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How Do Firms Form Their Expectations? New Survey Evidence[†]

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We survey New Zealand firms and document novel facts about their macroeconomic beliefs. There is widespread dispersion in beliefs about past and future macroeconomic conditions, especially inflation. This dispersion in beliefs is consistent with firms' incentives to collect and process information. Using experimental methods, we find that firms update their beliefs in a Bayesian manner when presented with new information about the economy and that changes in their beliefs affect their decisions. Inflation is not generally perceived as being important to business decisions so firms devote few resources to collecting and processing information about inflation. (*JEL* D22, D83, D84, E31, E52)

Central banks like the US Federal Reserve or the European Central Bank target inflation and employment rates, both of which depend on firm-level decisions. Because of their dynamic nature, the employment and pricing choices made by firms depend directly upon their expectations of future economic conditions. Measuring and understanding these expectations is therefore fundamental to the effective use of monetary policy. And yet, information on firms' beliefs is scant.[1] Economists have access to detailed surveys of consumers' expectations, along with those of professional forecasters, financial market participants, and even Federal Open Market Committee (FOMC) members. But comparable quantitative surveys of firms' beliefs are inexplicably lacking. As Bernanke (2007)

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[1] We refer to the beliefs of decision makers within firms as "firms' beliefs" as shorthand, with obvious abuse of terminology.

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

In this paper, we take a first step toward filling this gap by reporting results from a new large quantitative survey of firms in New Zealand. This survey provides detailed information about general managers' economic beliefs, including not just their expectations of future macroeconomic conditions but also their beliefs over recent economic dynamics. This allows us to characterize how closely firms pay attention to recent macroeconomic developments and whether inattention to recent economic conditions is reflected in firms' expectations of the future, as posited by models of information rigidities (e.g., Mankiw and Reis 2002, Woodford 2003, Sims 2003). We also study the determinants of firms' macroeconomic forecasts and backcasts, using a rich set of quantitative firm-level controls from the survey.

This survey of firms is unique in several ways. First is its quantitative nature. While some surveys of firms' expectations exist (e.g., Conference Board, Ifo), they tend to be primarily qualitative (e.g., "do you expect prices to rise, fall, or stay the same in the next twelve months?"), thus making it difficult to extract quantitative measures of expectations (Bachmann and Elstner 2015). In contrast, we extract *quantitative* answers from firms about their beliefs in the same manner as existing surveys of households' or professional forecasters' expectations. In addition, we ask firms to provide probability distributions for their forecasts so that we can examine not only distributions of point forecasts across respondents but also construct firm-level measures of uncertainty about the future path of macroeconomic variables.

Second, the survey covers a wide range of firms. The few quantitative surveys which include some firms (e.g., Livingston survey) consider only very large firms. Because these firms typically employ macroeconomists on staff who are likely to be the respondents of any such survey, the reported forecasts mimic those of professional forecasters. But it is unclear whether these reported forecasts are in any way characteristic of other agents in the firm or are utilized in actual economic decisions made by the firm. In contrast, our survey includes both small- and medium-sized firms, with respondents being the general managers of each firm.

Third, we ask firms not only about their expectations of future economic outcomes but also their beliefs about recent economic conditions. Given that macroeconomic data are readily available to firms, this allows us to study how attentive firms are to macroeconomic developments as well as what factors determine how much attention firms devote to tracking macroeconomic conditions. Such potential factors include differences by industry, age, size, number of competitors, access to international markets, or the expected duration until the next price change, among many others that we collect in the survey.

Fourth, there are multiple waves to the survey. We conducted three follow-up surveys of firms from the first wave, yielding a panel dimension to the survey which contrasts with repeated cross sections in typical surveys of economic agents and allows us to study the evolution of firms' beliefs about past, current, and future economic conditions. We also use follow-up surveys to verify the accuracy of firms' responses. In addition to these four waves, we conducted another two waves using a combination of new firms as well as some firms from the original panel. The combined surveys cover the period 2013:IV until 2016:IV.

After verifying the high quality of these data, we document a number of new stylized facts about the macroeconomic beliefs held by those agents in charge of running firms. First, managers' average forecasts of inflation have been systematically higher than actual inflation over this period. However, this gap has declined over time as the price of petrol fell in New Zealand, which is consistent with the comovement of oil prices and households' inflation expectations in the United States (Coibion and Gorodnichenko 2015a). Managers' expectations also display much more cross-sectional disagreement than among professional forecasters, despite the fact that New Zealand was the first country to implement formal inflation targeting in 1989 and has experienced relatively low inflation since then. While there is similar heterogeneity in the managers' forecasts of other economic variables (such as unemployment or GDP growth), managers' forecasts of aggregate inflation are unique in their asymmetry. This feature is not due to the specific formulation of the questions: results are similar regardless of whether we ask managers about overall prices or Consumer Price Index (CPI) inflation or whether we ask for point forecasts or distributions. The asymmetry is absent, however, when we ask managers about prices in their industry, suggesting that aggregate inflation is unique in terms of agents' knowledge and understanding.

Second, we find that there is just as much dispersion in managers' perceptions of recent conditions as there is in their forecasts of future conditions. Furthermore, the two are strongly correlated: managers who believe that inflation has been high in the last year are much more likely to expect inflation to be high in the future. This suggests that inattention to recent conditions is a primary source of differences in expectations. Firms which are "informed" about recent inflation rates not only tend to report inflation forecasts much closer to ex post true values than do "uninformed" firms, they also tend to do so with more confidence. But being "informed" is not time-invariant: firms classified as "informed" in the first wave of the survey display a similar distribution of inflation forecasts by the fourth wave as do firms originally classified as "uninformed."

Third, given the richness of firm, industry, and manager-specific information in the survey, we can study the sources of variation in inattention across firms. Focusing on errors made by managers about recent inflation, we find that the characteristics of the manager account for very little of the variation in beliefs about recent inflation. Instead, we find robust evidence that firms' inattentiveness to recent macroeconomic information is systematically related to their incentives to process or track such information: firms which face more competitors and firms which expect to change their prices sooner are more likely to be better informed than firms with fewer competitors or those which do not expect to change their prices in the near future. In the same spirit, firms with steeper average profit functions (for whom information is more valuable) also tend to have better information. These patterns are consistent with rational inattention explanations of agents' expectations formation process, as in Sims (2003), Reis (2006), Mackowiak and Wiederholt (2009), and Afrouzi (2016). In addition, because the persistence of inattention, measured with backcast errors of different variables, can be mapped into underlying levels of information rigidity, our results speak to the economic significance of these frictions. We find very high levels of persistence in backcast errors, implying high levels of information rigidity of the same order as those found by Coibion and Gorodnichenko (2012) for the United States.

Fourth, we use novel experiments in which managers are provided with new information to assess how their beliefs respond to new information, both on impact and over longer periods, as well as whether these changes in their beliefs affect their actions. The first experiment, done in the fourth wave of the survey, provided random subsets of firms with additional information about recent macroeconomic variables, forecasts of professional forecasters, the value of the central bank's inflation target, or the average forecast of other firms in the survey. Firms were asked to quantify their forecasts and the uncertainty around their forecasts prior to this information being revealed, then were asked for new forecasts after the additional information was provided to them. Consistent with models of Bayesian learning, firms immediately and systematically adjusted their forecasts in response to this new information and did so in the expected direction. The responses to information about inflation were generally stronger than those for information about GDP growth or unemployment and were particularly large in response to information about the central bank's inflation target. Also consistent with Bayesian learning is the fact that those firms with higher levels of a priori uncertainty revised their forecasts by more than did firms that were more confident in their forecasts. This novel experimental evidence supports the notion that firms update their beliefs as in noisy information models and suggests that firms' inflation forecasts are particularly sensitive to new information.

In the second experiment, implemented in the fifth and sixth waves of the survey, a subset of firms were provided with information about the central bank's inflation target. Relative to a control group, the firms that were initially poorly informed about the Reserve Bank of New Zealand's (RBNZ) inflation target immediately reduced both their short-run and long-run inflation forecasts but did not materially change their views about other macroeconomic variables. When surveyed again six months later, their short-run forecasts of inflation were indistinguishable from those of the control group, but their long-run forecasts remained slightly lower. This implies that even credible information that significantly affects agents' expectations on impact has only transitory effects on their views of the economy. Despite this short-lived effect on expectations, the firms which received the information and lowered their inflation expectations significantly reduced their employment and investment relative to what they were planning before the information was provided and relative to the control group. Their prices and wages, in contrast, were on average unchanged relative to their initial plans. This implies that policies which successfully affect managers' inflation expectations are likely to have real effects, but doing so requires communication strategies that break through the veil of inattention that pervades managers' views about aggregate inflation.

To address this point, we explore how firms seek out and process macroeconomic information. Rational inattention models suggest that agents should devote more resources to tracking variables which affect their profits or utility more. The survey asked firms to rank macroeconomic variables in terms of their importance for their business decisions. Consistent with rational inattention models, firms make systematically smaller errors about recent values of the variables that are important to their business decisions and report less uncertainty about them. There is also a strong correlation between the variables that firms identify as being important to business decisions and those which they track. Strikingly, well under half of firms report

that they track inflation (whereas 80 percent report tracking GDP) and the average inflation backcast errors of these firms are five times larger on average than those made by firms which track inflation. One likely reason why some firms' inflation forecast errors are so large may therefore be that these firms do not view aggregate inflation as being as important to their business as other macroeconomic variables and devote relatively fewer resources to tracking inflation's evolution. Another prediction of models with endogenous acquisition of information is that strategic complementarities should induce firms to focus relatively more on public signals. We find a strong positive correlation between the degree of strategic complementarity in price setting of firms and their preference for receiving public over private signals, which is in agreement with predictions of Hellwig and Veldkamp (2009). Higher strategic complementarity is also positively associated with firms preferring to wait for other firms to change their prices first when facing uncertainty, consistent with Gorodnichenko (2008). Hence, the predictions of models with endogenous acquisition of information also receive support in the survey data. However, at odds with standard models, managers report a striking asymmetry in how they would respond to positive versus negative news about the economy on TV: over 70 percent of firms would seek out more information if the economic news were negative, while less than 30 percent would do so if the news were positive. This cyclicality is consistent with empirical evidence in Coibion and Gorodnichenko (2015b) and points toward important state-dependence in the acquisition and processing of information by firms, as in Gorodnichenko (2008) or Alvarez, Lippi, and Paciello (2011).

Our results build on a growing literature studying the properties of agents' expectations. Theoretical work has long found that departures from full-information rational expectations can have profound consequences for economic dynamics and optimal policy (e.g., Lucas 1972). More recent work has studied the empirical properties of agents' expectations and how these relate to different models of the expectations formation process. Mankiw, Reis, and Wolfers (2003), for example, document that the dispersion in US households' inflation forecasts is much larger than that of professional forecasters. Carroll (2003) studies the transmission of macroeconomic information from professional forecasters to households. Coibion and Gorodnichenko (2012) estimate the rates at which different agents' forecast errors respond to structural shocks while Coibion and Gorodnichenko (2015b) test for predictability of forecast errors from past forecast revisions as implied by models of imperfect information. Andrade and LeBihan (2013) assess the ability of imperfect information models to match key facts of the expectations of professional forecasters. Carvalho and Nechio (2014) find that many households report expectations that are inconsistent with monetary policy actions. This line of research has documented pervasive and systematic deviations from full-information rational expectations, with much of the empirical evidence being consistent with models of inattentiveness.

We differ from this previous work in that we implement and study the results of a new survey of firms' macroeconomic expectations, whereas previous research has relied primarily on forecasts of households (such as from the Michigan Survey of Consumers), professional forecasters (Survey of Professional Forecasters, Consensus Economics surveys), financial market participants (expectations extracted from asset prices), or policymakers (Greenbooks, FOMC member forecasts). Our work also contrasts with previous studies in combining surveys and experiments so

that we can draw causal inferences, while previous work generally documents correlations. Like this prior work, we find pervasive departures from full-information rational expectations but now for the case of firms. In addition, we document not only the heterogeneity in firms' beliefs about future macroeconomic outcomes but also dramatic differences in their perceptions of recent economic developments, a key feature of imperfect information models. Furthermore, and again consistent with predictions of rational inattention models, we find systematic evidence that the quality of firms' information about macroeconomic conditions in part reflects their incentives to track and process such information, as in, e.g., Gorodnichenko (2008) or Alvarez, Lippi, and Paciello (2011). We therefore interpret our results as not only filling an important gap in the literature by studying quantitative measures of firms' expectations but also as providing some of the most direct evidence for rational inattention motives in the setting of agents' macroeconomic expectations.

Our results contribute to the growing literature on nontraditional monetary policy tools (especially forward guidance) and the ways in which they may affect economic outcomes. In traditional New Keynesian models, long-run expectations are well anchored to the central bank's target and announcements about future monetary policies have immediate and large economic effects at the zero-bound as they shape short-run inflation and other economic expectations (see Krugman 1998, Eggertsson and Woodford 2003). Our results call for caution in taking these results at face value. While our experimental evidence does suggest that changes in firms' inflation expectations directly affect their economic decisions, breaking through the firms' veil of inattention is likely to be difficult. First, most managers do not view inflation as being a major consideration in their business decisions and devote few resources to tracking it, so transmitting information to them about new monetary policies will likely require more aggressive communication strategies. Second, our experimental evidence suggests that exogenously provided information about the central bank's inflation target is quickly tossed aside by managers, so central bankers should expect any changes in expectations to be transitory unless they engage in long-lived communications campaigns. Monetary policymakers' success in achieving low and stable inflation in countries like the United States and New Zealand may therefore have inadvertently made their own lives more difficult by inducing managers to turn their attention away from inflation and other aggregate risks.

The paper is organized as follows. Section I describes how the survey was implemented as well as evidence on the quality of firms' responses to survey questions. Section II describes basic results from the survey such as the mean forecasts and backcasts of firms for macroeconomic variables. Section III focuses in more detail on firms' attentiveness to recent macroeconomic developments. Section IV considers how firms update their beliefs in response to new information and how this maps into their decisions. Section V provides additional results on how firms seek out and process information about macroeconomic conditions. Finally, Section VI concludes by discussing some implications of these results.

I. Implementation of the Survey and Quality Control

In this section, we first describe the way in which the survey was implemented (sampling frame, response rates, etc.). We also assess the quality of the responses

provided by firms. We find that the quality of the survey is quite high: "error" rates hover between 1 and 5 percent.

