# Inflation Targets as Focal Points*

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In a world characterized by noisy information and conflicting signals, no central bank is able to affect private-sector expectations at all times. In order to evaluate the effectiveness of any central bank communication strategy, it is important to know what private agents rely on when they form expectations. We model monetary policy as an information game in which individuals form their expectations based on all the information that is available to them (public and private) and are, therefore, subject to the noise that characterizes that information. Individual agents also know that inflation is ultimately affected both by central bank policies and by the average expectation formed by all agents. The way individuals interpret these two components to form their expectations is explained in the context of a higher-order expectations setup and is central to our argument. We then apply Bacharach's (1993) variable-universe methodology to provide a framework for assessing everyone's interpretations. Therefore, our contribution is, first, to describe monetary policy as an information game in which interpretations matter and, second, to provide a way of solving for these interpretations. We show that a monetary policy regime that has explicit quantitative objectives may provide individuals with better anchors for coordinating their expectations. However, that is only true either if no great shocks are anticipated or if all other public information is very unclear, leaving the inflation target as the only clear piece of information available. We derive the conditions under which this is true.

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*Views expressed are our own and do not necessarily reflect those of De Nederlandsche Bank (DNB). Without wishing to implicate, we would like to

## 1. Introduction

Modern monetary policy theory emphasizes the central role of private-sector expectations in determining policy outcomes. Recent empirical evidence by Paloviita and Virén (2005) demonstrates this for inflation in the euro area. It is thus widely acknowledged that the success of maintaining a stable monetary environment depends crucially on the ability of the policy regime to control inflation expectations (Blinder et al. 2001). Evidence of that is shown by Orphanides and Williams (2005) in their analysis of U.S. monetary policy history, where they argue that monetary policy failures are connected with changes in public sentiment about the future state of the economy. In other words, policy mistakes alone are not enough to produce long-term negative effects on monetary stability.

The practice of monetary policy in the past ten to fifteen years has thus concentrated on providing institutional setups that provide an explicit information platform for expectations to be formed. The main objectives of such institutional setups are to attain

- credible institutions, mainly through independence and the pursuit of price stability as the principal objective;
- clear policy frameworks captured by well-defined intermediate policy objectives and procedures; and, finally,
- transparent policymaking implemented through publication and distribution of the information set used in the decision-making process (inflation forecasts, modeling strategies, and well-defined assumptions) and a clear demonstration of accountability (publication of minutes, regular appearance

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in front of parliamentary committees, and regular press conferences).

Practically every monetary policy authority nowadays defines its policies according to these criteria, emphasizing one or another aspect depending on preferences. The euro-area setup, e.g., has emphasized the importance of building and sustaining credibility and independence from governments as an instrument toward low expected inflation. In the U.S. experience, credibility and independence but also flexibility in following multiple objectives have helped achieve a stable monetary environment. Alternatively, inflation targeting—as implemented first by the Reserve Bank of New Zealand, then the Bank of England, and increasingly by more banks around the world—is understood to provide clear and immediate objectives for monetary policy. Inflation-targeting practitioners argue that the main advantage of an explicit numerical inflation target is its ability to provide a focal point for private-sector expectations. As Mervyn King (2002, 4) has claimed for the UK case, inflation expectations have indeed been anchored to the preannounced target. The ability of explicit quantitative targets to tie down expectations is also confirmed by the empirical analysis of Mishkin and Schmidt-Hebbel (2001, 2007), Johnson (2002), and more recently by Fatás, Mihov, and Rose (2007) and Levin, Natalucci, and Piger (2004).[1] However, conventional monetary policy models (Svensson 1999, 2003; Woodford 2003) allow for no difference in the way inflation targeting is modeled by comparison with other regimes.[2] There is thus no explicit analysis of the way the provision of a specific numerical target may constitute a better anchor for private-sector expectations. What is the mechanism that makes the inflation target a better anchor, and which conditions are required for this to be true? In our view, to be able to answer that, we need a mechanism of expectations formation more

[1]See also Leiderman and Svensson (1995) and Bernanke et al. (1999) for earlier accounts of experiences with inflation targeting.

[2]Kuttner (2004) also alludes to this fact. The benefits of inflation targeting as a coordination device have been discussed by Hughes Hallett and Viegi (2002) but in the context of two authorities, the policies of which might have strong "spillovers."

complex than the standard full-information rational-expectations paradigm.

The recent model put forward by Morris and Shin (2002a, 2002b) (and used in Amato, Morris, and Shin 2002 and Amato and Shin 2003) renders itself, first, to identifying how private agents form expectations based on private and public information available to them and, second, to showing how policymakers affect these expectations by providing greater or lesser information. This setup shows that in forming these expectations, private agents care not only about their own views but also about other people's expectations as a means to confirming their own beliefs. In fact, Phelps (1983, 35) noted the importance of general perceptions when he said that "in order to reduce the price level (in relation to the accustomed trend), it is not sufficient that the central bank (CB) persuade each agent to reduce his private expectation of the money supply (in relation to the past trend) by the warranted amount. The prevalence of this expectation must be public knowledge—an accepted fact." And as the "beauty contest" element[3] (based on Keynes 1936) is understood to play a greater role in expectations forming, signals provided by public institutions can conceivably become tantamount to coordination devices. This therefore implies that monetary policy can be viewed as a coordination game between the central bank and the private sector but also as a matching game between members of the private sector themselves. Due to the latter, public information then acquires a dual role—"of conveying fundamentals information, as well as serving as a focal point for beliefs" (Morris and Shin 2002b; henceforth, MS 2002). The question that arises following this argument is, which monetary policy regimes provide better signals, and in what way do these signals constitute focal points?[4] The aim of this paper is to formalize the widely believed

[3]The British comedy team Monty Python epitomizes the essence of higher-order expectations in the following: "I think that all good, right thinking people in this country are sick and tired of being told that all good, right thinking people in this country are fed up with being told that all good, right thinking people in this country are fed up with being sick and tired. I'm certainly not, and I'm sick and tired of being told that I am."

[4]See Sugden (1995) for a theory on focal points. Bryan and Palmqvist (2006) also apply the term "focal points" to monetary policy, in a similar fashion to ours.

but little-analyzed benefits of inflation targeting in coordinating private individuals' expectations and the conditions necessary for this to be achieved.

The theory on coordination games provides valuable insight into the way that such games are resolved. For example, it is often observed that in matching games, players coordinate much more frequently than they would if they were just randomizing (Casajus 2000). Indeed, according to Wilson and Rhodes (1997), it is to the benefit of all actors to avoid the conflict that escalates as solutions are delayed. To achieve that, players rely heavily on salient features when deciding on their actions. And salience, in this context, can be a "social custom or convention, namely a mode of behavior that finds automatic acceptance" (Dixit and Skeath 1999). A salient item then is "one that stands out from the rest by its uniqueness in some conspicuous respect" (Bacharach 1993). Furthermore, Wilson and Rhodes (1997) argue that all that is required for such salience to be achieved is a signal from somebody who can be recognized as the "leader" in the game. A commonly accepted leader, in a clearly defined leader-follower(s) game, can thus provide such a focal point. In our setup, the central bank arguably acquires such a leadership role by the sheer extent of its contribution to the final inflation outcome. Compared with other potential providers of "focal points" (say, newspapers, the government, or even big financial players in the system), the central bank is better positioned to fulfill such a role. Providing a numerical target, we argue, grants private agents the choice between two actions, in contrast to a regime absent of a numerical target. These actions are either to internalize the announced target and treat it as an additional piece of public information or, driven by their incentive to coordinate, to ignore all other information and fix their expectations at that level. Given the intentions of the central bank, the latter is naturally the preferred option, but only if everybody else pursues this option as well. In deciding between these two options, therefore, the agent remains uncertain as to how others view the target. Trusting the target for oneself is neither necessary nor sufficient for pursuing it; what is actually pivotal to one's choice is how every individual understands others' interpretation of the target and the central bank's ability to achieve it. What the individual needs, therefore, is a framework that will help, first, identify what the options are and, second, evaluate how these options are understood by all others. To this end, we employ the *variable-universe games* approach put forward by Bacharach (1993), which describes how players evaluate their options in the context of what everyone else might believe about those options.

