Central bank's communication: Fragmentation as an engine for limiting the publicity degree of information[1]

Emna Trabelsi

Higher Institute of Management, University of Tunis
emna.trabelsi2007@yahoo.fr

Abstract: In earlier theoretical framework, Morris and Shin (2002) highlight the potential dangers of transparency policy. In particular, public announcements may be detrimental to social welfare. Later, Morris and Shin (2005) uphold that more precise communication can degrade the signal value of prices. Researchers suggest reducing the precision of public information or withholding it. The latter seems to be unrealistic. We consider a static coordination game in which the private sector receives *n* semi-public information plus their specific information, and we analyse the impact on the private sector's welfare. First, we determined the conditions under which the central bank faces a trade-off between enhancing commonality and the use of more precise, but fragmented information. Such intermediate transparent strategies may prevent the bad side of the public information from overpowering the good side of it. Second, introducing costs to that framework in equilibrium shows that strategic substitutability between public and private precision is a very likely outcome.

JEL codes: D82, D83, E58

Keywords: Transparency, Central bank Communication, semi public information, private information, coordination

[1] The author wishes to thank professor Mohamed Ayadi for a current work's supervising and Doctor Walid Hichri for constructive comments.

1. Introduction

What constitutes an optimal communication strategy? This question is of fundamental importance to financial economics, and therefore deserves to receive an extensive attention in the literature. Econometric studies show that communication exerts a substantial impact on asset prices (Andersson et al. (2006), Kohn and sack (2004), Ehrmann and Fratzscher (2007a)…). Although it is widely accepted that improved transparency of monetary policy and the associated communication have been effective, the question remains if a central bank should reveal more information to the public, thereby making its communication more explicit and forward looking. In real world, no central bank discloses all the information it has. This may reflect the fear of loosing credibility.

In recent years, there has been revived interest in how to design an optimal communication strategy by central banks. This renewal began with Morris and Shin (2002) and Amato et al. (2002), who sparked a debate on the value of transparency[2]. They studied a simple coordination game with imperfect common knowledge. It rests on the presumption that economic agents hold two signals that differ in nature, namely, they receive both private and public information about economic fundamentals. With respect to this theoretical framework, private information can be interpreted as insider information or simply as individual interpretation of commonly accessible information. In that sense, private information will differentiate potentially within market participants. As for the second type of signals, it is commonly shared by all agents[3]. Both types of information are faulty signals of the true fundamental state of economy. From a social welfare perspective, their central result states that agents may put too much weight on public information relative to private signals. In that sense, more precise public information plays two roles: it conveys fundamental information, but also it acts as a focal point for coordination. Cornand (2006) brought experimental evidence that the focal potential of public information cannot be ignored. Subjects particularly overweigh the public information when they receive both public and private signals. If private agents overreact to public information, then a policy of limited transparency may be warranted. "Svensson (2006)[4] argues that the Morris and Shin (2002) result holds only in unlikely regions of the parameter space". However, an empirical support of the Morris and Shin's hypothesis was found by Ehrmann and Fratzscher (2007b). In a model of price-setting, "Hellwig (2005) points out that the public information is always welfare improving because the induced reduction in cross-sectional price dispersion dominates any increase in aggregate volatility"[5]. Even in the presence of investment complementarities, Angeletos and Pavan (2004) think that welfare is enhanced.

In this short paper, we investigate the welfare effects of fragmented information in the presence of private signal. We consider the same beauty contest[6][7] in Morris and Shin (2007a). This means that public information is common only among agents belonging to the same group. Such modelling of the information structure is consistent with the idea that fragmented information may reduce eventual detrimental effects of the release of public information on social welfare, as agents overreact to the public information when it is fully disseminated.

---

[2] It is a necessary condition for an efficient communication policy.

[3] Examples of public signals, inflation report, macroeconomic announcement…

[4] "In a reply to Svensson (2006), Morris, Shin and Tong (2006) argue that if public signal is correlated with the private signal, then quantitative evaluation supports their original results", adopted from Kozo (2009, p 1)

[5] We refer to Mendes (2008, p. 82-83) for these comments.

[6] A **Keynesian beauty contest** is a concept developed by John Maynard Keynes to explain price fluctuations in equity markets.(http://en.wikipedia.org/wiki/Keynesian_beauty_contest)

[7] The information structure in Morris and Shin (2007a) assumes that agents receive a common signal and n semi-public signals, while ours includes n semi-public information and a private signal.

Although our analysis is simple, we believe it is important, as it gives a robust contribution to the fact that introducing certain opacity (i.e. fragmented information) may lead to superior results.

The remainder of this paper is as follows. In section 2, we dress the advantages and the drawbacks from disseminating fully a public information. In section 3, we describe the model, it develops a short stylized model of the reception of two types of signals, and we characterize the equilibrium set. In section 4, we present the welfare outcomes. We check also if substitutability is likely to occur even with that information structure. Finally, some remarks and discussion will be offered in section 5. Section 6 concludes

2. "Good" and "dark" side of public information

Generally, one might expect that better public information improves market functioning which means that financial markets become better at predicting the outcome of unrealized fundamentals. The coordination game approach shows, however, that increased transparency may lead to non optimal results, and then hamper market functioning. The purpose of this section is to shed light on the effects of public information in Morris and Shin's framework in order to motivate our subsequent framework.