A. *Implementation of the Survey*

The survey of firms in New Zealand was done in six waves. The first and largest wave was implemented between September 2013 and January 2014 and included 3,144 firms. Subsets of these firms were then surveyed again for each of the next three waves, which occurred in 2014:I (712 firms), 2014:III (1,601 firms), and 2014:IV (1,257 firms), respectively. In the fifth wave, conducted in 2016:II, we randomly selected some firms from the first wave to participate as well as new previously-uncontacted firms, yielding a total of 2,040 firms of which 150 had participated in at least the first wave and the rest had not participated in any wave. The sixth wave, in 2016:IV, contained 1,404 firms, all of which had participated in the fifth wave.

As described in more detail in online Appendix 1, the selection of firms for participation in the first wave was implemented as follows (new firms for the fifth wave were selected in the same way). We first combined two directories of firms in New Zealand: Kompass New Zealand (KNZ) and Knowledge Management Services (KMS). Around 10,000 firms were selected from the former and an additional 5,000 new firms from the latter.[2] Both directories were purchased and contain comprehensive profiles of New Zealand businesses including their activities, brands, management, products, and services. Firms come from four broad industrial groups: manufacturing, retail and wholesale trade, construction and transportation, and professional and financial services, where sectors are defined according to the Australia and New Zealand Standard Industrial Classification 2006 (ANZSIC06). Following the standard classification of New Zealand firms, firm size within each industry is classified as small (6–19 workers), medium (20–49 workers), and large (50 or more workers).

Since manufacturing and professional and financial services account for relatively large shares of New Zealand's GDP (Statistics NZ 2012), we aimed to have two-thirds of our sample from these two industries. The remaining one-third is a combination of firms from other industries. We excluded industries related to the government, community service, agriculture, fishing and mining, and energy, gas, and water from the sample. These sectors are often dominated by a few extensively-regulated firms or by very small firms.

The general managers of the approximately 15,000 firms were emailed the information sheet and questionnaire about ten days before receiving a phone call to collect their responses, giving them time to consider their participation.[3] The phone survey occurred as follows: a research assistant (RA) called the general manager and asked questions. The RA recorded the answers in the questionnaire by hand and also recorded the responses in the phone. An independent RA then confirmed that

[2] KNZ contains information about 15,000 firms, but approximately 5,000 have less than 6 employees or annual GST turnover less than NZ$30,000, which are cutoffs that we impose for inclusion in the sample. The KMS directory contains around 30,000 firms and we randomly selected around 5,000 new firms not included in the KNZ directory.

[3] The most frequently mentioned reason for not participating was a concern for confidentiality, and especially an unwillingness to answer questions on total production value and capacity, as well as questions about profit margins. In wave 1, there were 394 incomplete surveys. We drop these firms from our sample.

the answers written in the questionnaire corresponded to the recorded responses in the phone. To maintain confidentiality of the participants and information, the phone records were deleted at the end of the survey. The collected data were verified by two independent RAs. Specifically, they checked whether the spreadsheet responses matched the answers in the hard copy questionnaire. Responses that were observable outliers were deleted from the sample; for instance, a firm that claims to have employed around 300 workers and sells about $10,000 worth of goods in three months. At the onset, we ran a pilot survey of 60 firms (which are not included in the main survey) to verify whether the questions made sense to firms or if there were some questions which they systematically refused to answer. The response rate for the first wave was approximately 20 percent, with 3,144 managers completing the survey. The response rate of new firms for the fifth wave was 14 percent. For waves 2–4 and 6, response rates were 23, 51, 40, and 69 percent respectively from the previous pool of firms.[4]

In addition to the four main industries (which constitute a slightly more aggregated grouping than SIC1), we also consider more disaggregated classifications, which we will refer to as "sub-industries," and which are more aggregated than SIC2 (online Appendix 2 describes ANZSIC codes associated with each sub-industry). This level of aggregation ensures that each sub-industry has more than 100 firms in the first wave of the survey. The construction and transportation industry is not further decomposed as this sector contains significantly fewer firms in the survey than other industries. We construct sampling weights for firms in each wave of the survey at the level of the sub-industry/firm-size cell to correct for any discrepancies between the distribution of employment by firms in our sample relative to the population of employment by firms in New Zealand.

Online Appendix Table 1.5.1 presents some summary characteristics about firms in the first wave of the sample. The average age of firms in our sample is 14.5 years and the average number of employees is just under 30. Both mask substantial underlying heterogeneity. For example, the largest firm in this sample has just under 700 employees. The combined employment of firms in the first wave represents about 5 percent of total employment in New Zealand. The share of total revenues going to labor costs varies significantly across sectors but averages nearly 50 percent across all firms in the survey, with significantly lower shares in manufacturing firms and significantly higher shares in professional services. The share of revenues from foreign sales also varies widely: manufacturing firms have much higher shares of revenues coming from abroad than do other firms. Firms in professional and business services reported significantly higher margins both on average and at the time of the first survey than did firms in other industries, with finance having the largest average margin while construction and transportation firms report the lowest average margins. Firms in all industries reported that margins at the time were below historical margins.

The set of questions varies across survey waves. A significant portion of the first wave was devoted to price setting and information collection decisions

[4] In online Appendix 1, we document that attrition of firms from wave 1 to waves 2, 3, 4 is not explained by observable characteristics of firms. We find a similar result for attrition from wave 5 to wave 6. Thus, nonparticipating firms are missing approximately at random.

by firms. For example, we asked firms how frequently they formally review their prices (e.g., weekly, monthly, quarterly, etc.). The average duration between price reviews for all firms is 7.4 months, with much higher durations in construction and transportation (almost 11 months) and non-food retailing (over 11 months). We also asked firms when they expected to change the price of their main product and by how much. The average firm reported an expectation of nearly six months before their next price change, which would be a 5.6 percent increase in price on average. Within industries, sectors in which firms report longer durations until their next price change also report, on average, larger expected price changes. While some of the questions are repeated across two or more waves, each wave generally included a new set of questions. For example, the second wave expanded the set of macroeconomic variables which firms were asked about, the third wave primarily focused on collecting individual characteristics of the respondent (e.g., age, income, education), and the fourth wave explored how firms acquire and process new information. The fifth and sixth waves focused primarily on an experiment designed to assess whether firms' economic decisions are affected by changes in their beliefs about aggregate inflation. We provide specific questions used from each wave in online Appendix 5.

B. *Assessing the Quality of the Survey Data*

Because firms have no direct incentive to participate in the survey or to provide thoughtful or truthful answers, one may be concerned about the quality of the responses to the questions. To ascertain the quality of the survey responses, we considered a number of checks.

The first is to directly verify the quality of those responses which can be checked against other sources. We do so in a number of ways (see online Appendix 4 for a full description). For example, respondents were asked about the age of their firm. Since firms must be registered with the government, we can check administrative records to verify whether the reported age of the firm and administrative records conform. We performed this check for all firms in the survey and found that, for 87 percent of the firms in the sample, the reported age of the firm conformed to administrative records. Similarly, we can compare what managers report for the price of their main product against what the company websites report online. For the 245 randomly-selected firms for which we could either identify prices on their websites or via direct online inquiry, only nine reported prices different from those in the follow-up survey, an "error" rate of 3.7 percent. For another randomly-selected subset of managers, we checked whether their responses about their position, qualifications, and experiences were consistent with the publicly available data about them and found a very strong match with the survey responses ($\approx$99 percent).

In addition to verifying firms' survey responses against outside sources, we can also assess the internal consistency of their responses. For example, the survey includes a question about the *average* frequency at which firms review their prices, which we convert to an average number of months between price reviews, and also includes questions about their actual prices over the previous 12 months. As illustrated in online Appendix 1, longer durations between price reviews are negatively related to the number of price changes reported by firms for the previous 12 months.

We can also verify whether firms report the same answers in response to the same question across the two surveys. For example, managers are asked about the average frequency of price reviews in two different waves. Regressing one response on the other yields a coefficient that is indistinguishable from 1, and an extremely high R^2, consistent with very low reporting errors. Similarly, managers asked about their prices for overlapping periods in different waves give consistent answers over time.

Ultimately, because we will focus on firms' beliefs about macroeconomic conditions, we would like to verify the quality of reported expectations of firms. We can do so using two survey questions. First, we asked firms in the first wave in how many months they expected to next change their price. Given that the second wave includes reported price changes since the main survey, we can therefore verify whether firms that expected to change their prices soon did so at a higher frequency than firms that expected not to change their prices for an extended period. For each firm, we determine whether the firm changed its price between the first and second waves, by comparing the "current" price in the second wave with either the "current price" from the first wave or the three- or six-month prior price in the second wave. We then construct the fraction of firms that changed their price within each bin of possible durations until next price change reported in the first wave. As illustrated in panel A of Figure 1, for firms that expected to change their price within the next four months at the time of the first wave, approximately 90 percent did indeed change their price by the time of the second wave. For firms that originally expected not to change their price for at least seven months, almost none of the firms changed their price (exactly none when price changes are measured relative to the price from the main survey). In between four and seven months of expected price duration, there is a sharply falling share of firms which changed their prices, consistent with the time difference between the surveys. Hence, firms' original answers about when they next expected to change their prices have very strong predictive power for their ex post decisions about whether to change prices.

One possible limitation of this test is that if firms change their prices at very fixed frequencies (as in Taylor 1980), then their ability to predict the date of the next price change may not be very informative about the quality of their expectations. An alternative test is to examine their expectation of the *size* of their next price change. We do so in panel B of Figure 1, which plots the expected percentage price change reported in the first wave against actual price changes (percentage difference between "current" prices in the second wave and "current" prices in the first wave). Note that these can differ because firms changed prices by a different amount than expected or changed them more than once. Nonetheless, there is a strikingly strong correlation between the ex ante expectation of firms about the amount by which they will change their prices and their ex post price changes from the follow-up survey, with most of the observations lying very close to the 45-degree line.[5] These results are therefore consistent with firms reporting their true expectations in the survey.[6]

[5] Panel D of online Appendix Table 1.3.1 confirms the fact that the estimated slope of the relationship is not statistically different from 1.

[6] Low predictability of subsequent outcomes from ex ante expectations would not necessarily imply that expectations are poorly measured, since there could be shocks occurring after expectations are formed that would lead to different decisions ex post relative to those anticipated ex ante. But the fact that there is high predictability of ex post outcomes from ex ante expectations requires the expectations measures to be of high quality.

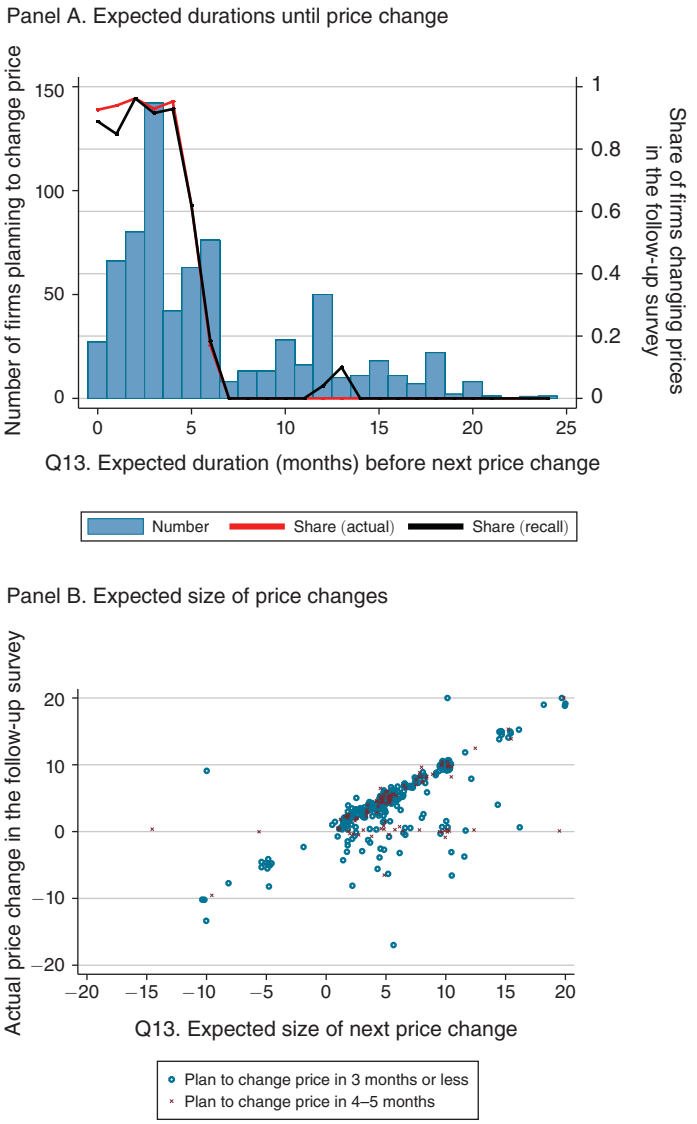

FIGURE 1. FIRMS' EXPECTED AND ACTUAL PRICE CHANGES

Notes: In panel A, the bars (left axis) show the number of firms reporting a given expected duration before next price change in the first wave. The lines show the fraction of firms that actually adjusted their prices between the first and second waves, grouped by each duration. The red line measures changes in prices as the difference in current prices reported in the two waves. The black line measures changes in prices as the change between the current price reported in the second wave and the previous price reported in the second wave. The previous price is the price three months ago for firms surveyed in December 2013 or January 2014 and six months ago for firms surveyed in September 2013, October 2013, or November 2013. Panel B plots firms' expectation of the size of their next price change (in percent) as reported in the first wave (x-axis) versus firms' actual percentage change in price between the first and second waves (y-axis) for firms that reported that they expected to change prices within the next five months. Circles and crosses indicate the expected duration (reported in the first wave) before the next price change. See Section I for details.