Our contribution is to merge the MS (2002) framework with that of Bacharach (1993) in order to provide the individual with a framework to identify the best action. We find that numerical targets are effective coordinators of expectations when no great shocks are anticipated, or when all other public information available to individuals is relatively imprecise.

The paper is organized as follows. With the aid of a standard monetary policy model, section 2 describes how monetary policy can be seen as an information game based on the work by MS (2002). We then explain how the provision of numerical targets increases the options available to individuals in section 3 and describe Bacharach's (1993) approach to interpret these options. Section 4 then merges the two models and discusses the conditions for which the individual forms expectations according to the target provided by the central bank. Section 5 concludes.

## 2. Monetary Policy as an Information Game

The central bank has a standard loss function in which it chooses the rate of inflation $x$ to minimize the distance from the inflation objective set $x^T$ and close the output gap $y$,

$$L_{CB}|_\xi = \frac{1}{2}\mathbb{E}[(x - x^T)^2 + y^2], \tag{1}$$

subject to a standard Lucas supply function, $y = x - x^e + \xi$, where $\xi$ is a supply shock with zero mean and constant variance, $\sigma_\xi^2$. Note that any central bank will have an objective $x^T$ irrespective of whether it communicates it to the public clearly, or even at all. We assume for simplification that the central bank's instrument is $x$. Optimization of (1) implies that

$$x|_\xi = \frac{x^T}{2} + \frac{x^e}{2} - \frac{\xi}{2}, \tag{2}$$

where $x$ is now the ex post inflation outcome conditional on the shock $\xi$ and $x^e$ is private-sector expectations about the relevant rate of inflation. Representation (2) is of a structural form in the sense that expectations are not replaced (Leitemo 2005).[5] In a typical commitment game, where the central bank communicates its target $x^T$ and commits to it, expectations formed by all individuals collectively are equal to the CB's objectives, $x^e = x^T$, and the ex post outcome is

$$x|_\xi = x^T - \frac{\xi}{2} \tag{3}$$

$$\mathbb{E}(x) = x^T. \tag{4}$$

The objective of this paper, however, is to depart from the assumption that expectations are always equal to the objectives of the central bank and analyze how individuals go about interpreting the information that is available to them when forming expectations. Every individual $i$ will be forming an expectation of inflation $x_i$ such that the collective outcome, which is the one that is relevant to ex post inflation, is $x^e = \int_0^1 x_j dj$ (for a continuum of agents). The timing of the game assumed has the central bank deciding what its objectives are first; shocks occur next, then private agents form expectations based on information available about these shocks and policy objectives, and, finally, the central bank reacts to them.

[5]Note that (2) is specific to the underlying Lucas supply function assumed but demonstrates that the outcome will be a function of both the policy the central bank pursues and what the private sector anticipates. Analogously, had the model been of the standard neo-Keynesian type based on Clarida, Galí, and Gertler (1999),

$$x_t = \beta E_t x_{t+1} + k y_t + \varepsilon_t$$
$$y_t = E_t y_{t+1} - \gamma(i_t - E_t x_{t+1}) + \eta_t,$$

then the structural representation of the ex post inflation outcome would be

$$x_t = \frac{k^2}{1+k^2} x^T + \frac{1}{1+k^2} E_t x_{t+1} + \frac{\varepsilon_t}{1+k^2}.$$

Our point is to show that the ex post outcome is a function of both the central bank's objective and the private sector's expectations.

### *2.1 The Formation of Expectations*

We start by arguing that while the central bank itself may be clear about what its objectives are, it is not always possible to assume that private individuals form expectations that are consistent with these objectives. It becomes important then to examine the information that is available to the private sector and how the private sector uses that information to form expectations. Typically, every individual forms expectations based on two information sets—namely, what is publicly available and therefore common to everyone, and what is available to them privately. Furthermore, every individual is aware of the fact that the ex post outcome of inflation $x$ will be determined by (2); in other words, it will be affected equally (given the model we assume) by the policy the central bank pursues to attain its objectives and by the average of expectations formed by the public.

However, as the individual is interested in predicting the ex post level of inflation correctly (in order, e.g., to base her wage negotiations on[6]), she needs to interpret both components of (2) based on the information she has. Her objectives are captured by a standard expected disutility,[7]

$$u_i(\mathbf{x}^e, x^T) \equiv \frac{1}{2}\mathbb{E}_i(x_i - x)^2. \tag{5}$$

$x_i$ is individual $i$'s expectation of what inflation will be, and $x$ is again the ex post inflation outcome. Note that subscript $i$ in the expectations operator indicates that the individual will be seeking to minimize her expected disutility, given her own perceptions. We use $\mathbf{x}^e$ to refer to the expectations profile over all agents. The

[6]We assume that the individual consumer sets a price variable (individual wage) and supply elastically to the amount of labor demanded. This is just a narrative trick: the argument would work equally well in a setup as in Lucas's island model, in which individuals set the price of a good in an imperfect knowledge setup.

[7]See Canzoneri (1985). Unlike MS (2002), this objective function does not have the "beauty contest" term in it, but as we will show in (6), it delivers the same type of "action," in the sense that the individual's expectation relies on both her evaluation of the "state" and the average "action." The "beauty contest" term is therefore not strictly necessary for higher-order expectations to become relevant (Angeletos and Pavan 2007 make a similar point).

individual decides her action $x_i$ based on the first-order condition of (5). This is

$$\arg\min_{x_i} u_i(\mathbf{x}^e, x^T) = \mathbb{E}_i(x)$$

and, from (2),

$$\begin{aligned} x_i &= \mathbb{E}_i(x) \\ x_i &= \mathbb{E}_i\left(\frac{x^T}{2} + \frac{x^e}{2} - \frac{\xi}{2}\right) \\ x_i &= \frac{1}{2}\mathbb{E}_i(x^T - \xi) + \frac{1}{2}\mathbb{E}_i(x^e). \end{aligned} \tag{6}$$