The main feature of Morris and Shin framework is that public information is perceived as playing a dual role: on the one hand, it provides information about relevant fundamentals to financial markets. The central bank's assessment will be of importance to financial market participants, as it will affect future policy actions. On the other hand, public information may serve as a coordinating device for the beliefs. Decision by investors, are thus, based both on their specific information and their beliefs about other agents' beliefs. The damaging effect of public information comes from the fact that agents put more weight on public signal caused by the coordination motive. According to Svensson (2006), however, this negative impact occurs only when the precision of public information is below a certain threshold. Beyond such optimum, more transparency is undesirable. There are two exceptions, for which transparency is dangerous, as underlined by Cruisjen et al. (2010, p. 4), "(1) each agent puts more weight on the coordination motive than on the motive to bring actions in line with economic fundamentals, and (2) the noise in the public signal is at least eight times higher than the noise of the private signal. This is unlikely because central banks spend a lot of resources on collecting and interpreting data." Morris and Shin (2005) explored another model in which public information is endogenous, and gave rise to the result of possible negative effects of public information. Providing a lot of information to steer market expectations might be undesirable because it could lower the informativeness of financial markets and prices and, therefore, worsen public information. Woodford (2005) argues, however, the damaging effect of public information is due to the fact that "beauty contest" term disappears at the aggregate level of the welfare[8]. Now, what possible solutions are suggested in the literature in order to reduce agents' overreaction to the public information?

- ***Partial Announcement***: Walsh (2007) and Cornand and Heinemann (2008) propose an original definition of transparency based on the degree of information dissemination: in this new framework, the central bank may decide to reveal its information, not to all agents, but only to a part of the population. Walsh (2006) uses this definition in terms of information dissemination while Cornand and Heinemann (2008) also retain the definition of transparency in terms of information more or less noisy. The authors show, based on

[8] He found that when the "beauty contest" term is conserved in the welfare function, any increase of the public information precision is always beneficial to the social welfare.

the results of Morris and Shin, in situations such as public information is not desirable because of its effect of coordinating the expectations on an equilibrium that moves away from the optimum, a more precise public signal but revealed only to a portion of the population is higher from a welfare perspective than a signal of low precision revealed to all agents. The fact that information is not revealed to the general population reduces the incentives of individuals to overreact to the public signal and therefore reduces the deleterious effect associated with higher-order beliefs. Reducing the number of agents who receive the public signal is, according to these authors, an effective way to avoid the negative effects resulting from the coordination of expectations. Ultimately, if the public signal is very accurate, then the central bank has the interest to reveal it to all agents. In contrast, information with low precision should make the object of a partial publication, i.e. a limited number of individuals.

- ***Fragmentation***: The idea of fragmented information put by Morris and Shin (2007a) goes back to Issing (2005, p 72) who stressed the challenges the central banker faces in communicating with the public: "Striking the balance between the need for clear and simple messages and the need to adequately convey complexity is a constant challenge for central bank communication". Because simplicity is a great virtue in its ability to generate common understanding, there would be a trade-off, as pointed by Morris and Shin (2007a). ***How to establish fragmented information in real world?*** The cheap talks used by central banks, for example, speeches by governors may be considered as a fragmented way of communication. It doesn't lead to common framework across private agents. Different interpretations by the agents lead to the fact that public signals become private ones.

3. The Set up

There are many small agents, who have to decide on an underlying unknown state θ, but also try to guess other individuals' beliefs in the economy. Following Morris and Shin (2002, 2007a), the decision rule for an agent j is given by:

$$a_j = (1-r)E_j(\theta) + rE_j(\bar{a}) \tag{1}$$

Where $\bar{a}$ is the average action in the population, such that $\bar{a} = \int a_j dj$, r is a parameter that lies between zero and one, it measures the degree of strategic complementarities, called also the "beauty contest" term. The optimal action for an individual j is thus a function of two things: the view about the state θ, and the average expectation formed by all individuals.

According to Morris and Shin (2007a), the Central Bank publishes its information in a fragmented way. Thus, we argue that information used by agents are available in the form of n semi-public signals, observed each by $1/n$ of the population, and a private signal that is specific to each agent in the economy. These take the form:

$$\text{Semi-public signal: } Z_i = \theta + \eta_i \tag{2}$$

$$\text{Private signal: } x_j^i = \theta + \varepsilon_j^i \tag{3}$$

Both η_j and ε_j^i are i.i.d normally distributed with zero mean and variance σ_η^2 and σ_ε^2, respectively. We define the relative precision of the semi-public signal as $\gamma = \frac{1}{\sigma_\varepsilon^2}$ and of the private signal $\beta = \frac{1}{\sigma_\eta^2}$. As interpreted by Geraats (2007, p), the noises η_j and ε_j^i express the difficulty the private sector has in interpreting the central bank's communication. When $\sigma_\eta^2 = \sigma_\varepsilon^2 = 0$, the signals Z_i and x_j^i communicate θ without any noise. There's no more information asymmetry and there's perfect transparency about the central bank's objective.
Following Morris and Shin (2002), actions are linear[9] function of signals:

$$a_j^i = \lambda Z_i + (1-\lambda) x_j^i \tag{4}$$

The superscript *i* denotes the group to which the agent *j* belongs.
Applying (2) and (3) on (1) then gives:

$$a_j^i = \frac{\gamma Z_i + \beta\left(1 - \frac{r}{n}\right) x_j^i}{\gamma + \beta\left(1 - \frac{r}{n}\right)} \tag{5}$$

