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Abstract

We investigate the updating behavior of individual consumers regarding their short- and long-run inflation expectations. Utilizing the University of Michigan Survey of Consumer's rotating panel microstructure, we can identify whether individuals adjust their inflation expectations over a period of six months. We find evidence that the updating frequency has been underestimated. Furthermore, looking at the possible determinants of an update we find support for imperfect information models. Moreover, individual expectations are found to be more accurate after an update and forecast accuracy is affected by inflation volatility measures and news regarding inflation. Finally, the updating frequency is found to significantly move spreads in bond markets.

Keywords: Rational Inattention, updating inflation expectations, microdata, news.

JEL classification: D84, E31.

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1 Introduction

Inflation expectations play a central role in modern macroeconomic models and are an important factor for economic policy. Despite their importance, we still know very little about how people form their expectations. Researchers have proposed a wide array of frameworks to model the expectations formation process. Contributions by Sims (2003), Mankiw and Reis (2002) or Woodford (2001) revived the interest in information rigidities and highlight their importance for the process of forming inflation expectations. Accounting for information rigidities allows to solve several empirical puzzles that did not match the predictions of the full-information rational expectations models, as shown in Ball et al. (2005).[1]

The idea of this paper is to explore the updating behavior regarding inflation expectations of individual consumers using micro survey data. Specifically, we aim at evaluating the updating frequency over time and with regard to macroeconomic factors that may trigger an updating of inflation expectations. In doing so, we test the relevance of imperfect information models, such as rational inattention as proposed by Sims (2003) or sticky information as introduced by Mankiw and Reis (2002). Furthermore, we analyze which factors influence the individual forecast accuracy and explore implications for financial markets.

For our analysis we make use of the rotating panel microstructure of the University of Michigan Survey of Consumers, where a fraction of individuals is re-interviewed after six months. This allows us to track individuals and their expectations over a period of six months. In doing so, we can directly calculate the change in individual expectations and the share of individuals that have adjusted their expectations and, thus, do not need to rely on identification coming only from the cross section or the aggregated series.

Our paper is related to the literature that analyzes the updating behavior of consumers regarding inflation expectations and tests for evidence of information frictions. For the US, Carroll (2003) finds support for the conjecture of Mankiw and Reis (2002) that consumers update their inflation expectations roughly once a year. For Europe, Döpke et al. (2008a) show that consumers update their inflation expectations once every 18 months.[2] Looking at the movements of forecast errors in relation to the variable being forecasted, Coibion and Gorodnichenko (2010, 2012) document pervasive and robust evidence consistent with information rigidities and derive a test for information frictions consistent under both sticky information and models of imperfect information as in Woodford (2001). Lamla and Sarferaz (2012) document substantial time-variation in the inflation expectation updating behavior of German households. In sum, these studies provide evidence for staggered updating and for information frictions.

[1] For an overview see also Mankiw and Reis (2011).

[2] For evidence regarding the expectations updating by professional forecasters, see Döpke et al. (2008b).

Most of the mentioned papers use aggregate survey data of inflation expectations to test models with informational frictions. However, microdata of individual consumers' inflation expectations is clearly preferable as it allows for a more direct identification of the underlying processes. Our analysis makes not only of use of the cross-sectional dimension of the available microdata, but also of the time dimension due to the rotating panel of the Michigan Survey of Consumers. Thus, we directly track individuals' changes in *individual* inflation expectations *over time* at the micro level.

To the best of our knowledge, only very few studies use the rotating panel dimension of the University of Michigan Survey of Consumers. Souleles (2004) employs the rotating panel to construct individual forecast errors, which are then subjected to rationality tests and evaluated with respect to their forecasting power regarding household expenditure. Anderson et al. (2010) analyze differences in the formation of consumers' inflation expectations conditional on sociodemographic characteristics. Finally, Pfajfar and Santoro (2013) test the hypotheses of the epidemiology model proposed by Carroll (2003).

Our results show that the updating frequency of quantitative inflation expectations is much higher than represented in the aggregate data. According to our calculation individuals adjust their quantitative short-run inflation expectations 1.5 times a year instead of only once a year. We argue that this is likely to be related to the aggregation phenomenon. Moreover, those adjustments are rather small and may be interpreted as some kind of fine-tuning. Substantial adjustments to inflation expectations are conducted on a much lower frequency (roughly every 9 months with respect to short-run inflation expectations), which varies strongly over time. In addition, long-term expectations are adjusted less frequently compared to short-run expectations.

Furthermore, we link the updating behavior to models of information frictions, most prominently the concepts of rational inattention and of sticky information, and empirically test for hypotheses derived from those theories. We analyze the updating behavior for short- and long-run expectations and investigate the determinants of changes in individual absolute forecast errors also with regard to imperfect information models. We provide evidence in favor of information rigidities showing that measures of volatility of inflation raise attention and consequently trigger an updating of inflation expectations by consumers. In addition, we find support for news effects: If people have heard news on inflation, they are more likely to adjust their expectations.

Moreover, we find support for an effect of information rigidities on forecast errors at the individual level. First, we can report that forecast accuracy increases if inflation expectations are updated. Second, we investigate the role of possible determinants. Changes in individual forecast errors in the case of updated inflation expectations are explained by measures of inflation volatility and by news regarding inflation. In line with the hypotheses of imperfect information models, a higher volatility of inflation induces more attention and, thus, is related to a larger improvement in individual forecast accuracy after an update. An interesting result is that individual consumers' forecast accuracy deteriorates with news on inflation, where the effect is driven by news on rising inflation.

Finally, we link the updating of inflation expectations to term spreads in bond markets and find evidence that a higher share of consumers with updated expectations corresponds to a larger change in the term spread between 5-year and 1-year treasury bill rates as well as between nominal and inflation indexed yields.

The paper is structured as follows. We discuss models with imperfect information in section 2, where we derive our hypotheses for the empirical analysis. In section 3 we discuss the data set used in the analysis. Empirical results regarding the updating behavior of individual inflation expectations and their forecast errors are presented in section 4. Section 5 concludes.

2 Theoretical Determinants of Imperfect Information

We start our analysis of individuals' inflation expectations by implementing a simple test for information frictions derived in Coibion and Gorodnichenko (2010). The test is valid under both sticky information or models of information frictions as in the Lucas (1972) island model or in Woodford (2001) and is based on the relation between forecast errors and forecast revisions. It may thus be regarded as a rationality test against the alternative hypothesis of information frictions affecting expectations. Coibion and Gorodnichenko (2010) derive the following formulation for the test equation under sticky information:[3]

$$\pi_{t+h} - E_t^i \pi_{t+h} = \frac{\lambda}{1-\lambda} \Delta E_t^i \pi_{t+h} + \nu_{t+h,t}, \tag{1}$$

where $\pi_{t+h} - E_t^i \pi_{t+h}$ is the individual's realised forecast error in period $t+h$, $\Delta E_t^i \pi_{t+h} = E_t^i \pi_{t+h} - E_{t-1}^i \pi_{t+h}$ is the individual forecast revision between periods t and $t-1$, $\lambda \in [0,1)$ is the fixed degree of information stickiness and $\nu_{t+h,t}$ is the rational expectations error. Similarly, under information frictions as in Lucas (1972) and Woodford (2001), agents continuously update their forecasts with a Kalman filter, but underly information constraints and, thus, never obtain the full information set. The relation between forecast errors and forecast revisions is then given by:

$$\pi_{t+h} - E_t^i \pi_{t+h} = \frac{1-G}{G} \Delta E_t^i \pi_{t+h} + \xi_{t+h,t}, \tag{2}$$

where $G \in (0,1]$ is the Kalman gain, measuring how much weight is given to new information, and $\xi_{t+h,t} = \sum_{i=1}^{h} \rho^i \nu_{t+i}$ is the rational expectations error. Since Coibion and Gorodnichenko (2010) only test for information frictions in aggregate survey data of infla-

[3]The detailed derivation of the test is given in Coibion and Gorodnichenko (2010).

tion expectations, we incorporate their test for our analysis of individual microdata and thus get as a first hypothesis:

> **H1:** Under imperfect information, individual forecast errors should be a positive function of individual forecast revisions, where the coefficient is bounded above by one.

In order to derive testable hypotheses for individuals' updating behavior, we next present a simple model of inflation expectations under rational inattention. Following the seminal paper by Sims (2003), models of rational inattention assume that individuals are constrained in their capacity to acquire and process information and, hence, may not be able to form full information rational expectations. Nevertheless, some information is observed each period and individuals may choose where to allocate their limited attention.

The structure of the model presented here follows closely the example in Wiederholt (2010), who presents a model of price setting under rational inattention. Since individuals may update their expectations each period, the model can be written as a static problem, omitting time indices. Suppose that the full information rational forecast of inflation, $\pi^{e,*}$, is given by:

$$\pi^{e,*} = \theta\Delta, \tag{3}$$

where $\Delta \sim N(0, \sigma_\Delta^2)$ is a combination of aggregate shocks driving inflation, which is assumed to be normally distributed with mean zero and variance σ_Δ^2, and θ is a parameter. Individuals cannot fully observe $\pi^{e,*}$. However, if they choose to pay attention to inflation, they will receive an individual signal $s_i = \Delta + \varepsilon_i$, where the idiosyncratic noise ε_i is independent from aggregate shocks Δ and is also assumed to be normally distributed as $\varepsilon \sim N(0, \sigma_\varepsilon^2)$, so that s_i is multivariate normal. Note that the individual signals s_i may be interpreted as active searching for information on the part of individuals. Thus, individuals' inflation forecast, π_i^e, can be stated as:

$$\pi_i^e = E\left[\pi^{e,*}|s_i\right] \tag{4}$$

Next, the amount of information conveyed in the signal is measured as a reduction in uncertainty. In line with information theory, uncertainty is measured by the entropy of a random variable. In our model with Gaussian shocks, entropy of a random variable $x \sim N(0, \sigma_x^2)$ is given by:

$$H(x) = \frac{1}{2}\log_2\left(2\pi e\sigma_x^2\right) \tag{5}$$

Similarly, the conditional entropy of x given the signal s_i can be written as:

$$H(x|s_i) = \frac{1}{2}\log_2\left(2\pi e\sigma_{x|s_i}^2\right) \tag{6}$$

where $\sigma^2_{x|s_i}$ is the conditional variance of x given s_i. Hence, the amount of information on x in s_i, called *mutual information*, is given by the change in entropies conditional on the observation of the signal:

$$I(x; s_i) = H(x) - H(x|s_i) \tag{7}$$

Inflation in our model is driven by aggregate shocks Δ, so that we replace x with Δ to get the mutual information in the signals s_i on inflation shocks Δ. When forecasting inflation under less than full information, individuals thus incur a loss, since an inaccurate inflation forecast leads for instance to suboptimal pricing decisions or wage negotiations. Hence, individuals aim at minimizing these losses subject to their information processing constraint. We assume that individuals can choose both the amount of attention κ, paid to inflation at a cost μ, and the signals obtained. Additionally, we assume that the marginal cost μ of an additional unit of attention devoted to inflation is a negative function of public news on inflation, N, as perceived by the individual: $\mu(N)$ with $\mu'(N) < 0$. We argue that this effect reflects passive learning about inflation developments, for instance via the exposure to media news, which then reduces the individual marginal cost of actively searching for information on inflation. Hence, the problem of optimal inattention can be stated as follows:

$$\min_{\sigma^2_{\Delta|s_i}, \kappa \geq 0} E_{\Delta, s_i} \left[(\pi_i^e - \pi^{e,*})^2 \right] + \mu(N)\kappa \tag{8}$$

subject to equations (3) and (4), $s_i = \Delta + \varepsilon_i$ and the information constraint

$$\frac{1}{2} \log_2 \left(2\pi e \sigma^2_{\Delta} \right) - \frac{1}{2} \log_2 \left(2\pi e \sigma^2_{\Delta|s_i} \right) \leq \kappa \tag{9}$$

