The Role of Media for Consumers' Inflation Expectation Formation

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Abstract

The full-information rational expectations model is clearly rejected by the data. The expectation formation process has therefore important implications for macroeconomic outcomes. We examine how consumers react to information provided by the media, by taking into account that this information is imperfect. Theoretically, there are two sources of imperfect information. First, consumers receive new information infrequently (sticky information). Second, they have to distinguish news from noise (partial information). We show that both play a role empirically. Intensive news reporting improves the accuracy of consumers' inflation expectations, because they receive more information. However, this effect depends on the tone of the news. If news are badly toned, the effect reverts.

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1 Introduction

Well-anchored inflation expectations are essential not only for securing price stability but also for facilitating overall economic stability over time. Therefore, monetary policy makers often emphasize that managing consumers' inflation expectations has become one of their most important tasks. It is thus not surprising that the literature on inflation expectation formation has been growing rapidly in recent years.

Models with full-information rational expectations are clearly rejected by the data (see for example Mankiw et al., 2003; Döpke et al., 2008a,b). An explanation for this empirical finding is that peoples' abilities to process information are constrained (Sims, 2003). In recent years, there has been considerable effort in developing theoretical models of expectation formation featuring imperfect information. In these models, the way agents form their expectations has important macroeconomic implications (see for example Ball et al., 2005; Paciello and Wiederholt, 2011). Empirical models describing how empirical expectations are formed are, however, still scarce. This paper sheds some light on the formation of consumers' inflation expectation by investigating the role of news media as transmitters and filters of news.

In theoretical models, there are two approaches to imperfect information models: sticky information and partial information models (see Mankiw and Reis, 2011). In sticky information models, agents update information only infrequently, because acquiring information continuously is too costly (Mankiw and Reis, 2002). However, once agents update their information sets, they gain full information. In contrast, in partial information models, agents update their information sets continuously, but they observe only a noisy signal on the underlying economic variables (Woodford, 2001). Arguably, both sources of imperfection should play a role in reality.

Media are relevant for the expectation formation process, because most people obtain their information from media reports. For example, Blinder and Krueger (2004) show that consumers obtain their economic information largely from TV and newspapers. Thus, media may affect the way consumers update their inflation expectations, just as it influences, for example, peoples' voting behavior (see for example DellaVigna and Kaplan, 2007; Hetherington, 1996; Doms and Morin, 2004).

We examine how consumers react to information provided by the media. We build upon an influential paper by Carroll (2003), who models sticky information by assuming that news media provides information, which is received only by a share of the population. This information is then spread from period to period through the population, similar to the way diseases spread. Our paper extends his model by also allowing for partial information, assuming that the news transmitted by the media is noisy. In our model, media act as a transmitter of news within a Bayesian learning framework, which allows us to examine both sources of informational imperfection. First, just as in the Carroll model, the intensity of news reports determines how many consumers receive new information (sticky information). Second, the quality of news determines how informative news reports are. When consumers receive this information, they have to distinguish news from noise (partial information).

Our findings suggest that the reaction of inflation expectations to news delivered via media reports depends on both the quality and the quantity of news. In general, intensive media reporting informs consumers and thus brings them to update their information sets more frequently. This, however, is only the case if media reports are neutrally toned. Unfavorably toned media reports tend to bias consumers' expectations. Thus, our results suggest that both sources of informational imperfection play a role empirically.

The effect of media is economically important. Our analysis rests on a rich media data set for Germany over 10 years, containing close to 4,000 media reports related to the topic 'inflation'. As proposed by Carroll (2003), we use the gap between consumers' inflation expectations and expectations of professional forecasters to quantify the accuracy of consumers' expectations. On average, the gap amounts to 56 basis points. According to our estimates, it declines by 10 basis points with 10 additional neutrally toned media reports. On the contrary, 10 unfavorably toned media reports raise the gap by about 45 basis points.

The remainder of the paper is organized as follows. Section 2 derives a simple Bayesian learning framework to motivate our hypotheses. Section 3 introduces the data and explains the methodology. In Section 4, the results are presented and robustness checks are conducted. Section 5 concludes.

2 Model and Hypotheses

This section outlines a simple theoretical framework that allows us to describe the influence of media coverage on consumers' inflation expectation formation. The model develops in three steps. First, the model describes how information about inflation is received and processed by consumers. We assume that the media i) report infrequently and ii) that the signal consumers receive from the media is noisy. In a second step, a media bias is introduced into the model. It is shown that such a bias may impair the accuracy of consumers' expectations. In a third step, we show the implications of the learning model for aggregate inflation expectations in a reduced from equation.

2.1 Bayesian Learning

The Bayesian learning model assumes that the media send a noisy signal about the true underlying state, which is the rational inflation forecast. Consumers face a signal extraction problem and they learn about the the rational inflation forecast from the signals they receive. The more signals they observe the better becomes their assessment of future inflation. We also discuss the effect of biased media reporting.

The first part of the model shows how consumers learn from the information provided by the media. Assume a representative consumer i holds a normally distributed prior belief $\Pi_{i,t} \sim N(\pi_{i,t}, \sigma_a)$ about future inflation $\pi_{i,t+1}$ and receives a normally distributed signal $\psi_{v,t} \sim N(\theta_t, \sigma_\psi)$ from the news. Given V units of noisy media reports with contents $\psi_{v,t}$, the consumer has to infer the (rational) inflation forecast denoted by θ_t. Consumer i updates the prior belief according to Bayes' rule:

$$k_i(\pi_{i,t+1}|\psi_{v,t}) \propto \Pi_{v=1}^{V} f_i(\psi_{v,t}|\pi_{i,t}) h(\pi_{i,t}). \quad (1)$$

where $h(.)$ is the prior density, $f_i(.)$ is the conditional density of the observed public information given the prior belief $\pi_{i,t}$ and $k_i(.)$ is the resulting posterior density given media reports.

