DAMJAN PFAJFAR
EMILIANO SANTORO

# News on Inflation and the Epidemiology of Inflation Expectations

This paper examines the nexus between news coverage on inflation and households' inflation expectations. In doing so, we test the epidemiological foundations of the sticky information model (Carroll 2003, 2006). We use both aggregate and household-level data from the Survey Research Center at the University of Michigan. We highlight a fundamental disconnection among news on inflation, consumers' frequency of expectation updating, and the accuracy of their expectations. Our evidence provides at best weak support to the epidemiological framework, as most of the consumers who update their expectations do not revise them toward professional forecasters' mean forecast.

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THE RATIONAL EXPECTATIONS REVOLUTION that has swept through the economics profession in the 1970s has shaped macroeconomic modeling ever since. Nevertheless, rational expectations have often been criticized based on their inadequacy to account for a realistic process of economic forecasting. In response to this criticism, recent years have borne witness to alternative theories of expectation formation, whose common trait consists of relaxing the set of strong assumptions imposed by the rational expectations paradigm. One of such novel approaches

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DAMJAN PFAJFAR *is an Assistant Professor at CentER, EBC, University of Tilburg (E-mail:* D.Pfajfar@uvt.nl). EMILIANO SANTORO *is an UniCredit Foscolo Fellow at Catholic University of Milan and Associate Professor at Department of Economics, University of Copenhagen (E-mail:* emiliano.santoro@unicatt.it).

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assumes that information is sticky and disseminates slowly throughout the population, so that economic agents revise their expectations periodically. Carroll (2003, 2006; henceforth, Carroll) has put forward an epidemiological mechanism of expectation formation, according to which consumers update their expectations from the media, which are assumed to transmit professional forecasters' projections. The resulting framework is consistent with the intuition behind the sticky information model of Mankiw and Reis (2001, 2002).

Carroll examines inflation and unemployment forecasts collected by the University of Michigan's Survey Research Center. He shows that households revise their expectations toward the mean forecast from the Survey of Professional Forecasters, which he claims to be rational. The estimated absorption rate is rather low, with only a fourth (third) of the agents updating their inflation (unemployment) forecasts in every quarter.[1] He also provides empirical support to a main implication of the model; that is, greater news coverage induces "more rational" household forecasts. In fact, he shows that higher dissemination of news narrows the gap between the mean forecast from the Michigan Survey and that of professional forecasters.

This paper tests the epidemiological theory of expectation formation. From a methodological viewpoint, one of its main novelties consists of exploiting both aggregate and household-level data from the Michigan Survey. The analysis with aggregate data primarily focuses on Carroll's corollary that more news stories imply that people are better informed and produce better forecasts. To this end, we complement Carroll's index of newspapers coverage with Michigan Survey data on consumers' perception of favorable and unfavorable price developments in the period before the interview. Unlike the index of newspapers coverage employed by Carroll, which is not necessarily informative about the actual degree of receptiveness to publicly available information on prices, the Michigan Survey provides us with a direct measure of the flow of news on prices that consumers have heard. Surprisingly, both available and perceived news stories do not help at restricting the forecast gap between consumers' mean forecast and that of the professional forecasters, but rather widen it. Once we account for the content of the information that disseminates throughout the population, it turns out that unfavorable news (i.e., higher prices) exerts a positive impact on the forecast gap, while favorable news (i.e., lower prices) has either no statistically significant impact or weakly contributes to reducing consumers' expectation bias. Overall, these results stand in sharp contrast with the theoretical apparatus put forward by Carroll.

The analysis with household-level data represents the core of the study. We show that an average of about 75% of the respondents revise their inflation forecasts with respect to their first interview. This figure is considerably greater than the absorption rate estimated by Carroll. We also show that accessing some recent information on

1. Doepke et al. (2008) estimate Carroll's sticky information model of inflation expectations with data from Italy, Germany, United Kingdom, and France. They propose two alternative parameterizations of the sticky information model that differ in the stationarity assumptions about the underlying series. On average, European households revise their forecasts once every 18 months when stationarity applies. Otherwise, the VECM analysis shows that expectation updating takes place on a yearly basis.

prices does not necessarily reflect into more accurate forecasts,[2] though it raises the chances that consumers revise their expectations. The microdata from the Michigan Survey give us the opportunity of addressing these inconsistencies and examining the epidemiological foundations of the sticky information model in greater detail, as they contain explicit information about the size and direction of consumers' expectation updating. To this end, we distinguish between respondents that adjust their forecasts toward and away from the professional forecasters' mean expectation. Surprisingly, survey participants split evenly in the two categories, though the average adjustment of those who revise toward professional forecasters' mean forecast is generally greater. This result might explain the discrepancy between Carroll's model—which formalizes the process of expectation updating underlying households' mean forecast—and the evidence from household-level data.

Our analysis suggests that just a small fraction of consumer forecasts can be explained according to the epidemiological model. Moreover, it appears that households do not make the best use of the information they perceive, as they persistently deviate from professional forecasters' mean expectation, displaying no tendency to adjust their forecasts appropriately. One possible interpretation is that news transmitted by the media distorts consumers' expectations, as it may contain judgmental assessments of professional forecasters' views. As a consequence, media reports could be biased and the epidemiological mechanism results as a channel that transmits distorted expectations. This factor could also explain why the degree of perception of unfavorable news on prices is significantly higher than that of favorable news, and why the accuracy of consumers' expectations decreases in the volume of negative news being perceived. We believe these results should lead academics and policymakers altogether to reconsider the role of information dissemination in stimulating consumers' expectation updating. Most importantly, they should serve as a useful guideline to envisage communication strategies and channels capable of ensuring that private expectations are well anchored.

The remainder of the paper is laid out as follows. Section 1 describes the data; Section 2 explores the nexus between expectation updating, consumers' predictive accuracy, and news on prices; Section 3 examines household-level data from the survey of consumer attitudes and behavior; and Section 4 concludes.

## 1. DATA AND PRELIMINARY EVIDENCE

We employ both aggregate and household-level data, though greater emphasis will be posed on the microeconometric evidence. Household-level data contain

2. These results are in line with the tendencies reported by Curtin (2005) in the analysis of both time-series and panel data from the Michigan Survey, though no information about news on prices is exploited in this study. Curtin shows that consumers do not efficiently use all available information and display staggered updating of their information set. Moreover, increases in the rate of inflation have a larger impact than declines on inflation expectations.

information on a wide range of factors that influence consumers' expectations. As such, they allow us to explore the process of expectation updating in greater detail. In this section, we describe the key features of the data set and report some preliminary evidence on households' and professional forecasters' inflation expectations, as well as on the newspapers index proposed by Carroll and a direct measure of consumers' receptiveness toward news on prices.

### *1.1 Inflation Expectations*

In the estimation of his model Carroll proxies household expectations with the mean inflation forecast from the Survey of Consumer Attitudes and Behavior, which is conducted by the Survey Research Center (SRC) at the University of Michigan. The Michigan Survey (henceforth, MS) has been available on a monthly basis since January 1978.[3] The short rotating panel design represents its main peculiarity: 40% of prior respondents are reinterviewed in every round, the remaining 60% being initial interviews from a random subsample of the telephone-owning mainland U.S. population. Two relevant questions about expected changes in the price level are addressed to the participants: first, they are asked whether they expect prices to go up, go down or stay the same in the next 12 months, and second, they are asked to provide a quantitative statement about the expected change.[4]

As to professional forecasts, Carroll employs the mean inflation expectation from the Survey of Professional Forecasters (henceforth, SPF). The SPF, currently conducted by the Federal Reserve Bank of Philadelphia, has collected and summarized forecasts from leading private forecasting firms since 1968. The survey questionnaire is distributed once a quarter and asks participants for quarter-by-quarter forecasts, spanning the current and next five quarters.[5]

The present study explores both aggregate and household-level data from the MS. The analysis at the aggregate level (Section 2) relies on quarterly data over the 1978Q1–2011Q2 time window, while Section 3 reports evidence based on MS monthly microdata data over the 1978M1–2011M2 period.[6] In the analysis at the aggregate level we take the MS and SPF mean forecasts as indicators of central tendency in inflation forecasting, so as to be coherent with Carroll's

3. Over the time window we examine the survey covers a monthly average of 575 households, with a peak of 1,479 respondents in 1978M11 and a minimum of 492 in 1992M11. A monthly average of about 500 respondents has been interviewed since 1987M1.

4. If a respondent expects prices to stay the same, the interviewer must make sure she does not actually expect that prices will change at the same rate they have changed in the past 12 months.

