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The reception of public signals in financial markets – what if central bank communication becomes stale?

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Contents

Tables and figures

Tables

Figures

Abstract

How do financial markets price new information? This paper analyzes price setting at the intersection of private and public information, by testing whether and how the reaction of financial markets to public signals depends on the relative importance of private information in agents' information sets at a given point in time. It studies the reaction of UK short-term interest rates to the Bank of England's inflation report and to macroeconomic announcements. Due to the quarterly frequency at which the Bank of England releases one of its main publications, it can become stale over time. In the course of this process, financial market participants need to rely more on private information. The paper develops a stylized model which predicts that, the more time has elapsed since the latest release of an inflation report, market volatility should increase, the price response to macroeconomic announcements should be more pronounced, and macroeconomic announcements should play a more important role in aligning agents' information set, thus leading to a stronger volatility reduction. The empirical evidence is fully supportive of these hypotheses.

JEL classification: E58, E43, G12, G14.

Keywords: public signals; inflation reports; monetary policy; interest rates; announcement effects; co-ordination of beliefs; Bank of England.

Non-technical summary

This paper studies the importance of private and public information in the price discovery process of financial markets. In particular, it tests whether and how the reaction of financial markets to public signals depends on the relative importance of private information in agents' information sets at a given point in time. In order to pin down the relative importance of private information, it studies the example of a financial market where one of the most decisive public signals is issued only at a low frequency and can therefore become stale over time. In the course of this process, financial market participants need to rely more on private information, such that the relative importance of private information is identified by the time that has elapsed since the last update of the public signal.

Other public signals, even if less directly relevant for the pricing of the underlying asset than the low frequency signal, will be used by agents to update their information set in the meantime. The paper assumes that public signals serve to homogenize the information set of traders, and as such should lead to a convergence of views. This effect should be magnified when private signals are relatively dominant, and traders' information sets accordingly heterogeneous, suggesting a stronger market reaction to the release of a public signal.

The empirical application of this paper studies the role of central bank communication for short-term interest rates, given that these depend closely on the course of monetary policy. The paper investigates whether the price discovery process depends on the freshness of information that has been provided by the central bank. With more recent, and thus more precise, public information about the current thinking within the central bank, the importance of private information should be relatively limited. With growing distance to the release of the central bank's public signal, its information content is becoming stale, thus leaving more room for heterogeneous beliefs and private information. We will use the Bank of England's inflation report as a testing case. The inflation report is released quarterly, and contains an in-depth analysis of the current economic situation in the UK, as well as forecasts for GDP and inflation. Importantly, the Bank of England's inflation report is signed off by the Monetary Policy Committee (MPC), i.e. the body that decides on the Bank's policy rates, and has been judged to be of very high quality. We therefore conjecture that the inflation report conveys a rather precise (albeit infrequent) signal on the current thinking of the policy makers, such that it should be closely watched by financial market participants. In the interim period between two inflation reports, financial market participants can update their beliefs about the course of the economy and the likely setting of monetary policy based on the information content of releases of macroeconomic data. As set out above, our hypothesis is that these serve to homogenize agents' views, but that financial market reactions to their release vary in between two inflation reports, with the effects becoming larger over time.

In line with the hypothesis that public signals serve to homogenize agents' information sets, the paper finds that conditional volatility declines in response to both the inflation report and macroeconomic news. The increasing reliance on private information with growing distance to the last release of an inflation report is also confirmed, as conditional volatility generally rises over time in between two reports. Furthermore, in response to macroeconomic releases price adjustments become more pronounced, and the reduction of conditional volatility also strengthens, suggesting that these public signals are given more weight in the updating of beliefs, the more distant the last central bank communication, and therefore the larger the role played by private information.

These findings have a number of important implications. In the realm of monetary policy, central banks routinely study the market response to macroeconomic news. To appropriately judge the magnitude of such market movements, it is important to compare these against the correct benchmark, which is not the average response, but rather the average response conditional on the freshness of central bank communication. An above average response to the release of inflation data shortly prior to the publication of a major central bank release, for instance, is to be expected, and should be assessed accordingly. Beyond a pure monetary policy perspective, these findings might help explain why it is at times difficult to establish a link between asset prices and macroeconomic fundamentals. What the current paper suggests is that a missing (or a muted) responsiveness need not automatically imply a broken link. Rather, muted responsiveness can very well arise if the information contained in another source (that could have entered the information set already at an earlier stage) is sufficiently precise to dominate the new signal. Finally, it is important to remember that this paper has used the case of central bank communication as a testing case for its hypotheses, but that the implications are applicable to a much broader set of situations. Gropp and Kadareja (2006) show related effects for stock markets, where the price discovery process depends on the distance from the last release of commercial banks' annual reports. Taken together, these findings imply that transparency by actors that have the potential to affect asset prices (be it policy makers or publicly traded companies) is generally beneficial.

Introduction

How do financial markets price new information? This question is of fundamental importance to financial economics, and has therefore received extensive attention in the literature. The reception of public signals in financial markets has been subject to particular scrutiny, inter alia because the news arrival process is relatively easily identified in the case of public news. The literature on announcement effects (Ederington and Lee 1993, Fleming and Remolona 1999a, Andersen et al. 2003, 2007, and many others), for instance, has substantially improved our understanding of the price discovery processes at work in financial markets.

Studying the importance of private information, in contrast, is by definition much more difficult. Papers in this literature typically follow the approach of French and Roll (1986) and compare volatility of asset prices during exchange trading hours to its counterpart during non-trading hours, holding the arrival process of public information constant. Ito et al. (1998), for instance, study the role of private information in foreign exchange markets, by comparing its volatility before and after the introduction of lunch-time trading in Tokyo (a change which should not have altered the flow of public information). With this identification approach, private information has been identified as a major factor behind market volatility.

The current paper aims to contribute to both strands of the literature by studying price setting at the intersection of private and public information. It tests whether and how the reaction of financial markets to public signals depends on the relative importance of private information in agents' information sets at a given point in time. In order to pin down the relative importance of private information, we will look at the example of a financial market where one of the most decisive public signals is issued only at a low frequency, such that it can become stale over time. In the course of this process, financial market participants need to rely more on private information, such that the relative importance of private information is identified by the time that has elapsed since the last update of the public signal.

Other public signals, even if less directly relevant for the pricing of the underlying asset than the low frequency signal, will be used by agents to update their information set in the meantime. The paper assumes that public signals serve to homogenize the information set of traders, and as such should lead to a convergence of views. This effect should be magnified when private signals are relatively dominant, and traders' information sets accordingly heterogeneous, suggesting a stronger market reaction to the release of a public signal.

This paper is therefore closely related to Gropp and Kadareja (2006), who study the response of realized volatility of commercial banks' stocks to monetary policy shocks, and show that the magnitude of this response increases with the time since the commercial bank has released its annual report. In the current paper, we will look at another example of this mechanism, following a somewhat different approach, which allows disentangling the response of the conditional mean and the conditional variance. Furthermore, we are interested in longer-term effects, and will therefore use daily rather than intraday data.

The example we study relates to central bank communication as a public signal of direct and major relevance for short-term interest rates (which are known to closely depend on the course of monetary policy). We will investigate whether the price discovery process depends on the freshness of information that has been provided by the central bank. With more recent, and thus more precise, public information about the current thinking within the central bank, the importance of private information should be relatively limited. With growing distance to the release of the central bank's public signal, its information content is becoming stale, thus leaving more room for heterogeneous beliefs and private information. We will use the Bank of England's inflation report as a testing case. The inflation report is released quarterly, and contains an in-depth analysis of the current economic situation in the UK, as well as forecasts for GDP and inflation. Importantly, the Bank of England's inflation report is signed off by the Monetary Policy Committee (MPC), i.e. the body that decides on the Bank's policy rates, and has been judged to be of very high quality (Fracasso et al. 2003). We therefore conjecture that the inflation report conveys a rather precise (albeit infrequent) signal on the current thinking of the policy makers, such that it should be closely watched by financial market participants. In the interim period between two inflation reports, financial market participants can update their beliefs about the course of the economy and the likely setting of monetary policy based on the information content of releases of macroeconomic data. As detailed above, our hypothesis is that these announcements serve to homogenize agents' views, but that financial market reactions to their release vary in between two inflation reports, with the effects becoming larger over time.

Modeling the market response to signals by means of GARCH models allows separating effects on the conditional mean from those on the conditional volatility equation. This approach is distinct from several other related papers, which study the response of either asset prices (without a simultaneous modeling of the conditional variance, such as Gürkaynak et al. 2006), or (realized) volatility (such as Gropp and Kadareja 2006). The separation of the two is important for the purposes of this paper: conditional volatility should fall in response to a public signal that homogenizes agents' views, whereas realized volatility might actually increase (due to a response of the conditional mean equation). As a matter of fact, we find very strong evidence that the conditional volatility of short-term interest rates is significantly reduced in response to the release of the Bank of England's inflation report, as well as in response to macroeconomic releases, especially when separating the incidence of releases from their surprise component. At the same time, the paper provides evidence that the market reaction to the latter is strongly dependent on the time that has elapsed since the release of the preceding inflation report. Three findings are important in that respect. First, conditional volatility generally increases with the distance to the preceding inflation report, suggesting that as central bank communication becomes stale, private information plays a relatively larger role in market participants' information set. Second, the response of the mean equation to macroeconomic releases becomes more pronounced, and third, the reduction of conditional volatility in response to macroeconomic releases is also stronger, the larger the time gap since the last update of the inflation report.