Based on (6), the optimal action for individual $i$ is thus a function of three things: (i) the objectives of the central bank and hence the policy it will pursue, (ii) the shock that has occurred, and, finally, (iii) the average expectation formed by all individuals. Moreover, in forming expectations $x_i$, individual $i$ needs to evaluate these three things, captured here by the expectations operator, subscript $i$. It follows that if $x_i = x_j\ \forall j$, then $x_i = x^e$ and individuals' expectations are matched. However, although desirable, coordination between agents at any level of inflation is not sufficient; the optimal outcome occurs when agents coordinate at the objective pursued by the central bank, $x^T$. Coordination at any other expectation rate still leaves agents away from the level of inflation that the central bank aims to achieve. We will argue later that knowledge of the central bank's objective is necessary but not sufficient for coordination at it. Following MS (2002), we argue that information used by the agents is available in the form of a public signal that is common to all and a private signal that is specific to each agent in the economy. Individuals therefore observe $p$ and $z_i$, where

$$\text{Public signal: } p = (x^T - \xi) + \eta \tag{7}$$

$$\text{Private signal: } z_i = (x^T - \xi) + \varepsilon_i. \tag{8}$$

Both $\eta$ and $\varepsilon_i$ have a zero mean and constant variance, $\sigma_\eta^2$ and $\sigma_\varepsilon^2$, respectively. Furthermore, the two error terms are independent of $x$ and of each other, such that $\mathbb{E}(\varepsilon_i\varepsilon_j) = 0$ for $i \neq j$. The clarity of public information is not under the full control of the central bank but is affected by a combination of the central bank's information strategy, the general market information available, and noise. Based on these two types of signals, Morris and Shin show that agent $i$'s action then is

$$x_i = \frac{2\alpha p + \beta z_i}{2\alpha + \beta} = x^T - \xi + \frac{2\alpha\eta + \beta\varepsilon_i}{2\alpha + \beta}, \tag{9}$$

where $\alpha = \frac{1}{\sigma_\eta^2}$ and $\beta = \frac{1}{\sigma_\varepsilon^2}$, the level of precision for the two information sets, respectively.

Definition 1. *We call (9) the "MS action."*

We assume homogenous agents and calculate expectations across all agents as follows:

$$x^e = \int_0^1 x_j dj = x^T - \xi + \frac{2\alpha\eta}{2\alpha + \beta}. \tag{10}$$

Equation (10) shows that the average expectation across all agents will be distorted by the (lack of) precision of the two signals as well as the preference for the "beauty term," here equal to $\frac{1}{2}$ (from (6)).

## 3. The Role of Inflation Targets

As argued earlier, the central bank's objectives are captured by (1). In reflecting central bank practices, "price stability" is at the heart of its communication. We differentiate, however, between banks in terms of the way they communicate this objective. We identify a central bank that communicates a quantitative target $x^T$ as an "inflation targeter."[8] On the other hand, a central bank that does not

[8] The benefits or risks of communication have been discussed extensively in the literature. Rudebusch and Williams (2007) carry out an exercise that is similar in spirit to ours by showing that when private agents have imperfect information, central bank communication (in their case, in the form of publishing interest rate projections) can help manage financial-market expectations.

make an attempt to explicitly quantify the term "price stability" and communicate it to the public is, in turn, a "non-inflation targeter." We investigate next what this implies for the choices available to the individual.[9]

Our analysis so far shows that if the central bank does not explicitly quantify its objective of price stability, then the best individual $i$ can do is (9), which relies on what public and private information she has about the central bank's inflation objective and the supply shock. Based on (5), we can then calculate individual $i$'s disutility:

$$u_i(x_i, x^e) = \frac{\alpha + \beta}{(2\alpha + \beta)^2}. \tag{11}$$

We contrast this now with the case where the central bank *does* announce what it means by the term "price stability." The individual now receives an extra signal in addition to (7) and (8):

$$\text{Central bank signal: } h = x^T. \tag{12}$$

As a result, every individual is faced with the choice between two alternatives for her action $a_i$: either weigh all information available to her and thus follow the strategy suggested by Morris and Shin ($x_i$) *or*, driven by her desire to coordinate, fix her expectations at the inflation target announced by the central bank ($x^T$). In modeling terms, these alternatives are summarized in (13) and (14), respectively:

$$a_i : x_i = x^T - \xi + \frac{2\alpha\eta + \beta\varepsilon_i}{2\alpha + \beta}, \tag{13}$$

$$a_i : x^T. \tag{14}$$

By analogy, the same applies for the collective action $\bar{a}$[10] such that, respectively for the two alternatives, the MS action leads to

[9]We appreciate that this is a crude distinction and not one that necessarily captures all the differences between inflation and non-inflation targeters. On the other hand, inflation-targeting countries have also experienced the regime in very different ways. Our objective here is simply to capture that characteristic that applies to all inflation targeters—namely, of providing a quantitative target—and that differentiates them from non-inflation targeters.

[10]In our terminology, individual $i$ is thus confronted with the "average" or "collective" action. We will use these terms interchangeably.

an average inflation expectation of $x^e$, whereas following the central bank's target leads to $x^T$. In modeling terms, these amount to (15) and (16), respectively:

$$\bar{a} : x^e = x^T - \xi + \frac{2\alpha\eta}{2\alpha + \beta}, \tag{15}$$

$$\bar{a} : x^T. \tag{16}$$

In the absence of an announced inflation objective, average inflation expectations will be formed based on (15). However, when the central bank announces what its objective is, private agents then have the option of forming expectations according to either (15) or (16). We can see, therefore, that the communication strategy of the central bank with respect to the inflation objective affects the formation of expectations by increasing the number of options available to the agents. The rationale behind such a central bank announcement is the knowledge that agents need to form a view about the average expectation of inflation (as shown in (6)) and are therefore looking to identify salient points for inflation. Inflation targeting, in the way we define it here, aspires to appeal to the agents' coordination motive. It is interesting to note that while an agent that forms expectations according to the target resolves the coordination motive, by bypassing any information noise ($\alpha$ and $\beta$), it does so at the cost of throwing away information about the supply shock $\xi$. The optimal situation for the individual would be $\eta = 0$—i.e., no information shocks—as the individual's action would then account for both the target and the shock. But in the presence of information imprecision, there are instances where the benefits of coordination more than outweigh the loss of information on shocks. The decisive factor in the individual's decision is the credibility of the announced target, as we will show later in the paper.

For a continuum of agents, the inflation outcome is affected by the collective action $\bar{a}$ only. Ex post inflation (from (2)) is thus

$$\begin{aligned} x|_{\xi, x^e} &= \frac{x^T}{2} + \frac{x^e}{2} - \frac{\xi}{2} \\ &= x^T - \xi + \frac{\alpha\eta}{2\alpha + \beta} \end{aligned} \tag{17}$$

when $\bar{a} : x^e$ and

$$x|_{\xi,x^T} = \frac{x^T}{2} + \frac{x^T}{2} - \frac{\xi}{2}$$
$$= x^T - \frac{\xi}{2} \tag{18}$$

when $\bar{a} : x^T$. Based on (5), we turn next to the general form of individual $i$'s disutility, affected by both her own action ($a_i$) and the average action ($\bar{a}$), i.e.,

$$u_i(a_i, \bar{a}) \equiv \mathbb{E}_i(a_i - x)^2. \tag{19}$$

Four different disutilities are then possible outcomes for individual $i$:

- Choice 1: $a_i = x_i, \bar{a} = x^e$

$$u_i(x_i, x^e) = \frac{\alpha + \beta}{(2\alpha + \beta)^2} \tag{20}$$

- Choice 2: $a_i = x^T$, $\bar{a} = x^e$

$$u_i(x^T, x^e) = \sigma_\xi^2 + \frac{\alpha}{(2\alpha + \beta)^2} \tag{21}$$

- Choice 3: $a_i = x_i$, $\bar{a} = x^T$

$$u_i(x_i, x^T) = \frac{1}{4}\sigma_\xi^2 + \frac{4\alpha + \beta}{(2\alpha + \beta)^2} \tag{22}$$

- Choice 4: $a_i = x^T$, $\bar{a} = x^T$

$$u_i(x^T, x^T) = \frac{1}{4}\sigma_\xi^2 \tag{23}$$

The very provision of an inflation target now increases the number of options available to the individual and thus the number of potential outcomes. Table 1 summarizes the pure-form strategies available to individual $i$ (and the disutility outcomes associated

**Table 1. Individual $i$'s Disutility in Normal Form**

| NIT | | IT | | |
|---|---|---|---|---|
| $a_i \backslash \bar{a}$ | $x^e$ | $a_i \backslash \bar{a}$ | $x^e$ | $x^T$ |
| $x_i$ | $\frac{\alpha+\beta}{(2\alpha+\beta)^2}$ | $x_i$ | $\frac{\alpha+\beta}{(2\alpha+\beta)^2}$ | $\frac{1}{4}\sigma_\xi^2 + \frac{4\alpha+\beta}{(2\alpha+\beta)^2}$ |
| | | $x^T$ | $\sigma_\xi^2 + \frac{\alpha}{(2\alpha+\beta)^2}$ | $\frac{1}{4}\sigma_\xi^2$ |

with them) for the two alternative monetary regimes of non-inflation targeting (NIT) and inflation targeting (IT).

Thus, if the central bank does not announce a value for its inflation objective, the best individual $i$ can do is apply the MS action. However, if the central bank does announce a quantitative objective for inflation, then which response is optimal for individual $i$ depends crucially on the relative size of the variance of the supply shock, $\sigma_\xi^2$. In particular, we argue the following.

Proposition 1. *Applying the inflation target becomes individual $i$'s "dominant" strategy for a relatively low variance of the supply shock; otherwise, expectations forming becomes a "matching" game.*

*Proof.* Table 1 shows that for any given level of precision for public and private information, adopting the inflation target $x^T$ becomes a dominant strategy for individual $i$ if the variance of the supply shock is below a given threshold, i.e.,

$$\sigma_\xi^2 < \frac{\beta}{(2\alpha+\beta)^2}. \tag{24}$$

As we assume homogenous agents (and, by implication, that everyone adopts their dominant strategy), the game has *one* Nash equilibrium—namely, $E_1 \equiv (x^T, x^T)$. The inflation outcome is equal to (18), and individual $i$ ends up facing disutility equal to $\frac{1}{4}\sigma_\xi^2$. However, if condition (24) is not satisfied, i.e., $\sigma_\xi^2 \geq \frac{\beta}{(2\alpha+\beta)^2}$, then individual $i$'s optimal response in pure-form strategies requires "matching" the average action. In other words, $a_i = x_i$ is the best response to $\bar{a} = x^e$, and $a_i = x^T$ is the best response to $\bar{a} = x^T$. The game now has *two* Nash equilibria in pure form—namely, $E_2 \equiv (x^T, x^T)$ and $E_3 \equiv (x_i, x^e)$.[11]

In the latter case, individual $i$ is unable to differentiate between the two Nash equilibria in pure form. To decide on an action, she needs to compare the *expected* (rather than *actual*) disutility that each of them delivers; in other words, $\mathbb{E}[u_i(a_i, \bar{a})]$, where $a_i \in \{x_i, x^T\}$ and $\bar{a} \in \{x^e, x^T\}$. This in turn depends on the probability with which the average action takes one of its own two respective values.

DEFINITION 2. *Define* $q \equiv \Pr(\bar{a} = x^T)$ *and* $(1 - q) \equiv \Pr(\bar{a} = x^e)$, $q \in [0, 1]$.

Expected disutility for individual $i$ for each of her two actions is then

$$\mathbb{E}\{u_i[x_i, (x^e \text{ or } x^T)]\} = (1 - q)u_i(x_i, x^e) + q\, u_i(x_i, x^T) \tag{25}$$

$$\mathbb{E}\{u_i[x^T, (x^e \text{ or } x^T)]\} = (1 - q)u_i(x^T, x^e) + qu_i(x^T, x^T). \tag{26}$$

The difficulty with this, however, is that probability $q$ is unknown to individual $i$ and she is thus unable to evaluate which action to take based on (25) and (26). She needs to identify an alternative framework that provides her with sufficient information on which she can then base her choice. We will argue that rather than evaluate $q$, it will suffice for individual $i$ simply to know how the target is perceived (and not necessarily applied) on average. Otherwise put, it will suffice for the individual to know the proportion of people that consider the target credible. We believe that in the context of monetary policy, this information is publicly available and easier for the individual to deduce. Based on that, we will show that she can then identify under which conditions following the target provided by the central bank is to her advantage. We describe the framework for doing that next, based on Bacharach's (1993) variable-universe games.

[11] The condition is such that if equality holds, then the individual is indifferent between the two.

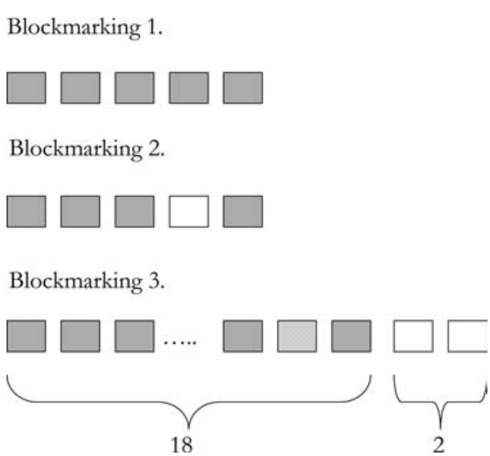
### *3.1 A Framework for Interpreting Expectations*

Bacharach's (1993) variable-universe games framework helps describe how players evaluate their strategies to identify salient points when forming expectations in matching games.[12] The novelty of this approach is that it allows explicitly for differences in perceptions, which then helps players choose rationally between alternative outcomes. The framework provided shows that in matching games, the players' incentive to coordinate induces them to look for salient points. However, as salience is subject to personal interpretation, the existence of such features is not necessarily uniquely defined. We describe the approach first, then apply it explicitly to our question in section 4.

#### *3.1.1 The Game of Blockmarking*

The game of blockmarking is played in the following way. Two players (player 1 and player 2) are shown a number of wooden blocks, and each has to secretly mark one. If both players mark the same block, they receive an identical pecuniary prize; otherwise, they receive nothing. There are then three variants of the game, summarized in figure 1.

**Figure 1. The Game of Blockmarking**




[12]This framework was used and extended by Janssen (2001).