5. The SPF was previously carried out as a joint product of the National Bureau of Economic Research (NBER) and the American Statistical Association (ASA) on a wide variety of economic variables, including GDP growth, various measures of inflation, and the rate of unemployment. For a comprehensive analysis of the SPF forecasts, the interested reader should refer to Croushore (1998).

6. SPF forecasts of consumer price index (CPI) inflation are only available from 1981Q3. Therefore, from 1978Q1 to 1981Q3 we proxy the SPF mean forecast of CPI inflation with the mean forecast of the GDP deflator. The two series are highly correlated. However, for robustness purposes and to exclude the disinflation in the first part of the sample and the ongoing period of financial and macroeconomic turmoil, we replicate the entire analysis on the 1984–2004 subsample. The results, reported in an extended working paper version of the present manuscript, are virtually unchanged (see Pfajfar and Santoro 2012).

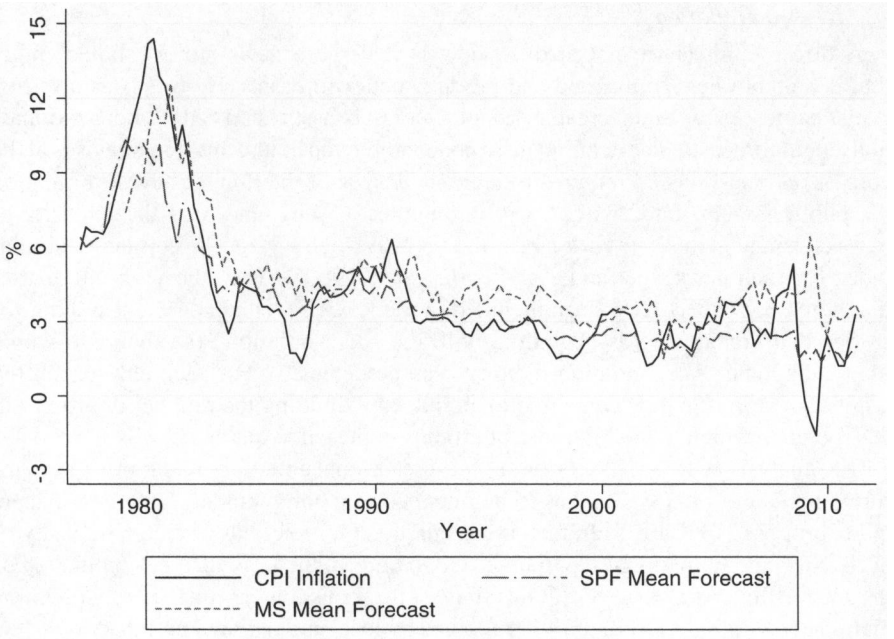


FIG. 1. CPI Inflation, MS and SPF Mean Forecasts.

framework.[7,8] Figure 1 reports household and professional mean forecasts against CPI inflation.[9] Both surveys underpredict rising inflation in the first part of the sample, though their predictive accuracy improves remarkably during the subsequent disinflation. This is probably due to the credibility the Federal Reserve had acquired in the early 1980s, when the Federal Reserve System was headed by Paul Volcker. From 1984 onward, expectations appear reasonably anchored, although they often fail to match periods of low inflation and, most notably, the 2009Q1–2009Q3 deflation.

7. One could argue that the median is less sensitive to outliers. In fact, cross-sectional variation in consumers' forecasts is substantial, with some implausible responses. Moreover, Thomas (1999) shows the median of the MS to be a better forecast than its mean. Nevertheless, Carroll's framework delivers predictions only for the mean and not for the median. For robustness purposes, in Pfajfar and Santoro (2012) we replicate the analysis at the aggregate level using the median forecasts from the MS and the SPF. We observe negligible (quantitative) differences with respect to the results reported in the present manuscript.

8. Given the presence of some implausible responses it is advisable to exclude outliers. Curtin (1996) shows that alternative truncation rules lead to nearly unchanged results. In the analysis of household-level data we opt for a truncation at −5% and +30%: this yields 228,837 interviews over the 1978M1–2011M2 period.

9. Inflation expectations carried out at time $t$ are graphed at the realized date (i.e., $t + 4$), so as to enhance comparability with the forecast target.

### *1.2 News on Inflation*

A direct implication of Carroll's view is that more news stories should imply that people are better informed and produce better forecasts. He proposes a formal statistical test of whether greater news coverage is associated with "more rational" household forecasts. The econometric model employed to test this hypothesis is at the core of our analysis and requires reliable indicators of the flow of news on inflation the public is confronted with. Carroll computes a yearly index of the intensity of news coverage in the *New York Times* and the *Washington Post*. We compute a similar index for each newspaper and each quarter since 1980Q1 (i.e., the year and quarter that both newspapers have been included in the LexisNexis database), searching for stories that contain words beginning with the root "inflation" (so that also words like "inflationary" or "inflation-fighting" can be detected). For each newspaper, the number of stories is then converted to an index by dividing the number of articles in a given quarter by the total number of articles in the same quarter.[10]

Our analysis will partly rely on a measure of consumers' perception of new information about prices. This has to be intended as a complement to the newspapers index proposed by Carroll. In fact, the accuracy of a proxy based on the intensity of news coverage on national newspapers can be questioned on different grounds. For instance, Blinder and Krueger (2004) suggest that consumers primarily rely on information about inflation from the TV, followed by local and national newspapers.[11] It is also plausible to expect that the volume of news about inflation does not necessarily match the flow of information that is assimilated by the public. In this respect, a nontrivial discrepancy could result from the interplay of two mutually reinforcing effects: (i) news from the media do not necessarily reach the public uniformly and (ii) the connection between news and inflation expectations is likely to be affected by consumers' receptiveness to this news and the capacity to process new information. Indeed, Sims (2003) emphasizes the presence of information-processing constraints that could be compatible with such inefficiencies. In light of these considerations, it is advisable to complement the analysis with a variable that accounts for consumers' actual perception of the information reported in the media. Household-level data from the MS allow us to compute a measure of the fraction of respondents that have heard of recent changes in prices. Information about the content of this news is also available, with the survey participants indicating whether they have heard about positive or negative changes. Specifically, the following question is addressed to each household: "During the last few months, have you heard of any favorable or unfavorable changes

10. A potential problem connected with this type of search is that the resulting index may include articles that do not primarily cover U.S. inflation. Thus, we test the robustness of this methodology by restricting the search to articles that just cover U.S. inflation. Moreover, we exclude articles with less than 120 words, so as to rule out short comments and summaries, searching for words beginning with the root "inflation" that are located either in the headline or among the "index terms." The resulting index yields empirical evidence in line with the results we report in the present article.

11. We should also consider that over the last decade the Internet has become a main source of news on various economic statistics.

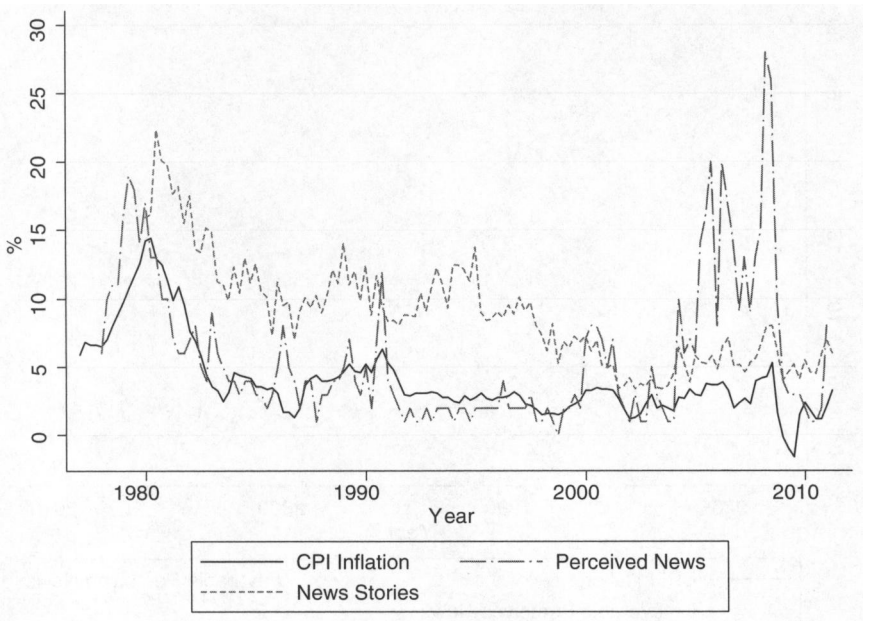


FIG. 2. Perceived News and News Stories.

in business conditions?"[12] In case of an affirmative response, a second question is asked: "What did you hear?" To address this query, the respondent is presented with a number of options regarding the type of business conditions she might have heard about, such as government, unemployment, prices, consumer demand, stock market, credit, and trade deficit. She is allowed to name at most two of these options. Should prices be one of the selected options, she can reply either (i) "Favorable News: Lower Prices" or (ii) "Unfavorable News: Higher Prices."[13,14]

Figure 2 reports the fraction of MS respondents that have heard news about prices, together with the newspapers index and CPI inflation. The two news-related series display poor correlation. Moreover, the newspapers index displays weaker comovement with the rate of inflation, as compared to our measure of "perceived news."

