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The Inflation Expectations of Firms: What Do They Look Like, Are They Accurate, and Do They Matter?

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JEL classification: E31, C81, C90, E60, E37

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The Inflation Expectations of Firms: What do they look like, are they accurate, and do they matter?*

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December 15, 2014

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"Information on the price expectations of businesses–who are, after all, the price setters in the first instance...is particularly scarce."

Ben Bernanke, July 2007

1 Introduction

Inflation expectations matter. In the canonical New Keyesian Phillips curve model (see Clarida, Gali, and Gertler (1999) or Woodford (2003) for an exposition) inflation expectations are a key determinant of current inflation. For monetary policymakers, understanding and monitoring inflation expectations is crucial to achieving their policy goals.

In empirical research and for policy purposes, the measurement of inflation expectations has taken three forms, 1) empirical constructs based on observed inflation trends, 2) estimates derived from inflation-protected security yields, and 3) survey data of economists and households.

Accelerationist Phillips curves—which proxy for inflation expectations with past inflation—are still a standard workhorse model of inflation. Gordon (1990), Hooker (2002), Stock and Watson (2008), and recently Ball and Mazumder (2011) are examples of research using empirically estimated accelerationist Phillips curves.

New Keynesian Phillips curve (NKPC) models, however, emphasize explicitly forward-looking measures of inflation expectations. Woodford (2005) notes, "Because the key decision makers in an economy are forward-looking, central banks affect the economy as much through their influence on expectations as through any direct, mechanical effects of central bank trading in the market for overnight cash." Roberts (1995), Zhang et al (2006), and Nason and Smith (2009) (among others) use survey measures of inflation expectations in Phillips curves (often called "expectations-augmented" Phillips curves).[1] Usually, these data come from either surveys of professional forecasters, or households.[2]

[1] Roberts (2004) and Mishkin (2007) highlight the anchoring of inflation expectations as recently altering inflation dynamics in a Phillips Curve framework, suggesting the need for forward-looking inflation expectations data instead of a backward-looking proxy.

[2] A hybrid approach to the NKPC suggests that the inflation process depends upon both expected future inflation and lagged inflation. Appealing to the inclusion of lagged inflation usually falls out of estimation procedures where lagged inflation appears statistically significant (see Gali and Gertler (1999) or Linde (2005). Critics of this approach, such as Rudd and Whelan (2005), argue that inclusion of lagged inflation is not robust to alternative specifications and estimation strategies. Importantly, these appeals to the significance (and interpretation) of lagged inflation in the NKPC say little of the theoretical basis for the inclusion of lagged inflation.

However, explicit in the NKPC is that the inflation expectation of interest is that of the firm, which is the price setter after all.

Several papers have considered the appropriateness of alternative measures of inflation expectation as proxies for the price expectations of firms. For example, Nunes (2010) examines whether firms' expectations in a NKPC model are better proxied by rational expectations or survey expectations of professional forecasters. He found that rational expectations appeared to be dominant, which suggests professional forecasters' expectations are not a sufficient proxy for firm expectations.

Unfortunately, data on the inflation expectations of firms have been limited—until now. In this paper, we take advantage of recently available data on the inflation expectations and inflation uncertainty of firms derived from the Federal Reserve Bank of Atlanta's Business Inflation Expectations Survey (BIE survey).[3]

We offer an answer to each of the questions posed in the title of this paper. We evaluate the inflation expectations of firms by way of comparison to the other two popularly used survey approaches, a survey of professional economists conducted by the Federal Reserve Bank of Philadelphia, and a survey of households, conducted by the University of Michigan. We then examine the accuracy of firm inflation expectations by comparing their ex-ante expectations to their future, ex-post realizations. We also test whether the degree of uncertainty a firm has about future costs influences the accuracy of their predictions. Finally, we consider whether firm inflation expectations matter through the empirical estimation of a cross-sectional Phillips curve.

The remainder of the paper is organized as follows; Section 2 provides a detailed description of the BIE survey compiled by the Federal Reserve Bank of Atlanta since October, 2011. Section 3 describes the data in comparison to the two other popularly used survey measures of inflation expectations; household inflation expectations as surveyed by the University of Michigan's Survey of Consumers and professional forecaster's inflation expectations as surveyed by the Federal Reserve Bank of Philadelphia. In Section 4, we evaluate the forecasting accuracy of firm inflation expectations by comparing their ex-ante unit-cost expectations against their future, ex-post perceptions of unit-cost realizations. Section 5 establishes that firm inflation

[3] https://www.frbatlanta.org/research/inflationproject/bie/

expectations appear to matter in the sense that they fit well when applied to a cross-sectional Phillips Curve. Section 6 concludes and offers suggestions for future investigation.

2 A Description of the Survey

Information on the inflation expectations of firms has been limited. For example, the National Federation of Independent Business asks a business panel about their current prices compared to three months earlier and about planned changes to prices over the next three months. These questions are qualitative in nature, asking only if their prices were "higher" or "lower" or whether they plan to "increase" or "decrease" prices.[4]

Two (other) Federal Reserve Surveys are worthy of note. The Federal Reserve Bank of Richmond conducts four surveys (Maryland Survey of Business Activity, Carolinas Survey of Business Activity, Survey of Manufacturing, and Survey of Service Sector Activity) each asking businesses to report the percentage change in "prices paid for inputs" and the "prices received for outputs" over the past month and expected percentage changes "six months from now". In data that is more closely aligned to the survey used in this study, the Federal Reserve Bank of New York conducts two surveys, the Business Leaders Survey of service and retail firms, and the Empire State Manufacturing Survey. Each asks business to report their inflation perceptions and expectations. Specifically, the survey records the average percentage change in their selling prices and prices paid, as well as the percentage change each firm anticipates, for the next six months and the year ahead.[5] The New York Fed surveys also elicit a probability assessment for various inflation outcomes for each firm. For year-ahead projections, the Empire State Manufacturing Survey has been conducted annually beginning in May 2008. For six-month horizons, the survey has been conducted annually since September, 2008. The same data from the Business Leaders Survey is available since May, 2013.

The data we use to investigate the inflation expectations and uncertainties of business come from the BIE survey conducted by the Federal Reserve Bank of Atlanta. The monthly BIE survey is an online panel survey of more than four hundred CEOs, CFOs, and business owners

[4] Their large sample consists exclusively of small firms, with approximately 80% of firms having less than 20 employees.

[5] For details of the New York Business Leaders survey, see http://www.ny.frb.org/survey/business_leaders/bls_overview.html. The New York Fed's Empire State survey can be found at http://www.newyorkfed.org/survey/empire/empiresurvey_overview.html.