With

$$\lambda_{eq} = \frac{\gamma}{\gamma + \beta\left(1 - \frac{r}{n}\right)} \tag{6}$$

This implies that

$$\bar{a} = \frac{\gamma \bar{Z} + \beta\left(1 - \frac{r}{n}\right) \theta}{\gamma + \beta\left(1 - \frac{r}{n}\right)} \tag{7}$$

Proof See Appendix A■

From equation (7), when the semi public information is imprecise ($\gamma \to 0$) or the number of fragmented information is unlimited ($n \to \infty$) or the private information is extremely imprecise ($\beta \to \infty$), the coordinating role of the semi-public signal is ignored.
If the semi-public information is very precise ($\gamma \to \infty$) or the private information is imprecise ($\beta \to 0$), then the private sector will ignore its own information and coordinate on the semi public information.

$\lim(\ )$	$\gamma \to 0$	$\gamma \to \infty$	$\beta \to 0$	$\beta \to \infty$	$n \to \infty$
$\bar{a}$	θ	$\bar{Z}$	$\bar{Z}$	θ	θ

The weight assigned to the public signal in anticipating the fundamental state is given by the relative precision of that signal: $\frac{\gamma}{\gamma + \beta}$. That is by its informational content. Thus, agents assign greater weight to the public signal because it contains information on the higher order beliefs in addition to information on fundamentals. However, the weight assigned to the semi

[9] To guarantee equilibrium uniqueness.

public signal is given by (6), which is always greater than the informational content of the signal.
The weight is an increasing function of the degree of complementarities r and the precision γ. It is decreasing in n. Clearly the more important the coordination motive is, the more likely that the agent acts closely to his estimation of average action ($\frac{\partial \lambda}{\partial r} > 0$). We find that in presence of many sectors, agents attach less weight to the semi public information ($\frac{\partial \lambda}{\partial n} < 0$).
Disseminating n semi public information is almost equivalent to disseminate one public information, observed by a proportion P of the whole population. A restriction on the degree of publicity of information will be more effective in avoiding adverse effects from the public announcement than a restriction on the information accuracy (Cornand and Heinemann (2008)[10]). A limited degree of publicity leads to common knowledge among the receivers and to P-common beliefs among the whole population. Fragmentation leads to common knowledge among agents belonging to the same group. Both fragmentation and P-common beliefs share the same goal, namely to confine the threats from detrimental effects of public information. In the same context, Heinemann and Illing (2002) suggest that the central bank should release information to each agent privately with some idiosyncratic noise. This solution may avoid commonality. The idea of fragmentation is that central bank should provide agents with more precise public information in addition to private information, but that public information differs within groups of agents.
Note that the limiting case where n=1 leads to the same decision function as in Morris and Shin (2002) paper, where each agent has an individual private information and a common information. In that case, agents may prefer to coordinate on the same action even with poor quality of public signal. The unique equilibrium will be:

$$a_j = \frac{\gamma}{\gamma + \beta(1-r)} y + \frac{\beta(1-r)}{\gamma + \beta(1-r)} x_j \quad (8)$$

Again, the weight attached to the public information in (8), (the case of Morris and Shin (2002)) exceeds the informational content on fundamental θ (which is $\frac{\gamma}{\gamma+\beta}$). This reflects the disproportionate impact of the public signal on the coordination of agents' actions. But mostly exceeds $\frac{\gamma}{\gamma + \beta\left(1 - \frac{r}{n}\right)}$ when $n \geq 2$. The overreaction to public information when information is fragmented is then weaker than when it is fully disseminated.

4. Welfare effects and policy implications

We now examine how the incentives of the private sector may be affected if the transparency components were subject to choice, depending also on the private sector's objectives.
The mixture (case 3) is a variant of Radner (1962).

Table 1- The loss functions and their corresponding first derivatives

[10] The only difference lies in the fact that Cornand and Heinemann (2008) investigate the number of private agents to be informed by a central bank while Morris and Shin (2007a) investigate the optimal number of signals to be disseminated.