12. Consumer sentiment indices as those that can be derived from household-level data on the perception of business conditions have been successfully employed in various studies (see, among others, Souleles 2004).

13. Should the interviewer perceive that the respondent has an uncorrect understanding of the question on perceived changes in prices, a further question is asked that aims at making sure that the responses "Favorable News: Lower Prices" and "Unfavorable News: Higher Prices" are correctly interpreted.

14. The MS respondents primarily report about news on unemployment, followed by news on the government (elections) and then prices. It is important to stress that 41% of the respondents report having heard no news at all and that in 28% of the cases only one option is reported. This is to say that, on average, only 31% of the respondents are confronted with a potentially binding limit of two options. Therefore, though some underreporting may affect our measure of perceived changes in prices, this is not likely to be primarily induced by the specific design of the questionnaire.

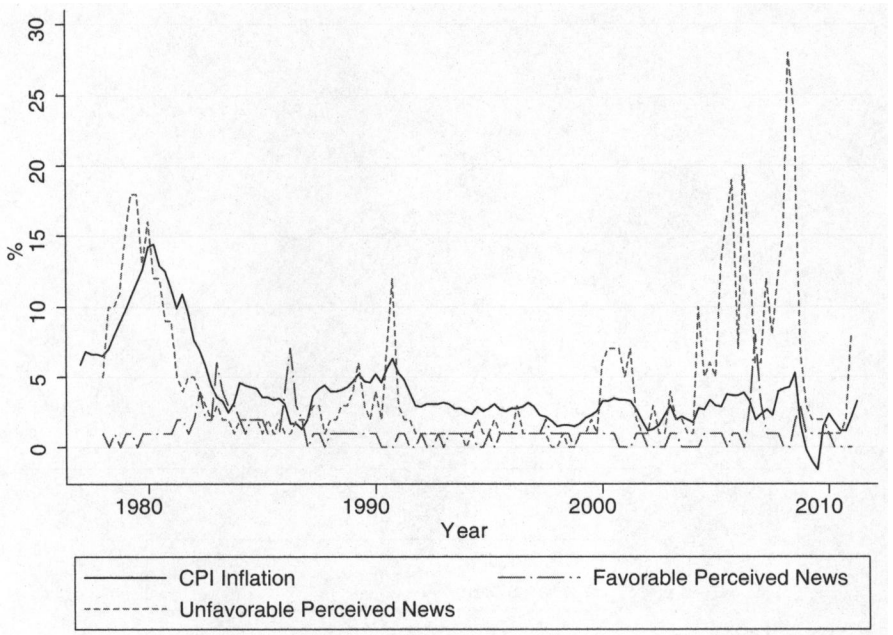


FIG. 3. Favorable and Unfavorable Perceived News on Prices.

The latter is more volatile, especially when abrupt changes in the rate of inflation occur, though in the last part of the sample it displays sizable fluctuations that neither actual inflation nor the newspapers index present. This probably reflects higher uncertainty characterizing consumers' information during the recent period of marked macroeconomic and financial turmoil.

When looking at the perceived tone of the news consumers have heard (Figure 3), it can be noted that the fraction of consumers that report favorable news almost constantly lie below the fraction of those that report unfavorable news. The latter proportion of respondents is more volatile and tends to peak when inflation accelerates. As expected on *a priori* grounds, the percentage of agents reporting favorable news is negatively (yet weakly) correlated with the rate of inflation. The sign of this correlation is reversed when considering the fraction of respondents that have heard negative news, indicating that households pay attention to news coverage mostly during adverse periods, which are characterized by relatively higher and more volatile inflation.[15] This type of asymmetry is in line with the prospect theory pioneered by Kahneman and Tversky (1979), as agents tend to manifest higher

15. In the last part of the sample, higher volatility in the measure of (perceived) unfavorable news is not coupled with higher volatility in the rate of inflation. Such a delinking in the behavior of the two series probably reflects the emergence of additional determinants of consumers' receptiveness toward news about inflation, as well as the substantial increase in the volume of economic reporting on different aspects of the ongoing financial and macroeconomic turmoil.

receptiveness toward bad news on prices, as compared to good news. According to Hamilton (2004) and Soroka (2006), a common finding in literature on news coverage is that there is more reporting of bad news than good news. To explain this evidence, Lamla and Lein (2008) suggest that newspapers may have an incentive to favor bad news over good news, so as to catch more attention from the readers and increase their sales.

## 2. NEWS AND EXPECTATION UPDATING: EVIDENCE FROM AGGREGATE DATA

According to the epidemiological foundations of the sticky information model, consumers update their forecasts from news reports, which are influenced by the expectations of the professional forecasters.[16] The key assumption is that news spreads slowly across agents, reaching only a fraction of the population in each period. Carroll examines his model's ability to explain the MS data by estimating an equation of the form

$$\pi^{C}_{t+4|t} = \alpha_1 \pi^{F}_{t+4|t} + \alpha_2 \pi^{C}_{t+3|t-1} + v_t, \tag{1}$$

where $\pi^{C}_{t+4|t}$ denotes the time $t$ mean MS forecast of inflation at time $t+4$, while $\pi^{F}_{t+4|t}$ is the SPF mean expectation over the same forecast horizon. We estimate (1) by ordinary least squares (OLS) and report the estimation results in Table 1. Overall our evidence is qualitatively in line with Carroll, as the rate of absorption we estimate implies that about a fourth of the MS participants update their forecasts in every quarter. An important difference with the benchmark study is that the proposition $\alpha_1 + \alpha_2 = 1$ can be rejected at standard levels of statistical confidence. Thus, we reject the key model's prediction that households' mean expectation should result as a simple weighted average of the current "rational" (or newspaper) forecast and last period's mean inflation expectation.[17] We also expand the set of regressors in equation (1) with the most recently published annual inflation rate as of time $t$. As in Carroll, the past inflation rate exerts a negative impact, though its coefficient is not statistically significant. Finally, the constant term is usually not significant or barely significant, implying that expectation updating through local or global interaction should not be an issue of concern.[18]

16. Mankiw and Reis (2001, 2002) envisage a similar framework. They assume that agents update their forecasts only occasionally, due to the presence of an explicit cost to obtain and process information.

17. Nunes (2009) reports similar evidence.

18. Carroll (2006) explores the idea that individuals update their forecasts through informal communication networks, demonstrating that a significant constant term in the epidemiological model could reflect social transmission of inflation expectations via conversations with neighbors (in addition to the news media channel). Carroll's exercise assumes that households who do not encounter the news source still face some probability of having an informal conversation about inflation (with a randomly selected other person in the population). For robustness purposes, we estimate alternative models of expectation updating whose common assumption is that "informed" consumers (i.e., individuals who report hearing

TABLE 1

ESTIMATION OF $\pi^{C}_{t+4|t} = \alpha_0 + \alpha_1 \pi^{F}_{t+4|t} + \alpha_2 \pi^{C}_{t+3|t-1} + \alpha_3 \pi_{t-1} + v_t$

| | Equations | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| $\alpha_0$ | | 0.245 | | 0.373* | |
| | | (0.177) | | (0.218) | |
| $\alpha_1$ | 0.280*** | 0.279*** | 0.278*** | 0.285*** | |
| | (0.069) | (0.067) | (0.069) | (0.065) | |
| $\alpha_2$ | 0.769*** | 0.726*** | 0.784*** | 0.642*** | 1.018*** |
| | (0.059) | (0.069) | (0.061) | (0.091) | (0.040) |
| $\alpha_3$ | | | −0.015 | 0.059 | −0.036 |
| | | | (0.042) | (0.049) | (0.050) |
| Test | $\alpha_1 + \alpha_2 = 1$ | $\alpha_0 = 0$ | $\alpha_1 + \alpha_2 + \alpha_3 = 1$ | | $\alpha_2 + \alpha_3 = 1$ |
| $p$-value | 0.006 | 0.169 | 0.012 | | 0.328 |
| $T$ | 130 | 130 | 130 | 130 | 130 |
| $R^2$ | 0.985 | 0.911 | 0.985 | 0.912 | 0.982 |

NOTES: $\pi^{C}_{t+4|t}$ and $\pi^{F}_{t+4|t}$ are the (four-quarters-ahead) mean expectations from the Michigan Survey and the Survey of Professional Forecasters in period $t$, respectively; $\pi_{t-1}$ is the most recently published annual inflation rate as of time $t$. Robust standard errors computed with the Huber–White sandwich estimator are reported in parentheses. *** and * indicate significance at the 1% and 10% levels, respectively.

