-month lagged moving average prior to then.

16c. Capital Investment

Notes: This figure shows our Business Expectations and Uncertainty Indices for in Investment Rate Growth looking four quarters ahead. Data are from the SBU and the sample period covers 1/2015 to 3/2019. We construct each index as the employment-weighted average across firms' subjective expectations and uncertainty for sales growth over the next 12 months. Then we smooth each series using a 3-month lagged moving average since 9/2016, with a 9-month lagged moving average prior to then.
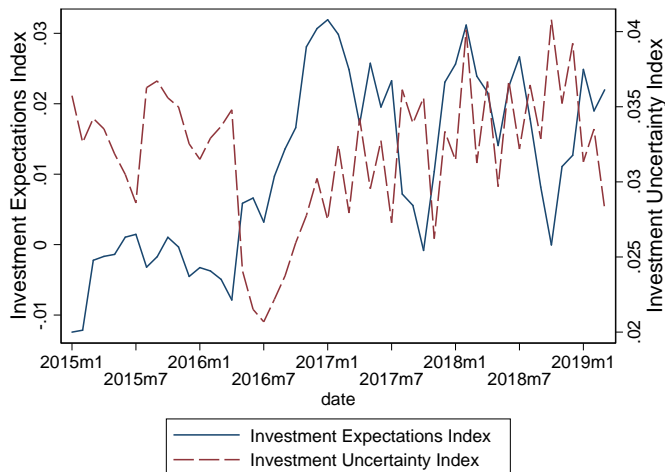
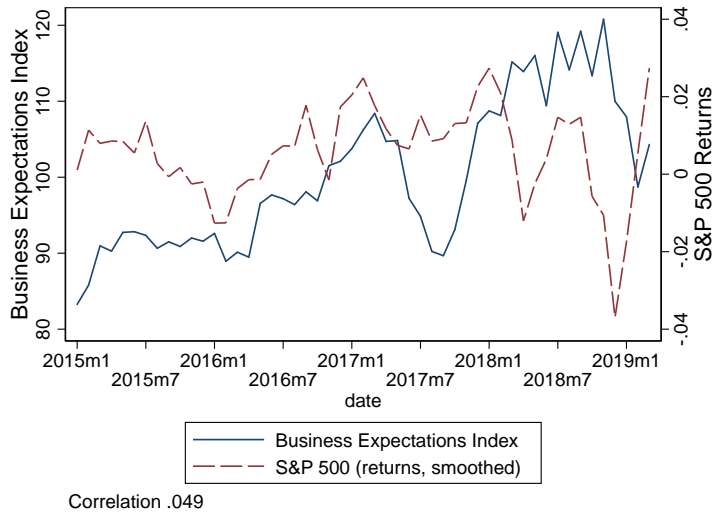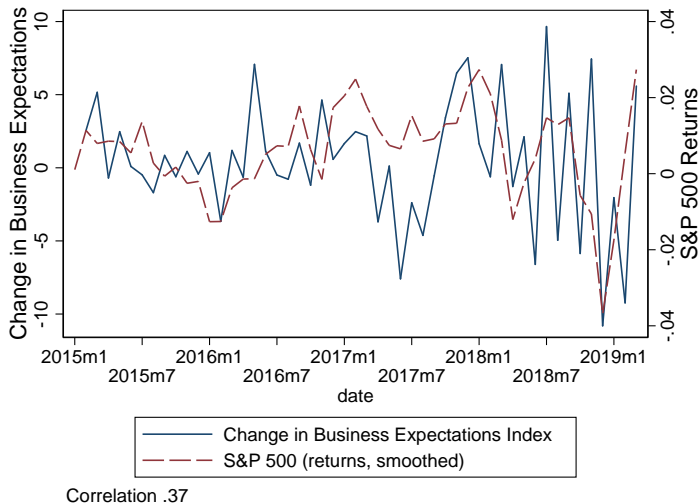# Figure 17: Business Expectations Index Performance
17a. Expectations Index vs. S&P 500 Returns

Notes: This figure shows our Business Expectations Index against monthly S&P 500 returns between 1/2015 and 3/2019. We compute S&P 500 returns in month t as the growth rate of the dividend-adjusted S&P 500 Index (Source: Yahoo! Finance) between the 15th day of month $t-1$ and the 15th day of month t. If the 15th is not a trading day, we try the 16th, 14th, 17th, 13th, 18th, or 12th in that order. Then, we smooth this series of monthly S&P 500 returns using the same procedure as for our Business Expectations Index.

Correlation .049

17b. Change in Expectations Index vs. S&P 500 Returns

Notes: This figure shows the change in our Business Expectations Index across months $t-1$ and t against monthly S&P 500 returns between 1/2015 and 3/2019. We compute S&P 500 returns in month t as the growth rate of the dividend-adjusted S&P 500 Index (Source: Yahoo! Finance) between the 15th day of month $t-1$ and the 15th day of month $t.$ If the 15th is not a trading day, we try the 16th, 14th, 17th, 13th, 18th, or 12th in that order. Then, we smooth this series of monthly S&P 500 returns using the same procedure as for our Business Expectations Index.