Table 1: BIE Panel Composition

Firm size composition and comparative U.S. national averages

	Share of firms in the BIE Panel	Share of all U.S. Establishments	Share of Annual Payroll in the U.S.
Small (1-99 employees)	61.4%	79.0%	28.6%
Midsize (1--499 employees)	16.2%	4.8%	13.4%
Large (500+ employees)	22.4%	16.2%	58.0%
Total	**100%**	**100%**	**100%**
Industrial composition of the BIE Panel and comparative U.S. national averages			
	Share of firms in the BIE Panel	Industry contribution to U.S. GDP*	Industry share of all U.S. Firms
Mining and utilities	2.4%	5.2%	0.5%
Construction	10.4%	4.2%	11.6%
Manufacturing	16.4%	14.5%	4.5%
Retail and wholesale trade	29.1%	13.6%	17.0%
Transportation and warehousing	3.6%	3.4%	2.8%
Information	2.4%	5.6%	1.2%
Finance and Insurance	6.4%	7.7%	4.1%
Real estate and rental and leasing	7.3%	15.3%	4.6%
Professional and business services	12.1%	14.0%	19.4%
Educational services	1.7%	1.3%	1.4%
Health care and social assistance	3.3%	8.3%	11.0%
Leisure and hospitality	3.1%	4.3%	10.4%
Other services except government	1.9%	2.5%	11.5%

located in the southeastern United States. The data is publically available starting in October 2011.[6]

Table 1 reports the characteristics of the BIE survey panel. By design, the industry composition of the panel roughly reflects the makeup of the national economy at the two-digit NAICS level.[7] The size distribution of the BIE survey is somewhat more heavily weighted toward smaller firms. For example, over our three year sample, firms with less than 500 employees represented 61 percent of the BIE panel. Small firms represent 79 percent of all U.S. establishments, but 29 percent of total U.S. payrolls.[8]

The monthly BIE survey is composed of six questions; four questions that form the core of the monthly survey, a fifth, rotating question (three questions that rotate into the survey on a quarterly basis), and a special, non-repeating question that addresses a research or policy-issue

[6] Roughly 55% of panelists self-report as being the firm's President, CEO, or CFO and about 25% as "owners". BIE panelists represent firms headquartered within the Sixth Federal Reserve District, which includes the states of Alabama, Florida, Georgia, and sections of Louisiana, Mississippi, and Tennessee.

[7] Nevertheless, when computing the aggregate statistics, survey responses are weighted by two-digit NAICS industry shares of U.S. Gross Domestic Product.

[8] Katherine Kobe, "The Small Business Share of GDP, 1998-2004", Small Business Administration Office of Advocacy, April 2007.

of the day.[9] One of the core monthly questions is a backward looking, year-ago assessment of a firm's unit cost changes (inflationary perceptions), where panelists are given a menu of five unit-cost change response options.[10]

Looking back, how do your UNIT COSTS compare with this time last year?

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

A second core question elicits forward-looking inflation expectations and uncertainties from a firm's probability assessment of year-ahead unit-cost changes.[11][12]

Projecting ahead, to the best of your ability, please assign a percent likelihood to the following changes to UNIT COSTS over the next 12 months. *values should sum to 100%*

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

As in Manski (2004), Engleberg et al (2006), and Bruine de Bruin et al (2009) we take a probabilistic approach to surveying panelists' inflation expectations for 12-month ahead unit cost changes. In this paper, we compute the firm's inflation expectation as the mean of the probability distribution (although we also consider the median and mode of the probability

[9] See the BIE website for a description of the survey questions and design.

[10] The quantitative guides to "about unchanged", "up somewhat", "up significantly" and "up very significantly" are based on historical inflation experience in the United States and centered on 2 percent, roughly the average inflation rate over the past twenty years.

[11] This "probabilistic approach" to the measurement of expectations has been used by other researchers, notably in the Survey of Professional Forecasters, see Diebold, Tay, and Wallis (1999) and Clements (2002), and for households, see Dominitz and Manski (1994), Manski (2004), and Bruine de Bruin, Manski, Topa, and van der Klaaus (2009).

[12] "Hover over" definitions embedded in the questions are provided for respondents:

Sales Levels: "If possible, please respond on the basis of units sales levels rather than sales levels in terms of dollar value."

Profit Margins: "Margins are markups over costs. They might also be thought of as the profit per unit sold."

Unit Cost: "Unit costs are distinct from total costs. If possible, please report the cost per unit sold."

distribution in some instances). We gauge the firm's uncertainty about future inflation using the variance of the probability distribution.

A firm's "unit costs" is the appropriate perspective for assessing the inflation expectations of business. The current foundational model for studying inflation dynamics is the NKPC, where price rigidities arise from monopolistically competitive firms (as in Calvo (1983), Calrida, Gali, and Gertler (1999), and Woodford (2003)). In this NKPC framework, firms set price as a markup over their marginal cost, and they adjust prices on expected future marginal costs.[13] Indeed, we think firm expectations of some inflation aggregate, like a specific price index (as in the Survey of Professional Forecasters) or a broad notion of inflation like "prices in general" (as in the University of Michigan Survey of Consumers) is unlikely to be the primary determinant for year ahead pricing decisions of firms. This is our interpretation of the findings of Nunes (2010), and we provide evidence that these disparate concepts are not closely related in the minds of price setters.

3 What do firm inflation expectations look like?

In this section, we describe the characteristics of the BIE survey data in comparison with two popularly used survey measures of inflation expectations—the University of Michigan's Survey of Consumers (households) and the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters (professional forecasters).

Table 2 reports the mean and average cross-sectional variance (heterogeneity of expectations) of the 12-month ahead and longer-run inflation expectations of firms, professionals, and households. Our sample runs from October 2011 to September 2014—a relatively sanguine period for retail prices.[14]

[13] Our conversations with businesses in early development of the BIE survey also lead us to conclude that firm pricing decisions generally begin with their expectation of future costs. Further, the setup of the survey in this way allows us to monitor cost expectations and margin pressures as independent decision points in the price decisions by firms.

[14] For example, the annualized growth rate in the all-items Consumer Price Index (CPI) over our sample period was 1.7 percent, with a monthly variance of 5.3 percent. This compares favorably with a pre-recession, three-year annualized growth rate in the CPI of 3.3 percent and a monthly variation of 19.1 percent (from January 2005 to December 2007). On a core basis, the annualized inflation rate was 1.7 percent over our three-year sample (vs. 2.3 percent pre-recession) with a variance roughly half as large as the 2005-07 period.

Table 2: Summary Descriptive Statistics: Inflation Expectations (Oct. 2011 - Sep 2014)

1-year ahead inflation expectations			
	Mean	Variance	N
Firms	**1.9**	**1.6**	6055
Professional Forecasters	**2.0**	**0.3**	475
Households	**3.9**	**14.7**	15631
Long-run inflation expectations			
	Mean	Variance	N
Firms	**2.7**	**1.9**	1830
Professional Forecasters	**2.2**	**0.2**	463
Households	**3.3**	**9.0**	15631

Notes: Source data for professional forecaster inflation expectations is the Philadelphia Fed's *Survey of Professional Forecasters*, CPI inflation expectations. Household forecasts are taken from the UM *Survey of Consumers*, and firm inflation expectations are from the Atlanta Fed's *Business Inflation Expectations Survey*. "Long-run" expectation questions for households and firms ask for inflation "5-10 years ahead", while the SPF data is the 5-year ahead CPI-based inflation forecasts

For year-ahead expectations, the firm data show an average inflation expectation of 1.9 percent, essentially the same as the inflation expectations of professional forecasters (2.0 percent) but two percentage points less than the inflation expectations of households (3.9 percent). We also note that the heterogeneity of expectations for firms, at 1.6 percentage points, is larger than that of professional forecasters (0.3 percentage point), but well under that of households (14.7 percentage points).

For the longer-term, the inflation expectations of firms runs about 0.5 percentage point higher than for professional forecasts (2.7 percent vs. 2.2 percent), but about 0.5 percentage point less than households (2.7 percent vs. 3.3 percent). Again, there is a large discrepancy in the observed heterogeneity of expectations between the three groups. The cross-sectional variance of long-run inflation expectations over the three-year period was 0.2 percentage point for professional forecasters, 1.9 percentage points for firms, and 9.0 percentage points for households.

While comparisons of this sort are common in the literature (see Mankiw, Reis, and Wolfers (2004) for example), the three surveys are not fully comparable because each asks for a prediction of a different perspective of inflation. Professional forecasters are asked to predict the growth rate of a particular price index (in this paper we report their expectation for the Consumer Price Index—CPI—or the Consumer Price Index less food and energy items—the core CPI.) Households, however, are asked to predict the growth rate of "prices in general," a rather

vague concept. And in the BIE survey of firms, respondents are asked to predict changes in their unit costs, something that is unique to each firm's pricing decision.