The results so far are somewhat supportive of the epidemiological process of expectation formation. However, an indirect test of the model's ability to fit the data can be envisaged by comparing the estimates of $\alpha_1$ in equation (1) with the degree of receptiveness to news displayed by the MS participants. In this respect, survey data reflect a higher degree of information stickiness, as compared to the indirect measure of updating frequency obtained by Carroll. On average, only 5.8% of the interviewees report having heard news about prices in each quarter. Such a discrepancy emphasizes the need to distinguish between "available" and "perceived" news for a reliable assessment of the relationship between news coverage of inflation, staggered updating of expectations, and consumers' predictive accuracy. To this end, we examine the corollary that greater news coverage should be associated with "more rational" household forecasts. As a formal procedure to test for this, Carroll fits an OLS regression of the squared distance between the MS and SPF forecasts, $GAPSQ_t = (\pi^{C}_{t+4|t} - \pi^{F}_{t+4|t})^2$, on the intensity of news coverage of inflation, $NEWS^{N}_{t}$:

$$GAPSQ_t = \gamma_0 + \gamma_1 NEWS^{N}_{t} + \mu_t. \tag{2}$$

A negative $\gamma_1$ implies that an increase in the volume of news induces an alignment of consumers' expectations to the SPF mean forecast. We propose a general model to account for the joint effect of perceived and available news, as well as for their

news on prices) may transmit their views to "uninformed" ones. However, we report mixed evidence on the empirical relevance of this type of informal communication networks. Additional analysis on this topic is available upon request from the authors.

TABLE 2

ESTIMATION OF $GAP_t = \gamma_0 + \gamma_1 NEWS_t^N + \gamma_2 NEWS_t^P + \gamma_3 (NEWS_t^P \times NEWS_t^N) + \mu_t$

| | Equations | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $GAPSQ_t$ | $GAPSQ_t^*$ | $GAPSQ_t$ | $GAPSQ_t^*$ | $GAPSQ_t$ | $GAPSQ_t^*$ | $GAPSQ_t$ | $GAPSQ_t^*$ |
| $\gamma_0$ | 0.027 | 2.510** | −0.294 | −1.034 | −2.153** | −1.079 | 2.091 | −3.632** |
| | (0.864) | (1.119) | (0.437) | (1.267) | (1.062) | (1.308) | (1.537) | (1.772) |
| $\gamma_1$ | 0.236** | 0.046 | | | 0.192* | −0.018 | −0.330 | 0.294* |
| | (0.115) | (0.076) | | | (0.098) | (0.124) | (0.209) | (0.149) |
| $\gamma_2$ | | | 0.435*** | 0.727** | 0.481*** | 0.773** | −0.112 | 1.126** |
| | | | (0.110) | (0.282) | (0.119) | (0.334) | (0.307) | (0.453) |
| $\gamma_3$ | | | | | | | 0.073* | −0.043 |
| | | | | | | | (0.042) | (0.027) |
| $T$ | 123 | 122 | 131 | 130 | 123 | 122 | 123 | 122 |
| $R^2$ | 0.057 | 0.001 | 0.364 | 0.320 | 0.455 | 0.323 | 0.561 | 0.335 |

NOTES: $GAP_t = \{GAPSQ_t, GAPSQ_t^*\}$, where $GAPSQ_t$ is the squared difference between the MS and SPF mean inflation forecasts and $GAPSQ_t^*$ is the squared difference between the MS mean inflation forecast and CPI inflation (at the forecast horizon); $NEWS_t^P$ is the fraction of MS participants that have heard of favorable or unfavorable changes in prices in the period before the interview; $NEWS_t^N$ is an index of the intensity of news coverage of inflation in the *New York Times* and the *Washington Post*. Robust standard errors computed with the Huber–White sandwich estimator are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

potential interaction:

$$\begin{aligned} GAP_t &= \gamma_0 + \gamma_1 NEWS_t^N + \gamma_2 NEWS_t^P + \gamma_3 \left(NEWS_t^P \times NEWS_t^N\right) + \mu_t, \\ GAP_t &= \{GAPSQ_t, GAPSQ_t^*\}, \end{aligned} \tag{3}$$

where $NEWS_t^P$ is the fraction of MS respondents that have heard news about prices. As exposed above, we interpret this measure as an explicit indicator of the actual flow of information assimilated by the public, as compared to the newspapers index employed by Carroll.[19] To test the robustness of our results we also consider an alternative measure of expectation bias, which depends on the distance between the time $t$ MS mean forecast of inflation at time $t+4$ and CPI inflation at time $t+4$: $GAPSQ_t^* = (\pi_{t+4|t}^C - \pi_{t+4})^2$. In fact, $GAPSQ$ does not account for the fact that professional forecasters may not form expectations rationally, as a number of studies indicate (e.g., Roberts 1998, Lanne, Louma and Luoto 2009, Nunes 2009).

Surprisingly, estimating (3) and various alternative specifications points to a positive and statistically significant relationship between the expectation gap and either measure of the flow of news on inflation (see Table 2).[20] Therefore, a rise in the

19. Note that $NEWS_t^P$ proxies the amount of news heard before the inflation forecast is carried out. This allows us to avoid the impact of reverse causation.

20. Importantly, we reach the same conclusions by regressing the expectation gap over a constant and the newspapers index. These results are not overturned if we consider the time window examined by Carroll (additional results are available upon request from the authors). By contrast, it should be noted that Carroll's estimates are not robust in this sense, as he shows that excluding the first year of the SPF mean forecast from the sample may affect the statistical significance of the estimated impact of news on the expectation gap. It should also be noted that Carroll uses a yearly index in regressions involving quarterly data. Our estimates do not suffer from this type of inconsistency, as we compute a quarterly newspapers index.

fraction of "informed" consumers increases the distance between the MS and SPF mean forecasts, a result that stands in sharp contrast to Carroll. When accounting for the joint effect of $NEWS_t^P$ and $NEWS_t^N$, only the former exerts a positive impact on the expectation gap, while the coefficient attached to $NEWS_t^N$ is either not statistically different from zero or barely significant. Finally, we search for the presence of interaction effects between newspapers' coverage and households' receptiveness toward news about inflation, allowing for the term $NEWS_t^P \times NEWS_t^N$ in the set of regressors. The additional regressor explains most of the variability in $GAPSQ_t$, though its coefficient is only significant at the 10% level. As to $NEWS_t^P$ and $NEWS_t^N$, they both exert a negative impact, though their coefficients are not statistically different from zero.[21] This comes as no surprise, given that both measures of news present positive correlations with $GAPSQ_t$. Nevertheless it should be noted that perceived news presents greater correlation with both measures of prediction bias and dominates their correlations with the interaction term.[22]

We now focus on a second dimension of the relationship between news on inflation and expectation updating, which consists of accounting for the perceived content of the news consumers have heard of. Doms and Morin (2004) show that media coverage is important in that it affects households' perception of the economy in at least three ways. First, media affect sentiment by informing consumers about economic data and professional opinions. Second, the greater the volume of news about the economy, the greater the likelihood that consumers update their expectations. These channels are explicitly at work in Carroll's framework. However, Doms and Morin point to a third channel that the epidemiological model disregards, suggesting that consumers receive a signal about the economy through the tone of economic reporting.[23] The next exercise aims at disentangling the differential impact that favorable and unfavorable news on prices may exert on the distance between MS and SPF mean forecasts. The following equation is estimated:

$$GAP_t = \gamma_0 + \gamma_1^U NEWS_t^{P,U} + \gamma_1^F NEWS_t^{P,F} + \mu_t. \tag{4}$$

Table 3 shows that while favorable news exerts a negative—yet not statistically significant—impact on the expectation gap, unfavorable news tends to enlarge it. Thus, we cannot appreciate a negative impact of news on the expectation gap even when consumers' overall perception is more pessimistic and their forecasts should reflect higher accuracy and/or attentiveness to economic reporting. Also Lamla and Lein (2008) report similar evidence based on German data on inflation expectations,

21. When assuming $GAPSQ_t^*$ as the dependent variable, the interaction term has no statistically significant impact, while $NEWS_t^P$ exerts a stronger positive impact than $NEWS_t^N$, whose effect is only significant at the 10% level.