While one should always bear in mind the limitations of survey data, these results suggest that the quality of this survey data is quite high. For questions which can be independently verified against external sources, we find high consistency

Table 1—Macroeconomic Forecasts of Firms and Other Economic Agents

	Central bank	Professional forecasters		Households		Firms	
		Mean	SD	Mean	SD	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. 2013:IV (*wave 1, number of observations: 3,144*)							
Inflation	1.3	2.0	0.2	3.6	2.4	5.3	3.2
Panel B. 2014:I (*wave 2, number of observations: 712*)							
Inflation	1.9	2.0	0.3	3.7	2.1	6.1	2.7
Unemployment	4.9	5.3	0.3	NA	NA	5.2	0.7
GDP growth	3.5	3.4	0.5	NA	NA	3.1	0.7
Panel C. 2014:III (*wave 3, number of observations: 1,601*)							
Inflation	1.6	1.9	0.2	3.5	2.4	4.1	2.5
Panel D. 2014:IV (*wave 4, number of observations: 1,257*)							
Inflation	1.1	1.7	0.3	3.1	2.0	4.5	2.8
Unemployment	5.2	5.2	0.3	NA	NA	5.9	1.2
GDP growth	3.5	3.0	0.3	NA	NA	3.6	1.0
Panel E. 2016:II (*wave 5, number of observations: 2,040*)							
Inflation	1.6	1.3	0.2	2.3	2.1	2.8	2.3
Unemployment	5.2	5.5	0.2	NA	NA	5.5	0.6
GDP growth	3.4	2.6	0.3	NA	NA	2.7	0.5
Panel F. 2016:IV (*wave 6, number of observations: 1,404*)							
Inflation	1.7	1.6	0.2	2.8	2.6	2.7	2.4
Unemployment	4.7	4.8	0.3	NA	NA	5.5	0.6
GDP growth	3.4	3.0	0.4	NA	NA	2.4	0.6

Notes: The table reports recent 12-month-ahead forecasts and the dispersion in forecasts of different macroeconomic variables for different agents. Inflation refers to annual changes in prices (CPI when specified), unemployment refers to the unemployment rate at a specific quarter, GDP growth refers to annual changes in real GDP. Central bank forecasts are from Monetary Policy Statements of the Reserve Bank of New Zealand. Professional forecasters are from Consensus Economics. Households are from the Reserve Bank of New Zealand's Survey of Households. The inflation forecasts of households are trimmed by the Reserve Bank of New Zealand and exclude all forecasts of inflation above 15 and below −2 percent, so same trimming is applied to firms' inflation forecasts for comparison. Other firm forecasts are unadjusted. Moments for firms and households are calculated using sampling weights. See Section IIA for details.

between responses and outside sources. There is also high consistency across related questions within the survey, e.g., firms which review their prices frequently also change prices more frequently on average. Finally, firms' responses about their expectations also line up very closely with their subsequent actions, suggesting that we can be confident about the quality of respondents' answers about their beliefs and that firms' actions are based on these beliefs.

II. Baseline Results of the Survey

In Table 1, we report means and standard deviations of macroeconomic forecasts, both from firms in our survey as well as other agents' forecasts for New Zealand over the same periods. At the time of the first wave, in December 2013, the Reserve Bank of New Zealand was predicting that annual CPI inflation for September 2014 would be 1.3 percent, just slightly below the 1.5 percent annual CPI inflation rate experienced over the preceding 12 months. Professional forecasters included in the December 2013 Consensus Economics survey for New Zealand were forecasting

annual CPI inflation of 2.0 percent over the next 12 months. The cross-sectional standard deviation of these forecasts was very low, at 0.2 percent, indicating widespread agreement among professional forecasters about the likely future dynamics of inflation. Household forecasts of 1-year-ahead annual inflation are available from a quarterly survey of 1,000 households run by the Reserve Bank of New Zealand. Reported values from this survey are trimmed, dropping all inflation forecasts above 15 percent and below −2 percent. In the December 2013 survey, households in New Zealand were on average forecasting an inflation rate of 3.4 percent, with a much higher level of disagreement indicated by a cross-sectional standard deviation of 2.0 percentage points. The much wider disagreement in inflation forecasts among households than for professional forecasters has been widely documented in the literature, especially for the United States (e.g., Mankiw, Reis, and Wolfers 2003). The higher mean of household inflation forecasts, which is also observed in the United States over the same time period, is another unique characteristic of household forecasts, although this difference is not always historically present.

The mean forecast of inflation among firms, after applying the same trimming procedure as that used for households, was 5.3 percent, with a cross-sectional standard deviation of 3.1 percentage points. Thus, firms in New Zealand, at least during this time period, exhibited the same upward bias in inflation forecasts as households relative to professional forecasters and the same characteristic of widespread disagreement. This is despite nearly 25 years of official inflation targeting on the part of the Reserve Bank of New Zealand. These large disparities in means and dispersion also suggest that professional forecasts are unlikely to be representative of firms' macroeconomic beliefs. The same qualitative results obtain using the subsequent waves: the mean forecast and the standard deviation of firm inflation beliefs remain significantly higher than what is observed for professional forecasters. However, by the final two waves in 2016, firms' inflation forecasts had declined to under 3 percent, as had those of households.[7] As illustrated in panel B of Figure 2, these short-run swings in inflation expectations coincide closely with the large decline in the level of gasoline prices, a feature that has previously been documented in the case of US households (Coibion and Gorodnichenko 2015a).

Table 1 also reports means and standard deviations of forecasts from waves 2, 4, 5, and 6 for other macroeconomic variables, including the unemployment rate and the growth rate of real GDP. Unfortunately, no household forecasts of these variables are available for households in New Zealand, so we can only compare forecasts of firms to those of professional forecasters and the Reserve Bank of New Zealand. For unemployment rates, the Reserve Bank of New Zealand projected in its March 2014 Monetary Policy Report that the unemployment rate in March 2015 would decline to 4.9 percent, from its value of 6.0 percent in December 2013. Professional forecasters in March 2014 were predicting an unemployment rate of 5.3 percent, again with very little disagreement as displayed by a standard deviation of only 0.3 percentage points. In contrast, while firms in the second wave were predicting a mean unemployment rate 12 months later of 5.2 percent, there was

[7] This finding is not driven by the presence of new firms in the sample or prior firms "learning" from their repeated participation in the survey. We find no meaningful difference in the forecasts of newly incorporated firms relative to those who participated in previous waves.

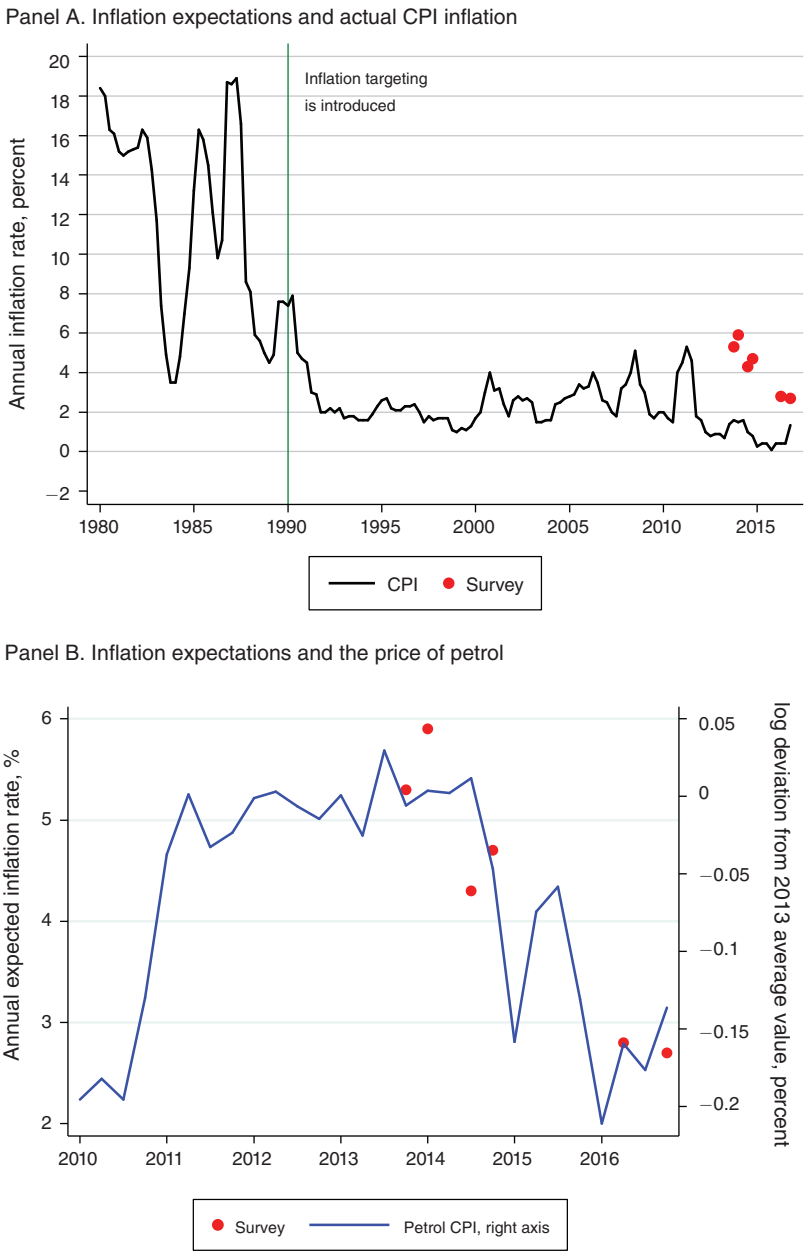

FIGURE 2. INFLATION IN NEW ZEALAND

Notes: The figure plots annual CPI inflation in New Zealand, price for petrol products (measured as log percent deviation from the average price in 2013), and mean inflation expectations reported in six survey waves.

again much more disagreement among firms than professionals, with a standard deviation of firm forecasts of 1.2 percentage points. Very similar results obtain for the expected annual growth in real GDP over the next 12 months and in subsequent waves for these variables: mean forecasts of firms and professionals are similar, but

the disagreement among firms is larger. Nonetheless, it is clear that inflation forecasts present the largest disparities between firms and professionals.

Why do firms' inflation forecasts have such different characteristics than those of professionals? One possibility is that managers are not predicting aggregate prices but rather the prices of their own consumption bundles. Consistent with this, previous work has found that the responses of households are sensitive to whether questions about inflation are framed as being about "prices overall in the economy" (as in the Michigan Survey of Consumers) or more specifically about "inflation" or a specific price index (Bruine de Bruin et al. 2012 and Dräger and Fritsche 2013). To investigate this conjecture, managers in the fifth wave randomly received different wording for inflation questions.[8] One-third (approximately 500 firms) were surveyed using the term "prices overall," one-third were asked about "overall inflation," and the remaining third were asked about "inflation (*specifically the Consumer Price Index*)." As documented in online Appendix 3, we find no difference in either the mean or dispersion of inflation forecasts across these different groups of firms, in contrast to previous results found for households.[9] Hence, the properties of managers' inflation forecasts that we document are *not* driven by the specific language used. A related possibility is that point forecasts may be biased or unduly dispersed if respondents round their answers. One alternative, as suggested by Engelberg, Manski, and Williams (2009), is to ask respondents to assign probabilities to a set of possible outcomes. Managers in the fifth wave were asked to assign probabilities to different inflation outcomes (with randomly selected participants receiving different bin sizes), but as documented in more detail in online Appendix 3, their answers to these questions are consistent with their point forecasts. For example, the mean point forecast of inflation in 2016:II was 2.8 percent with a cross-sectional dispersion of 2.3 percentage points while the equivalents using bin-based questions are 2.6 and 2.5 percent. Similar results obtain in other waves in which distributional questions were asked and also hold for other macroeconomic variables. The properties of managers' inflation forecasts therefore are insensitive to the use of either distributional or point forecasts.

While the specific wording used to characterize aggregate inflation or the manner in which respondents are asked to provide their answers matter little for the results, whether managers are asked about aggregate conditions or what their own firm will do yield very different results. For example, firms in the survey were asked how much they expect to change their prices or by how much they expect their unit costs to change. As documented in online Appendix 3, the correlation between their answers to these questions and their expectations about *aggregate* inflation is essentially zero in this specific survey. This means that correctly measuring firms' expectations of aggregate inflation requires the survey to explicitly ask firms about their expectations about aggregate inflation, and that one should be wary of drawing

[8] The standard wording of the question we use is "During the next twelve months, by how much do you think prices will change overall in the economy? Please provide an answer in percentage terms," which follows the wording used in the Michigan Survey of Consumers.

[9] Kumar et al. (2015) document additional differences between the forecasts of managers in the New Zealand survey and those of households. For example, whereas many households cannot define inflation, Kumar et al. (2015) find that 86 percent of firm managers who were asked could correctly explain what inflation means. In addition, managers believed that statistical agencies were credible in measuring price changes (86 percent).

any immediate inference about their aggregate expectations from their expectations over their own price changes or unit costs. Some surveys of firms, such as the Business Inflation Expectations survey of the Federal Reserve Bank of Atlanta, ask firms only about expectations over their own unit costs rather than about aggregate inflation. While firms' expectations of their own prices and costs are interesting in their own right, the absence of any strong correlation between the two in our survey suggests that these surveys are uninformative about firms' beliefs about *aggregate* inflation.

There is very little other evidence on firm forecasts to compare these results to. In September 2014, the Federal Reserve Bank of Atlanta surveyed selected US firms and found that their mean forecast of aggregate inflation was 4.4 percent, with a cross-sectional standard deviation of 4.2 percentage points (Bryan, Meyer, and Parker 2015), while US households were predicting an average of 3.7 percent, with a cross-sectional standard deviation of 3.5 percentage points, very similar to our results in New Zealand. In contrast, a new survey of firms in Iran, where inflation has been high and volatile, finds firms there to be relatively more informed about aggregate inflation dynamics (Central Bank of Iran 2016). Coibion and Gorodnichenko (2015c) find that the inflation forecasts of firms in Ukraine, where inflation has also been high and volatile, have tracked actual inflation closely. This suggests that the history of low and stable inflation in inflation targeting countries in the United States and New Zealand may be reducing the incentives of managers to pay close attention to actual inflation. A similar result for households is documented by Cavallo, Cruces, and Perez-Truglia (2017), finding that households in high-inflation Argentina are more informed about aggregate inflation than households in the United States.

Consistent with this interpretation, we find (Table 2) that the amount of disagreement among firms about *recent* inflation dynamics (over the last 12 months) is of the same order of magnitude as the disagreement in their forecasts of future inflation, with mean beliefs about recent inflation tracking mean beliefs about future inflation across surveys. Similar results hold for other macroeconomic variables. One possibility is thus that managers are optimally *choosing* to not be as well informed about recent macroeconomic conditions as professional forecasters, and that the resulting misinformation about recent economic dynamics affects their views about the future.