In two separate experiments, we put to the BIE panel the same questions put to households by the University of Michigan and to professional forecasters by the Federal Reserve Bank of Philadelphia. In our September 2014 survey, we asked the BIE panel to give us their expectations for "prices in general", the same notion of inflation described in the University of Michigan survey of consumers. We compare these results to that reported by the University of Michigan for the same month.

When asked the same question put to households by the University of Michigan, our panel of business responded with an inflation expectation that looked very much like the response of households (Table 3). Firms in our panel expected "prices in general" to rise 4.4 percent in the year ahead, compared with a 3.7 percent rise reported for households by the University of Michigan that month. The firm response was 2.3 percentage points greater than how much they expected their unit costs to rise over the same period (2.1 percent).

We also found exceptionally large heterogeneity in firm assessments of "prices in general", similar to what is seen in the Michigan survey data. Specifically, the cross-sectional variance of expectations for "prices in general" as seen by the panel of firms—at 18.2 percentage points—was 13 times the magnitude of the heterogeneity of their unit cost expectations (1.4 percent), but broadly comparable to the 12.1 percent reported for households in the University of Michigan survey.

Table 3: Own Unit Cost Expectations vs Prices in General

(BIE panel and University of Michigan *Survey of Consumers,* September 2014)

1-year ahead inflation expectations of firms:					
	Mean	**Heterogeneity**	**min**	**max**	N
Unit-Cost Expectations	**2.1**	**1.4**	**-1.5**	**6.0**	182
Prices "overall in the economy"	**4.4**	**18.2**	**-10.0**	**25.0**	182
1-year ahead inflation expectations of households:					
Prices "overall in the economy"	**3.7**	**12.1**	**-10.0**	**20.0**	454

Notes: Household forecasts are taken from the UM *Survey of Consumers*, September 2014; and firm inflation expectations are from the Atlanta Fed's *Business Inflation Expectations Survey*, September 2014. In order to make the comparison as close as possible, we follow the same truncation procedure that the UM uses for outliers (see Curtin 1996).

In the following month (October 2014) we asked the BIE panel if they were familiar with the "core" Consumer Price Index (CPI) and to tell us how much they expected this particular

Table 4: Own Unit Cost Expectations vs Core CPI Expectations

(BIE panel and Survey of Professional Forecasters, October 2014)

	Inflation Expectation	Heterogeneity of Inflation Expectation			Inflation Uncertainty (variance of individual's probability assessment)		
1-year ahead inflation expectations of firms:							
	mean	min	max	variance	mean	variance	N
Unit-Cost Expectations	2.0	-1.6	6.0	1.8	2.4	3.1	210
Core CPI (full sample)	1.9	-1.0	5.0	0.8	0.5	0.2	199
Core CPI (familiar with term)	2.0	-0.3	3.9	0.6	0.5	0.2	131
1-year ahead inflation expectations of professional forecasters:							
Core CPI (Q4/Q4 growth, August 2014)	2.0	1.2	2.6	0.1	0.3	0.2	40

Notes: Source data for professional forecaster inflation expectations is the Philadelphia Fed's *Survey of Professional Forecasters*, Core CPI inflation over the year ahead. Firm inflation expectations are from the Atlanta Fed's *Business Inflation Expectations Survey*, October 2014. The BIE question was, "Please indicate what probabilities you would attach to the various possible percentage changes to the CORE (excluding food and energy) CONSUMER PRICE INDEX over the next 12 months. (Values should sum to 100%)." A given firm's expected value of their probabilistic forecast was calculated by taking the weighted average of the share of probability mass in each bin multiplied by its midpoint. -1 percent and 5 percent were used as midpoints for the left-censored and right-censored bins respectively. Familiarity with the term "Core CPI" was judged on a 5 point likert scale. Responses 4 and 5 were judged "familiar."

price index to increase over the next twelve months. A summary of their responses, along with the most recent survey of professional economists for the same variable are reported in Table 4.

The sample of firms reported an expectation that the core CPI would increase 1.9 percent over the next twelve months, with a cross-section variance of 0.8 percent. This compares to 2.0 percent expectation by professional forecasters, with a cross-section variance of 0.1 percent. Firms, unlike professional forecasters, may not be expert in the core CPI. However, we found that a significant subsample of the BIE panel claimed to be either "fairly" or "very" familiar with the core CPI. Of these, the mean and variance of their inflation expectation of their core CPI prediction was 2.0 percent and 0.6 percentage point, respectively, closely aligned to what we see in the survey of professional forecasters.[15] [16]

Leveraging the probabilistic responses allows us to compute statistics that describe how tightly respondents assigned probability about the mean of their distribution (what we call "uncertainty") and the cross-sectional variance of uncertainty—what we call the "heterogene-

[15] One potential source for the relatively higher variance of expectations on the part of firms is that they were posed the question over a 12-month horizon as opposed to the SPF, which is a Q4/Q4 concept.

[16] An analysis of the time it took each respondent in the October's BIE panel to complete the survey did not reveal a significant difference in the amount of time it took a typical respondent to complete the survey relative to the sample average, nor did it reveal a relationship between the amount of time a respondent took to fill out the survey and his or her similarity to the professionals. On average, the survey was completed within roughly 4.8 minutes for those respondents whose estimates fell within the range of professional forecasters' estimates of Core CPI over the next four quarters (1.2 to 2.6 percent). For those who were below the range of SPF estimates, the survey was completed in roughly 4.7 minutes and for those above the range, in approximately 6.5 minutes, on average.

ity of uncertainty." Perhaps unsurprisingly, we find that firms hold somewhat more uncertain expectations of core CPI inflation over the year ahead. What is perhaps more interesting is that, on average, firms are more uncertain about their own future unit costs than they are about the future core CPI. Moreover, the shape of firms' probability distributions for future unit costs is much more heterogeneous than their distributions of future values of the core CPI. We see this as evidence of the idiosyncratic nature of firm costs.

Table 5. Measures of Firm Inflation Expectations:
Pairwise Correlations

	Unit Costs	Core CPI
Core CPI	**0.35*** **	-
p-value	(0.000)	
"Prices in General"	0.06	-0.11
p-value	(0.199)	(0.5029)

Notes: This is an "apples-to-apples" comparison for 145 respondents in Sept. and Oct. 2014 that responded to all three questions.
*** indicates significance at the 1% level.

An "apples-to-apples" comparison of the respondents that answered all three questions (the "prices in general" question, the probabilistic core CPI question, and the probabilistic unit cost question) suggests that firm inflation expectations are positively (and significantly) related to their expectations for core CPI inflation over the next year, but are unrelated to the more ambiguous question typically posed to households. Respondents views on the core CPI over the year ahead and "prices in general" over the year ahead were negatively correlated (-0.11) but statistically insignificant, strongly suggesting that these two concepts are unrelated in the minds of respondents.

The conclusion we draw from these experiments is pretty clear. It matters quite a bit the perspective on inflation that forecasters are being asked to provide. Predictions about "prices in general", the core CPI, and unit costs are not synonymous. If you ask about a specific price index, you will get a prediction that is roughly of the magnitude of the observed trend in that particular price index, and the heterogeneity of expectations will be relatively narrow. If you ask firms to predict "prices in general", an ambiguous notion of inflation, you get back a prediction that is several percentage points higher than the observed inflation trend, and an exceptionally large heterogeneity in response.[17]

[17] There is a very large literature documenting the seemingly high and exceptionally diverse predictions of

If you ask firms about unit cost expectations, you will, on average, get back an inflation expectation that is roughly similar in magnitude to the observed inflation trend, but there will be more heterogeneity exhibited in the cross-section of firm expectations. This observation seems perfectly reasonable since each firm is predicting their own, somewhat idiosyncratic bundle of costs.