22. Table A1 in the Appendix reports pairwise correlations among the variables employed in the regression analysis of Section 2. The correlation between $GAPSQ_t$ and $NEWS_t^P$ ($NEWS_t^N$) is about 60% (24%). Otherwise, Corr($NEWS_t^P$, $GAPSQ_t^*$) is about 57 %, while Corr($NEWS_t^N$, $GAPSQ_t^*$) is not statistically different from zero.

23. According to Sims (2003), rational inattention provides an explanation why the tone and volume of economic reporting affect sentiment beyond the economic information contained in the reporting.

TABLE 3

ESTIMATION OF $GAP_t = \gamma_0 + \gamma_1^U NEWS_t^{P,U} + \gamma_1^F NEWS_t^{P,F} + \mu_t$

| | Equations | | | | | |
|---|---|---|---|---|---|---|
| | $GAPSQ_t$ | $GAPSQ_t^*$ | $GAPSQ_t$ | $GAPSQ_t^*$ | $GAPSQ_t$ | $GAPSQ_t^*$ |
| $\gamma_0$ | 2.503*** | 3.680*** | 0.107 | −0.352 | 0.191 | −0.222 |
| | (0.446) | (0.851) | (0.332) | (0.975) | (0.311) | (1.052) |
| $\gamma_1^F$ | −0.230 | −0.392 | | | −0.069 | −0.106 |
| | (0.153) | (0.385) | | | (0.101) | (0.297) |
| $\gamma_1^U$ | | | 0.454*** | 0.758*** | 0.453*** | 0.756*** |
| | | | (0.112) | (0.285) | (0.112) | (0.286) |
| $T$ | 131 | 130 | 131 | 130 | 131 | 130 |
| $R^2$ | 0.005 | 0.005 | 0.391 | 0.343 | 0.392 | 0.344 |

NOTES: This table reports the OLS estimates from equation (4). Robust standard errors computed with the Huber–White sandwich estimator are reported in parentheses. *** indicates significance at the 1% level.

while Dräger (2011) obtains analogous results in the analysis of both expected and perceived inflation in Sweden. These facts certainly deserve to be examined in further detail. The next section investigates these issues with the support of household-level data.

## 3. NEWS AND EXPECTATION UPDATING: EVIDENCE FROM HOUSEHOLD-LEVEL DATA

The MS household-level data provide us with a further opportunity to test Carroll's microfoundation of the sticky information model. To this end, we examine the nexus between individual-specific information on prices and expectation updating. We start by extracting the proportion of survey participants that have updated their inflation forecasts in the second interview: Figure 4 reports the resulting time-varying frequency of expectation updating, together with CPI inflation. The two series comove positively, though the former displays higher volatility. It is interesting to note that, on average, expectation updating takes place at a faster pace when inflation is higher and more volatile, as in the first part of the sample. Notably, the time-varying frequency reaches its maximum only in two episodes, namely, March 1980 (i.e., the highest peak in the rate of inflation) and November 1989.[24]

On average, 74.9% of the respondents do update their inflation forecasts in the second interview. Among these, 53.2% (46.8%) adjust their expectations downward (upward).[25] Thus, the fraction of consumers that revise their forecasts is significantly

24. In early 1980, Volcker's new FED policy began to bite. The U.S. interest rates started to increase substantially, with the prime rate hitting 20% in April 1980. As to the second episode, this might reflect increasing fears of contraction in economic activity, as it actually happened in the early 1990s.

25. Unless otherwise indicated, the proportions of MS participants we report in this section (conditional on alternative attributes) are statistically different at the 1% level of significance.

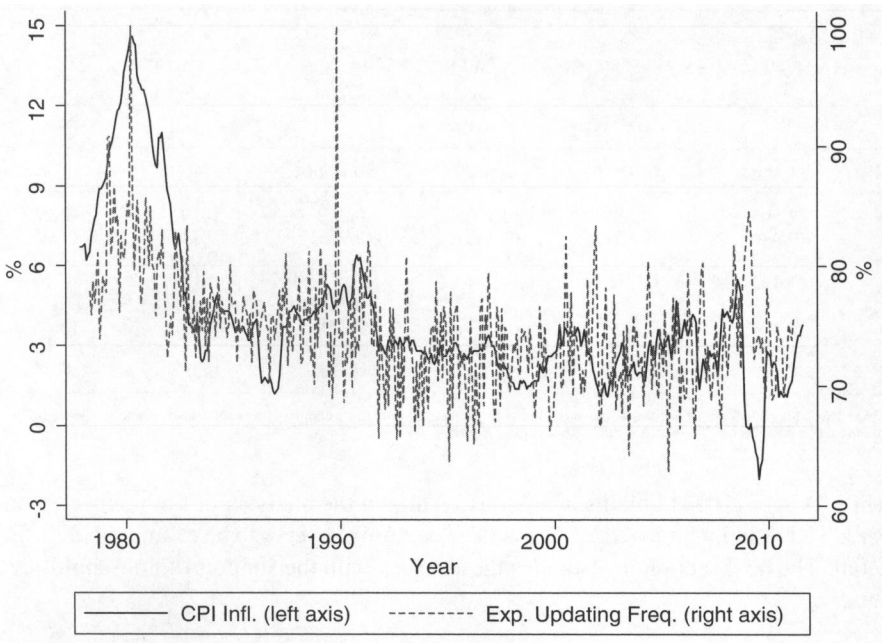


FIG. 4. Time-Varying Frequency of Expectation Updating.

greater than the proportion of those who have perceived news about inflation, as well as than the absorption rate estimated by Carroll. Deeper insights come from inspecting the direction of expectation updating. We compare the fraction of respondents that revise their expectations toward the SPF mean forecast with those who move further away. Interestingly, households split evenly into these categories, with 51.3% of the participants revising expectations in the "right" direction. In addition, only for 16.2% of the consumers who revise their forecasts we cannot reject the null hypothesis according to which their expectations match exactly the SPF mean expectation. The picture remains virtually unchanged even if we just consider "informed" households: in this case, the percentage of those who update expectations toward the SPF benchmark is 49.4%.[26] We also compute the average forecast error for those who update their expectations and those who do not, as well as for the households that report some recent news on prices and those who do not (see Table 4). Surprisingly, the average forecast error is about 12% higher when consumers update their forecasts, regardless of whether they are aware of some recent changes in prices. Table 4 also

26. We also consider expectation updating "toward" the CPI rate of inflation. In this case 50.5% of the MS interviewees that update their forecasts do revise them in the "right" direction. This figure reduces to 49% when we consider agents that have heard of recent changes in prices, though this percentage is statistically lower than 50% only at the 10% level of statistical significance.

TABLE 4

PREDICTIVE ACCURACY, EXPECTATION UPDATING, AND NEWS PERCEPTION

| | | AFE conditional on news | |
|---|---|---|---|
| | AFE | YES | NO |
| Updated forecast | 3.09 | 3.33 | 3.10 |
| Forecast stays the same | 2.76 | 2.99 | 2.77 |

NOTES: This table reports the average forecast error (AFE) implied by household-level data: this is computed both for agents who have updated their forecast with respect to the first interview (first row, labeled "Updated forecast") and those who have not revised their forecasts (second row, labeled "Forecast stays the same"). Moreover, we compute the average forecast error for those who have heard of recent changes in prices (column labeled "AFE conditional on news—YES"), and those who have not (column labeled "AFE conditional on news—NO").

implies that the average forecast error is significantly higher when consumers report of recent changes in prices, as compared to when they do not.