Correlation .37

17c. Expectations Index
vs. Growth in Industrial Production

Correlation .65
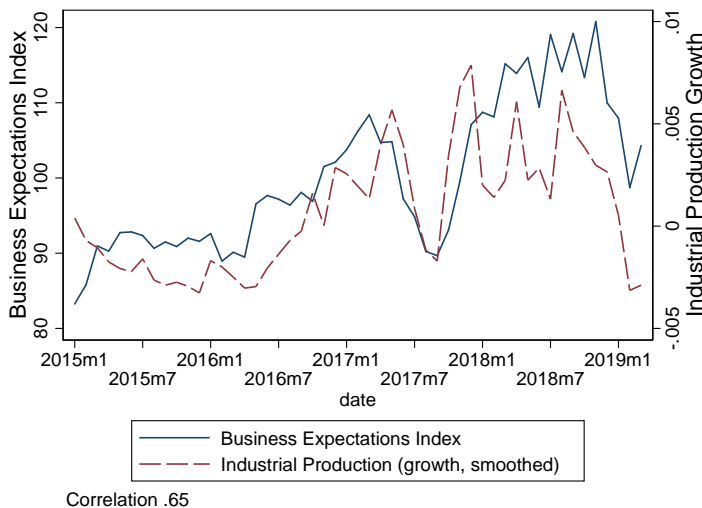
Notes: This figure shows our Business Expectations Index against the monthly growth rate of the Industrial Production (IP) Index between 1/2015 and 3/2019 (Source: Federal Reserve Board via FRED). In each month we compute the growth rate of seasonally-adjusted IP since the previous month and then smooth this series of growth rates using the same procedure as for our Business Expectations Index.

Figure 18: Business Uncertainty Index Performance
17a. Business Uncertainty Index vs. 1-year VIX

Correlation = .34
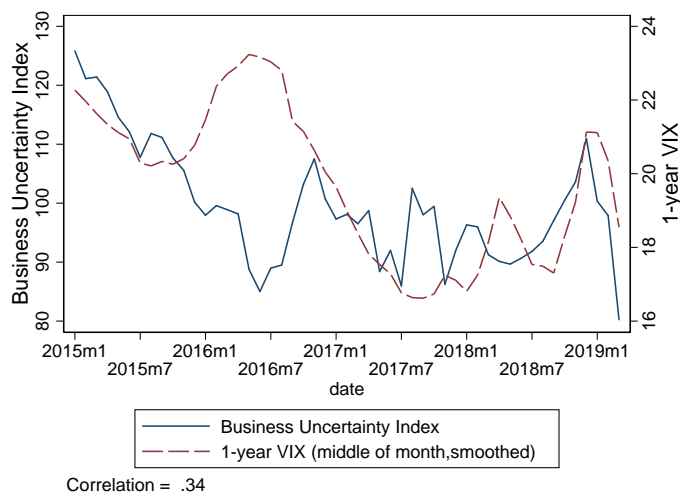
Notes: This figure shows our Business Uncertainty Index against the value of the 1-year VIX on the 15th day each month between 1/2015 and 3/2019 (Source: Yahoo! Finance). If the 15th is not a trading day we try the 16th, 14th, 17th, 13th, 18th, or 12th in that order. We smooth the monthly 1-year VIX series using the same procedure as for our Business Uncertainty Index.

18b. Business Uncertainty Index
vs. SPF Disagreement (Current Quarter GDP)
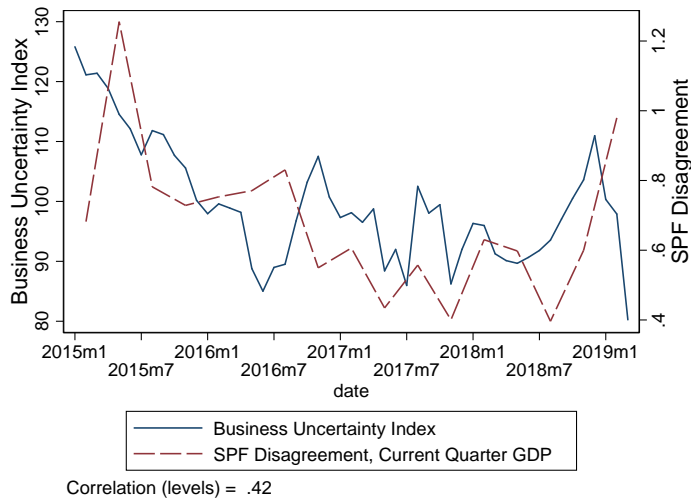
Correlation (levels) = .42

Notes: This figure shows our Business Uncertainty Index against measures of forecast dispersion about current quarter GDP from the Survey of Professional Forecasters between 1/2015 and 3/2019. The SPF is in the field during the second month of each calendar quarter so we plot data from a particular wave of the SPF during the appropriate month.

18c. Business Uncertainty Index
vs. SPF Disagreement (4 Quarters Ahead GDP)
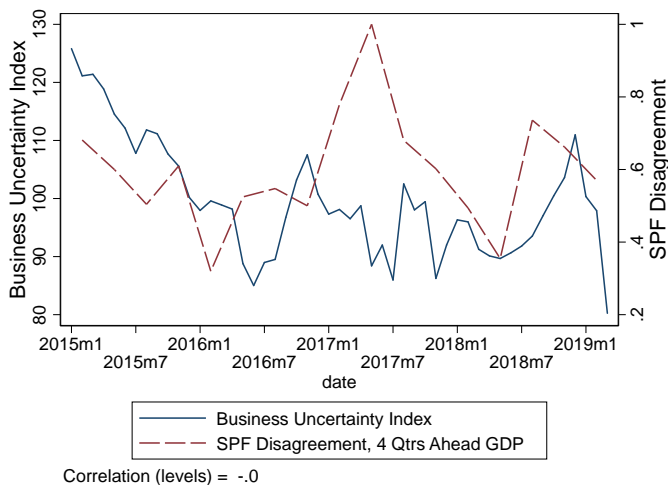
Correlation (levels) = -.0

Notes: This figure shows our Business Uncertainty Index against measures of forecast dispersion about GDP four quarters ahead from the Survey of Professional Forecasters between 1/2015 and 3/2019. The SPF is in the field during the second month of each calendar quarter so we plot data from a particular wave of the SPF during the appropriate month.