In summary, the descriptive statistics computed from the probability distributions on year-ahead unit cost expectations of firms reveal inflation expectations that, on the surface at least, appear perfectly reasonable. On average, firm expectations of inflation are in line with observed inflation trends and virtually indistinguishable from professional forecasters' predictions of the CPI.[18] However, firm inflation expectations exhibit a little more heterogeneity than economists' predictions of core inflation, a result we attribute to the idiosyncratic nature of a firm's unit costs, compared to a single, common price statistic like the core CPI. Moreover, when we ask firms a vague, Michigan-like question on general price expectations, we get a Michigan-like response, with Michigan-like variation that bears little similarity to a firm's unit-cost expectations or their judgments on year-ahead core CPI inflation. What remains to be shown, however, is whether firm inflation expectations are reasonably accurate.

4 Are firm inflation expectations accurate?

The BIE data lack a time-series sufficient to make any inference about the accuracy of aggregated firm inflation expectations. Nevertheless, the panel structure allows us to compare a firm's ex-ante unit cost expectation against their ex-post unit cost realizations (inflation perception). We do this by comparing the expected value of a firm's year-ahead probabilistic unit-cost expectation to the backward-looking unit cost growth they report 12 months hence.[19]

"prices in general." See, for example, Batchelor and Dua (1989), Thomas (1999), Bryan and Venkatu (2001a,b), Mehra (2002), Carroll (2003), and Bruine de Bruin et al (2010).

[18] The three-year annualized trend in both the all-items and core CPI corresponding to our sample period (October 2011 to September 2014) was 1.7 percent.

[19] As described above, we compute the mean of a firm's inflation expectation by taking the weighted average of the probability mass assigned to a particular bin multiplied by the midpoint of that particular bin. Our procedure for the unbounded bins is to add (or subtract) an additional percentage point and use that as the "midpoint." So, we'd use 6 for the 'up very significantly' bin and -2 for the 'down' bin. We compute a given firm's median expectation by summing up the probability mass from the lowest bin to the highest bin and assigning the median to whatever bin crosses 50 percent on the CDF. The modal expectation reflects the midpoint of the particular bin the respondent assigns the highest amount of the probability mass. For simplicity, we ignore cases where

Table 6 reports the forecasting accuracy statistics for firms' and professional forecasters' 1-year ahead expectations. We report the simple forecast error (expected minus observed inflation) and root-mean squared errors (RSMEs) for various measures of firm unit-cost expectations (mean, median, and mode of the reported probability distribution) relative to their reported unit-cost changes twelve months ahead. Professional forecast errors are based on their projections for headline CPI inflation (4-quarter growth rates).

On average, firms are fairly accurate forecasters of their own unit cost growth. The average forecast error for the mean of the probability distribution is roughly 0.1 percentage point from the unit-cost growth firms report one-year later. The forecast errors from the firm's median and modal prediction are negligible.[20] By comparison, the average forecast error for professional forecasters predicting the CPI 1 year-ahead is 0.4 percentage point.

The RMSE for all firms is 1.5 percentage points, which is larger than the RMSE of economist predictions of the all-items CPI for the same period. The RMSE for the survey of professional forecasters year-ahead CPI prediction over this period was 0.8 percentage point.[21] This result is not at all surprising due to the substantial heterogeneity observed in firms' unit cost expectations. Again, given the idiosyncratic nature of the firm cost structures, we would expect RMSEs to be higher here relative to a common forecasting object, like the CPI. The nature of large forecasting errors on the part of firms operating in highly variable pricing environments is heavily penalized in the RMSE calculation.[22]

the respondent's distribution is multi-modal. While there may be some interesting information here regarding uncertainty, of the useable 2469 observations we have gathered only 395 of those are multi-modal. Perceived unit cost growth is binned. We use the midpoint of the bin as the firm's inflation perception when calculating forecast accuracy.

[20] We provide the frequency tables in the appendix. Table A1. This yields a richer understanding of what constitutes a "forecast miss."

[21] The RMSE for professional forecasters is 1.5 percentage points over the entire SPF sample period (1981Q3-2014Q3).

[22] Indeed, a comparison of the variance in reported unit cost growth and the year-over-year growth rate in the CPI reveal that firms' unit cost growth 7.4 times more volatile than the CPI over this time period.

Table 6: Forecast Accuracy (Oct. 2011 - Sep 2014)

Firm 1-year ahead unit cost forecast errors			
	Forecast error	**RMSE**	**N**
Mean	**0.13**	**1.53**	2469
Median	**-0.08**	**1.64**	2469
Mode	**-0.03**	**1.67**	2074
SPF 1-year ahead CPI forecast errors			
Mean	**0.43**	**0.80**	316

Notes: Firm inflation expectations and observed inflation data are from the Atlanta Fed's *Business Inflation Expectations Survey*. Professional forecasts taken from the Federal Reserve Bank of Philadelphia's *Survey of Professional Forecasters (SPF)*

Since firm inflation expectations are derived from their expected unit-cost probability distributions, we can also investigate what role uncertainty plays in the accuracy of firm inflation predictions. In other words, do firms know what they don't know? It seems reasonable that a firm with a relatively uncertain view about future unit cost growth will yield a less accurate prediction than firms with relatively tightly-formed expectations. Engelberg, Manski, and Williams (2006) and Bruine de Bruin et al (2009, 2010) investigate the concept of individual (probabilistic) uncertainty across professional forecasters and households, respectively, finding that uncertainty is a different and distinct concept from disagreement (heterogeneity). However, little attention is paid in this literature to see if uncertainty materially affects an individual's forecast accuracy.

Table 7 reports forecast errors relative to the variance of a firm's probability distribution (uncertainty) at the time the forecast was made. The exercise separates the unit cost forecasts on the basis of the forecasters' uncertainty. We compare the predictions of firms who have a larger-than-median degree of prediction uncertainty against those which less-than-median uncertainty. We also consider the most uncertain firms (firms that reported uncertainty in the top 25th percentile of all firms) against the firms with the least uncertainty (firms that report uncertainty in the lowest 25th percentile of all firms).

The median level of uncertainty is 1.95 in this sample, with a minimum uncertainty level of 0 percent and a max of 9.6 percent.[23]

[23] For this exercise, and throughout the paper, we are treating all the probability within a bin as residing at the mid-point. A firm that responds with 100 percent of the probability weight in 1 bin would have a variance of zero in this case. Others, such as Engleberg et al (2006) estimate a triangular distribution for probabilistic forecasts that only have weight in one or two bins.

Table 7: Uncertainty and Forecast Accuracy (Oct. 2011 - Sep 2014)

By degree of uncertainty about future unit costs				
	Forecast error	**Squared error**	**RMSE**	**N**
Overall	**0.13**	**2.33**	**1.53**	2469
If firm's uncertainty (variance) <=1.95 (p50)***	**0.03**	**1.93**	**1.39**	1234
If firm's uncertainty (variance) > 1.95 (p50)***	**0.24**	**2.73**	**1.65**	1235
***P-value of difference in mean squared forecasting error = 0.000				
If firm's uncertainty (variance) <=1 (p25)***	**-0.04**	**1.89**	**1.37**	726
If firm's uncertainty (variance) >3.31 (p75)***	**0.32**	**3.13**	**1.77**	611
***P-value of difference in mean squared forecasting error = 0.000				

Notes: Forecast accuracy statistics calculated using mean and (variance about the mean) of firm's probabilistic unit cost forecast relative to their perceived unit cost growth (1 year ahead). Equality of prediction tests (difference in squared forecasting errors) between groups with higher and lower variance (either above/below the median or in the tails) indicate that the mean squared forecast error in each group is statistically different from each other at the 1% level.