In Blockmarking 1 (B1), the players are given five blocks identical in size, color, shape, and material. In Blockmarking 2 (B2), the same game is repeated, except now one of the five blocks is of a different color (white). In Blockmarking 3 (B3), players are now given twenty blocks, eighteen of which are grey and two of which are white. Furthermore, closer inspection of the blocks allows players to see that the grain of the wood in just one of the grey blocks is wavy (block 17 on the graph). B3 can thus be described either in terms of color ($C$) or in terms of the grain of the wood ($G$). As the game is of a matching nature, it is to the players' interest to look for salient features that help achieve tacit coordination. In example B1, there is no clear way of differentiating between the blocks, so one is inclined to simply choose at random. In example B2, however, the difference in color allows players to distinguish between the blocks in such a way that it is always wise to go for the one that is white. The *unique instantiation* of the white block thus provides the two players with a focal point. Similarly, in B3, if color is the distinguishing feature that occurs to the players, they are then inclined to mark one of the white blocks, even though such action does not automatically lead to coordination. However, if players have managed to see that not only color but also the grain of the wood differentiates the blocks, uniqueness can again be guaranteed. The difficulty now, however, is that the grain pattern of the wood is not necessarily identifiable (*conspicuous*) by (*to*) all players.

How does player 1 proceed with forming her choice in B3? Bacharach argues that there is no one mechanical method of answering this question. However, one "can make use of certain general considerations about how agents understand situations and understand each other to understand them, considerations built on the notion of 'normality'" (Bacharach 1993, 262). This notion of "normality" provides a common platform that allows the individual to begin to evaluate her options. It is "normal" therefore to assume that all players distinguish the blocks according to color, but that not all players see the difference in grain. This is the most basic assumption about B3. Next to that, Bacharach also adds that while seeing the grain is by no means certain, there is a definite probability $v$ with which an arbitrary normal person will have seen it. If the player is normal herself, then it is natural to assume that she knows of this probability $v$ and believes it to hold for her (equally normal) partner.[13] Bacharach's contribution then is to demonstrate that knowledge of this prior $v$ is sufficient for player 1 to base her choice on. His analysis shows that if this likelihood is big, then it is to her advantage to mark the grey block with the wavy pattern; otherwise, she is better off marking one of the white blocks and facing, at most, a 50 percent chance of matching her partner's choice. In the appendix we describe how this is derived analytically and show that for the action of selecting the wavy-grained block to be optimal in B3, the condition that needs to be satisfied is that $v > \frac{1}{2}$. In general, the balance of reasons favors marking the block with the wavy grain only if $v$ is a large enough number by comparison with $\frac{1}{m}$, where $m$ is the number of white blocks. Bacharach concludes that the relative rarity of the white blocks, captured here by $\frac{1}{2}$, is pulling against the conspicuousness $v$ of the grain pattern, as the less rare the white blocks are (the bigger $m$ is), the more likely the player is to mark the wavy-patterned grey block (provided she has seen it).

## 4. Variable Universes and Inflation Targets

How does the analogy carry over to monetary policy? As argued earlier, our analysis aims to show how announcing a quantitative target for monetary policy alters the number of options available to the individual. The first observation is that if the central bank does *not* announce an explicit quantitative target, then as far as the individual is concerned, the best she can do is implement the MS action, equivalent to marking a white block at random. The option of following the target is therefore not given to her, and her position in the game is as though she has not seen the difference in grain.

When the central bank does, however, announce an explicit quantitative target, then we interpret Bacharach's notion of "normality" to imply the following three things:[14]

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[13]Naturally, this probability is not relevant to her decision, or indeed known to her, if she has not seen the difference in grain herself.

[14]Note that our description of what the provision of an explicit quantitative target implies draws heavily from the common notion that IT constitutes "a simple yardstick by which to judge policy. Given lexicographic preferences over

(i) First, the option of following the target is available to everyone. We believe this to be an adequate representation of the fact that inflation targets are widely announced and are therefore seen and understood by everyone. In that respect, it is reasonable to assume that any random individual would understand that the options shown in table 1 under IT are now available to them.

(ii) Second, not necessarily everyone believes that the target is credible. In other words, not everyone believes that the central bank can actually achieve the target, or even that the notion of "price stability" and the value $x^T$ announced are necessarily equivalent. This is, in our view, an important reflection of the fact that revealing a quantitative objective is not automatically sufficient for attaining it.

(iii) Finally, and in the spirit of the game of blockmarking, while credibility is by no means certain, there is nevertheless a common perception as to how credible such a target might be. In other words, everyone knows and understands how the target is perceived by others on average, or, alternatively, everyone knows what proportion of people consider the target credible. This frequency, or likelihood, is now our parameter $v$ and, based on Bacharach's notion of normality, constitutes common knowledge. We would want to investigate what levels of credibility are required before the individual decides to form expectations according to the target (equivalent to the $\frac{1}{m}$ condition above).

Based on the above, we provide the following definition.

Definition 3. *Define $v$ as follows: the proportion of people that believe that the target is credible.*

We can now rely on this likelihood $v$ to evaluate individual $i$'s expected disutility $\mathbb{E}[u_i(a_i, \bar{a})]$ of following action $a_i$ for a given collective action $\bar{a}$. This has the advantage that the priors used are now known to her. However, as $v$ is not the actual probability with

inflation and other goals, an inflation target range, and a fixed horizon, inflation targeting becomes very easy to monitor" (Faust and Henderson 2004, 127).

which the collective action is equal to the target ($v \neq q$), we need to proceed in two steps in order to provide a comprehensive framework that accounts for all possible outcomes.[15]

Case 1. First, we consider the case when the collective choice is always the default MS action. The target is therefore never applied, irrespective of whether it is deemed credible. This may happen either because the average perception is that the central bank's target is not credible or because the average individual does not believe that others think the target is credible. The default MS action is then applied on average, and inflation expectations equal $x^e$. Are there then circumstances in which individual $i$ is still better off following the target? Her expected disutility of following either of her two options is then

$$\begin{aligned}\mathbb{E}[u_i(x_i, x^e)] &= (1-v)u_i(x_i, x^e) + vu_i(x_i, x^e) \\ &= u_i(x_i, x^e) \\ \mathbb{E}[u_i(x^T, x^e)] &= (1-v)u_i(x^T, x^e) + vu_i(x^T, x^e) \\ &= u_i(x^T, x^e).\end{aligned}$$

From table 1, these equal, respectively,

$$\begin{aligned}\mathbb{E}[u_i(x_i, x^e)] &= \frac{\alpha+\beta}{(2\alpha+\beta)^2} \\ \mathbb{E}[u_i(x^T, x^e)] &= \sigma_\xi^2 + \frac{\alpha}{(2\alpha+\beta)^2}.\end{aligned}$$

It follows that

$$\begin{aligned}\mathbb{E}[u_i(x^T, x^e)] < \mathbb{E}[u_i(x_i, x^e)] \quad \textit{iff} \\ \sigma_\xi^2 < \frac{\beta}{(2\alpha+\beta)^2}.\end{aligned} \tag{27}$$

Expression (27) illustrates the condition for which individual $i$ would effectively ignore the fact that everyone else applies the MS

[15] Actually, there are three steps, but the third is trivial, as we show later in footnote 16.

default action and still follow the target, even though she is aware she would be the only one. But this is only rational if following the target constitutes her dominant strategy. It is therefore no surprise that (27) is identical to the condition shown earlier under dominance, i.e., (24).