Figure 19. Uncertainty and Survey Tenure: No. of Previous Responses

Dep Variable: Uncertainty about Empl. Growth, t to t+12

Notes: This figure shows estimated coefficients from a regression of employment growth uncertainty over the next 12 months on a full set of indicators for the firm's number of previous SBU responses on the r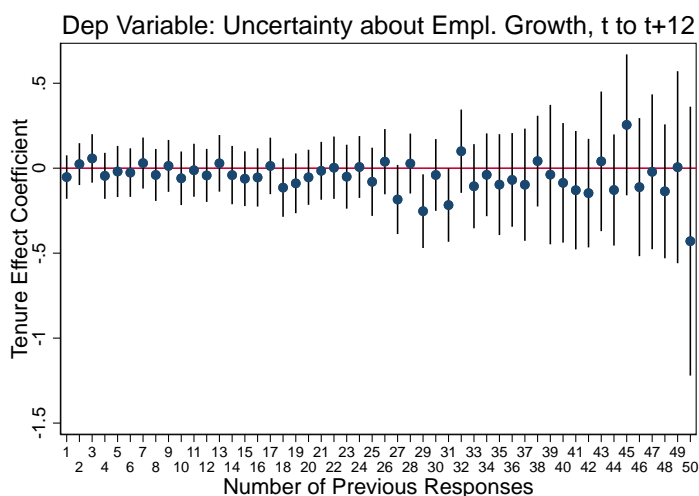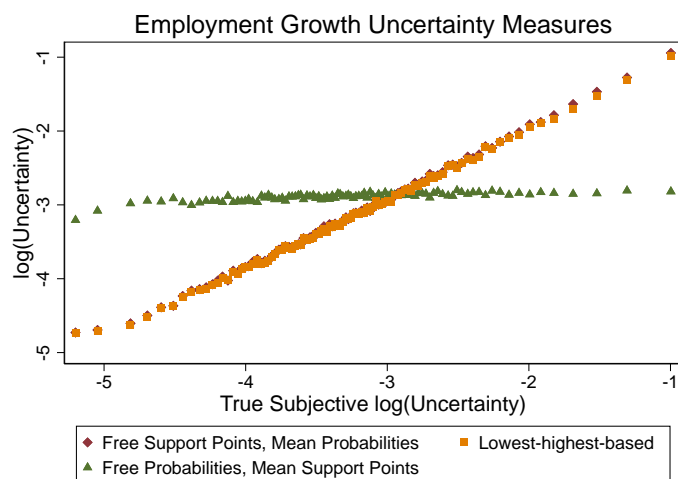ight-hand-side and date fixed effects (not shown). Data are from the SBU and cover all survey waves between 10/2014 and 3/2019. The vertical lines are 95 percent confidence intervals based on firm clustered robust standard errors.

Figure 20. Alternative Measures of Uncertainty: Fixing vs. freeing the support point and probability vectors
19a. Alternative measures in the cross section

Employment Growth Uncertainty Measures

◆ Free Support Points, Mean Probabilities   ■ Lowest-highest-based
▲ Free Probabilities, Mean Support Points

Notes: This figure shows a bin-scatter plot of our baseline measure of employment growth uncertainty for the next 12 months on the horizontal axis against alternative measures of employment growth uncertainty on the vertical axis. These alternative measures use: 1. The respondent's own support points, and the mean probability vector across the cross section of respondents; 2. The respondent's own probabilities and the mean vector of employment growth support point scenarios; 3. the respondent's lowest, highest, and middle support point scenarios for employment growth, imputing the 2nd (low) and 4th (high) points using interpolation, and the mean probability vector in the cross section. Data are from all waves of the SBU from 10/2014 to 3/2019.

20b. Alternative measures of uncertainty and absolute forecast errors

Employment Growth t to t+12
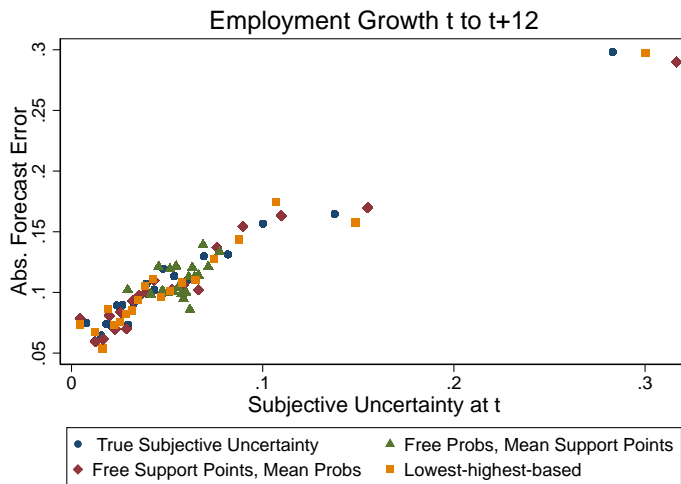
Notes: This figure shows a bin-scatter plot of absolute forecast errors for employment growth over the next 12 months on the vertical axis against alternative measures of employment growth uncertainty on the horizontal axis. These alternative measures use: 1. The respondent's own support points and probabilities ("True Subjective Uncertainty"). 2. The respondent's own support points, and the mean probability vector across the cross section of responses for that topic; 3. The respondent's own probabilities and the mean vector of employment growth support point scenarios; 4. the respondent's lowest, highest, and middle scenarios for employment growth, imputing the 2nd (low) and 4th (high) support points using interpolation, and the mean probability vector in the cross section. Data are from all waves of the SBU from 10/2014 to 3/2019.