These findings have a number of important implications. In the realm of monetary policy, central banks routinely study the market response to macroeconomic news. To appropriately judge the magnitude of such market movements, it is important to compare these against the correct benchmark, which is not the average response, but rather the average response conditional on the freshness of central bank communication. An above average response to the release of inflation data shortly prior to the publication of a major central bank release, for instance, is to be expected, and should be assessed accordingly. Beyond a pure monetary policy perspective, these findings might help explain why it is at times difficult to establish a link between asset prices and macroeconomic fundamentals (see, e.g, the discussion on this issue in Andersen et al. 2003). What the current paper suggests is that a missing (or a muted) responsiveness need not automatically imply a broken link. Rather, muted responsiveness can very well arise if the information contained in another source (that could have entered the information set already at an earlier stage) is sufficiently precise to dominate the new signal. Finally, it is important to remember that this paper has used the case of central bank communication as a testing case for its hypotheses, but that the implications are applicable to a much broader set of situations. Gropp and Kadareja (2006) show related effects for stock markets, where the price discovery process depends on the distance from the last release of commercial banks' annual reports. Taken together, these findings imply that transparency by actors that have the potential to affect asset prices (be it policy makers or publicly traded companies) is generally beneficial.

The paper adds to various different strands of the literature. A very recent literature (surveyed in Blinder et al. 2008) deals with aspects related to monetary policy, transparency and central bank communication. In particular, Morris and Shin (2002) and Amato, Morris and Shin (2002) deal with the problem that communication by central banks can reduce welfare if its signals are relatively noisy, yet are used by market participants to nonetheless coordinate their beliefs. Whether this implies limits to central bank transparency in practice has been challenged by Svensson (2006), however, on the grounds that central bank information may not be sufficiently noisy to lead to this result. Ehrmann and Fratzscher (2007b) test the predictions of the model empirically, and find support for the Morris and Shin hypothesis. A related empirical literature assesses how central bank transparency and communication affects financial markets. There is ample evidence that communication exerts a substantial impact on asset prices (Guthrie and Wright 2000, Kohn and Sack 2004, Andersson et al. 2006, Ehrmann and Fratzscher 2007a). Reinhart and Sack (2006) as well as Reeves and Sawicki (2007) show that in particular communication on behalf of the entire policy-making committee is a strong market mover; for the case of the Bank of England, the inflation report has been shown to be particularly important.

The paper also is closely related to the literature on announcement effects in financial markets. Ederington and Lee (1993) demonstrate that prices of interest rates and foreign exchange futures markets respond significantly to macroeconomic news announcements. Fleming and Remolona (1999a) expand this analysis by furthermore testing the effect on trading volume and bid-ask spreads, and identify two distinct adjustment processes. In the first stage, prices adjust nearly instantaneously to news, thus confirming the conjecture of French and Roll (1986) that public information affects prices before anyone can trade on it. In the second stage, which is somewhat more persistent, trading volume surges and price volatility persists, as residual disagreements among the traders about the interpretation of the news triggers trading. Note that these two periods span a couple of hours, i.e. are typically concluded within the course of a trading day. Effects of macroeconomic news on stock, bond and foreign exchange markets have subsequently been found in various studies (for interest rates in particular see Balduzzi et al. 2001, Goldberg and Leonard 2003, and Faust et al. 2007). Andersen et al. (2003 and 2007) document important asymmetries in that respect, e.g. a greater impact of bad news than of good news on exchange rates, or a different response of equity markets depending on the stage of the business cycle.

While most evidence has focused on the US, a number of contributions also provide evidence for British financial markets. Gürkaynak et al. (2006) focus on the responsiveness of long-term inflation compensation to macroeconomic news in the US, the UK and Sweden. They find that they are insensitive to news releases in Sweden and in the UK (since the Bank of England was granted independence), whereas they are in the US and were in the UK prior to 1997. The authors conclude that inflation targeting can anchor inflation expectations. Importantly for the purposes of this paper, they also show that zero coupon yields (obtained from the same source as in this paper, and estimated over a similar sample, namely 1998-2005) at the 1-year maturity are responsive to macroeconomic news.

A number of papers in this literature estimate conditional mean and conditional variance equations: Andersen et al. (2003 and 2007), as well as Ehrmann and Fratzscher (2005) using a weighted least squares approach, Jones et al. (1998) or Flannery and Protopapadakis (2002) using GARCH models, and Goodhart et al. (1993) even using GARCH in mean models. The key insight from these studies is that the effects on the conditional mean might very well differ from the effects on the conditional variance. Flannery and Protopapadakis (2002), for instance, find that inflation news affect only the conditional mean of stock returns, whereas some real factors trigger responses in the conditional variance, without affecting the conditional mean.

A third strand of the literature that is of relevance for this paper attempts to disentangle the role of private and public information in financial markets, and to understand the drivers for market volatility. Shalen (1993) develops a model where agents' dispersion of expectations is causal for excess market volatility. Similarly, in the model by Harris and Raviv (1993), traders receive common information, but interpret it in different ways. Both models are closely related to our paper, where the heterogeneity in agents' beliefs is a function of the quality of the public signal. The older the signal, the more likely it is that agents interpret it differently, which in turn should lead to an elevated volatility in markets. Empirical tests for the importance of private information in generating market volatility typically rely (following the approach of French and Roll 1986) on identifying differences in volatility between trading and non-trading times, while keeping the flow of public signals constant. In particular changes in institutional settings have been applied as a testing vehicle. Ito and Lin (1992) show that the reduction in market volatility during lunchtime is smaller for the New York Stock Exchange (which does not break for lunch) than for the Tokyo Stock Exchange (which does break for lunch). As mentioned above, Ito et al. (1998) make use of the abolishment of the lunch break in the Tokyo foreign exchange market. Furthermore, Barclay et al. (1990) analyze volatility before and after the half-day trading in the Tokyo Stock Exchange on Saturdays was abandoned. The literature strongly suggests that private information is playing a large role in generating market volatility.

The present paper attempts to contribute to these three lines of research. It develops a short, stylized model of the reception of different public signals in financial markets, and describes the data and the methodology underlying our empirical analysis in Section 2. Section 3 provides the empirical results, first looking at the unconditional reception of public signals, and subsequently asking how this perception changes if central bank communication becomes stale. Section 4 concludes.

1

1
Modeling the reception of different public signals in financial markets

The purpose of this section is to present a simple modeling framework, illustrating the effect of the release of inflation reports and of macroeconomic news and their interaction,[1] as well as the setup of our subsequent empirical analysis.

1.1 The theoretical model

Every period t, agent i forms an expectation $E_{it}(\theta_{t,t+h})$ about the future path of interest rates $\theta_{t,t+h}$ (where the expectation is formed over the horizon from period t to period $t+h$). The agent has a utility function of the form

$$U_{it} \equiv -\left(E_{it}(\theta_{t,t+h}) - \theta_{t,t+h}\right)^2 \tag{1}$$

suggesting that the agent wants her expectation to closely reflect and be consistent with the later realization of $\theta_{t,t+h}$. Each agent receives a private signal about $\theta_{t,t+h}$ each period. This signal is unbiased, yet noisy, and can be modeled as $\chi_{it} = \theta_{t,t+h} + \varepsilon_{it}$, where ε_{it} is i.i.d.-normal with zero mean and variance σ_{ε}^2, and $E(\varepsilon_{it}\varepsilon_{jt}) = 0$ for $i \neq j$. For simplicity, we assume that the variance of this signal remains fixed over time. In the absence of other signals, the agent's expectation will be $E_{it}(\theta_{t,t+h}) = \chi_{it}$. Note that it is these private signals which generate heterogeneity in expectations.

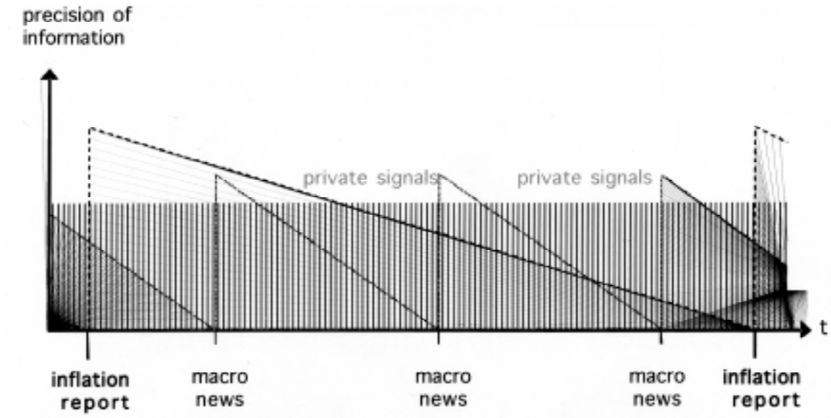
To expand the model, we can assume that agents also receive a second signal, namely a public signal (such as the central bank's inflation report), $y_t = \theta_{t,t+h} + \eta$, where η is also normally distributed with zero mean and variance σ_{nt}^2 and independent of ε_t. The public signal is updated only infrequently. With $\theta_{t,t+h}$ evolving over time, the public signal becomes stale. We model this by means of a time-varying variance of the public signal, whereby σ_{nt}^2 is monotonically increasing with the elapsed time since the public signal was issued.[2]

Figure 1 illustrates these assumptions. Each period, a private signal is received (indicated by the gray vertical lines), with their precision being constant. Occasionally,

[1] The notation and modeling approach are borrowed from Morris and Shin (2002).
[2] This is a simplification, which does not affect our results qualitatively. As a matter of fact, it represents a lower bound of the loss of information contained in the public signal. If we assume a data generating process for the fundamental of the type $\theta_{t+1,t+h+1} = \Psi_\theta \theta_{t,t+h} + \varsigma_{t+1}$, last period's signal enters the expectation about the fundamental (in the absence of other signals) as $E_{t+1}(\theta_{t+1,t+h+1}) = E_{t+1}(\Psi_\theta \theta_{t,t+h} + \varsigma_{t+1}) = E_{t+1}(\Psi_\theta y_t + \Psi_\theta \eta_t + \varsigma_{t+1})$. Accordingly, the signal to noise ratio deteriorates over time. If the fundamental is a random walk, i.e., $\Psi_\theta = 1$, the modeling shortcut of an increasing variance σ_{nt}^2 is correct. If the fundamental is less persistent, i.e. $\Psi_\theta < 1$, the signal to noise ratio deteriorates even faster over time. In the extreme case of a white noise process, a signal will not be informative for any subsequent period any more. Except for this extreme case, which we do not believe to be realistic when it comes to monetary policy, our modeling shortcut leads to the wanted result that agents put less weight on the public signal over time.

a public signal, namely the inflation report (depicted by means of the dashed line), is issued.[3] Given the infrequent update of this public signal, its precision erodes over time, until a new public signal is released. The chart assumes that the inflation report, when being issued, provides a cleaner picture of the central bank's intentions than the private signal. Note, however, that the results of the model do not depend on the relative precision of the various signals.

