

The Mass Media Transmission of Central Bank Communication under Uncertainty

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Abstract

The media are one of the most influential institutions in society and, to most people, they are the only source of information on central banks' decisions. Considering that effectively managing expectations is essential for policy success and given that the media influence public's perceptions of monetary policy issues, this paper proposes a theoretical model that incorporates the role played by the media in the monetary transmission mechanism. When the general perception of uncertainty is affected by the news, information release may lead to effects not anticipated by the central bank; therefore, the design of communication strategies should go beyond the concern of providing information to financial markets and steering their behaviour in the direction desired by the central bank. In fact, the bank would be well advised to explicitly acknowledge that most people only hear about its information through news outlets, who influence their expectations and their response to central bank communication.

Keywords: Central bank communication, monetary transmission mechanism, media, uncertainty.

JEL classification: E52, E58, D80

Resumo

A mídia é uma das instituições mais influentes na sociedade e, para a maioria das pessoas, é a única fonte de informação sobre as decisões dos bancos centrais. Considerando que um gerenciamento eficiente das expectativas é essencial para o sucesso de política e dado que a mídia influencia a percepção do público sobre a política monetária, esse artigo propõe um modelo teórico que incorpora o papel da mídia no mecanismo de transmissão monetária. Quando a percepção geral com relação à incerteza é afetada pelo noticiário, a publicação de informações pode levar a efeitos não antecipados pelo banco central; por isso, a elaboração de estratégias de comunicação deve ir além do desejo de fornecer informações aos mercados financeiros e influenciar seu comportamento. Na verdade, o banco central deveria reconhecer explicitamente que a maior parte das pessoas tem acesso às suas informações somente através da mídia, a qual influencia as expectativas e as respostas à comunicação do banco central.

Palavras-chave: Comunicação do banco central, mecanismo de transmissão monetária, mídia, incerteza.

Área de interesse: Macroeconomia, Economia Monetária e Finanças

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1 Introduction

Central bank communication practices experienced a revolution in the last two decades. Previously seen as a secretive art, too mysterious for most people to grasp, monetary policymaking went through profound modifications, guided by the principles of transparency and accountability. The emergence of inflation targeting regimes and the recognition of the importance of effectively managing expectations for policy success brought new incentives for the design of communication strategies that privilege sharing information with financial markets and the public in general. Questions about what to share, when and through which means remain (and are vigorously debated), but the general understanding that good policies depend on good communication is here to stay.

At the beginning of this change in paradigm, both academic research and central banks' efforts were concentrated on improving the flow of information from monetary authorities to financial markets, given the influence of future expectations on financial asset prices and on market confidence in general. Developing efficient communication channels with market participants was seen as essential and good progress was made in this area.

Perhaps surprisingly, however, little attention was paid to how the general public obtains information on monetary policy and perceives central banks' actions. Certainly, following financial market prices and behaviour is somewhat easier than gathering information on enormous numbers of households and firms making daily consumption, pricing and investment decisions; but it is, by no means, less important as, ultimately, it is their expectations and choices that determine the path of inflation (the main variable most contemporaneous central banks aim to affect).

In the last few years, some researchers started to investigate this issue more closely, incorporating a crucial insight: the existence of an intermediary in the communication between monetary authorities and the general public. Unlike market participants, ordinary people have not the incentives nor the expertise to collect and digest central bank information by themselves. As a result, they mainly rely on the media as a tool for gathering, selecting, editing, simplifying and transmitting information. However, this process is subject to errors and misunderstandings, which may influence what is actually communicated to the public (in ways not desired nor anticipated by the central bank). Research has shown that the media are far from being a neutral conduit; in fact, they transform the content they distribute, choose the tone in which it is going to be reported and affect people's perceptions of it. There is abundant evidence of media effects on *what* the audience think about and *how* they feel about the issues that appear on the news. In particular, the selection of events that are covered and the nature of coverage change beliefs about risk and uncertainty, influencing behaviour as a result.

Building on the recent empirical work on how the media report central bank information, this paper proposes a theoretical model that incorporates the media's influence on agents' beliefs after the central bank releases an economic forecast. Taking into account results from mass communication theory and information economics, we propose seeing the media as an important link in the monetary transmission chain. If the news affects agents' expectations of the future and if coverage is partial and potentially biased, then central banks should take into account the influence of the media when designing their communication strategies.

Specifically, the model uses journalism's concept of a "man-bites-dog" signal (formalized by [Nimark, 2014](#))¹ to deal with a scenario in which media reporting increases the perception of uncertainty, which in turn affects private inflation expectations. When the public has access to central bank information only through the media, the level of volatility will depend on the perceived accuracy of the central bank's forecast. If it is seen as very accurate, then it is possible for ex-post uncertainty to be lower even though media reporting increases the general perception of volatility. However, if the bank's estimation is seen as very imprecise, then the actual levels of volatility and inflation are higher, output is lower and the exchange rate is more appreciated, leading to the conclusion that the central bank should refrain from releasing forecasts that are

¹ A detailed definition is provided in section 3.1.

likely to be perceived as imprecise. But if there are legal disclosure requirements, publication should occur in the fuzziest possible way, discouraging media reporting.

The paper is organized into five parts. Following this introduction, section 2 discusses the importance of the media in contemporaneous societies, starting with some remarks on the pervasiveness of uncertainty, its impacts on agents' behaviour and the role of the media as the main information provider in this uncertain world. It proceeds with a presentation of the main theories on media effects and concludes with a discussion of the recent empirical research on media reporting of central bank communication. Then, section 3 presents a theoretical model of how the media may influence agents' perceptions of uncertainty and affect the results of monetary policy. In a context in which news coverage changes the public's beliefs about the level of volatility, the media are more than a disseminator of information. Section 4 builds on this idea and on the results of the previous section to draw some possible implications for the design of central bank communication strategies taking into account the role played by the media. The paper finishes with a brief conclusion in which the main points and results are stressed.

2 The importance of the media

The media are today one of the most influential institutions in society. They fulfill the essential role of collecting, interpreting and reporting information, helping audiences to make sense of the world. However, the relationship is not one-way. In the case of the government, while it provides information to the media, it also tries to anticipate how people will react to news on policy moves and to the specific way in which policy is presented in the news. This is especially relevant for monetary policy, as its effects are indirect and subject to uncertainty, depending to a great extent on agents' beliefs. For instance: when the central bank makes reserves more easily available to commercial banks, its aim may be to stimulate lending; but, ultimately, an increase in credit operations will depend on the banks' willingness to lend and on firms' and consumers' desire to borrow. In a situation where banks are pessimistic about the future, their liquidity preference increases, causing a fall in their willingness to lend. Thus, if expectations are negative, cheaper money may not be translated into an actual increase in the stock of credit, making monetary policy less effective as a tool to stimulate demand (ARESTIS; SAWYER, 2006). This is an example of why effective managing expectations is so important for policy efficacy, which is a reason behind many contemporaneous central banks' efforts to improve communication with the public.

Talking about investment decisions (perhaps the most emblematic type of choice under uncertainty), Gerrard (1994) argues that long-term expectations depend on people's beliefs about the most probable forecast (the best estimate of a likely future outcome), but also on the state of confidence (the degree of confidence with which expectation is held, reflecting the fact that the best estimate may turn out to be wrong). The state of confidence "(...) is a state of mind, a belief about the adequacy or otherwise of the knowledge base from which the forecasts of the future are derived. In contrast to forecasts, the state of confidence cannot be verified or falsified by actual outcomes" (p. 332), but can be influenced by a myriad of factors and agents. One of them is the media.

Acknowledging that to most people the media are the only source of information on the monetary authority's decisions may help to improve the success of a given policy strategy, and even more so if we consider that the media are more than a disseminator of information: they shape beliefs.

In this section, theories on media effects are briefly presented, as well as some insights from information economics and the emerging evidence on how the media translate central banks' information to their audiences.

Media effects theories and information economics

The study of mass communication is mainly concerned with how media content shapes beliefs, attitudes, emotions and the world view of the audiences, particularly in the medium and long terms. Does the amount of media coverage affect what topics people talk about? Does the way an issue is approached (the *tone* of coverage) influence how people view the matter in question (positively or negatively)? Many mass communication theories have been developed to deal with these questions. Among the most prominent of them are the *Agenda-setting theory* and the *Cultivation theory*.²

The main idea of the Agenda-setting theory is that the media have a significant role in setting the public agenda. They may not tell their audience *what* to think, but they do influence what viewers think *about*. Focusing on some subjects and arguments but not on others, the media influence the list of topics that are object of public debate. Moreover, the audience not only obtain factual information on public affairs, but also receive cues on the importance of each subject, attributing greater relevance to issues that are more salient on the news. A cognitive process known as *accessibility* implies that prominent issues become more memorable; this is the mechanism through which agenda-setting works: topics featured more frequently on the news make a more lasting impression and are more likely to be remembered at later dates.