III. (In)Attentiveness to Current and Recent Economic Conditions

An unusual dimension of the survey is that we ask firms about their beliefs regarding *recent* macroeconomic conditions. Whereas full-information rational expectations models assume that agents can immediately observe economic developments, models of inattention imply that agents find it optimal to limit the resources they devote to tracking information about the economy, leading to imperfect information about current and past economic conditions. The questions in the survey about perceptions of recent and current economic conditions can therefore provide a metric to evaluate the amount of inattention to aggregate economic conditions on the part of firms. In this section, we first document how beliefs about the past shape beliefs about the future, then discuss possible sources of firms' inattention to recent economic conditions.

Table 2—Recent Values and Nowcasts of Firms and Other Economic Agents

	Recent data	Households		Firms	
		Mean	SD	Mean	SD
	(1)	(2)	(3)	(4)	(5)
Panel A. 2013:IV (*wave 1, number of observations: 3,144*)					
Inflation	1.4	3.1	2.0	4.4	3.5
Panel B. 2014:I (*wave 2, number of observations: 712*)					
Inflation	1.6	2.9	1.8	5.5	3.3
Unemployment	5.6	NA	NA	6.5	1.4
Panel C. 2014:III (*wave 3, number of observations: 1,601*)					
Inflation	1.6	2.9	2.0	NA	NA
Panel D. 2014:IV (*wave 4, number of observations: 1,257*)					
Inflation	1.0	2.9	2.2	3.9	2.4
Unemployment	5.2	NA	NA	6.1	1.2
GDP growth	3.4	NA	NA	3.7	1.2
Panel E. 2016:II (*wave 5, number of observations: 2,040*)					
Inflation	0.4	1.8	1.5	2.6	2.1
Panel F. 2016:IV (*wave 6, number of observations: 1,404*)					
Inflation	0.4	2.4	2.4	NA	NA

Notes: The table reports recent values and nowcasts/backcasts as well as the dispersion in nowcasts of different macroeconomic variables for different agents. Inflation refers to annual changes in prices (CPI when specified) over the past 12 months, unemployment refers to the unemployment rate in that quarter, GDP growth refers to annual changes in real GDP. Households are from the Reserve Bank of New Zealand's Survey of Households. The inflation nowcasts of households are trimmed by the Reserve Bank of New Zealand and exclude all nowcasts of inflation above 15 and below −2 percent, so same trimming is applied to firms' inflation nowcasts for comparison. Other firm nowcasts are unadjusted. Moments for firms and households are calculated using sampling weights. See Section IIA for details.

A. *Beliefs about the Past and Beliefs about the Future*

To understand the link between managers' beliefs about the recent past and their forecasts of future events, we exploit the fact that our survey provides each individual's backcasts/nowcasts of a variety of macroeconomic variables and their forecasts of these variables. Jonung (1981) documents that in a survey of Swedish households from 1978, those households who believed recent inflation to have been higher than other households also tended to have higher forecasts of future inflation. Armantier et al. (2016) find similar patterns in a 2011 survey of US households. We follow this previous work using forecasts and backcasts and estimate the following regressions:

$$F_t^i x_{t+12} = \alpha + \beta B_t^i x_t + \delta_j + error, \tag{1}$$

where $F_t^i x_{t+12}$ denotes the 12-month-ahead forecast of firm i for variable x, which we regress on the firm's belief (nowcast or backcast) about recent values of that variable ($B_t^i x_t$). The δ_j are sub-industry fixed effects. Estimates for each variable are pooled across all waves for which both forecasts and nowcasts/backcasts are available.

Table 3—Beliefs about Future and Past Values of Macroeconomic Variables

	No firm fixed effects (1)	Firm fixed effects (2)
Inflation rate: aggregate	0.339	0.286
	(0.025)	(0.044)
Observations	5,130	3,531
R^2	0.389	0.730
Inflation rate: industry	1.038	
	(0.014)	
Observations	1,154	
R^2	0.959	
Unemployment rate	0.863	0.758
	(0.012)	(0.091)
Observations	1,842	770
R^2	0.826	0.828
GDP growth rate	0.909	
	(0.010)	
Observations	1,194	
R^2	0.928	
Exchange rate	0.998	
	(0.002)	
Observations	1,035	
R^2	0.994	

Notes: The table reports Huber-robust regressions of firms' 12-month-ahead forecasts of a given variable, indicated in the left column, on the backcast (over previous 12 months) or nowcast of the variable. Nowcasts are used for the unemployment rate and the exchange rate. Sub-industry fixed effects are included but not reported. In column 1, a constant term is included but not reported. Column 2 reports results for the specification when data are pooled across waves and firm fixed effects are included. Aggregate inflation uses data from waves 1, 2, 4, and 5. Unemployment rate uses data from waves 1 and 2. Industry inflation rate, GDP growth rate, and Exchange rate use data from wave 4. Robust standard errors (clustered at the 3-digit ANZ SIC level) are reported in parentheses. See Section IIIA for details.

The specific variables for which we have at least one set of forecasts and nowcasts/backcasts are aggregate and industry-specific inflation rates, the unemployment rate, the growth rate of GDP, and the level of the exchange rate vis-à-vis the dollar. We also consider specifications with firm-specific fixed effects when multiple waves are available for a variable. Each regression uses sampling weights and is a Huber-robust regression, which automatically controls for outliers and influential observations. The estimated βs from this regression are presented in Table 3. For every variable, we find that backcasts/nowcasts are strong predictors of manager forecasts, including when firm fixed effects are included. These results corroborate the findings of Jonung (1981) that differences in beliefs about past economic conditions play an important role in accounting for differences in beliefs about the future, but in this case for firms.

Another way to assess the role played by different information sets is to compare the distribution of inflation forecasts for "informed" firms, i.e., those with absolute errors about recent inflation of less than 2 percentage points, with that for "uninformed" firms, i.e., those making larger errors about recent inflation. This is illustrated in panel A of Figure 3, using data from the first wave of the survey. The distribution

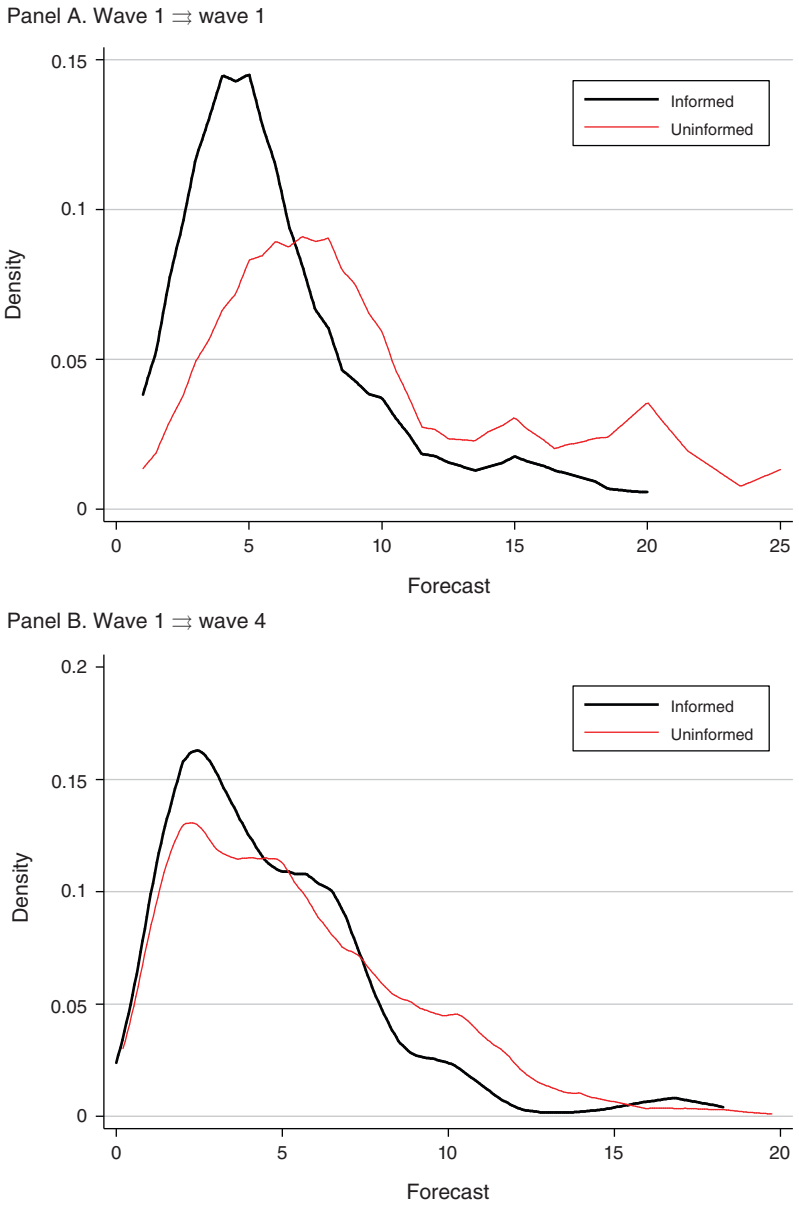

FIGURE 3. DISTRIBUTION OF INFLATION EXPECTATIONS ACROSS FIRMS

Notes: The two panels plot distributions of firms' inflation forecasts over the next 12 months. Panel A plots the distribution for "informed" firms (those with errors about recent inflation were less than 2 percentage points) versus "uninformed" firms in the first wave. Panel B plots equivalent distributions in the fourth wave of the survey, but continuing to identify "informed" and "uninformed" firms based on the size of their backcast errors in the first wave. Sample weights are used for both panels. See Section IIIB for details.

of forecasts for informed firms is much more concentrated than that for uninformed firms, with the latter having a much more pronounced tail of very high inflation forecasts, a pattern which is repeated in each wave of the survey. Few firms that are aware of recent inflation levels predict inflation rates above 10 percent, in contrast to uninformed firms. However, if we classify firms as informed and uninformed

using their errors in the first wave of the survey and compare the distributions of inflation forecasts of these two groups in the *fourth* wave, as illustrated in panel B of Figure 3, we find that the two distributions are much closer to each other than in the first wave. This finding is consistent with the view that as firms' information about recent inflation dynamics evolves over time, their forecasts change as well. In Section IV, we test this notion directly using an experimental design. Jointly, these results imply that to understand the heterogeneity in firms' forecasts, a first step is to understand the sources of the differences in their beliefs about recent economic dynamics.

B. *Measuring Inattention*

Given that recent economic conditions are largely observable in real-time, we can measure inattention to aggregate conditions by examining the size of their nowcast or backcast errors, i.e., the difference between actual values of each variable and managers' beliefs about them. For example, in the case of inflation, we construct the "errors" made by firms with respect to inflation over the preceding 12 months by subtracting their reported belief about recent inflation from the actual inflation rate over this time period. Panel A of Figure 4 plots the distribution of these errors vis-à-vis recent inflation in the first wave. About one-half of firms (49 percent) made relatively small errors, within 2 percentage points of the actual inflation rate. Approximately one in three firms made errors of more than 5 percentage points, and 1 in 10 firms in that wave made errors of more than 10 percentage points. This points to large heterogeneity in firms' attentiveness to recent inflation dynamics, with a wide range of beliefs about recent price changes in the New Zealand economy.

A second point to note from panel A of Figure 4 is that the distribution of inflation errors is highly asymmetric. Large errors are systematically negative, with these firms believing that price changes have been much larger than what actually happened. Only 5 percent of firms report a perception of recent inflation that is lower than actual inflation. Thus, the distribution of firm beliefs about recent inflation is very unevenly distributed around the actual value, despite the fact that inflation at the time of the survey was not exceptionally low. Armantier et al. (2016) document a similar distribution of perception errors on the part of US households.

The dramatic heterogeneity in beliefs about recent inflation is not unique to inflation, but the asymmetry of errors is. In the fourth wave of the survey, we also asked firms about their perceptions of the growth rate of GDP over the last 12 months and the current unemployment rate, from which we can construct analogous backcast errors made by firms. The distributions of these errors are also plotted in panel A of Figure 4. As with inflation, there is significant heterogeneity in beliefs across firms about the recent GDP growth rate and unemployment rate, although the dispersion of beliefs for these variables is significantly lower than for inflation and is largely symmetric around true values. In the fourth wave of the survey, we also asked firms to report their beliefs about price changes in their industry over the last 12 months. Using PPI inflation rates at the two-digit industry (SIC2) level, we also display the distribution of errors made by firms about industry-specific inflation rates in panel A of Figure 4. Unlike errors about aggregate inflation, the distribution of errors about industry-specific inflation rates is symmetric