Under the normality assumptions the posterior distribution is again normal with mean

$$E(\pi_{i,t+1}|\psi_{v,t}) = \rho_t \pi_{i,t} + (1-\rho_t)\bar{\psi}_t, \tag{2}$$

where $\bar{\psi}_t = V^{-1}\sum_{v=1}^{V} \psi_{v,t}$. Thus, the mean of the posterior distribution is a weighted average of the prior mean and the average noisy signal obtained from the media. The weight ρ_t is given by

$$\rho_t = \frac{\frac{1}{V}\sigma_\psi}{\sigma_a + \frac{1}{V}\sigma_\psi}. \tag{3}$$

Because $\partial\rho_t/\partial V < 0$, in the limit: $lim_{V\to\infty}\rho_t = 0$.

In the next paragraph, we assume that media obtain their information from individual professional forecasters. These may disagree in their inflation forecast. Consumers try to infer the rational inflation forecast from the media reports they receive. In addition, we introduce different forms of media bias. We will show that only a persuasion bias may bias consumers' expectations. This extension follows the politician ability model presented in DellaVigna and Kaplan (2007).

Consider a finite number of professional inflation forecasters denoted by J. These forecasters are interviewed by the media and thereby reveal their individual forecasts. Each media report is assumed to contain the inflation forecast of one professional forecaster. On average, professional forecasters make rational predictions, i.e. $\frac{1}{J}\sum_{j=1}^{J}\theta_{j,t}$ denotes the rational forecast. However, some forecasts deviate from the average. The difference between the interviewed forecaster in the media report j and the average of all forecasts is denoted by $\theta_j = \psi_{j,t} - \bar{\psi}_t$. We refer to θ_j as the relative inflation forecast, and we assume that it is drawn from the distribution $N(0, \sigma_\theta^2)$. As the media want to deliver exciting stories, they do not fully reveal how much the interviewed forecaster deviates from the rational forecast. Thus, they report with a time invariant bias $b \sim N(b_0, \sigma_b^2)$. The consumer observes a media report with content ψ_j

$$\psi_j = \theta_j + b, \tag{4}$$

which is a composite of the true relative inflation forecast θ_j and the bias b.

The consumer is faced with a signal extraction problem, because θ_j and b cannot be observed perfectly. A positive ψ_j could be due to the fact that the inflation forecast of the interviewed forecaster lies above the average ($\theta_j > 0$) and the bias is very small or due to the fact that the interviewed forecaster is rational ($\theta_j = 0$) but the media report contains a large bias ($b > 0$), or both. The consumer is assumed to know the distributions of θ_j and b. Therefore, the conjugate prior is used to form the Bayesian estimate for b. The posterior estimate after observing V news reports with average $\bar{\psi}$ is thus

$$\widehat{b_V} = w\bar{\psi} + (1-w)b_0 \tag{5}$$

with

$$w = \frac{\frac{V}{\sigma_\theta^2}}{\frac{V}{\sigma_\theta^2} + \frac{1}{\sigma_b^2}}.$$

To estimate the quality of the forecast observed in the V-th media report, the consumer subtracts the estimate of the media bias from the observed signal ψ_V. The prior for θ_V is

$$\begin{aligned}
\widehat{\theta_V}^P &= \psi_V - \widehat{b_V} \\
&= \psi_V - \frac{\frac{V}{\sigma_\theta^2}}{\frac{V}{\sigma_\theta^2} + \frac{1}{\sigma_b^2}}\bar{\psi} - \left(1 - \frac{\frac{V}{\sigma_\theta^2}}{\frac{V}{\sigma_\theta^2} + \frac{1}{\sigma_b^2}}\right)b_0 \\
&= \frac{\frac{1}{\sigma_b^2}(b - b_0) + \left(\frac{V-1}{\sigma_\theta^2} + \frac{1}{\sigma_b^2}\right)\theta_V - \frac{1}{\sigma_\theta^2}\sum_{v=1}^{V-1}\theta_v}{\frac{V}{\sigma_\theta^2} + \frac{1}{\sigma_b^2}}
\end{aligned} \tag{6}$$

and the estimated variance of $\widehat{\theta_V}^P$ is

$$Var(\widehat{\theta_V}^P) = \frac{\frac{1}{\sigma_b^2} + \frac{V-1}{\sigma_\theta^2}}{\left(\frac{V}{\sigma_\theta^2} + \frac{1}{\sigma_b^2}\right)^2} \equiv W. \tag{7}$$

The Bayesian estimate of θ_V is

$$\widehat{\theta_V} = \frac{\frac{1}{\sigma_\theta^2}}{\frac{1}{\sigma_\theta^2}+\frac{1}{W}} \cdot 0 + (1 - \frac{\frac{1}{\sigma_\theta^2}}{\frac{1}{\sigma_\theta^2}+\frac{1}{W}})(\psi_V - \widehat{b}_V)$$
$$= \frac{\frac{1}{W}}{\frac{1}{\sigma_\theta^2}+\frac{1}{W}}(\psi_V - \widehat{b}_V). \quad (8)$$

Proposition 1: *More news improves the ability of consumers to correctly identify the media bias, and their forecast equals the average of all forecasters in the limit, i.e.,* $lim_{V\to\infty}\widehat{\theta_V} = 0$*. This also implies that the effect of media bias on beliefs is zero in the limit:* $lim_{V\to\infty}\frac{\partial\widehat{\theta_V}}{\partial b} = 0$

The proof follows immediately from $lim_{V\to\infty}\frac{1}{W} \setminus (\frac{1}{\sigma_\theta^2}+\frac{1}{W}) = 1$ and $lim_{V\to\infty}w = 1$, thus $lim_{V\to\infty}\widehat{b_V} = \bar{\psi}$ and hence $lim_{V\to\infty}\widehat{\theta_V} = 0$.