Since the pioneering studies of McCombs and Shaw in the 1960s and 1970s,³ many others have investigated the agenda-setting role of the media. McCombs (2000) presents a comprehensive list of instances in which empirical research has showed the media to have a significant impact on public agenda at both local and national levels in several countries, including Argentina, Japan, Spain and the United States.

Another important communication theory, originally proposed by George Gerbner in the 1960s, is the Cultivation theory, which focuses on long term exposure to television. Its main idea is that frequent exposure changes people's perception of the world, over time influencing their conception of social reality. Television projects a distorted image of the world, full of stereotypes and exaggerations that its audience is unconsciously led to adopt. Its content cultivates specific values and beliefs, ultimately affecting people's behaviour. The proponents of the theory argue that these effects are small and gradual, but cumulative, over time amounting to significant impacts on our culture as a whole.

In their original studies, Gerbner and his colleagues analysed television content and the effects on viewers for several years, focusing on the quantity of violence on prime time programming. They found that heavy viewers (those who watched four hours a day or more of TV) were more likely to perceive the world as much more violent than it actually is and to hold a general mistrust of people (GERBNER; GROSS, 1976). Subsequent research has applied the theory to other topics, finding evidence that mass media cultivation effects span over a diverse range of topics (health, religion, political orientation, gender roles, etc.).

These theories are not proposing that the media are the only factor affecting people's beliefs. Indeed, the old simplistic view of the media as an all-powerful entity has been left in the past, but they are still widely recognized as one of the most important institutions in contemporaneous societies. Although they are only one force affecting perceptions, the less direct experience a person has, the more her/his opinions are likely to be influenced by the media (LISCHKA, 2014).⁴

The arguments and findings of mass communication research are consistent with results from information economics. As Stiglitz (2015) reminds us, high quality information is essential for good decision making but, in reality, the market for information is imperfect. Not only information is incomplete, but there are incentives for it to be distorted, which alters outcomes even if agents are rational and know that market imperfections exist. The pervasiveness of information imperfections imply that, even if agents (including

² See Bryant and Miron (2004) for a survey on the theories and the research on Mass Communication.

³ See McCombs and Shaw (1972).

⁴ Certainly, in several contexts that media is not the most important determinant of people's beliefs, as is well argued by Wu et al., 2002. But if there is one area in which we can safely assume most people have no direct experience, it is monetary policymaking, thus making them more likely to adopt the media standpoint.

news outlets) wish to learn everything about a given topic, they will not be able to - and this is not innocuous: research shows that even a small amount of information imperfection has profound effects on outcomes.

Also, acquiring more information is not necessarily good for society as a whole, as it can adversely affect economic volatility (STIGLITZ, 2001). Information economics helps explain economic volatility through the notions of imperfect, costly and asymmetric information. As we will see later, these ideas can be applied to a situation in which the public does not have direct access to a relevant piece of information produced by the central bank, depending on media coverage. If the coverage biases the audience's perception of uncertainty, the result may be a higher level of volatility in comparison to a situation where information can be directly obtained from the central bank (that is, a context without the presence of the media as an intermediary) and also to a context in which information is not made available at all.

But before investigating this issue more thoroughly in a theoretical model, the next subsection explores the recent empirical work on the media's role as a disseminator of central bank communication.

Media and central bank communication

Central banks have direct control of the overnight interest rate only, but aim to affect longer rates and asset prices to, ultimately, have an impact on crucial economic variables (rate of inflation, output growth). This depends on the bank's ability to influence private expectations, which in turn is related to the monetary authority's communication strategy: because some economic variables (exchange rate, long interest rates) reflect future expectations, communication is an important element of monetary policymaking, especially when inflation stability is pursued.

However, the set of private agents is highly diverse and not all of them are equally attentive to central bank communication. While some are more easily reached (notably, financial market participants, who have greater incentives to follow policy announcements and moves), others only hear about central bank news through the media - if at all. Reaching this second type of agent - the general public - is crucial for the bank to be able to affect inflation expectations, as actual inflation depends on the beliefs and behaviour of households and firms making their everyday consumption and pricing choices. Since these agents' knowledge of policy announcements is acquired indirectly via news outlets, the media's perception and understanding of the central bank's actions and communication is essential for policy success: the media play a crucial part in the expectations channel of the monetary transmission mechanism.

Several studies have focused on the effects of central bank communication on financial markets' perceptions and actions, reaching the conclusion that markets pay close attention and respond to the monetary authority's announcements and signals (ANDERSSON; DILLEN; SELLIN, 2006; GUTHRIE; WRIGHT, 2000; CONNOLLY; KOHLER, 2004). Recently, some studies have found that market participants not only collect information directly from the central bank but also resort to the media as a source of news on monetary policy. Ehrmann and Fratzscher (2009) analyse the effects of press conferences (PC) held after the announcement of interest rate decisions by the European Central Bank (ECB), finding that PC add information not contained in the policy decision itself: financial markets reactions are larger during the conference, whereas the effects on volatility are lower. Also, the more unexpected the decision and the higher the degree of macroeconomic uncertainty, the greater the markets' reaction during the first part of the conference, when the policy rationale is explained. Ehrmann and Fratzscher show that newswire services play an important role as disseminators of information conveyed during the press conference; in particular, snaps summarizing the main points are closely followed by financial market participants. Even though these snaps are subject to errors and misinterpretations, they do constitute the information that actually reaches a great part of the market (although the PC is televised, many agents receive the information in real-time via newswire services). The authors conclude that press conferences may fulfill an important role in the monetary policy strategy, helping to explain the central bank's actions to the public and, as a result, contributing to policy effectiveness.

In a study of four major central banks (Japan, United States, United Kingdom and the euro area), [Hayo and Neuenkirch \(2015\)](#) analyse financial markets' access to monetary policy information, using a survey with 195 participants from all over the world. They find that, although the media are not a substitute for self-monitoring, they are a tool widely relied upon. In fact, except for interest rate decisions in the respondent's home region (in which case self-monitoring appears to be more important), participants resort as much to the media as to self-monitoring to follow central bank information. The authors highlight that agents' perceptions of the bank's actions and communication are crucial, which implies that the media play a relevant role in the monetary transmission mechanism; as a consequence, central banks should invest in clarification strategies (especially with respect to the language used) to make sure their information reaches the intended audience with as little noise as possible.

The papers cited above are only a small sample of the copious research on how markets perceive and react to central bank communication, whereas studies on the general public's perceptions are still rare. [Blinder et al. \(2008, p. 58\)](#) notice that "virtually all the research to date has focused on central bank communication with the financial markets. It may be time to pay some attention to communication with the general public. Admittedly, studying communication with the general public will pose new challenges to researchers — not least because financial market prices will be less relevant. But the issues are at least as important."

Since then, some researchers have accepted the challenge and started to investigate how the general public accesses central bank information. An important point they highlight is that while it is rational for market participants to closely follow central bank announcements and decisions, for the general public it is rational not to, as they have other priorities. Acquiring and processing information is costly so it makes sense for the public to rely on the media as an intermediary.

In a pioneering work, [Berger, Ehrmann and Fratzscher \(2011\)](#) studied how the ECB's messages are transmitted by the media, investigating the extent and favourableness of newspapers coverage of monetary policy from 1999 to 2010. They found that the circumstances, nature and explanations of a policy action affect the amount and type of coverage. The tone of reporting is more negative if a policy decision surprises the markets and if inflation in the euro area exceeds the 2% target, suggesting that the media assume a monitoring role of the ECB. But the bank is able to affect coverage through the use of communication (in press conferences and inter-meetings statements): explanations of the reasoning behind a surprising decision lead to a more positive assessment by the press. Moreover, the coverage of an interest rate change is significantly more favourable if it has been preceded by a systematic communication effort by the ECB, except when inflation is high.

Following [Berger, Ehrmann and Fratzscher's](#) approach, [Böhm, Král and Saxa \(2012\)](#) analyse media perceptions of the Czech National Bank (CNB) policies in the period 2000-2007. Their empirical results suggest that decisions that surprise the markets attract more coverage but are not more likely to be critically assessed. Also, interest rate changes (in any direction) are welcomed and more extensively covered, suggesting the media understand they are indeed necessary. Rising inflation leads to a more negative coverage while GDP growth results in a more positive assessment (and vice-versa). More intensive inter-meeting communication leads to favourable reporting when a policy decision is surprising. The authors conclude that the media seem to understand the CNB monetary policy actions and tend to pay attention to relevant developments.