Figure 1: The informational assumptions



Note: This stylized figure shows the assumptions of the model with regard to the arrival of signals, and their precision. Inflation report: dashed line; macro announcement: dotted line; private signals: grey line.

Having available two signals about the fundamental, the agent now needs to decide on the weights that should be attached to each when forming her expectations. The determining factor for the allocation of weights is the relative precision of the two signals, with a larger weight being allocated to the more precise signal. Defining the precision of the private signal as $\beta_{it} \equiv 1/\sigma_{\varepsilon}^{2}$ and of the public signal as $\alpha_{it} \equiv 1/\sigma_{nt}^{2}$ implies that the expected value of the fundamental $\theta_{t,t+h}$ is

$$E_{it}(\theta_{t,t+h}) = \frac{\alpha_t y_t + \beta x_{it}}{\alpha_t + \beta} = \theta_{t,t+h} + \frac{\alpha_t \eta_t + \beta \varepsilon_{it}}{\alpha_t + \beta} \tag{2}$$

This expression allows us to analyze the heterogeneity in expectations. The variance of individual expectations across agents is given by

$$\sigma^2_{E(\theta)} = \left(\frac{\beta}{\alpha_t + \beta}\right)^2 \sigma^2_{\varepsilon} \tag{3}$$

Taking the first derivative of (3) with respect to α_t yields

$$\frac{\partial \sigma^2_{E(\theta)}}{\partial \alpha_t} = -2\frac{\beta^2}{(\alpha_t + \beta)^3}\sigma^2_{\varepsilon} < 0 \tag{4}$$

This implies that heterogeneity in expectations varies with the freshness of the public signal, as it is smaller, the more recently the public signal has been issued. Accordingly,

[3] The chart also contains a second public signal (e.g., a macroeconomic announcement, indicated by the dotted lines), which is relatively more frequent, but similar in nature to the first public signal. The model will be expanded with this second public signal below.

heterogeneity in expectations should increase with the time that has elapsed since the last update of the public signal and drop in the time period when the public signal gets updated (and thus experiences a substantial increase in its precision).

1

Let us further assume that while the public signal y_t becomes stale, another public signal (such as a macroeconomic announcement) $z_t = \theta_{t,t+h} + \xi_t$ is observed. In analogy to the other signals, ξ_t is assumed to be normally distributed with zero mean and variance $\sigma^2_{\xi t}$, and independent of both ε_t and η_t. Like in the case of the other public signal, the precision of this signal also erodes over time, leading to the variance $\sigma^2_{\xi t}$ being monotonically increasing with the elapsed time since the public signal was issued. The precision of the signal is defined as $\gamma_t \equiv 1/\sigma^2_{\xi t}$. The informational assumptions regarding this signal are also illustrated in Figure 1.

In this case, the decision rule of agent i is

$$E_{it}(\theta_{t,t+h}) = \frac{\alpha_t y_t + \beta x_{it} + \gamma_t z_t}{\alpha_t + \beta + \gamma_t} = \theta_{t,t+h} + \frac{\alpha_t \eta_t + \beta \varepsilon_{it} + \gamma_t \xi_t}{\alpha_t + \beta + \gamma_t} \tag{5}$$

Equation (5) allows us to analyze two further sets of questions. First, we can test the reaction of expectations to a changing public signal z_t, and how this depends on the precision of the other public signal. Second, we examine to what extent heterogeneity of expectations evolves in response to the release of the public signal z_t, and again how this depends on the precision of the other public signal. Looking at the first case, we find that

$$\frac{\partial E_{it}(\theta_{t,t+h})}{\partial z_t} = \frac{\gamma_t}{\alpha_t + \beta + \gamma_t} > 0 \tag{6}$$

$$\frac{\partial(\partial E_{it}(\theta_{t,t+h})/\partial z_t)}{\partial \alpha_t} = -\frac{\gamma_t}{(\alpha_t + \beta + \gamma_t)^2} < 0 \tag{7}$$

Hence, expectations will react to a release of the public signal z_t (equation 6), and this reaction will depend on the precision of the first public signal y_t (equation 7): the more precise is the public signal, the less pronounced will the expectations reaction be. With regard to the heterogeneity in expectations, we find that

$$\sigma^2_{E(\theta)} = \left(\frac{\beta}{\alpha_t + \beta + \gamma_t}\right)^2 \sigma^2_\varepsilon \tag{8}$$

$$\frac{\partial \sigma^2_{E(\theta)}}{\partial \gamma_t} = -2\frac{\beta^2}{(\alpha_t + \beta + \gamma_t)^3}\sigma^2_\varepsilon < 0 \tag{9}$$

$$\frac{\partial(\partial \sigma^2_{E(\theta)}/\partial \gamma_t)}{\partial \alpha_t} = 6\frac{\beta^2}{(\alpha_t + \beta + \gamma_t)^4}\sigma^2_\varepsilon > 0 \tag{10}$$

As with the first public signal, heterogeneity will be smaller, the higher the precision of the public signal, and therefore drops whenever the signal gets updated (equation 9).

At the same time, however, this relationship will crucially depend on the precision of the other public signal: the more precise is y_t, the smaller the heterogeneity reduction in response to an update of the public signal z_t (equation 10).

1.2 The data and the econometric model

The stylized model developed in the preceding section has led to a number of hypotheses that we would like to put to an empirical test. The model is formulated in terms of agents' expectations about the future path of interest rates and their heterogeneity. A direct test of the model's hypotheses would therefore require data on expectations, e.g. as derived from surveys. Unfortunately, there are no surveys available with a sufficiently high frequency. Instead, we will need to extract the relevant information from financial market data. We will make two assumptions in this regard. First, a change in expectations about the future path of interest rates should be reflected in financial market prices, most directly in market interest rates; the more liquid the market, the better the price response will reflect the change in expectations. Second, as Shalen (1993) and Harris and Raviv (1993) have shown, differences in expectations trigger market volatility. A changing heterogeneity should therefore be mirrored in variations of volatility. Also in that regard, market interest rates seem most promising, given their close link with monetary policy.

We will therefore use British zero coupon government bond yields for different maturities ranging from 2 to 12 months. Our dependent variable is defined as the first difference of the daily yields, as is common practice in the announcement literature. These data have been provided by the Bank of England. The choice of these data is based on the assumption that short-term interest rates should be particularly sensitive to news related to monetary policy. A possibly preferable alternative would have been to use interbank rates, as these are arguably more tightly linked to monetary policy; unfortunately, the available series do typically not vary at the daily frequency, especially at the beginning of our sample, such that we had to use government bond yields instead. The sample spans all trading days from March 1997 until December 2008. While the start of the sample is owed to the unavailability of earlier zero coupon yields data, it coincides roughly with the independence of the Bank of England, and as such constitutes a meaningful choice. The starting point is also just prior to the 1998 Bank of England Act, which requires the MPC, i.e. the Bank of England's rate-setting body, to sign off the Bank's inflation report.

We use the inflation report as our measure of the Bank of England's public signal, despite the fact that there are a large number of other important communication events. Monetary policy decisions and the accompanying statements or the subsequent release of the minutes of MPC meetings are obvious examples, as are speeches by MPC members. We opted for the inflation report for a number of reasons: The regular publication schedule (compared to speeches), the relatively low publication frequency (compared to minutes and policy statements) and the in-depth analysis provided therein (taking the length of the documents as a proxy, inflation reports are at around 50-60 pages more than 5 times as long as minutes, which typically contain around 10 pages). Importantly, the inflation report also contains the forecasts of inflation and GDP, and as such an important forward-looking element of the Bank's economic assessment, which directly feeds into policy deliberations. According to the Bank of England (2009), the inflation report "serves two purposes. First, its preparation provides a comprehensive and forward-looking framework for discussion among MPC members as an aid to our decision making. Second, its publication allows us to share our thinking and explain the reasons for our decisions to those whom they affect." According to Lomax (2005), the inflation report plays a "central role" in the MPC's communication. As further indications for its prominence, note that the inflation reports are the first on the list of the Bank's "Main publications" on its website (www.bankofengland.co.uk), and that it is the only publication that is accompanied by a regular press conference, where the Governor engages in a Q&A session with journalists.[4] We have collected the release dates of the Bank of England's inflation report from the Bank of England website, and create a dummy variable that is equal to one on release dates, and zero otherwise. The time elapsed since the last report is measured by counting the days since the preceding release, and dividing this number by the total number of days in between the preceding and the subsequent release. To facilitate the interpretation of coefficients, we have normalized the resulting variable by subtracting its mean. The variable does therefore range from -0.5 to +0.5.