This model implies that consumers' estimates on average converge to the true value of the media bias and thus converge to the rational forecast of inflation. In the next step, we extend the model to allow for persuasion. The literature reviewed in Hamilton (2004) and our introduction provides evidence that the media does not necessarily report the true state of the world. As a result, people may be persuaded by biased media reports.[1]

The degree of persuasion is denoted by ϕ with $0 \leq \phi \leq 1$. Consumers believe that the news report equals $\psi_j = \theta_j + (1-\phi)b$. Therefore, a positive ϕ implies that consumers systematically believe that a part of the biased news report is actually true. Therefore, the estimate of θ_V is

$$\widehat{\theta_V^\phi} = \frac{\frac{1}{W}}{\frac{1}{\sigma_\theta^2}+\frac{1}{W}}(\psi_V - (1-\phi)\widehat{b}_V). \quad (9)$$

From this equation we can derive following proposition:

Proposition 2: *If* $\phi > 0$*, the effect of the media bias on the estimated forecaster quality is positive for finite* V*, i.e.,* $\frac{\partial\widehat{\theta_V}}{\partial b} > 0$*. In the limit, the effect of the media bias is equal to the degree of persuasion* ϕ*:* $lim_{V\to\infty}\frac{\partial\widehat{\theta_V}}{\partial b} = \phi$. The proof follows directly from the proof of proposition 1.

[1] DeMarzo et al. (2003) show that persuasion is likely because consumers do not sufficiently account for bias in the media, even if they are aware of it. They may simply underestimate its effect.

2.2 Hypotheses

Based on the theoretical model, this section derives a reduced form equation for the empirical tests. An interesting aspect is that this testable equation nests the empirical specification shown in Carroll (2003), although it is derived from an a different theoretical approach.

Recall equation (2)

$$E(\pi_{i,t+1}|\psi_{v,t}) = \rho_t \pi_{i,t} + (1 - \rho_t)\bar{\psi}_t,$$

which shows that the inflation forecast of the representative consumer is a weighted average of the prior belief and the public signal. The weight is determined by the volume of media reports.

For aggregate inflation expectations, the subindex i is dropped. $\bar{\psi}_t$ is the rational average forecast of professional forecasters. Thus, the absolute forecast error consumers make is the absolute difference of their forecast and $\bar{\psi}_t$.

$$\begin{aligned} \mid E(.) - \bar{\psi}_t \mid &= \mid \rho_t \pi_t + (1 - \rho_t)\bar{\psi}_t - \bar{\psi}_t \mid \\ &= \mid (1 - \rho_t)(\pi_t - \bar{\psi}_t) \mid . \end{aligned} \tag{10}$$

The partial effect of more news on the accuracy of the inflation forecast of consumer is described by:

$$\frac{\partial \mid E(.) - \bar{\psi}_t \mid}{\partial V_t} = -\frac{\partial \rho_t}{\partial V_t} \mid (\pi_t - \bar{\psi}_t) \mid < 0. \tag{11}$$

Thus, our first testable hypothesis is

> **Hypothesis 1:** *If consumers are not subject to persuasion by a media bias, more media reporting brings consumers' forecasts closer to the rational forecast.*

If the media persuade consumers and $\phi > 0$, then the effect of more media reporting on expectations is ambiguous. This is because under Proposition 2, in the limit, consumers update with $\bar{\psi}_t + \phi$. Therefore, the absolute forecast error is

$$\begin{aligned} \mid E(.) - \bar{\psi}_t \mid &= \mid \rho_t \pi_t + (1-\rho_t)(\bar{\psi}_t + \phi) - \bar{\psi}_t \mid \\ &= \mid (1-\rho_t)(\pi_t - \bar{\psi}_t) + \rho_t \phi \mid . \end{aligned} \tag{12}$$

The partial effect of more media reports including a persuasion bias is then:

$$\frac{\partial \mid E(.) - \bar{\psi} \mid}{\partial V_t} = -\frac{\partial \rho_t}{\partial V_t} \mid (\pi_t - \bar{\psi}_t) \mid + \frac{\partial \rho_t}{\partial V_t} \phi.$$

More news improves the accuracy only if $\phi < |(\pi_t - \bar{\psi}_t)|$.

The intuition behind this result is straightforward. More media reporting has two effects. First, more media reporting implies that more consumers have the newest information and thus that the error they make is smaller. Second, more media reports also imply that more people are subject to persuasion and thus that their forecast error becomes larger. For a relatively small bias or a relatively large prior gap between consumers' and professional forecasters' expectations, more reporting improves the accuracy of consumer inflation forecasts. However, for a larger bias (ϕ) and a relatively smaller gap $|(\pi_t - \bar{\psi}_t)|$, the second effect dominates. Therefore, the effect of media reports on expectations depends on the *tone* of media reports. As a result, the second hypothesis reads as follows:

> **Hypothesis 2:** *If consumers are subject to persuasion by a media bias, the tone of media reports may impair the accuracy of consumer forecasts. The volume of reporting has an ambiguous effect on the accuracy of consumer forecasts.*

3 Data and Estimation

For the empirical analysis, a media data set allows us to quantify the intensity and content of reporting on inflation in the media. Furthermore, we use survey data to capture inflation expectations of consumers and survey data for the forecasts of professional economists.