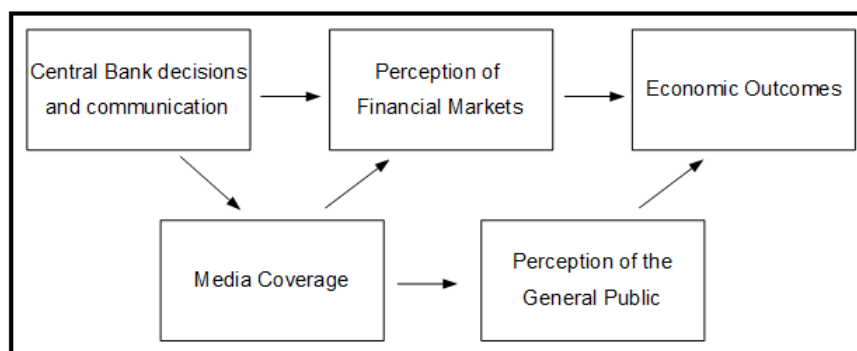
Applying the same methodology, [Reid and Plessis \(2011\)](#) study how the print media transmit central bank communication to the general public in the case of South Africa. They find biases in coverage, with interest rate cuts being welcomed and rises criticized, regardless of the economic circumstances, suggesting little attempt by journalists to understand the reasons behind the policy decisions and to reflect on their appropriateness. Also, inter-meeting communication does not seem to influence media perceptions of monetary policy. Given their empirical results, [Reid and Plessis](#) believe that the print media are not adequately fulfilling their role of transmitting monetary policy information to the public: there are errors and misinterpretations in reporting, including a lack of understanding of the inflation targeting system, which jeopardize the effective use of the expectations channel of the monetary transmission mechanism. Therefore,

they conclude that there is room for a better use of communication by the South African Reserve Bank, tailoring its language to the audience (considering that its messages are filtered and edited by the media), quickly reacting to clarify misunderstandings in the way policy is portrayed in the news and more effectively using inter-meeting communication. A good understanding of the role played by the media should be an input for the development of a coherent and effective communication strategy.

Lamla and Sturm (2013) study how the ECB’s policy decisions and the information provided during press conferences are reported by the print media on the two subsequent days. Specifically, the authors are interested in the effects of the bank’s statements on media expectations of future monetary policy. Using a series of indicators, they find that both the actual policy decision as well as ECB communication significantly impact expectations of future rates as transmitted by the media to the public.

Considering the literature’s suggestion that the media’s perception and understanding of monetary policy is not neutral nor error free, and that they do influence people’s beliefs and behaviour, it can be argued they play a role in the monetary transmission mechanism, which can therefore be depicted as in figure 1.

Figure 1 – Transmission of Central Bank Decisions and Communication



Note: Adapted from Hayo and Neuenkirch (2015).

The figure highlights the fact that most agents (the “general public”) only hear about monetary policy decisions through the media, as they have neither the time nor the incentives to monitor the central bank directly. As a result, they only receive policy information after it has been through a process of selection, editing and interpretation, being therefore subject to biases and misunderstandings - although the degree of this probably varies from country to country, as the research surveyed in this section indicates. Moreover, the transmission chain proposed in figure 1 makes clear an often neglected aspect, brought to light by Hayo and Neuenkirch’s research: financial market participants also resort to the media when following the monetary authority’s announcements and decisions. This additional layer of media influence is significant as, even if market players are consciously aware of the potential shortcomings of news coverage, they are not immune to its subtle impacts on their beliefs.

In the next section a theoretical model that incorporates the media’s influence on public perceptions of uncertainty is proposed.

3 Model

In this section central bank communication and the media’s influence on public’s beliefs are studied in a model for a small open economy. Following Cukierman (2001), we adopt a neo-Keynesian transmission mechanism, emphasizing the impact of the interest rate on aggregate demand and the lagged effect of output on inflation. The small open economy is modeled similarly to Ball (1998); the only major difference is the absence of persistence in output.

The open economy is described by four equations:

$$\pi_{t+1} = \pi_{t+1}^e + \alpha y_t + \gamma e_t + z_t \quad (1)$$

$$y_t = -\beta r_t + \delta e_t + d_t \quad (2)$$

$$r_t = e_{t+1}^e - e_t + f_t \quad (3)$$

$$r_t = R_t - \pi_{t+1}^e, \quad (4)$$

where all variables are in logarithms and presented as deviations from the steady state (except for the interest rates), all parameters are positive and x_{t+1}^e indicates the expectation of the time $t+1$ value of variable x based on the information available at the beginning of period t .

The first equation is the aggregate supply curve, which relates time $t+1$ inflation to time t output gap y_t , real exchange rate e_t (an increase in e denotes a depreciation) and supply shock $z_t \sim N(0, \sigma_z^2)$. The second equation states that aggregate demand is decreasing in the real interest rate r_t and increasing in the real exchange rate; also, it is subject to a shock $d_t \sim N(0, \sigma_d^2)$. Equation 3 is an uncovered interest parity (UIP) condition, with $f_t \sim N(0, \sigma_f^2)$ representing a risk premium shock,⁵ and (4) is the Fisher equation, where R_t is the nominal interest rate. All shocks are distributed normally and independently of each other.⁶

There are three types of agents: the private sector, the central bank and the media. The first two make forecasts of the risk premium shock. Private agents perceive the central bank's forecast as a “man-bites-dog” signal, as explained below.

The central bank aims to stabilize the output gap and inflation, choosing the nominal interest rate to minimize their squared deviations from their targets, as represented by the following loss function:

$$L_t = (\pi_{t+1} - \pi^*)^2 + \lambda y_t^2, \quad (5)$$

where π^* is the bank's (constant) inflation target (known to all agents). The target for the output gap is zero (that is, the monetary authority aims to keep output at potential).

3.1 “Man-bites-dog” signal

The phrase “man bites dog” is used in journalism to describe an unusual event which, as such, is considered more newsworthy than a more common, everyday fact, like a “dog biting a man”. While commonplace facts appear less often on the news, rare events are more likely to be reported, which may distort the public's perception of how frequently an event occurs. Therefore, media reporting *per se* can be seen as an indication that a “tail event” is more likely to have occurred (NIMARK, 2014).

Definition.⁷ A signal z about a variable x is a man-bites-dog signal if it is more likely to be available when the realization of x is more uncommon. From Bayes rule, it is *as if* x were drawn from a different distribution when z is available. Defining S as an indicator variable that takes the value $S=1$ when z is available and $S=0$ when z is not available, and $p(x)$ as the unconditional probability density function of x , we have $p(x|S=1) \neq p(x|S=0)$. More precisely: for two realizations x' and x'' of x such that $p(x') < p(x'')$, if z is a man-bites-dog signal then the following inequality holds:

$$p(S=1|x') > p(S=1|x'').$$

⁵ The risk premium shock adds extra uncertainty to the open economy versus a closed economy.

⁶ At this point an observation is in order, regarding the timing in the model. Notice that the lagged impact of output on inflation does not actually imply a dynamic set up, but only that inflation is determined after output. The idea is simply to capture the delayed effect of the interest rate on prices, via the level of activity: in the short run, changes in the nominal interest rate translate into changes in the real rate, which have an impact on output. Subsequently, the change in output induces a change in prices and, thus, in inflation. Additionally, there is an exchange rate channel in the model: an increase in the nominal interest rate leads to an exchange rate appreciation, which has a negative impact on output.

⁷ Based on Nimark (2014).

In the context of our model, we assume that the central bank publishes a forecast f_t^{cb} (the signal) of the risk premium shock f_t , but that the media do not always report it (or, alternatively, usually do not give the forecast any emphasis). When the media do report the forecast, it is often because it is an unusual/unexpected forecast. The aim here is to model the fact that the news influences people's *perception* of the overall level of uncertainty;⁸ thus, when $S = 1$, the private sector's perception of uncertainty increases. Formally, this happens because, under a “man-bites-dog signal structure”, for two realized values f_t' and f_t'' of the risk premium shock f_t , such that $p(f_t') < p(f_t'')$, we have:

$$\frac{p(f_t'|S_t=1)}{p(f_t''|S_t=1)} > \frac{p(f_t')}{p(f_t'')}.$$

That is: the more uncommon realization is relatively more likely when the bank's forecast is reported.

In our model, the private sector also makes a forecast, f_t^{ps} , of the risk premium shock. Each forecast follows the distributions:

$$\begin{aligned} \text{central bank: } f_t^{cb} &= f_t + \eta_t^{cb}, & \eta_t^{cb} &\sim N(0, \sigma_{cb}^2) \\ \text{private sector: } f_t^{ps} &= f_t + \eta_t^{ps}, & \eta_t^{ps} &\sim N(0, \sigma_{ps}^2), \end{aligned}$$

where η_t^{cb} and η_t^{ps} are independently distributed.

