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Social Value of Information and Optimal Communication Policy of Central Banks

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Abstract

Monetary policy as a tool for expectations management is believed to be most effective if it can coordinate the beliefs and expectations of the economic agents. The optimal communication policy is in an environment where central bank announcements are common knowledge and abundant information is complete transparency. The above conclusion is altered in the more realistic situation where economic agents face uncertainty regarding underlying economic fundamentals combined with strategic complementarity between player's actions. The optimal communication policy in a case with imperfect common knowledge is incomplete transparency or a degree of opacity. Uncertainty about the underlying economic state in the presence of strategic complementarity is the origin for the emergence of imperfect common knowledge. We further develop these issues in the context of a Lucas-island model. Full policy transparency in this setting leads to an economic distortion residing in a wedge between economic agent's expectations and optimal fundamental-based allocations—dubbed as over-reaction to the central bank announcements.

Key Words: *Optimal communication policy, Common sense, Strategic complementarity, Transparency*

JEL Classifications: *E50, E58, E59, G11, G12, G13, G14*

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Introduction

When economic agents decide or act independently, or in other words, agents make their choice(s) regardless of what others do, having more information is generally helpful and beneficial, and it makes little difference whether the additional information is private or public. Under perfect competition individuals make decisions based on market prices and the action or perception of other agents regarding prices and quantities do not enter in their decision process.[1] Within this type of market structure availability of more information, either private or public improves welfare. Can the same general conclusion be extended to situations or social settings where decision by an individual depends on other individual or group decisions? In other words, does the above conclusion stands in cases where an individual's payoff depends on the action of other economic agents motivated by their belief. In this case, I would certainly pay attention to what other people think and expect. This is a situation of strategic complementarities amongst economic agents. In these models with strategic complementarities, if it is assumed that there is no uncertainty about others' beliefs and there is a common knowledge about fundamentals, there can be indeterminate equilibriums arising from beliefs (Cooper 1999).

In many actual cases, particularly in the asset (financial) markets, there seems to have been an apparent indeterminacy in beliefs in the sense that one set of beliefs motivate actions which bring about the state envisaged in the beliefs, while another set of fulfilling beliefs bring about quite different outcomes. In both cases, the beliefs are logically coherent and consistent with the known features of the economy. However, they are not fully determined

1. In the economy with symmetric information, the informational requirements for competitive equilibrium are very weak. If each agent knows market prices and maximizes utility subject to his budget constraint, and market clears, then we have a competitive equilibrium. It is not necessary to assume anything about what agents believe or know about other agent's behavior, market clearing or anything else.

by the underlying description of the economy and leaving a role for sunspots[1].

For example, there is a fundamental indeterminacy in the level of prices where an increase in one agent's strategy increases the optimal strategy of the other agents which is called strategic complementarities. In this case, when businesses set prices, they must form beliefs about how others are setting prices now and in the future. How others set prices will depend on what they think about inflation and so on. Beliefs in this setting may be self-fulfilling. Thus it is no coincidence that monetary policy in particular is subject to much commentary on how people are interpreting it; how they think others are interpreting it, and so on. Therefore, there is a large coordination dimension with much indeterminacy in outcomes called sunspots.

Such self-fulfilling expectations generally occur when various agents' actions depend on each other but cannot be synchronized. Consider a situation where sunspots activity is observed by all agents in the economy. If in this setting sunspot activity turn out to be a good predictor of pricing behavior by other agents, it becomes a significant cause of their pricing decision that can coordinate expectations. However, to coordinate expectations, mere observation of sunspot activity does not suffice and an additional element, common knowledge[2] amongst agents, is needed so that every agent observes the sunspot and each and every agent is acting on the sunspot similarly. Common knowledge is knowledge that is known and shared by everyone;

1. The rational expectation forecast errors in linear rational expectation models are due to two sources, namely, the fundamental shocks and a vector of sunspot shocks. If the forecast error is expressed as a function of the exogenous fundamental shocks, there will be a unique stable (saddle path) solution for the linear rational expectation model because it eliminates explosive components of endogenous variables such as price. In other words, the solution is unique, if the mapping from fundamentals exogenous shocks to forecast errors is one-to-one. On the other hand, if the fundamental shocks fail to completely explain the rational expectation forecast errors, the forecast error will be a function of sunspots as well. In this case, linear rational expectation model is indeterminate (Sink) and we encounter multiple equilibrium.

2 . This segment is based on Morris and Shin (2005).

every agent knows that each and every agent shares this knowledge until an infinite degree of secularity.

Morris and Shin (2002) argue that in models (games) with strategic complementarities if we do not have uncertainty about fundamentals, the payoff we obtain depends on our beliefs about the actions of other players (agents); hence we get multiple equilibriums for payoffs. They also show that under imperfect common knowledge emanating from idiosyncratic uncertainty about the fundamentals, resulting in uncertainty about other agents' actions due to the presence of strategic complementarities, unique equilibrium is obtained[1]. Under imperfect common knowledge, sunspots can contribute to approximate common knowledge by sending signals for coordination on unique equilibrium. Under imperfect common knowledge central bank announcements regarding economic fundamentals can be viewed to play a role of sunspots other than its role as a device to convey information about fundamentals.[2]