The last set of variables relates to the release of macroeconomic data. It is a well known fact that asset prices, at the time of a release, react only to the surprise component contained therein (Kuttner 2001); as we will show in this paper, this is not the case for market volatility, though. To construct the surprise component we follow the standard in the announcement literature, and deduct the expectation of the announcement from the actual announcement value of the variable. To allow a comparison of the magnitude of the financial market responses, we furthermore standardize the surprises by their own standard deviation. This standardization removes differences in the unit of measurement across variables, and regression coefficients for each series can then be interpreted as a response per one standard deviation surprise. We obtained data on financial market expectations of the various macroeconomic data releases from two sources, namely Money Market Services (MMS) and Bloomberg Financial Services, and use the median response of the respective polls as our measure of market expectations.[5] The macroeconomic announcements contained in our dataset relate to the Consumer Price Index (month on month), the Manufacturing Purchasing Managers Index, retails sales (month on month), unemployment, and the trade balance. By opting for nominal and real indicators, we aim to cover a relatively broad spectrum of the economy; by choosing forward-looking ones such as the PMI, we intend to capture indicators that might help markets to infer news about the future course of monetary policy. Given that the bulk of the announcement literature has studied market responses to US releases, we furthermore collected US announcement data, again covering nominal and real aspects as well as leading indicators, namely the Conference Board's composite index of leading indicators, industrial production, core CPI and non-farm payrolls. The US data will provide a basis for testing the robustness of our results. Note that we can be agnostic on why US surprises move British yields, given that we are only interested in how financial markets react to public signals conditional on the time elapsed since the preceding inflation report, regardless on the underlying perceived transmission mechanism from the US to the British economy.

As mentioned above, we are interested in how expectations about the fundamental, as well as their heterogeneity across agents evolve. Our empirical counterparts to these two concepts are the price response and the volatility response, respectively. It is important to note, however, that we are interested in the volatility response conditional on the price response. The release of a public signal can have two effects: first, a change in the expectation about the future path of interest rates of the average market participant. This will be reflected in the price response. Second, also the heterogeneity of expectations might be affected. Once the market has settled to the new average expectation, we would expect to see a change in volatility compared to the time prior to the release of the signal.

[4] The importance of inflation reports for financial markets has also been shown by Fracasso et al. (2003). Based on indicators of the quality of inflation reports for 19 countries, they show that higher quality reports are associated with smaller policy surprises. Importantly, the Bank of England's inflation reports have outperformed those of all other central banks in their quality ranking.

[5] Ehrmann et al. (2007) note that the information content of the MMS and Bloomberg series is very similar. In particular, when both surveys co-exist, the release data are identical, and the expectations agree almost perfectly. The quality of these data as measures of expectations has been verified by, e.g., Balduzzi et al. (2001) and Andersen et al. (2003) for MMS, and by Ehrmann and Fratzscher (2005) for Bloomberg.

The "immediate" price response to the signal should therefore not be considered part of the volatility response. We do therefore need to estimate an econometric model that allows testing for the effect of news on both the conditional mean and the conditional variance of asset prices. We estimate an exponential GARCH (EGARCH) model, following Nelson (1991).[6] An EGARCH(1,1) model is sufficient to address the non-normality of the data, in particular the serial correlation and heteroskedasticity of the daily interest rate series. We will use different variants of the econometric model. In its most extended version, the conditional mean equation is formulated as

$$r_t = c_1 + \sum_k \delta^k \; s_t^k + \sum_k \phi^k \; s_t^k g_t + \omega g_t + \psi \; r_{t-1} + \sum_l \nu^l \; d_t^l + \mu_t \tag{11}$$

with r_t as the change in the daily UK zero coupon rates, r_{t-1} as the lagged change, and d_t^l as a set of controls containing day-of-the-week effects. S_t^k denotes the standardized surprise component contained in macroeconomic announcement k. Finally, g_t stands for the time that has elapsed since the preceding release of the inflation report.[7] Conditioned on the information set of last period (I_{t-1}), we assume the distribution of the disturbance to be $\mu_t \mid I_{t-1} \sim (0, h_t)$. Hence, we express the conditional variance of UK interest rate changes, h_t, as

$$\begin{aligned} \log(h_t) = c_2 + \kappa_1 \left(\left| \frac{\mu_{t-1}}{\sqrt{h_{t-1}}} \right| - \sqrt{2/\pi} \right) + \kappa_2 \left(\frac{\mu_{t-1}}{\sqrt{h_{t-1}}} \right) + \kappa_3 \log(h_{t-1}) \\ + \lambda^{IR} \; a_t^{IR} + \sum_k \lambda^k \; a_t^k + \sum_k \rho^k \; a_t^k g_t + \zeta \; g_t + \sum_l \tau^l d_t^l \end{aligned} \tag{12}$$

a_t^k and a_t^{IR} are announcement dummies that take the value one on all days a macroeconomic announcement or an inflation report is released, and zero otherwise. All other variables are as described in equation (11). The model is estimated via maximum likelihood, using the BHHH algorithm for optimization. Note that the model is estimated for all business days in the sample, i.e. also for days when neither an inflation report is issued, nor a macroeconomic announcement is made. The corresponding variables are equal to zero on such days.

Taking the inflation report as the public signal y_t, and the release of a given macroeconomic data as the second public signal z_t, the stylized model leads to the following hypotheses:

1) The publication of an inflation report should lead to a reduction in the heterogeneity of beliefs, and thus to a reduction in conditional volatility in financial markets (first derivative of equation (4)); $H_0 : \lambda_t^{IR} < 0$.

[6] In order to test for asymmetries in volatility, we apply the Engle and Ng (1993) sign and size bias test. It examines whether sign and size of the shocks impact differently upon the conditional variance. The joint hypothesis of no asymmetry is rejected for all maturities, suggesting the use of Nelson's (1991) EGARCH. The results are not displayed but are available from the authors upon request.

[7] The mean equation does not contain a variable controlling for the release of the inflation report. In contrast to the macroeconomic announcements, we do not have a measure of market expectations available, such that we cannot construct a variable for the surprise component contained in an inflation report. Controls for the release of an inflation report do therefore only enter the conditional variance equation, where a dummy variable indicating the release date is sufficient for our purposes. To facilitate the interpretation of coefficients, we have normalized the variable gt to range from -0.5 to +0.5. This implies that the variable has a mean of zero, such that the coefficients β^k can be interpreted as the average effect of announcement k on interest rates.

2) Also the release of macroeconomic data should lower conditional volatility (equation 9)); $H_0 : \lambda_t^k < 0$.[8]

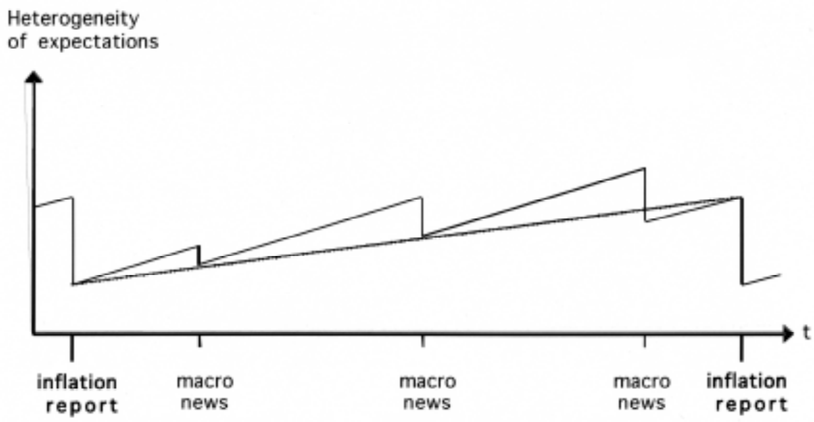
3) With passage of time, the information contained in a given inflation report becomes stale, which should lead to an increase in conditional volatility – until the subsequent inflation report is released (first derivative of equation (4)); $H_0 : \xi > 0$.

4) The volatility reduction in response to macroeconomic releases should be more pronounced, the more time has elapsed since the preceding release of an inflation report (equation (10)); $H_0 : \rho^k < 0$.

5) The update of beliefs, and thus the reaction of asset prices to macroeconomic news in the mean equation should be stronger, the more time has elapsed since the preceding release of an inflation report (equation (7)); $H_0 : sign\ (\delta^k) = 0\ sign\ (\phi^k)$.

Hypotheses 1 to 4 are illustrated in Figure 2. The solid line shows the evolution of the heterogeneity in expectations (proxied by market volatility) that is predicted by the model of Section 2.1. Importantly, the figure also contains the dotted line, which shows that the estimate of the volatility increase over time depends crucially on the inclusion of macro announcements in the regression model: without these, the slope of the line gets underestimated. This is important to bear in mind when interpreting our results: while our model controls for a few macroeconomic announcements, it will never be able to include all relevant news, such that we would expect to find a relatively subdued estimate for ζ.

Figure 2: The predicted evolution of expectation heterogenity



Note: This stylized figure shows the predicted evolution of the heterogenity of agents' expectations. Heterogeneity drops in response to news, this volatility reduction in response to macro news increases with the distance to the last inflation report, and volatility increases with the distance to the last inflation report. The dotted line shows the slope for this volatility increase that would be estimated if macro news were mistakenly omitted from the econometric model.

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[8] In contrast to this hypothesis, a number of studies find positive reaction coefficients. This result is plausible if the surprise component contained in an announcement dominates the incidence of the announcement, and its tendency to homogenize agents' information sets. This issue is touched upon in Kim and Sheen (2000), Kim et al. (2004) and DeGennaro and Shrieves (1997). Which effect dominates remains an empirical question. In our analysis, we will therefore distil the pure effect arising from the incidence of the public signal on the harmonization of beliefs by controlling for the effect of the surprise component in the signal.