3.1 Media Data

The media data is produced by the media research institute Mediatenor, which collects and quantifies the media coverage on various topics.[2] The data comprise newspaper, magazine articles and TV news on a daily frequency for the time span 01/1998 to 09/2007 in Germany. To ensure a minimum coverage of the topic inflation only statements are included that are at least five lines long in the case of printed media and last at least five seconds for TV broadcasts.[3] In sum, the data comprises roughly 4,000 reports on a daily basis.

The advantage of the data is that it covers all media reports in the leading German press/TV and that the coding is based on a scientific method, which ensures objectivity and reproducibility. The coding is based on the standards of Media Content Analysis.[4] Several specifically trained analysts, so-called coders, code the news according to several characteristics, such as the topic or the tone. Using human coders allows Mediatenor to extract the full content of statements, because machine coding would not allow to capture all variations of phrasing a specific content. The methodology warrants objectivity because at least two different coders analyze the same text independently. If the coders do not come up with the same result, the respective passages in the text are re-coded.

The data comprises detailed information on each news report: whether it deals with rising or falling inflation and its tone. From this data set, the following monthly time series are generated.

- *Volume*: the number of inflation reports within a given month.
- *Rising*: the number of inflation reports that deal with 'rising inflation'.
- *Falling*: the number of inflation reports that deal with 'falling inflation'.

[2] See `www.mediatenor.de` for details on the coding of news.

[3] In detail, the following news sources are analyzed: daily press: Frankfurter Allgemeine Zeitung, Welt, Süddeutsche Zeitung, Frankfurter Rundschau, Tageszeitung, Bild, Neue Zürcher Zeitung, Berliner, Volksstimmer, Sächsische, Westdeutsche Allgemeine Zeitung, Kölner Stadt-Anzeiger, Rheinischer Merkur; daily TV-News: ARD Tagesschau, Tagesthemen, ZDF Heute, Heute Journal, RTL Aktuell, SAT.1 18:30, ProSieben Nachrichten. Weekly press: Spiegel, Focus, Die Woche, Wochenpost, Welt am Sonntag, Bild am Sonntag, Die Zeit.

[4] See for instance Holsti (1969) for a detailed description on this methodology.

- *Notrend*: the number of inflation reports that do not contain information regarding rising or falling inflation.
- *Good*: the number of inflation reports that asses inflation as ‘good’.
- *Bad*: the number of inflation reports that asses inflation as ‘bad’.
- *Neutral*: the number of inflation reports that do not give an assessment.
- *Badrising*: the number of inflation reports that asses inflation as ‘bad’ *and* deal with ‘rising inflation’.
- *Otherrising*: the number of inflation reports that *do not* asses inflation as ‘bad’ *and* that deal with ‘rising inflation’.

As a robustness analysis, we examine the effect of the discussion about the euro introduction in the German media. Therefore, we collect data by searching through `LexisNexis`, an online database of media articles. We use an alternative source to ensure that our results do not depend on the data collection method. We count specific words that are two popular terms related to inflation. First, we count the articles that use the term ‘Teuro’ (*Teuro*). ‘Teuro’ is a concatenation of the words ‘teuer’, the German equivalent for expensive, and the word ‘euro’. Second, we count the number of articles with the expression ‘Euro Einführung’, i.e. news related to the introduction of the new currency (*Eurointrod*). The latter *per se* does not contain a particular tone, as it just reminds the public of a particular event related to the currency changeover. The word ‘Teuro’, however, clearly presumes that inflation has been and/or will be rising.

Summary statistics suggest that media has on average a tendency to report more on rising inflation ($Rising > Falling$) and judge the developments to be mostly unfavorable ($Bad > Good$) (see Table 1). Furthermore, there is also quite some variation in media attention, the month with the smallest number of media reports on inflation is in February 1999, with only 6 reports. The maximum is ten times larger.

3.2 Inflation Expectation Data

Data on consumers' inflation expectations are taken from the monthly European Commission's Business and Consumer Survey. Over 2,000 German consumers are asked every month whether they expect prices to rise, fall or remain unchanged in the coming 12 months (expected inflation). The qualitative data is quantified using an extended version of the Carlson and Parkin (1975) approach (Berk, 1999).[5] It assumes that expectations are normally distributed and does not impose unbiasedness *ex ante*. One advantage of this quantification method is that it directly links the expected rate of inflation to the currently perceived inflation rate.

Inflation expectations from professional forecasters are taken from Consensus Economics. Consensus Economics is a survey company. The monthly survey of experts of private and public institutions asks for economists' inflation expectations for the rest of the current year and for the entire following year. The mean of these forecasts is the measure of professional forecasters' expectations. As the time horizon used in this paper is always the 12-month-ahead expectation, the data have been transformed to obtain this fixed-event forecast horizon. We follow Dovern et al. (2012) and transform the forecast as follows: for month m of a given year t, the expectation of inflation is defined as $(13-m)/12$ times the forecast for year t plus $(m-1)/12$ times the forecast for year $t+1$.

As we are interested in the accuracy of inflation expectations, we calculate the deviation of consumers' inflation expectations from an optimal forecast. We employ the absolute value of the difference between consumers' inflation expectations $E(.)$ and the average expectation of professional forecasters $\bar{\psi}_t$ as $Gapexp_t = |E(.) - \bar{\psi}_t|$. We refer to this variable as the 'expectations gap'.

[5] The data has been kindly provided by the Bundesbank. The calculation is also described in Bundesbank (2007).