The key message we retrieve from the preliminary investigation of household-level statistics is that having some information at hand does not necessarily reflect into more accurate forecasts. Armed with this preliminary evidence, a main task of our analysis is to examine in closer detail the interconnection between the degree of receptiveness to news about inflation and the probability that households revise their expectations. We specify a binary response model of the process underlying expectation updating at the household level. The following variable is defined:

$$z_i = \begin{cases} 1 & \text{if } z_i^* > 0 \\ 0 & \text{if } z_i^* \leq 0 \end{cases}, \quad i = 1, 2, \ldots, N, \tag{5}$$

where $z_i^*$ is the latent variable that accounts for consumers' expectation updating. Its discrete counterpart, $z_i$, takes value 1 if the $i$th respondent has updated her expectations from the first interview, and 0 otherwise. Since individuals are interviewed only twice, the only reference term to determine whether expectation updating has taken place is represented by the response in the second interview. Thus, we avoid reporting time-subscripts. The following latent process is assumed:

$$z_i^* = \alpha + NEWS_i^P \beta + NEWS^N \rho + \pi\delta + \pi^F \vartheta + \mathbf{x}_i \gamma + u_i, \tag{6}$$

where $\alpha$ is a constant, $NEWS_i^P$ is an individual-specific indicator of news perception (which equals 1 if the interviewee has heard of recent changes in prices and 0 otherwise), $NEWS^N$ indexes the intensity of news coverage, $\pi$ denotes the last observed CPI inflation rate,[27] $\pi^F$ is the mean forecast from the SPF, $\mathbf{x}_i$ is a vector of sociodemographic characteristics (such as gender, age, income, education, race, marital status, location in the United States, and some interaction terms) and $u_i$ is normally distributed. A word of caution is in order before we proceed with the analysis. As described in Section 1, sample selection is designed so that not all initial

27. We have also considered the possibility that consumers look at alternative inflation measures, such as the average rate of inflation over the 6-month reinterview period. However, we obtain neither qualitatively nor quantitatively different results.

TABLE 5

DETERMINANTS OF EXPECTATION UPDATING AT THE HOUSEHOLD LEVEL

| | Models | | | | |
|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
| $NEWS_i^P$ | 0.042*** | | 0.031*** | 0.035*** | 0.035*** |
| | (0.008) | | (0.008) | (0.008) | (0.008) |
| $NEWS^N$ | | 0.004*** | | | −0.003*** |
| | | (0.000) | | | (0.001) |
| $\pi$ | | | 0.007*** | 0.001 | 0.001 |
| | | | (0.001) | (0.001) | (0.001) |
| $\pi^F$ | | | | 0.010*** | 0.016*** |
| | | | | (0.002) | (0.003) |
| Controls | Yes | Yes | Yes | Yes | Yes |
| SSC | 0.000*** | 0.001*** | 0.005*** | 0.554 | 0.818 |
| $N$ | 72,853 | 71,644 | 72,853 | 72,853 | 71,644 |
| Wald test ($\chi^2$) | 204*** | 260*** | 346*** | 368*** | 353*** |

NOTES: This table reports the marginal partial effects from the estimation of $\Pr(z_i = 1|\mathbf{h}_i) = \Phi(\mathbf{h}_i\xi)$, where $\Phi(\cdot)$ is the cumulative distribution function of the standard normal distribution, $\mathbf{h}_i$ is the vector of covariates, and $\xi$ is a vector of coefficients; $z_i$ takes value 1 if the $i$th respondent has updated his or her expectations from the first interview, and 0 otherwise. Vector $\mathbf{h}_i$ includes: $NEWS_i^P$, which is an individual-specific indicator of news perception (this equals 1 if the interviewee has heard of changes in prices in the past few months before the interview, and 0 otherwise); $NEWS^N$, which is an index of the intensity of news coverage of inflation in the *New York Times* and the *Washington Post*; $\pi$, which denotes the last observed consumer price index inflation rate; $\pi^F$, which is the mean forecast from the Survey of Professional Forecasters at the time the individual is interviewed; a vector $\mathbf{x}_i$ of control variables, where we include information on the sociodemographic characteristics of the Michigan Survey respondents (such as gender, age, income, education, race, marital status, and location in the United States), as well as a number of interaction terms among them. To account for the presence of question attrition, we perform a sample selection correction test: *SSC* stands for the *p*-value of the Wald test of independence from the sample selection equation (which includes as regressors some sociodemographic characteristics as well as the tone of the news consumers have heard). A constant has been included in all regressions. Standard errors are calculated with the delta method (Oehlert 1992) and are reported in parentheses. *** indicates significance at the 1% level.

survey respondents are reinterviewed. Moreover, though the SRC tries to ensure that first interviews are a random subsample of the population, not all respondents who are selected for a second interview agree to participate. We label the resulting drop off as "interview attrition." It is also possible to identify a fraction of respondents that participate in the second interview but do not provide a year-ahead inflation expectation. This type of drop off is usually referred to as "question attrition." Although this amounts to 6.8% of the total number of survey respondents over the time window we examine, it may represent a potential source of bias. To account for this factor, we implement the Heckman correction (Heckman 1979), a procedure that offers a means of correcting for nonrandomly selected samples.[28]

The binary response framework provides some support to the sticky information paradigm. As shown in Table 5, hearing news on prices on average increases the probability that households revise their inflation forecasts, no matter which news-related variable is considered.[29] However, when both $NEWS_i^P$ and $NEWS^N$ are accounted

28. For brevity of exposition, we only report estimates corrected for question attrition. Pfajfar and Santoro (2012) allow for the presence of interview attrition as well, reporting results that are in line with those presented in this article.

29. Table 5 reports marginal effects for a representative agent with the following characteristics: white (non-Hispanic), married, male, 40 years old, with a high school diploma, with an income in the middle quintile of the distribution and living in the North-Center of the country.

for in the set of regressors, only the former is found to exert a statistically significant positive effect. Finally, both current inflation and the SPF mean forecast have a positive impact, though the latter seems to induce a stronger marginal effect on the probability of revising expectations.

The analysis of household-level data also confirms that an increase in the volume of (available or perceived) news expands the gap between household forecasts and the SPF mean expectation, as indicated by the impact of $NEWS^P_{i,t}$ in the following regression:

$$GAP_{i,t} = \alpha + NEWS^P_{i,t}\beta + \mathbf{h}_{i,t}\eta + u_{i,t}, \tag{7}$$

$$GAP_{i,t} = \left\{GAPSQ_{i,t}, GAPSQ^*_{i,t}\right\},$$

where $GAPSQ_{i,t}$ is the squared difference between the MS household-specific forecast and the SPF mean inflation forecast, $GAPSQ^*_{i,t}$ is the squared difference between the MS household-specific forecast and CPI inflation (at the forecast horizon), $\mathbf{h}_{i,t}$ is a vector of all other covariates reported in equation (6), and $\eta$ is a vector of coefficients. Moreover, $u_{i,t} = v_i + \varepsilon_{i,t}$, where $v_i \sim N(0, \sigma_v^2)$ is an individual-specific random effect, $\varepsilon_{i,t} \sim N(0, \sigma_\varepsilon^2)$ is the idiosyncratic component of the error term, and $\mathrm{Cov}(v_i, \varepsilon_{i,t}) = 0$. The results from the estimation of (7) are reported in Tables 6 and 7. Both $NEWS^P_i$ and $NEWS^N$ contribute at widening $GAP_{i,t}$. We also observe that (perceived) unfavorable news has a positive effect on the expectation bias, while perceiving favorable news exerts a marginally significant negative impact.[30]

The econometric and statistical analyses with the MS microdata provide us with two elements whose coexistence is problematic for the internal consistency of Carroll's argument. On one hand, hearing news about prices increases the probability that consumers update their expectations. On the other hand, even if consumers have heard of some recent changes in prices, expectations are not necessarily revised in the right direction. The last point in particular raises the problem of investigating in closer detail how expectations are actually revised. To address this issue we specify the following probit regression:

$$\Pr(y_{i,2} = 1|\mathbf{w}_i) = \Phi(\mathbf{w}_i\psi), \tag{8}$$

where $\Phi$ is the cumulative distribution function (CDF) of the standard normal distribution, and $y_{i,2}$ is a binary variable that indicates whether the $i$th respondent's prediction is greater ($y_{i,2} = 1$) or lower ($y_{i,2} = 0$) than professional forecasters' mean prediction in the second interview. Moreover, $\mathbf{w}_i$ is the vector of covariates (whose first entry is one), $\psi$ is the vector of parameters. The main objective of estimating (8) is to understand whether households' potential overprediction (or underprediction) with respect to the SPF mean forecast in the first round interview affects the probability

30. Curtin (2005) employs household-level data and reports asymmetric responses of inflation expectations to positive and negative changes in actual inflation. He interprets this evidence as signaling the possibility of an asymmetric response to changes in the perceived credibility of central banks. According to this view, increases in inflation will more promptly diminish the credibility of central banks, but declines in inflation will only slowly rebuild lost credibility.