2

Financial market reactions to the release of public signals

This section presents the empirical results. We will first ask how financial markets respond to the release of public signals in general, looking at the response to inflation reports as well as to macro releases. Subsequently, we will test what happens over time following the release of an inflation report, with the information becoming stale.

2.1 The unconditional reception of public signals

Our first test relates to the reaction of yields to the release of public signals, i.e. hypotheses 1 and 2. They suggest that public signals provide an opportunity for financial market participants to update their beliefs, and as such should lead to more homogeneous views about the future evolution of interest rates. Market volatility should therefore be reduced in response to public signals.[9] Table 1 shows the results of a model that contains, in the variance equation, dummies that are equal to one on release dates for inflation reports and the UK macro announcements.[10]

The model furthermore controls for the effect of macroeconomic releases on the mean equation (as explained above, given the unavailability of a measure containing market expectations about the content of inflation reports, we cannot control for the release of inflation reports in the mean equation). In the next section, we will focus more on the effects in the mean equation. For the time being it shall suffice to note that a number of macroeconomic releases lead to significant responses. The direction of these effects is as one would expect, with interest rates rising in response to higher than expected inflation and real developments, and with interest rates falling in response to higher than expected unemployment (although this effect is not statistically significant).

Table 1: The average effect of announcements on yields

	2-months			3-months			6-months			12-months		
	Coeff.		*std. error*	Coeff.		*std. error*	Coeff.		*std. error*	Coeff.		*std. error*
UK CPI	0.004	***	*0.002*	0.012	***	*0.002*	0.021	***	*0.002*	0.027	***	*0.003*
UK PMI	0.006	***	*0.002*	0.006	**	*0.003*	0.010	***	*0.004*	0.019	***	*0.007*
UK retail sales	0.003	***	*0.001*	0.005	***	*0.001*	0.014	***	*0.002*	0.018	***	*0.003*
UK unemployment	-0.001		*0.001*	-0.001		*0.001*	-0.001		*0.002*	-0.003		*0.003*
UK trade balance	-0.003	**	*0.001*	-0.006	***	*0.001*	-0.005	***	*0.002*	-0.002		*0.002*
Variance Equation												
UK CPI (dummy)	-0.164		*0.117*	0.041		*0.112*	0.110		*0.103*	0.015		*0.098*
UK PMI (dummy)	-0.551	***	*0.090*	-0.622	***	*0.080*	-0.412	***	*0.079*	-0.156	**	*0.072*
UK retail sales (dummy)	-0.867	***	*0.064*	-0.877	***	*0.060*	-0.607	***	*0.059*	-0.384	***	*0.069*
UK unemployment (dummy)	-0.805	***	*0.099*	-0.747	***	*0.098*	-0.539	***	*0.089*	-0.143	*	*0.075*
UK trade balance (dummy)	0.110	*	*0.060*	0.127	**	*0.060*	0.157	***	*0.057*	0.101	*	*0.057*
Inflation report	-0.930	***	*0.080*	-0.856	***	*0.081*	-0.515	***	*0.085*	-0.255	***	*0.085*

9 The reduction in conditional volatility should happen once initial disagreement about the interpretation of the news has subsided. In that context, it is important to remember that our analysis is based on daily data, thereby not capturing short-term phenomena as identified, e.g., in Fleming and Remolona (1999a).

10 For brevity, the (E)GARCH coefficients are not displayed in Table 1 and the following tables. Throughout all estimations, the GARCH term is strongly significant and close to but below one, indicating a high persistence of the conditional volatility. Both EGARCH parameters are equivalently significant in all estimations. The sign asymmetry parameter exhibits a negative sign, although small in size. The estimates confirm the asymmetry assumption proposed by the Engle and Ng (1993) test results and can be read as a negative innovation increasing volatility more than a positive innovation of equal magnitude. The results are available from the authors upon request.

Note: The table shows, for the different maturities (in the various columns), the reaction coefficient of UK zero coupon yields to macroeconomic announcements and the release of the inflation report. Numbers in italics denote the standard errors. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. The mean equation is specified as $r_t = c_1 + \sum_k \sigma^k s_t^k + \psi r_{t-1} + \sum_l \nu^l d_t^l + \mu_t$,

the variance equation as $log\,(h_t) = c_2 + \kappa_1 (|\mu_{t-1} / \sqrt{h_{t-1}}| - \sqrt{2/\pi}) + \kappa_2 (\mu_{t-1} / \sqrt{h_{t-1}}) + \kappa_3\, log\,(h_{t-1}) + \lambda^{IR} a_t^{IR} + \sum_k \lambda^k a_t^k + \sum_l \tau\, d_t^l$.

2

The important thing to note in Table 1 is that conditional volatility is reduced in response to nearly all announcements. The importance of the inflation report to market participants is confirmed by the fact that the volatility-reducing effect in response to its release is one of the strongest across the different announcements contained in this model. Another interesting fact is the consistency of these results across maturities. At all maturities, the announcements reduce volatility, with the effect becoming smaller, the longer the horizon. The single exception in the table relates to the UK trade balance. Its release seems to heighten rather than dampen market uncertainty.

To understand the possible reasons for this finding, it is useful to conceptually separate two simultaneous events that are contained in the release of macro news. First, the news release typically contains a surprise component, which the markets need to price. The inclusion of the surprise component in the mean equation attempts to control for this effect. However, if the surprise component is particularly large, or creates confusion for instance because it is at odds with the information contained in other recent releases, uncertainty in markets might well increase, counteracting the second factor that is at play, namely the homogenizing of agents' information sets, and thus the co-ordination of beliefs.

To separate these two effects, we have expanded the current regression model by furthermore controlling for the absolute surprise in the conditional volatility equation. Table 2 reports the corresponding results, and very convincingly supports the conjecture. First, volatility increases in response to the surprise component of virtually all announcements. Second, the results with regard to the announcement dummies (now cleanly measuring the effect of the incidence of a release) improve in several ways: the coefficient estimate with regard to the trade balance dummy switches sign, and turns negative in line with all other coefficients; at the 2- and 3-month maturities, the previously insignificant coefficient on the CPI dummy is now also significant and negative; all coefficients are substantially larger than their correspondents in Table 1.

Table 2: The average effect of announcements on yields; incidence vs surprise component

	2-months		3-months		6-months		12-months	
	Coeff.	*std. error*	Coeff.	*std. error*	Coeff.	*std. error*	Coeff.	*std. error*
UK CPI	0.006 ***	*0.002*	0.013 ***	*0.002*	0.022 ***	*0.003*	0.027 ***	*0.003*
UK PMI	0.008 **	*0.003*	0.007 *	*0.004*	0.011 **	*0.005*	0.019 **	*0.008*
UK retail sales	0.003 ***	*0.001*	0.005 ***	*0.001*	0.014 ***	*0.002*	0.018 ***	*0.003*
UK unemployment	-0.001	*0.001*	-0.001	*0.001*	-0.002	*0.002*	-0.004	*0.004*
UK trade balance	-0.001	*0.002*	-0.003	*0.002*	-0.004	*0.003*	-0.002	*0.003*
Variance Equation								
UK CPI (dummy)	-0.515 ***	*0.160*	-0.453 ***	*0.145*	-0.172	*0.140*	-0.018	*0.138*
UK PMI (dummy)	-1.001 ***	*0.124*	-1.145 ***	*0.107*	-0.787 ***	*0.104*	-0.322 ***	*0.091*
UK retail sales (dummy)	-1.034 ***	*0.083*	-1.035 ***	*0.081*	-0.586 ***	*0.076*	-0.368 ***	*0.077*
UK unemployment (dummy)	-1.087 ***	*0.147*	-1.123 ***	*0.142*	-0.890 ***	*0.126*	-0.275 ***	*0.102*
UK trade balance (dummy)	-0.437 ***	*0.087*	-0.414 ***	*0.069*	-0.346 ***	*0.072*	-0.093	*0.074*
UK CPI (abs. surprise)	0.322 **	*0.129*	0.496 ***	*0.122*	0.358 ***	*0.122*	0.097	*0.120*
UK PMI (abs. surprise)	0.829 ***	*0.173*	0.864 ***	*0.153*	0.605 ***	*0.153*	0.261 ***	*0.100*
UK retail sales (abs. surprise)	0.308 ***	*0.054*	0.309 ***	*0.050*	0.100 *	*0.053*	0.045	*0.050*
UK unemployment (abs. surprise)	0.095	*0.104*	0.198 **	*0.095*	0.209 **	*0.087*	0.010	*0.072*
UK trade balance (abs. surprise)	0.658 ***	*0.058*	0.648 ***	*0.053*	0.592 ***	*0.054*	0.233 ***	*0.048*
Inflation report	-0.883 ***	*0.091*	-0.840 ***	*0.094*	-0.519 ***	*0.096*	-0.276 ***	*0.088*

Note: The table shows, for the different maturities (in the various columns), the reaction coefficient of UK zero coupon yields to macroeconomic announcements and the release of the inflation report, separating the effect of the announcement incidence and the absolute surprise in the variance equation. Numbers in italics denote the standard errors. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. The mean equation is specified as $r_t = c_1 + \sum_k \sigma^k s_t^k + \psi r_{t-1} + \sum_l v^l d_t^l + \mu_t$,

the variance equation as $log\,(h_t) = c_2 + \kappa_1 (\mu_{t-1} / \sqrt{h_{t-1}}| - \sqrt{2/\pi}) + \kappa_2 (\mu_{t-1} / \sqrt{h_{t-1}}) + \kappa_3 \log(h_{t-1}) + \lambda^{IR} a_t^{IR} + \sum_k \lambda^k a_t^k + \sum_k \varpi^k |s_t^k| \sum_l \tau\, d_t^l$.