20c. Time series of alternative measures of uncertainty

Employment Growth Uncertainty
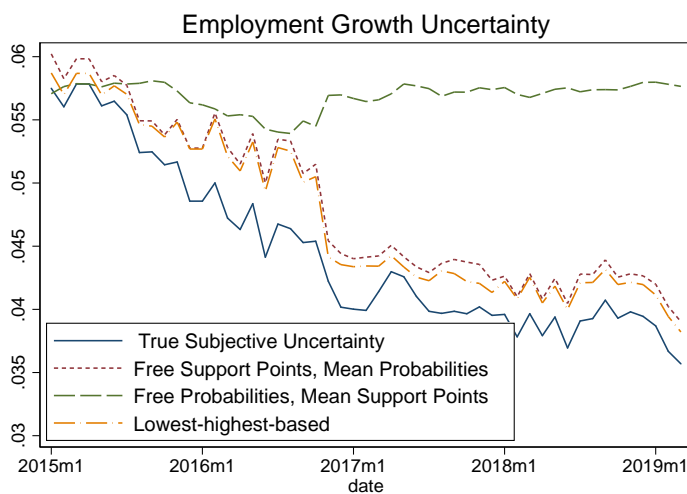
Notes: This figure shows versions of our topic-specific Business Uncertainty Index for employment growth over the next 12 months against indices we construct based on alternative measures of employment growth uncertainty. We consider measures that alternatively use: 1. The respondent's own support points and probabilities ("True Subjective Uncertainty"). 2. The respondent's own support points, and the mean probability vector across the cross section of responses for that topic; 3. The respondent's own probabilities and the mean vector of employment growth support point scenarios; 4. the respondent's lowest, highest, and middle scenarios for employment growth, imputing 2nd (low) and 4th (high) support points using interpolation, and the mean probability vector in the cross section. Data are from all waves of the SBU from 10/2014 to 3/2019.

Appendices – Not Intended for Publication

Appendix A. Computing Moments of the Firm–Level Subjective Probability Distributions

- The next five slides explain how we use the survey responses to compute moments of subjective probability distributions over own–firm future outcomes.
- We calculate first and second moments of the subjective growth rate distributions of employment, sales and unit costs over the next 12 months or four quarters, as appropriate.
- Following standard practice in the literature on business–level dynamics, we calculate the growth rate of x from $t–1$ to t as $g_t = 2(x_t - x_{t-1})/(x_t + x_{t-1})$. [*]
- For capital investment, we calculate first and second moments of the subjective distribution for future investment rate (I/K).

[*] This definition of the growth rate of sales is convenient for its symmetry around zero and because its support lies on the closed interval [–2, 2], with the endpoints of the interval corresponding to entry and exit. See "Gross Job Creation, Gross Job Destruction, and Employment Reallocation" by Steven J. Davis and John Haltiwanger in the 1992 *Quarterly Journal of Economics* for a more extensive discussion.

A1. Employment

Respondent Data

$CEmp$ = firm's current employment level, as reported by the respondent

$FEmp_i$ = employment 12 months hence, $i = 1, 2, 3, 4, 5$

p_i = *the associated probabilities, $i = 1, 2, 3, 4, 5$*

Scenario-Specific Growth Rates

$EGr_i = 2(FEmp_i - CEmp)/(FEmp_i + CEmp), \; i = 1, 2, 3, 4, 5$

First and Second Moments of the Subjective Growth Rate Distribution

Mean(EGr) $= \sum_{i=1}^{5} p_i \, EGr_i$

Var(EGr) $= \sum_{i=1}^{5} p_i (EGr_i - Mean(EGr))^2$

SD(EGr) $= \sqrt{Var(EGr)}$

A2. Sales Revenue (Current SE Questionnaire)

Respondent Data

$CSale$ = firm's sales revenue in the current quarter, as reported by the respondent

$FSaleGr_i$ = respondent's scenario–specific sales growth rate from now to four quarters hence, $i = 1, 2, 3, 4, 5$

p_i = *the associated probabilities, $i = 1, 2, 3, 4, 5$*

Implied Future Sales Level

$FSale_i = \left(1 + \frac{FSaleGr_i}{100}\right) CSale, i = 1, 2, 3, 4, 5$

Scenario–Specific Growth Rates (re–expressing respondent growth rates to our growth rate measure)

$SaleGr_i = 2(FSale_i - CSale)/(FSale_i + CSale) = 2FSaleGr_i/(FSaleGr_i + 2), i = 1, 2, 3, 4, 5$

