Institut für Wirtschaftsforschung Halle
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Evaluating communication strategies for public agencies: transparency, opacity, and secrecy

Axel Lindner

August 2008 No. 8

IWH-Diskussionspapiere
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Abstract

This paper analyses in a simple global games framework welfare effects stemming from different communication strategies of public agencies if strategies of agents are complementary to each other: communication can either be fully transparent, or the agency opaquely publishes only its overall assessment of the economy, or it keeps information completely secret. It is shown that private agents put more weight to their private information in the transparent case than in case of opacity. Thus, in many cases, the appropriate measure against overreliance on public information is giving more details to the public instead of denying access to public information.

Keywords: transparency; private information; common knowledge.
JEL-Codes: D83, E58

Zusammenfassung

Der Beitrag analysiert im Rahmen eines einfachen Global Games-Ansatzes die Wohlfahrtseffekte verschiedener Kommunikationsstrategien von Behörden, etwa von Zentralbanken: Sie können entweder vollständig *transparent* sein und alle Informationen veröffentlichen, die sie haben; oder sie veröffentlichen nur die aus diesen Informationen gewonnene Gesamteinschätzung über den Zustand der Volkswirtschaft. Diese Kommunikationsstrategie wird *opak* genannt. Schließlich besteht auch die Mglichkeit, alle Informationen vollkommen *geheim* zu halten. Es wird gezeigt, dass sich die privaten Wirtschaftssubjekte im Fall von Transparenz stärker an ihrer privaten Information orientieren als im Fall opaker Kommunikation. Das bedeutet, dass in vielen Fällen das geeignete Instrument gegen eine Übergewichtung von öffentlichen Angaben durch Private nicht die Zurückhaltung dieser Angaben ist. Vielmehr sollten auch diejenigen Informationen veröffentlicht werden, welche den Angaben der Behörden zugrunde liegen.

Schlagwörter: Transparenz; Private Information; Common Knowledge.
JEL-Codes: D83, E58

* I would like to thank participants in the session "monetary transparency and heterogeneity" at the 2007 meeting of the European Economic Association, Diemo Dietrich, Juliane Scharff and Marco Sunder for helpful comments on an earlier version of this paper. Any errors are my own.

Contents

1 Introduction **5**

2 A formal framework **8**

3 Equilibrium strategies of agents **10**

3.1 The case of secrecy 11

3.2 The case of transparent communication 11

3.3 The case of opaque communication 13

3.4 Comparing equilibrium strategies in the cases of transparency and opacity 15

4 Welfare effects of different communication policies **17**

5 Conclusions **19**

A Appendix **21**

A.1 Exact form of equation (8) 21

A.2 Deriving $E_i(\Theta_{-i})$ and $E_i(\Theta)$ 21

A.3 Proof of proposition 1 21

A.4 Deriving the welfare function for transparency 22

A.5 Deriving the welfare function for opacity 22

A.6 Proof of proposition 2 23

References **24**

Evaluating communication strategies for public agencies: transparency, opacity, and secrecy

1 Introduction

In July 2007, when the recent crisis on credit markets was just about to start, Chuck Prince, then chief executive of Citigroup, told the Financial Times: "When the music stops, in terms of liquidity, things will be complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing."[1] This quote can serve as a fitting description for two aspects that many observers think are typical for financial markets: first, agents tend to behave like other market participants or, using a technical term, their strategies are strategic complements; and second, what behaviour the agents coordinate on might depend on outside signals; such signals should have, like music, the property that all agents observe them and know that all agents observe them; in short, the signals should be common knowledge. Such a behaviour of agents on financial markets appears, as the recent credit crisis suggests, suboptimal from a social point of view, and one reason for this is that agents might focus too much on the public signals and thus disregard valuable private information about the fundamental state of the economy. Such a reasoning was formalized by Morris and Shin (2002): they show that if the central bank has the option to publish information about the fundamental state of the economy as common knowledge, and coordination of agents is irrelevant for welfare, then it might be better not to publish information that might have the effect that private information about the state of the economy is neglected, because agents focus too much on public information in order to coordinate their behaviour.