The results clearly support the conclusion that as uncertainty increases, forecast errors increase. A more uncertain respondent tends to be a less accurate forecaster, as firms with uncertainty above the median level carry a RMSE that is 19 percent higher. These results hold across the uncertainty (variance) distribution. Interestingly, while more uncertain firms tend to be less accurate forecasters (at least in this sample), they also appear to have a small positive inflation bias. In other words, their mean forecast error, while small, is significantly greater than zero.

On average, however, firms provide relatively accurate, unbiased assessments of their future unit cost changes. In addition, firms facing uncertain cost conditions understand that they do. This finding could be potentially useful when assessing whether inflation expectations are becoming unanchored.

5 Do firm inflation expectations matter? A Cross-Sectional Phillips curve investigation

In this section we provide evidence that firms act within a Phillips curve framework.

An investigation of aggregate firm inflation expectations in a Phillips curve setting along the lines of Ang, Beckaert, and Wei (2008), Carrol (2003), or Faust and Wright (2012) isn't feasible using BIE data given the short time series available. However, we can exploit the cross-sectional firm-level evidence to identify a relationship between inflation, inflation expectations,

and economic slack at the micro-level.[24]

There is ample precedent for this type of investigation. Bils (1985) and Blanchflower and Oswald (1989), trace out the relationship between wages and unemployment in the spirit of Phillips (1958) using individual wages and (local area) unemployment rates. Köberl and Lein (2011), who use a panel survey data from 1985 to 2009 (approximately 1,100 firms respond each quarter) to uncover a 'non-inflationary rate of capacity utilization' (NIRCU) and find it performs very well as an indicator of prescient inflationary pressure.

More closely related our work, Gaiotti (2010) tests whether the relationship between firm level capacity utilization and prices depend on the level of foreign competition each firm faces using a large dataset of 2,000 Italian firms.[25] One drawback of Gaiotti (2010) is the lack of firm-specific inflation expectations. Without available data on firm specific inflation expectations, Gaiotti (2010) assumes inflation expectations are equal across all firms, an assumption that doesn't appear valid given the above results.

The BIE survey data not only yields information on firm inflation expectations, but also their assessment of business activity at the firm level. Each panelist provides their judgments regarding firm-level slack and margins "compared to normal times."

Each firm provides a subjective evaluation of whether their current sales levels are above, below, or about normal. The sales "gap" question reads: "How do your current sales levels compare with sales levels during what you consider to be "normal" times?" Response options include, 'much less than normal', 'somewhat less than normal', 'about normal', 'somewhat greater than normal', and 'much greater than normal'. For profit margins, the question posed to the panel reads: "How do your current profit margins compare with "normal" times?" The same response options are given. This "sales gap" response in this sense is similar to an individual firm output gap, as each firm is responding relative to their respective judgments on the firm's steady state sales levels.

Table 8 provides some distributional characteristics of firms' sales gap and margins gap

[24] One advantage of the micro-approach is that potentially important cross-sectional variability could be masked in aggregate, time-series studies. One could imagine future studies that investigate the periodicity of the significance of the coefficient on slack in the Phillips curve. Akteson and Ohanian (2001) cast some doubt on the use of slack at all. The below results suggest that slack appears to matter at the micro level over this sample.

[25] Other examples of a cross-sectional approach would be Ball (2006) or Ihrig et al (2007) examine the effect globalization has had on the Phillips curve in aggregate.

responses and Table 9 relates industry-level sales gaps to industry-level output gaps. It is perhaps unsurprising that the majority of firms over the sample period respond that sales levels are somewhat less than normal given the relatively tepid pace of real GDP growth following the 2007-09 recession. At the industry level, the correlation between the output gap (percentage deviation in real GDP relative to trend) and respondents' judgment of firm-level slack is 0.44.[26] While this comparison is imperfect, it appears that firms' assessments of slack are significantly related to common measures of aggregate slack (such as the output gap).

Table 8: Frequencies: Sales and Margins Gaps

Sales levels relative to "normal" (Sales Gap)	
Category	**Frequency**
Much less than normal	918
Somewhat less than normal	2,254
About normal	1,763
Somewhat greater than normal	989
Much greater than normal	78
total	6002
Profit margins relative to "normal" (Margins Gap)	
Category	**Frequency**
Below normal	3,341
About normal	2,034
Above normal	627
total	6002

Table 9: Sales Gap and Industry Performance

	Industry Output Gap*	Diffusion index: Sales Gap	N
Construction	-23.4	-49	283
Retail and Wholesale Trade	-18.1	-21	1070
Nondurable Good Manufacturing	-15.4	-25	442
Durable Goods Manufacturing	-11.7	-29	713
Utilities	-11.6	-39	269
Information	-10.9	-32	261
Finance and Insurance	-6.4	-33	656
Transportation and Warehousing	-6.0	-1	237
Professional and Business Services	-5.0	-18	782
Real Estate and Rental Leasing	-3.8	-23	708
Healthcare and Social Assistance	-2.3	-14	331
Educational Services	-5.3	-29	143
Other Services	-2.1	-29	153
Leisure and Hospitality	-10.8	-6	187

Notes: *Gap is calculated as the percentage deviation in industry-level real GDP (real value-added) from a linear time trend estimated prior to 2008. The sales gap diffusion index is bounded by -100 (much less than normal) and +100 (much greater than normal). The correlation coefficient between the industry-specific output gaps and the respective sales gap measures is 0.61 for industries with a sample size greater than 200 and 0.44 overall.

[26] Excluding the 3 industrial sectors where we have less than 200 observations raises the correlation coefficient to 0.61.

In order to trace out the existence of a firm-level Phillips Curve, we start with the following form:

$$\pi_{it} = E_{it}\pi_{i,t+1} + bx_{it} + \epsilon_{it}$$

where x_{it} is a firm-specific activity variable and $E_{it}\pi_{i,t+1}$ are the firm's inflation expectations for the period ahead at time t, as in Gali and Gertler (1999). We estimate a firm-level Phillips curve of this type using firms' responses to a question of the growth rate of unit costs as the current inflation variable, the probabilistic mean from each firm's elicited distribution of expected unit cost growth over the year ahead as our measure of inflation expectations, and the sales gap (or sales relative to normal) variable as our firm-level activity variable. Since the firm-level inflation measure from the BIE survey is not a continuous variable, we cannot proceed directly to estimating via OLS.[27] Given the ordinal nature of the dependent variable–with the response ordering going from 'down' to 'up very significantly'–we proceed by estimating an ordinal logistic regression (also called a proportional odds model) of perceived inflation on firm-level inflation expectations, the sales gap, and the margins gap.[28] As previously mentioned the sales and margin gap measures are categorical variables, where firms report current sales and margins relative to normal times.

We have 6034 observations over the time period from October 2011 to September 2014 (and 6002 useable responses–meaning the respondent gave an answer to all the variables we use in this analysis). Table 8 reports the results of the ordered logit regression.[29][30]

The results suggest a relatively good fit of the data. The McFadden pseudo-R^2 for this model is 0.2 and the chi-square test for overall model fit is statistically significant at the 1 percent level.[31] Another, intuitive way to check the fit of the model is to assess how often it

[27] Response options for the observed inflation question are; 'down'. 'unchanged', 'up somewhat', 'up significantly', and 'up very significantly'. The parenthetical values for unit cost growth assigned to each response option are (<-1%),(-1% to 1%), (1.1% to 3%), (3.1% to 5%), and (>5%).