TABLE 6

"GAP" LINEAR REGRESSIONS (RANDOM EFFECTS)

| | Equations | | | | |
|---|---|---|---|---|---|
| | $GAPSQ_{i,t}$ | $GAPSQ_{i,t}$ | $GAPSQ_{i,t}$ | $GAPSQ_{i,t}$ | $GAPSQ_{i,t}$ |
| Constant | 29.854*** | 10.170*** | 9.763*** | 8.613*** | 13.139*** |
| | (1.414) | (1.501) | (1.462) | (1.499) | (1.470) |
| $NEWS^P_{i,t}$ | 7.046*** | | 5.136*** | 6.227*** | |
| | (0.642) | | (0.645) | (0.682) | |
| $NEWS^N_t$ | | 1.322*** | | 0.173** | |
| | | (0.033) | | (0.068) | |
| $\pi^F_{t+12\|t}$ | | | 3.220*** | 3.041*** | 0.796*** |
| | | | (0.068) | (0.160) | (0.161) |
| $\pi_{t-1}$ | | | | | 1.752*** |
| | | | | | (0.108) |
| $NEWS^{P,U}_{i,t}$ | | | | | 4.371*** |
| | | | | | (0.668) |
| $NEWS^{P,F}_{i,t}$ | | | | | −2.846* |
| | | | | | (1.537) |
| Controls | Yes | Yes | Yes | Yes | Yes |
| $N \times T$ | 175,307 | 170,860 | 175,307 | 170,860 | 175,307 |
| Wald test ($\chi^2$) | 3,809*** | 5,073*** | 6,446*** | 5,707*** | 6,749*** |

NOTES: We estimate (7) by feasible GLS. $GAPSQ_{i,t}$ is the squared difference between the Michigan Survey household-specific forecast and the Survey of Professional Forecasters mean inflation forecast; $NEWS^P_{i,t}$ is an individual-specific indicator of news perception (which equals 1 if the interviewee has heard of changes in prices in the past few months, and 0 otherwise); $NEWS^{P,F}_{i,t}$ and $NEWS^{P,U}_{i,t}$ are individual-specific responses about the content of the news the survey participant has heard about; $NEWS^N_t$ is an index of the intensity of news coverage of inflation in the *New York Times* and the *Washington Post*; $\pi_{t-1}$ denotes the last observed consumer price index inflation rate as of time $t$; $\pi^F_{t+12|t}$ is the (12-month-ahead) mean forecast from the Survey of Professional Forecasters; the vector of control variables includes information on the sociodemographic characteristics of the $i$th respondent (such as gender, age, income, education, race, marital status, and location in the United States), as well as some interaction terms among these characteristics. Clustered standard errors (computed at the individual level through the sandwich estimator) are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

of overpredicting (or underpredicting) in the second interview. To this end, we include $y_{i,1}$ in $\mathbf{w}_i$. We are also interested in understanding whether news absorption exerts any asymmetric impact depending on whether consumers have overpredicted or underpredicted in the first interview. Thus, along with $NEWS^P_i$, $\mathbf{w}_i$ also includes the interaction term $NEWS^P_i \times y_{i,1}$.

Table 8 shows that overprediction is inertial, as $y_{i,1}$ exerts a positive marginal effect on the probability that $y_{i,2} = 1$. Also, $NEWS^P_i$ has a positive effect, while the interaction term $NEWS^P_i \times y_{i,1}$ has no statistically meaningful impact on the probability of overpredicting, unless it enters as the only regressor in $\mathbf{w}_i$, together with $y_{i,1}$ and the vector of control variables.[31] The general tone of the news that consumers have perceived seems to have an asymmetric effect, as unfavorable news increases the chances of overpredicting, while favorable news has a negative marginal effect. Finally, the actual rate of inflation exerts a positive impact on the chances that $y_{i,2} = 1$ in most of the regressions, which signals a certain overreaction to marginal

31. Otherwise, $NEWS^N$ does not exert a statistically significant impact when $NEWS^P_i$ is also included in $\mathbf{w}_i$.

TABLE 7

"GAP" LINEAR REGRESSIONS (RANDOM EFFECTS)

| | Equations | | | | |
|---|---|---|---|---|---|
| | $GAPSQ^*_{i,t}$ | $GAPSQ^*_{i,t}$ | $GAPSQ^*_{i,t}$ | $GAPSQ^*_{i,t}$ | $GAPSQ^*_{i,t}$ |
| Constant | 32.017*** | 10.342*** | 8.045*** | 8.945*** | 12.889*** |
| | (1.580) | (1.659) | (1.624) | (1.657) | (1.637) |
| $NEWS^P_{i,t}$ | 10.923*** | | 8.660*** | 9.942*** | |
| | (0.734) | | (0.740) | (0.786) | |
| $NEWS^N_t$ | | 1.429*** | | 0.341*** | |
| | | (0.035) | | (0.072) | |
| $\pi^F_{t+12\|t}$ | | | 3.865*** | 2.878*** | 0.411** |
| | | | (0.074) | (0.171) | (0.185) |
| $\pi_{t-1}$ | | | | | 2.491*** |
| | | | | | (0.121) |
| $NEWS^{P,U}_{i,t}$ | | | | | 7.570*** |
| | | | | | (0.763) |
| $NEWS^{P,F}_{i,t}$ | | | | | −3.258** |
| | | | | | (1.617) |
| Controls | Yes | Yes | Yes | Yes | Yes |
| $N \times T$ | 172,838 | 168,391 | 172,838 | 168,391 | 172,838 |
| Wald test ($\chi^2$) | 3,480*** | 4,496*** | 6,390*** | 5,030*** | 7,045*** |

NOTES: We estimate (7) by feasible GLS. $GAPSQ^*_{i,t}$ is the squared difference between the Michigan Survey household-specific forecast and consumer price index (CPI) inflation (at the forecast horizon); $NEWS^P_{i,t}$ is an individual-specific indicator of news perception (which equals 1 if the interviewee has heard of changes in prices in the past few months and 0 otherwise); $NEWS^{P,F}_{i,t}$ and $NEWS^{P,U}_{i,t}$ are individual-specific responses about the content of the news the survey participant has heard about; $NEWS^N_t$ is an index of the intensity of news coverage of inflation in the *New York Times* and the *Washington Post*; $\pi_{t-1}$ denotes the last observed CPI inflation rate as of time $t$; $\pi^F_{t+12|t}$ is the (12-month-ahead) mean forecast from the Survey of Professional Forecasters; the vector of control variables includes information on the sociodemographic characteristics of the $i$th respondent (such as gender, age, income, education, race, marital status, and location in the United States), as well as some interaction terms among these characteristics. Clustered standard errors (computed at the individual level through the sandwich estimator) are reported in parentheses. *** and ** indicate significance at the 1% and 5% levels, respectively.

variations in the inflation outlook. Such a pessimistic attitude may indeed play a role in preventing households from making an efficient use of the information they perceive and adjust their expectations toward the SPF mean forecast.

With this picture at hand, one important question needs to be addressed: how can we explain the coexistence of an updating mechanism à la Carroll—which is generally supported by the analysis with aggregate data—with the fact that household-level data are not consistent with the epidemiological hypothesis? To rationalize these mutually contradicting phenomena, one could argue that although only half of the respondents update their expectations in the "right" direction, yet the magnitude of their adjustments is such that the "aggregate revision" moves toward the SPF mean forecast.[32] To test this hypothesis we compute, for all respondents that update their forecasts in the second interview, the average distance between their expectations and the SPF mean expectation, both in the first and second interviews. The statistics

32. Another possible explanation relies on the role of the predictions of those who are interviewed for the first time. In fact, it may be the case that even if incumbents' expectation updating does not work as predicted by Carroll, new respondents' predictions influence the dynamics of the average forecast. However, we test this hypothesis and obtain no supportive evidence.