[1] In autumn 2007 large writedowns on commitments to lend made clear that Citigroup had expanded its exposure to the credit markets for too long, and Mr Prince had soon to resign.

This paper argues that the stark alternative of either giving public information or not is an oversimplification; if the information structure is formulated a bit richer and, as it is argued here, more realistic, interesting options about what sort of information should be published arise. In particular, we assume that the central bank or, put more generally, a public agency has specific information about the fundamental state of subsectors of the whole economy, and that it can either communicate *all* these pieces of information to the public or just publish the *overall* assessment about the fundamental state of the economy or publish *nothing*. The first policy of communication is called *transparent*, the second *opaque*, and the third *secret*. The transparent policy does not yield better common knowledge about the state of the overall economy than in the case of the opaque policy. However, the detailed account on the information which has led to the assessment by the public agency makes the agents' private information on the economy more valuable. This is so because each agent is expert for a specific sector of the economy, and a detailed account from the agency gives valuable information to the agent about those sectors she is not expert of. One interesting result that can be derived from this framework is that private agents put always more weight on their private information with transparent communication than with opaque communication, although the latter gives less public information. The reason for this result is that a transparent communication gives the agents a better chance to utilize their own information. Thus, for a certain range of parameter values, the appropriate measure against overreliance on public signals might be to give more detailed information to the public instead of denying any access to public information. From a welfare point of view, it can be shown that transparency is always better than opacity. However, if complementarities are strong and public information lacks precision, secrecy is best. Moreover, for an infinity of sectors, transparent communication is equivalent to opacity and the model presented here reproduces the results of Morris/Shin (2002).

The framework this paper uses is still quite simple: the overall economy is just the sum of all the specific sectors. There are, however, real world cases that resemble this very simple framework quite well. Here are two examples for *opaque* communication: firstly, the European Central Bank regularly publishes forecasts for growth and inflation in the euro area. These forecasts are, inter alia, derived from a euro area wide model, and from assessments for the single countries the euro area consists of; these assessments are, however, not published. A second example is the regular publication of the quarterly national accounts data for the euro area by Eurostat, the statistical office of the European Union (and for single EU countries by some national statistical offices): an overall figure for GDP is published about three weeks before the publication of results for the main components of GDP.[2]

The paper is a contribution to the theory on the macroeconomic implications of higher order believes in a global games context. Starting with the seminal articel of Morris and Shin (1998), a rich literature on this topic has evolved. Many contributions (see, e.g. Bacchetta and van Wincoop (2007)) focus on implications for the evaluation of assets. The paper that comes closest to our contribution is Gosselin et al. (2007), because, similar to the paper at hand, it distinguishes between different degrees of transparency. Gosselin et al. add the interest rate to the list of signals that the central bank can reveal and analyze under which conditions it is preferable to publish only the interest rate or all the bank's information about the economy. Morris and Shin (2007) assume that the central bank can either publish several pieces of information for experts or an overall assessment for the public, but not both. Lindner (2006) analyzes conditions for multiplicity of equilibria in a global games context that is similar to that presented here. Eijffinger und Geraats (2006) as well as Geraats (2006) give an overview about theoretical and empirical aspects

[2] Because the first estimate of national accounts data is subject to large revisions, the statistics offices in some countries such as Canada and Australia postpone publication until it is more comprehensive.

concerning transparency of central banks. Crowe and Meade (2008) show that more central bank transparency is associated with more accurate private sector forecasts. Andersen et al. (2005) show that publications of macroeconomic news indeed have discernible effects on asset valuations on financial markets.

The rest of the paper proceeds as follows: section 2 sets the framework. In section 3 equilibrium strategies of private agents depending on the communication policy of the public agency are derived. Section 4 compares the welfare effects of the different policies depending on the parameters of the model. Section 5 sums up and gives an outlook on possible future research.