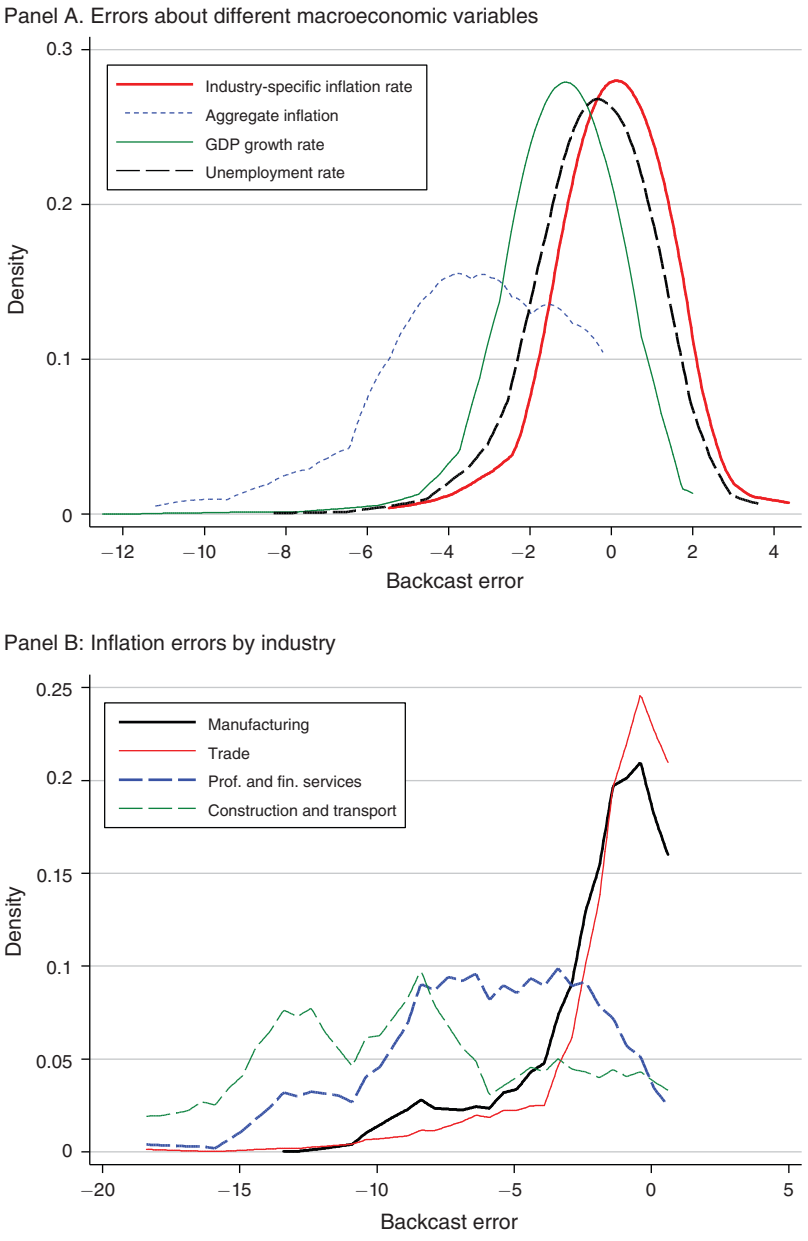

FIGURE 4. DISTRIBUTIONS OF ERRORS ABOUT RECENT MACROECONOMIC CONDITIONS

Notes: Panel A plots kernel density estimates of distributions of errors about recent values of different macroeconomic variables made by firms. Panel B plots kernel density estimates of the distribution of errors about recent inflation made across different industries. Sample weights are used for both panels. See Section IIIB for details.

and centered around zero, with the same order of dispersion as errors about GDP growth and unemployment. Hence, these results suggest that aggregate inflation generates unique patterns of errors on the part of firms that differ both qualitatively and quantitatively from those that arise for other macroeconomic variables or industry-specific price changes.

There is also significant heterogeneity in the dispersion of firm-level errors about inflation within industries. Panel B of Figure 4 plots these inflation errors from the first wave for the four broad industry groupings: manufacturing; trade; professional and financial services; and construction and transportation. In both manufacturing and trade, the majority of firms are well informed. For example, two-thirds of firms in the manufacturing sector and 80 percent of firms in the trade sector have inflation errors of less than 2 percentage points. In contrast, the equivalent shares for the professional and financial services sector and the construction and transportation sector are only 13 percent and 20 percent respectively. Furthermore, these last two sectors also have much larger fractions of firms making large errors than do firms in manufacturing or trade. These features systematically occur within each sub-industry as well, suggesting that inattention to inflation reflects deeper structural characteristics of firms or respondents.

C. *Sources of Inattention to Inflation*

What accounts for the degree of inattention paid by firms to recent inflation dynamics? Panel B of Figure 4 highlights pronounced industry characteristics as one potential source. There are many economic differences between these sectors. For example, manufacturing and trade firms have, on average, a smaller share of costs coming from labor, lower profit margins, more exposure to foreign trade, and more frequent price reviews than do firms in construction, transportation, and professional financial services (online Appendix Table 1.5.1). There could also be differences in the recent pricing decisions of firms in these industries which affect their perceptions of overall price changes. Alternatively, differences in inattention could be driven by the personal characteristics of respondents, such as their age, income, or education.

To assess the relative importance of these potential determinants of firm-level inattention, we regress firms' inattention to inflation, as measured by their absolute errors about recent inflation rates, on four groups of variables. The first group includes firm-level characteristics, such as the (log) age of the firm, its (log) total employment, labor costs as a share of revenues, and the share of foreign sales in total revenues.

The second group of explanatory variables focuses on the amount of competition faced by firms. Specifically, we include the number of direct competitors faced by the firm in its primary product, the average profit margin of the firm (similar results obtain using contemporaneous margins), as well as the firm's perception of how its price compares to those of its main competitors (as a percentage differential). Rational inattention arguments would imply that more competition should induce firms to devote more resources to collecting and processing information about their economic environment, as emphasized in Afrouzi (2016). The last variable in this block is the absolute value of the slope of the profit function with respect to firm's price. We calculate the slope as the ratio of by how much a firm could increase its profit (as a percent of revenue) if it could reset its price freely at the time of the survey relative to the percent price change the firm would implement if it could reset its price freely at the time of the survey. Economic theory (e.g., Gorodnichenko 2008, Alvarez, Lippi, and Paciello 2011) suggests that if the slope of the profit

function around the current price is close to 0, then a firm's incentive to change its price or to acquire information is low since the incremental gain in profits is approximately second-order while the costs could be first order. A greater slope in the profit function should therefore be associated with better information and hence smaller forecast errors.

The third block of variables that we include focuses on price changes, both at the level of the firm and the industry. These include the percentage change in the firm's price over the previous 12 months. One might expect that firms which have raised their prices more could be extrapolating from their own behavior to that of others in forming beliefs about recent inflation, leading to larger errors about recent inflation. Similarly, we include the Producer Price Index (PPI) inflation rate over the preceding 12 months for the firm's industry.[10] Again, one might expect that firms in industries where prices have gone up more rapidly would extrapolate these patterns to the broader economy leading to larger errors over recent inflation dynamics. Rational inattention motives suggest an opposite effect: firms that have raised their prices by more (or that are in industries where prices have gone up by more) face higher incentives to track economic conditions because of this greater volatility, potentially leading to smaller errors about recent inflation. We also include firms' reports about the expected size of their next price change as well as the number of months until they expect to change their price next. There is a clear rational inattention interpretation for the latter: firms have an incentive to collect information prior to changing prices (e.g., Gorodnichenko 2008, Alvarez, Lippi, and Paciello 2011) so one would expect firms which report short durations until the next price change to have more precise information about economic conditions. Correlation among these variables could also be going in the opposite direction: if firms think inflation is high, then they should be more likely to change their prices sooner and by more. This channel would induce a positive correlation between inflation errors (since these are almost exclusively driven by beliefs of high inflation) and the expected size of price changes and negative correlation between inflation errors and expected durations until the next price change.

The fourth and final group of variables focuses on the characteristics of the individual respondent rather than the firm. These include the age of the respondent, income, education, and tenure at the firm.[11] Unlike all other variables, which were collected in the first wave of the survey, personal characteristics of respondents were collected in the third wave and are therefore available only for a subset of firms. We present results excluding individual characteristics but using all firms in the first wave in Table 4 (column 1), results using only individual characteristics of respondents (column 2) for firms participating in the third wave, and results using all variables (column 3). In each case, we use the absolute value of inflation errors in the first wave as the dependent variable since some control variables (such as expected

[10] PPI inflation rates are not made available at a consistent aggregation level. We use the most detailed level of industry inflation rates available for each firm. For some firms, these inflation rates are available at a more disaggregated level than the sub-industry sector while for others, inflation rates are available only at more aggregated levels than our sub-industry classification.

[11] Respondents are asked to report their income by choosing one of six income bins. We construct a continuous variable by assigning the midpoint of each income bin.

Table 4—Determinants of Firm Inattention

	(1)	(2)	(3)
Firm characteristics			
log(age)	0.114		0.175
	(0.031)		(0.059)
log(employment)	0.384		0.486
	(0.061)		(0.074)
Labor's share of costs	−0.005		−0.005
	(0.004)		(0.005)
Foreign trade share	0.009		0.011
	(0.003)		(0.004)
Number of competitors	−0.006		−0.005
	(0.002)		(0.003)
Average margin	0.002		0.003
	(0.004)		(0.003)
Price relative to competitors	0.003		0.001
	(0.003)		(0.003)
Firm's past price changes	−1.165		−0.872
	(0.264)		(0.364)
Industry PPI inflation	−0.011		−0.015
	(0.007)		(0.007)
Expected size of price change	−0.002		−0.001
	(0.003)		(0.004)
Duration until price change	0.028		0.029
	(0.009)		(0.013)
Absolute slope of profit function	−0.203		−0.323
	(0.044)		(0.059)
Manager characteristics			
Age		−0.002	−0.003
		(0.003)	(0.004)
Education:			
Some college		0.032	0.073
		(0.069)	(0.066)
College		0.064	0.086
		(0.069)	(0.084)
Graduate (MA+)		−0.058	−0.065
		(0.078)	(0.092)
Tenure		0.029	−0.013
		(0.006)	(0.008)
Income		0.000	−0.000
		(0.001)	(0.001)
Industry fixed effects	Yes	Yes	Yes
Observations	2,912	1,332	1,338
R^2	0.799	0.828	0.834

Notes: The table reports results for the Huber robust regression. Dependent variable is the absolute value of firm errors about past 12-month inflation from wave 1 survey. Omitted category for manager's education is "high school diploma or less." Sample weights are applied to all specifications. Robust standard errors (clustered at the 3-digit ANZ SIC level) are reported in parentheses. See Section IIIC for details.

duration until next price change) are not time-invariant and were only measured in the first wave of the survey.

As documented in Table 4, the correlations in the data are broadly supportive of rational inattention motives. First, the correlation between inflation errors and the

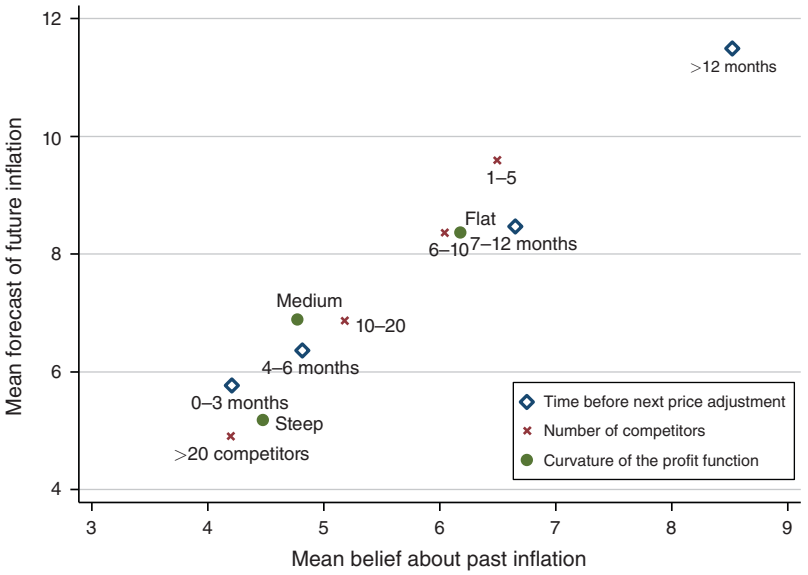

Figure 5. Inflation Backcasts and Forecasts by Firm Characteristic

Notes: The figure plots mean backcasts and forecasts of inflation for firms grouped by firm characteristics in the first wave. One grouping is by number of months until next expected price change, a second grouping is by the number of competitors, and the third grouping is by the tercile of the distribution of the steepness of the profit function. See Section IIIC for details.

expected duration until the next price change is negative. This is consistent with rational inattention motives since firms which do not expect to change their price soon should value information less. Second, the coefficient on the slope of the profit function is negative, such that firms with steeper slopes in their profit functions have better information on average. Third, firms facing more competitors also make smaller errors on average. As emphasized in Afrouzi (2016), firms with fewer competitors are expected to allocate more of their attention toward tracking the actions and beliefs of their competitors rather than aggregate economic conditions. Fourth, firms that sell more of their products abroad have less incentive to track domestic prices and make larger errors about aggregate inflation. These results are robust to controlling for individual characteristics of respondents and therefore point squarely toward rational inattention motives in firms' decisions about tracking inflation dynamics.

The strong correlation between beliefs about the past and forecasts of the future noted in Section IIIA suggests that the same forces which account for the heterogeneity in beliefs about recent inflation might also account for much of the variation in beliefs about future inflation. We illustrate that this is indeed the case for these rational inattention motives in Figure 5. In the figure, we show both average backcasts and forecasts of inflation for firms grouped by each of these characteristics: number of competitors, duration until the next price change, and slope of the profit function. Firms which face more competitors, firms which expect to change their prices sooner, and firms with steeper profit functions have not only lower backcasts of inflation on average but also much lower inflation forecasts.

Two other results stand out from Table 4. First, older and larger firms make systematically larger errors about inflation, even after controlling for other firm or industry characteristics. However, firms in New Zealand are much smaller on average than firms in larger economies like the United States (for example, the largest firm in our sample has 698 employees), so it is unclear to what extent this result would apply in other countries. Second, the personal characteristics of respondents play little role in determining inflation errors once firm-level characteristics are included. This may reflect selection issues, since all respondents are general managers of firms and thus are not representative of the broader population, for which household surveys typically reveal systematic differences in beliefs about inflation along individual characteristics.

D. *Persistence of Inattention*

Because our data have a panel component, we can assess the average persistence of inattention among firms, i.e., do firms with bigger errors in one period also tend to make bigger errors in the following period? This persistence, as shown in Coibion and Gorodnichenko (2012), can be mapped directly into the underlying degree of information rigidity and shed light about the economic significance of information frictions. To assess the persistence of inattention, we regress firms' absolute errors in later survey waves on the absolute errors they made in the previous waves:

$$\left|x_t - B_t^i x_t\right| = \alpha + \beta\left|x_{t-1} - B_{t-1}^i x_{t-1}\right| + \delta_j + error, \tag{2}$$

where x is the variable being predicted by firms, B_t^i denotes firm i's belief (nowcast or backcast) about variable x, and δ_j is a fixed effect for the industry or sub-industry.

Panels A and B of Table 5 present results using beliefs about inflation over the last 12 months across the first two waves of the survey as well as between the first and fourth waves (no question about inflation backcasts was asked in the third wave). The persistence of inflation errors between the first two waves is about 0.75. With the average time between waves 1 and 2 of the survey being 5 months, an estimate of 0.75 in the persistence of inflation errors at this frequency is equivalent to a quarterly rate of 0.83, which is approximately the convergence rate of 12-month-ahead inflation forecast errors found for different agents in the United States (Coibion and Gorodnichenko 2012). This amount of persistence points to economically large information rigidities. For example, Mankiw and Reis (2002) assume a lower persistence of 0.75 in their sticky information model while Woodford (2003) and Sims (2003) use similar magnitudes in their noisy information models. Using data from wave 4 relative to wave 1, we find a similar implied level of quarterly persistence in forecast errors of 0.80. The implied quarterly persistence in errors for unemployment is even higher, indicating that the degree of information rigidity is economically large across macroeconomic variables.