When the central bank's forecast (signal) is reported by the media, the agents⁹ update their conditional prior distribution $p(f_t|S_t)$, as they aim to form expectations based on all available information (as long as the cost of doing so is not prohibitively large).

Conditionally on S_t , f_t is normally distributed:

$$\begin{aligned} p(f_t|S_t=0) &= N(0, \sigma^2) \\ p(f_t|S_t=1) &= N(0, \theta\sigma^2), \quad \theta > 1, \end{aligned}$$

and the unconditional distribution of f_t is a *mixture of normals*:¹⁰

$$f_t \sim (1 - \omega)N(0, \sigma^2) + \omega N(0, \theta\sigma^2), \text{ with } E[f_t] = 0 \text{ and } \text{Var}[f_t] = \sigma_f^2 = (1 - \omega)\sigma^2 + \omega\theta\sigma^2,$$

where $\omega = p(S=1)$; that is, ω determines the frequency with which the signal f_t^{cb} is reported. If $\omega \rightarrow 0$, reporting f_t^{cb} is a rare event. The parameter θ determines how informative the reporting of f_t^{cb} is about the conditional distribution of f_t . When θ is large, the reporting of f_t^{cb} implies a conditional distribution of f_t substantially different from the unconditional distribution.¹¹

It is important to make clear that the *availability* of the signal changes the public's perception of the level of *volatility*, while the signal itself changes the perception of the *value of the shock*: $\text{Var}[f_t|S_t=0] \neq \text{Var}[f_t|S_t=1]$, whereas $E[f_t|f_t^{cb}] \neq E[f_t]$. That is: while media reporting changes the conditional variance, the central bank's signal makes the conditional mean of the risk premium shock differ from the unconditional mean.

As in [Geraats \(2007\)](#), the public does not know the true distributional parameter values and, therefore, forms expectations based on *perceived* distributions. Thus, for a variable $x \sim N(x_0, \sigma^2)$, expectations are formed based on $N(\tilde{x}_0, \tilde{\sigma}^2)$, where \tilde{x}_0 and $\tilde{\sigma}^2$ are the *perceived* mean and variance of x , respectively. This means that the actual degree of uncertainty is never known for sure, being to a large degree a feeling, an impression, as argued in section 2.

⁸ As discussed in section 2, research shows that the media influence beliefs and people's perception of risk and uncertainty.

⁹ From this point on, we will use “agents” to refer to the private sector only.

¹⁰ A mixture of normals averages two (or more) normal distributions over a mixing distributing. For a detailed presentation of mixture normals, see [Rossi \(2014, chapter 1\)](#).

¹¹ See appendix A for proof that $\theta > 1$ is a necessary condition for a man-bites-dog signal. For a more thorough discussion, see [Nimark \(2013\)](#).

In what follows we apply these ideas to a situation in which the private agents observe the central bank's signal only if it is reported by the media. That is, we suppose media reporting is the only way for the private sector to observe f_t^{cb} .¹² In this case, when $S_t = 0$ (no media reporting of the bank's signal), the public forms expectations based only on f_t^{ps} and uses $\widetilde{Var}[f_t|S_t=0] = \tilde{\sigma}^2$. When $S_t = 1$, expectations are formed based on both f_t^{ps} and f_t^{cb} and the public uses $\widetilde{Var}[f_t|S_t=1] = \tilde{\theta} \tilde{\sigma}^2$. Therefore, the private sector will only use the central bank's information when it perceives a higher degree of uncertainty (which happens when the media report the bank's signal).

Let Ω^0 be the private sector's information set when $S=0$ and Ω^1 the information set when $S=1$. Then, posterior beliefs are:

$$\begin{aligned} \tilde{E}[f_t|\Omega^0] &= \left(\frac{\tilde{\sigma}_{ps}^{-2}}{\tilde{\sigma}^{-2} + \tilde{\sigma}_{ps}^{-2}} \right) f_t^{ps} = \left(\frac{\tilde{\sigma}^2}{\tilde{\sigma}^2 + \tilde{\sigma}_{ps}^2} \right) f_t^{ps} = \tilde{\tau}_{ps} f_t^{ps} \\ \tilde{E}[f_t|\Omega^1] &= \left(\frac{\tilde{\sigma}_{ps}^{-2}}{\tilde{\theta}^{-1} \tilde{\sigma}^{-2} + \tilde{\sigma}_{ps}^{-2} + \tilde{\sigma}_{cb}^{-2}} \right) f_t^{ps} + \left(\frac{\tilde{\sigma}_{cb}^{-2}}{\tilde{\theta}^{-1} \tilde{\sigma}^{-2} + \tilde{\sigma}_{ps}^{-2} + \tilde{\sigma}_{cb}^{-2}} \right) f_t^{cb} = \tilde{\tau}_{ps}^1 f_t^{ps} + \tilde{\tau}_{cb}^1 f_t^{cb} \\ \widetilde{Var}[f_t|\Omega^0] &= (\tilde{\sigma}^{-2} + \tilde{\sigma}_{ps}^{-2})^{-1} = \frac{\tilde{\sigma}_{ps}^2 \tilde{\sigma}^2}{\tilde{\sigma}^2 + \tilde{\sigma}_{ps}^2} = \tilde{\sigma}_{ps}^2 \tilde{\tau}_{ps} \\ \widetilde{Var}[f_t|\Omega^1] &= (\tilde{\theta}^{-1} \tilde{\sigma}^{-2} + \tilde{\sigma}_{ps}^{-2} + \tilde{\sigma}_{cb}^{-2})^{-1} = \frac{\tilde{\theta} \tilde{\sigma}^2 \tilde{\sigma}_{cb}^2 \tilde{\sigma}_{ps}^2}{\tilde{\theta} \tilde{\sigma}^2 \tilde{\sigma}_{cb}^2 + \tilde{\theta} \tilde{\sigma}^2 \tilde{\sigma}_{ps}^2 + \tilde{\sigma}_{ps}^2 \tilde{\sigma}_{cb}^2} = \tilde{\sigma}_{ps}^2 \tilde{\tau}_{ps}^1, \end{aligned} \quad (6)$$

where the $\tilde{\tau}$'s represent the perceived degrees of accuracy of each forecast. For instance: $\tilde{\tau}_{ps}$ is the perceived degree of accuracy of the private signal when the central bank's forecast is not reported. In this case, for a given (perceived) variance of the risk premium shock, the signal f_t^{ps} will be seen as more accurate when the variance of the error η_t^{ps} is perceived as small. But when the central bank's forecast is reported and is, therefore, incorporated into the public's expectations-formation process, the accuracy of the private forecast, $\tilde{\tau}_{ps}^1$, is also influenced by the precision of the central bank's. In this case, the perceived accuracy $\tilde{\tau}_{ps}^1$ will rise with $\tilde{\sigma}_{cb}^2$: a central bank's signal perceived as more volatile leads the private signal to be seen as relatively more precise and, as a consequence, f_t^{ps} receives a greater weight on private expectations of f_t (that is, $\tilde{\tau}_{ps}^1$ in the second line of (6) is higher). The same reasoning applies to $\tilde{\tau}_{cb}^1$.¹³

Given this set up, let's define the sequence of events in the model: in time t , after the realization of π_t (which is determined by time $t-1$ variables), (1) the private sector and the central bank make forecasts of the risk premium shock f_t ; (2) the media decide S (i.e., to publish f_t^{cb} or not); (3) the public forms expectations based on its own forecast and the central bank's (if it is reported by the media), using the perceived distributions of the shocks; (4) shocks z_t and d_t are realized and observed by the central bank; (5) the central bank sets the nominal interest rate R_t ; (6) shock f_t is realized; (7) y_t and e_t are realized; (8) π_{t+1} is realized at the beginning of period $t+1$.

To solve the model, let's start by combining the UIP condition (eq. 3) and the Fisher equation (4) and solve for the exchange rate:

$$e_t = e_{t+1}^e + \pi_{t+1}^e + f_t - R_t. \quad (7)$$

Substituting (4) and (7) into the aggregate demand (eq. 2) gives output as:

$$y_t = -(\beta + \delta)(R_t - \pi_{t+1}^e) + \delta(e_{t+1}^e + f_t) + d_t. \quad (8)$$

And from (7), (8) and the aggregate supply (eq. 1) we get an expression for inflation as a function of expectations and the nominal interest rate (plus shocks):

¹² Possibly because central bank communication is confusing or because f_t^{cb} is not easily found among all the information released by the central bank. Or still, because following central bank announcements is timing consuming and, therefore, too costly for most agents.