If economic agents are persuaded that central bank's announcements (as a sunspot) can coordinate expectations about interest rates and prices, then CB has a ready-made signaling instrument (believable information or announcements believed by the public) to influence outcomes. The effectiveness of central banking as sunspots entails that CB statements have the same general features as the sunspots discussed in the above. That is, all agents must observe it. Moreover, it needs to be common knowledge observable by all. Furthermore, there should be common knowledge of the exact meaning of the policy statement. That is; CB policy communications must be transparent (Morris and Shin 2002). Note that in this setting, there are two aspects to CB announcements. It is an instrument for communicating information regarding CB's current views on the economy as well as current

1. For more information refer to global game theory in literature.

2. Throughout the discussions we assume that the central bank acts as a social planner, although in practice the loss function of the monetary authority may not coincide with the representative agent.

and future policy action, say, regarding interest rate. In this capacity many CBs want to be transparent in their announcements. CB communications are also a focal point for economic actors and functions as coordination instrument regarding fundamental variables, say, interest rates or exchange rates.

This dual role may have unintended consequences in an environment of imperfect common knowledge.[1] On the one hand, effective signaling can promote coordination powers of CB to guide public belief towards fundamentals. On the other, this capacity has the potential to do some damage if expectations are coordinated actions away from fundamentals (Amato and Morris 2006). If the public puts a large weight on public signals in forming their expectations on fundamentals, then there is a possibility of overreaction to public (CB) signals (announcements) and magnify the harm caused by public signal noise. Hence, the value of public information should be assessed by its dual role of sending fundamental information and as a central reference for improved coordination.

This paper attempts to examine the controversy surrounding the issue of optimal communication in central banks. The issue involves complete transparency under rational expectation, along with perfect common knowledge. This transparent communication policy, which is generally prescribed in the standard inflation targeting package, has been criticized by the above underlying assumption regarding perfect common knowledge and replacing it with imperfect common knowledge under rational expectation. In this paper we further develop the Lucas-Phelps island economy model in a situation of imperfect common knowledge and discuss the issues in this setting. The latter is derived from more realistic assumptions regarding uncertainty about underlying state of the economy and the existence

1. Plausibly, when CB has perfect foresight and there is no information cost, no harm is associated with CB's role as a social planner.

of strategic complementarity among agent's actions. This setting results in solutions that point to sub-optimality of complete transparent communication policy. The interesting and non-trivial result from the model suggests that under certain circumstances partial transparent communication policy is superior.

Section one formalizes the discussion on CB communication policy in an environment of imperfect common knowledge arising from strategic complementarities amongst economic agents and uncertainty regarding economic fundamentals [Morris and Shin (2002)] in conjunction with a Lucas-island model that shows how higher order beliefs can result in overreaction to public signals. We present differing views on the degree of transparency by the Central Bank (CB). Morris and Shin (2002) argue that when private information signals are low signals and the public signals are associated with inaccuracies, transparency by CB can have harmful consequences due to overreaction to noise contaminated public signals. Section two discusses the welfare implications of public overreactions. Section three provides counter arguments to Morris and Shin by Svensson (2006) and generalization of Morris and Shin by Baeriswyl (2011) as a response to Svenssons's criticism are also discussed. Section four provides policy implications based on the issues discussed in the paper.

1. Theoretical Background

In this section we provide an analytic discussion and evaluation of the issues in the context of a Lucas-Phelps island economy. Here, we have further developed and extended a simple beauty contest set up used by Morris and Shin (2002), which is a static representation for a variety of settings with incomplete (dispersed) information and strategic complementarity. By casting this model in an island economy model environment, [Phelps (1970) Lucas (1972, 1973)] some macroeconomic foundation and structure can be infused to it. Following these papers, assume an economy that consists of a large number of small islands (or distinct geographical regions) with a single (homogeneous) commodity whose supply function in the i[th] island is described by:

$$y_i^s = b\left[p_i - E_i\big((\bar{p}|\Omega_i)\big)\right] \quad (1)$$

where p_i represents the price of the commodity in island (i), $\bar{p}$ represents the economy-wide average price throughout all islands, and $b > 0$ is a parameter. The expectation operator $E_i(\bar{p})$ denotes the expectation of the economy-wide price level given the information available to agents in island (i). This equation can give rise to an environment in which strategic complementarity between agents in different islands occurs. Note that, residents in island (i) do not exactly know $\bar{p}$ hence they have to form an expectation based on their information set. Output of the good in each island depends on the price of that good in other islands.

The demand for the goods in island (i), (y_i^d) linearly and inversely is related to the price of the goods in island (i). It also depends on the best estimate of some underlying fundamental (or scale) variable, m, the money supply which is assumed to be controlled by the central bank:

$$y_i^d = c\left[E_i\big((m|\Omega_i)\big) - p_i\right] \quad (2)$$

Where c is a parameter reflecting the sensitivity of demand to own price. Summing across all firms in island (i) yields the aggregate demand in i. Note that uncertainty regarding other island prices does not affect demand for residents in island (i). However, uncertainty regarding the fundamentals (here m) enters into the demand functions. Equations (1) and (2) yield the market clearing price in island i:

$$p_i = (1-r)E_i\big((m|\Omega_i)\big) + rE_i\big((\bar{p}|\Omega_i)\big) \quad (3)$$

where $r = \frac{b}{b+c}$. This is the pricing rule obtained by Phelps (1983). In the original formulation of Lucas island economy, it is assumed that the information set in island i (Ω_i) is the same as information set in other islands like j (Ω_j). However, the interpretation in the context in which (3) holds is different. In this model although fundamental variable (m) as in the original version of the island economy model is a variable that the central bank has full control over, and is known across agents in the islands, hence, it is a "common knowledge", but there is also an idiosyncratic effect which originates from heterogeneity of information set between islands ($\Omega_i \neq \Omega_j$) due to private information that is not common knowledge

Parameter r between zero and unity governs the strategic interaction between islands. Agents in each island assign a positive weight on the expected fundamental variable (m) and a weight equal to r on the expected action of others, to arrive at the price in island i. If r is large (close to 1) price decisions in island (i) is dominated by anticipation of what others do, rather than what the fundamentals are. Equation (3) has the interpretation in the spirit of the beauty contest example mentioned in Keynes General theory (1936).