Loss functions	Actions get right[11] Case 1	Reducing heterogeneity[12] Case 2	Mixture Case 3
	$\iint \left(a_j^i - \theta\right)^2 didj$	$\int\iiint \left(a_j^i - a_h^k\right) didkdhdj$	$E\left(L^{PS}\right) = (1-r)\iint \left(a_j^i - \theta\right)^2 didj + \frac{r}{2}\int\iiint \left(a_j^i - a_h^k\right) didkdhdj$
Varying r	$\frac{2\beta\gamma\frac{r}{n^2}}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^3} > 0$	$\frac{4\beta\gamma\frac{r-1}{n^2}}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^3} < 0$	$\frac{-\frac{\gamma}{n}}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^2} < 0$
Varying γ	$\frac{\beta(1-\frac{r}{n})(2\frac{r}{n}-1)-\gamma}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^3} \leq 0$	$2\left(1-\frac{1}{n}\right)\frac{\beta(1-\frac{r}{n})(2\frac{r}{n}-1)-\gamma}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^3} \leq 0$	$\frac{-\frac{1}{1-\frac{r}{n}}}{\left(\frac{\gamma}{1-\frac{r}{n}}+\beta\right)^2} < 0$
Varying n	$\frac{-2\beta\gamma\frac{r^2}{n^3}}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^3} < 0$	$\frac{2\beta\gamma\frac{r}{n^3}(1-r)+\frac{\gamma}{n^2}\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^3} > 0$	$\frac{\gamma\frac{r}{n^2}}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^2} > 0$
Varying β	$-\frac{(1-\frac{r^2}{n^2})\gamma+\beta\left(1-\frac{r}{n}\right)^3}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^3} \leq 0$	$2\left(1-\frac{r}{n}\right)\frac{\left(\frac{2-r}{n}-1\right)\gamma-\beta(1-\frac{r}{n})^2}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^3} \leq 0$	$\frac{-\left(1-\frac{r}{n}\right)^2}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^2} < 0$

Note: The cases coloured in yellow are the transparency components used by the central bank.

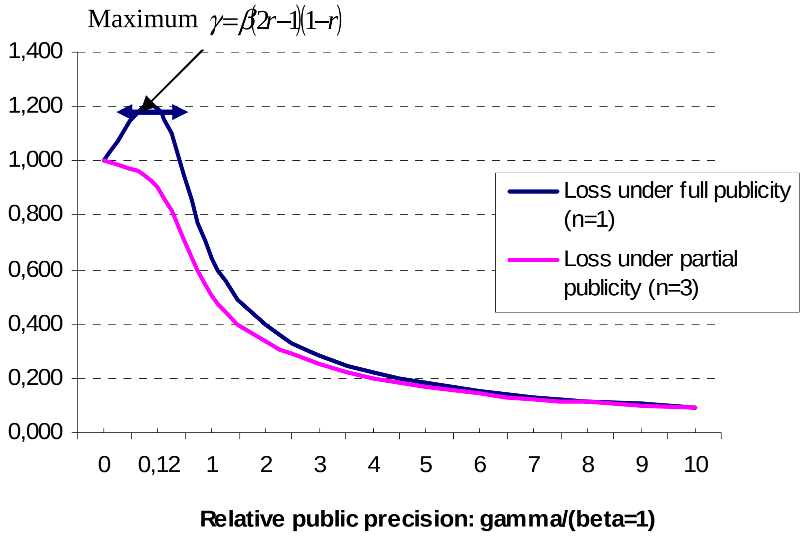
Remark 1 *The weight attached to the semi public information is the weight at which the loss function in case 3 is minimized.*
Proof See Appendix B■

We first examine how the overall loss of the private sector is affected through the existence of the term *r*, to be as close to the average expectations as possible.
We can see that an increase of the "beauty contest" term moves the action away from the otherwise optimum; this is because agents put less weigh on their own information. However, the coordination motive reduces the distance between pair wise individual actions, whose effect seems to be dominant as an increase of strategic complementarities degree leads to a reduction of the weighted sum of the two first losses.
In all cases, an increasing of the precision of the semi public information as well as the private information leads unambiguously to a reduction in the private sector's loss.

[11] Expression used by Morris (2005).
[12] Expression used by Morris (2005).

In the case of Morris and Shin (2002), which corresponds to a particular situation at the aggregate level of the first loss function when *n*=1, this is only true for a very specific choice of parameter values, the precision of the public information is beneficial to welfare only when it exceeds a certain threshold (See Fig1). According to that objective function, it is always beneficial that the central bank establishes fragmented information than sending unique public information. The central bank will not face a trade-off between enhancing commonality and the use of more precise, but fragmented information, as this latter leads always to better outcomes.

Fig 1 Loss against relative public information: Case 1 Actions get right



This trade-off is found in the last case (which is mainly our function of interest), as the marginal effect of the fragmentation measure has now the opposite sign ($\partial E\left(L^{PS}\right)/\partial n > 0$). The central bank has the choice between full publicity with low precision or to disseminate *n* semi-public information with an excellent quality. This is clearly shown in Fig 2. The parameters used for calibration are $r = 0.7, \beta = 1$.

The point A describes the benchmark situation in which the central bank discloses all the information (*n*=1) with precision GA (low). The corresponding loss is LA. We will illustrate the trade-off concept by comparing this situation to situations of more precise, but fragmented information (i.e. *n*=2).