¹³ To some extent, the $\tilde{\tau}$'s can be seen as proxies for the *state of confidence* with which beliefs are held (as defined and explained in Gerrard's work, mentioned in section 2): when agents have little confidence on the accuracy of a prediction, it receives less weight in the formation of expectations (that is, its respective $\tilde{\tau}$ is lower).

$$\pi_{t+1} = \pi_{t+1}^e - [\gamma + \alpha(\beta + \delta)](R_t - \pi_{t+1}^e) + (\gamma + \alpha\delta)e_{t+1}^e + (\gamma + \alpha\delta)f_t + \alpha d_t + z_t. \quad (9)$$

The expressions above are the constraints on the central bank's optimization problem. The bank chooses R_t to minimize the loss function (5) subject to (8) and (9), which results in the following policy function:

$$R_t = \pi_{t+1}^e + \frac{a_1(\pi_{t+1}^e - \pi^* + z_t) + (\alpha a_1 + \lambda a_2)d_t + [(a_1 - \alpha\beta)a_1 + \lambda\delta a_2](e_{t+1}^e + f_t^{cb})}{a_1^2 + \lambda a_2^2} \quad (10)$$

where, for given expectations,

$$a_1 = \gamma + \alpha(\beta + \delta) = -\frac{\partial \pi_{t+1}}{\partial R_t}$$

$$a_2 = \beta + \delta = -\frac{\partial y_t}{\partial R_t}.$$

Notice that f_t^{cb} appears in the policy function (instead of f_t) because when the central bank sets the nominal interest rate it does not know the actual value of the risk premium shock and, therefore, uses the forecast f_t^{cb} .¹⁴

The next step is to use the policy function to get expressions for inflation, exchange rate and output gap as functions of expectations and the shocks only. Starting with inflation, let's substitute (10) into (9) to get:

$$\pi_{t+1} = \pi^* + \frac{\lambda a_2^2(\pi_{t+1}^e - \pi^* + z_t) + \gamma\lambda a_2^2(\beta f_t + \beta e_{t+1}^e - d_t) - a_1[(a_1 - \alpha\beta)a_1 + \lambda\delta a_2]\eta_t^{cb}}{a_1^2 + \lambda a_2^2}. \quad (11)$$

This expression shows that inflation will be above the target π^* if (a) private sector expectations are higher than the target; (b) the economy is hit by a positive supply shock, a positive risk premium shock (which leads to a currency depreciation and an increase in import prices) or a negative demand shock;¹⁵ (c) the exchange rate was expected to depreciate; or (d) the central bank underestimates the risk premium shock (the forecast error η_t^{cb} is negative).

We obtain an expression for the exchange rate by substituting (10) into (7):

$$e_t = -\frac{a_1(\pi_{t+1}^e - \pi^* + z_t) + (\alpha a_1 + \lambda a_2)d_t - \beta(\alpha a_1 + \lambda a_2)(f_t + e_{t+1}^e) + [(a_1 - \alpha\beta)a_1 + \lambda\delta a_2]\eta_t^{cb}}{a_1^2 + \lambda a_2^2}, \quad (12)$$

which shows that the exchange rate will depreciate if it is expected to depreciate, if the economy is hit by a positive risk premium shock (which induces capital flight) and if the central bank's inflation target increases. On the other hand, higher inflation expectations and positive supply and demand shocks lead to an appreciation (due to the rise in interest rates), and so does a positive central bank's forecast error (as it leads to a higher interest rate than would otherwise be necessary).

Finally, the expression for output results from combining (8) and (10):

$$y_t = \frac{-a_1 a_2(\pi_{t+1}^e - \pi^* + z_t) + \gamma a_1(d_t - \beta e_{t+1}^e - \beta f_t) - a_2[(a_1 - \alpha\beta)a_1 + \lambda\delta a_2]\eta_t^{cb}}{a_1^2 + \lambda a_2^2}. \quad (13)$$

The output gap increases with the inflation target and the demand shock, and decreases with inflation and exchange rate expectations, the risk premium shock and the central bank's forecasting error (as they induce an interest rate hike).

¹⁴ Because our focus is on the impact of central bank communication on private sector's expectations and, through them, on relevant economic variables, it is assumed that, unlike the private sector, the bank simply uses its own forecast to set the interest rate (that is, the central bank does not solve a signal extraction problem). A reason for such behaviour might be a belief that the central bank possesses better data and that the private sector's forecast does not add any relevant information to that already contained in the bank's forecast. [El-Shagi, Giesen and Jung \(2014\)](#) present results supporting this assumption for the case of the US. [Hubert \(2015\)](#) finds no empirical support for the hypothesis that private forecasts influence central bank's in a panel of five countries (Sweden, United Kingdom, Canada, Switzerland and Japan), whereas the monetary authorities' estimations do induce revisions on private forecasts.

¹⁵ A positive risk premium shock increases inflation because it leads to a currency depreciation and an increase in import prices.

In what follows, we analyse two situations: in the first one, there is no media reporting of the central bank's signal, whereas in the second one the signal is featured in the news.

The central bank's signal is not reported

If the central bank's forecast is not reported by the media, it is also not incorporated into agents' expectations. Thus, from the point of view of the private agents, it is *as if* the bank had produced no signal, that is, as if it were following an opaque policy stance with respect to information on the risk premium shock.

When the central bank's forecast is not reported ($S=0$), we showed that:¹⁶

$$\tilde{E}[f_t|\Omega^0] = \tilde{\tau}_{ps} f_t^{ps}. \quad (14)$$

And, as the private sector does not have any information about the supply and demand shocks, we have: $\tilde{E}[d_t|\Omega^0] = \tilde{E}[z_t|\Omega^0] = 0$. Therefore, taking expectation of (11) and solving for inflation expectations gives:

$$\tilde{E}^0[\pi_{t+1}] = \pi^* + \frac{\beta\lambda\gamma a_2}{a_1^2} (\tilde{E}^0[e_{t+1}] + \tilde{E}^0[f_t]), \quad (15)$$

where $\tilde{E}^0[x]$ denotes $\tilde{E}[x|\Omega^0]$. When the public does not know the bank's forecast, inflation expectations deviate from the target if agents expect a change in the exchange rate or a non-zero risk premium shock.

Taking expectations of the exchange rate (eq. 12) and using (15) results in $\tilde{E}^0[e_{t+1}] = 0$.¹⁷ Therefore, if the central bank's forecast is not reported by the media, the best the private sector can do is to expect:

$$\tilde{E}^0[\pi_{t+1}] = \pi^* + \frac{\beta\lambda\gamma a_2(\tilde{\tau}_{ps} f_t^{ps})}{a_1^2}. \quad (16)$$

From this expression we see that the private information (f_t^{ps}) only matters for inflation expectations because the central bank gives a positive weight to output stabilization ($\lambda > 0$). Otherwise, the public would simply expect inflation to be equal to the central bank's inflation target π^* .

The last step is to solve for the realized values of inflation, exchange rate and output gap, obtaining:

$$\pi_{t+1}^0 = \pi^* + \frac{\lambda a_2^2 z_t - \lambda \gamma a_2^2 d_t - a_1[(a_1 - \alpha\beta)a_1 + \lambda \delta a_2] \eta_t^{cb}}{a_1^2 + \lambda a_2^2} + \frac{\beta\lambda\gamma a_2 [\lambda a_2^2(\tilde{\tau}_{ps} f_t^{ps}) + a_1^2 f_t]}{a_1^2(a_1^2 + \lambda a_2^2)} \quad (17)$$

$$e_t^0 = -\frac{(\alpha a_1 + \lambda a_2)d_t + a_1 z_t + [(a_1 - \alpha\beta)a_1 + \lambda \delta a_2] \eta_t^{cb}}{a_1^2 + \lambda a_2^2} + \frac{\beta [a_1(\alpha a_1 + \lambda a_2)f_t - \lambda \gamma a_2(\tilde{\tau}_{ps} f_t^{ps})]}{a_1(a_1^2 + \lambda a_2^2)} \quad (18)$$

$$y_t^0 = \frac{a_1[\gamma d_t - a_2 z_t] - a_2[(a_1 - \alpha\beta)a_1 + \lambda \delta a_2] \eta_t^{cb}}{a_1^2 + \lambda a_2^2} - \frac{\beta\gamma [\lambda a_2^2(\tilde{\tau}_{ps} f_t^{ps}) + a_1^2 f_t]}{a_1[a_1^2 + \lambda a_2^2]}, \quad (19)$$

where x_t^0 is the value of variable x at time t when $S=0$.