Based on equation (3), the price of goods for agents in island (i) is influenced by two sources of uncertainty: uncertainty about the expectation of the economy-wide price in island i given the information set available to the agents in island, and uncertainty about fundamental variable. In the simplest, base case m is common knowledge, hence the equilibrium implies $p_i = m$ for all i. That is, under perfect information, individual rational actions are consistent with socially optimal actions. However, if we relax the perfect common knowledge assumption, what would be the effect of the degree of information precision regarding the fundamental variable on the profile of prices throughout islands? Does more precision on the fundamental variable imply that prices are more closely aligned to the money supply? This is where we can appreciate the signaling role of the central bank. To start, let us consider a case where the fundamental variable (m) is not common knowledge.[1]

Does greater information precision on money supply mean that the prices are tied closer to the fundamentals?[2]We now examine the case where money supply is not common knowledge.

As it is shown in equation (3), price in island (i) depends on the realization of a fundamental state of the economy (money supply) which is unobserved. Fundamental variable has a prior distribution which is common knowledge. At the start of the play, nature picks a value for the money supply, which the players cannot observe. There are two sorts of signals on money supply: public and private signal.

Public signal is commonly observed by the residents in all islands. This signal can be taken to represent information gleaned from newspaper articles or other sources that report on central bank procedures. The public signal is given by:

$$y = m + \varepsilon \qquad ; \varepsilon \sim N\left(0, \frac{1}{k_y}\right) \tag{4}$$

Where ε is distributed normally, independent of m, with mean zero and standard deviation $\frac{1}{k_y}$. The fundamental variable (m) is the true value of money supply and y is a noise-contaminated public signal for m—for instance, the monetary policy instrument. In addition to the public signal (y), residents of island (i) observe the realization of a private signal:

$$x_i = m + \nu_i \qquad ; \nu_i \sim N\left(0, \frac{1}{k_x}\right) \tag{5}$$

Noise (ν_i) associated with the private signal (x_i) is distributed normally

1. The arguments follow Amato, Morris and Shin (2002a), Morris and Shin (2002b).
2. Phelps (1983) posed this question in the context of an economy in which the central bank is determined to combat the inflation expectation of the private sector agents, and noted that the answer depends on the interaction of beliefs between agents.

with mean zero and standard deviation $\frac{1}{k_x}$, and is independent of m and ε, hence $E(\nu_i\nu_j) = 0$ for $i \neq j$. The private signal can be taken to represent any information that each island has observed but is not common knowledge, such as news received through private discussions. This is the sense in which these signals are private.[1]

The information set available to residents of island (i) is limited to observation on the pair (y, x_i). Residents of each island form posteriors about the money supply and the signals received by other islands on the above information set. k_x represents the precision of the private signal and k_y denotes the precision of the public information. The expected value of m based on both private and public information available in island (i) can be calculated by Bayes updating rule as:

$$E_i(m|x_i, y) = \frac{k_x}{k_x + k_y} x_i + \frac{k_y}{k_x + k_y} y \tag{6}$$

$\frac{k_x}{k_x+k_y}$ and $\frac{k_y}{k_x+k_y}$ are precision weights of private and public signal, respectively. The variance of this expectation can be calculated by combining the variances of the two stochastic error terms of public and private signals:

$$E_i(m|x_i, y) = \frac{k_x}{k_x + k_y} x_i + \frac{k_y}{k_x + k_y} y \tag{7}$$

Substituting equation (6) in equation (3) and solving the difference equation with the method of undetermined coefficients, the price in island (i) will be:

$$p_i = \frac{(1-r)k_x}{(1-r)k_x + k_y} x_i + \frac{k_y}{(1-r)k_x + k_y} y \tag{8}$$

Note that when r = 0, the best response is given by $p_i = E_i(m|x_i, y)$, hence an agent's action is based on his own expectation. In this case, the

1. The assumption that each member of the public receives a noisy private signal regarding the fundamental variables is used in the literature on global games which attempts to model situations of imperfect common knowledge. See Morris and Shin (2001).

weight of each signal, public and private, corresponds to their relative precision. But when there is strategic complementarity (r#0), agents put less weight on their own (private) signal relative to the case where there is no strategic interaction (r=0), and put more weight on the public signal[1]. In this case, the aggregate price in the economy is given by:

$$\bar{p} = \frac{(1-r)k_x}{(1-r)k_x + k_y} m + \frac{k_y}{(1-r)k_x + k_y} y \\ = m + \frac{k_y}{(1-r)k_x + k_y} \varepsilon \tag{9}$$

As can be seen, that coefficient on ε is increasing in r. Therefore, the presence of strategic complementarity amplifies the impact of the noise associated with public signal (ε) on the aggregate price (outcome).