Table 1: Summary statistics

Variable	Mean	Std	Min	Max
$E(.)$	1.45	0.71	0.70	3.9
$\bar{\psi}_t$	1.52	0.34	0.83	2.24
HICP	1.43	0.62	0.1	2.8
$Gapexp_t$	0.56	0.43	0	2.26
Volume	19.73	8.99	6	60
Rising	7.23	6.84	0	45
Falling	4.38	4.38	0	20
Notrend	8.10	4.41	0	33
Good	0.93	1.39	0	6
Bad	1.39	2.38	0	21
Neutral	17.4	7.58	3	52
Badris	1.06	2.33	0	21
Risotherjudg	6.15	5.22	0	26
Teuro	16.14	31.1	0	177
Eurointrod	13.66	17.25	0	117

Notes: This table shows summary statistics of all variables. $E(.)$ denotes consumers' inflation expectations, $\bar{\psi}_t$ professional forecasters' inflation expectations, and HICP the y/y growth rate of the Harmonized Index of Consumer Prices for Germany (source: Eurostat). All in %. As for the variables capturing media reporting, *Volume* is the number of reports dealing with inflation. *Rising*, *Falling* and *Notrend* is the number of reports dealing with 'rising', 'falling' and 'neither rising nor falling' inflation, respectively. *Good*, *Bad* and *Notrend* is the number of reports assessing inflation as 'good', 'bad' and 'no assessment', respectively. *Badrising* is the number of inflation reports that asses inflation as 'bad' *and* deal with 'rising inflation'. *Otherrising* captures all reports that deal with 'rising inflation' but do not assess inflation as 'bad'.

3.3 Descriptive Analysis

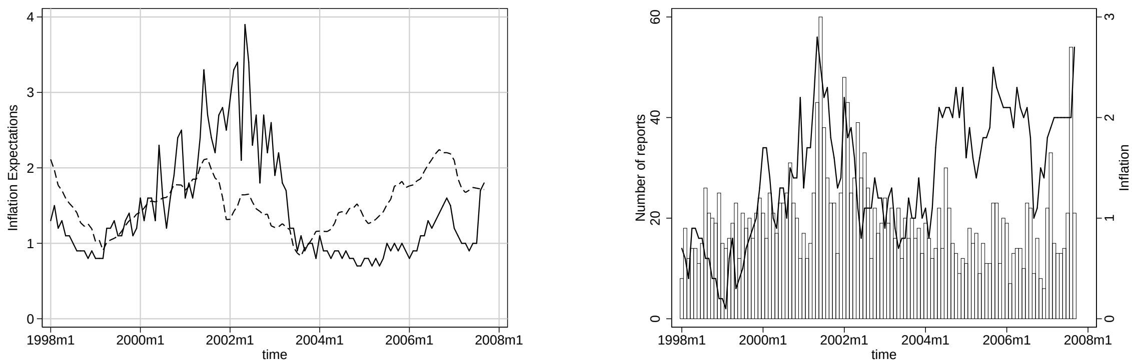
Consumers and professional forecasters have quite similar inflation expectations on average (1.45% vs. 1.52%). The difference is not statistically significant (Table 1).[6] The expectations gap is not very large on average (56 basis points). However, the maximum of 226 basis points is sizeable, suggesting that there are periods where inflation expectations of consumers deviate substantially from those of professional forecasters.

The expectations gap may be substantial. As shown in Figure 1(a), it is particularly apparent in the aftermath of the euro cash changeover. Until mid-2001, consumers and professionals assessed future inflation about equally. However, in 2001 consumers' inflation

[6] Mestre (2007) finds that average consumers' inflation expectations exhibit a small bias while professional forecasters' expectations are unbiased. He furthermore shows that the forecast error of the professional forecaster is smaller than the forecast error made by the consumers.

expectations increased substantially while the expectations of professionals began to ease. After a peak of the expectations gap in mid-2002, consumers' inflation expectations converge back to professional forecasters' expectations.

Figure 1: Inflation Expectations, Media Coverage and Inflation



(a) Inflation expectations: consumers vs. professionals

(b) Media Coverage and Inflation

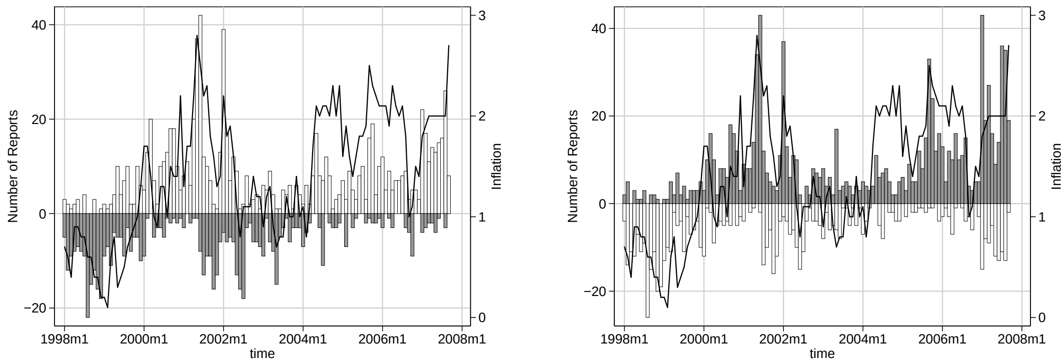
Notes: Figure (a): the solid line represents inflation expectations of German consumers ($E(.)$), the dashed line represents professional forecasters' inflation expectations for Germany ($\bar{\psi}_t$). Figure (b): the solid line represents the growth rate of the HICP (rhs). The bars show the amount of inflation reports in the media (*Volume*).