Case 2. Second, we relax the stringency of the first assumption and assume now that the proportion of people who believe that the target is credible actually apply it. When, then, should individual $i$ choose the target? This is a somewhat less restrictive case than the one above, and expected disutility for player $i$ of pursuing either of her two options is now

$$\mathbb{E}\{u_i[x_i, (x^e \text{ or } x^T)]\} = (1-v)u_i(x_i, x^e) + vu_i(x_i, x^T),$$
$$\mathbb{E}\{u_i[x^T, (x^e \text{ or } x^T)]\} = (1-v)u_i(x^T, x^e) + vu_i(x^T, x^T)$$

and, from table 1,

$$\mathbb{E}\{u_i[x_i, (x^e \text{ or } x^T)]\} = (1-v)\frac{\alpha+\beta}{(2\alpha+\beta)^2} + v\left[\frac{1}{4}\sigma_\xi^2 + \frac{4\alpha+\beta}{(2\alpha+\beta)^2}\right],$$
$$\mathbb{E}\{u_i[x^T, (x^e \text{ or } x^T)]\} = (1-v)\left[\sigma_\xi^2 + \frac{\alpha}{(2\alpha+\beta)^2}\right] + v * \frac{1}{4}\sigma_\xi^2.$$

It follows that

$$\mathbb{E}\{u_i[x^T, (x^e \text{ or } x^T)]\} < \mathbb{E}\{u_i[x_i, (x^e \text{ or } x^T)]\}, \quad \textit{iff}$$
$$\sigma_\xi^2 < \frac{\beta + v4\alpha}{(1-v)(2\alpha+\beta)^2}. \tag{28}$$

Again, the size of the shock needs to be below a given ratio before the individual applies the target. However, as the condition is less restrictive than before, (since $\frac{\beta}{(2\alpha+\beta)^2} < \frac{\beta+v4\alpha}{(1-v)(2\alpha+\beta)^2}$), it is also the sufficient condition for individual $i$ to follow that target. Interestingly, we can rewrite this condition in terms of $v$:

$$\frac{(2\alpha+\beta)^2\sigma_\xi^2 - \beta}{4\alpha + (2\alpha+\beta)^2\sigma_\xi^2} < v. \tag{29}$$

This now shows that the sufficient condition for individual $i$ to follow the target is when a suitably large proportion (in relation to the shocks and the quality of information available) of the public believe the target to be credible.[16]

Having identified this condition, we discuss briefly the role of $v$ in the monetary policy game.[17] Credibility of central bank actions is an aspect that is highly (if not only) dependent on the institution's track record. In other words, we believe that people revise their beliefs about the central bank based on what they observe (past performance). At time $t$, $v_t$ therefore depends on whether actual inflation in the previous period was equal (or close, by a well-predefined amount) to the target ($x_{t-1} \simeq x^T$). If so, the private sector will increase $v_t$ for the current period (by comparison with $v_{t-1}$); if not, it will reduce it and hence penalize the bank. This implies automatically that while credibility is endogenous to the system, it is also *predetermined* at the time the decision is made, in the sense that $v_t$ is the "stock" of credibility that the central bank can no longer affect. The central bank's actions at time $t$ will therefore only affect $v_{t+1}$. The implicit timing of the static game at any period is therefore as follows:

$$v_t|_{x_{t-1}} \longrightarrow \xi_t \longrightarrow a_{i,t} = \begin{cases} x^e & \text{if } v_t < \text{condition} \\ x^T & \text{if } v_t \geq \text{condition} \end{cases} \longrightarrow x|_{\xi_t, \bar{a}_t} \longrightarrow x_t.$$

[16] Note that we also need to examine a third case in which the average action is now assumed to always be the target. One could envisage a situation (admittedly unlikely) in which everyone thinks for themselves that the target is not credible but choose nevertheless to follow it, because they believe they are alone in thinking that. It is trivial then to show that following the target is individual $i$'s preferred strategy.

$$E\{u_i[x_i, x^T]\} = \frac{1}{4}\sigma_\xi^2 + \frac{4\alpha + \beta}{(2\alpha + \beta)^2}$$
$$E\{u_i[x^T, x^T]\} = \frac{1}{4}\sigma_\xi^2$$
$$E\{u_i[x^T, x^T]\} < E\{u_i[x_i, x^T]\}$$

[17] The formation of expectations described here is similar in spirit to what Bomfin and Rudebusch (2000) have in that, depending on the level of credibility of the central bank, the private sector shifts its expectations between the target and an alternative—in their case, past inflation; in our case, MS action. Also, while we have the choice between two values (hence discrete), they have the choice within a range of values (hence continuous).

Credibility is assessed first, based on last period's performance; the supply shock materializes; agents then form expectations accordingly; and the central bank reacts, leading to an inflationary outcome for the period equal to $x_t$. How this credibility is updated, however, is beyond the scope of this paper. Our efforts above were confined to establishing the condition required for an individual to want to switch from $x^e$ to $x^T$ when forming expectations.

### *4.1 Inflation Targeting and Individual i's Options: A Discussion*

We argue that the decision by a central bank to explicitly quantify its objective of price stability aims at providing a platform for individuals to coordinate their expectations. From the point of view of the individual, however, this becomes interesting only if certain conditions are met. Our analysis has shown that what matters is, first, the economic conditions that prevail (namely, supply shocks) and, second, the way this quantitative target is perceived by the public.

Figure 2 summarizes the conditions for the variance of the supply shock $\sigma_\xi^2$ that need to hold for the inflation target to be individual $i$'s best option. We discuss these next in greater detail.

#### *4.1.1 Inflation Targeting as a Dominant Strategy*

We have shown that if $\sigma_\xi^2 < \Psi$ (from figure 2), then following the target becomes the individual's dominant pure-form strategy. For this to be true, it is important that the supply shock is relatively small in relation to the given ratio of the public and private information precision. Figure 3 now plots the value of this ratio $\Psi$ (vertical axis)

**Figure 2. Individual *i*'s Options**

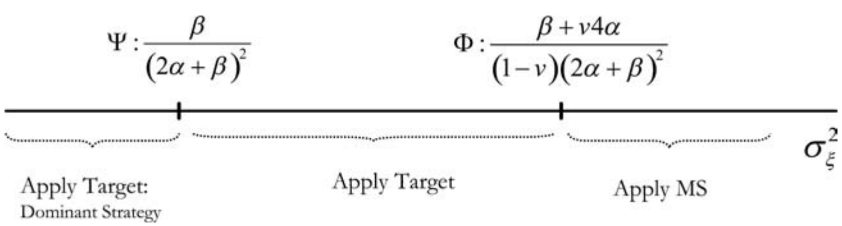
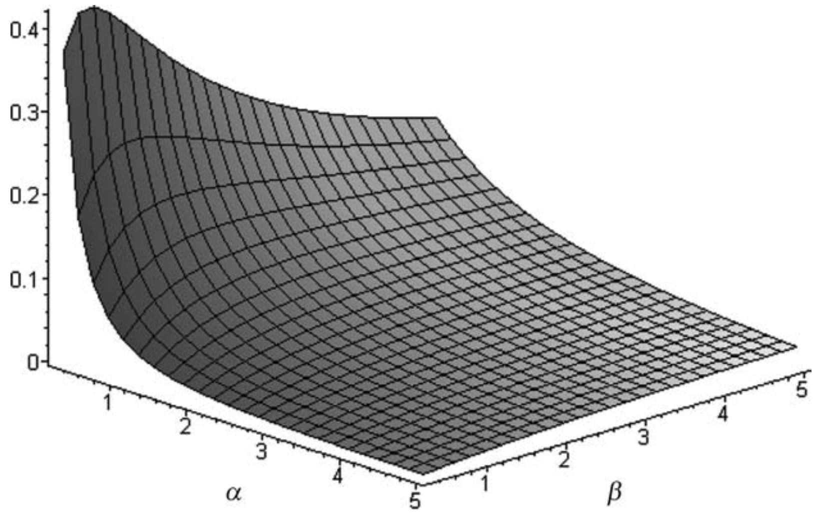