Agents minimize (8) over the joint distribution of the true inflation state and the signal, where the joint distribution is chosen to be Gaussian due to the assumption of Gaussian states. Using the law of iterated expectations and because the conditional variance of a Gaussian random variable is constant, the objective function can be written in terms of the conditional variance of inflation:

$$\begin{aligned}
&\min_{\sigma^2_{\Delta|s_i}, \kappa \geq 0} E_{\Delta, s_i} \left[(E_{\Delta}[\pi^{e,*}|s_i] - \pi^{e,*})^2 \right] + \mu(N)\kappa \\
&= \min_{\sigma^2_{\Delta|s_i}, \kappa \geq 0} E_{s_i} \left[Var(\pi^{e,*}|s_i) \right] + \mu(N)\kappa \\
&= \min_{\sigma^2_{\Delta|s_i}, \kappa \geq 0} Var(\pi^{e,*}|s_i) + \mu(N)\kappa \\
&= \min_{\sigma^2_{\Delta|s_i}, \kappa \geq 0} \theta^2 \sigma^2_{\Delta|s_i} + \mu(N)\kappa
\end{aligned} \tag{10}$$

We thus get the following Lagrangian and corresponding first-order conditions:

$$\mathcal{L} = \theta^2\sigma^2_{\Delta|s_i} + \mu(N)\kappa - \lambda\left[\frac{1}{2}\frac{\ln\sigma^2_\Delta}{\ln 2} - \frac{1}{2}\frac{\ln\sigma^2_{\Delta|s_i}}{\ln 2} - \kappa\right] \tag{11}$$

$$\frac{\partial\mathcal{L}}{\partial\sigma^2_{\Delta|s_i}} = \theta^2 + \frac{1}{2}\lambda\frac{1}{\ln 2}\frac{1}{\sigma^2_{\Delta|s_i}} \stackrel{!}{=} 0 \tag{12}$$

$$\frac{\partial\mathcal{L}}{\partial\kappa} = \mu(N) + \lambda \stackrel{!}{=} 0 \quad \Rightarrow \quad \lambda = -\mu(N) \tag{13}$$

Using (13) in (12) then gives the following expression for the conditional variance of inflation $\sigma^2_{\Delta|s_i}$:

$$\sigma^2_{\Delta|s_i} = \frac{\mu(N)}{2\ln(2)\theta^2} \tag{14}$$

Finally, substituting for $\sigma^2_{\Delta|s_i}$ from (14) in the information constraint in (9) gives an expression for optimal attention towards inflation:

$$\kappa^* = \begin{cases} \frac{1}{2}\log_2\left(\frac{2\ln(2)\theta^2\sigma^2_\Delta}{\mu(N)}\right) & \text{if} \quad \frac{2\ln(2)\theta^2\sigma^2_\Delta}{\mu(N)} \geq 1 \\ 0 & \text{otherwise} \end{cases} \tag{15}$$

where the fraction $(2\ln(2)\theta^2\sigma^2_\Delta)/\mu(N)$ gives the marginal benefit of paying attention to inflation. From equation (15), we can thus state the next two hypotheses regarding attention towards inflation:[4]

H2: Under rational inattention, updates of inflation expectations, i.e. attention towards inflation, should be a positive function of the variance of inflation forecasts under full information $\theta^2\sigma^2_\Delta$, which is driven by the variance of aggregate shocks on inflation.

H3: Under rational inattention, attention towards inflation should be a positive function of news N regarding inflation perceived by the individual, since these reduce the marginal cost μ of devoting attention to inflation.

Another approach to implications of imperfect information can be found in Dräger (2011a). In line with the literature on heterogeneous expectations, individuals in the model in Dräger (2011a) may choose between two forecasts of inflation, where one forecast is formed under full information (E^{FI}), while the second forecast is formed with outdated (sticky) information (E^{SI}). The aggregate expectations index for inflation expectations is then given by:

[4] Note that Reis (2006) derives at a similar conclusion regarding the determinants of consumers' optimal degree of inattentiveness in a model with sticky information. However, in contrast to models of rational inattention, the concept of sticky information assumes that forecasts are only updated within fixed intervals, so that the model in Reis (2006) yields in fact the optimal inattentiveness interval.

$$\widetilde{E}_t(\pi) \equiv \lambda_t^\pi E_t^{FI}(\pi) + (1-\lambda_t^\pi)E_t^{SI}(\pi) = \lambda_t^\pi E_t(\pi) + (1-\lambda_t^\pi)\overline{\lambda}\sum_{j=0}^{\infty}(1-\overline{\lambda})^j E_{t-1-j}(\pi), \quad (16)$$

where λ_t^π is the endogenous and time-varying probability of choosing the full information forecast of inflation. The model thus derives a version of a sticky information model. Moreover, the model also incorporates aspects of rational inattention, since attention as captured by λ_t^π may change every period. Individuals are assumed to base their decision for a forecast on its forecast performance, measured by the respective squared forecast errors. Additionally, full information can only be obtained at a fixed cost C^{FI}, which has to be paid each period. Forecast attractiveness is thus given by the expressions:

$$V_t^{FI} = (\pi_{t-1} - E_{t-2}\pi_t)^2 + C^{FI} \quad (17)$$

$$V_t^{SI} = \left(\pi_{t-1} - \overline{\lambda}\sum_{j=0}^{\infty}(1-\overline{\lambda})^j E_{t-j-3}\pi_t\right)^2 \quad (18)$$

The probability of choosing the full information forecast, given by each forecast's attractiveness from equations (17) and (18) is then modelled as a choice of two discrete alternatives under rational inattention. This implies that although individuals have some information on the predictors' accuracy, there remains some uncertainty regarding the optimal forecast or the true values in $V = (V^{FI}, V^{SI})$. As shown in Matějka and McKay (2011), the probability of forecasting inflation with full information is in this case given by a multinominal logit model:[5]

$$\lambda_t^\pi = \frac{\exp(V_t^{FI}/\mu)}{\exp(V_t^{FI}/\mu) + \exp(V_t^{SI}/\mu)}, \quad (19)$$

where μ is the cost of a unit of information derived above. From this model, we can thus state the fourth hypothesis regarding attention towards inflation:

> **H4:** Under imperfect information and with a choice between costly new information or costless outdated information, attention towards inflation should increase with higher past forecast errors regarding inflation.

3 The Data

We analyze microdata from the University of Michigan Survey of Consumers, which is available for the sample period January 1978 to November 2011. Since October 1987, each month a sample of about 500 households is interviewed, where the sample is chosen

[5] Detailed derivations are given in Matějka and McKay (2011).

to statistically represent households in the US, excluding Alaska and Hawaii. Sample sizes before 1987m10 were about 600-1400 interviews per month from 1978m1-1980m2, and about 600-700 interviews per month from 1980m3-1987m9. The monthly telephone survey focuses on respondents' perceptions and expectations regarding personal finances, business conditions and news regarding the economy in general, as well as macroeconomic aggregates such as unemployment, interest rates and inflation. Furthermore, the survey collects individual and household socioeconomic characteristics.[6]

For the analysis of the dynamics of individuals' inflation expectations, we exploit the fact that the Michigan Survey of Consumers includes a rotating panel: Each month, a randomly determined sub-sample of households is chosen to be re-interviewed six months after the first interview. The complete cross-section each month includes about 40% of individuals that are interviewed for the second time. Via the rotating panel structure of the survey, we are able to identify changes in expectations on an individual consumer level. Figure 1 shows the total sample size of the Michigan Survey of Consumers from 1978 to 2011 and the size of the rotating panel, which includes all households that are interviewed twice, consisting of about 80% (about 400 since 1987m10) of the complete cross-section each month. As shown in Figure 1, sample sizes varied considerably in the earlier months of the survey, and have been relatively constant since October 1987. Consequently, in the following analysis we restrict our sample period to those cross-sections from October 1987 onwards. While this ensures a homogeneous sample size for each cross-section (with very few exceptions) of about 400 individuals each month, we can at the same time exclude any effects from the downward trend in inflation during the Great Moderation.[7]

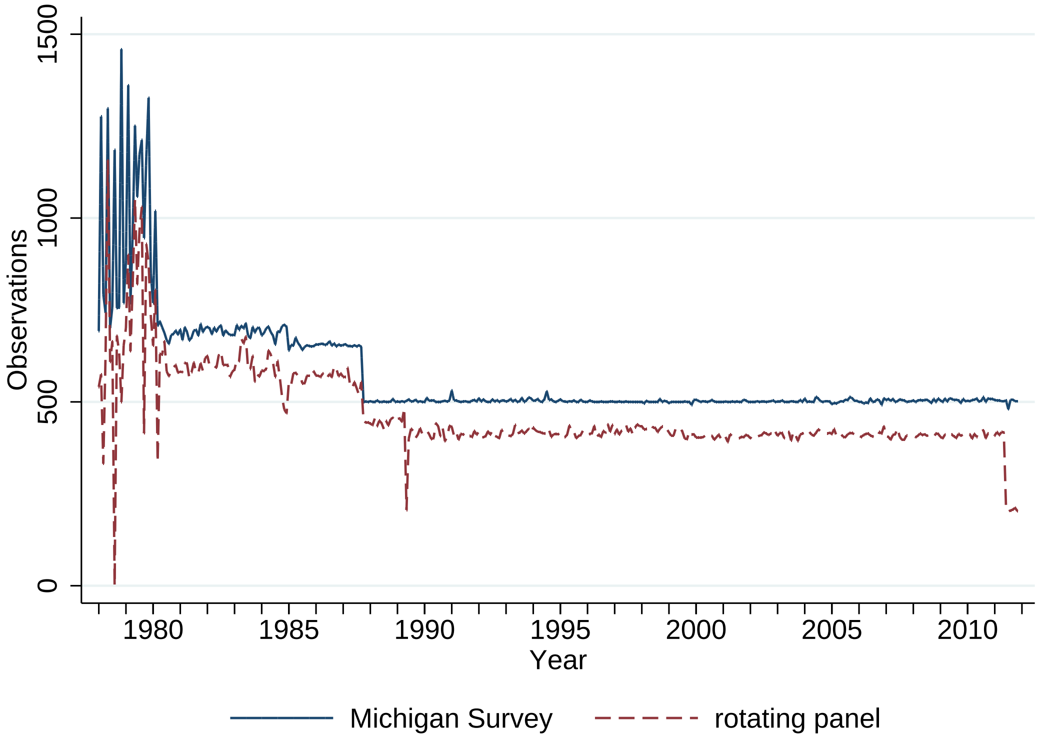
In order to identify individual changes in inflation expectations at a micro level, we follow Souleles (2004) and Pfajfar and Santoro (2013) and restrict our sample to households where the same person answered both interviews. We thus keep all pairs of observations in the rotating panel, where the interviews were six months apart and where the respondent reported the same sex, race as well as month and year of birth. Additionally, we control for the age of the respondent and only allow increases by one year between interviews. In order to rule out extreme values for inflation expectations, we further truncate our sample by excluding the upper and lower 2.5% of the distribution of both short- and long-run quantitative inflation expectations.