Based on this evidence, we conclude that public signals do effectively co-ordinate the beliefs of market participants, thus lowering conditional volatility. This effect can possibly be overshadowed by the volatility-enhancing effect of the announcement's surprise component. However, in the majority of cases, the volatility-reducing factor turns out to be dominating. Taken together, these results provide strong evidence in favor of hypotheses 1 and 2.

2.2 What if central bank communication becomes stale?

To test hypotheses 3 to 5, we will now turn to measuring the market reaction conditional on the freshness of central bank communication. For that purpose, we expand the econometric model by including the variable that measures how much time has elapsed since the preceding release of an inflation report, and by interacting this variable with the macroeconomic release data. The results are provided in Table 3.

Table 3: The effect of announcements on yields; distance to the preceding inflation report

	2-months		3-months		6-months		12-months	
	Coeff.	*std. error*	Coeff.	*std. error*	Coeff.	*std. error*	Coeff.	*std. error*
UK CPI	0.004 **	*0.002*	0.009 ***	*0.002*	0.018 ***	*0.002*	0.026 ***	*0.003*
UK PMI	0.003	*0.002*	0.005 *	*0.003*	0.010 **	*0.004*	0.020 ***	*0.007*
UK retail sales	0.004 ***	*0.001*	0.006 ***	*0.001*	0.014 ***	*0.002*	0.017 ***	*0.003*
UK unemployment	-0.002	*0.001*	-0.002	*0.002*	-0.001	*0.002*	-0.002	*0.004*
UK trade balance	-0.002	*0.001*	-0.005 **	*0.002*	-0.004 *	*0.002*	0.000	*0.002*
UK CPI * Time elapsed	0.014 ***	*0.005*	0.018 ***	*0.005*	0.023 ***	*0.007*	0.026 **	*0.010*
UK PMI * Time elapsed	0.014 *	*0.007*	0.008	*0.009*	0.001	*0.013*	-0.007	*0.024*
UK retail sales * Time elapsed	0.006	*0.004*	0.004	*0.004*	0.000	*0.006*	-0.005	*0.009*
UK unemployment * Time elapsed	-0.006 **	*0.003*	-0.004	*0.005*	-0.006	*0.005*	0.008	*0.010*
UK trade balance * Time elapsed	-0.005	*0.006*	-0.005	*0.006*	-0.007	*0.006*	-0.012 *	*0.007*
Time elapsed	-0.001	*0.001*	0.001	*0.001*	0.001	*0.002*	0.000	*0.002*
Variance Equation								
UK CPI (dummy)	-0.270 *	*0.139*	-0.031	*0.129*	0.078	*0.111*	-0.028	*0.097*
UK PMI (dummy)	-0.544 ***	*0.099*	-0.594 ***	*0.084*	-0.435 ***	*0.085*	-0.180 **	*0.073*
UK retail sales (dummy)	-0.852 ***	*0.074*	-0.919 ***	*0.071*	-0.623 ***	*0.071*	-0.425 ***	*0.073*
UK unemployment (dummy)	-0.754 ***	*0.104*	-0.666 ***	*0.103*	-0.570 ***	*0.096*	-0.078	*0.076*
UK trade balance (dummy)	0.158 **	*0.066*	0.147 **	*0.062*	0.155 ***	*0.060*	0.084	*0.058*
UK CPI (dummy) * Time elapsed	-1.059 ***	*0.259*	-0.943 ***	*0.254*	-0.338	*0.232*	0.358	*0.239*
UK PMI (dummy) * Time elapsed	-0.375	*0.278*	-0.213	*0.257*	-0.155	*0.278*	0.367	*0.289*
UK retail sales (dummy) * Time elapsed	-0.419 *	*0.240*	-0.466 **	*0.233*	-0.659 ***	*0.249*	-0.469 **	*0.229*
UK unemployment (dummy) * Time elapsed	0.475 *	*0.277*	0.389	*0.274*	0.218	*0.293*	-0.343	*0.241*
UK trade balance (dummy) * Time elapsed	-0.444 *	*0.229*	-0.081	*0.247*	0.155	*0.225*	0.159	*0.178*
Time elapsed	0.075 ***	*0.016*	0.030 *	*0.017*	0.039 **	*0.017*	-0.008	*0.017*
Inflation report	-1.075 ***	*0.110*	-1.010 ***	*0.105*	-0.710 ***	*0.121*	-0.340 ***	*0.095*

Note: The table shows, for the different maturities (in the various columns), the reaction coefficient of UK zero coupon yields to macroeconomic announcements and the release of the inflation report in general, and depending on the time elapsed since the release of the preceding inflation report. Numbers in italics denote the standard errors. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. The mean equation is specified as $r_t = c_1 + \sum_k \sigma^k s_t^k + \sum_k \phi^k s_t^k g_t + \omega g_t + \psi r_{t-1} + \sum_l v^l d_t^l + \mu_t$,

the variance equation as $log\,(h_t) = c_2 + \kappa_1 (\mu_{t-1} / \sqrt{h_{t-1}}| - \sqrt{2/\pi}) + \kappa_2 (\mu_{t-1} / \sqrt{h_{t-1}}) + \kappa_3 \log(h_{t-1}) + \lambda^{IR} a_t^{IR} + \sum_k \lambda^k a_t^k + \sum_k \rho^k a_t^k g_t + \zeta g_t + \sum_l \tau\, d_t^l$.

Looking at the direct effect of the elapsed time, it is apparent that volatility does indeed increase with the distance from the preceding inflation report release. This effect is strongest at the 2-month maturity, but also present and statistically significant up to a horizon of 6 months. Despite its statistical significance, it has to be noted that the magnitude of the effect is small, however. At the same time, Figure 2 has shown that the omission of macroeconomic announcements will tend to depress estimates of ζ. Interestingly, this conjecture is confirmed by the inclusion of 4 US announcements in a subsequent robustness test, which tends to double or even triple the estimates of ζ. The volatility-increasing effect disappears at the one-year horizon, and consistently so in all further models that we will analyze. At the same time, as should be expected, the elapsed time does not matter for the mean of yields, as shown by the very small and statistically highly insignificant coefficients for this variable in the mean equation. This result is in clear support of hypothesis 3.

What about the volatility reduction in response to macroeconomic releases? Hypothesis 4 stated that this effect should be more pronounced, the more time has elapsed since the preceding release of an inflation report. As a matter of fact, with very few exceptions, the interaction terms are typically negative, supporting the hypothesis. Although a number of these are not estimated to be significant, the picture that emerges is fairly consistent: with one exception, all significant coefficients are negative. Furthermore, the effects are sizable. To take the example of the CPI release: its effect on average is estimated to be -0.27 for the 2-month maturity. However, the first CPI release after a given inflation report has virtually no effect on volatility, with its coefficient estimated at +0.005, while the third CPI release has a coefficient estimate of -0.608.[11] As before, the effects are particularly pronounced at shorter maturities.

The results strengthen by imposing the split of announcement effects into the announcement incidence and the absolute surprise component, as shown in Table 4. In this specification, all statistically significant coefficients on the non-interacted dummies are negative, as are all the significant coefficients on the interaction terms. At the same time, all significant coefficients on the absolute surprise as well as on the respective interaction terms are positive. Controlling for the surprise component, in the example of CPI the differences between the first and the last announcement are even more striking, with an effect of -0.239 for the first and of -0.916 for the last, suggesting that the volatility reduction of the last announcement is nearly four times as large as for the first announcement. The evidence is therefore clearly in support of hypothesis 4.

Table 4: The effect of announcements on yields; distance to inflation report & incidence vs absolute surprise, mean equation

	2-months		3-months		6-months		12-months	
	Coeff.	*std. error*	Coeff.	*std. error*	Coeff.	*std. error*	Coeff.	*std. error*
UK CPI	0.004	*0.002*	0.010 ***	*0.003*	0.018 ***	*0.003*	0.026 ***	*0.003*
UK PMI	0.003	*0.004*	0.007	*0.004*	0.011 **	*0.005*	0.020 **	*0.008*
UK retail sales	0.004 ***	*0.002*	0.006 ***	*0.002*	0.014 ***	*0.002*	0.017 ***	*0.003*
UK unemployment	-0.001	*0.001*	-0.002	*0.002*	-0.002	*0.002*	-0.003	*0.004*
UK trade balance	0.000	*0.002*	-0.002	*0.003*	-0.003	*0.004*	0.000	*0.003*
UK CPI * Time elapsed	0.013 **	*0.007*	0.015 *	*0.008*	0.020 **	*0.009*	0.024 **	*0.010*
UK PMI * Time elapsed	0.012	*0.011*	0.003	*0.014*	-0.004	*0.018*	-0.008	*0.027*
UK retail sales * Time elapsed	0.005	*0.005*	0.003	*0.005*	0.002	*0.006*	-0.003	*0.010*
UK unemployment * Time elapsed	-0.005	*0.003*	-0.002	*0.004*	-0.004	*0.007*	0.005	*0.011*
UK trade balance * Time elapsed	-0.006	*0.008*	-0.007	*0.009*	-0.007	*0.011*	-0.011	*0.008*
Time elapsed	-0.001	*0.001*	0.000	*0.001*	0.000	*0.001*	0.000	*0.002*

[11] These numbers are calculated as follows: the average value of the "time elapsed" variable gt is calculated for the first and the third CPI releases. These values amount to -0.260 and 0.319, respectively. The average effect of the first CPI release on volatility is then given by λ^{CPI}+ (-0.260)ρ^{CPI} = -0.270+0.260*1.059=0.005; the average effect for the third CPI release is λ^{CPI}+ 0.319ρ^{CPI} = -0.270-0.319*1.059=-0.608.