First and Second Moments of the Subjective Growth Rate Distribution

Mean(SaleGr) $= \sum_{i=1}^{5} p_i \, SaleGr_i$

Var(SaleGr) $= \sum_{i=1}^{5} p_i (SaleGr_i - Mean(SaleGr)_i)^2$

SD(SaleGr) $= \sqrt{Var(SaleGr)}$

A3. Sales Revenue (Old SE Questionnaire)

Respondent Data

$CSale$ = firm's sales revenue in the current quarter, as reported by the respondent

$FSale_i$ = sales revenue four quarters hence, $i = 1, 2, 3, 4, 5$

p_i = the associated probabilities, $i = 1, 2, 3, 4, 5$

Scenario–Specific Growth Rates

$SaleGr_i = 2(FSale_i - CSales)/(FSale_i + CSale), i = 1, 2, 3, 4, 5$

First and Second Moments of the Subjective Growth Rate Distribution

$Mean(SaleGr) = \sum_{i=1}^{5} p_i \, SaleGr_i$

$Var(SaleGr) = \sum_{i=1}^{5} p_i (SaleGr_i - Mean(SaleGr))^2$

$SD(SaleGr) = \sqrt{Var(SaleGr)}$

A4. Capital Investment Rates

Respondent Data

$CCap$ = firm's capital investment expenditures in the current quarter, as reported by the respondent

$FCap_i$ = capital investment expenditures 4 quarters hence, $i = 1, 2, 3, 4, 5$

p_i = the associated probabilities, $i = 1, 2, 3, 4, 5$

K = our measure of the firm's capital stock

Current Investment Rate

$CInvRate = CCap/K$, which we winsorize at the 1st and 99th percentiles

First and Second Moments of the Subjective Distribution for Future Capex:

$Mean(FCap) = \sum_{i=1}^{5} p_i \, FCap_i$

$Var(FCap) = \sum_{i=1}^{5} p_i (FCap_i - Mean(FCap))^2$

$SD(FCap) = \sqrt{Var(FCap)}$

Capital Investment Rates (cont.)

First and Second Moments of the Distribution of Future Investment Rates:

$Mean(InvRate) = Mean(FCap)/K$

$SD(InvRate) = SD(FCap)/K$

We also winsorize these first and second moments at the 1st and 99th percentiles

For constructing indices we focus on expectations about the change in investment rate between now and 4 quarters hence:

$Mean(InvRate) - CInvRate = Mean(FCap)/K - CCap/K$ (both normalized by current K)

Focusing on the <u>change in investment rates</u> between quarters *t* and *t+4* makes our investment rate index comparable to our employment and sales indices, which measure expectations about <u>employment and sales growth</u> over the next year.

A5. Average Unit Costs

Respondent Data

$FCostGr_i$ = average unit cost growth between now and 12 months hence, $i = 1, 2, 3, 4, 5$

$p_i = the\ associated\ probabilities,\ i = 1, 2, 3, 4, 5$

Implied Future Cost Level

$FCost_i = \left(1 + \frac{FCostGr_i}{100}\right) CCost, i = 1, 2, 3, 4, 5$

Scenario–Specific Growth Rates (re–expressing respondent growth rates to our growth rate measure)

$CostGr_i = 2(FCost_i - CCost)/(FCost_i + CCost) = 2FCostGr_i/(FCostGr_i + 2), i = 1, 2, 3, 4, 5$

First and Second Moments of the Subjective Growth Rate Distribution

$Mean(CostGr) = \sum_{i=1}^{5} p_i\ CostGr_i$

$Var(CostGr) = \sum_{i=1}^{5} p_i(CostGr_i - Mean(CostGr))^2$

$SD(CostGr) = \sqrt{Var(CostGr)}$

Appendix B. Measuring Capital Stocks

- In September and October 2017 as well as February and March 2019 we included the following special question with the CC (Capex/Unit Costs) questionnaire:

    > Please provide an estimate of the book value of all property, plant, and equipment owned by your firm.
    >
    > $ [0]

- We thus have data on our respondents' capital stock (PPENT) during at most two survey waves.

- Our goal is to approximate firm's actual investment rates $\left(\frac{I}{K}\right)_t$ in quarter t, as well as their expectations and uncertainty for future investment from the standpoint of quarter t: $\mathrm{E}_t\left[\left(\frac{I}{K}\right)_{t+4}\right]$, $\mathrm{SD}_t\left[\left(\frac{I}{K}\right)_{t+4}\right]$ in <u>all survey waves</u>.

- We impute the firm's capital stock based on the responses to the special questions from September/October 2017 and February/March 2019 as follows:
    - <u>Case 1. We observe a firm's reported capital stock once:</u>
      In this case we impute the capital stock $K_t = K$, the reported capital stock for all survey waves t the firm participates in.
    - <u>Case 2. We observe a firm's reported capital stock twice, once in 2017 and once in 2019:</u>
      - In months prior to the first observation, we impute $K_t = K_1$, the first reported capital stock.
      - In months between the two observations, we impute $K_t = w_t * K_1 + (1 - w_t) * K_2$ where $w_t = (D_2 - t)/(D_2 - D_1)$, $D_i, i = 1,2$ is an integer representing the month in which we observe a reported capital stock, and $D_1 < t < D_2$.
    - <u>Case 3. We do not observe the firm's reported capital stock in any survey wave:</u>
      - We impute K_t based on a regression $\log K_{ft} = \alpha_s + \alpha_t + \beta \log E_{ft} + \varepsilon_{ft}$ where f indexes firms, s indexes sectors, and t indexes dates and E = employment. Our estimate for $\hat{\beta} = 1.009(0.013)$ and the R-squared of the regression is 0.432.