For the evaluation of changes in individuals' inflation expectations, we are able to exploit the fact that, in addition to a qualitative question asking about expectations regarding "prices in general", the Michigan Survey includes questions asking for a quantitative estimate of expected inflation. Moreover, the survey allows to distinguish between individuals' expectations regarding inflation during the next year and expectations at a longer horizon of five to ten years. The precise questions of the survey read:

[6] For further details on the University of Michigan Survey of Consumers, see http://www.sca.isr.umich.edu.

[7] We check for robustness of our results with respect to the sample period and present estimations for our main results with the full sample period in section 4.6.

Figure 1: Identified Cross-Section of Individuals



A12. "During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?"
1. GO UP 3. STAY THE SAME 5. GO DOWN 8. DON'T KNOW

A12b. "By about what percent do you expect prices to go (up/down) on the average, during the next 12 months?"

A13. "What about the outlook for prices over the next 5 to 10 years? Do you think prices will be higher, about the same, or lower, 5 to 10 years from now?"
1. HIGHER 3. STAY THE SAME 5. LOWER 8. DON'T KNOW

A13b. "By about what percent per year do you expect prices to go (up/down) on the average, during the next 5 to 10 years?"

As we are interested in evaluating the role of information frictions for the formation of inflation expectations, we employ the question in the Michigan Survey of Consumers asking for news on the economy heard by the respondent as a measure of perceived news regarding inflation. The wording of the question is as follows:

A6. "During the last few months, have you heard of any favorable or unfavorable changes in business conditions?"
1. YES 2. NO

If the question is answered with "yes", an open question with two possible answers follows:

A6a. "What did you hear? (Have you heard of any other favorable or unfavorable changes in business conditions?)"

The answers are coded into categories by the Michigan Survey of Consumers. For our purposes, we construct a dummy variable "newsprices" which takes on the value of 1 if the respondent reported news heard on either *"falling prices/deflation"*, *"high prices/inflation"*, *"higher prices/inflation is good"* or *"lower, stable prices/less inflation"* as either the first or the second piece of news heard, and zero otherwise. Additionally, we distinguish between news heard about high and low inflation or prices with the dummy variables "newsprices_high" and "newsprices_low". In order to be able to distinguish between favorable or unfavorable news regarding inflation, we further construct the dummy variables "newsprices_bad" and "newsprices_good". We code news on *"higher prices/inflation is good"* and on *"lower, stable prices/less inflation"* as favorably perceived by the respondent, while the other two categories are coded as unfavorable news.

Furthermore, we employ a number of sociodemographic control variables from the Michigan Survey of Consumers in the following analyses, such as age and sex of the respondent as well as income quartiles and a categorical variable measuring education of the respondent in six categories. These are defined as follows: Educ1 – "*Grade 0-8, no high school diploma*", Educ2 – "*Grade 9-12, no high school diploma*", Educ3 – "*Grade 0-12, with high school diploma*", Educ4 – "*4 yrs. of college, no degree*", Educ5 – "*3 yrs. of college, with degree*" and Educ6 – "*4 yrs. of college, with degree*".

In addition to the microdata from the Michigan Survey of Consumers, we employ monthly data on actual U.S. inflation since 1978m1 from the FRED database of the St. Louis FED. Monthly data for Treasury-bill constant maturity secondary market rates is also extracted from the FRED database. We further use quarterly data of inflation expectations regarding U.S. inflation from the Survey of Professional Forecasters (SPF), which is available from 1981q3 onwards for one-year-ahead inflation forecasts, and from 1991q4 onwards for ten-years-ahead inflation forecasts. As a measure of cross-sectional dispersion and, thus, as a proxy for professional forecasters' disagreement, we include the interquartile range from the SPF for both one-year-ahead and ten-years-ahead inflation forecasts. Finally, we account for the attention of the media to topics related to U.S. inflation with the number of articles published on U.S. inflation in the New York Times. This measure of external information is obtained from the media research institute MediaTenor and is available on a monthly basis from 1998m1 to 2011m5.[8]

[8] This data is coded by humans following the standards of media content analysis.

4 Results

4.1 The Individual Updating Frequency of Inflation Expectations

As a first step, we calculate the share of individuals in each monthly cross-section that adjusted their expectations, denoted as "updating share". In line with the literature, we interpret the updating share as the share of individuals which updated their information, and, hence, also their expectations. However, it should be noted that in theory it might be possible to update information on inflation and nevertheless keep expectations constant on the basis of new information. While we cannot verify this possibility, we note that the updating share represents the lower bound of the monthly number of individuals which updated their information regarding inflation. The updating share is calculated for both short- and long-run inflation expectations captured by both the qualitative and the quantitative answers. Summary statistics are given in Table 1.

Table 1: Summary Statistics of the Monthly Updating Shares for Inflation Expectations

Variable	Obs	Mean	SD	Min	Max
Short-run expectations, 1 year	289	0.74	0.06	0.60	0.87
Short-run expectations, 1 year, qualitative answer	289	0.38	0.09	0.16	0.67
Long-run expectations, 5-10 years	255	0.72	0.06	0.57	0.86
Long-run expectations, 5-10 years, qualitative answer	255	0.17	0.05	0.03	0.34

Notes: Results for the sample period from 1987m10-2011m11. *Obs* denotes the sample size, *SD* is the standard deviation while *Min* and *Max* represent the minimum and maximum values.

According to our calculations, individuals in the Michigan survey on average update their one-year-ahead inflation expectations based on the quantitative question every 8 months and every 16 months based on the qualitative question. Regarding long-run inflation expectations, the updating frequencies vary between 8 and 36 months based on the quantitative and the qualitative question, respectively. Overall, we find higher updating frequencies using the answers to the quantitative question as reported in the literature from aggregate data.[9] Using the population mean of quantitative inflation expectations from U.S. surveys Carroll (2003) estimates an updating share of roughly 0.25 over a quarter, corresponding to a value of 0.5 over six months. This implies that expectations are updated once within a year. For Europe, using qualitative survey data, Döpke et al. (2008a) report a somewhat lower updating frequency than that in the US: A

[9]The Michigan Survey imposes that quantitative inflation expectations be stated as full numbers, excluding decimals. Therefore, an update of quantitative inflation expectations implies a change of at least one percentage point. Hence, we capture as "updating" already a meaningful deviation from the preceding forecast. In order to test whether more substantial changes have different effects, we also analyze updating frequencies with expectation changes larger than 1 or 5 percentage points. Results are presented in the robustness section 4.6.

typical household updates its inflation expectations roughly once in eighteen months. One possible explanation for our result of a higher updating frequency at the micro level may be related to the aggregation phenomenon. The effect that aggregation of individual data series reduces the variability of the underlying microdata and increases its persistence is a known result, e.g. from movements in price indices (Altissimo et al., 2007).

Notably, the difference in the updating frequency between the qualitative and quantitative answers is quite remarkable. Given the way the questions are phrased, this suggests that individuals fine-tune their quantitative expectations very regularly, but change their general view regarding inflation much less frequently. This implies that qualitative adjustments co-move with substantial adjustments in the quantitative assessment. Alternatively, the high updating share reported from the quantitative question might also be a hint to macroeconomic illiteracy or memory loss (Blanchflower and Kelly, 2008): Some individuals might not have changed their view on inflation, but fail to recall the exact number reported six months ago.

To test the hypothesis of fine-tuning, we check whether the mean change in quantitative expectations is smaller if there is no change in the qualitative assessment. For this purpose we employ comparison of mean tests with different variances. Conducting those tests we find support for the hypothesis that quantitative changes are indeed significantly smaller if the qualitative response did not change.[10] This implies that the high updating frequency identified from the quantitative answer represents mainly only very gradual adjustments, where larger adjustments occur when qualitative expectations are adjusted as well. To test the hypothesis with regard to macroeconomic illiteracy, we check whether updating of inflation expectations improves the forecast accuracy. If updating significantly alters forecast errors, this should hint to a sufficient degree of macroeconomic literacy and hence imply that the updating we identify is indeed something very meaningful. The results of this analysis are presented in the upcoming section.

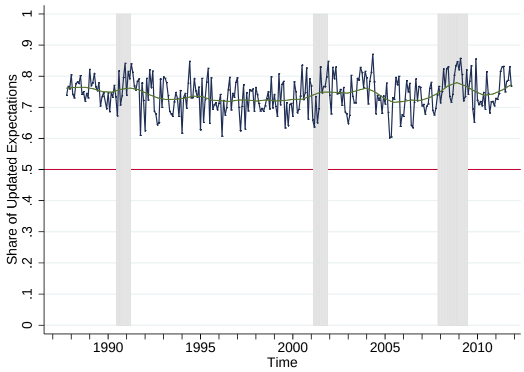
Coming back to the different results presented in the literature for the updating propensity of US and European consumers, our study allows for an insight that challenges this result. In fact, our data suggests that this difference between US and European consumers might be driven by the type of survey data available: Qualitative vs. quantitative data. In the above paragraph, the results of Döpke et al. (2008a) indicate that European consumers are more sluggish in adjusting their expectations than US consumers. This result is based on qualitative data, while the results for the US are based on quantitative data. If we now consider that our results for the US show that qualitative expectations are adjusted less frequently than quantitative expectations, the reported difference in those studies comparing European and US consumers may be only driven by the fact that

[10] Test statistics equality of means t-test with unequal variances and with H0: difference of means=0. One-year expectations: t-value=-32.81, Satterthwaite's degrees of freedom=16808, p-value=0.000; test 5-10 years expectations: t-value=-19.79, Satterthwaite's degrees of freedom=3692.68, p-value=0.000

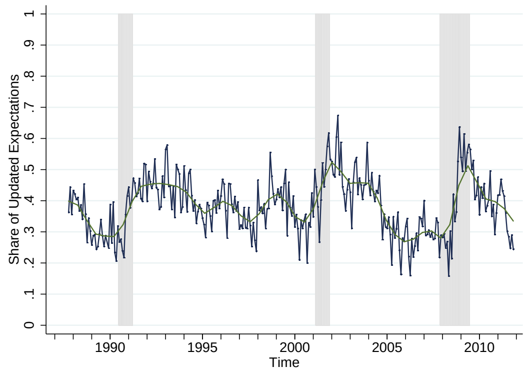
different types of survey data were used and consequently may imply that the US and Europe have very similar updating frequencies.

Long-run expectations are, in line with our expectations, adjusted less often than short-run expectations, particularly qualitative expectations, and hence seem more firmly anchored on average. Long-run expectations should not be affected much by business cycle effects, but rather be related to fundamental factors. Such fundamentals might include the long-run stance of monetary policy, for instance with respect to an inflation target.