Jointly, these results indicate that the high levels of cross-sectional dispersion in inflation forecasts across managers are in large part a reflection of their different perceptions of recent inflation dynamics. These differences are consistent with rational inattention motives. Finally, the implied economic significance of this imperfect information is large.

TABLE 5—PERSISTENCE OF INATTENTION

	Absolute error in the follow-up surveys
Panel A. Inflation over the previous 12 months, wave 2	
Absolute error for inflation in wave 1	0.744
	(0.026)
Observations	667
R^2	0.719
Panel B. Inflation over the previous 12 months, wave 4	
Absolute error for inflation in wave 1	0.410
	(0.018)
Observations	1,211
R^2	0.554
Panel C. Output gap, wave 2	
Absolute error for output gap in wave 1	0.994
	(0.004)
Observations	569
R^2	0.981
Panel D. Unemployment rate, wave 4	
Absolute error for unemployment rate in wave 2	0.771
	(0.026)
Observations	441
R^2	0.794

Notes: The table reports Huber-robust regressions of firms' absolute errors for inflation over the last 12 months (panels A and B), the contemporaneous output gap (panel C), and contemporaneous unemployment rate (panel D) in waves 1, 2, and 4 on firms' errors over the same variables in waves 1 and 2. Sample weights are used in all specifications. Constant is included but not reported. Robust standard errors (clustered at the 3-digit ANZ SIC level) are reported in parentheses. See Section IIIC for details.

IV. New Information and Firms' Revisions in Their Forecasts

The robust link between firms' beliefs about the past and their forecasts of the future suggests that different information sets play a leading role in accounting for the heterogeneity in macroeconomic forecasts of firms. However, firms do revise their forecasts. A key question is therefore how firms adjust their forecasts when they receive new information and how changes in these beliefs then affect their economic decisions. In this section, we use two unique experiments to assess this question.

A. *The Short-Run Effect of New Information on Expectations*

We first consider how managers revise their macroeconomic expectations in the face of exogenously provided information. We do so using both experiments. The first experiment was conducted in the fourth wave of the survey. Firms in this wave were asked to assign probabilities to different outcomes for future inflation, output growth, and unemployment rates, from which we can compute their mean forecasts and the

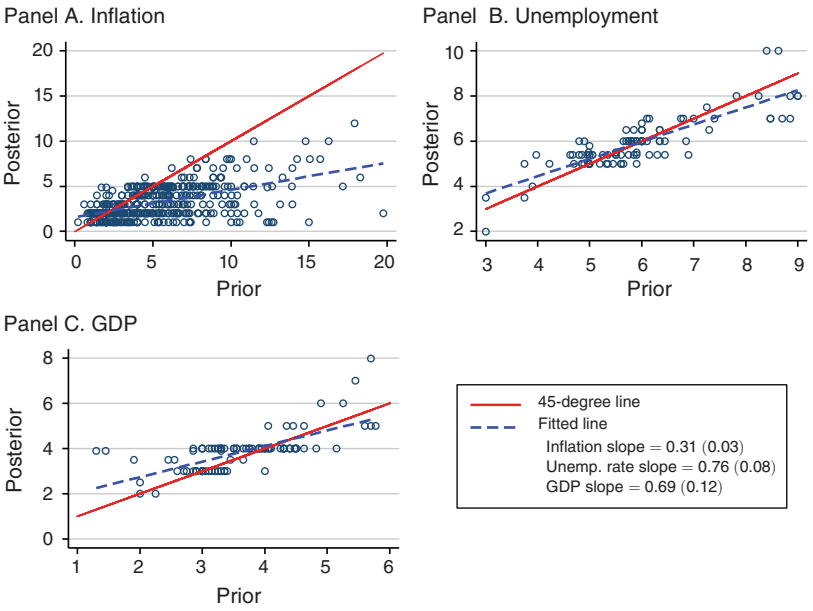

FIGURE 6. FORECAST UPDATING BY FIRMS UPON RECEIVING NEW INFORMATION

Notes: Each panel plots initial forecasts of firms in wave 4 (prior) against their revised forecasts (posterior) after being provided with new information. Panels include the 45-degree line and regression lines. Each panel is for forecasts of individual macroeconomic variable. See Section IV for details.

uncertainty surrounding these forecasts. Seven hundred firms were then randomly allocated to 1 of 7 groups of 100 firms, each of which were treated with additional information about the economy. After receiving this information, firms were asked for a point forecast for the variable about which they received the information, allowing us to measure the extent to which they revised their forecasts in response to new information. The remainder of the firms did not receive additional information.

There were two groups of firms which received information about unemployment rates or GDP growth. For each of these groups, firms were told the most recent outcomes for one of these two variables (the most recent unemployment rate of 5.4 percent or the most recent annual real GDP growth rate of 3.9 percent). The remaining five groups were provided with information about inflation: (i) the most recent professional forecast of inflation over the next 12 months (2 percent), (ii) the central bank's inflation target (2 percent), (iii) both the professional forecast and the central bank's inflation target, (iv) the most recent available value of annual inflation (1 percent), and (v) the average inflation forecast of other firms in the survey (4.9 percent). Firms in each treatment group received only one piece of additional information.

Figure 6 plots, for each macroeconomic variable, firms' priors against their posteriors after receiving the information. Firms with above average beliefs tended to revise their forecasts down while those with beliefs below average tended to revise their forecasts up, as indicated by the regression lines having slopes less than 1. This pattern is consistent with firms engaging in Bayesian learning.

To see the workings of Bayesian learning more formally, suppose firm i has prior with mean μ_i and precision τ_i (one can relate precision to the standard deviation of the "forecast/nowcast error" $\tau_i = 1/\sigma_i^2$). We assume that the prior is normally distributed. Each firm receives a common signal s (this is equivalent to the information treatment in each group) with precision ψ_s. The precision can vary with the type of signal depending on, for example, the credibility that firms attribute to the source. We assume that the signal is also normally distributed. Firms use Bayesian updating to obtain posterior p_i:

$$(3) \qquad p_i = \mu_i + \frac{\psi_s}{\psi_s + \tau_i}(s - \mu_i) \Leftrightarrow (p_i - \mu_i) = \frac{\psi_s}{\psi_s + \tau_i}(s - \mu_i).$$

Firms should revise their forecasts in the direction of the signal and should do so by more when the signal they receive is further from their prior. This revision should also be larger when the source of the signal is more credible, i.e., interpreted as having a greater precision ψ_s.

We can evaluate this insight more formally using the following regression:

$$(4) \qquad p_i = c + \beta\mu_i + error,$$

where we present estimates pooled across the different inflation treatment groups (with fixed effects for each treatment group), as well as for each group separately. In this specification, $\beta = 1 - \frac{\psi_s}{\psi_s + \tau_i}$ and the constant term absorbs the common signal. Panel A of Table 6 and Figure 6 show that the pooled estimate of β for inflation is 0.339, much lower than the estimates of 0.647 and 0.565 for unemployment and GDP growth respectively. Thus, the sensitivity of firms' inflation beliefs to new information is much higher than it is for real macroeconomic variables. This does not appear to reflect the source of the information: when we estimate the sensitivity of inflation revisions to information about the most recent values (equivalent to the information provided about unemployment and GDP growth), the coefficient is similar.

There is considerable variation in the sensitivity of inflation forecast revisions depending on the source of the information. Firms revised their forecasts by the most when presented with information about the central bank's inflation target or recent inflation values, and responded by less when presented with professional forecasts and even less so with the forecasts of other firms in the survey. This suggests that firms assign the highest precision to the signal about the central bank's inflation target and recent inflation dynamics, more so than to predictions of professional forecasters or those of other firms.

A related prediction of Bayesian updating is that the precision of the firm's prior also matters in determining by how much it revises its forecast in light of new information. To demonstrate this intuition formally, we can approximate the revision in firm forecasts in equation (3) as

$$(5) \qquad \log\left(\frac{p_i - \mu_i}{s - \mu_i}\right) = -\frac{1}{\psi_s} \times \left(\frac{1}{\sigma_i^2}\right) + h.o.t.$$

Table 6—Information Updates

Information source:	Inflation						Unempl.	GDP
	Pool (1)	SPF (2)	CB target (3)	CB target + SPF (4)	π_{t-1} (5)	$E_{-i}\overline{\pi_{t+12}}$ (6)	$UE_{t,t-12}$ (7)	$GDP_{t,t-12}$ (8)
Panel A. Dependent variable: Posterior p_i								
Prior, μ_i	0.339	0.309	0.228	0.284	0.282	0.567	0.647	0.565
	(0.021)	(0.062)	(0.047)	(0.038)	(0.041)	(0.033)	(0.042)	(0.067)
Observations	500	100	100	100	100	100	98	99
R^2	0.375	0.319	0.195	0.273	0.347	0.676	0.737	0.498
Panel B. Dependent variable: Scaled revision of posterior: $\frac{p_i-\mu_i}{s-\mu_i}$								
Uncertainty, σ_i	0.058	0.065	−0.024	0.041	0.036	0.140	0.294	−0.471
	(0.012)	(0.036)	(0.023)	(0.021)	(0.013)	(0.027)	(0.136)	(0.178)
Observations	448	86	78	91	89	98	81	80
R^2	0.082	0.021	0.011	0.028	0.029	0.118	0.040	0.055

Notes: Panel A reports results for specification (4) where the dependent variable is the posterior point prediction of the variable indicated in the first row of the table and the regressor is the prior, i.e., the point prediction implied by the reported probability distribution for the corresponding variable. The prior is the belief of a firm *before* the firm is presented with additional information. The posterior is the belief of a firm *after* the firm is presented with additional information. Fixed effects for source of information are included in column 1 but not reported. Panel B reports result for specification (6) where the dependent variable is the revision in beliefs (posterior minus prior) scaled by the difference between the signal s and the prior for the variable indicated in the first row of the table. The posterior and prior are defined as in panel A. The regressor is the standard deviation implied by the probability distribution for the corresponding variable. Fixed effects for source of information are included in column 1 but not reported. To minimize the effects of extreme observations, the sample in each column is constrained to include only observations with $\left|\frac{p_i-\mu_i}{s-\mu_i}\right| \leq 2$. Huber robust regression is used for all specifications. Robust standard errors are reported in parentheses. See Section IV for more details.

Firms with more uncertainty about their priors (high σ_i^2) should revise their forecasts by more for a given difference between the signal and their prior. This effect should be weaker when the precision of the signal is high. In the limit, if the signal is perfectly informative, the prior uncertainty does not matter as $p_i = s$ and hence $\log\left(\frac{p_i-\mu_i}{s-\mu_i}\right) = 0$. We examine this prediction using the following regression:

$$\frac{p_i-\mu_i}{s-\mu_i} = c + \beta\sigma_i + error, \tag{6}$$

where we expect $\beta > 0$ and to be lower for signals associated with higher levels of credibility. With the exception of GDP growth, we indeed find that firms with more uncertainty about their priors tend to revise their forecasts by more, as illustrated in panel B of Table 6. The magnitudes of the coefficients conform to those found in the previous set of regressions: the implied precision of the signal is highest when firms are told about the central bank's inflation target and lowest when they are told of other firms' forecasts.

At the end of wave 5, we ran a second, related experiment.[12] A randomly chosen subset of 1,020 firms (one-half of the sample) was told about the Reserve Bank of New Zealand's inflation target after having been asked about their belief over this target.

[12] To ensure that the second experiment in waves 5 and 6 is not contaminated by participation in the first experiment (wave 4), we drew a fresh panel of participants for waves 5 and 6.

We then immediately asked respondents for their new point estimates of inflation as well as their updated forecasts of other economic variables. Thus, this experiment allows us to assess how firms revise their beliefs about other economic variables when they also revise their inflation expectations. For simplicity of exposition, we group firms based on their prior belief about the inflation target and report their average revisions after the provision of information relative to a control group with the same prior beliefs but that received no information. Table 7 illustrates that managers who initially expected inflation to be high revised their inflation forecasts down by 1.2–1.3 percentage points on average and revised their long-term forecasts of inflation down by almost a full percentage point but had almost no revision in their expectations of either GDP or unemployment.[13] Hence, information about the central bank's inflation target primarily affects managers' short-run and long-run inflation expectations but has little effect on their expectations of real outcomes.

In short, when presented with new macroeconomic information, firms update their beliefs in a Bayesian manner, both in that they revise their forecasts toward the signal they receive and do so more when they are more uncertain. This updating is particularly strong for inflation forecasts, which likely reflects the lack of information firms seem to have about recent inflation dynamics and the high levels of uncertainty that they report around their forecasts.

B. *The Long-Run Effects of New Information on Expectations*

A unique feature of our second experiment is that firms that participated in the fifth wave were asked to participate in a follow-up survey six months later (wave 6) so that we can characterize the persistence of the effects on expectations of the exogenously provided information. Of the initial 2,040 firms from wave 5, 1,404 participated in the follow-up survey, of which 712 were provided information about the RBNZ's inflation target in the fifth wave and 692 were not.[14]

Firms in the sixth wave were again asked for their one-year-ahead and long-run inflation expectations, as well as their expectations of real variables and their beliefs about the RBNZ's inflation target. In Table 7, we provide results for the average change in each of these expectations relative to their initial beliefs (i.e., those extracted prior to the information being provided) and relative to firms which did not receive any information. Strikingly, we find no difference in the beliefs about the RBNZ's inflation target between the treatment group and the control group, regardless of whether their initial beliefs were close to the truth or not. Hence, within six months, the effect of the information on their beliefs about the RBNZ target had *completely* dissipated, in line with the Cavallo, Cruces, and Perez-Truglia (2017) estimates for households.

Consistent with this dissipation, we find few differences across groups in their expectations of macroeconomic conditions. Firms in the treatment group that initially were quite uninformed about the RBNZ target have somewhat lower

[13] Of the firms with initial beliefs about the target between 1 and 3 percent, most were below 2. This explains why their average inflation expectation rises slightly when told about the RBNZ's 2 percent inflation target. We find similar results when we estimate specifications (4) and (6) on the data generated in this experiment (see online Appendix Table 4.4.).