Allen, Morris and Shin (2002) extended this argument to an asset pricing model where the price of an asset today is the average of islanders' expectation of tomorrow's price. From (3), we can get the best response of the residents in island (i) as in (10):

$$p_i = (1-r)E_i(m) + rE_i\left(\int p_j dj\right) \tag{10}$$

Substituting for p_j in (10) and iterating the equation forward, equation (11) can be obtained.

$$p_i = (1-r)E_i(m) + (1-r)rE_i\left(\bar{E}(m)\right) \\ + (1-r)r^2E_i\left(\bar{E}^2(m)\right) \\ + \cdots = (1-r)\sum_{k=0}^{\infty} r^k E_i\left(\bar{E}^k(m)\right) \tag{11}$$

1. Consider the case in which precision of both signals are the same. The weight of private signal is $\frac{1-r}{2-r}$ and weight of public signal: $\frac{1}{2-r}$. With the presence of strategic complementarity, public signal weight is more than private signal. But, in the absence of strategic interaction the weight of public and private signals are both equal $(\frac{1}{2})$.

$\bar{E}(m)$ Stands for the average expectation operator as given by:

$$\bar{E}(m) = \int E_j[.]dj \tag{12}$$

Equation (11) yields the optimal price in each island which is a geometric sum of higher order beliefs about money supply. Note that the greater the strategic complementarity, the greater the weight placed on higher-order beliefs about *m*. In order to determine the expression for p_i in (11) we must solve for $E_i\left(\bar{E}^k(m)\right)$. Recall from (6) that the expected price of residents in island (i) for money supply is:

$$E_i(m|x_i, y) = \frac{k_x}{k_x + k_y}x_i + \frac{k_y}{k_x + k_y}y \tag{12-1}$$

By integration of (6.1) across islands, the average expectation for money supply can be obtained as:

$$\bar{E}(m) = \int E_j[(m|x_j, y)]dj = \frac{k_x}{k_x + k_y}m + \frac{k_y}{k_x + k_y}y \tag{13}$$

Now, the expectation of residents in island (i) of the average expectation of money supply $\bar{E}(m)$ in other islands is:

From (14), we can surmise that, the average expectation operator does not satisfy the law of iterated expectation when there is asymmetric information, i.e. information across agents are not homogeneous because of differences in their information set due to different private signals. That is to say, the average expectation of islander i for the average expectation of money supply is not the same as the average expectation of money supply. This is because of the stipulation that expectation of residents in island (i) regarding the expectation of island (j)'s expectation about money supply partially depends on his private signal--and crucially does not solely depend on a common signal, private or public.

$$\begin{aligned}
&E_i\big((\bar{E}(m)|x_i,y)\big) = E_i\left(\frac{k_x}{k_x+k_y}m + \frac{k_y}{k_x+k_y}y\right)\\
&= \frac{k_x}{k_x+k_y}E_i\big((m|x_i,y)\big) + \frac{k_y}{k_x+k_y}y\\
&= \frac{k_x}{k_x+k_y}\left(\frac{k_x}{k_x+k_y}x_i + \frac{k_y}{k_x+k_y}y\right) + \frac{k_y}{k_x+k_y}y\\
&= \frac{\left(\left(k_x+k_y\right)^2 - {k_x}^2\right)}{\left(k_x+k_y\right)^2}\,y + \frac{{k_x}^2}{\left(k_x+k_y\right)^2}x_i
\end{aligned} \tag{14}$$

$$\begin{aligned}
&E_i\big(E_j(m)\big|x_i,y\big) = E_i\left(\frac{k_x}{k_x+k_y}x_j + \frac{k_y}{k_x+k_y}y\bigg|x_i,y\right)\\
&= \frac{k_x}{k_x+k_y}E_i\big(x_j\big) + \frac{k_y}{k_x+k_y}y\\
&= \frac{k_x}{k_x+k_y}\left(\frac{k_x}{k_x+k_y}x_i + \frac{k_y}{k_x+k_y}y\right) + \frac{k_y}{k_x+k_y}y\\
&= E_i(m|x_i,y) + \frac{k_xk_y}{\left(k_x+k_y\right)^2}(y-x_i)
\end{aligned} \tag{15}$$

So long as public signals for islander i deviates from her private signal-that is, $(y - x_i)$ is non-zero, the law of iterated expectation does not apply. For instance, if islander (i) observes a low public signal about money supply (say a low y; 100) and a high private signal regarding the same variable *m* (say x_i 200), he forms an average expectation of *m* based on their relative precision weights $(\frac{k_x}{k_x+k_y}, \frac{k_y}{k_x+k_y})$, however, islander (i) expects islander (j) to have a lower expectation for m compared to his own expectation, because the second term on the right-hand-side is negative (200-100). The converse also stands.[1]

Higher order expectation (average of average expectation of average expectation of m) as in (14) puts more weight on the (noisy) public information, that is, the value of y becomes more weighty and the second term on the RHS becomes with less significant weights (hence the precision weight of the actual m) for formation of $\bar{E}^k(m)$. For instance, when k tends to infinity, the weight of m tends towards zero, and the coefficient of y tends towards unity—that is, the k[th] order belief of m, $\bar{E}^k(m)$: equals public signal. By induction we have:

$$\bar{E}^k(m) = (1 - \left(\frac{k_x}{k_x + k_y}\right)^k)\, y + \left(\frac{k_x}{k_x + k_y}\right)^k m \tag{16}$$

Note that, since y=m+ε, higher order beliefs are more sensitive to the noise in the public signal than lower orders. By substituting (16) in equation (11) we obtain:

$$p_i = \frac{(1-r)k_x}{(1-r)k_x + k_y} x_i + \frac{k_y}{(1-r)k_x + k_y} y \tag{16-1}$$

which is exactly equation (8), we found before. This explicit solution allows us to address the important question of how the precision of public disclosures of central banks regarding the variable of interest (m) can affect welfare. Is the welfare always improving with the increase in the precision of public signal about money supply? We answer this question through an explicit policy loss function as in Morris and Shin (2002).