At Point B(GB>GA, *n*=2): LB>LA: Full publicity with low precision is the best choice. There's no trade-off.

At Point C(GC>GA, *n*=2): LC<LA: more accurate fragmented information is the best choice. There's no trade-off.

Now, let D be another point that corresponds to a precision GD, *n* =1 and a corresponding loss LD.

At point C(GC>GD, *n*=2): LC=LD: the central bank faces a trade-off, because both strategies yield the same outcome.

Proposition 1 *With respect to the loss function described in case3, it is better for the central bank to disseminate fully public information with low precision if the ratio (high to low) precision is smaller than* $\dfrac{1-\frac{r}{n}}{1-r}$.

Proof See Appendix C■

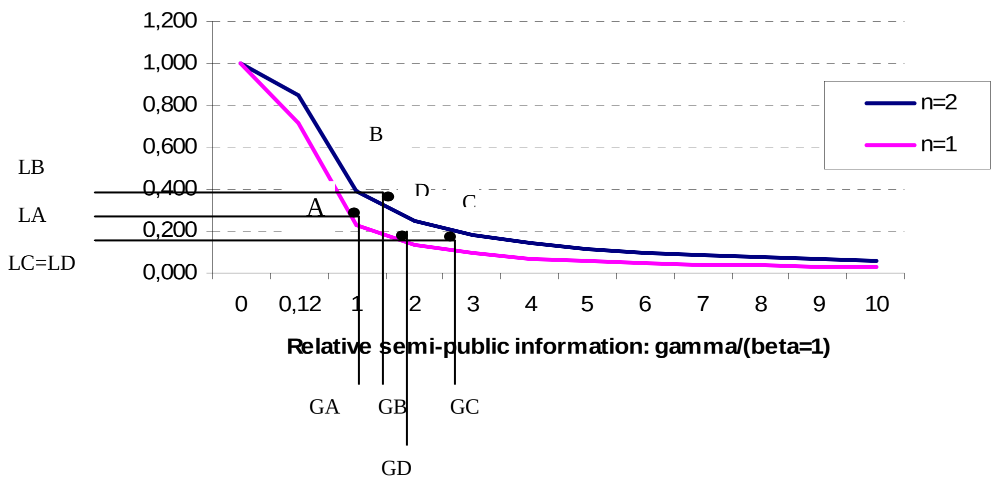


Fig 2 Loss varying with n
Case 3 Mixture

4.1. Strategic substitutability between the precision of the public and the private information

The analysis presented above which is mainly derived from Morris and Shin (2002, 2007a) frameworks made the assumption that no costs are attached to the provision of private information. We start by assuming a linear cost of improving the precision for a private agent. An assumption of a linear[13] cost seems to be logical since there is a competition between a large number of private information providers. In such a case, the cost of increasing the private precision would be the same for all agents, as underlined by Colombo and Femminis (2008).

$$C^{PS}(\beta) = c\beta, \qquad c > 0$$

$$E\left(T^{PS}\right) = E\left(L^{PS}\right) + C^{PS}(\beta) = \frac{1}{\dfrac{\gamma}{1-\frac{r}{n}} + \beta} + c\beta$$

An optimizing private sector is now faced with the first order condition:

[13] We treat the case of non linear costs in appendix D,

$$\frac{\partial E\left(T^{PS}\right)}{\partial \beta} = \frac{-1}{\left(\frac{\gamma}{1-\frac{r}{n}} + \beta\right)^2} + c = 0 \;\Rightarrow \beta^* = Max\left(0, \frac{1}{\sqrt{c}} - \frac{\gamma}{1-\frac{r}{n}}\right) \tag{9}$$

The second order condition is always met:

$$\frac{\partial^2 E\left(T^{PS}\right)}{\partial \beta^2} > 0 \Leftrightarrow \frac{2\left(1-\frac{r}{n}\right)^3}{\left[\gamma + \beta\left(1-\frac{r}{n}\right)\right]^3} > 0 \tag{10}$$

By differentiating (8), we obtain:

$$\frac{\partial \beta^*}{\partial \gamma} = -\frac{1}{1-\frac{r}{n}} < 0 \tag{11}$$

From (10), an increase of the precision of public information leads strictly and unambiguously to a reduction of the private information. Note that (10) is a function of the coordination motive *r* and the fragmentation measure *n*. The ratio 1/(1-r/n) is larger than one. In fact, if the coordination motive is large, an increase of the precision of the public information leads agents to overpower that information and this situation crowds out from investing in their specific information. However, if the number of semi-public information is large, this will urge agents to invest in their own information.