	Variance Equation											
UK CPI (dummy)	-0.543	***	*0.211*	-0.445	**	*0.190*	-0.139		*0.175*	-0.002		*0.135*
UK PMI (dummy)	-0.975	***	*0.141*	-1.101	***	*0.121*	-0.779	***	*0.111*	-0.321	***	*0.090*
UK retail sales (dummy)	-1.051	***	*0.091*	-1.092	***	*0.088*	-0.638	***	*0.088*	-0.448	***	*0.085*
UK unemployment (dummy)	-0.939	***	*0.177*	-1.029	***	*0.174*	-0.878	***	*0.144*	-0.129		*0.101*
UK trade balance (dummy)	-0.494	***	*0.095*	-0.474	***	*0.079*	-0.340	***	*0.080*	-0.097		*0.083*
UK CPI (abs. surprise)	0.299		*0.195*	0.439	***	*0.166*	0.291	*	*0.169*	0.061		*0.120*
UK PMI (abs. surprise)	0.751	***	*0.207*	0.758	***	*0.186*	0.588	***	*0.164*	0.257	***	*0.098*
UK retail sales (abs. surprise)	0.375	***	*0.069*	0.404	***	*0.066*	0.186	***	*0.059*	0.074		*0.052*
UK unemployment (abs. surprise)	-0.036		*0.125*	0.067		*0.123*	0.163		*0.102*	-0.033		*0.072*
UK trade balance (abs. surprise)	0.744	***	*0.071*	0.760	***	*0.066*	0.617	***	*0.066*	0.202	***	*0.056*
UK CPI (dummy) * Time elapsed	-1.169	**	*0.530*	-1.196	**	*0.515*	-0.939	*	*0.515*	-0.066		*0.375*
UK PMI (dummy) * Time elapsed	0.173		*0.410*	0.074		*0.392*	0.176		*0.402*	0.512		*0.365*
UK retail sales (dummy) * Time elapsed	-0.805	**	*0.317*	-0.893	***	*0.319*	-1.428	***	*0.328*	-0.976	***	*0.299*
UK unemployment (dummy) * Time elapsed	0.202		*0.535*	0.176		*0.510*	0.046		*0.443*	-0.744	**	*0.325*
UK trade balance (dummy) * Time elapsed	-0.566	*	*0.325*	-0.459		*0.339*	-0.364		*0.299*	-0.247		*0.285*
UK CPI (abs. surprise) * Time elapsed	0.013		*0.551*	0.204		*0.473*	0.640		*0.503*	0.582	*	*0.339*
UK PMI (abs. surprise) * Time elapsed	-0.383		*0.718*	-0.805		*0.686*	-0.765		*0.690*	-0.679		*0.526*
UK retail sales (abs. surprise) * Time elapsed	0.447		*0.347*	0.436		*0.342*	0.933	***	*0.309*	0.563	**	*0.246*
UK unemployment (abs. surprise) * Time elapsed	1.031	***	*0.375*	1.155	***	*0.360*	0.890	***	*0.316*	0.596	**	*0.261*
UK trade balance (abs. surprise) * Time elapsed	-0.481		*0.311*	-0.265		*0.302*	-0.021		*0.314*	0.261		*0.223*
Time elapsed	0.083	***	*0.018*	0.052	***	*0.018*	0.058	***	*0.019*	0.003		*0.018*
Inflation report	-1.059	***	*0.121*	-1.020	***	*0.121*	-0.734	***	*0.134*	-0.324	***	*0.099*

Note: The table shows, for the different maturities (in the various columns), the reaction coefficient of UK zero coupon yields to macroeconomic announcements and the release of the inflation report in general, and depending on the time elapsed since the release of the preceding inflation report, separating the effect of the announcement incidence and the absolute surprise in the variance equation. Numbers in italics denote the standard errors. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. The mean equation is specified as $r_t = c_1 + \sum_k \sigma^k s_t^k + \sum_k \phi^k s_t^k g_t + \omega g_t + \psi r_{t-1} + \sum_l \nu^l d_t^l + \mu_t$,

the variance equation as $log\,(h_t) = c_2 + \kappa_1 (\mu_{t-1} / \sqrt{h_{t-1}}|-\sqrt{2/\pi}) + \kappa_2 (\mu_{t-1} / \sqrt{h_{t-1}}) + \kappa_3\, log\,(h_{t-1}) + \lambda^{IR} a_t^{IR} + \sum_k \lambda^k a_t^k + \sum_k \rho^k a_t^k g_t + \sum_k \varpi^k |s_t^k| \sum_k \iota^k |s_t^k| g_t + \zeta g_t + \sum_l \tau d_t^l$.

The last hypothesis to be tested, number 5, stated that the update of beliefs, and thus the reaction of asset prices to macroeconomic news should be stronger, the more time has elapsed since the preceding release of an inflation report. To see whether this is the case, we need to check the coefficients in the mean equation. As mentioned above, the non-interacted coefficients in the mean equation show the sign that should be expected according to economic reasoning. The question to be settled is whether the coefficients on the interacted variables show the same sign, and are statistically significant. While it is generally true that the coefficients of the interacted variables have the same sign as those of the non-interacted variables, their statistical significance (against zero) is rather weak. Only in the case of the CPI announcement do we find such a pattern consistently across the different maturities.

One interesting observation in that context relates to the evolution of coefficients across the maturity spectrum. Contrary to what was observed for the volatility equation, effects are now larger with increasing maturities. This finding is in line with Fleming and Remolona (1999b), who had also found an increasing magnitude over the maturities studied in the current paper. At the 1-year horizon, the effects are relatively stark, though: the response of 1-year yields to a one standard deviation surprise in the first CPI release following an inflation report is estimated at 1.9 basis points, whereas the response to the last CPI release is substantially larger at 3.4 basis points.

Table 5: The effect of UK & US announcements on yields; distance to inflation report, mean equation

	2-months			3-months			6-months			12-months		
	Coeff.		*std. error*	Coeff.		*std. error*	Coeff.		*std. error*	Coeff.		*std. error*
UK CPI	0.004	**	*0.002*	0.009	***	*0.002*	0.018	***	*0.002*	0.026	***	*0.003*
UK PMI	0.002		*0.002*	0.005	*	*0.003*	0.010	**	*0.004*	0.019	**	*0.007*
UK retail sales	0.003	***	*0.001*	0.005	***	*0.001*	0.013	***	*0.002*	0.017	***	*0.003*
UK unemployment	-0.001		*0.001*	-0.002		*0.002*	-0.001		*0.002*	-0.002		*0.004*
UK trade balance	-0.001		*0.002*	-0.003		*0.002*	-0.004		*0.002*	-0.001		*0.003*
US composite index	0.005	*	*0.003*	0.005	*	*0.003*	0.006		*0.004*	0.005		*0.006*
US industrial production	0.000		*0.001*	0.000		*0.001*	0.000		*0.002*	0.003		*0.003*

US CPI	0.001	*0.001*	0.001	*0.002*	0.002	*0.002*	0.004	*0.003*
US non-farm payrolls	-0.003	*0.003*	0.000	*0.003*	0.006 *	*0.003*	0.019 ***	*0.003*
UK CPI * Time elapsed	0.012 **	*0.006*	0.018 ***	*0.005*	0.023 ***	*0.007*	0.028 **	*0.011*
UK PMI * Time elapsed	0.014 *	*0.008*	0.008	*0.010*	0.000	*0.014*	-0.006	*0.025*
UK retail sales * Time elapsed	0.004	*0.004*	0.002	*0.004*	-0.001	*0.005*	-0.005	*0.009*
UK unemployment * Time elapsed	-0.006 *	*0.003*	-0.003	*0.005*	-0.003	*0.006*	0.010	*0.012*
UK trade balance * Time elapsed	-0.005	*0.006*	-0.007	*0.007*	-0.006	*0.007*	-0.010	*0.007*
US composite index * Time elapsed	0.013	*0.009*	0.014	*0.010*	0.013	*0.013*	0.013	*0.016*
US industrial production * Time elapsed	-0.002	*0.003*	-0.001	*0.004*	-0.004	*0.006*	-0.005	*0.010*
US CPI * Time elapsed	0.005	*0.005*	0.001	*0.007*	-0.001	*0.008*	-0.012	*0.011*
US non-farm payrolls * Time elapsed	-0.004	*0.010*	-0.001	*0.009*	-0.002	*0.011*	-0.018 *	*0.010*
Time elapsed	-0.001	*0.001*	0.000	*0.001*	0.001	*0.002*	0.000	*0.002*
	2-months		3-months		6-months		12-months	
	Coeff.	*std. error*	Coeff.	*std. error*	Coeff.	*std. error*	Coeff.	*std. error*
				Variance Equation				
UK CPI (dummy)	-0.181	*0.139*	0.046	*0.133*	0.146	*0.108*	0.041	*0.094*
UK PMI (dummy)	-0.585 ***	*0.106*	-0.629 ***	*0.094*	-0.418 ***	*0.086*	-0.243 ***	*0.074*
UK retail sales (dummy)	-0.796 ***	*0.080*	-0.803 ***	*0.076*	-0.533 ***	*0.076*	-0.273 ***	*0.089*
UK unemployment (dummy)	-0.690 ***	*0.111*	-0.648 ***	*0.108*	-0.420 ***	*0.095*	0.055	*0.070*
UK trade balance (dummy)	0.144 **	*0.072*	0.106	*0.068*	0.111 *	*0.065*	0.039	*0.062*
US composite index (dummy)	0.224 ***	*0.065*	0.223 ***	*0.063*	0.092	*0.066*	-0.051	*0.071*
US industrial production (dummy)	-0.237 ***	*0.088*	-0.209 **	*0.089*	-0.280 **	*0.110*	-0.267 **	*0.106*
US CPI (dummy)	-0.242 **	*0.095*	-0.264 ***	*0.098*	-0.119	*0.106*	-0.134	*0.107*
US non-farm payrolls (dummy)	0.097	*0.068*	0.183 ***	*0.064*	0.125 *	*0.070*	0.165 **	*0.074*
UK CPI (dummy) * Time elapsed	-0.944 ***	*0.274*	-0.897 ***	*0.274*	-0.298	*0.257*	0.294	*0.236*
UK PMI (dummy) * Time elapsed	-0.604 *	*0.345*	-0.465	*0.326*	-0.124	*0.303*	0.349	*0.301*
UK retail sales (dummy) * Time elapsed	-0.316	*0.257*	-0.409	*0.251*	-0.610 **	*0.257*	-0.569 **	*0.233*
UK unemployment (dummy) * Time elapsed	0.477 *	*0.279*	0.553 **	*0.271*	0.344	*0.279*	-0.206	*0.236*
UK trade balance (dummy) * Time elapsed	-0.608 **	*0.243*	-0.309	*0.263*	-0.001	*0.225*	0.083	*0.180*
US composite index (dummy) * Time elapsed	-0.152	*0.212*	-0.242	*0.216*	0.094	*0.252*	0.286	*0.255*
US industrial production (dummy) * Time elapsed	-0.310	*0.278*	-0.310	*0.249*	-0.266	*0.279*	-0.401 *	*0.213*
US CPI (dummy) * Time elapsed	-0.558 **	*0.277*	-0.537 **	*0.258*	-0.345	*0.277*	0.112	*0.203*
US non-farm payrolls (dummy) * Time elapsed	-0.250	*0.182*	-0.620 ***	*0.185*	-0.473 **	*0.199*	-0.595 ***	*0.215*
Time elapsed	0.132 ***	*0.027*	0.109 ***	*0.027*	0.063 **	*0.030*	0.017	*0.026*
Inflation report	-1.064 ***	*0.114*	-0.996 ***	*0.114*	-0.681 ***	*0.124*	-0.210 *	*0.117*