[28] Another option would have been to estimate an interval regression that treats the dependent variable as a censored variable. The results of this estimation strategy are in Appendix Table A2. The results appear to show a significant firm-level Phillips Curve.

[29] We use robust (White) standard errors. The result of the Brant (1990) test for the proportional odds assumption does violate the parallel regression assumption. However, the results of the more complicated generalized ordered logistic regression were not economically different enough to justify its use.

[30] We also ran a specification that included time fixed effects, but the corresponding Wald Chi-square test fails to reject the null of zero coefficients on the time dummies.

[31] Typical measures of goodness of fit for ordered logit models, such as R^2 are invalid. One typical measure

assigns the highest probability to the correct firm's inflation outcome. The model correctly assigns the highest probability to 63 percent of the sample and is accurate within one category over 95 percent of the time. This compares quite favorably relative to the unconditional (naïve) probability of correcting predicting firms' observed inflation (1/5 or 20 percent).[32]

Turning to the specifics of the model, nearly all the coefficients are statistically significant at the 1 percent level. The coefficient on firm inflation expectations is positive and large, indicating that firms that hold higher inflation expectations are much more likely to hold elevated perceptions of current inflation. Taking the exponential of the coefficient yields an odds-ratio of 3.6, meaning that a 1 percentage point increase in a firm's (mean) inflation expectation makes it 3.6 times more likely for a firm to report higher current unit cost growth.[33] The coefficients (and corresponding odds-ratios) on the categorical sales gap and margins gap variables are a bit harder to interpret, but these are of the expected sign. Larger sales gaps (sales 'somewhat less' and 'much less' than normal) relative to the 'about normal' case significantly decrease the odds of higher perceived inflation responses, and negative sales gaps (sales greater than normal) significantly increase the odds of higher inflation. For the margins gap, firms under margin pressure (margins 'less than normal') are more likely to perceive higher current inflation, and firms with ample margins (margins 'greater than normal') are likely to have lower perceived inflation. The Wald χ^2 tests strongly reject the null that the sales gap and margins gap are insignificant, suggesting these variables are important determinants of a firm's inflation dynamics.

of explanatory is the McFadden's pseudo-R^2, which is 1 minus the ratio of the log likelihood of the model with explanatory variables versus the model with only one constant. An alternative way to describe the fit of a model that appears in the literature is to compare the exponentiated ratio of the log likelihood to the number of observations (which is exp(-5781.425/6002) = 0.382 in our model) to the unconditional likelihood (given 5 categories of the dependent variable is equal to 0.2). Models that have explanatory power have a ratio greater than 1. For our model, the ratio is equal to 1.91.

[32] Table A3 in the Appendix provides a cross tabulation between the model's predictions and the observed inflation responses.

[33] Specifically, for a one percentage point increase in firm inflation expectations, the odds of reporting perceived inflation is 'up very significantly' versus the combined lower 4 categories is 3.6 times greater. Likewise, for a one percentage point increase in firm inflation expectations, the odds of reporting perceived inflation is 'unchanged' or higher relative to 'down' is 3.6 times greater.

Table 10: Ordered Logit Regression Results					
Ordinal dependent variable: Firm-level perceived inflation					
	Coefficient	Std. err.	z-score	p-value	odds-ratio
Firm inflation expectations ($E_{it}\pi_{i,t+1}$)	1.2813	.0326	39.287	0.000	3.601
Sales Gap (base level = "about normal") (x_t)					
'Much less than normal'	−0.1544	0.0942	−1.64	0.101	0.857
'Somewhat less than normal'	−0.1929	0.0656	−2.94	0.003	0.825
'Somewhat greater than normal'	0.2627	0.0767	3.43	0.001	1.300
'Much greater than normal'	0.7659	0.240	3.19	0.001	2.151
Margins Gap (base level = "about normal")					
'less than normal'	0.1979	0.060	3.30	0.001	1.219
'Greater than normal'	−0.4410	0.099	−4.47	0.000	0.643
Pseudo (McFadden) R2 = 0.2045					
Log likelihood = −5781.4251					
LR $\chi^2 test$ for model fit ($dof = 7, p - value = 0.000$)					
Wald $\chi^2 test$ for sales gap ($\chi^2 = 43.89, dof = 4, p - value = 0.000$)					
Wald $\chi^2 test$ for margins gap ($\chi^2 = 38.69, dof = 2, p - value = 0.000$)					

A graphical way to aid in the interpretation of the sales and margins gap coefficients and to assess how meaningful these variables are to a firm's perceived inflation rate is to plot the adjusted predictions (predictive margins). These figures show the probability of perceiving a certain level of inflation for a given value of the sales or margins gap. These predictive margins are evaluated at different values of inflation expectations. Figure 2a plots the predictive margins for the sales gap and Figure 2b plots the predictive margins for the margins gap.

As an example of how to read this figures; the middle graph in the top row of Figure 2a plots the adjusted predictions of the sales gap for reporting perceived inflation as unchanged. The general slope of all 5 lines (which represent the 5 different cases for the sales gap) suggests that as inflation expectations increase, the likelihood of reporting unchanged unit cost growth diminishes. Given an inflation expectation of 1 percent, there is a 40 percent chance of reporting relatively unchanged unit costs given slack sales conditions. At that same inflation expectation, the probability falls to just over 20 percent if reported sales conditions are running well-above normal. These results condense as inflation expectations rise to 3 percent. For the next graph– that plots the probability associated with perceived inflation 'up somewhat'–the predictive margins for the sales gap show the most variation across different levels of inflation expectations.