Even though high inflation periods are often associated with a large volume of media reports, there are periods where these two do not necessarily co-move. Figure 1(b) illustrates the variable *Volume* (bars) together with inflation (line) measured by the growth rate of the Harmonized Index of Consumer Prices (HICP). In general, media attention correlates with the level of inflation. In the period 2004 to 2007, however, inflation is high but media reporting remains moderate.

In general, more reports on rising inflation coincide with periods of rising HICP inflation. However, there are not necessarily more reports on falling inflation in periods with falling HICP inflation. This is illustrated in Figure 2(a), which shows reports dealing with rising and falling inflation together with HICP inflation. This observation is in line with the findings of earlier studies, which show that media tend to report more intensively on bad news (Groeling and Kernell, 1998).

The judgement of reports with respect to inflation is shown in Figure 2(b). Badly toned news are more prevalent during the periods when inflation rose in 2001 and 2005. However, a

Figure 2: Media Tone and Inflation



Notes:

(a) Direction of Reports and Inflation

(b) Judgement of Reports and Inflation

Figure (a): the solid line represents the growth rate of the HICP (rhs). White bars represent the amount of reports dealing with rising inflation (*Rising*). Shaded bars represent the amount of reports dealing with falling inflation (*Falling*, inverted). Figure (b): the solid line represents the growth rate of the HICP (rhs). White bars represent the amount reports toned favorably (*Good*). Shaded bars represent the amount of reports toned unfavorably (*Bad*, inverted).

large amount of media reports in the beginning of 2002 is badly toned as well, which coincides with the euro cash changeover.

3.4 Estimation

Empirically, we test whether the effect of media reporting on the expectations gap is positive, negative or zero. The empirical equation is derived from equation (12) in the theoretical part. Note, that it nests the case with no persuasion by media in equation (10), if the last term in equation (12) is zero. Thus, the empirical equation consists of three terms, the lagged expectations gap, the measure of persuasion by a media bias, and some additional controls. We estimate the simple equation

$$Gapexp_t = \alpha + \beta Gapexp_{t-1} + \Gamma \mathbf{Media}_t + \delta Z_t + \varepsilon_t, \qquad (13)$$

where $\mathbf{Media}_t$ denotes a vector of media variables and Z_t a vector of controls, which are a dummy that is equal one during the year of the euro cash changeover 2002 (*Deuro*) and zero otherwise and the lagged rate of HICP inflation (*HICP*).[7] Equation (13) is estimated using

[7] We control for the euro cash changeover period to account for the fact that inflation perceptions displayed very unusual patterns in Germany during the changeover period (Lamla and Lein, 2010), which arguably feed

OLS with robust standard errors.[8]

We include the lagged HICP figure because it is released with a lag and thus inflation in $t-1$ is the most recent information regarding inflation consumers and professionals have in period t.

We control for a potential endogeneity problem in the specification we estimate in two ways. First, we include the lagged expectation gap. It is not only important because it is present in the theoretical model but also because it accounts for a possible endogeneity problem, which we could potentially be faced with. The problem may arise when the dependent variable is highly persistent and contemporaneously affects the explanatory variable. In our case, the persistence term in the expectations gap may affect media reporting in the previous period. Thus, including the media reports with a time lag would not be sufficient to control for the endogeneity problem. Including both the lagged expectations gap and the lagged media reports as explanatory variables should avoid such a reverse causality. Second, in the days after the release of the consumer survey data, media may comment on these figures. To avoid that such reports induce reverse causality and contaminate our estimates, we exploit the fact that we have daily media data. To aggregate the media data to monthly data, we sum up the media reports in a given month only up to the day before the release date for the consumer survey.

4 Results

The volume of news is not significantly correlated with the expectations gap. Column (1) in Table 2 shows the estimates including only *Volume* and the euro cash changeover dummy *Deuro*. The coefficient of *Volume*, however, is insignificant. This is the same equation as the one estimated in Carroll (2003) for the U.S. He finds a statistically significant negative relationship between the *Volume* and the expectations gap.[9]

into expectations.

[8]We considered different methods and specifications to estimate this single equation (see also robustness section). Our main results prove robust. We chose to report OLS because they are straightforward to interpret. Additional results using 3SLS or first differences can be provided by the authors upon request.

[9]In the original specification, Carroll uses the squared gap. As this measure overweights extreme events, we employ the absolute gap. Another advantage of using the absolute gap is that it makes our measure easier

This result remains unchanged when controlling for additional variables and non-linearities. Columns (2) and (3) show the coefficient estimates for the equation including the lagged dependent variable and lagged HICP inflation. Both control variables are statistically significant with expected signs. The estimate for the lagged dependent variable is between 0.45 and 0.28. This suggests that the persistence of the expectations gap is not very high. Nevertheless, *Volume* remains, despite having the anticipated sign, insignificant. Non-linearities in the relationship are controlled for by adding the squared term of the volume variable. Results are reported in column (4). Both *Volume* variables remain insignificant.

If indeed a media bias exists, the finding that the volume is not significantly correlated with the expectations gap is in line with the predictions of the theoretical model. In the theoretical model, more news reporting indeed has an ambiguous effect on the expectations gap (equation 12). The effect depends on the quality of the media signal.

To condition on the tone of reports, *Volume* is disentangled into the number of news reports on rising, falling, and unspecified direction and news that are explicitly toned good, bad, and neutral. The estimates reported in column (5) show that neutrally toned news narrow the expectations gap. This variable is of particular interest, as it measures volume adjusted for the tone. Therefore, the coefficient on the impact of neutral statements allows us to identify whether the frequency of reporting itself is relevant. Thus, conditional on the tone of the news, we can confirm the results of Carroll (2003) for Germany.