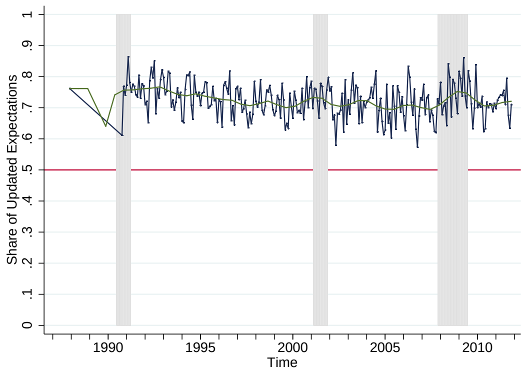
Figure 2: Updating Shares for Inflation Expectations



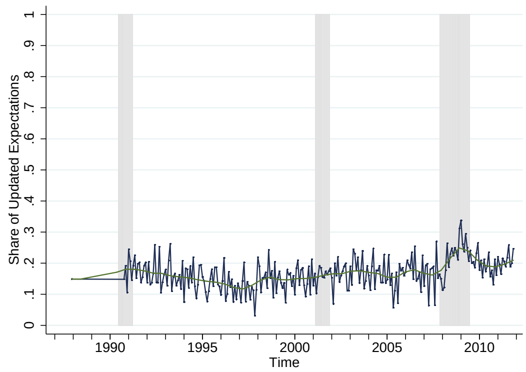
(a) Short-run expectations, 1 year



(b) Short-run expectations, 1 year, qualitative answer



(c) Long-run expectations, 5-10 years



(d) Long-run expectations, 5-10 years, qualitative answer

Notes: The graphs show the share of individual consumers that change their inflation expectations within six months together with a smoothing polynomial trend. Shaded areas are recession phases as identified by the NBER. The share is calculated by taking all individuals that adjusted their expectations during the last six months and dividing them by the overall number of individuals that have been re-interviewed.

Next, we plot the share of households that update their inflation expectations over time together with a smoothing polynomial trend, shown in Figure 2. Several approaches in the literature report evidence that updating shares regarding inflation expectations in the population may vary substantially over time. Dräger (2011a) argues that people respond to the variance of the forecasted variable, Coibion and Gorodnichenko (2010) show that the information rigidity changes over the business cycle and Lamla and Sarferaz

(2012) relate the variation of the updating speed for expectations of German consumers to uncertainty and news effects. Finding time-varying updating frequencies would favor models of rational inattention rather than sticky information, where the updating share of individuals should stay constant over time.

Looking at the changes in qualitative one-year-ahead inflation expectations, we can observe substantial variation in the updating share, which fluctuates between about 20% and 60%. Interestingly, we can observe relatively strong surges during recessionary periods. Especially from 2008 onwards, the share of individuals that updated their inflation expectations rose substantially. The cyclical pattern is also present in the updating share from quantitative short-run expectations, albeit less pronounced.

Regarding the updating shares of long-run inflation expectations, we find significantly less time-variation compared to one-year-ahead inflation expectations. Fundamentals and the monetary stance should not change often and hence a rather constant updating share has to be expected. Unfortunately, the question on long-run inflation expectations was not included in every monthly survey before October 1990, leading to missing values in the time series of the updating shares. For the following regression analysis, we thus restrict the sample period for individual long-run inflation expectations to a start in October 1990.

4.2 Testing for Imperfect Information in Individual Inflation Expectations

After showing that updating shares of inflation expectations vary significantly over time, we next test whether relevant information is incorporated into short-run inflation expectations in the sense that a significant effect of the relevant macroeconomic variables on forecast errors indicates a violation of the rational expectations hypothesis. While most approaches in the literature, for instance Mankiw et al. (2004), regress mean forecast errors on a set of macroeconomic aggregates to test for the rational expectations hypothesis, Coibion and Gorodnichenko (2010) argue that a more concise test for information frictions can be derived as a test for models with information frictions. This is our hypothesis H1, where in the presence of information frictions, individual forecast errors should be positively affected by the invididuals' own forecast revisions. We test this assumption with individual forecast errors from our microdata sample for the period from 1987m10 onwards.

Due to the fixed horizon of inflation expectations in the Michigan survey, instead of forecast revisions ($E_{i,t}\pi_{t+12} - E_{i,t-6}\pi_{t+12}$) between the first and the second interview, we have the individual change in the 1-year-ahead inflation forecast ($E_{i,t}\pi_{t+12} - E_{i,t-6}\pi_{t+6}$) between interviews. Using this measure as a proxy for individual forecast revisions introduces persistence in the error term. In line with Coibion and Gorodnichenko (2010), we thus instrument for the individual forecast revision with an oil-price shock. Addi-

Table 2: Test for Information Frictions with Microdata

	(1) $(\pi_{t+12} - E_t\pi_{t+12})$	(2) $(\pi_{t+12} - E_{i,t}\pi_{t+12})$
$(E_t\pi_{t+12} - E_{t-1}\pi_{t+11})$	1.207	
	(1.288)	
$(E_{i,t}\pi_{t+12} - E_{i,t-6}\pi_{t+6})$		0.314***
		(0.0698)
Constant	-0.737***	-0.242***
	(0.106)	(0.0292)
Observations	281	23,329
Wald $\chi^2(1)$	0.88	20.30
Prob > χ^2	0.349	0.000
Hansen's J $\chi^2(34)$	–	175.559
Prob > χ^2		0.000
Summary statistics of the first stage		
Adj. R^2	0.0221	0.0061
Robust F-stat	6.802	10.597
Prob > F	0.010	0.000

Note: IV regression estimated via GMM. Monthly mean forecast revisions instrumented with the oilpriceshock. Individual forecast revisions instrumented with the oilpriceshock and demographic controls. Robust standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5%and 10% level, respectively. $(\pi_{t+12} - E_t\pi_{t+12})$ is the forecast error, which is explained by the forecast revision based on individual data $(E_{i,t}\pi_{t+12} - E_{i,t-6}\pi_{t+6})$ and aggregated data $(E_t\pi_{t+12} - E_{t-1}\pi_{t+11})$.

tional instruments include sociodemographic characteristics such as age, sex, education and income groups.[11]

Table 2 shows the results of the test for information rigidities from GMM estimates with robust standard errors. It compares estimation results of monthly mean forecast errors with individual forecast errors from the underlying microdata. Hence, the first column is basically a replication of the analysis in Coibion and Gorodnichenko (2010) where forecast revisions are proxied by the change in mean expectations with respect to the previous month, while the second column evaluates individual forecast errors using individual changes in expectations between interviews as a proxy for forecast revisions. In contrast to the findings of Coibion and Gorodnichenko (2010), the coefficient of forecast revisions, albeit positive, is insignificant when using aggregated expectations. This may be due to the slightly differing estimation period and the fact that we use monthly instead of quarterly data. When testing for information frictions directly with the underlying microdata, we find a smaller, but significantly positive coefficient on instrumented forecast

[11]The oil-price shock is derived as in Coibion and Gorodnichenko (2010) using the residual of a regression of nominal oil price increases on an AR(1) and AR(2) term.

revisions, indicating that H1 cannot be rejected. However, this result should be interpreted cautiously as the additional demographic instruments are likely correlated with the error term in the second stage, leading to a rejection of Hansen's overidentification test. Nevertheless, we argue that they are necessary to account for individual-specific variation.

4.3 Updating Inflation Expectations

The general test by Coibion and Gorodnichenko (2010) in the previous section indicated that information frictions may affect individuals' formation of inflation expectations. In this section, we go one step further and link the updating behavior regarding inflation expectations to possible determinants derived from the theories of imperfect information discussed in section 2. Specifically, we estimate pooled cross-section probit models for the propensity to update both individual quantitative and qualitative short- and long-run inflation expectations in the second interview, including aggregate regressors derived from the theoretic models as well as demographic factors.

From the simple model of rational inattention regarding inflation derived in section 2, we get our second hypothesis H2, stating that attentiveness towards inflation should be affected by the variance of inflation forecasts under full information, i.e. the variance of actual inflation. This result is also presented in Maćkowiak and Wiederholt (2009) in a rational inattention model of price setting and in Reis (2006) in a sticky information model. In order to test for H2, we thus include both the variability of actual inflation and of professional forecasters' inflation outlook from the Survey of Professional Forecasters as determinants for the probability of an update of inflation expectations. We argue that the latter may be regarded as a proxy for the full information forecast of inflation. Both measures are calculated as the sum of squared monthly changes of inflation from $t-1$ to $t-6$. According to H2, if the variability of either actual inflation or professional forecasts increases, people should pay more attention to inflation and, thus, have an increased probability to update their expectations. Additionally, we test for an effect of disagreement of professional forecasters, measured by the interquartile range, and of the volatility of mean forecasts over all consumers.

Next, we attempt to evaluate hypothesis H3 from the rational inattention model by testing for the effect of news on individuals' updating behavior. Hypothesis H3 states that attention towards inflation should be a positive function of news regarding inflation, as these should lower the marginal cost of attention and, thus, increase the probability of an update. This is in line for instance with arguments in Lamla and Sarferaz (2012). We account for news effects by including the change in the number of news on inflation in the media over the last six months and the individual change between interviews in the variable stating whether the individual observed any news on inflation. We thus disentangle the sender and receiver perspective regarding the news. Additionally, we also account for possible asymmetries, e.g. that news heard on high inflation might be more likely to trigger an adjustment of expectations compared to news on low or falling inflation.

Finally, we test for evidence regarding hypothesis H4, which was derived from the model in Dräger (2011a). Under H4, the probability of updating inflation expectations should be positively affected by an increase in individuals' own past forecast errors, since the predictor formed with outdated information becomes less attractive, the higher its forecast error. We thus include the absolute individual forecast error from the first interview as an explanatory variable for the propensity to update expectations in the second interview. Notably, as we have only a six-months lag between both interviews, the forecast error from six months ago has not been fully realized yet. Therefore, we instrument for individual absolute forecast errors six months ago with the mean lagged absolute forecast error from professionals' six-months-ahead inflation forecasts, where the forecast error is realized in the current period.

Tables 3-8 comprise the estimation results for the probability of updating inflation expectations. The first set of results shows models including different measures of inflation volatility as well as individual absolute forecast errors as determinants for the updating of both short- and long-run quantitative and qualitative inflation expectations. In a second set of tables, we test for the effects of different news variables. All tables report marginal effects with standard errors clustered at the year level and all models additionally include demographic controls such as age and sex of respondent as well as education and income groups. Our sample starts in 1987m10 for the regressions on one-year-ahead expectations. For the 5-10-year expectations, the sample starts in 1990m10, since the regular monthly sampling of this question starts there.

In general, we find that the suggested explanatory variables can explain more of the short-run updating behavior than the long-run updating behavior. This is certainly in line with our expectations. Long-run expectations should be more related to fundamental factors that vary only little and are not sufficiently captured by our set of determinants. While we find some evidence that inflation volatility and own past forecast errors have a positive effect also on the updating of long-run expectations, there are no significant news effects. Results for the updating models with news for long-run expectations are thus shown in Tables A.1-A.2 in the Appendix .