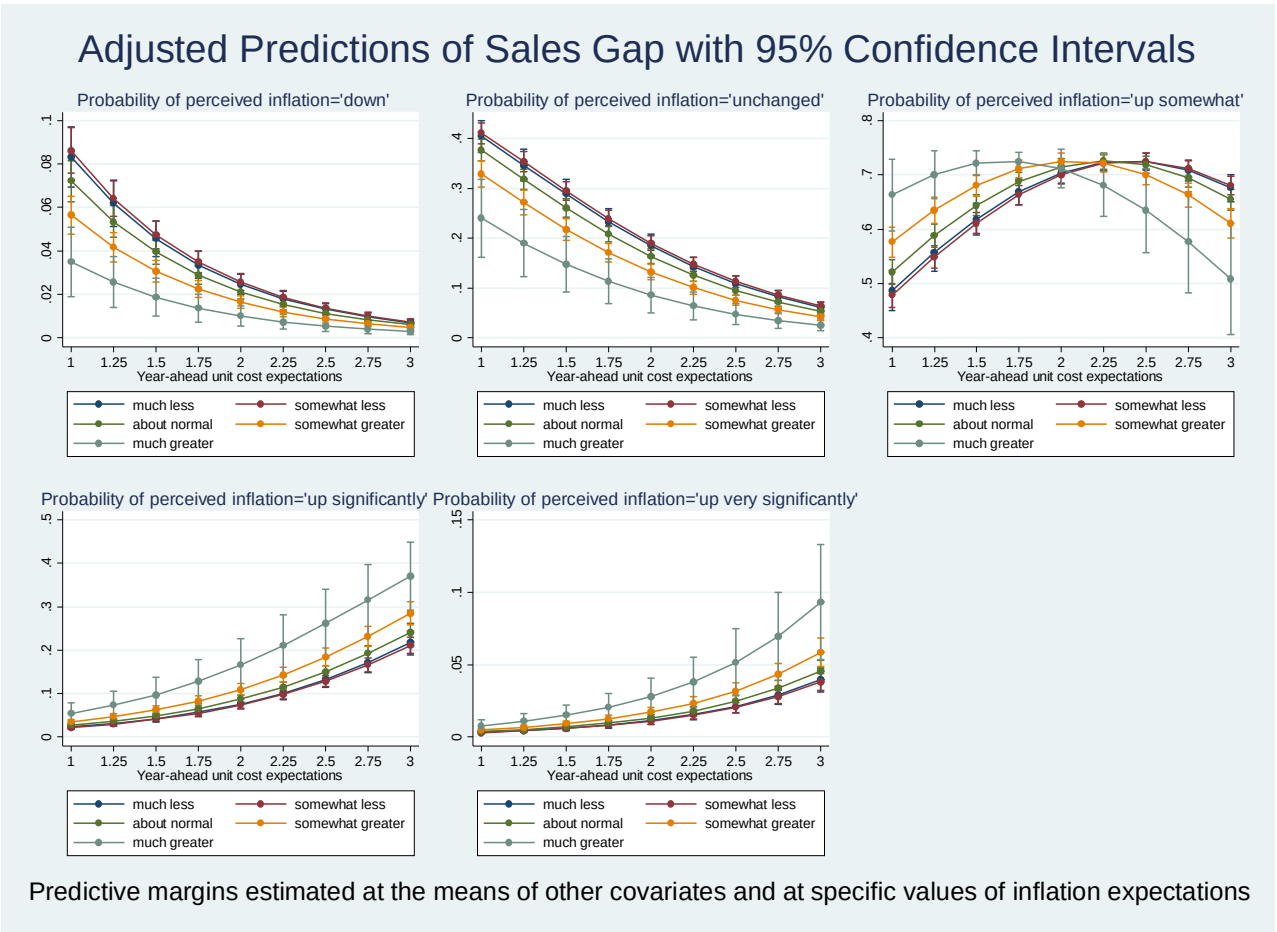

Figure 2a: Adjusted Predictive Margins of the Sales Gap evaluated at different values of inflation expectations

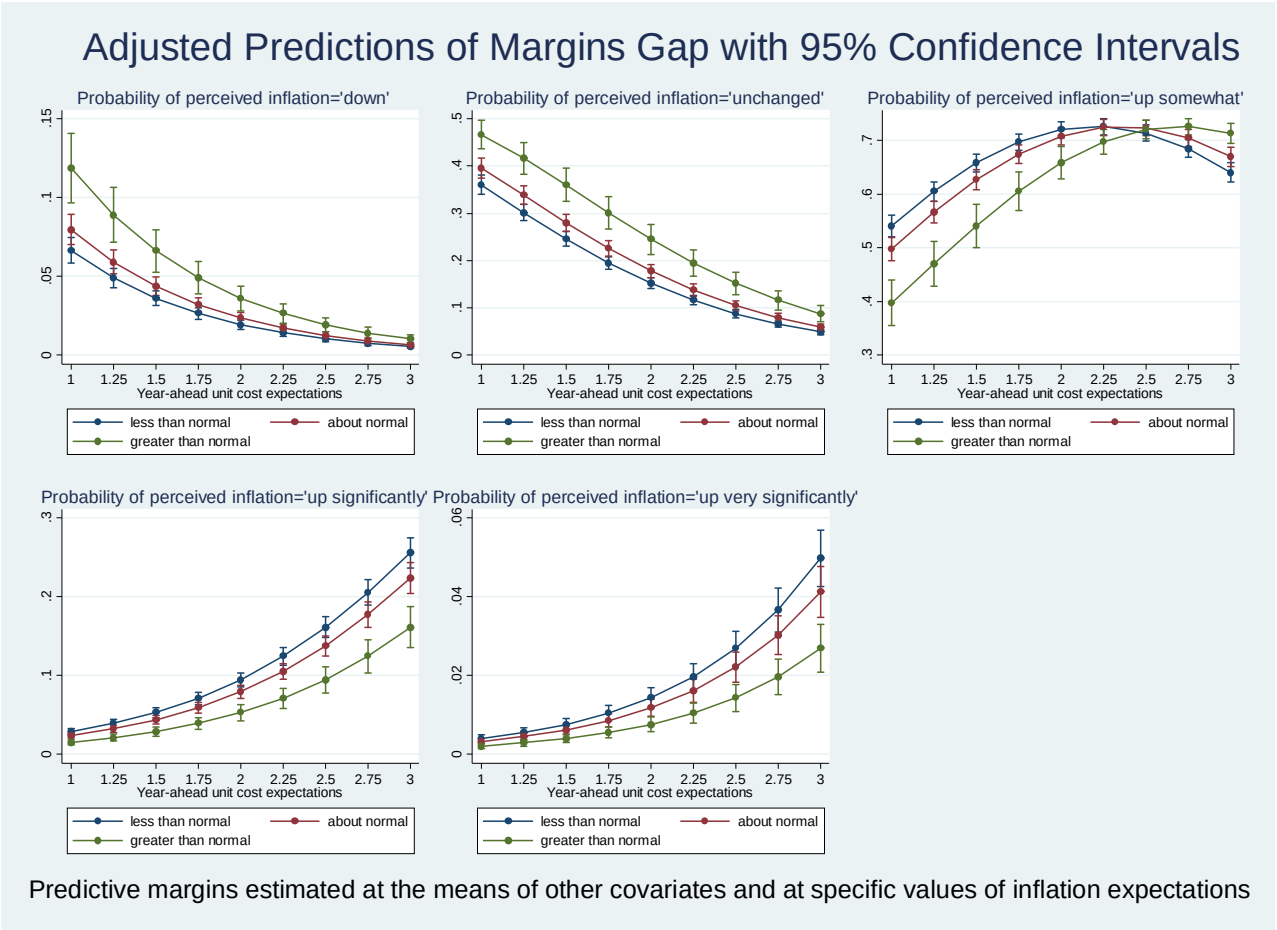

Figure 2b: Adjusted Predictive Margins of the Margins Gap evaluated at different values of inflation expectations

In general, these figures reveal a Phillips curve. Higher values for inflation expectations lower the probability of perceiving low inflation and increase the probability of reporting higher inflation rates (around an inflection point of 2 percent). The sales gap operates like an activity variable in an aggregate Phillips curve does. Reporting weak sales relative to normal increases the probability of responding that perceived inflation is low and reporting a negative sales gap substantially increases the probability of responding higher unit cost growth rates. Margins appear to work in the opposite direction of the sales gap–responding that margins are greater than normal decreases the probability of responding that perceived inflation rates are higher. A pattern that is also consistent with the aggregate literature is that the effect of inflation expectations appears to swamp that of activity variables. These results are promising in that they suggest aggregation (once we've gathered a long enough time series) could prove useful

to monetary policymakers wanting to leverage a key source of inflation expectations and an alternative measure of economic slack.

6 Conclusion

Inflation expectations matter and, according to the New Keynesian Phillips curve, the inflation expectations of price setters—firms—are especially important. In this paper, we investigate the inflation expectations of firms, a study that, up until now, hasn't been possible due to data limitations. Using a large, monthly survey of businesses, we describe the inflation expectations and uncertainties of a representative panel of U.S. firms over the period of October 2011 to September, 2014.

We document that, in the aggregate, firm inflation expectations are very similar to the predictions of professional forecasters for national inflation statistics. However, firm inflation expectation exhibit somewhat greater heterogeneity compared to professional forecasters, an observation that we attribute to the idiosyncratic cost structure firms face when setting prices. We also show that firm inflation expectations bear little in common with the "prices in general" expectations reported by households.