[14] As documented in online Appendix 1, there is little predictability in terms of which firms chose to participate in this follow-up wave and which did not.

Table 7—Effects of Information about RBNZ Inflation Target on Firms' Beliefs and Actions

	No controls for firm characteristics		Controls for firm characteristics	
	High prior about RBNZ target (4 or more percent) (1)	Low prior about RBNZ target (1 to 3 percent) (2)	High prior about RBNZ target (4 or more percent) (3)	Low prior about RBNZ target (1 to 3 percent) (4)
Forecast error in firm-level outcome				
Sales growth	0.044	0.202	0.032	0.227
	(0.301)	(0.336)	(0.306)	(0.350)
Wage growth	−0.112	−0.037	−0.121	−0.046
	(0.069)	(0.055)	(0.072)	(0.055)
Unit cost growth	−0.069	0.287	−0.142	0.285
	(0.107)	(0.168)	(0.112)	(0.161)
Investment	−1.954	0.222	−2.129	0.227
	(1.075)	(0.582)	(1.125)	(0.597)
Employment growth	−2.925	−0.001	−3.544	−0.043
	(0.949)	(0.411)	(1.007)	(0.552)
Price change	−0.103	0.025	−0.095	0.031
	(0.077)	(0.116)	(0.077)	(0.117)
Change in expectations immediately after treatment				
One-year-ahead inflation	−1.271	0.475	−1.212	0.467
	(0.220)	(0.162)	(0.208)	(0.151)
Five-year-ahead inflation	−0.892	−0.108	−0.960	−0.147
	(0.182)	(0.161)	(0.202)	(0.162)
One-year-ahead unemployment	0.046	−0.173	0.100	−0.190
	(0.116)	(0.133)	(0.127)	(0.130)
One-year-ahead GDP growth rate	0.176	0.217	0.189	0.214
	(0.077)	(0.119)	(0.076)	(0.116)
Change in expectations six months after treatment				
One-year-ahead inflation	0.310	0.024	0.341	−0.031
	(0.157)	(0.096)	(0.161)	(0.092)
Five-year-ahead inflation	−0.405	−0.194	−0.389	−0.225
	(0.202)	(0.176)	(0.193)	(0.175)
One-year-ahead unemployment	−0.186	−0.091	−0.157	−0.090
	(0.096)	(0.148)	(0.090)	(0.146)
One-year-ahead GDP growth rate	0.043	0.146	0.053	0.115
	(0.063)	(0.105)	(0.058)	(0.094)
RBNZ inflation target	0.073	−0.026	0.073	0.015
	(0.150)	(0.089)	(0.142)	(0.082)

Notes: The table shows estimates of the treatment effect of providing information about the inflation target of the Reserve Bank of New Zealand on firms with priors close to the true target (columns 2 and 4) and on firms with priors far from the true target (columns 1 and 3). Influential observations are identified as observations that move the estimation by more than 0.5 of the standard error. These observations are excluded. Robust standard errors are reported in parentheses. See Section IV for more details.

long-run forecasts of inflation (−0.4 percentage points) relative to their prior beliefs and the control group, less than one-half of the initial change in beliefs. For other variables, the effects are even smaller. Firms in the treatment group have marginally higher one-year-ahead inflation forecasts and marginally lower forecasts of unemployment. Firms that were initially well informed about the RBNZ target have economic forecasts that appear unaffected by the treatment after six months.

Hence, while the provision of information about the RBNZ's target has relatively large contemporaneous effects on agents' inflation expectations, these effects are quite transitory, having largely dissipated within six months. One implication of this result is that successfully anchoring the expectations of economic agents requires a long-lived communication campaign by central bankers as one-time announcements are unlikely to have persistent effects on the beliefs of agents.

C. *How Inflation Expectations Affect Firms' Actions*

Ultimately, policymakers care about inflation expectations because models predict that they affect agents' decisions. While some evidence of this has been documented for households (e.g., Armantier et al. 2015), no equivalent evidence exists for how inflation expectations affect firms' decisions. Since one cannot readily interpret unconditional correlations (reported in online Appendix Table 4.7) between firms' actions and their inflation expectations due to endogeneity concerns, the second experiment was designed to address this issue. In wave 5, all managers were asked to provide forecasts of their expected price, employment, investment, unit cost, wage, and sales changes over the next six months prior to receiving information treatments. The follow-up wave, done six months later, then asked them to report the outcomes for each of these variables over the previous six months. Hence, for each firm, we can assess the extent to which their actions deviated from their ex ante expectations, and whether firms in the treatment group did so in a systematic way relative to those in the control group. This design therefore should capture the causal effect, if any, of firms' revisions in inflation expectations (since their other expectations are largely unchanged) on their subsequent actions.[15]

Table 7 reports the results for each group of firms in the treatment group (relative to the control group), namely those that initially were uninformed about the RBNZ target and sharply revised down their inflation expectations and those that were informed and slightly raised their inflation expectations. Firms in the group with high priors about the RBNZ's target had investment 2 percent below their ex ante expectations and employment growth 3 percent lower over this six-month period than firms in the control group. Given that inflation expectations for this group of firms were only 1 percentage point lower on impact and that this effect had faded within six months, this points toward a high elasticity in investment and employment decisions to inflation expectations.[16] In contrast, we find few effects on prices,

[15] Using deviations from forecasts helps us isolate treatment effects in the sense that forecasts filter out some of the unconditional variation in outcomes. For example, some firms may plan to have zero employment growth while some other firms may plan to have 50 percent employment growth. This variation likely dwarfs variation due to the treatment and so treatment effects may be drowned in other variation. We design our experiment to have a pre-treatment firm-specific benchmark (i.e., firm-specific forecasts for the outcomes) to absorb this variation as much as possible so that treatment effects can be detected with reasonably large sample sizes. The results (available upon request) are similar when we use actual outcomes as regressands but, as expected, the effects are estimated less precisely.

[16] Because we do not know whether (or if) managers revise their expectations about nominal interest rates when they revise their expectations of inflation, we cannot make a precise statement about the implied elasticity of employment and investment decisions with respect to perceived real interest rates. In addition, note that we manipulate information about the RBNZ inflation target rather than inflation expectations. Since the target can influence not only inflation expectations but also expectations about other macroeconomic aggregates, the "total" treatment effect may be different from the treatment effect of manipulating only inflation expectations. However,

wages, and unit costs: firms in the treatment group that significantly revised their inflation expectations downward had slightly lower prices and wages, but the effect is not generally statistically significant. Hence, the most direct effect of inflation expectations appears to be on firms' decisions about their desired quantities of inputs into the production process.

To our knowledge, this is the first direct *causal* evidence that inflation expectations meaningfully impact firms' economic decisions. Furthermore, the implied economic magnitudes for employment and investment are large. So the inattention that we observe in managers' inflation expectations is not due to the fact that inflation expectations play no role in their decisions. One implication for policymaking is that policies that are successful in changing managers' inflation expectations should be expected to have direct real effects, even more so than the nominal effects that are commonly emphasized. Knowing what types of communications strategies are likely to succeed, however, requires better understanding when and how firms seek out information on macroeconomic conditions, a point to which we now turn.

V. How Do Firms Seek Out New Information?

To understand why some firms have more precise information about different economic variables than others, we first focus on which variables firms report as being important to their business decisions and how this correlates with the errors firms make about these variables. We then investigate which macroeconomic variables firms actually track and the ways in which they acquire information about economic conditions. Finally, we consider the degree of strategic complementarity and how this relates to their information acquisition decisions.

A. *Which Variables Do Firms Care About?*

In rational inattention models (e.g., Mackowiak and Wiederholt 2009, Afrouzi 2016), agents face limited information processing capacity and endogenously choose how to allocate these limited resources to tracking information which most matters for their objective function. In such a setting, one would expect firms to therefore have better information about recent values of the variables that affect their profits more. In the fourth wave of the survey, firms were asked to rank inflation, GDP, and unemployment in terms of their importance for firms' business decisions. Approximately one-half of firms ranked inflation as the least important variable among the three while just over one-third ranked it as most important. GDP was the most commonly top-ranked macroeconomic variable. We can utilize these firm rankings of the relative importance of different macroeconomic variables to determine whether a variable's relative importance to a firm's business decisions is reflected in the quality of the firm's information about that variable. For each possible pair of macroeconomic variables (among inflation, unemployment, and GDP), we create two metrics to capture their relative importance to firm i. The first is a dummy variable equal to 1 if firm i identifies variable X as more important than

we conjecture that the difference between these two treatment effects is likely small given that inflation expectations exhibit the largest reaction.

TABLE 8—RANKING OF ATTENTION AND ASSOCIATED BACKCAST ERRORS AND FORECAST UNCERTAINTY

	Regressor: $\mathbf{1}(Rank_i^X > Rank_i^Y)$			Regressor: $Rank_i^X - Rank_i^Y$		
X	Inflation	Inflation	UE	Inflation	Inflation	UE
Y	UE	GDP	GDP	UE	GDP	GDP
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Dependent variable is the relative size of willingness to pay for a professional forecast $\log\left(\frac{Pay_i^X}{Pay_i^Y}\right)$						
Rank regressor	0.760	0.831	0.607	0.286	0.293	0.271
	(0.012)	(0.015)	(0.011)	(0.003)	(0.003)	(0.004)
Observations	1,212	1,217	1,215	1,214	1,221	1,217
R^2	0.798	0.824	0.794	0.870	0.892	0.804
Panel B. Dependent variable is the relative uncertainty in forecasts $\log\left(\frac{\sigma_i^X}{\sigma_i^Y}\right)$						
Rank regressor	−0.183	−0.107	−0.050	−0.068	−0.028	−0.010
	(0.025)	(0.032)	(0.027)	(0.008)	(0.011)	(0.011)
Observations	1,067	1,108	1,052	1,067	1,109	1,053
R^2	0.053	0.017	0.004	0.062	0.011	0.001
Panel C. Dependent variable is the relative size of backcast errors $\log\left(\frac{\lvert B_t X_{t-h} - X_{t-h}\rvert}{\lvert B_t Y_{t-h} - Y_{t-h}\rvert}\right)$						
Rank regressor	−2.001	−1.724	−0.929	−0.723	−0.530	−0.471
	(0.059)	(0.043)	(0.053)	(0.017)	(0.014)	(0.020)
Observations	1,213	1,199	1,198	1,217	1,188	1,198
R^2	0.650	0.601	0.263	0.678	0.625	0.352

Notes: Panel A: $\log\left(\frac{Pay_i^X}{Pay_i^Y}\right)$ is the log of the ratio of willingness to pay (\$/year) for a professional forecast for variable X to willingness to pay (\$/year) for a professional forecast for variable Y. Panel B: $\log\left(\sigma_i^X/\sigma_i^Y\right)$ is the relative uncertainty in forecasts where σ_i^X measures uncertainty in forecasts from the probability distribution for variable X. Panel C: relative size of backcast errors $\log\left(\frac{\lvert B_t X_{t-h} - X_{t-h}\rvert}{\lvert B_t Y_{t-h} - Y_{t-h}\rvert}\right)$ where $B_t X_{t-h}$ is the backcast made at time t for variable X at time $t-h$. The horizon h is 12 months for inflation and GDP growth rate and 0 for the unemployment rate.

We use this question to rank variables in terms of relative attention:

"Which macroeconomic variables are most important to you in making your business decisions? Please rank the variables below from 1 (most important) to 3 (least important)

a. Unemployment rate . . .
b. GDP . . .
c. Inflation . . .
d. None of these is important to my decisions"

$Rank_i^X - Rank_i^Y$ is the difference in ranks of variables X and Y as perceived by firm i. Ranks can take values 1, 2, 3. Thus the maximum difference is 2 and the minimum is −2. A higher value of the difference indicates that variable X is more important than variable Y. $\mathbf{1}(Rank_i^X > Rank_i^Y)$ is the dummy variable equal to 1 if firm i thinks that variable X is more important for firms business decisions than variable Y. All estimates are based on Huber robust regressions. Sample weights are applied in all specifications. Robust standard errors (clustered at the 3-digit ANZ SIC level) are reported in parentheses. See Section V for details.

variable Y and 0 otherwise. The second is the difference between the rank of variable X and the rank of variable Y. Managers were also asked how much they would be willing to pay, per year, for forecasts on each macroeconomic variable, which provides a simple quantitative metric of how valuable (ex ante) information about each variable would be to firms. As illustrated in panel A of Table 8, firms which rank

inflation as more important than unemployment or GDP would be willing to pay twice as much (around 80 log points) more for inflation forecasts than for forecasts about either of these other variables.

We use the two rank metrics as explanatory variables in regressions where the dependent variable is either the relative uncertainty in forecasts about the two variables reported by firms, $\log(\sigma_i^X/\sigma_i^Y)$, or the relative size of backcast errors made by firms about the two variables, $\log\left(\frac{|B_t X_{t-h} - X_{t-h}|}{|B_t Y_{t-h} - Y_{t-h}|}\right)$. Note that given the structure of the survey, we compare uncertainty and inattention across variables within a firm so one can interpret these regressions as controlling for firm fixed effects.

Using either the relative uncertainty in forecasts (panel B of Table 8) or the relative size of backcast errors (panel C) as well as either metric for the relative rank of two macroeconomic variables, we find robust evidence that when firms rank one variable as more important than another for their business decisions, they tend to have better knowledge of recent dynamics of that variable and have less uncertain forecasts of that variable.[17] The only exception is when comparing the effect of UE and GDP relative ranks on the relative uncertainty surrounding firms' forecasts of these variables, in which case the estimates are not significantly different from zero (they are statistically significant in the case of relative backcast errors). Jointly, these results are supportive of rational inattention channels through which firms have better knowledge of those variables which matter for their objective functions.