Given these results, we concentrate more on the updating behavior of short-run inflation expectations. We find that an increase in the volatility of professionals' inflation forecasts significantly increases the probability of an update of both individual quantitative and qualitative inflation expectations. Additionally, short-run qualitative expectations are less likely to be updated when disagreement among professional forecasters has increased. This might be interpreted as indicating periods, where the accuracy of signals from professional forecasters is reduced. Generally, we thus find evidence in favor of H2 and, hence, in favor of rational inattention regarding inflation.

With regard to the hypothesis H4, we find that instrumented own past forecast errors from the first interview positively affect the probability of an expectations update in the second interview in all models, except for the model for qualitative short-run expectations. In line with H4, this suggests that consumers' own forecast accuracy may be used as a signal regarding the benefit of an information update.

Finally, regarding the news measures, we find some positive news effects on the propensity to update both quantitative and qualitative short-run inflation expectations. In the case of quantitative expectations, there is a general positive impact of a change in perceived news regarding prices, while in the case of qualitative inflation expectations, the effect is driven only by a change in positive inflation news perceived. Overall, we thus find some tentative evidence in favor of H3.

Table 3: Updating One-Year-Ahead Inflation Expectations

	(1)	(2)	(3)	(4)	(5)[1]
$\Delta(Newsprices)_t$	0.015*	0.015*	0.014*	0.013*	0.054**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.027)
$\sigma^2_{\pi,t-1}$	0.003				
	(0.002)				
$\sigma^2_{\pi^{e,1yr}_{prof,t-1}}$		0.033**			
		(0.013)			
$\sigma^2_{\pi^{e,1yr}_{cons,t-1}}$			0.003		
			(0.002)		
$\Delta(IQR^{e,1yr})_{prof,t-1}$				0.017	
				(0.017)	
$AFE_{i,t-6}$					0.082**
					(0.039)
Observations	24,021	24,021	24,021	24,021	23,802
Demographics Controls	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.00117	0.00131	0.00119	0.00115	–
Wald test for exogeneity	–	–	–	–	3.74e-05
Prob.	–	–	–	–	0.995

Note: Marginal effects with clustered standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. [1] IV probit estimated with maximum likelihood. $\Delta(Newsprices)_t$ is a dummy variable indicating whether individuals have changed their opinion on news heard over prices with respect to the first interview. $\sigma^2_{\pi,t-1}$ denotes the sum of squared changes of inflation over the recent six months. $\sigma^2_{\pi^{e,1yr}_{prof,t-1}}$ represents the sum of squared changes of inflation expectations of professional forecasters in the Survey of Professional Forecasters (SPF) over the recent six months. $\Delta(IQR^{e,1yr})_{prof,t-1}$ is change in the corresponding dispersion of expectations of professionals captured by the interquartile range over the recent six months. $\sigma^2_{\pi^{e,1yr}_{cons,t-1}}$ denotes the sum of squared changes of mean inflation expectations of consumers in the Michigan Survey over the recent six months. $AFE_{i,t-6}$ stands for the individual absolute forecast error made with the prediction of the first interview $|(\pi_{t+6} - E_{i,t-6}(\pi_{t+6}))|$, instrumented with the lagged absolute forecast error from professionals' six-months-ahead forecast of inflation.

Table 4: Updating One-Year-Ahead Qualitative Inflation Expectations

	(1)	(2)	(3)	(4)	(5)[1]
$\Delta(Newsprices)_t$	0.001	0.001	0.000	0.001	-0.015
	(0.013)	(0.013)	(0.013)	(0.013)	(0.045)
$\sigma^2_{\pi,t-1}$	0.007				
	(0.006)				
$\sigma^2_{\pi^{e,1yr}_{prof,t-1}}$		0.085*			
		(0.051)			
$\sigma^2_{\pi^{e,1yr}_{cons,t-1}}$			0.007		
			(0.006)		
$\Delta(IQR^{e,1yr})_{prof,t-1}$				-0.074**	
				(0.031)	
$AFE_{i,t-6}$					-0.021
					(0.152)
Observations	25,349	25,349	25,349	25,349	23,802
Demographics Controls	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.00244	0.00323	0.00252	0.00299	–
Wald test for exogeneity	–	–	–	–	0.0783
Prob.	–	–	–	–	0.780

Note: Marginal effects with clustered standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. [1] IV probit estimated with maximum likelihood. $\Delta(Newsprices)_t$ is a dummy variable indicating whether individuals have changed their opinion on news heard over prices with respect to the first interview. $\sigma^2_{\pi,t-1}$ denotes the sum of squared changes of inflation over the recent six months. $\sigma^2_{\pi^{e,1yr}_{prof,t-1}}$ represents the sum of squared changes of inflation expectations of professional forecasters in the Survey of Professional Forecasters (SPF) over the recent six months. $\Delta(IQR^{e,1yr})_{prof,t-1}$ is change in the corresponding dispersion of expectations of professionals captured by the interquartile range over the recent six months. $\sigma^2_{\pi^{e,1yr}_{cons,t-1}}$ denotes the sum of squared changes of mean inflation expectations of consumers in the Michigan Survey over the recent six months. $AFE_{i,t-6}$ stands for the individual absolute forecast error made with the prediction of the first interview $|(\pi_{t+6} - E_{i,t-6}(\pi_{t+6}))|$, instrumented with the lagged absolute forecast error from professionals' six-months-ahead forecast of inflation.

Table 5: Updating Five-to-Ten-Years-Ahead Inflation Expectations

	(1)	(2)	(3)	(4)	(5)[1]
$\Delta(Newsprices)_t$	-0.002	-0.003	-0.003	-0.003	-0.007
	(0.007)	(0.008)	(0.008)	(0.008)	(0.023)
$\sigma^2_{\pi,t-1}$	0.004				
	(0.004)				
$\sigma^2_{\pi^{e,5-10yr}_{prof,t-1}}$		0.058			
		(0.069)			
$\sigma^2_{\pi^{e,5-10yr}_{cons,t-1}}$			0.006*		
			(0.003)		
$\Delta(IQR^{e,5-10yr})_{prof,t-1}$				0.020	
				(0.019)	
$AFE_{i,t-6}$					0.041*
					(0.024)
Observations	19,225	16,842	19,225	17,696	18,487
Demographics Controls	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.00512	0.00516	0.00518	0.00513	–
Wald test for exogeneity	–	–	–	–	0.0822
Prob.	–	–	–	–	0.774

Note: Marginal effects with clustered standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. [1] IV probit estimated with maximum likelihood. $\Delta(Newsprices)_t$ is a dummy variable indicating whether individuals have changed their opinion on news heard over prices with respect to the first interview. $\sigma^2_{\pi,t-1}$ denotes the sum of squared changes of inflation over the recent six months. $\sigma^2_{\pi^{e,5-10yr}_{prof,t-1}}$ represents the sum of squared changes of long-run inflation expectations of professional forecasters in the Survey of Professional Forecasters (SPF) over the recent six months. $\Delta(IQR^{e,1yr})_{prof,t-1}$ is change in the corresponding dispersion of expectations of professionals captured by the interquartile range over the recent six months. $\sigma^2_{\pi^{e,5-10yr}_{cons,t-1}}$ denotes the sum of squared changes of mean long-run inflation expectations of consumers in the Michigan Survey over the recent six months. $AFE_{i,t-6}$ stands for the individual absolute forecast error made with the prediction of the first interview $|(\pi_{t+6} - E_{i,t-6}(\pi_{t+6}))|$, instrumented with the lagged absolute forecast error from professionals' six-months-ahead forecast of inflation.

Table 6: Updating Five-to-Ten-Years-Ahead Qualitative Inflation Expectations

	(1)	(2)	(3)	(4)	(5)[1]
$\Delta(Newsprices)_t$	-0.006	-0.014	-0.010	-0.014	0.012
	(0.011)	(0.013)	(0.013)	(0.012)	(0.054)
$\sigma^2_{\pi,t-1}$	0.008***				
	(0.002)				
$\sigma^2_{\pi^{e,5-10yr}_{prof,t-1}}$		-0.089			
		(0.079)			
$\sigma^2_{\pi^{e,5-10yr}_{cons,t-1}}$			0.001		
			(0.002)		
$\Delta(IQR^{e,5-10yr})_{prof,t-1}$				0.000	
				(0.026)	
$AFE_{i,t-6}$					0.149***
					(0.033)
Observations	20,415	17,959	20,415	18,844	19,007
Demographics Controls	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.0198	0.0171	0.0180	0.0172	–
Wald test for exogeneity	–	–	–	–	10.47
Prob.	–	–	–	–	0.001

Note: Marginal effects with clustered standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. [1] IV probit estimated with maximum likelihood. $\Delta(Newsprices)_t$ is a dummy variable indicating whether individuals have changed their opinion on news heard over prices with respect to the first interview. $\sigma^2_{\pi,t-1}$ denotes the sum of squared changes of inflation over the recent six months. $\sigma^2_{\pi^{e,5-10yr}_{prof,t-1}}$ represents the sum of squared changes of long-run inflation expectations of professional forecasters in the Survey of Professional Forecasters (SPF) over the recent six months. $\Delta(IQR^{e,1yr})_{prof,t-1}$ is change in the corresponding dispersion of expectations of professionals captured by the interquartile range over the recent six months. $\sigma^2_{\pi^{e,5-10yr}_{cons,t-1}}$ denotes the sum of squared changes of mean long-run inflation expectations of consumers in the Michigan Survey over the recent six months. $AFE_{i,t-6}$ stands for the individual absolute forecast error made with the prediction of the first interview $|(\pi_{t+6} - E_{i,t-6}(\pi_{t+6}))|$, instrumented with the lagged absolute forecast error from professionals' six-months-ahead forecast of inflation.

Table 7: Updating One-Year-Ahead Inflation Expectations and News

	(1)	(2)	(3)	(4)
$\sigma^2_{\pi^{e,1yr}_{prof,t-1}}$	0.033**	0.013	0.033**	0.033**
	(0.013)	(0.025)	(0.013)	(0.013)
$\Delta(Newsprices)_t$	0.015*			
	(0.008)			
$\Delta(Volume)_{t-1}$		-0.000		
		(0.001)		
$\Delta(Newsprices\_high)_t$			0.012	
			(0.008)	
$\Delta(Newsprices\_low)_t$			0.028	
			(0.018)	
$\Delta(Newsprices\_bad)_t$				0.014
				(0.010)
$\Delta(Newsprices\_good)_t$				0.021
				(0.015)
Observations	24,021	11,710	24,021	24,021
Demographic Controls	Yes	Yes	Yes	Yes
Pseudo R^2	0.00131	0.00167	0.00134	0.00133

Note: Marginal effects with clustered standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. $\sigma^2_{\pi^{e,1yr}_{prof,t-1}}$ represents the sum of squared changes of inflation expectations of professional forecasters in the Survey of Professional Forecasters (SPF) over the recent six months. $\Delta(Newsprices)_t$ is a dummy variable indicating whether individuals have changed their opinion on news heard over prices with respect to the first interview. $\Delta(Volume)_{t-1}$ denotes the change in the volume of media news on inflation within the past six months, starting in the last observed period. $\Delta(Newsprices\_high)_t$, $\Delta(Newsprices\_low)_t$, $\Delta(Newsprices\_good)_t$ and $\Delta(Newsprices\_bad)_t$ denote changes in news heard on rising/falling inflation and prices as well as favorable and unfavorable news.