- After these imputations we have a (rough) measure of K for most survey responses.

- We winsorize our measure of K at the 1st and 99th percentile before running the procedure in case 3.

Appendix C. Obtaining Realizations and Forecast Errors

- Consider a firm's subjective mean employment growth in month *t,* looking 12 months ahead ($Mean(EGr)$).
- We measure the firm's realized employment growth $Realized(EGr)$ as follows:
  - We record its realized employment <u>level</u> in month *t+12,* $CEmp_{t+12}$.
  - We record Realized(EGr)= $2*(CEmp_{t+12}- CEmp_t)/(CEmp_{t+12}+ CEmp_t)$.
  - If $CEmp_{t+12}$ is missing, we use $CEmp_{t+11}$ and define *Realized*(EGr)= $2*(CEmp_{t+11}- CEmp_t)/(CEmp_{t+11}+ CEmp_t)$*12/11.
  - If $CEmp_{t+11}$ is also missing, we use $CEmp_{t+13}$ and record *Realized*(EGr)= $2*(CEmp_{t+11}- CEmp_t)/(CEmp_{t+11}+ CEmp_t)$*12/13.
  - If $CEmp_{t+13}$ is also missing, we use the same formula with $CEmp_{t+10}$, or with $CEmp_{t+14}$ as a last resort.
- We record the firm's forecast error for employment growth looking 12 months ahead = $Mean(EGr) - Realized(EGr)$.

- Consider a firm's subjective mean sales growth in month *t* of quarter *q,* looking 4 quarters ahead ($Mean(SaleGr)$).
- We measure the firm's realized sales growth, *Realized*(SaleGr), as follows:
  - We record its current quarterly sales <u>level</u> reported in month *t+12,* $CSale_{t+12}$.
  - We record *Realized*(SaleGr)= $2*(CSale_{t+12}- CSale_t)/(CSale_{t+12}- CSale_t)$.
  - If $CSale_{t+12}$ is missing, we proceed differently depending on whether *t* is the first, second, or third month of the quarter.
    - If *t* is the first month of the quarter, we then try $CSale_{t+13}$ and $CSale_{t+14}$ in that order.
    - If *t* is the second month of the quarter, we then try $CSale_{t+11}$ and $CSale_{t+13}$ in that order.
    - If *t* is the third month of the quarter, we then try $CSale_{t+11}$ and $CSale_{t+10}$ in that order.
  - This procedure ensures that we use the level of quarterly sales reported in quarter *q+4,* though not necessarily in month *t+12*.

- We record the firm's forecast error for sales growth looking four quarters ahead = $Mean(SaleGr) - Realized(SaleGr)$

- Consider a firm's subjective mean investment rate looking four quarters ahead, as recorded in month t of quarter q ($Mean(InvRate)$).
- We measure the firm's realized investment rate in quarter $q+4$ $Realized(InvRate)$ as follows:
  - We record their current quarterly capital expenditures <u>level</u> reported in month $t+12$, $CCap_{t+12}$.
  - We record $Realized(InvRate)= CCap_{t+12}/K_t$. Here we use K_t rather than K_{t+12} to focus on changes in investment rather than changes in (potentially mis-measured) capital stocks. This is symmetrical with how we construct expectations of future investment $Mean(InvRate)$ in Appendix A.
  - If $CCap_{t+12}$ is missing, we proceed differently depending on whether t is the first, second, and third month of the quarter.
    - If t is the first month of the quarter, we then try $CCap_{t+13}$ and $CCap_{t+14}$ in that order.
    - If t is the second month of the quarter, we then try $CCap_{t+11}$ and $CCap_{t+13}$ in that order.
    - If t is the third month of the quarter, we then try $CCap_{t+11}$ and $CCap_{t+10}$ in that order.
  - This procedure ensures that we use the level of quarterly capital expenditures reported in quarter $q+4$, though possibly not in month $t+12$.

- We record the firm's forecast error for its investment rate looking four quarters ahead = $Mean(InvRate) - Realized(InvRate)$.

Appendix Figure 1: Additional SBU Questions During 1st Generation (August 2014-August 2016)
1a. Profit Margins

Currently, what is your AVERAGE PROFIT MARGIN, considering all of your products and services (in percentage terms)?

☐ %

Looking <u>back</u>, 12 months ago, what was your AVERAGE PROFIT MARGIN (in percentage terms)?

☐ %

Looking ahead, 12 months from now, what AVERAGE PROFIT MARGIN would you assign to each of the following scenarios (in percentage terms)?