**Figure 3. Inflation Targeting as a Dominant Strategy—"Ψ" against $\alpha$ and $\beta$**




against values of private ($\boldsymbol{\alpha}$) and public ($\boldsymbol{\beta}$) information precision. As the condition is satisfied for values below the surface shown, we can see that supply shocks are required to be very small for this to hold. Indeed, if the economy is hit by large shocks instead, then it is unlikely that this condition is met, implying that the provision of a target does not help agents coordinate at the level intended by the central bank. We find this intuitively appealing because it evaluates the effectiveness of the target publicized within the context of the economic conditions in which it is applied.

Moreover, figure 3 also shows that if public information is very imprecise (i.e., $\alpha$ is low), then the condition is easier to satisfy, ceteris paribus, and the provision of an inflation target is indeed helpful. This implies that numerical targets become substitutes for imprecise public information; in the absence of concrete alternative information, the provision of one clear inflation target becomes the only unequivocal piece of information available to all. To carry the analogy to the blockmarking game, if white blocks become more and more numerous, then having seen the block with the wavy grain, one is more likely to mark it.

*4.1.2 Expectations Formation as a Matching Game*

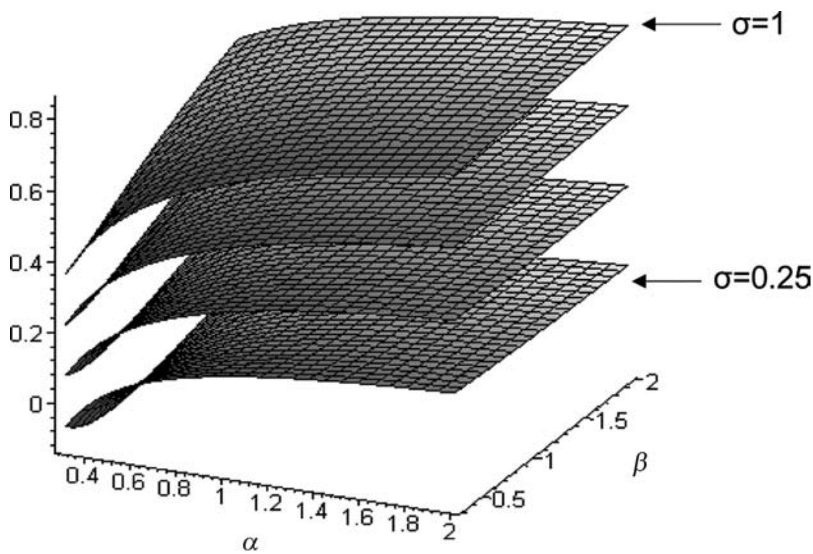
However, if (24) is not satisfied (i.e., $\sigma_\xi^2 > \Psi$), then individual $i$'s optimal action in pure-form strategies requires "matching" the average action. We differentiate between two cases:

(i) If $\Psi < \sigma_\xi^2 < \Phi$, then she is still better off fixing her expectations at the central bank's announced target. We show that this condition can be interpreted in terms of $v$, which suggests that the individual needs to know how credible the target is considered on average, i.e.,

$$K = \frac{(2\alpha + \beta)^2\sigma_\xi^2 - \beta}{4\alpha + (2\alpha + \beta)^2\sigma_\xi^2} < v. \tag{30}$$

If this level of confidence is greater than the ratio shown, then it is still to her advantage to form expectations according to the target. Figure 4 now describes how easy it is for this condition to be met in relation to $\alpha$, $\beta$, and the supply shock

**Figure 4. The Role of Interpretations—"*K*" against *α* and *β***



$\sigma_\xi$. On the vertical axis we plot the left-hand side of (30) in terms of $\alpha$ and $\beta$ and for four different values of the supply shock $(0 < \sigma_\xi < 1)$.

The condition is now satisfied for values that fall above each of the surfaces shown; thus, the higher the plateau, the more difficult it is to meet it. There are two interesting features that arise from figure 4. First, it is the case that as the variance of the shock increases, then (30) becomes more difficult to satisfy. In other words, if larger shocks are expected, then individual $i$ needs an ever-greater degree of confidence that the target is perceived to be credible (i.e., higher $v$) before she chooses it herself. This is consistent with what is mentioned above—namely, that in the presence of large shocks, inflation targeting is less convincing in its role as a coordinator of expectations. Second, as public information suffers from lack of clarity (i.e., $\alpha$ is low), the provision of a clear and unique quantitative signal helps relax the stringency of the condition. We see this as each of the layers in figure 4 tilt downward for small values of $\alpha$, thus making the condition easier to satisfy.

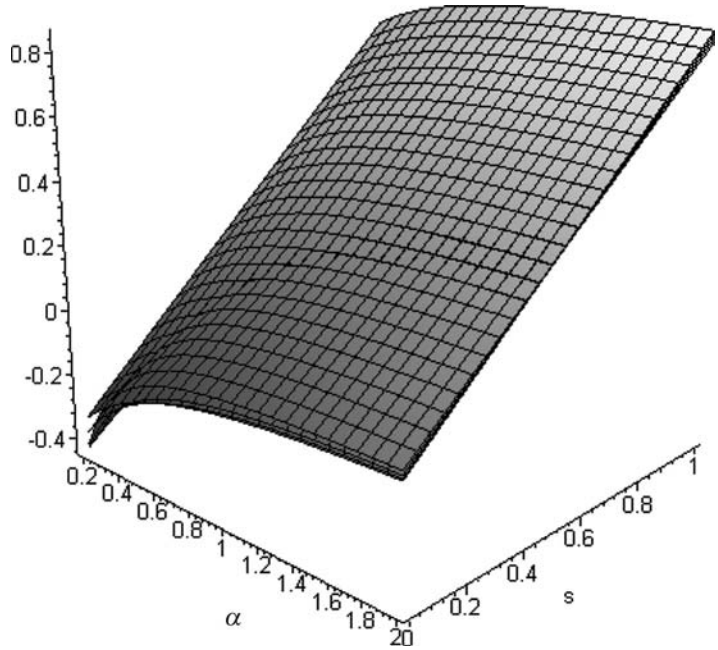
(ii) If, however, $\sigma_\xi^2 > \Phi$, then the individual is expected to do better by applying the MS default action.

In all cases above, the role of private information is de-emphasized in that it does not impose a constraint on either (27) or (30). This is demonstrated in figure 5 for the latter condition, which is now plotted against $\alpha$ and $\sigma_\xi$ and then for different values of $\beta$. We see this as the plates are very closely overlapping, thus indicating that changing private information does not help alter the stringency of the condition.