The expressions above show that the impact of the risk premium shock on inflation and the exchange rate is positive and that the effect on output is negative. However, there is also an indirect effect through the private forecast: as a positive f_t^{ps} increases inflation expectations, it leads to a higher rate of inflation and to a lower output gap. But because it also induces an increase in the interest rate (due to higher inflation expectations), it contributes to a more appreciated exchange rate (unlike the actual shock). The greater the value of the forecast in relation to the actual shock (that is, the higher the private forecasting error), the more likely it is for the second (negative) effect to predominate. Note that both forecast errors lead to a more appreciated exchange rate because they induce the central bank to set nominal interests at a higher level than it would otherwise be necessary.¹⁸

¹⁶ See the first expression in (6), where $\tilde{\tau}_{ps} = \left(\frac{\sigma^2}{\sigma^2 + \tilde{\sigma}_{ps}^2} \right)$ is the perceived accuracy of the private signal.

¹⁷ See Appendix B for a step-by-step derivation.

¹⁸ Here and throughout the paper we are considering positive shock realizations, forecasts and forecasts errors, so that all forecasts are greater than the actual shocks.

Substituting (17) and (19) into the objective function (eq. 5) we can calculate the central bank's (unconditional) expected loss when its forecast is not reported:

$$E[L_t^0] = \frac{\lambda(\gamma^2 \sigma_d^2 + a_2^2 \sigma_z^2) + [(a_1 - \alpha\beta)a_1 + \delta\lambda a_2]^2 \sigma_{cb}^2}{a_1^2 + \lambda a_2^2} + \frac{(\beta\gamma)^2 \lambda [\lambda^2 a_2^4 (\tilde{\tau}_{ps})^2 \sigma_{ps}^2 + (a_1^2 + \lambda a_2^2 \tilde{\tau}_{ps})^2 \sigma_f^2]}{a_1^4 (a_1^2 + \lambda a_2^2)}, \quad (20)$$

where σ_f^2 is the posterior unconditional variance of f_t .

The central bank's signal is reported

When the central bank's signal is reported by the media, private sector's updated expectations of the risk premium shock f_t are:

$$\tilde{E}[f_t|\Omega^1] = \tilde{\tau}_{ps}^1 f_t^{ps} + \tilde{\tau}_{cb}^1 f_t^{cb}, \quad (21)$$

where $\tilde{\tau}_{ps}^1 = \left(\frac{\tilde{\sigma}_{ps}^{-2}}{\tilde{\theta}^{-1} \tilde{\sigma}^{-2} + \tilde{\sigma}_{ps}^{-2} + \tilde{\sigma}_{cb}^{-2}} \right)$ and $\tilde{\tau}_{cb}^1 = \left(\frac{\tilde{\sigma}_{cb}^{-2}}{\tilde{\theta}^{-1} \tilde{\sigma}^{-2} + \tilde{\sigma}_{ps}^{-2} + \tilde{\sigma}_{cb}^{-2}} \right)$ are the perceived accuracies of the private and central bank's signals, respectively.

As before, $\tilde{E}[d_t|\Omega^1] = \tilde{E}[z_t|\Omega^1] = 0$. Therefore, the expression for inflation expectation is analogous to (15):

$$\tilde{E}^1[\pi_{t+1}] = \pi^* + \frac{\beta\lambda\gamma a_2}{a_1^2} (\tilde{E}^1[e_{t+1}] + \tilde{E}^1[f_t]), \quad (22)$$

and $\tilde{E}^1[e_{t+1}] = 0$, which gives:

$$\tilde{E}^1[\pi_{t+1}] = \pi^* + \frac{\beta\lambda\gamma a_2 (\tilde{\tau}_{ps}^1 f_t^{ps} + \tilde{\tau}_{cb}^1 f_t^{cb})}{a_1^2}. \quad (23)$$

Media reporting of the central bank's forecast leads the agents to incorporate this new information when forming expectations, which also alters the weight given to their own forecast ($\tilde{\tau}_{ps}^1 \neq \tilde{\tau}_{ps}$). Once more, the forecasts only matter for inflation expectations because the agents know the central bank values output stabilization. The weight given to the shock's forecasts depends on how inflation and output gap respond to changes in the interest rate: if y_t is very sensitive to R_t (large $|a_2|$), inflation expectations are higher, as the agents anticipate the central bank to be more reluctant to increase R_t ; the opposite is true for the sensitivity of inflation with respect to the nominal interest rate (the higher $|a_1|$, the lower inflation expectations).

These results yield realized inflation, exchange rate and output gap as:

$$\pi_{t+1}^1 = \pi^* + \frac{\lambda a_2^2 z_t - \lambda \gamma a_2^2 d_t - a_1 [(a_1 - \alpha\beta)a_1 + \lambda \delta a_2] \eta_t^{cb}}{a_1^2 + \lambda a_2^2} + \frac{\beta\lambda\gamma a_2 [\lambda a_2^2 (\tilde{\tau}_{ps}^1 f_t^{ps} + \tilde{\tau}_{cb}^1 f_t^{cb}) + a_1^2 f_t]}{a_1^2 (a_1^2 + \lambda a_2^2)} \quad (24)$$

$$e_t^1 = - \frac{(\alpha a_1 + \lambda a_2) d_t + a_1 z_t + [(a_1 - \alpha\beta)a_1 + \lambda \delta a_2] \eta_t^{cb}}{a_1^2 + \lambda a_2^2} + \frac{\beta [a_1 (\alpha a_1 + \lambda a_2) f_t - \lambda \gamma a_2 (\tilde{\tau}_{ps}^1 f_t^{ps} + \tilde{\tau}_{cb}^1 f_t^{cb})]}{a_1 (a_1^2 + \lambda a_2^2)} \quad (25)$$

$$y_t^1 = \frac{a_1[\gamma d_t - a_2 z_t] - a_2[(a_1 - \alpha\beta)a_1 + \lambda\delta a_2]\eta_t^{cb}}{a_1^2 + \lambda a_2^2} - \frac{\beta\gamma[\lambda a_2^2(\tilde{\tau}_{ps}^1 f_t^{ps} + \tilde{\tau}_{cb}^1 f_t^{cb}) + a_1^2 f_t]}{a_1[a_1^2 + \lambda a_2^2]}. \quad (26)$$

Finally, the loss function (eq. 5) and the expressions for inflation and output (24 and 26, respectively) yield the central bank's (unconditional) expected loss when the signal is reported:

$$E[L_t^1] = \frac{\lambda(\gamma^2 \sigma_d^2 + a_2^2 \sigma_z^2)}{a_1^2 + \lambda a_2^2} + \frac{\{a_1^4[(a_1 - \alpha\beta)a_1 + \delta\lambda a_2^2]^2 + (\beta\gamma)^2 \lambda^3 a_2^4 (\tilde{\tau}_{cb}^1)^2\} \sigma_{cb}^2}{a_1^4(a_1^2 + \lambda a_2^2)} + \frac{(\beta\gamma)^2 \lambda \left\{ \lambda^2 a_2^4 (\tilde{\tau}_{ps}^1)^2 \sigma_{ps}^2 + [a_1^2 + \lambda a_2^2 (\tilde{\tau}_{ps}^1 + \tilde{\tau}_{cb}^1)]^2 \sigma_f^2 \right\}}{a_1^4(a_1^2 + \lambda a_2^2)}. \quad (27)$$

3.2 Discussion

Let's now compare the realized values of the relevant variables and the unconditional expected losses under each situation. From the expressions for inflation, exchange rate and output, it is straightforward to see that, for a variable x_t , the sign of $x_t^1 - x_t^0$ depends on

$$(\tilde{\tau}_{ps}^1 - \tilde{\tau}_{ps})f_t^{ps} + \tilde{\tau}_{cb}^1 f_t^{cb}. \quad (28)$$

Considering positive forecasts of the risk premium shock ($f_t^{ps} > 0$, $f_t^{cb} > 0$), a sufficient condition for the expression above to be positive is $\tilde{\tau}_{ps}^1 > \tilde{\tau}_{ps}$: the perceived accuracy of the private signal under a “man-bites-dog” situation is greater than the perceived accuracy when the central bank's signal is ignored. From the expressions for the $\tilde{\tau}$'s, it can be shown that this will happen when:¹⁹

$$\tilde{\sigma}_{cb}^2 > \frac{\tilde{\sigma}^2}{1 - \tilde{\theta}^{-1}}. \quad (29)$$

For a given $\tilde{\theta} > 1$, the central bank's forecast must be (perceived as) noisy enough. If that is the case, the rate of inflation will be higher and output will be lower when $S = 1$ vis-à-vis $S = 0$.