Badly toned news have the opposite effect. They are associated with a rising expectations gap. These results suggest that both the frequency and tone of reporting matter. News that do not contain a specific tone help to update consumers' information sets with the latest information, in line with the first hypothesis. Badly toned news may exaggerate certain developments and contain a bias which feeds into consumers' expectations, in line with the second hypothesis. On the contrary, good news with respect to inflation have no statistically significant effect. This result also suggests that there is an asymmetric response of expectations to media reporting.

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to interpret. However, the qualitative results do not change when using the squared gap.

Table 2: Media and expectations gap

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Deuro	0.813***	0.446*	0.588**	0.598**	0.637***	0.607***	0.586***
	(0.169)	(0.230)	(0.228)	(0.234)	(0.228)	(0.227)	(0.212)
$Gapexp_{t-1}$		0.450***	0.315**	0.318**	0.302**	0.278*	0.308**
		(0.114)	(0.126)	(0.127)	(0.125)	(0.144)	(0.128)
$HICP_{t-1}$			0.192***	0.173***	0.147***	0.219***	0.203***
			(0.046)	(0.047)	(0.056)	(0.077)	(0.070)
$Volume$	0.002	0.003	-0.000	-0.017			
	(0.005)	(0.005)	(0.005)	(0.012)			
$Volume^2$				0.000			
				(0.000)			
Good					0.006		
					(0.020)		
Bad					0.046***		
					(0.011)		
Neutral					-0.010**		
					(0.004)		
Rising						0.001	
						(0.005)	
Falling						0.008	0.000
						(0.009)	(0.009)
Notrend						-0.007	-0.004
						(0.009)	(0.008)
Badrising							0.045***
							(0.013)
Otherrising							-0.017*
							(0.009)
Constant	0.438***	0.208**	0.054	0.272*	0.219*	0.041	0.123
	(0.116)	(0.103)	(0.099)	(0.162)	(0.112)	(0.125)	(0.118)
Observations	117	116	116	116	116	116	116
R-squared		0.486	0.544	0.554	0.598	0.553	0.591

Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. Dependent variable: $Gapexp_t$. *Deuro* = 2002 is a dummy that is equal to one for the year 2002 and zero otherwise. $HICP_{t-1}$ is the rate of inflation. *Volume* is the number of inflation reports within a given month and $Volume^2$ the squared value of *Volume*. The number of reports on rising inflation is denoted by *Rising* and on falling inflation by *Falling*. Statements that do not contain information regarding rising or falling inflation, are denoted by *Notrend*. *Good* is the number of media reports that claim that the reported developments in inflation is good and *Bad* denotes the reports claiming inflation developments are bad. Neutral judgments are termed by *Neutral*. *Badris* contains all reports that explicitly judge rising inflation to be bad. *Otherrising* comprises all reports that have no explicit negative reporting on rising inflation.

The effect of media reports is also economically relevant. Our results suggest that an increase in neutrally toned media reports by 10 (one standard deviation of *Neutral*) reduces the gap by about 10 basis points, which is more than 20% of the average expectations gap. An increase in the amount of badly toned news by one standard deviation raises the gap by about 11 basis points.

News about rising inflation do not necessarily bias consumers' expectations. Column (6) reports the estimates using the direction of the change of inflation catered in the news articles as media variables. The variables *Rising* and *Falling* are not significant.

News about rising inflation, which are at the same time badly toned, contain a bias. This is shown in column (7), where the equation with the direction variables is estimated with news about rising inflation split into the two variables *Badrising* and *Otherrising*. While badly toned news about rising inflation widen the gap, news about rising inflation without a bad tone have the opposite effect. The economic effect is almost identical to the effect of badly toned news (*Bad*) alone, suggesting that the effect is driven mainly by negatively toned news reports about rising inflation.

4.1 Robustness

This section presents further results and robustness checks. First, we examine the effect of the discussion about the euro introduction in the media. Second, we estimate the effect of media reports in a more dynamic setting.

The period of the euro introduction in January 2002 is an interesting case study because the introcution of the euro coins triggered an extensive discussion in the media about the inflationary effect of the new currency. Given that there is only weak evidence that introduction of the euro would have raised prices in Germany significantly (Sturm et al., 2009), the discussion about the 'Teuro' provides a case of a media exaggeration.[10]

The media discussion regarding the euro cash changeover and the 'Teuro' is examined by estimating the equation

[10] Inflation perceptions were significantly affected by the euro cash changeover. Ehrmann (2011) shows that the gap between perceived and actual inflation widened substantially during the cash changeover. He finds that the complexity of conversion rates explains the variation in this gap across euro area countries. Lamla and Lein (2010) provide evidence that media reporting also plays an important role in explaining this discrepancy.

$$absGapexp_t = \alpha + \delta_t Teuro_t + \delta_e Eurointrod_t + \varepsilon_t. \tag{14}$$

As expected, On the one hand, the number of news stories discussing a 'Teuro'-effect increases the gap between consumers' and professional forecasters' inflation expectations (Table 3). On the other hand, the more neutral 'euro introduction' expression does not have a significant effect. This confirms the earlier result that media may bias consumers' expectations, in particular during periods with more badly toned reporting, such as during the 'Teuro'-debate.