Table 8: Updating One-Year-Ahead Qualitative Inflation Expectations and News

	(1)	(2)	(3)	(4)
$\sigma^2_{\pi^{e,1yr}_{prof,t-1}}$	0.085*	0.131*	0.085*	0.085*
	(0.051)	(0.078)	(0.051)	(0.051)
$\Delta(Newsprices)_t$	0.001			
	(0.013)			
$\Delta(Volume)_{t-1}$		-0.001		
		(0.001)		
$\Delta(Newsprices\_high)_t$			-0.003	
			(0.014)	
$\Delta(Newsprices\_low)_t$			0.022	
			(0.027)	
$\Delta(Newsprices\_bad)_t$				-0.007
				(0.014)
$\Delta(Newsprices\_good)_t$				0.033*
				(0.020)
Observations	25,349	12,578	25,349	25,349
Demographic Controls	Yes	Yes	Yes	Yes
Pseudo R^2	0.00323	0.00603	0.00326	0.00331

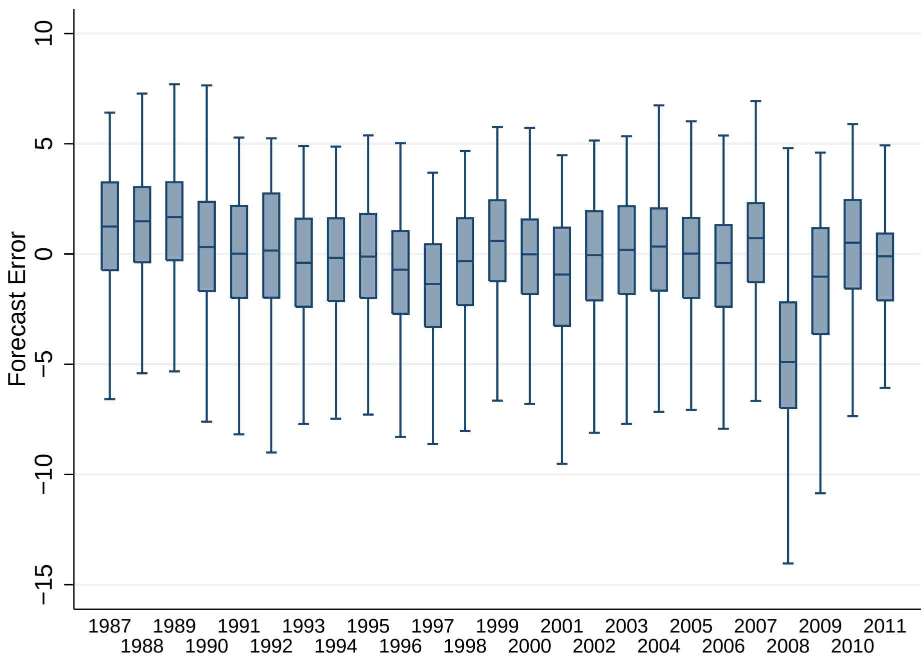
Note: Marginal effects with clustered standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. $\sigma^2_{\pi^{e,1yr}_{prof,t-1}}$ represents the sum of squared changes of inflation expectations of professional forecasters in the Survey of Professional Forecasters (SPF) over the recent six months. $\Delta(Newsprices)_t$ is a dummy variable indicating whether individuals have changed their opinion on news heard over prices with respect to the first interview. $\Delta(Volume)_{t-1}$ denotes the change in the volume of media news on inflation within the past six months, starting in the last observed period. $\Delta(Newsprices\_high)_t$, $\Delta(Newsprices\_low)_t$, $\Delta(Newsprices\_good)_t$ and $\Delta(Newsprices\_bad)_t$ denote changes in news heard on rising/falling inflation and prices as well as favorable and unfavorable news.

4.4 Explaining Individual Forecast Errors

After analyzing the factors that may trigger an updating of short-run and long-run expectations in the previous section, we next evaluate forecast errors calculated from one-year-ahead quantitative inflation expectations for those individuals.

Figure 3 presents a Boxplot of individual forecast errors. Over the estimation period starting in 1987m10, errors are about zero on average, with the exception of largely negative forecast errors at the start of the financial crisis in 2008, when actual and expected inflation moved temporarily in opposite directions.[12] Furthermore, individual forecast errors have slightly more mass on the negative side. This suggests that more individuals overestimated, rather than underestimated, inflation during the sample period.

Figure 3: Boxplot of Individual Forecast Errors



The results in the previous sections give evidence of information frictions affecting individuals' attentiveness towards inflation in line with the theoretical hypotheses H1-H4. However, the question remains whether more attentiveness towards inflation, resulting in a higher probability of updating inflation forecasts, also coincides with a higher forecast accuracy. In short: does updating improve the forecast accuracy? Therefore, we next analyze how absolute forecast errors regarding inflation change when short-run inflation expectations were updated between interviews as opposed to the case when no update occurred.

[12]Forecast errors since 1987m10 have a mean of -0.572 and standard deviation of 3.418, with a minimum of -19.254 and a maximum of 7.703. Hence, on statistical grounds, given standard levels of confidence, this calculated mean is not different from zero.

Table 9: Individual Changes in Absolute Forecast Errors Conditional on Updating

	Mean	Median	SD	Obs
All	-0.61	-0.11	4.14	24,385
short-run quant. updated	-0.85	-0.38	4.78	17,900
short-run quant. not updated	0.06	0.04	0.96	6,485
short-run qual. updated	-0.93	-0.37	4.33	9,176
short-run qual. not updated	-0.41	-0.03	4.02	15,209

Note: Summary statistics for the truncated sample from 1987m10-2011m11. *SD* denotes the standard errors and *Obs* the number of observations.

Table 9 presents summary statistics for the individual changes in absolute forecast errors between interviews. Including all observations, the statistics show that, on average, absolute forecast errors decrease between interviews. This suggests, that in our sample average quantitative inflation expectations are more accurate in the second interview compared to the first interview. However, when we distinguish between individuals that updated either their quantitative or their qualitative inflation expectations and those that did not update, the summary statistics show that absolute forecast errors decrease strongly after an update of inflation expectations. In the case when quantitative inflation expectations have not been updated, the absolute forecast error even increases. Overall, these summary statistics give tentative evidence that, on average, an update of inflation expectations improves the forecast accuracy regarding inflation.

In a second step, we test whether the determinants which are found to affect the probability of an update in the models of the previous section also have an impact on the individual change in forecast accuracy in the event of an update.[13] We thus estimate models for the change in absolute forecast errors of those individuals that updated their qualitative short-run inflation expectations in the second interview.[14] Specifically, we are interested in the sign of the effect of macroeconomic determinants, i.e. whether changes in macroeconomic conditions lead to a larger improvement of forecast accuracy or whether they have a detrimental effect.

As in the previous sections, we choose the explanatory variables for our analysis in line with the implications of imperfect information models. Possible determinants of individual forecast errors thus include the variance of actual inflation and of professional forecasts. Additionally, we include the variance of mean short-run expectations by individual consumers and account for the dispersion of professional forecasts as a proxy for disagreement. Moreover, we test for the effect of news, again distinguishing between per-

[13]Since we are interested in analyzing the effects of an update of inflation expectations on individual forecast accuracy, we consequently present regression results only for those individuals that updated their qualitative short-run expectations.

[14]We differentiate between the updating of qualitative forecasts, since these seem to indicate a more substantial adjustment of inflation expectations. Results for individuals that updated their quantitative short-run inflation expectations are available upon request.

ceived news and those reported in the media. The lagged level of inflation is included in all regressions in order to capture macroeconomic level effects on forecast errors. Finally, we test whether individual forecasts are significantly affected by the business cycle, as put forward for instance in Maćkowiak and Wiederholt (2009), including a dummy for recessionary periods identified by the NBER.

Results from pooled cross-section OLS regressions with standard errors clustered at the year level are presented in Tables 10 to 11. We account for individual variation by incorporating demographic control variables such as sex, age as well as education and income groups. Again, the estimation sample starts in 1987m10.

Table 10: Individual Changes in Absolute Forecast Errors and Macroeconomic Determinants With Updated Inflation Expectations

	(1)	(2)	(3)	(4)
π_{t-1}	0.165*	0.220***	0.197**	0.233**
	(0.086)	(0.065)	(0.093)	(0.101)
$\Delta(Newsprices)_t$	0.440**	0.502**	0.485**	0.522**
	(0.182)	(0.220)	(0.204)	(0.222)
$NBER\_recession_t$	-0.132	-0.477*	-0.175	-0.567
	(0.269)	(0.261)	(0.338)	(0.376)
$\sigma^2_{\pi,t-1}$	-0.221***			
	(0.056)			
$\sigma^2_{\pi^{e,prof},t-1}$		-1.102***		
		(0.371)		
$\sigma^2_{\pi^{e,cons},t-1}$			-0.201**	
			(0.080)	
$\Delta(IQR^{e,1yr})_{prof,t-1}$				0.352
				(0.417)
Observations	8,818	8,818	8,818	8,818
Demographic Controls	Yes	Yes	Yes	Yes
Adj. R^2	0.0153	0.0135	0.0148	0.0103

Note: Clustered standard errors at the year level are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. π_{t-1} is the latest consumer inflation figure from the previous month. $\Delta(Newsprices)_t$ indicates whether individuals have changed their opinion on news heard over prices with respect to the first interview. $NBER\_recession_t$ is a dummy indicating that this period is an official recession period. $\sigma^2_{\pi,t-1}$ is the inflation volatility in the previous six months. $\sigma^2_{\pi^{e,prof},t-1}$ denotes the volatility of professionals' inflation forecasts. $\sigma^2_{\pi^{e,cons},t-1}$ is the volatility of mean short-run inflation expectations by consumers in the previous six months. $\Delta(IQR^{e,1yr})_{prof,t-1}$ is the change in the individual dispersion of professional forecasts as measured by the interquartile range in the recent six months.

The results in Table 10 suggest that a higher volatility of actual inflation as well as of mean professionals' and consumers inflation forecasts is negatively correlated with the change in absolute forecast errors after an update of qualitative expectations. Since results in Table 9 show that on average absolute forecast errors in our sample are reduced

Table 11: Individual Changes in Absolute Forecast Errors and News on Inflation With Updated Inflation Expectations

	(1)	(2)	(3)	(4)
π_{t-1}	0.220***	0.310***	0.220***	0.219***
	(0.065)	(0.079)	(0.065)	(0.065)
$\sigma^2_{\pi^{e,prof},t-1}$	-1.102***	-1.147**	-1.101***	-1.099***
	(0.371)	(0.464)	(0.368)	(0.366)
$NBER\_recession_t$	-0.477*	-0.608**	-0.476*	-0.475*
	(0.261)	(0.246)	(0.262)	(0.262)
$\Delta(Newsprices)_t$	0.502**			
	(0.220)			
$\Delta(Volume)_{t-1}$		0.032		
		(0.022)		
$\Delta(Newsprices\_high)_t$			0.571*	
			(0.308)	
$\Delta(Newsprices\_low)_t$			0.216	
			(0.297)	
$\Delta(Newsprices\_bad)_t$				0.687**
				(0.298)
$\Delta(Newsprices\_good)_t$				-0.021
				(0.284)
Observations	8,818	4,396	8,818	8,818
Demographic Controls	Yes	Yes	Yes	Yes
Adj. R^2	0.0135	0.0368	0.0134	0.0138

Note: Clustered standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. π_{t-1} denotes the consumer inflation in the previous month, $\sigma^2_{\pi^{e,prof},t-1}$ the volatility of professionals' 1-year-ahead inflation expectations. $NBER\_recession_t$ is a dummy indicating that this period is an official recession period. $\Delta(Newsprices)_t$ is a dummy variable indicating whether individuals have changed their opinion on news heard over prices with respect to the first interview. $\Delta(Volume)_{t-1}$ denotes the change in the volume of media news on inflation within the past six months, starting in the last observed period. $\Delta(Newsprices\_high)_t$, $\Delta(Newsprices\_low)_t$, $\Delta(Newsprices\_good)_t$ and $\Delta(Newsprices\_bad)_t$ denote changes in news heard on rising/falling inflation and prices as well as favorable and unfavorable news.

after an update of expectations, the negative correlation implies that in the case of an update, absolute forecast errors are reduced by more when inflation volatility is relatively high. This result is in line with the theoretical implications of rational inattention in hypothesis H1, where a higher inflation volatility is associated with a higher degree of attentiveness towards inflation and, hence, a better forecast accuracy when expectations have been updated.

