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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. Cornand and Heinemann (2008) suggest rather limiting the publicity degree. We found that the same effect can be reached by establishing fragmented public information, but in presence of private signal.
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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 (see 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[1]. 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[2]. 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)[3] 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"[4]. 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[5] in Morris and Shin (2007a), but we assume 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 public information may be detrimental for social welfare as agents overreact to the public information. We found a relationship between that case and the P-common beliefs of Cornand and Heinemann (2008).

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

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

[3] "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)

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

[5] 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)

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).

The remainder of this paper is as follows. In section 2, we describe the model; it develops a short stylized model of the reception of two types of signals. In section 3, we characterize the equilibrium set and some properties of the equilibria. In section 4, we present the welfare outcomes. Finally, some concluding remarks will be offered in section 5.

2. The Set up

The basic model of the central bank’s communication strategies centres around an index, denoted θ, of fundamentally relevant variables and represents the state of the economy. For example, publishing interest rate forecasts is a way to communicate about central bank’s view of the state of economy.

The time structure of the game is as follows. There is a continuum of agents in the unit interval [0, 1] that get random a private signal x_j. There are n ‘semi public’ signals Z_i observed each by a proportion of 1/n of the whole population. Having available two signals, agents need to decide on the weight that should be attached to each when forming their expectations. The determining factor for the allocation of weights is the relative precision of the two signals. Defining the precision of Z_i as γ and of x_j as β, implies that the expected value of the fundamental is given by:

$$E_{ij}(\theta) = \frac{\gamma Z_i + \beta x_j}{\gamma + \beta} \tag{1}$$

This expression allows us to analyse heterogeneity in expectations. Agents weigh the two signals according to the same loss function, following Radner (1961):

$$L = (1-r)\int (a_k - \theta)^2 dk + \frac{r}{2}\iint (a_k - a_m)^2 dkdm \tag{2}$$

The solution to this model is determined by solving the equilibrium conditions backwards.

3. The Equilibrium

In this section, we look at the equilibrium strategy of agents. Agent *j* of type *i* minimizes his loss function according to (2) by choosing the following action a_{ij}:

$$a_{ij} = (1-r)E_{ij}(\theta) + rE_{ij}(\bar{a}) \tag{3}$$

With $\bar{a}$ is the average action. The expected level of the economy $E_{ij}(\theta)$ and the average action of other agents expected by agent *j* of type *i* $E_{ij}(\bar{a})$ depend on information published by central bank.

Agents know that there are *n* different types of agents. The equilibrium may be found by the “Guess and Solve” method. Assuming the fact that an action a_{ij} is a linear combination of the overall activity level expected by the agent and the overall activity level expected by the central bank gives the following representation of the optimal strategy a_{ij}:

$$a_{ij} = \lambda Z_i + (1-\lambda)x_j \tag{4}$$

Where,

$$\begin{aligned} x_j &= \theta + \varepsilon_j, \qquad \varepsilon_j \to N\left(0, \sigma_\varepsilon^2 = \frac{1}{\beta}\right) \\ Z_i &= \theta + \eta_i, \qquad \eta_{\mathrm{i}} \to N\left(0, \sigma_\eta^2 = \frac{1}{\gamma}\right) \end{aligned} \tag{5}$$

We use this assumption for determining $E_{ij}(\bar{a})$, we obtain:

$$a_{ij} = \left(\frac{\gamma}{\gamma+\beta} + \frac{\lambda}{n}\frac{r\beta}{\gamma+\beta}\right)Z_i + \left(\frac{\beta}{\gamma+\beta} - \frac{\lambda}{n}\frac{r\beta}{\gamma+\beta}\right)x_j \tag{6}$$

If all agents behave according to (6), it is optimal for them to do it with: $\lambda = \left(\frac{\gamma}{\gamma+\beta} + \frac{\lambda}{n}\frac{r\beta}{\gamma+\beta}\right)$ from which we can deduce:

$$\lambda = \frac{\gamma}{\gamma + \beta\left(1 - \frac{1}{n}r\right)} \tag{7}$$

The weight assigned to the semi 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 public signal is given by (7), 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 acting in close alignment with other agents is, the more closely to his estimation of average action the agent acts ($\frac{\partial\lambda}{\partial r} > 0$). Again, we find that in presence of many sectors, agents attach less weight to the semi public information ($\frac{\partial\lambda}{\partial n} < 0$). Another result is that the weight is the same found in Cornand and Heinemann[6] framework: The equilibrium strategy of an agent j$\in [0, P]$: $a_j = \lambda y + (1-\lambda)x_j$. The weight associated to the public signal is given by: $\lambda_{eq} = \frac{\gamma}{\gamma + \beta(1 - rP)}$[7].