Because the central bank's forecast is ignored when it is not reported by the media, its (perceived) variance ($\tilde{\sigma}_{cb}^2$) does not influence the (perceived) accuracy of the private signal. On the other hand, when it is reported, the (perceived) accuracy of f_t^{ps} increases with $\tilde{\sigma}_{cb}^2$: as the accuracy is a relative measure and depends on all the variances, even if there is no change in the perceived variance of f_t^{ps} , this forecast is seen as relatively more precise when the central bank's forecast is seen as noisier, which means that the weight given by the private sector to its own forecast goes up with $\tilde{\sigma}_{cb}^2$. And because inflation increases with the risk premium forecasts, a greater weight on f_t^{ps} also means a higher rate of inflation. At the same time, we saw from (19) and (26) that the output gap falls with the forecasts and, thus, is lower when the central bank's signal is reported and is perceived as relatively noisy.

As a result, if the inequality in (29) holds, expected losses will be greater when $S = 1$: in this case, the incorporation of f_t^{cb} into private expectations takes inflation and output further away from the targets, reducing welfare. This can be easily seen by subtracting (20) from (27):

$$E[L_t^1] - E[L_t^0] = \frac{(\beta\gamma)^2 \lambda^3 a_2^4 \{(\tilde{\tau}_{cb}^1)^2 \sigma_{cb}^2 + [(\tilde{\tau}_{ps}^1)^2 - (\tilde{\tau}_{ps})^2] \sigma_{ps}^2\}}{a_1^4(a_1^2 + \lambda a_2^2)} + \frac{(\beta\lambda\gamma)^2 a_2^2 (\tilde{\tau}_{ps}^1 - \tilde{\tau}_{ps} + \tilde{\tau}_{cb}^1)[2a_1^2 + \lambda a_2^2 (\tilde{\tau}_{ps}^1 + \tilde{\tau}_{ps} + \tilde{\tau}_{cb}^1)] \sigma_f^2}{a_1^4(a_1^2 + \lambda a_2^2)},$$

¹⁹ See Appendix C.

which is always positive if $\tilde{\tau}_{ps}^1 > \tilde{\tau}_{ps}$.

By comparing the posterior variances in (6), we notice that $\tilde{\tau}_{ps}^1 > \tilde{\tau}_{ps}$ also implies that ex-post uncertainty is higher when f_t^{cb} is reported compared to when it is not. Even though the agents have more information when $S=1$, ex-post beliefs are more volatile because the central bank's forecast is perceived as relatively noisy. For a given level of noise, this will be even more so the greater the value of $\tilde{\theta}$, as in this case media reporting is seen as an indication that very unusual realizations of the risk premium shock are considerably more likely.²⁰

Regarding the exchange rate, its value will be lower (more appreciated) when the media report the central bank's signal and it is incorporated into private sector's expectations. Because a positive risk premium forecast increases inflation expectations and induces a rise in the interest rate, it leads to a more appreciated exchange rate, and this effect is stronger when the central bank's forecast is perceived as relatively very noisy, as this results in a larger $\tilde{\tau}_{ps}^1$.

Note that the higher $\tilde{\theta}$, the smaller the value of $\tilde{\sigma}_{cb}^2$ necessary for condition (29) to hold, although $\tilde{\theta}$ must necessarily be greater than $\tilde{\sigma}^2$ - media reporting must contribute significantly to increase perceived volatility. If this is not the case, then the coefficient of the private forecast in (28) is negative and the whole expression may be smaller than zero for a sufficiently large f_t^{ps} . A small $\tilde{\sigma}_{cb}^2$ leads to a low value of $\tilde{\tau}_{ps}^1$; in the limit:

$$\lim_{\tilde{\sigma}_{cb}^2 \rightarrow 0} (\tilde{\tau}_{ps}^1 - \tilde{\tau}_{ps}) = -\tilde{\tau}_{ps}.$$

If the private sector forecasts a high value for the risk premium shock and if the central bank's forecast error is not perceived as very volatile, then even though the agents see the media reporting of the central bank's forecast as an indication of a likely increase in uncertainty (that is, despite $\tilde{\theta} > 1$), it is possible for ex-post uncertainty to actually be lower when $S=1$. In this case, because the central bank's forecast is seen as relatively precise, its incorporation into private sector's expectations may indirectly contribute to reduce the rate of inflation: from (28), we see that the *direct* contribution of f_t^{cb} to the rate of inflation is always positive (it increases inflation); but, as a low enough $\tilde{\sigma}_{cb}^2$ makes the coefficient of f_t^{ps} smaller than zero, it is possible that (28) is negative for a sufficiently large private sector forecast f_t^{ps} . Also, if (28) is negative, inflation expectations are *lower* when $S=1$ and, as a result, the central bank sets the nominal interest rate at a lower level, contributing to a relatively higher output; with output closer to the target, central bank's losses are smaller. As for the exchange rate, a negative value of condition (28) implies a more depreciated rate. Hence, a central bank that produces good forecasts may have an incentive to make them easily available (so as to reduce inflation expectations) even in a “man-bites-dog” context.

4 Implications for communication strategies

Forming future expectations is part of all economic decisions. Since the results of our present actions unfold gradually over time, having a good idea of what the future may look like can ease the task of choosing one of several different possible paths. As no one knows for sure what tomorrow will bring, collecting information and making forecasts is important. However, even our best estimations are surrounded by uncertainty, further complicating matters and compelling us to seek more information. In times of calm and staleness, this may not be that crucial; but when uncertainty rises, many of us cannot really afford not searching for more data. Data gathering may be costly, but so is making bad choices.

Accordingly, there is evidence suggesting that agents are more likely to pay attention to central banks' announcements when uncertainty is high (EHRMANN; FRATZSCHER, 2009; FILARDO; GUINIGUNDO, 2008; FRATZSCHER, 2008). In the present paper, this situation is studied in a setting where the perception

²⁰ However, the ex-post perceived *unconditional* variance of agents' beliefs is always lower than the ex-ante perceived unconditional variance. That is: $(1 - \omega)\text{Var}[f_t|\Omega^0] + \omega\text{Var}[f_t|\Omega^1] < (1 - \omega)\tilde{\sigma}^2 + \omega\tilde{\theta}\tilde{\sigma}^2$.

of uncertainty is influenced by the media. As we saw, in a model in which the private sector does not actual variances, the effects of the central bank's risk premium forecast will depend on perceived variances. Under high (perceived) volatility (modeled as a large perceived variance of the risk premium shock), a central bank's forecast seen as very precise may help to reduce inflation, increase output and contribute to a more depreciated exchange rate, which may be desirable in the case of a small open economy.²¹ On the other hand, if the central bank's forecasting error is large and its forecast is seen as very volatile, its incorporation into private sector's expectations may actually lead to higher losses. This result is consistent with Cukierman's (2001) observations for the closed economy case, emphasizing that the release of central bank's forecasts may not be desirable. However, the long run recommendations that can be drawn from our model are more similar to Issing's (1999): as the bank's forecasting capabilities improve, becoming more open about the forecasts may be a good strategy. In an institutional setting in which the central bank is required to release its forecasts, this means that the bank should keep a somewhat fuzzy communicating strategy while the forecasts are still inaccurate. This could discourage (at least part of) the agents from using the forecasts, thus preventing the inaccurate central bank's information from having undesirable economic impacts. However, during times of high uncertainty, the costs of ignoring the monetary authority's communication are likely to be larger; in this case, the poor-quality central bank's forecasts will be used by the private sector and will contribute to higher losses.

In the case of a central bank that has already implemented a clear and standardized procedure for releasing its information (including forecasts) so that no agent has to rely on intermediaries to access or interpret the bank's data, the bank should invest in producing accurate forecasts but also in dissociating media reporting of its information from an increase in uncertainty (i.e., it is necessary to reduce $\tilde{\theta}$). Holding regular press conferences may help, as they should increase news outlets' incentive to always publish the bank's information; and, if $\omega = 1$, there is no reason for $\tilde{\theta} > 1$. That is: if the media always report the central bank's forecasts, it does not make sense for the public to associate the reporting with a higher degree of uncertainty.

Studying the case of the US Federal Reserve, Neuenkirch (2014) notices that newswire services are selective in their reporting. His results show that: (i) the more formal the communication event, the more likely it is to be covered by newswire services; (ii) hierarchy matters: the likelihood of speeches by the chairperson being reported is greater than other open market committee members; (iii) content matters: speeches that contain direct information on the future course of policy are more frequently reported; and (iv) the probability of a piece of information released on a Friday being reported is higher, perhaps because it is easier to sell it to the audience before the weekend (when no communication happens). On the other hand, monetary policy announcements are less likely to be reported if on the same day important macroeconomic data is released; it is therefore better to avoid disclosing relevant information on these occasions. These findings may help central banks design their communication strategies to increase the chances of media coverage. More specifically, with respect to the model presented in section 3, Neuenkirch's findings are particularly relevant for those central banks with a good forecasting performance: following the author's suggestions would increase the chances of coverage, contributing to increasing ω and lowering $\tilde{\theta}$.