1.If islander (i) observes a high public signal (200) and a low private signal (100) on money supply with the same relative precision weights, she forms identical expectation on m, however, islander (i) expects islander (j) to have a higher expectation of m than for him.

2. Social Value of Public Information

Given our previous discussions regarding the possibility of overreaction to public signals, we continue to assess welfare implications of overreactions. Based on the beauty contest model discussed in the first section, under perfect information, like Lucas islands $m=p_i$, the question is in what ways precision of public information matters for alignments between prices and the money supply (fundamental variable).[1] We can specify a loss function following Morris and Shin (2002) by defining a unit integral of the difference between p_is across islands and the money supply as in (17):

$$L = \int_0^1 (p_i - m)^2 di \tag{17}$$

To minimize social loss, the central bank attempts to minimize the distance between the decision of agents (i) regarding price in each island (p_i) and *m*. When uncertainty is absent regarding *m,* prices are identical across all islands and equal to *m* and there is no loss. However, in the presence of uncertainty regarding the fundamentals, *L* measures the social loss and can be reduced by the ability of islanders to better approximate *m*. Note that the loss in welfare does not only emanate from coordination by itself, rather from information spillovers created by second guessing the decisions of other agents throughout the islands. Such external effect on prices is socially inefficient because, as assumed [by Morris and Shin (2000)], it is zero-sum hence gain by winners is compensated by the loss of the losers. The rate of externality on price decision can be measured by the strategic

1. In a simple equilibrium setting only relative prices have implications for resource allocation. However, in an incomplete information setting where monetary policy actions work through market expectations, price levels transmit information regarding future financial conditions, therefore, their tightness with the fundamentals matters, Morris and Shin, (2002).

complementarities parameter r (as it appears in equation 3)[1].

For computing the loss function, let us assume that islander (i) knows for certain the behavior of other islanders and they all observe announcement on m by the central bank as common knowledge[2], however, they are uncertain regarding the fundamental (m) signaled by the central bank. Note that since in this case there is no private signal we focus on public information and errors associated with it. Thus, in this case posteriors via Bayes updating rule can be derived as:

$$(m|y) \sim \mathbb{N}\left(y, \frac{1}{k_y}\right) \tag{18}$$

By symmetry, the unique equilibrium is given by:

$$p_i = \bar{p} = E(m|y) = y \tag{19}$$

Expected loss conditional on *m* is thus given by:

$$E(m|y) = E\int_0^1 (p_i - m)^2 di \rightarrow= E(y-m)^2 \rightarrow= \frac{1}{k_y} \tag{20}$$

Therefore, based on (20), social loss is decreasing in the precision of public signal (k_y). We now compare this result with the more general case in which residents in each island have private information (x_i) in addition to public information (y). From previous discussions we know that with private and public signal, the unique equilibrium is given by equation (8). We can rewrite the equilibrium price in (8) as:

1. Note that, the zero sum nature of coordination element is questioned by Woodford (2005), Angeletos and Pavan (2004) and Hellwig (2004). They believe that coordination itself has some social value, and by adding the value of coordination to social welfare function in Morris and Shin (2002) more public information precision will always be welfare improving.
2. That is, they all have observed announcement on m they all know that others have also observed the announcement, and they all have the same understanding regarding the announcement.

$$p_i = m + \frac{(1-r)k_x}{(1-r)k_x + k_y} v_i + \frac{k_y}{(1-r)k_x + k_y} \varepsilon \tag{21}$$

If in equation (21) r = 0, the two types of noises, private and public, would be given weights in price determination proportionate to their respective precision as in (22):

$$p_i = m + \frac{k_x}{k_x + k_y} v_i + \frac{k_y}{k_x + k_y} \varepsilon \tag{22}$$

Since r=0, equation (22) represents a case where there is no spillover effect coming from coordination role of the central bank announcement (public signal). In the presence of strategic complementarity, (22) is not valid, because, the public signal gets a larger weight (i.e. overreaction to public signal) its noise also finds a relatively larger weight as in (21). What is the effect of the above over-reaction to public signal on the loss function? The expected social loss, given *m*, is obtained squaring the difference between *m* and p_i in (21) is shown by (23)

$$E(L|m) = \frac{(1-r)^2 k_x + k_y}{((1-r)k_x + k_y)^2} \tag{23}$$

From (23) we can find the effect of increased precision of private signal on expected social loss. This can be done by taking the derivative of the expected loss with respect to k_x.

$$\frac{\partial E(L|m)}{\partial k_x} = (r-1)(\frac{(1+r)k_y + (1-r)^2 k_x}{\left(k_y + (1-r)k_x\right)^3} < 0 \tag{24}$$