Then, 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

[6] Cornand and Heinemann (2008) investigate the number of private agents to be informed by a central bank. Morris and Shin (2007) investigate the optimal number of signals to be disseminated.
[7] Details of calculations are available in Cornand and Heinemann (2008) paper.

(2008)). This illustrates the equivalence between the P-common beliefs and the fragmentation of information. 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 objective, namely to confine the threats from detrimental effects of public information. In the same context, Heinemann and Illing (2002) suggest that 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:

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

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 $n \geq 2$. Then, with fragmented information, the overreaction to public announcement is weaker in theoretical models which are based on pure public information. This result is more in line with previous experimental results (particularly Cornand (2006)).

The overall loss function[8] is given by:

$$L = (1-r)\left(\frac{\lambda^2}{\gamma} + \frac{(1-\lambda)^2}{\beta}\right) + r\frac{\lambda^2}{\gamma}\left(1-\frac{1}{n}\right) = \frac{1}{\frac{\gamma}{1-\frac{r}{n}} + \beta}\left(1 - \frac{r\beta}{\frac{\gamma}{1-\frac{r}{n}} + \beta}\right) \tag{9}$$

The loss function consists of two weighted parts: the first part represents the deviation from the true state $\int (a_k - \theta)^2 dk$; the second part is the fragmentation loss $\iint (Z_k - Z_m)^2 dkdm$.

[8] We don't include the deviation from private information. It is not our purpose. That's why we conserve the same loss function as in Morris and Shin (2007), which takes into account the deviation from the true state of economy and the fragmentation loss from the semi public information.

4. Welfare effects

The objective of all agents is to minimize their loss function. The overall loss is given by expression (9), the first order derivative are as follows:

$$\frac{\partial L}{\partial n}=\frac{\gamma\frac{r}{n^2}}{\left(\frac{\gamma}{1-\frac{r}{n}}+\beta\right)^2\left(1-\frac{r}{n}\right)^2}\left(1-\frac{2r\beta}{\frac{\gamma}{1-\frac{r}{n}}+\beta}\right) \tag{10}$$

$$\frac{\partial L}{\partial \gamma}=\frac{-\frac{1}{1-\frac{r}{n}}}{\left(\frac{\gamma}{1-\frac{r}{n}}+\beta\right)^2}\left(1-\frac{2r\beta}{\frac{\gamma}{1-\frac{r}{n}}+\beta}\right) \tag{11}$$

Proposition 1 *Assume that* $r \leq \frac{1}{2}$. *Then L is; (i) increasing in n (ii) decreasing in* γ

Proposition 2 *Assume that* $r > \frac{1}{2}$. *Then L is; (i) decreasing in n if* $n \geq \max\left\{2, r\frac{\beta(2r\text{-}1)}{\beta(2r\text{-}1)-\gamma}\right\}$ *; (ii) decreasing in* γ *if* $\gamma \geq \beta(2r-1)\left(1-\frac{r}{n}\right)$

Thus, overreaction can be avoided by establishing fragmented information that has the role of limiting the negative effects of publicity.

We conclude that even for another specific informational structure, central bank faces a trade-off between enhancing common knowledge and the use of fragmented information. If few sectors *n* exist, this existence shall favour the higher order beliefs. 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 market participants. This is not necessarily the case of other central bank's communication channels 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 1). 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 1- *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.

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.

Towards a multidimensional information policy dissemination

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 particular, we have discussed one of dissemination policy's modalities, namely the publicity degree of information which can be reached by establishing a fragmented information *à la* Morris and Shin. 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[9]. 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.

[9] 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 speech of Greenspan. The author refers the reader to their paper for more details.

5. Discussion and Concluding remarks

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 (2007) 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 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.

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A. Derivation of equation (6)

Using the fact that the expected value of fundamental is given by:

$$E_{ij}(\theta) = \frac{\gamma Z_i + \beta x_j}{\gamma + \beta} \tag{12}$$

And the average expected action:

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

Putting (12) and (13) together yields:

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

Rearranging terms, we obtain (6).

B. Derivation of the loss function (9)

The loss consists of two weighted parts. The first part is:

$$\int (a_{kj} - \theta)^2 dk = E[\lambda Z_k + (1-\lambda)x_j - \theta]^2 = E[\lambda \varepsilon_k + (1-\lambda)\eta_j]^2 = \frac{\lambda^2}{\gamma} + \frac{(1-\lambda)^2}{\beta} \tag{15}$$

The second part is

$$\iint (Z_k - Z_m)^2 dk dm = \left(1 - \frac{1}{n}\right)E(\varepsilon_k - \varepsilon_m)^2 = \left(1 - \frac{1}{n}\right)\frac{2}{\gamma} \tag{16}$$

Summing up this two weighted parts and simplifying give equation (9).