Regarding the effect of news about inflation on changes in absolute forecast errors of individuals with updated qualitative inflation expectations in Table 11, we find that news are generally positively correlated with the change in absolute forecast errors. Thus suggests that perceived news reduce the accuracy of individuals' inflation forecasts after an update. This result is somewhat surprising, as news would be expected to contain relevant information on inflation and, thus, should increase forecast accuracy.

Disentangling the effect of perceived news on high versus low inflation or of favorable versus unfavorable news regarding inflation, we find that the adverse news effect on forecast accuracy is driven by bad news regarding inflation, i.e. news on high or rising inflation. By contrast, the coefficient on good news is negative, albeit insignificant. The overall negative news effect on forecast accuracy thus seems to be due to a dominance of negative news regarding inflation. The asymmetric media effects on consumers' inflation expectations and perceptions documented in Lamla and Lein (2008) and Dräger (2011b) for different European countries, hence also seem to play a role for individual consumers' expectations in the U.S.

4.5 The Role of Updates in Inflation Expectations for Explaining Bond Returns

In the previous section, we analyzed the impact of updating and its determinants on absolute forecast errors. Now we would like to know if updating behavior influences financial markets. For this purpose we investigate the effect of the share of people that adjusted their inflation expectations on the absolute change of the term spread. We argue that if more people adjust their expectations, this must imply a stronger movement in the term spread. In a second step, we then evaluate the effect of updating on the absolute change in the spread between nominal and inflation indexed bond yields. A change in the absolute gap can only be explained by market microstructure effects and most importantly by changes in the assessment regarding inflation. If many people change their expectations, the adjustment should be stronger.

For this purpose we extract the treasury-bill constant maturity secondary market rate from the economic research data base at the Federal Reserve Bank at St. Louis (FRED). We use the term-spread between the one-year and the five-year maturity (See, e.g., Fama and French, 1989). Furthermore, we take the 5-year nominal bond yield and subtract the

Table 12: Absolute Changes in Term Spreads and Updating Shares

	(1) $\|\Delta_6(r^5 - r^1)\|$	(2) $\|\Delta_6(r^5 - r^1)\|$	(3) $\|\Delta_6(r^5_{nom} - r^5_{real})\|$	(4) $\|\Delta_6(r^5_{nom} - r^5_{real})\|$
1year	0.722**			
	(0.310)			
1year qual.		0.011		
		(0.194)		
5-10 years			2.025**	
			(0.846)	
5-10 years qual.				4.713***
				(1.279)
Constant	-0.122	0.408***	-0.951*	-0.387*
	(0.230)	(0.075)	(0.578)	(0.217)
Observations	286	286	101	101
Adj. R^2	0.018	0.000	0.039	0.163

Note: Bootstrapped standard errors in parenthesis. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. 1year/1year qual. represents the share of people that changed their 1-year-ahead quantitative/qualitative expectations within six months. 5-10 year/5-10 year qual. represents the share of people that changed their 5-10-years-ahead quantitative/qualitative expectations within six months. $|\Delta_6(r^5 - r^1)|$ is the absolute change over six months in the term spread between the 5-year treasury bill rate and the 1-year treasury bill rate at constant maturity. $|\Delta_6(r^5_{nom} - r^5_{real})|$ represents the absolute change over six months in the spread between the 5-year nominal yield and the 5-year inflation indexed yield of the treasury bill at constant maturity.

5-year yield of the corresponding inflation indexed bond. For both measures we calculate the difference with respect to the previous six months and take absolute values.

Table 12 contains the regression results. Overall, we find evidence that changes in bond spreads are related to the share of people that adjusted their expectations within six months. This implies that information rigidities diffuse into financial markets. In the first two columns we regress the updating share on the absolute change in the term spread of 1- to 5-year treasury bill rates. As expected, if more people adjust their short-run inflation expectations, this leads to a greater movement in the term spread. In the last two columns we regress the updating share of 5-10-years expectations on the absolute change of the difference between nominal yields and inflation indexed yields for 5-years treasury bills. Similar to the previous findings, a higher updating share in the longer-term expectations significantly affects the movement in the inflation premium.[15]

[15] As further robustness checks we run estimations with different term-spreads up to 20 years. Furthermore, we replicate the results using the data employed by Welch and Goyal (2008) which lead to qualitatively identical results. All results are available upon request.

4.6 Robustness Checks

In this section, we present several robustness checks for our main results regarding the propensity to update short-run qualitative inflation expectations and the change in absolute forecast errors in the event of an update. First, we check whether our results are affected by the sample period chosen and re-estimate our models for the full sample (1978m1-2011m11). Second, we account for a possible attrition bias using the Heckman correction. Finally, we check whether our results are affected by the magnitude of the adjustment of inflation expectations and re-estimate the models for changes larger than 1% or 5% within six months.[16]

Overall, our conclusions remain unaffected throughout all those variations. When estimating the models for the full sample period (1978m1-2011m11), the effect of inflation volatility variables on the propensity to update expectations gains statistical significance. The effect of news on inflation on the updating of expectations diminishes, which may be due to less media reports in the beginning of our sample period.

When accounting for attrition of the respondents, we find that estimation results change only marginally.[17] This is not surprising as only 5.7% of the respondents that were re-interviewed failed to report an updated figure for inflation expectations. For the models testing the propensity to update inflation expectations (see Table 13) we find in addition a low support for the selection equation as identified through the insignificance of the Wald-test. For the regressions on the change in absolute forecast errors (see Table 14) the selection equation becomes statistically relevant, which, however, especially given the low amount of people that failed to respond does not influence the validity of the statements made earlier.

Finally, we control for the minimum size of adjustments in inflation expectations and re-calculate updating shares of quantitative inflation expectations of more than 1% and 5%, respectively. Calculating and plotting these alternative updating frequencies, we find that the updating shares are substantially lower and reveal a higher time variation, suggesting that larger updates occur much less frequently and look more like the qualitative updating measure (see Tables A.3-A.4 and Figure A.1 in the Appendix). This is as expected, as we demonstrated beforehand that qualitative adjustments in expectations are correlated with a substantial quantitative adjustment. The question hence remains if the selection of big and very big movements in expectation has consequences for our empirical results. Regarding the probability to update quantitative short-run inflation expectations larger than 1% or 5%, we find that macroeconomic determinants become economically more important, while the news channel becomes less relevant (see Table 13). Condi-

[16]For reasons of space limitations, we present estimation results for the models including the volatility of professionals' inflation forecast and the change in inflation news heard by the individual, i.e. the specification in Table 3, column 2, for the updating share and the specification in Table 10, column 2, for the change in absolute forecast errors. Robustness checks for all other models are available upon request.

[17]For the selection equation we add further socioeconomic characteristics, i.e. personal status, regional characteristics, race, number of kids and number of adults in the household.

Table 13: Robustness Checks for the Updating of Short-Run Quantitative Inflation Expectations

Model	(1) Baseline	(2) Full Sample	(3) Attrition	(4) $>1/\%$	(5) $>5/\%$
$\sigma^2_{\pi^{e,1yr}_{prof,t-1}}$	0.033**	0.019***	0.030*	0.094**	0.066**
	(0.013)	(0.005)	(0.014)	(0.044)	(0.032)
$\Delta(Newsprices)_t$	0.015*	0.009	0.015	0.003	-0.008
	(0.008)	(0.007)	(0.007)	(0.009)	(0.009)
Observations	24,021	37,437	25,323	24,021	24,021
Demographic Controls	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.00131	0.00174		0.00777	0.0236
ρ	–	–	-0.137	–	–
Wald-Test p-value	–	–	0.865	–	–

Note: Marginal effects for the probability of an update of short-run quantitative inflation expectations, with clustered standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. The Baseline model corresponds to the model in Table 3, column 2. $\sigma^2_{\pi^{e,1yr}_{prof,t-1}}$ represents the sum of squared changes of inflation expectations of professional forecasters in the Survey of Professional Forecasters (SPF) over the recent six months. $\Delta(Newsprices)_t$ is a dummy variable indicating whether individuals have changed their opinion on news heard over prices with respect to the first interview.

Table 14: Robustness Checks for Changes in Individual Forecast Errors

Model	(1) Baseline	(2) Full Sample	(3) Attrition	(4) $>1/\%$	(5) $>5/\%$
$\sigma^2_{\pi^{e,1yr}_{prof,t-1}}$	-1.102***	-0.468***	-1.463***	-1.134***	-1.088
	(0.371)	(0.138)	(0.465)	(0.385)	(0.864)
$\Delta(Newsprices)_t$	0.502**	0.447***	0.685***	0.635**	1.514***
	(0.220)	(0.159)	(0.254)	(0.272)	(0.439)
Observations	8,818	14,541	9,516	6,392	1,611
Demographic Controls	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.0135	0.0128		0.0131	0.0145
ρ	–	–	-0.890	–	–
Wald-Test p-value	–	–	0.000	–	–

Note: Effects on changes in individual absolute forecast errors after an update of qualitative short-run inflation expectations, with clustered standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. The Baseline model corresponds to the model in Table 10, column 2. $\sigma^2_{\pi^{e,1yr}_{prof,t-1}}$ represents the sum of squared changes of inflation expectations of professional forecasters in the Survey of Professional Forecasters (SPF) over the recent six months. $\Delta(Newsprices)_t$ is a dummy variable indicating whether individuals have changed their opinion on news heard over prices with respect to the first interview.

tioning on larger quantitative updates in order to explain changes in forecast errors we find that the media effect becomes slightly more important while the effect of inflation volatility stays about the same (see Table 14).

5 Conclusion

Our study contributes to the understanding of the formation of inflation expectations of consumers. Employing the rotating panel structure of the Michigan Survey of Consumers, which allows us to identify whether individuals adjust their expectations within a period of six months, we find evidence that the updating frequency of quantitative short-run inflation expectations has been underestimated in the aggregate. Furthermore, looking at the qualitative assessment regarding inflation one year ahead, we can report that expectations are adjusted much less frequently, where updating shows a cyclical pattern and is correlated with a more substantial revision in quantitative inflation expectations. Hence, this indicates that people fine-tune their expectations quite regularly, but change their general assessment less often. Regarding the horizon of expectations, we find that long-term qualitative expectations are adjusted less frequently than short-run expectations.