However, it is our belief that in many countries (especially emerging and small economies), the public's perception of uncertainty is very likely to be influenced by the media, there are costs to access and interpret central bank's information,²² the bank still suffers from a credibility problem and is unlikely to produce very

²¹ In a small open economy, exports represent a significant part of aggregate demand; thus, if exchange rate depreciations have an expenditure-switching effect (benefiting domestic production), they may stimulate output. If there are distortions in the local economy that lead to an inefficiently low level of equilibrium output (as in the case of imperfect competition), then a more depreciated exchange rate may result in an output level closer to what would actually be the socially optimal level in the absence of distortions. However, in the present setting we can not be sure of all the effects of a higher exchange rate, as the model lacks explicit micro-foundations.

²² As we saw, not only the general public but also financial market participants rely on the media to learn about central bank communication. Given the daily flood of information reaching the markets and the often not-so-clear language used by monetary authorities, even more sophisticated agents with higher incentives to follow the bank's decisions choose to resort to

accurate forecasts. In such a setting, the best strategy is for the central bank to be opaque about its forecasts - either by withholding the forecasts altogether or disclosing them in an unclear manner.

Regarding central bank information and communication in general (not only the release of forecasts), it is important to recognize the inevitable delays and errors in public perceptions, which means that the bank should invest in delivering its information in the simplest possible way, to avoid mistakes and confusions. This can also help the media to report on the bank's information more accurately and more frequently, as journalists' interpretation work will be facilitated. Over time, as the public is able to understand the value of the monetary authority's messages, the media incentives to report them more often should also increase: if there is a social perception that central bank information is important, news outlets, interested in building reputation and maintaining their audience, are more likely to cover it as often and as accurately as possible.

Insights from psychology can also be useful for the design of communication strategies. [Madrian \(2014\)](#) explains that people use reference points when making evaluations and decisions (that is, they do not make absolute judgments). From our discussion, it is possible to conclude that the media help to set these reference points, but [Madrian](#) argues that policy can also influence them. In fact, evidence shows that every detail matters, such as language and even the name given to a government initiative, which is something relatively easy to address. The simplification of information provision reduces uncertainty, misunderstandings, increases the perceived value of the information disclosed and is conducive to a more frequent and accurate media coverage of communication events, to a better alignment of private expectations to central bank's intentions and to a more efficient use of the bank's information. Surely, the level of economic literacy of the public also matters, which is an additional reason for the central bank to simplify its language and to work closely with the government and the media to improve the general understanding of monetary policymaking.

5 Conclusion

This paper emphasized the role of the media as a disseminator of central bank information to the public. Given the importance of communication for the effectiveness of monetary policy, we argued that it is essential to recognize that the media are more than a simple intermediary between the monetary authority and their audience: they collect, select, edit and interpret the bank's information before transmitting it to the public. In fact, an extensive body of research shows that the media shape beliefs, influencing people's view of the world - including their perception of uncertainty. This influence is strengthened by the rational inattentive behaviour of the public, for whom it makes sense to rely on news outlets for information and to give no or little weight to topics that are not on the news.

With this scenario as a background, we proposed a model to explain how media reporting of a piece of central bank information can influence people's perception of uncertainty which, in turn, affects the results of the bank's communication strategy. Applying [Nimark's \(2014\)](#) insightful modeling of a "man-bites-dog" signal to the context of monetary policymaking, the paper shows how media coverage of a communication event may change private expectations, with impacts on the actual level of economic variables. Because rare events tend to feature more often on the news, the reporting increases the audience's perception of uncertainty: the simple fact that the media decide to cover the communication event leads to a rise in perceived volatility, affecting inflation expectations.

Focusing on the publication of a forecast of an external shock, it was shown that if the public perceives this forecast as inaccurate, media reporting contributes to higher inflation and greater social losses. On the other hand, if the bank's forecast is seen as precise it is possible for inflation to be lower and output higher (despite the greater perception of uncertainty caused by news coverage).

In light of the research discussed in section 2, it is plausible to argue that most people only hear about central bank news through the media. If this is the case, there is room for central banks to work more

media outlets as intermediaries.

closely with news outlets. Strengthening the relationship with the mass media may help avoid errors and misinterpretations, give media outlets incentives to cover communication events more frequently and enhance people's understanding of monetary policy. Acknowledging the media's role in the monetary transmission mechanism when designing communication strategies (especially under inflation targeting regimes) may contribute to a more successful management of inflation expectations and, as a result, to an overall more effective policy.

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APPENDIX A –

To prove that $\theta > 1$ is necessary for f^{cb} to be a man-bites-dog signal, we start by noting that the probability $p(f)$ is decreasing in the absolute value of f . However, if f^{cb} is a man-bites-dog signal, then $p(S=1|f)$ is *increasing* in the value of f : the signal is more likely to be reported when there is an unusual realization of the risk premium shock. From Bayes' rule:

$$\frac{p(S=1|f)}{p(S=0|f)} = \frac{p(f|S=1)p(S=1)}{p(f|S=0)p(S=0)}.$$

Given that the conditional distributions are normal and that $p(S=1) = \omega$, it is possible to write:

$$\frac{p(S=1|f)}{p(S=0|f)} = \frac{(\sqrt{\theta}\sigma\sqrt{2\pi})^{-1} \exp(-\frac{1}{2}\frac{f^2}{\theta\sigma^2})}{(\sigma\sqrt{2\pi})^{-1} \exp(-\frac{1}{2}\frac{f^2}{\sigma^2})} \frac{\omega}{1-\omega}.$$

Using the fact that $p(S=0|f) = 1 - p(S=1|f)$ and simplifying yields:

$$\frac{p(S=1|f)}{1 - p(S=1|f)} = \frac{1}{\sqrt{\theta}} \left(\frac{\omega}{1-\omega} \right) \exp \left[\left(1 - \frac{1}{\theta} \right) \frac{f^2}{2\sigma^2} \right],$$

which is increasing in the absolute value of f if $(1 - \frac{1}{\theta}) > 0 \Leftrightarrow \theta > 1$. That is: when $\theta > 1$, the probability of the signal being available increases with the value of f , which characterizes a man-bites-dog signal.

APPENDIX B –

To solve for the private sector's expectations of the exchange rate we begin by taking expectations of (12):

$$\tilde{E}_A^0[e_t] = \frac{\beta(\alpha a_1 + \lambda a_2)(\tilde{E}_A^0[e_{t+1}] + \tilde{E}_A^0[f_t])}{a_1^2 + \lambda a_2^2} - \frac{a_1(\tilde{E}_A^0[\pi_{t+1}] - \pi^*)}{a_1^2 + \lambda a_2^2}$$

Using (15) to substitute for inflation expectations and rearranging yield the following first order difference equation:

$$\tilde{E}_A^0[e_{t+1}] - \left(\frac{a_1}{\alpha\beta} \right) \tilde{E}_A^0[e_t] = -\tilde{E}_A^0[f_t] \implies \text{For } i \geq 1 : \tilde{E}_A^0[e_{t+i+1}] - \left(\frac{a_1}{\alpha\beta} \right) \tilde{E}_A^0[e_{t+i}] = 0, \quad (30)$$

whose solution has the form:

$$\tilde{E}_A^0[e_{t+i}] = A \left(\frac{a_1}{\alpha\beta} \right)^i, \quad (31)$$

for some constant A . Imposing the stability condition: $\tilde{E}_A^0[e_{t+i+1}] - \tilde{E}_A^0[e_{t+i}] = 0$ for $i \geq N$ and evaluating (30) at $i = N$ we obtain: $\tilde{E}_A^0[e_{t+N}] = 0$. Finally, combining this result with (31) gives $A = 0$ and, therefore, $\tilde{E}_A^0[e_{t+i}] = 0$ for $i \geq 1$.

APPENDIX C –

To show the necessary condition for $\tau_{ps}^1 > \tau_{ps}$, we simply use the definitions of the τ 's:

$$\frac{\theta \sigma^2 \sigma_{cb}^2}{\theta \sigma^2 \sigma_{cb}^2 + \theta \sigma^2 \sigma_{ps}^2 + \sigma_{ps}^2 \sigma_{cb}^2} > \frac{\sigma^2}{\sigma^2 + \sigma_{ps}^2} \Leftrightarrow \theta \sigma_{cb}^2 > \theta \sigma^2 + \sigma_{cb}^2 \Leftrightarrow \sigma_{cb}^2 > \frac{\sigma^2}{1 - \theta^{-1}}.$$