Our LOWEST-CASE average profit margin would be:	1
Our LOW-CASE average profit margin would be:	2
Our MEDIUM-CASE average profit margin would be:	3
Our HIGH-CASE average profit margin would be:	4
Our HIGHEST-CASE average profit margin would be:	5

Please assign a percentage likelihood to the AVERAGE PROFIT MARGINS you entered above. (Values should sum to 100%)

LOWEST CASE: The likelihood of about a **1** percent average profit margin would be:	%
LOW CASE: The likelihood of about a **2** percent average profit margin would be:	%
MEDIUM CASE: The likelihood of about a **3** percent average profit margin would be:	%
HIGH CASE: The likelihood of about a **4** percent average profit margin would be:	%
HIGHEST CASE: The likelihood of about a **5** percent average profit margin would be:	%
Total	%

1b. Prices

Looking back, from 12 months ago to now, what was the approximate percentage change in the AVERAGE PRICE you charge, considering all of your products and services?
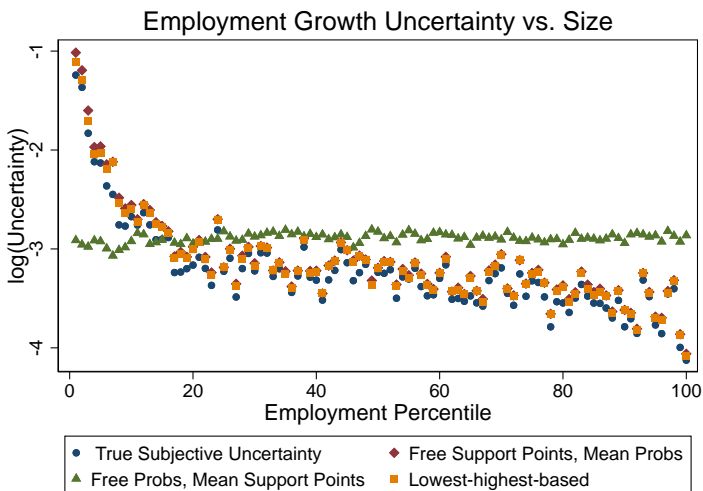
[ ] %

Looking ahead, from now to 12 months from now, what approximate percentage change in AVERAGE PRICE would you assign to each of the following scenarios?

The LOWEST-CASE percentage change in the average price you charge would be: 1

The LOW-CASE percentage change in the average price you charge would be: 2

The MEDIUM-CASE percentage change in the average price you charge would be: 3

The HIGH-CASE percentage change in the average price you charge would be: 4

The HIGHEST-CASE percentage change in the average price you charge would be: 5

Please assign a percentage likelihood to the AVERAGE PRICE changes you entered above. (Values should sum to 100%)

LOWEST CASE: The likelihood of about a **1** percent change in the average price you charge would be: %

LOW CASE: The likelihood of about a **2** percent change in the average price you charge would be: %

MEDIUM CASE: The likelihood of about a **3** percent change in the average price you charge would be: %

HIGH CASE: The likelihood of about a **4** percent change in the average price you charge would be: %

HIGHEST CASE: The likelihood of about a **5** percent change in the average price you charge would be: %

Total   %

Appendix Figure 2. Alternative Measures of Uncertainty vs. Firm Size

Employment Growth Uncertainty vs. Size

- True Subjective Uncertainty
- Free Probs, Mean Support Points
- Free Support Points, Mean Probs
- Lowest-highest-based

Notes: This figure shows a bin-scatter plot of alternative measures of uncertainty about employment growth over the next 12 months on the vertical axis by percentiles of the firm size distribution in terms of employment. The alternative measures of uncertainty use: 1. The respondent's own support points and probabilities ("True Subjective Uncertainty"). 2. the respondent's own support points, and the mean probability vector across the cross section of responses for that topic; 3. the respondent's own probabilities and the mean vector of employment growth support point scenarios; 4. the respondent's lowest, highest, and middle scenarios for employment growth, imputing 2nd (low) and 4th (high) support points using interpolation, and the mean probability vector in the cross section. Data are from all waves of the SBU from 10/2014 to 3/2019.
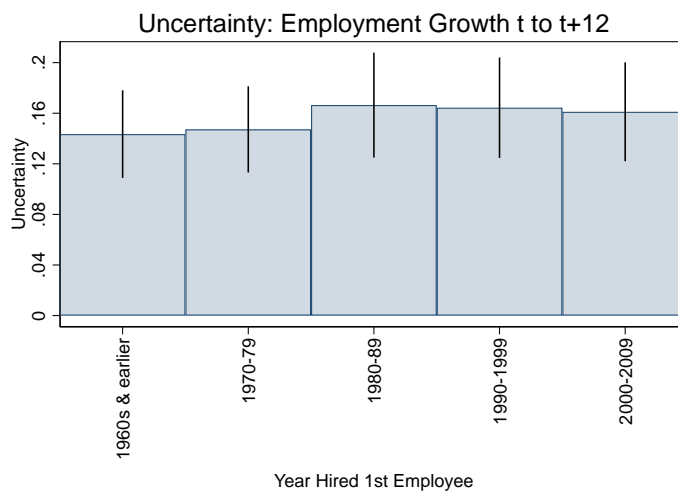
77

Appendix Figure 3. Uncertainty vs. Age
3a. Without controlling for size
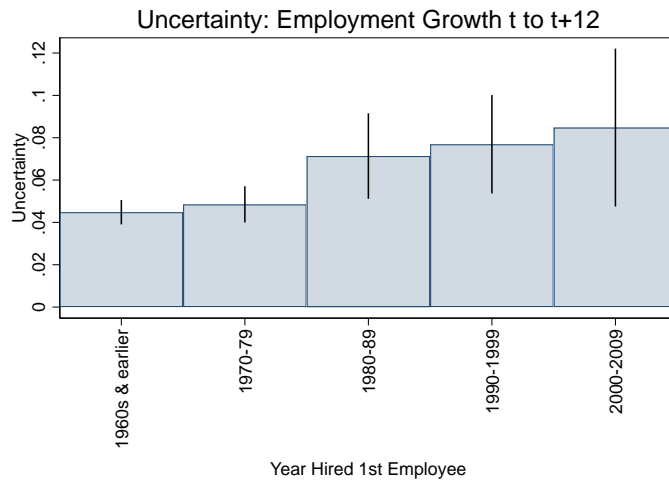
Uncertainty: Employment Growth t to t+12

Notes: This figure shows within group means and 95 percent confidence intervals of employment growth uncertainty over the next 12 months, grouping firms by the decade in which they hired their first paid employee. Data are from the SBU and cover all survey waves between 10/2014 and 3/2019. The vertical lines are 95 percent confidence intervals based on firm clustered robust standard errors.