5. Discussion and avenue for future research

The public information could lead agents to make decisions more in line with fundamentals, but compared to the private information, it facilitates the coordination of agents. The coordination game's approach doesn't mean advocating the lack of transparency, but rather identifying the mechanism for information disclosure to prevent a situation of overreaction.
This paper outlines proposals regarding information policy dissemination that central banks could follow within a context of monetary policy. In fact, according to Cornand and Allegret (2006), the information dissemination policy shall benefit from the existence of at least four tools: the precision of information, the publicity degree of information, the number of information and granting private information upon request by agents[14]. If public announcements may be detrimental to welfare, then introducing a certain degree of uncertainty about their interpretation may reduce their focal potential and improves outcomes.
Giving the fact that "publicity" or common knowledge of the information plays a large role in coordinating expectations (Morris and Shin (2007b)), agents will attach more weight to the fragmented information. According to Gai and Shin (2003, p. 93): "a fragmented communication strategy is akin to an e-mail message in which the list of recipients is partially obscured. The recipient of such message cannot be sure whether everyone has received the same message". The fragmented nature, as commented by Gai and Shin (2003), of speeches and /or testimonies may lead to a difficulty to reach and capture the desired picture by the

[14] All these communication mechanisms are available in the central banking practice. In fact, central bankers are known for their "mystical" speeches. Cornand and Allegret (2006) made the example of the speech of Greenspan. The author refers the reader to their paper for more details.

market participants. This is not necessarily the case of other central bank's communication channels[15] such as inflation report, minutes, votes that provide a clear informational platform in order to disseminate a coherent message to the audience.
In a related paper, Lindner (2007) argues that central bank should not face a trade-off, but good public information is a precondition for an efficient use of fragmented information (see Table 2). Unlike theoretical works using global games framework to study how central bank's transparency affects welfare, in which transparency is viewed as an exogenous increase in precision of public announcement, Lindner (2007) treats transparency as a strategic choice by the central bank, namely the central bank's policy is derived endogenously in his model.

Table 2- Some theoretical findings

Morris and Shin (2007a)	- Fragmentation of information is a tool for limiting the overreaction to public signal used as a focal point by agents. - Central bank faces a trade-off between enhancing common knowledge and the precision of the information, to the extent that common knowledge becomes important, a greater precision of information may be detrimental if it comes at the expense of a greater fragmentation or this greater precision leads to an exacerbation of externalities in the use of that information.
Lindner (2007)	- Transparent policy is welfare enhancing even in presence of negative or positive externalities of actions coordination. This result is in contrast with the observations of Morris and Shin (2002). - Transparency is a precondition for an efficient use of private information by the agents.

6. Conclusion

The recent debate on central bank communication shows that this latter might be perceived as "a double edged" instrument. On one hand, there are good reasons to think that communication is a beneficial tool (see Lu (2008)), in the sense that it contributes to the effectiveness of monetary policy by steering expectations. On the other hand, the disclosure of all available information is often not optimal. If financial markets participants attach too much weight to central bank's views and don't take into account what they reflect as noisy signals, communication will be detrimental. Because communication is associated with both positive and negative aspects, an important, but scarcely explored question of what constitutes an optimal communication policy arises. This question remains unclear, with the exception of Morris and Shin (2007a) framework. They explain the precision- commonality trade-off: "it is not easy to communicate information in such a way that it becomes common knowledge within private sector", (Morris and Shin (2007b, p12). If the announcement is interpreted differently by the audience, then commonality is not achieved. The same effect is reached when some agents don't pay attention to the content of the announcement. This trade-off may

[15] These communication techniques, however, may lead to another problem which is the information overload: the receiver is unable to filter the information and evaluate which is the one she really needs.

illustrate the current debate surrounding the conduct of monetary policy. In fact, the bank of Norway, New Zealand and the Riksbank made the decision to publish their own forecasts of the policy rate. This decision puts these three inflation targeting countries "at the vanguard of the trend toward greater central bank disclosure" as commented by Morris and Shin (2007b). From a technical point of view, it will be interesting to test the theoretical predictions discussed above. One step in this direction would be referring to experimental economics. This will be examined in a forthcoming research.

References

Amato, J., S. Morris, and H. S. Shin (2002), "Communication and Monetary Policy," *Oxford Review of Economic Policy*, **18**(4), 495-503.

Andersson, M., H. Dillén and P. Sellin, (2006), "Monetary Policy Signaling and Movements in the Swedish Term Structure of Interest Rates," *Journal of Monetary Economics*, **53**(8), 1815–1855.

Angeletos, G. M., and A. Pavan (2004), "Transparency of Information and Coordination in Economies with Investment Complementarities," *American Economic Review* (Papers and Proceedings), **94**, 91-98.

Colombo, L. and G. Femminis (2008) "The social value of public information with costly information acquisition," *Economics Letters*, Elsevier, **100**(2), 196-199.

Cornand, C. (2006), "Speculative Attack and Informational Structure: An Experimental Study," *Review of International Economics*, **14**(5), 797-817.

Cornand, C., and J.P Allegret (2006), "La politique de diffusion de l'information : la transparence des banques centrales est-elle toujours préférable?", Revue française d'Economie, **21**(1), 87-126.

Cornand, C., and F. Heinemann (2008), "Optimal Degree of Public Information Dissemination," *Economic Journal*, April, **118**(518), 718-734.