TABLE 8

DETERMINANTS OF THE FORECAST BIAS AT THE HOUSEHOLD LEVEL

| | Models | | | | | | |
|---|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 |
| $y_{i,1}$ | 0.273*** | 0.256*** | 0.256*** | 0.254*** | 0.261*** | 0.270*** | 0.277*** |
| | (0.004) | (0.003) | (0.005) | (0.004) | (0.005) | (0.004) | (0.005) |
| $\pi$ | −0.007*** | 0.018*** | 0.042*** | 0.041*** | 0.042*** | | |
| | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | | |
| $\pi^F$ | | | −0.086*** | −0.084*** | −0.086*** | | |
| | | | (0.003) | (0.002) | (0.003) | | |
| $NEWS_i^P$ | 0.134*** | | 0.106*** | | 0.113*** | | 0.128*** |
| | (0.009) | | (0.009) | | (0.013) | | (0.013) |
| $NEWS^N$ | | −0.022*** | | | | | |
| | | (0.001) | | | | | |
| $NEWS_i^{P,U}$ | | | | 0.108*** | | | |
| | | | | (0.009) | | | |
| $NEWS_i^{P,F}$ | | | | −0.079** | | | |
| | | | | (0.040) | | | |
| $NEWS_i^P \times y_{i,1}$ | | | | | −0.012 | 0.102*** | −0.011 |
| | | | | | (0.017) | (0.012) | (0.017) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| SSC | 0.000*** | 0.000*** | 0.001*** | 0.000*** | 0.001*** | 0.000*** | 0.001*** |
| $N$ | 68,216 | 67,106 | 68,216 | 68,216 | 68,216 | 68,216 | 68,216 |
| Wald test ($\chi^2$) | 5,805*** | 7,374*** | 6,300*** | 5,886*** | 6,321*** | 5,044*** | 5,627*** |

NOTES: This table reports the marginal partial effects from the estimation of $\Pr(y_{i,2} = 1|\mathbf{w}_i) = \Phi(\mathbf{w}_i\psi)$, where $\Phi(\cdot)$ is the cumulative distribution function of the standard normal distribution, $\mathbf{w}_i$ is the vector of covariates, and $\psi$ is a vector of coefficients; $y_{i,2}$ is a binary variable that indicates whether the $i$th respondent's prediction is greater ($y_{i,2}= 1$) or lower ($y_{i,2}= 0$ ) than professional forecasters' mean prediction in the second interview. Vector $\mathbf{w}_i$ includes: the binary variable $y_{i,1}$, which indicates whether the $i$th respondent's prediction has been greater ($y_{i,1}= 1$) or lower ($y_{i,1}= 0$) than professional forecasters' mean prediction in the first interview; $NEWS_i^P$, which is an individual-specific indicator of news perception (which equals 1 if the interviewee has heard of changes in prices in the past few months before the interview, and 0 otherwise); $NEWS^N$ is an index of the intensity of news coverage of inflation in the *New York Times* and the *Washington Post*; $NEWS_{i,t}^{P,F}$ and $NEWS_{i,t}^{P,U}$ are individual-specific responses about the content of the news the survey participant has heard about; $\pi$ denotes the last observed consumer price index inflation rate; $\pi^F$ denotes the (12-month-ahead) mean forecast from the Survey of Professional Forecasters; a vector $\mathbf{x}_i$ of control variables include information on the sociodemographic characteristics (such as gender, age, income, education, race, marital status, and location in the United States), as well as a number of interaction terms among them. We include information on the sociodemographic characteristics of the MS respondents (such as gender, age, income, education, race, marital status, and location in the United States), as well as a number of interaction terms among them. To account for the presence of question attrition, we perform a sample selection correction test; *SSC* stands for the $p$-value of the Wald test of independence from the sample selection equation (which includes as regressors some sociodemographic characteristics as well as the tone of the news consumers have heard). A constant has been included in all regressions. Standard errors are calculated with the delta method (Oehlert 1992) and are reported in parentheses. *** and ** indicate significance at the 1% and 5% levels, respectively.

show that the average prediction gap narrows down by about 43.2% from the first to the second survey response, implying that the aggregate revision is on average dominated by the adjustment of those who update correctly, as compared to those who shift their projections further away from the SPF mean forecast.[33] The main implication of this result is that the empirical relevance of the model behind equation (1) may actually result as a statistical artifact. In this case, the key driver of the expectation updating mechanism underlying consumers' mean response could be

33. This mechanism turns out to be reinforced if the two statistics include those who do not update their predictions between the first and second interviews. This is because the SPF mean forecast tends to decrease over time, driving down the average prediction gap between the first and second interviews.

represented by the relative size of the adjustments in household-level forecasts rather than by the epidemiology of inflation expectations.

## 4. CONCLUDING REMARKS

This paper has extensively tested the epidemiological foundations of the sticky information model. We provide at best weak support for the view according to which consumers update their forecasts from the media, which are assumed to transmit professional forecasters' projections. An average of about 75% of the survey respondents update their inflation forecasts with respect to their first interview. However, just a small fraction of those who update their forecasts (16.2%) potentially revise them in accordance with the epidemiological model. Moreover, in each quarter only 5.8% of the households display some receptiveness to news on prices. This suggests a fundamental disconnection between news on inflation and consumers' expectation updating.

A key result is that hearing news on prices does not necessarily help at producing better forecasts, though it increases the probability that consumers revise their expectations. Consumers' expectation updating is also characterized by a marked degree of pessimism, which shows at different stages of the analysis. Importantly, the rate of CPI inflation and households' receptiveness to unfavorable news on prices exert a positive effect on the expectation gap between households' and professional forecasters' mean expectations. These factors also increase the likelihood that households persistently produce higher forecasts than professional forecasters' mean expectation. Along with households' pessimistic attitude, two alternative interpretations may be put forward to explain why consumers display stronger perception of unfavorable rather than favorable news on prices, and why this news exerts a negative impact on the accuracy of their forecasts. On one hand, news coverage may be biased by the views of players in the media, so that the views of professional forecasters are not reported objectively. On the other hand, as discussed by a number of contributors, professional forecasters often produce biased projections and, even if their views are objectively transmitted by the media, they may induce further distortions in consumers' forecasts. These considerations altogether point to the epidemiological mechanism of expectation formation as a transmission channel of potentially biased forecasts. In addition, the existence of a substantial fraction of consumers who do not adjust their forecasts toward professional forecasters' mean expectation is likely to induce an omitted-variable bias in Carroll's estimates of the absorption rate.

Our study has some relevant implications for evaluating the cost of disinflations and the role of communication and credibility in monetary policymaking. As to the first aspect, a number of authors stress the importance of quantifying the cost of disinflations in contexts where expectations are updated in a staggered fashion (see, e.g., Mankiw and Reis 2001, 2002, Carroll 2003, 2006). Time-varying measures of the frequency of expectation updating as the one we retrieve from household-level

data can be used to explore these issues. In fact, in agreement with the rational inattention argument that consumers should be more intensely focused on news on inflation and inflation-fighting policies during periods of high inflation, we show that consumers' frequency of expectation updating has actually reached its maximum right before Volcker's disinflationary policy kicked in during the 1980s. As to the role of communication in policymaking, Carroll suggests that credibility among experts may not be sufficient to achieve a desired inflationary outcome and suggests that the views of the experts need to be communicated effectively to the population to become effective. These may certainly be important aspects, provided that the experts produce efficient forecasts and these are objectively transmitted by the media. Nevertheless, we should also account for the possibility that consumers do not necessarily follow experts' views or they may not make an efficient use of the information they retrieve from the media.

## APPENDIX

TABLE A1

PAIRWISE CORRELATIONS

| | $GAPSQ_t$ | $GAPSQ_t^*$ | $NEWS_t^N$ | $NEWS_t^P$ | $N_t^P N_t^N$ | $NEWS_t^{P,F}$ | $NEWS_t^{P,U}$ | $\pi_t$ |
|---|---|---|---|---|---|---|---|---|
| $GAPSQ_t$ | 1 | | | | | | | |
| $GAPSQ_t^*$ | 0.537*** | 1 | | | | | | |
| $NEWS_t^N$ | 0.238** | 0.026 | 1 | | | | | |
| $NEWS_t^P$ | 0.604*** | 0.566*** | 0.071 | 1 | | | | |
| $N_t^P N_t^N$ | 0.718*** | 0.414*** | 0.567*** | 0.799*** | 1 | | | |
| $NEWS_t^{P,F}$ | −0.074 | −0.071 | 0.216* | 0.149 | 0.223* | 1 | | |
| $NEWS_t^{P,U}$ | 0.626*** | 0.586*** | 0.017 | 0.973*** | 0.758*** | −0.083 | 1 | |
| $\pi_t$ | 0.535*** | 0.177* | 0.752*** | 0.501*** | 0.787*** | −0.029 | 0.512*** | 1 |

NOTES: This table reports pairwise correlations among the variables employed in the regression analysis of Section 2. $N_t^P N_t^N$ stands for $NEWS_t^P \times NEWS_t^N$. ***,**, and * indicate significance at the 0.1%, 1%, and 5% levels.

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