Over our three-year sample, the inflation expectations of firms appear to be unbiased predictors of their observed inflation experience twelve months hence. The accuracy of firm inflation expectations is significantly and negatively related to their uncertainty about future inflation. Firms that face uncertain cost conditions realize that they do, and those facing uncertain environments tend to forecast year-ahead costs with less accuracy.

Lastly, we demonstrate, by way of a cross-sectional Phillips curve, that firm inflation expectations are a useful addition to a policymaker's information set. We show that firms' inflation perceptions depend (importantly) on their inflation expectation and perception of firm-level slack.

In this paper we describe what firm inflation expectations look like, evaluate the inflation forecasting accuracy of firms, and show that firm inflation expectations matter in a Phillips curve setting. What we have yet to do is demonstrate how firms form their expectations. To paraphrase Bernanke in his 2007 speech on inflation expectations, we need to develop a richer

understanding of how firms' expectations change with new information and attempt to trace out a "learning rule" that would help with the formation of monetary policy. We believe these data on firm inflation expectations are likely to provide useful foundation for further research in this area.

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7 Appendix

Table A1: Forecast Accuracy (Oct. 2011 - Sep. 2014), frequency tables

Panel A : Firm's mean inflation expectations

1-year ahead unit cost expectation (lagged 12	Observed unit cost growth					
	down (>-1)	unchanged (-1 to 1)	up somewhat (1.1 to 3)	up significantly (3.1 to 5)	up very significantly (>5)	total
down (>-1)	**3**	3	5	1	0	12
frequency	***0.12***	*0.12*	*0.2*	*0.04*	*0*	*0.49*
unchanged (-1 to 1)	32	**266**	309	27	4	638
	1.3	***10.77***	*12.52*	*1.09*	*0.16*	*25.84*
up somewhat (1.1 to 3)	52	254	**969**	155	11	1,441
	2.11	*10.29*	***39.25***	*6.28*	*0.45*	*58.36*
up significantly (3.1 to 5)	8	18	153	**91**	35	305
	0.32	*0.73*	*6.2*	***3.69***	*1.42*	*12.35*
up very significantly (>5)	1	2	6	12	**52**	73
	0.04	*0.08*	*0.24*	*0.49*	***2.11***	*2.96*
total	96	543	1,442	286	102	2,469
	3.89	*21.99*	*58.4*	*11.58*	*4.13*	*100*

Panel B : Firm's median inflation expectations

1-year ahead unit cost expectation (lagged 12	Observed unit cost growth					
	down (>-1)	unchanged (-1 to 1)	up somewhat (1.1 to 3)	up significantly (3.1 to 5)	up very significantly (>5)	total
down (>-1)	**5**	11	16	1	0	33
frequency	***0.2***	*0.45*	*0.65*	*0.04*	*0*	*1.34*
unchanged (-1 to 1)	30	**294**	361	29	4	718
	1.22	***11.91***	*14.62*	*1.17*	*0.16*	*29.08*
up somewhat (1.1 to 3)	50	217	**925**	157	11	1,360
	2.03	*8.79*	***37.46***	*6.36*	*0.45*	*55.08*
up significantly (3.1 to 5)	10	19	132	**86**	33	280
	0.41	*0.77*	*5.35*	***3.48***	*1.34*	*11.34*
up very significantly (>5)	1	2	8	13	**54**	78
	0.04	*0.08*	*0.32*	*0.53*	***2.19***	*3.16*
total	96	543	1,442	286	102	2,469
	3.89	*21.99*	*58.4*	*11.58*	*4.13*	*100*

Panel C : Firm's modal inflation expectations

1-year ahead unit cost expectation (lagged 12	Observed unit cost growth					
	down (>-1)	unchanged (-1 to 1)	up somewhat (1.1 to 3)	up significantly (3.1 to 5)	up very significantly (>5)	total
down (>-1)	**12**	11	15	1	0	39
frequency	***0.58***	*0.53*	*0.72*	*0.05*	*0*	*1.88*
unchanged (-1 to 1)	15	**240**	264	28	3	550
	0.72	***11.57***	*12.73*	*1.35*	*0.14*	*26.52*
up somewhat (1.1 to 3)	34	160	**805**	127	12	1,138
	1.64	*7.71*	***38.81***	*6.12*	*0.58*	*54.87*
up significantly (3.1 to 5)	8	22	124	**69**	19	242
	0.39	*1.06*	*5.98*	***3.33***	*0.92*	*11.67*
up very significantly (>5)	3	4	16	21	**61**	105
	0.14	*0.19*	*0.77*	*1.01*	***2.94***	*5.06*
total	72	437	1,224	246	95	2,074
	3.47	*21.07*	*59.02*	*11.86*	*4.58*	*100*

Notes: Firm inflation expectations are from the Atlanta Fed's Business Inflation Expectations Survey. The shaded areas correspond with a forecsat that falls within the ex post perceived unit cost growth.

A richer understanding of these results can be seen in forecast accuracy frequency tables. The above table shows how often a firm's (mean) unit-cost expectation lies within their respective range for perceived unit cost growth one year hence. We can see that a preponderance of the forecasts (roughly 56 percent) lie within the observed range. That share is roughly the same for the median (55 percent) and the mode (57 percent).

Table A2: Interval (Censored) Regression Results

Dependent variable: firm-level perceived inflation				
	Coefficient	Std. Err.	Z-score	p-value
Firm inflation expectation	**0.804*** **	0.015	55.200	0.000
Sales Gap (base level = "about normal")				
much less	-0.032	0.061	-0.520	0.603
somewhat less	**-0.137*** **	0.047	-2.920	0.003
somewhat greater	**0.199*** **	0.058	3.460	0.001
much greater	**0.635*** **	0.167	3.790	0.000
Margins Gap (base level = "about normal")				
less than normal	**0.145*** **	0.044	3.320	0.001
greater than normal	**-0.353*** **	0.066	-5.330	0.000
Constant	**0.171*** **	0.045	3.770	0.000
Observation summary:	364 left-censored observations			
	0 uncensored observations			
	241 right-censored observations			
	5397 interval observations			
Log-likelihood of fitted model= -6418.06				
Log-likelihood of model with just a constant= -7830.2161				
1 minus the ratio of the fitted/constant log-likelihood: 0.18				

Note: Interval regression results of observed inflation on inflation expectations (ucexp), the sales gap (dummy variables with the 3rd case--"normal sales levels"--omitted), and the margins gap (dummy variables with the middle case--"normal margins" omitted). *, **, *** denotes significance at the 10 percent, 5 percent, and 1 percent level, respectively.

Table A3: Predictions from ordered logit model vs actual firm unit cost growth

	Model's prediction for unit cost growth					
Firm observed unit cost growth	down (>-1)	unchanged (-1 to 1)	up somewhat (1.1 to 3)	up significantly (3.1 to 5)	up very significantly (>5)	total
down (>-1)	**39**	168	148	8	1	364
unchanged (-1 to 1)	17	**532**	842	4	1	1396
up somewhat (1.1 to 3)	12	265	**2977**	62	11	3,327
up significantly (3.1 to 5)	2	23	483	**145**	21	674
up very significantly (>5)	4	16	56	64	**101**	241
total	74	1004	4,506	283	135	6,002

Note: The model assigns a probability to each binned outcome for a given firm based on that firm's characteristics (inflation expectation, sales gap, and margins gap). This cross-tabulation shows how often the model assigns the highest probability to the correct observed firm unit cost growth bin. The cells along the diagonal are shaded gray to denote correct predictions.