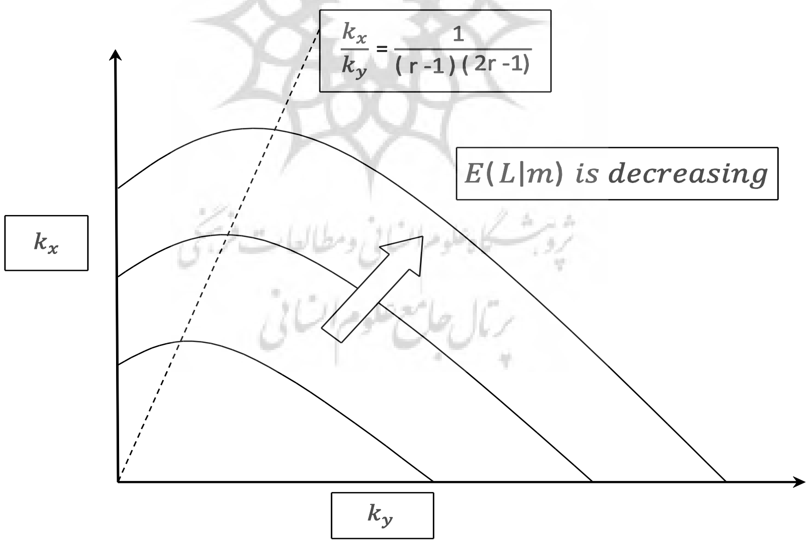
From (24) it is clear that social loss is decreasing with respect to private signal precision. However, if we take the derivative of social loss with respect to public signal precision, we get a different conclusion regarding the impact of public signal precision.

$$\frac{\partial E(L|m)}{\partial k_y} = \frac{-k_y + (1-r)(2r-1)k_x}{\left(k_y + (1-r)k_x\right)^3} \tag{25}$$

For determining the sign of (25) we observe the following

$$\frac{\partial E(L|m)}{\partial k_y} < 0 \qquad iff \qquad \frac{k_x}{k_y} < \frac{1}{(1-r)(2r-1)} \tag{26}$$

Figure 1: Social loss contours across Island



If r>0.5, there exists a range of values for parameter k_x *and* k_y whereby more precision of public information results in large social loss. Morris and Shin (2000) found that k_x must be sufficiently low, that is, private signal not very precise, so that higher precision of public information to be welfare improving.

Figure 1 shows that each curve is the locus of the pairs of k_x and k_y that correspond to the same level of social loss across islands (1). The curves or the contours show pairs of (k_x,k_y) that satisfy $\frac{(1-r)^2 k_x+k_y}{((1-r)k_x+k_y)^2} = constant$, for r greater than 0.5. The interpretation is that when the parameter of strategic complementary is high, r>0.5, i.e. "coordination motive" is high; hence individuals put more weight on the public signal or information (rather than private signal or fundamentals) to decide on their own action. If public information is not accurate, the above behavior results in over-reaction to public announcements. This behavior is welfare reducing since there is a wedge between the actual equilibrium and the fundamental equilibrium. Increasing the precision of public information helps agents coordinate their true actions, but they coordinate at the expense of choosing actions that are further away from the true money supply (m). The impact of the error in the public signal is amplified, leading to excess volatility. Since the planner wants agents to be close to the fundamental as possible, he finds this over-reaction to public noise, or excess volatility, socially costly.

In case where r<0.5, i.e. "coordination motive" is not high, the same quality of public information (as in the above case) is welfare improving. This is due to the first order effect that more accurate information implies that prices will be closer to money supply (fundamentals). On the other hand, when agents have a strong desire to coordinate (r>0.5), agents place more weight on public signal relative to private signal when choosing their equilibrium prices.

3. Critique of Morris and Shin Model

Svensson (2005) makes two observations regarding the base-line Morris and Shin model (2002). Firstly, the result that welfare is locally decreasing in the precision of public information holds only with restriction on information parameters that are empirically very restrictive. Secondly, when precision of the public signal is not less than that for the private information, availability of the public information results in higher welfare than in a case when the public signal is absent. In other words, the expression $f(r) = (1 - r)(2r - 1)$ in (26) reaches a maximum of $f(r) \leq f\left(\frac{3}{4}\right) = \frac{1}{8}$ when $r = \frac{3}{4}$. If "coordination motive" is high (r>0.5), condition (26) is violated if $\frac{k_x}{k_y} < 8$. In other words, private signal precision must be 8 times higher than that for public signal to allow for over-reaction by individuals. However, in line with their delegated mandates central banks have invested large resources in gathering, processing, and scrutinizing economic data, including receiving and purchasing of data from private entities thus have better access to economy-wide public and private information than any single private individual or company to (Romer and Romer 2000).

In reaction to Svensson (2005), Baeriswyl (2011) questioned the specification of the social welfare function in Morris and Shin (2002).[1] In particular, the zero-sum nature of the "coordination element" is a specific case of a more general social welfare function in which the negative effect of public signal transparency due to economic distortion (stabilization) is completely compensated by dispersion (coordination) at the social level. Baeriswyl (2011) introduced a non-zero sum social welfare and assumes that both the dispersion of prices[2] across islands $\int_0^1 (p_i - \bar{p})^2 di$ and the distortion of the average prices from money supply $(m - \bar{p})^2$ will reduce the social level of welfare. Therefore, the social loss function is:

1. On this Also see Woodford (2005) and Hellwig (2004).
2. When there are different prices for the same good in the economy called price dispersion, agents buys more of the relatively cheaper goods and less of the relatively more expensive goods. Because of diminishing marginal utility, the increase in utility derived from consuming more of some goods is less than the loss in utility due to consuming less of the more expensive goods. Hence, price dispersion reduces utility. This is the dynamic markup distortion originates from sticky prices and staggered price setting in canonical form of new Keynesian economics [Walsh (2010)].

$$L(p, m) = \int_0^1 (p_i - \bar{p})^2 di + \lambda(m - \bar{p})^2 \tag{27}$$

where p is the profile of prices among all islands and the parameter λ depicts the weight of economic distortion emanating from money supply (fundamental variable). The social loss shown in equation (27) may explain different specifications including the loss incurred by the representative household-derived from a micro-founded monopolistically competitive economy. The welfare in Morris and Shin is a special case that corresponds to the loss in (27) where $\lambda = 1$ (Baeriswyl 2011). Considering equation (22), the expected social loss can be calculated as:

$$E(L|m) = \frac{(1 - r)^2 k_x + \lambda k_y}{((1 - r)k_x + k_y)^2} \tag{28}$$

If the derivative of expected loss with respect to public signal precision k_y is taken, the following relationship is obtained:

$$\frac{\partial E(L|m)}{\partial k_y} = \frac{-\lambda k_y + (1 - r)(\lambda - 2(1 - r))k_x}{\left(k_y + (1 - r)k_x\right)^3} \tag{29}$$

Hence,

$$\frac{\partial E(L|m)}{\partial k_y} < 0 \qquad if \qquad \frac{k_x}{k_y} < \frac{1}{\lambda(1 - r)(\lambda - 2(1 - r))} \tag{30}$$

The expression $\lambda(1 - r)[\lambda - 2(1 - r)]$ in the denominator of equation (30) reaches its maximum when the value of strategic complementarity parameter (r) equals $r = 1 - \frac{\lambda}{4}$ which corresponds to $\frac{k_x}{k_y} < \frac{\lambda^3}{8}$. This result shows that if the social value of coordination is smaller than in Morris and Shin ($\lambda > 1$), Svensson's (2006) argument pertaining to unrealistic conditions for detrimental effect of transparency is invalid. In this case, lower transparency may be optimal even when the accuracy of public signal is higher than the private one. For example suppose the case where $\lambda = 2$, the maximum value of $\frac{k_x}{k_y}$ considering equation (30) equals unity for $\lambda = \frac{1}{2}$. This result shows that the overreaction effect of full-transparency may emerge even where the accuracy of both private and public signals are the same.

Considering the above results, it can be inferred that the issue of communication strategy of the central bank goes beyond the question of whether disclosing information is desirable or not: it also deals with the question of how to disclose the information in such a way that the market does not excessively overreact to it. Controlling the degree of market participant's overreaction to its disclosure is an important and challenging task for a central bank.

While the debate between Morris and Shin and Svensson focuses on two extreme cases of information disclosure (full transparency vs. full opacity), Cornand and Heinemann (2008) and Baeriswyl (2011) show that limited information publicity improves welfare by reducing the degree of common knowledge and thus limiting the overreaction of agents to public information. The theoretical literature envisages two disclosure strategies for reducing the overreaction of market participants to public information, partial publicity and partial transparency. The first one consists of disclosing the transparent information to a fraction of market participants only [Cornand and Heinemann (2008)]. The degree of publicity is determined by the fraction of market participants who receive the public signal. Choosing a communication channel which does not reach all market participants reduces overreaction to the disclosure as the uninformed participants can not react to it, whereas the informed participants react less strongly as they know that some of their peers are uninformed. The second strategy consists of disclosing ambiguous public information to all market participants [Heinemann and Illing (2002)]. The degree of transparency is determined by the idiosyncratic inaccuracy of the public signal disclosed to all market participants. Communicating with ambiguity reduces overreaction since ambiguity entails uncertainty about how other market participants interpret the disclosure, which mitigates its signaling role.

4. Conclusion

While in not so distant past central banks had a reputation for secrecy, over the last three decades central bankers and the majority of monetary economists subscribe to the idea that central bank transparency is one of the pillars of modern monetary policy and enhances its effectiveness. This idea seems to particularly fit the Inflation Targeting policy framework. In a case where the public is completely informed about the targets and policies of the central bank, a transparent communication policy can coordinate beliefs and expectations through common knowledge formation among economic agents. Given the importance of economic agents' perception regarding the current and future course of monetary policies and its impact on shaping their subjective expectation, central bank's potential to control real economic activities is enhanced by its ability to coordinate and manage public's expectations. Hence, the central bank must always be careful about the perceptions and expectations of economic agents regarding the fundamentals and take them into account when policy measures are announced. This expectations-channel for transmission of monetary policy increases the importance of communication policy in formulating optimal monetary policy.

Blinder (2009) believes that in an environment where the central bank commits to its announced rule-based policies, optimal communication policy should be completely transparent. In this setting, when monetary policy—as viewed by private economic agents—is highly predictable, it results in more effectiveness of the central bank measures and announcements through alignment of beliefs and expectations. This conclusion is violated in an imperfect common knowledge setting where economic agents face uncertainty regarding underlying economic state in combination with strategic complementarity among players' payoffs. Under this condition, economic agents are uncertain about both underlying economic fundamentals and the action of other players that may influence their decisions. Hence, public announcements by the central bank as a common knowledge not only convey information on the underlying fundamentals, but also may play a signaling role for coordination amongst economic agents trying to approximate common knowledge. If the central bank has the signaling instrument to influence outcomes, potential misallocations can result if expectations are coordinated actions away from fundamentals. When private information has low signals and public signals are contaminated with inaccuracies, transparency by central bank can have harmful consequences due to overreaction to public signals. In other words, inevitable error of central bank in terms of data collection, economic variables prediction and other sources of measurement errors pass on through announcements to public and provide a wedge between fundamental based equilibrium and the expectation-based sunspot equilibrium.