Cruijsen, Carin A.B. van der, Sylvester C W Eijffinger, and Lex H Hoogduin (2010), "Optimal Central Bank Transparency", *Journal of International Money and Finance* **29**(8), 1482-1507

Demertzis, M. and M. Hoeberichts (2007), "The costs of increasing transparency", *Open Economies Review*, **18**(3), 263-280.

Ehrmann, M., and M. Fratzscher (2007a), "Communication and decision-making by central bank committees: different strategies, same effectiveness?" *Journal of Money, Credit and Banking*, **39**(2–3), 509-541.

Ehrmann, M., and M. Fratzscher (2007b), "Social value of public information: testing the limits to transparency," ECB Working Paper No. 821.

Gai, P., and H. S. Shin (2003), "Transparency and financial stability," *Financial Stability Review*, December.

Geraats, P. M. (2007), "The Mystique of Central Bank Speak," *International Journal of Central Banking*, **3**, 37-80.

Hellwig, C. (2005), "Heterogeneous Information and the Benefits of Transparency," UCLA mimeo.

Issing, O. (2005), "Communication, Transparency, Accountability: Monetary Policy in the Twenty-First Century," Federal Reserve Bank of St. Louis Review, **87**, 65-83.

Kohn, D. L., and B. Sack (2004), "Central Bank Talk: Does it Matter and Why?" In: Macroeconomics, Monetary Policy, and Financial Stability, Ottawa: Bank of Canada, 175-206.

Kozo, U. (2009), "Central Bank Communication and multiple Equilibria," IMES Discussion Paper Series 2009-E-5.

Lindner, A. (2007), "Does too much Transparency of central bank prevent Agents from using their private information," IWH Discussion Paper No. 16.

Mendes, Rhys R. (2008), "Information, Central bank communication and aggregate fluctuations," PhD Thesis, Department of Economics, University of Toronto, 110 p.

Morris, S., and H. S. Shin (2002), "The Social Value of Public Information," *American Economic Review*, **92**, 1521-1534.

Morris, S. (2005), "Higher order expectations in economics and finance: an overview", http://www.princeton.edu/~smorris/pdfs/cambridge-beauty-contests.pdf

Morris, S. and H. S. Shin (2005), "Central Bank Transparency and the Signal Value of Prices," *Brookings Papers on Economic Activity* **2**, 1-66.

Morris, S., and H. S. Shin (2007a), "Optimal Communication," *Journal of the European Economic Association*, **5**(2-3), 594-602.

Morris, S., and H. S. Shin (2007b), "Coordinating expectations in Monetary Policy," UCLA Economics Online Papers Series.

Morris, S., H. S., Shin and H. Tong (2006), "Social Value of Public Information: Morris and Shin (2002) is Actually Pro-Transparency, Not Con: Reply," *American Economic Review* **96**(1), 453-455.

Radner, R. (1962), "Team Decision Problems," *Annals of Mathematical Statistics*, **33**, 857-881.

Svensson, L.E (2006), "Social Value of public Information: Morris and Shin (2002) is actually pro-transparency, not cons," *American Economic Review*, **96**(1), 448-451.

Walsh, C.E (2007), "Optimal economic transparency", *International Journal of Central Banking*, **3**(1), 5-36.

Woodford, M. (2005), "Central Bank Communication and Policy Effectiveness", NBER Working Papers No 11898.

A. Derivation of equation (5)

Using the fact that the best linear expectation of fundamental θ is given by:

$$E_j^i(\theta)=\frac{\gamma Z_i+\beta x_j^i}{\gamma+\beta} \tag{12}$$

Recall that i designates the group to which individual j belongs.

And the average expected action:

$$\begin{aligned}
E_j^i(\bar{a}) &= E_j^i\left(\lambda\bar{Z}+(1-\lambda)\theta\right)\\
E_j^i(\bar{a}) &= \lambda\left(\frac{n-1}{n}E_j^i(\theta)+\frac{1}{n}Z_i\right)+(1-\lambda)E_j^i(\theta)\\
E_j^i(\bar{a}) &= \lambda\left(\frac{n-1}{n}\frac{\gamma Z_i+\beta x_j^i}{\gamma+\beta}+\frac{1}{n}Z_i\right)+(1-\lambda)\frac{\gamma Z_i+\beta x_j^i}{\gamma+\beta}\\
E_j^i(\bar{a}) &= \left(\frac{\gamma}{\gamma+\beta}+\frac{\lambda}{n}\frac{\beta}{\gamma+\beta}\right)Z_i+\left(1-\left(\frac{\gamma}{\gamma+\beta}+\frac{\lambda}{n}\frac{\beta}{\gamma+\beta}\right)\right)x_j^i
\end{aligned} \tag{13}$$

Plugging (12) and (13) into (1) yields:

$$a_j^i=(1-r)\frac{\gamma Z_i+\beta x_j^i}{\gamma+\beta}+r\left[\left(\frac{\gamma}{\gamma+\beta}+\frac{\lambda}{n}\frac{\beta}{\gamma+\beta}\right)Z_i+\left(1-\left(\frac{\gamma}{\gamma+\beta}+\frac{\lambda}{n}\frac{\beta}{\gamma+\beta}\right)\right)x_j^i\right] \tag{14}$$

Rearranging terms, we obtain (5).