## 5. Conclusions

Any private individual forms expectations of inflation based on information that is available to her. Our paper concentrates on the way the central bank's communication strategy might affect these expectations. We begin our analysis by arguing that it is not always possible for a monetary policy authority to assume that it can affect private expectations in such a way that they will match its own intentions. Private individuals rely on information that is available

**Figure 5. The Role of Private Information**




to them publicly (and thus common to everyone) as well as information that might be unique to them individually. Monetary policy becomes an information game, then, in which private individuals base their decision on a combination of all information available, corrected for their respective degree of (or lack of) precision. As the level of expectations affects the final outcome of inflation, the private sector needs to deduce the central bank's objective, its ability to achieve it, and what everyone else believes. We apply the MS (2002) model to demonstrate that the latter point implies that coordinated expectations are preferable, although not necessarily the guarantee of optimal outcomes. We then use Bacharach's variable-universe approach to demonstrate exactly how people interpret the options available to them given the actions of all other players in the game. Our contribution has therefore been to merge the two models and provide a comprehensive framework for individuals to enumerate their options and thus form expectations.

Based on this, we find that a central bank that announces a quantitative target may, ceteris paribus, benefit from helping private-sector expectations coordinate at the level of its objectives. We describe the conditions for which this happens and discover that inflation targeting does indeed achieve coordination—first, when the supply shocks expected are small (in other words, the economy is stable) and, second, when public information fails in all other respects to provide the private sector with clear signals as to what the relevant level of inflation is going to be. It is in this sense that we argue that inflation targets are substitutes for poor public information. Naturally, as we show above, it is not sufficient for any individual to view this quantitative signal; the individual also needs to know that the signal is, on the whole, perceived to be credible. If this holds, then following the signal will constitute her preferred strategy and the central bank will have effectively provided a focal point.

## Appendix. Variable-Universe Games (B3)

Bacharach provides a thorough proof to B3 in the appendix to his paper, but the essence of the game faced by the two players individually can be summarized as follows. In solving B3, player 1 is effectively faced with two alternative actions: $M\widetilde{h}$, mark a white block at random, or $Mw$, mark the grey block with the wavy grain. Furthermore, as explained in the main text, the crucial point in this analysis is the likelihood with which player 2 has noticed the grain. Player 1 is thus left with the following two choices when forming her views about player 2. Either she believes that her opponent has seen the grain (and the assumption of normality implies that he will have with probability $v$), or she does not believe that he has seen the grain (with probability $1 - v$). It is reasonable to assume that if player 2 has indeed noticed the grain, then he will mark that block with some nonzero probability. However, if he has not noticed the grain, then he can never mark a block accordingly. From player 1's perspective, therefore, her expected utility from choosing one of her two actions is the following.

Definition 4. *Both players have an identical set of feasible strategies, $R^+ = \{C, G\}$, and possible actions, $A = \{M\widetilde{h}, Mw\}$. Define*

$U_1(x_{1,a(\bullet)}, x_{2,a(\bullet)})$, *player 1's utility from following action* $x_{1,a(\bullet)}$ *and player* 2 *following action* $x_{2,a(\bullet)}$, *for* $a \in A$, *where* $a(C) = M\widetilde{h}$ *and* $a(G) = Mw$.

As $v$ is not the probability with which player 2 marks the block with the wavy grain but merely the likelihood with which any "normal" player will have seen it, we need to deal with two cases in order to ensure that our approach accounts for all possible outcomes.

Case A1. Player 2 always marks a block according to color, either because he has not seen the grain himself or because he believes his partner has not. Then player 1's expected utility is

$$\mathbb{E}_1 U(M\widetilde{h}, M\widetilde{h}) = (1-v)U_1(M\widetilde{h}, M\widetilde{h}) + vU_1(M\widetilde{h}, M\widetilde{h})$$
$$\mathbb{E}_1 U(Mw, M\widetilde{h}) = (1-v)U_1(Mw, M\widetilde{h}) + vU_1(Mw, M\widetilde{h}).$$

Next, we normalize $U(x_1 = x_2) = 1$ and calculate the expected utilities:

$$\mathbb{E}_1 U(M\widetilde{h}, M\widetilde{h}) = (1-v)\frac{1}{2}U(x_1 = x_2) + v\frac{1}{2}U(x_1 = x_2) = \frac{1}{2}$$
$$\mathbb{E}_1 U(Mw, M\widetilde{h}) = (1-v) * 0 + v * 0 = 0.$$

This implies that $\mathbb{E}_1 U(M\widetilde{h}, M\widetilde{h}) > \mathbb{E}_1 U(Mw, M\widetilde{h})$, and therefore player 1 has an incentive to match her partner's action by also marking a white block at random.

Case A2. Player 2 now marks a block based on the grain when he has noticed it. Otherwise, he marks a block according to color. Expected utility for player 1 is now

$$\mathbb{E}_1 U[M\widetilde{h}, (M\widetilde{h} \text{ or } Mw)] = (1-v)U_1(M\widetilde{h}, M\widetilde{h}) + vU_1(M\widetilde{h}, Mw)$$
$$\mathbb{E}_1 U[Mw, (M\widetilde{h} \text{ or } Mw)] = (1-v)U_1(Mw, M\widetilde{h}) + vU_1(Mw, Mw)$$

and, therefore,

$$\mathbb{E}_1 U[M\widetilde{h}, (M\widetilde{h} \text{ or } Mw)] = (1-v)\frac{1}{2}U(x_1 = x_2) + v * 0 = \frac{1-v}{2}$$
$$\mathbb{E}_1 U[Mw, (M\widetilde{h} \text{ or } Mw)] = (1-v) * 0 + vU(x_1 = x_2) = v.$$

It follows that

$$\mathbb{E}_1 U[Mw, (M\widetilde{h} \text{ or } Mw)] > \mathbb{E}_1 U[M\widetilde{h}, (M\widetilde{h} \text{ or } Mw)], \quad \textit{iff} \quad v > \frac{1}{3}.$$

But between the two cases, the necessary and sufficient condition for player 1 to decide to mark a block according to the grain is

$$\mathbb{E}_1 U[Mw, (M\widetilde{h} \text{ or } Mw)] > \mathbb{E}_1 U(M\widetilde{h}, M\widetilde{h}) \Longleftrightarrow v > \frac{1}{2}. \tag{31}$$

In other words, the balance of reasons favors marking the block with the wavy grain only if $v$ is a large-enough number by comparison with $\frac{1}{m}$, where $m$ is the number of white blocks. Bacharach argues therefore that the relative rarity of the white blocks, captured here by $\frac{1}{2}$, is pulling against the conspicuousness $v$ of the grain pattern, as the less rare the white blocks are (the bigger $m$ is), the more likely the player is to mark the wavy-patterned grey block.

The point that is crucial to Bacharach's analysis is the fact that players have particular ways of perceiving the game, such that the framing of the game (universe) available to them individually is not necessarily available to other players as well (variable). Before deciding on a possible action—for example, marking the block with the wavy grain (provided they have seen it)—the player has to form a view as to how likely her counterpart is to have noticed the grain (as well as the color) as a possible distinguishing feature. Evaluating that is necessary before choosing a strategy, implying that having noticed the block with the wavy grain for oneself is not sufficient reason to mark it. Any player therefore needs to assess whether they believe that what is conspicuous to them is also conspicuous to others. Marking the wavy-grained block is the desirable strategy only if the expected value of doing so is greater than the expected value of marking a white block at random.

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