Table 3: 'Teuro' and 'euro introduction' in the media

	(1)	(2)
$EuroIntro_{t-1}$	0.003	
	(0.003)	
$Teuro_{t-1}$		0.007***
		(0.001)
$Constant$	0.517***	0.456***
	(0.077)	(0.058)
Observations	117	117
adj R^2	0.06	0.13

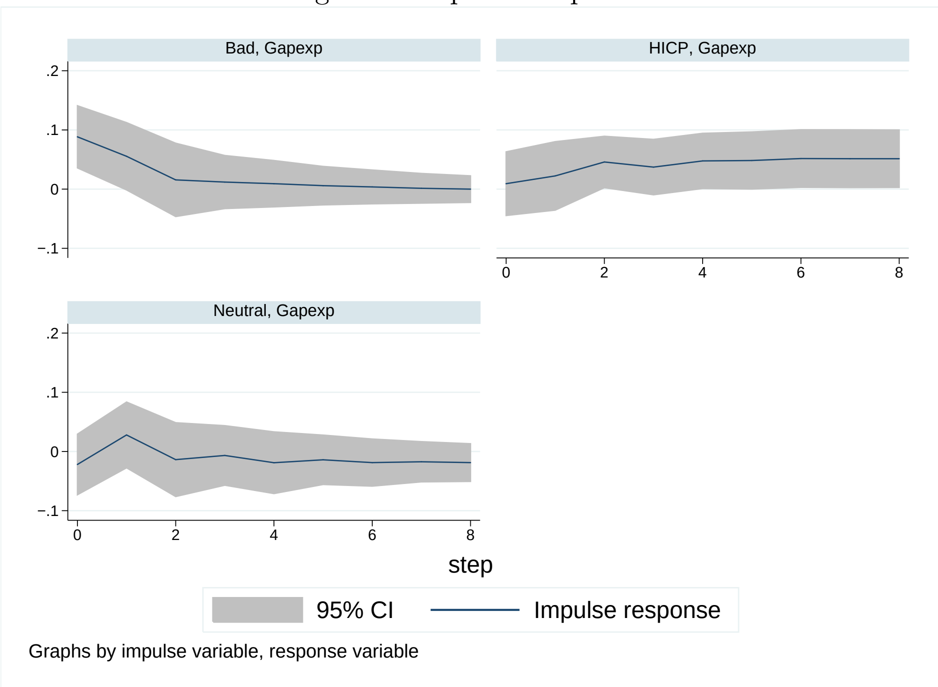
Robust standard errors in parentheses *** p<0.01 ** p<0.05 * p<0.1. Dependent variable: $Gapexp_t$. Columns (1)-(3) report OLS estimates with Newey West corrected standard errors. *EuroIntro* is the number of news articles containing the expression 'euro introduction', *Teuro* is the number of news articles containing the word 'Teuro'.

As a second robustness check, we examine the effect of media on consumers' expectation in a more dynamic setting by using structural VARs. In particular, we estimate the equation

$$Y_t = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & 0 \\ a_{31} & a_{32} & 0 & 0 \\ a_{41} & 0 & 0 & 0 \end{bmatrix} Y_{t-1} + \upsilon_t \tag{15}$$

where υ_t is the error term. We choose the restrictions based on the theoretical equations derived above, assuming that inflation is not contemporaneously affected by media reports or the expectations gap, and media reports are not contemporaneously affected by the expectations gap. The random vector is given by $Y_t = \begin{bmatrix} HICP & Bad & Neutral & Gapexp \end{bmatrix}'$. We include two lags as suggested by the AIC. Impulse responses of the expectations gap to innovations in the HICP and the media variables are shown in Figure 3. The results do not change qualitatively when we change the ordering of Bad and $Neutral$.[11] While the expectation gap widens in response to a bad news shock, it declines in response to more neutrally toned news. However, the is not significant at the 95% significance level. Meanwhile, the response to an unexpected increase in the HICP is more or less zero.

Figure 3: Impulse Responses



Notes: This figure shows impulse responses for the structural VAR in equation (15). The panels show the response of the expectations gap to an unexpected increase of a one unit change in the variables Bad, $HICP$ and $Neutral$.

[11]Results are available upon request.

5 Conclusions

Advances in modeling frictions in macroeconomics emphasize the role of information rigidities. The media may serve as an important transmitter of news in such a framework. This paper models the transmission mechanism between news provided by the media and expectations of consumers.

In the theoretical model, we combine ideas of sticky information and partial information models. Consumers receive information infrequently and the news are noisy and may be biased. Thus they face a signal extraction problem. We show that media affect consumers expectations via two channels. First, more news allow consumers to form more accurate inflation expectations. Second, accounting for a media slant, more news may lead to biased expectations.

Using a detailed media data set for Germany we find empirical evidence for the relevance of both channels. More news lead to a higher propensity to update inflation expectations, which finally result in more accurate inflation forecasts of consumers. However, this effect is conditional on the tone reports. If the reports exaggerate certain developments and are badly toned, more news may also bias expectations. This is especially true for the aftermath of the euro cash changeover.

Besides the statistical significance, the quantitative impact is also economically meaningful. Our results suggest that an increase in neutrally toned media reports by one standard deviation the accuracy of consumers' expectations improves by about 17%, while with increase in badly toned media reports by one standard deviation, the accuracy deteriorates by about 20%.

Our findings imply that media have a strong influence on consumers' expectations. Thus a media bias may also have real effects. First, inflation expectations can be self-fulfilling (Leduc et al., 2007). Second, a rise in inflation expectations may impede monetary policy effectiveness. On the positive side, media reporting may also have positive effects, if reporting is unbiased. Then, more news on inflation help to form rational inflation expectations, and reduce, for instance, the costs associated with disinflationary periods and facilitate central bank communication (Berger et al., 2011). Examining the transmission mechanism of media reporting to other parts of the economy is left for future research.

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