B. Derivation of the loss functions and the weight attached to the semi-public information in (6)

Case 1: “Actions get right”

$$E_j^i[(a_j^i-\theta)^2]=\frac{\lambda^2}{\gamma}+\frac{(1-\lambda)^2}{\beta}=\frac{\gamma+\beta\left(1-\frac{r}{n}\right)^2}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^2} \tag{15}$$

Case 2: “Reducing heterogeneity”

$$E_j^i\left[E_h^k\left(a_h^k-a_j^i\right)^2\right]=\left[\frac{\lambda^2}{\gamma}\left(1-\frac{1}{n}\right)+\frac{(1-\lambda)^2}{\beta}\right]=\frac{2\left[\gamma\left(1-\frac{1}{n}\right)+\beta\left(1-\frac{r}{n}\right)^2\right]}{\left[\gamma+\beta\left(1-\frac{r}{n}\right)\right]^2} \quad (16)$$

Case 3: The mixture consists of the weighted sum of losses in case 1 and 2, we get then:

$$E\left(L^{PS}\right)=(1-r)E_j^i[\left(a_j^i-\theta\right)^2]+\frac{r}{2}E_j^i\left[E_h^k\left(a_h^k-a_j^i\right)^2\right]=\frac{1}{\frac{\gamma}{1-\frac{r}{n}}+\beta} \quad (17)$$

We propose now to find (6) by using the loss function in case 3:

Agents are faced with the minimization of their loss function given by:

$$E\left(L^{PS}\right)=(1-r)E_j^i[\left(a_j^i-\theta\right)^2]+\frac{r}{2}E_j^i\left[E_h^k\left(a_h^k-a_j^i\right)^2\right]$$
$$s.t \quad a_j^i=\lambda Z_i+(1-\lambda)x_j^i$$

We get: $$E\left(L^{PS}\right)=(1-r)\frac{\lambda^2}{\gamma}+\frac{(1-\lambda)^2}{\beta}+r\left[\frac{\lambda^2}{\gamma}\left(1-\frac{1}{n}\right)+\frac{(1-\lambda)^2}{\beta}\right] \quad (18)$$

Differentiating with respect to λ, we obtain:

$$\frac{\partial E\left(L^{PS}\right)}{\partial\lambda}=2\frac{\lambda}{\gamma}\left(1-\frac{r}{n}\right)-2\frac{(1-\lambda)}{\beta}=0\Leftrightarrow\lambda=\frac{\gamma}{\gamma+\beta\left(1-\frac{r}{n}\right)}.$$

We check for the second order condition: $\frac{\partial^2 E\left(L^{PS}\right)}{\partial\lambda^2}=2\frac{1}{\gamma}\left(1-\frac{r}{n}\right)+2\frac{1}{\beta}>0$. And the proof is complete

C. Proof of proposition 1

Recall that $E\left(L^{PS}\right)=\frac{1}{\frac{\gamma}{1-\frac{r}{n}}+\beta}$

We denote $\begin{cases}\gamma_1 lowprecision\\ \gamma_2 highprecision\end{cases}$

We calculate the expected loss function under full publicity and low precision, we get:

$$E\left(L^{PS} / n = 1, \gamma_1\right) = \frac{1}{\frac{\gamma_1}{1-r} + \beta}.$$

Similarly, we calculate the expected loss under fragmented information with high precision:

$$E\left(L^{PS} / n \geq 2, \gamma_1\right) = \frac{1}{\frac{\gamma_2}{1-\frac{r}{n}} + \beta}$$

We have $E\left(L^{PS} / n = 1, \gamma_1\right) \leq E\left(L^{PS} / n \geq 2, \gamma_2\right) \Leftrightarrow \frac{\gamma_2}{\gamma_1} \leq \frac{1 - r/n}{1-r}$

D. Introducing non linear costs

Following Demertzis and Hoeberichts (2007), we assume that costs are positive and unbounded:

$$C^{PS}(\beta) = c\beta^{\phi}, \qquad c > 0 \text{ and } \phi > 1$$

$$E\left(T^{PS}\right) = E\left(L^{PS}\right) + C^{PS}(\beta) = \frac{1}{\frac{\gamma}{1-\frac{r}{n}} + \beta} + c\beta^{\phi} \tag{19}$$

An optimizing private sector is now faced with the first order condition:

$$\frac{\partial E\left(T^{PS}\right)}{\partial \beta} = \frac{-1}{\left(\frac{\gamma}{1-\frac{r}{n}} + \beta\right)^2} + \phi c \beta^{\phi-1} = 0 \tag{19}$$

We check for the second order condition:

$$\frac{\partial^2 E\left(T^{PS}\right)}{\partial \beta^2} > 0 \Leftrightarrow \frac{2\left(1-\frac{r}{n}\right)^3}{\left[\gamma + \beta\left(1-\frac{r}{n}\right)\right]^3} + \phi(\phi-1)\beta^{\phi-2} > 0 \text{ which is always satisfied.}$$