3b. Controlling for Size

Uncertainty: Employment Growth t to t+12

Notes: This figure shows within group means and 95 percent confidence intervals of employment growth uncertainty over the next 12 months, grouping firms by the decade in which they hired their first paid employee after controlling for the relationship between uncertainty and firm size. Data are from the SBU and cover all survey waves between 10/2014 and 3/2019. The vertical lines are 95 percent confidence intervals based on firm clustered robust standard errors.
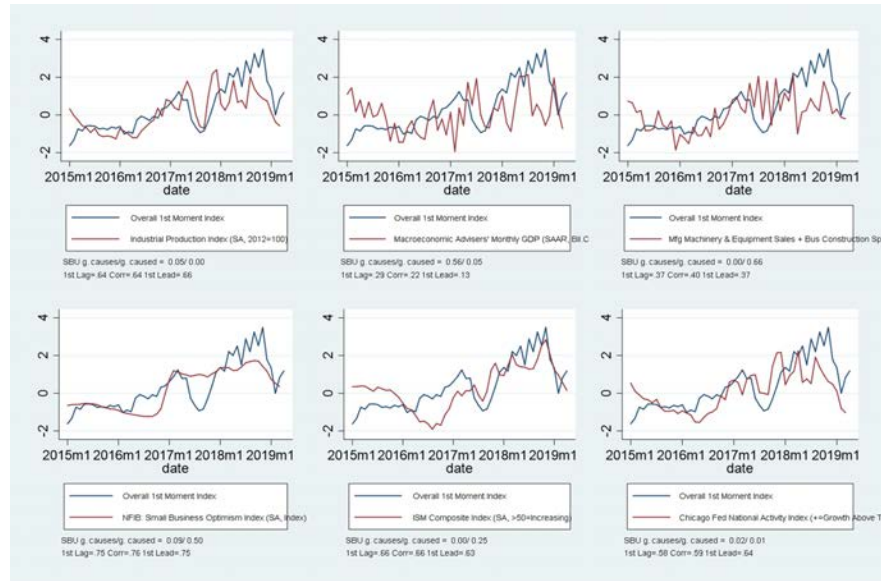
Appendix Figure 4. Business Expectations Index vs. 6 Macro Variables

Appendix Table 1. Granger-Causality Tests for our Expectations Indices

Macro Series	Overall Expectations Index			Employment Growth Expectations Index			Investment Expectations Index			Sales Growth Expectations Index		
	SBU granger-causes X	X granger-causes SBU	# lags in VAR	SBU granger-causes X	X granger-causes SBU	# lags in VAR	SBU granger-causes X	X granger-causes SBU	# lags in VAR	SBU granger-causes X	X granger-causes SBU	# lags in VAR
Industrial Production	**0.05**	**0.00**	3	0.21	0.07	3	0.20	0.53	3	**0.03**	**0.02**	3
Private Nonfarm Payrolls (BLS)	0.52	**0.02**	3	0.46	0.86	1	0.10	**0.02**	1	0.26	**0.00**	3
Private Nonfarm Payrolls (ADP)	0.28	0.07	3	0.66	0.66	1	0.84	**0.01**	1	0.47	**0.04**	3
Macroadvisers Monthly GDP	0.09	**0.03**	2	0.30	0.18	1	0.80	0.41	1	0.79	**0.00**	3
ISM Composite Index	**0.00**	0.25	3	**0.00**	**0.02**	3	0.38	0.47	1	0.28	**0.04**	3
FRB Chicago National Activity Index	**0.02**	**0.01**	3	**0.02**	0.16	4	0.42	0.41	4	**0.03**	**0.05**	3
Real Manu. & Trade Sales	0.08	**0.00**	3	0.93	0.69	1	**0.03**	0.10	1	0.10	0.07	3
Real Pers. Cons. Expenditures	0.35	**0.00**	4	0.53	0.07	3	**0.02**	**0.00**	6	0.77	0.17	3
NFIB Optimism Index	0.09	0.41	2	**0.01**	0.14	1	0.78	0.07	1	0.50	0.40	3

Notes: Bold p-values indicates statistical significance at the 5% level. Sample period January 2015 through March 2019. All macroeconomic data series transformed using the same procedure used to construct the SBU indexes. Granger-causality tests performed on first-differenced timeseries with optimal lag lengths chosen by BIC (Hannan-Quinn information criterion used if BIC finds zero lags). Max lag length = 6. **Sources:** Federal Reserve Board; Bureau of Economic Analysis; Bureau of Labor Statistics; Macroeconomic Advisers; Institute for Supply Management; Federal Reserve Bank of Chicago; National Federation of Independent Business