We furthermore explore the relevance of potential determinants that may trigger an updating of inflation expectations and their impact on the forecast accuracy. Applying the test proposed by Coibion and Gorodnichenko (2010) we can confirm that information frictions seem to be important for the explanation of short-run inflation expectations on an individual level. Specifically, we find that a rising volatility of professionals' inflation forecasts triggers an updating of consumers' inflation expectations, suggesting that rational inattention may play a role in the expectation formation process. In addition, individuals' own forecast errors as well as perceived news on inflation are also relevant drivers of adjustments in consumers' inflation expectations.

With regard to the effect of information frictions on forecast accuracy, we find that an update of short-run inflation expectations reduces the forecast error by up to 1%. Looking at the possible determinants, the change in individual absolute forecast errors is affected by the variability of actual inflation and mean inflation forecasts. Higher levels improve the forecast accuracy of consumers in the event of an update, in line with predictions from rational inattention theories. However, news on inflation are found to reduce the accuracy of consumers' inflation expectations after an update. This latter result is mostly driven by a detrimental effect of unfavorable news regarding inflation.

Finally, we provide evidence that the updating behavior of consumers has consequences for the evolution of term spreads in bonds markets. Specifically, a higher share of consumers with updated expectations is related to a larger change in the term spreads between 1-year and 5-years treasury bill rates, and at the same time increases the spread between nominal and inflation indexed bonds. A more detailed analysis of these effects would certainly be warranted, and is left for future research.

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6 Appendix

6.1 Updating of Long-Run Inflation Expectations and News

Table A.1: Updating Five-to-Ten-Years-Ahead Inflation Expectations and News

	(1)	(2)	(3)	(4)
$\sigma^2_{\pi^{e,5-10yr}_{prof,t-1}}$	0.058	-0.055	0.060	0.060
	(0.069)	(0.115)	(0.068)	(0.068)
$\Delta(Newsprices)_t$	-0.003			
	(0.008)			
$\Delta(Volume)_{t-1}$		-0.000		
		(0.001)		
$\Delta(Newsprices\_high)_t$			-0.006	
			(0.010)	
$\Delta(Newsprices\_low)_t$			0.015	
			(0.025)	
$\Delta(Newsprices\_bad)_t$				-0.006
				(0.010)
$\Delta(Newsprices\_good)_t$				0.014
				(0.024)
Observations	16,842	11,616	16,842	16,842
Demographic Controls	Yes	Yes	Yes	Yes
Pseudo R^2	0.00516	0.00415	0.00519	0.00519

Note: Marginal effects with clustered standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. $\sigma^2_{\pi^{e,5-10yr}_{prof,t-1}}$ represents the sum of squared changes of long-run inflation expectations of professional forecasters in the Survey of Professional Forecasters (SPF) over the recent six months. $\Delta(Newsprices)_t$ is a dummy variable indicating whether individuals have changed their opinion on news heard over prices with respect to the first interview. $\Delta(Volume)_{t-1}$ denotes the change in the volume of media news on inflation within the past six months, starting in the last observed period. $\Delta(Newsprices\_high)_t$, $\Delta(Newsprices\_low)_t$, $\Delta(Newsprices\_good)_t$ and $\Delta(Newsprices\_bad)_t$ denote changes in news heard on rising/falling inflation and prices as well as favorable and unfavorable news.

Table A.2: Updating Five-to-Ten-Years-Ahead Qualitative Inflation Expectations and News

	(1)	(2)	(3)	(4)
$\sigma^2_{\pi^{e,5-10yr}_{prof,t-1}}$	-0.089	-0.067	-0.089	-0.089
	(0.079)	(0.095)	(0.078)	(0.078)
$\Delta(Newsprices)_t$	-0.014			
	(0.013)			
$\Delta(Volume)_{t-1}$		-0.001		
		(0.000)		
$\Delta(Newsprices\_high)_t$			-0.017	
			(0.015)	
$\Delta(Newsprices\_low)_t$			0.000	
			(0.018)	
$\Delta(Newsprices\_bad)_t$				-0.017
				(0.015)
$\Delta(Newsprices\_good)_t$				0.001
				(0.016)
Observations	17,959	12,461	17,959	17,959
Demographic Controls	Yes	Yes	Yes	Yes
Pseudo R^2	0.0171	0.0168	0.0172	0.0171

Note: Marginal effects with clustered standard errors in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level, respectively. $\sigma^2_{\pi^{e,5-10yr}_{prof,t-1}}$ represents the sum of squared changes of long-run inflation expectations of professional forecasters in the Survey of Professional Forecasters (SPF) over the recent six months. $\Delta(Newsprices)_t$ is a dummy variable indicating whether individuals have changed their opinion on news heard over prices with respect to the first interview. $\Delta(Volume)_{t-1}$ denotes the change in the volume of media news on inflation within the past six months, starting in the last observed period. $\Delta(Newsprices\_high)_t$, $\Delta(Newsprices\_low)_t$, $\Delta(Newsprices\_good)_t$ and $\Delta(Newsprices\_bad)_t$ denote changes in news heard on rising/falling inflation and prices as well as favorable and unfavorable news.

6.2 Updating Shares with Quantitative Changes Above 1% or 5%

Table A.3: Summary Statistics of Monthly Updating Shares with Quant. Updates > 1%

Variable	Obs	Mean	SD	Min	Max
Short-run expectations, 1 year, update>1 %	289	0.56	0.08	0.39	0.83
Short-run expectations, 1 year, qualitative answer	289	0.38	0.09	0.16	0.67
Long-run expectations, 5-10 years,update>1 %	255	0.48	0.07	0.28	0.64
Long-run expectations, 5-10 years, qualitative answer	255	0.17	0.05	0.03	0.34

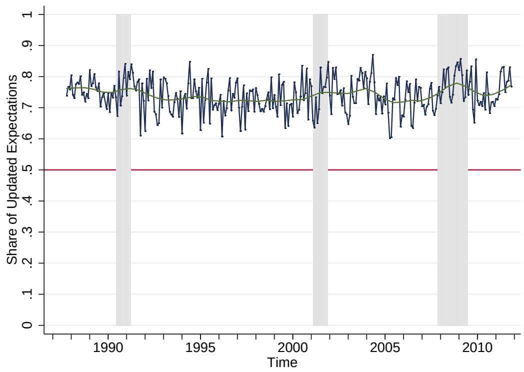
Notes: *Obs* denotes the sample size, *SD* is the standard deviation while *Min* and *Max* represent the minimum and maximum values.

Table A.4: Summary Statistics of Monthly Updating Shares with Quant. Updates > 5%

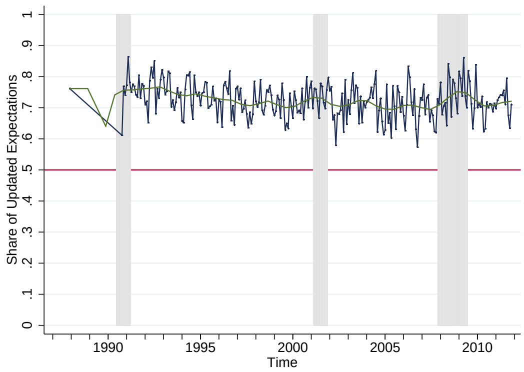
Variable	Obs	Mean	SD	Min	Max
Short-run expectations, 1 year, update>5 %	289	0.15	0.07	0.03	0.55
Short-run expectations, 1 year, qualitative answer	289	0.38	0.09	0.16	0.67
Long-run expectations, 5-10 years,update>5 %	255	0.11	0.05	0.00	0.26
Long-run expectations, 5-10 years, qualitative answer	255	0.17	0.05	0.03	0.34

Notes: *Obs* denotes the sample size, *SD* is the standard deviation while *Min* and *Max* represent the minimum and maximum values.

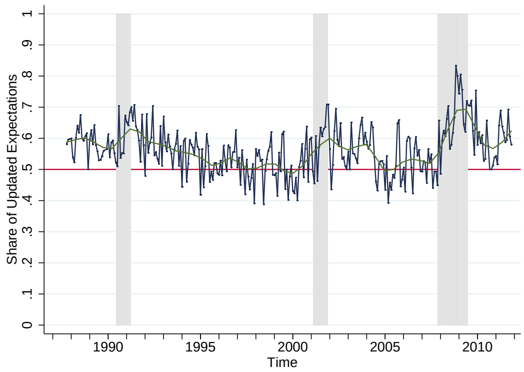
Figure A.1: Updating Shares for Quantitative Inflation Expectations



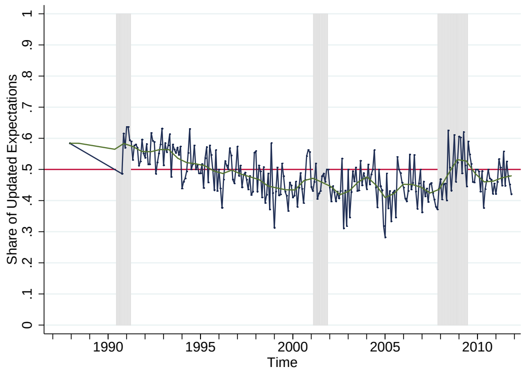
(a) Short-run expectations, 1 year



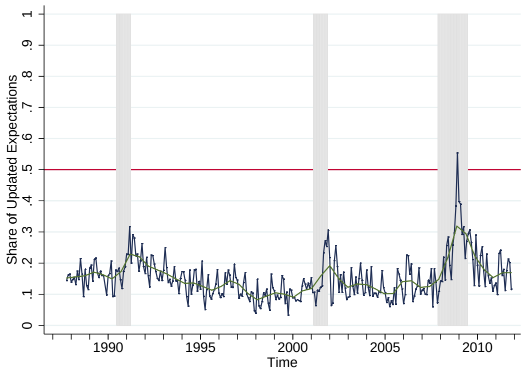
(b) Long-run expectations, 5-10 years



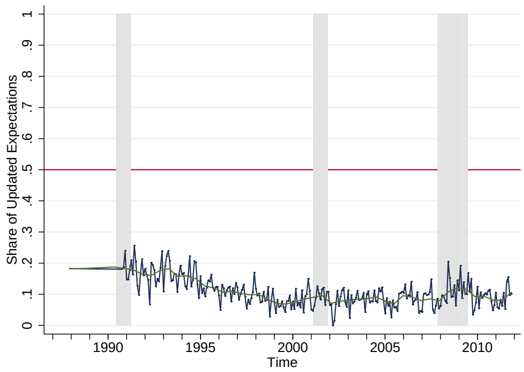
(c) Short-run expectations, update>1 %



(d) Long-run expectations, update>1 %



(e) Short-run expectations, update>5 %



(f) Long-run expectations, update>5 %

Notes: The graphs show the share of individual consumers that change their inflation expectations within six months together with a smoothing polynomial trend. Shaded areas are recession phases as identified by the NBER. The share is calculated by taking all individuals that adjusted their expectations during the last six months and dividing them by the overall number of individuals that have been re-interviewed.