B. *Which Variables Do Firms Track and How?*

Better knowledge of those variables which matter more for firms' business decisions could reflect an endogenous information acquisition decision or it could reflect stronger procyclicality in a firm's production. To assess whether the previous results reflect firms choosing to collect more information about specific macroeconomic variables, we asked them to identify which macroeconomic variables (out of inflation, unemployment, and GDP) they keep track of. Approximately 60 percent of firms report that they do not track inflation, compared to only 21 percent of firms that report not tracking GDP.[18] Hence, consistent with what firms reported about the relative importance of macroeconomic variables to their business decisions, inflation is tracked by a much smaller fraction of firms than real variables like GDP. In fact, the modal answer (32 percent of firms) is that they track both unemployment and GDP but not inflation. Conditional on tracking multiple variables, the vast majority of firms (over 90 percent) try to synchronize their acquisition of information across the variables they track. This feature of the data is strongly predicted by the canonical sticky information model where updates of information are perfectly synchronized across variables. It is also consistent with noisy information models in which firms track variables continuously and thus obtain new information about macroeconomic aggregates at the same time.

[17] We find similar qualitative evidence if we use the relative willingness to pay for each variable as dependent variable (online Appendix Table 4.3).

[18] A full breakdown on responses is given in online Appendix Table 4.5.

Table 9—Macroeconomic Variables: Importance for Business Decisions and Tracking

Importance for business decisions (1 = high, 3 = low)	Follow (percent) (1)	Do not follow (percent) (2)	Willingness to pay for a professional forecast ($/year) (3)
Panel A. Inflation			
Shares, percent			
1	41.87	0.10	211.38
2	3.63	9.47	138.85
3	1.57	43.36	92.04
Total	47.07	52.93	148.26
Backcast error	1.10	4.96	
Forecast	3.34	5.85	
Forecast uncertainty (SD)	1.75	2.12	
Panel B. Unemployment			
Shares, percent			
1	18.02	1.13	166.60
2	39.32	8.83	115.88
3	13.99	18.71	110.73
Total	71.33	28.67	123.91
Backcast error	0.46	1.98	
Forecast	5.59	6.80	
Forecast uncertainty (SD)	0.79	0.71	
Panel C. GDP			
Shares, percent			
1	37.01	1.87	168.32
2	30.54	8.21	132.94
3	11.43	10.94	102.69
Total	78.99	21.01	139.93
Backcast error	1.02	2.42	
Forecast	3.50	4.15	
Forecast uncertainty (SD)	0.73	0.73	

Notes: The table shows shares of firms reporting importance of a given macroeconomic variable for their business decisions and whether they track the variable. The differences between "follow" and "do not follow" means for forecasts, backcast errors, and forecast uncertainty are statistically different from zero at 1 percent for all cases but one: forecast uncertainty for GDP. Column 3 shows the average willingness to pay for a professional forecast of a given variable. See Section V for details.

The mapping between firms' answers as to which variables they track and the relative importance of different macroeconomic variables is summarized in Table 9 and illustrates the consistency of answers across these questions. For example, of the firms that reported that inflation was the most important out of the three macroeconomic variables for their business decisions, 99 percent of them reported that they track inflation. Similarly, 98 percent of the firms that ranked inflation as the least important of the three macroeconomic variables choose not to track inflation dynamics. Firms which rank inflation highest are willing to pay more than twice as much for inflation forecasts as firms which rank inflation as least important. Interestingly, of the firms that rank inflation as second most important to their business decisions, only one in five actually report tracking inflation. This is significantly at odds with what we observe for unemployment and GDP, where even among firms ranking these variables as least important, around 50 percent of them still track that variable. In the same spirit, there is significantly

less variation in willingness to pay for unemployment or GDP forecasts than there is for inflation forecasts.

These answers do not appear to be cheap talk on the part of firms, as the answers that they provide are very strongly associated with the forecasts and backcasts that they report. Table 9 also presents the mean size of backcast errors for each variable depending on whether firms reported tracking that variable or not, as well as corresponding mean forecasts and mean uncertainty around the forecasts. There are pronounced differences between firms that report tracking a variable and those that do not, especially for inflation. Firms that track inflation have average absolute backcast errors of approximately one percentage point compared to an average error of five percentage points for those which do not track inflation.[19] Differences in average forecasts of inflation are also very pronounced: firms that track inflation have an average year-ahead forecast of 3.3 percent while those that do not track inflation forecast inflation of 5.9 percent on average with higher levels of uncertainty around their forecasts. Thus, the endogenous decisions of firms as to whether to track a macroeconomic variable have profound consequences on their knowledge about this variable's recent dynamics and future values.

One can also relate a firm's decision about whether or not to track inflation or the relative rank of inflation in terms of their business decisions to observable and time-invariant characteristics of firms and managers, as done in Section IIIC to explain the size of errors about recent inflation made by firms. Because inflation backcast errors and a firm's decision about whether or not to track inflation are so highly correlated, the results are qualitatively similar (see online Appendix Table 4.2) in that rational inattention forces go a long way in accounting for how important firms view inflation or whether they track inflation. Firms facing fewer competitors and those for which foreign sales account for a larger share of revenues are less likely to track inflation and view inflation as important to their business decisions. Thus, much of the cross-sectional variation in firms' knowledge of inflation dynamics can be reconciled with rational inattention motives.

In addition to choosing which macroeconomic variables to track and whether to synchronize their updating about different variables, firms must decide when to collect new information. To better try and understand the circumstances that induce firms to seek out information, we presented them with two hypothetical questions. One was if they heard *bad* news about the economy on TV, would they be more or less likely to look for more information? This question targets whether there is state-dependence in the acquisition of information (if they say it is more likely), or whether information updating is time-dependent (if they say it makes no difference). The results (online Appendix Table 4.6) strongly support state-dependence in the information updating process: over 75 percent of firms report that they are much more likely or somewhat more likely to seek our new information when they receive

[19] Even if a firm tracks inflation closely, we should still not expect backcast errors to be zero as there are several additional sources of error. One is the fact that not all of the data are available at the time of the survey, so even an agent who knew all of the recently available data would not know the contemporaneous values. For example, if we ask someone by how much prices have changed over the last 12 months, they would not be able to rely on reported inflation rates for the most recent few months (delays are particularly long in New Zealand, as inflation reports are released quarterly and with significant delays). Another source of error is rounding: most managers report integer values.

bad news about the economy. This evidence is in line with the lower levels of information rigidity found during recessions in Coibion and Gorodnichenko (2015b).

The second question that firms were asked was if they heard *good* news about the economy on TV, would they be more or less likely to look for more information? This question targets not just state-dependence of information acquisition but also its symmetry. The results are the opposite of those found in response to bad economic news: over 60 percent of firms report that they are much less or somewhat less likely to seek out more information in response to good economic news. This evidence points toward an asymmetry in firms' information acquisition over the course of the business cycle, with firms actively looking for more information during downturns when news is bad but relying on their outdated information during booms when news is good.

C. *Strategic Complementarity*

Another important channel emphasized in the literature on firms' information acquisition is strategic complementarity in price setting (e.g., Hellwig and Veldkamp 2009; Afrouzi 2016). When firms place more weight on the decisions of others, this should affect their information acquisition decisions as well. For example, firms with higher levels of strategic complementarity should prefer to receive signals which are received by others ("common signal") over signals that are available only to themselves ("private signal"), since the common signal also provides information about the likely actions of other firms.

Our survey data allow us to measure one important component of the strategic complementarity faced by firms, namely how sensitive their revenues are to competitors' price changes, by asking them the following hypothetical question: "Suppose a typical firm in your industry cuts its price by 10 percent, by how much would your sales be affected?" The average response to this question is a decline in sales of 7 percent. We can also determine firms' preferences for signals which only they observe versus signals received by other firms by asking firms which signal they would prefer. Seventy-five percent of firms reported that they would prefer to receive the common signal. To assess whether higher levels of strategic interaction lead firms to prefer public signals, we regress one on the other and present results in panel A of Table 10. Regardless of whether we control for industry fixed effects or include firm-specific and manager-specific controls, we find a robust positive correlation between the firms' degree of strategic complementarity and their preference for a common signal. This provides unique and direct evidence for the effects of strategic interaction on firms' choice of signals, as emphasized in Hellwig and Veldkamp (2009).

A related prediction from Gorodnichenko (2008) is that firms facing uncertainty about the state will tend to wait for other firms to act instead of immediately changing their prices when there is strategic complementarity in price setting, since they can extract information about the state from the actions of others. Firms in the survey were asked "Suppose you want to adjust your prices but are uncertain about the state of the economy, what would you do?" Firms selecting the answer "wait until other firms make a price adjustment" would then be acting in the way predicted by the model. Using a dummy variable equal to 1 when firms select this answer and 0

Table 10—Complementarity in Acquisition of Information

	No controls (1)	Sub-industry fixed effects (2)	Sub-industry fixed effects Firm controls Manager controls (3)
Panel A. Information complementarity			
Price complementarity	0.311	0.313	0.326
	(0.036)	(0.037)	(0.034)
Observations	1,252	1,252	1,135
R^2	0.153	0.172	0.214
Panel B. Importance of waiting for other firms			
Price complementarity	0.613	0.618	0.828
	(0.298)	(0.302)	(0.314)
Observations	1,241	1,242	1,125
R^2	0.004	0.019	0.077
Panel C. Revision of inflation expectations when the main competitor raises its price			
Importance of waiting	0.151	0.150	0.150
for other firms	(0.028)	(0.028)	(0.030)
Observations	1,252	1,252	1,135
R^2	0.033	0.048	0.080

Notes: Panel A: The dependent variable is information complementarity which is a dummy variable equal to 1 if a firm picks "The source that can be seen by other firms" and 0 otherwise. The regressor is price complementary which measures (in percent, absolute value) by how much sales of a given firm fall when a typical firm in your industry cuts its price by 10 percent. The response is divided by 10.

Panel B: The dependent variable is the dummy variable equal to 1 when a firm chooses "Wait until other firms make a price adjustment" in response to "Suppose you want to adjust your prices but you are uncertain about the state of the economy. What would you do?" and 0 otherwise. The response is divided by 10. Price complementarity is defined as in panel A. Influential observations are identified as observations that move the estimation by more than 0.2 of the standard error. These observations are excluded.

Panel C: The dependent variable is the response to the following question: "Suppose your main competitor raises the price of its product by 10 percent. By how much would you revise your expectation of inflation over the next 12 months." The response is divided by 10. The regressor is the dummy variable equal to 1 when a firm chooses "Wait until other firms make a price adjustment" in response to "Suppose you want to adjust your prices but you are uncertain about the state of the economy. What would you do?" and 0 otherwise.

Robust standard errors (clustered at the 3-digit ANZ SIC level) are reported in parentheses. See Section V for details.

otherwise, we find (panel B of Table 10) that firms with higher levels of strategic complementarity are more likely to report that they would prefer to wait for other firms to adjust their prices, as predicted by the theory. This supports theories of inertia in prices that rely on the notion that information from other firms' prices does not rapidly diffuse through the economy because each firm is waiting for others to adjust their prices first.

A third implication of this class of models is that when strategic complementarity is high, another firm's price change is more informative about aggregate conditions than when strategic complementarity is low. This is because other firms also have an incentive to wait to change their prices and therefore tend to do so only when they have strong information about the economy. As a result, firms should draw

stronger inferences from the price changes of others when everyone has an incentive to delay their own actions. We can assess this prediction using another question from the survey: "Suppose your main competitor raises its price by 10 percent, by how much would you revise your expectation of inflation over the next 12 months?" We regress answers to this question on the dummy variable for whether firms prefer to wait until other firms change their prices. The results, in panel C of Table 10, point toward a significantly positive correlation between firms' desire to wait for other firms to change prices first and the inference they draw from their competitors' price changes, in line with theory.

These results therefore provide novel and direct evidence for models in which the gradual diffusion of information and price stickiness interact to delay the response of the economy to shocks when strategic complementarity is high. The latter induces firms to focus on public signals and rely on other firms' price changes as a source of information. As firms become more reticent to change prices, any firm that does change its price is providing a stronger signal to other firms about fundamentals. Each of these channels is supported by the survey data in a direct and transparent manner that illustrates the usefulness of surveys of firms.

VI. Conclusion

Using a novel survey of firms' macroeconomic expectations, we document a number of new stylized facts about firms' beliefs. One such fact is that disagreement among firms is pervasive and much larger than that among professional forecasters, both about past and future macroeconomic conditions. This disagreement about macroeconomic conditions resembles that among households along a number of dimensions, such as its size, its persistence, and its asymmetry. Twenty-five years after the Reserve Bank of New Zealand became the first country to officially adopt an inflation target, we find little evidence that firms fully grasp the stability that has characterized inflation dynamics in New Zealand.

Inattention among firms varies along some dimensions predicted by theory. Specifically, much of the inattention to macroeconomic conditions appears related to firms' incentives to collect and process information, as predicted by models of rational inattention in which firms face costs or frictions in collecting and processing information. For example, firms facing more competition or important pricing decisions in the near future have better information about inflation. And firms facing steeper profit functions, for which information should thus be more valuable, also have better information on average.

While we document pervasive inattention on the part of firms to different macroeconomic variables, aggregate inflation stands out as the variable about which firms seem least well-informed on average. Many firms view inflation as relatively unimportant to their business decisions and choose not to track its recent values, leading to large misperceptions about recent inflation dynamics and forecasts that are far out of line with historical values, even though they display significant knowledge about industry-specific price changes. While firms respond in a Bayesian manner to new information about inflation and incorporate this information into their economic decisions, they seem to find little incentive to seek out this information themselves, except when news reports are negative. Since negative news reports about inflation

tend to occur when inflation is unusually high, this may account for why firms' average beliefs about inflation, like those of households, are frequently higher than those of professional forecasters.

One potential implication of these results is that firms' expectations, especially about inflation, may not be nearly as well "anchored" as has been recently emphasized (e.g., Bernanke 2010), as developed further in Kumar et al. (2015). This could be problematic for policymakers for a number of reasons. First, there are little data currently available on firms' expectations for policymakers to track. Second, the wide dispersion in firms' and households' beliefs suggests that the average degree of inattention to economic conditions, and especially inflation trends, is high among these agents. To the extent that monetary policymakers have recently been relying upon policies whose key transmission mechanism is supposed to be inflation expectations, the outlook for such policies working effectively is likely limited unless policymakers find an efficient way to transmit this information to economic agents. Third, the willingness of monetary policymakers to engage in nontraditional actions at the zero-bound hinges on their view that agents' expectations are well anchored, leaving little concern about expectations becoming unmoored in the long run. But if expectations are not nearly as anchored as posited by policymakers, then the potential risks of these policies may well have been underestimated.

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