Note: The table shows, for the different maturities (in the various columns), the reaction coefficient of UK zero coupon yields to UK and US macroeconomic announcements and the release of the inflation report in general, and depending on the time elapsed since the release of the preceding inflation report. Numbers in italics denote the standard errors. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. The mean equation is specified as $r_t = c_1 + \sum_{k\in(UK,US)} \delta^k s_t^k + \sum_{k\in(UK,US)} \phi^k s_t^k g_t + \omega g_t + \psi r_{t-1} + \sum_l \nu^l d_t^l + \mu_t$,

the variance equation as $\log(h_t) = c_2 + \kappa_1 (|\mu_{t-1} / \sqrt{h_{t-1}}| - \sqrt{2/\pi}) + \kappa_2 (\mu_{t-1} / \sqrt{h_{t-1}}) + \kappa_3 \log(h_{t-1}) + \lambda^{IR} a_t^{IR} + \sum_{k\in(UK,US)} \lambda^k a_t^k + \sum_{k\in(UK,US)} \rho^k a_t^k g_t + \zeta g_t + \sum_l \tau d_t^l$.

We have tested the robustness of these results in a number of ways. First, Table 5 reports the estimated coefficients in a model including US macro releases. The overall picture is confirmed: some, albeit little evidence that the price response to news becomes larger with further distance from the previous inflation report; strong evidence that the announcements reduce conditional volatility and that, as central bank communication becomes stale, this effect becomes more pronounced, while market volatility as such increases.[12] Importantly, the volatility increase with the time elapsed since the last inflation reported is estimated to be two to three times as large as in Table 3. This clearly shows that controlling for the volatility reduction of additional news has substantial effects on this parameter estimate.

Second, we tested for robustness to the inclusion of other Bank of England communication events, which provide an occasion for financial market participants to update their information set. This might apply in particular to the communications in the context of interest rate changes, and the release of the minutes of the MPC meetings. For the former, it is possible to control for the surprise component by means of a Reuters survey among financial market participants; for the latter, as was the case for the inflation report, our analysis just comprises the inclusion of a dummy variable that is equal to one on the days of the release of the minutes. Our findings remain qualitatively robust. Furthermore, we also find the usual volatility reduction in response to these communications; however,

[12] We refrain from also including the absolute surprise component and its interaction with the elapsed time in this model, as estimating an EGARCH model of this size would not be feasible.

the magnitude of these responses does not depend on the time elapsed since the last inflation report. This suggests that due to their immediate relevance for the future path of interest rates, these signals are always considered an important piece of information, regardless of the freshness of other central bank communication.

Third, inflation reports are not the only type of news that is released at a quarterly schedule. GDP announcements, for instance, also are made quarterly. If these were to coincide roughly with the inflation report releases, our results might be driven by either central bank communication or the information content of GDP releases becoming stale. Although we believe that for short-term interest rates, monetary policy communications should be a dominant news source, compared to, e.g., GDP releases, it is important to exclude other possibilities. With regard to GDP, the average release is made with a 45 calendar-day distance to the closest inflation report, i.e. pretty much exactly half-way in between two reports. The same number is obtained for the releases of current account data, since these are usually published on the same day as GDP. In the case of GDP announcements, we would furthermore argue that their schedule is actually monthly, not quarterly, given that each month one news release of preliminary, provisional and final data is made. Another source of news that might be correlated with inflation reports is the Bank of England's interest rate changes, which are known to be more frequent in inflation report months (King 2007). Indeed, we find that 18 interest rate changes in our sample are made in inflation report months, and 18 in the other two months, which appears like a non-random distribution. However, our sample contains 47 inflation reports, i.e. a majority without an accompanying interest rate change. To ensure that we do indeed identify inflation report effects, we have included corresponding "time elapsed" variables for GDP and current account announcements as well as for interest rate changes. Neither of the included variables changes our results qualitatively, supporting the robustness of our findings.

Fourth, with respect to the functional form of the time elapsed variable, we have assumed a proportional increase in volatility with every additional day distance to the last inflation report. To control for possible non-linearity in this effect, i.e. a disproportional increase of conditional volatility, we use a quadratic trend as a substitute for the linear form of the variable. The coefficients of the quadratic time elapsed variable are similarly significant throughout the maturities. This suggests that the volatility effects of stale central bank communication increase in a non-linear fashion, the more time has elapsed, such that our linear specification might provide us with a lower bound of its relevance. However, it is important to note that the fit of the model remains basically unaltered.

Fifth, the incidents of the recent financial turmoil might have affected UK government bond yields. In order to ensure that the findings are not driven by the developments of 2007 and 2008, we shortened the sample period from March 1997 to the end of 2006. The results of this shortened sample are again qualitatively robust.[13]

[13] The results of the robustness checks are not displayed in the paper, but are available from the authors upon request.

Conclusions

The pricing processes in financial markets are, despite an extensive literature, still not well understood. Relatively more is known about the reception of public signals, given that these are readily identifiable. In particular, the large literature on announcement effects has come to the consensus view that, overall, financial markets respond to macroeconomic fundamentals, even if the strength of this link is still under debate. A complication in that regard is the presence of various asymmetries, whereby the market response depends on factors such as the state of the business cycle, whether the news is good or bad, etc. In this paper, we have highlighted another conditionality, namely that the market response to news depends on the prevalence of private information.

The role and importance of private information in financial markets is by definition subject to a substantial identification problem, and has therefore typically been studied in an indirect fashion. This paper has been concerned with the intersection of the two, public and private information, and has argued that a public signal is more valuable in updating agents' beliefs, the more these beliefs are based on private information. Our object of analysis has been the reaction of UK short-term interest rates to the Bank of England's inflation report and to macroeconomic announcements on the one hand, and to the interrelationship between the two on the other hand. Due to the quarterly frequency at which the Bank of England releases one of its main publications, it cannot be excluded that it becomes stale over time. In the course of this process, financial market participants are likely to increasingly base their views on private information. The paper has developed a stylized model which predicts that in this case, market volatility should increase, the price response to macroeconomic announcements should be more pronounced, and that macroeconomic announcements should play a more important role in aligning agents' information set, thus leading to a stronger volatility reduction than before.

The empirical evidence is fully supportive of these hypotheses. Macroeconomic announcements and the release of the inflation report clearly lead to a reduction in market volatility, especially when controlling for their surprise component. This suggests that public signals serve to homogenize the information sets of market participants, thus reducing the role of private information. While the increase in market volatility over the time window in between two inflation reports is statistically significant, but small in magnitude, the reactions to macroeconomic news are strongly dependent on the freshness of central bank communication: the volatility reduction of an announcement towards the end of the time window can be around four times as large as for an announcement at the beginning of the time window, and the response coefficient in the mean equation is also substantially elevated once central bank communication has become stale.

These findings have a number of important implications. First, they affect the benchmark against which a given market reaction to a macroeconomic release is to be judged: it is the typical reaction conditional on the freshness of central bank communication that constitutes the appropriate benchmark. Second, these findings suggest that even if on average, there is only a small or an insignificant response to news, its magnitude can easily be larger if the other publicly available information is relatively noisy, or if agents' trade is based on a relatively heterogeneous information set. Third, the case of central bank communication is only one example. Gropp and Kadareja (2006) show related effects for stock markets, where the price discovery process depends on the distance from the last release of commercial banks' annual reports. This suggests that transparency by actors that have the potential to affect asset prices (be it policy makers or publicly traded companies) is generally beneficial.

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