Svensson (2006) argues that the necessary condition for the emergence of the above mentioned overreaction, hence the case against full transparency, is far from reality. For transparency to be harmful to welfare in Morris and Shin (2002), the central bank information has to be less accurate than private information. In reality, however, the information available to public institutions is generally more accurate than information available privately. Morris, Shin and Tong (2006) respond to this criticism by incorporating correlated signals in their analysis and by showing that the result holds even if the public signal is more accurate than the private signals. In this paper we examined the relevance of these issues via a Lucas-island type model. Moreover, we assessed welfare implications of overreaction to public signals and examined the range of parameters that support Morris and Shin view and those that support the position supported by Svensson.

Policy conclusions that can be inferred from the discussions in this paper are: when central bank announcements are common knowledge and information is abundant, the optimal communication policy is complete transparency. However, in the more realistic situation where there is imperfect common knowledge in combination with strategic complementarity between player's actions, the optimal communication policy is incomplete transparency or a degree of opacity. When private information has low signals and public signals are contaminated with inaccuracies, transparency by central bank can have harmful consequences due to overreaction to public signals. In other words, inevitable error of central bank in terms of data collection, economic variables prediction and other sources of measurement errors pass on through announcements to public and provide a wedge between fundamental based equilibrium and the expectation-based sunspot equilibrium. In such a setting, tackling the overreaction problem entails reducing the degree of common knowledge about public information.[1]

References

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

0 Angeletos, G. M., & A. Pavan, (2004). *Transparency of information and coordination in economies with investment complementarities* (No. w10391). National Bureau of Economic Research.

0 Baeriswyl, R. (2011). "Endogenous central bank information and the optimal degree of transparency". *International Journal of Central Banking*, *7*(2), 85-111.

0 Baeriswyl, R., & C. Cornand, (2011). "Transparency and monetary policy effectiveness". *Annals of Economics and Statistics/Annales d'Économie et de Statistique*, 175-194.

0 Cooper, R. (1999). *Coordination games*. Cambridge University Press.

1. As mentioned previously, this can be performed by two proposed communication strategies: partial publicity and partial transparency. In the latter the public signals are unveiled only to a group of economic agents and in the former strategy; the public signal is disclosed with an idiosyncratic noise involving ambiguity of the central bank.

0 Cornand, C., & F. Heinemann, (2008). “Optimal degree of public information dissemination”. *The Economic Journal*, *118*(528), 718-742.

0 Heinemann, F., & G. Illing, (2002). “Speculative attacks: unique equilibrium and transparency”. Journal of International Economics, 58(2), 429-450.

0 Hellwig, C. (2004). *Heterogeneous information and the benefits of public information disclosures (October 2005)* (No. 283). UCLA Department of Economics.

0 Lucas, R. E. (1972). “Expectations and the neutrality of money”. *Journal of economic theory*, *4*(2), 103-124.

0 Lucas, R. E. (1973). “Some international evidence on output-inflation trade-offs”. *The American Economic Review*, 326-334.

0 Morris, S., & H. S. Shin, (2002). “Social value of public information”. *The American Economic Review*, *92*(5), 1521-1534.

0 Morris, S., & H. S. Shin, (2005). “Central bank transparency and the signal value of prices”. *Brookings Papers on Economic Activity*, *2005*(2), 1-66.

0 Morris, S., & H. S. Shin, (2007). “Optimal communication”. *Journal of the European Economic Association*, *5*(2-3), 594-602.

0 Morris, S., & Shin, H. S. (2001). “Rethinking multiple equilibria in macroeconomic modeling”. In *NBER Macroeconomics Annual 2000, Volume 15*(pp. 139-182). MIT Press.

0 Morris, S., and H. S. Shin, & H. Tong, (2006). “Social value of public information”. *The American Economic Review*, 453-455.

0 Phelps, Edmund S. (1970). "Introduction," in E. S. Phelps et al., eds., Microeconomic foundations of employment and information theory. New York: Norton, pp. 1-23.

0 Phelps, Edmund S. "The trouble with rational expectations and the problem of inflation stabilization," in R. Frydman and E. S. Phelps, eds., Individual forecasting and aggregate outcomes. New York: Cambridge University Press, 1983, pp. 31-40.

0 Romer, C. D., & D. H. Romer, (2000). “Federal Reserve information and the behavior of interest rates (Digest Summary)”. *American Economic Review*, *90*(3), 429-457.

0 Svensson, Lars E. O. (2006). “Social value of public information: Comment: Morris and Shin (2002) is actually pro transparency”, *American Economic Review*, 96(1), pp. 448–452.

0 Ui, T. (2003). “A note on the Lucas model: iterated expectations and the neutrality of money”. *Unpublished paper, Yokohama National University*.

0 Walsh, C. E. (2010). *Monetary theory and policy*. MIT press.

0 Woodford, M. (2005). “Central bank communication and policy effectiveness” (No. w11898). *National Bureau of Economic Research.*