2 A formal framework

The basic model of the public agency's communication policies builds on the approach in Morris/Shin (2002). It centres around a parameter Θ that represents the fundamental state of the economy: the higher Θ, the more productive is economic activity. There is a continuum of agents of unit mass indexed by $g \in [0;1]$. An agent g chooses her own activity level a_g such that her utility function $u_g(a,\Theta)$ is maximized:

$$u_g(a,\Theta) = -(1-r)(a_g-\Theta)^2 - r(L_g - \overline{L}) \tag{1}$$

with $0 \leq r < 1$,

$$L_g = \int_0^1 (a_h - a_g)^2 dh$$

and

$$\overline{L} = \int_0^1 L_h dh$$

Equation (1) shows that agent g has the incentive to align her activity level a_g to the fundamental state of the overall economy Θ. In addition, the agent benefits from aligning her action to those of the other agents (or from "coordination" of actions), with $(1-r)$ and r as the factors that give the two parts of the utility function their respective weights. The second part implies an externality: if other agents are good in aligning their actions to each other (if $\overline{L}$ is low), agent g gets lower utility. Thus, this part of the utility function gives agents an incentive to play a zero-sum game that resembles the famous "beauty contest" that served Keynes (1936, chapter 12) as a metaphor for modern stock market activities. Social welfare can be expressed by the normalized average of individual utilities:

$$V(a,\Theta) = \frac{1}{1-r}\int_0^1 u_g(a,\Theta)dg = -\int_0^1 (a_g - \Theta)^2 dg \tag{2}$$

Thus, a public agency that aims at maximizing social welfare should look for a communication policy that makes agents aligning their activity level to the fundamental state of the overall economy as closely as possible.

Parameter Θ is a catch-all variable for the fundamental state of the economy; it equals the sum of all fundamental states θ_i of the n sectors ($n \geq 2$) the economy consists of:

$$\Theta = \sum_{i=1}^{n} \theta_i \tag{3}$$

Every agent g is expert in one sector: an agent of type i is expert in sector i. This means that she knows the realisation of the fundamental state of one sector i, θ_i, with certainty. Experts are equally distributed over the sectors: $1/n$th of all agents are experts for a sector i. It is common knowledge that the realizations of the fundamental states in the single sectors are correlated in the same way. In particular, an agent of type i knows that the realization of the fundamental state in a sector j

is $\theta_j = \theta_i + \varepsilon_j$, with ε_j as independent and identically distributed random variable with mean zero and variance $1/\delta$ (precision δ), whose realization is not known by an agent of type i.[3] In the following, it suffices to identify an agent g just by her type i.

The public agency observes noisy signals $x_i = \theta_i + \eta_i$ over the fundamental states of the single sectors, with η_i as independent and identically distributed random variable with mean zero and variance $1/\gamma$ (precision γ). Thus, while it is not as well informed as the agents are about their own sector, it has some valuable information about every sector of the economy. The agency can choose between three communication policies: the first is called *transparent*. Here, it publishes the detailed reasons for the overall assessment X, i.e. making all x_i and with them $X = \sum_{i=1}^{n} x_i$ common knowledge. The second policy is called *opaque*, because it publishes only its assessment X of the fundamental state in the overall economy. Third, the agency can be *secret* and publish no information at all.

Next we look at the equilibrium strategies of agents under the three different regimes of public communication.

3 Equilibrium strategies of agents

An agent of type i minimizes her loss according to (1) by choosing the action a_i:[4]

$$a_i = (1-r)E_i(\Theta) + rE_i(\overline{a}) \tag{4}$$

[3] This framework is similar to that of Lindner (2007). That paper, however, works with the simplifying assumption of $\delta = 0$.

[4] This equation follows from the first order condition $\partial u_i / \partial a_i = 0$.

with $\overline{a}$ as the average action of all agents $\int_0^1 a_h dh$. The expected fundamental state of the economy $E_i(\Theta)$ and the average action of other agents $E_i(\overline{a})$ expected by an agent of type i depend on the information published by the public agency.

3.1 The case of secrecy

If the agency does not publish any information, the aspect of strategic interaction vanishes: because everyone has only her private information, $E_i(\Theta) = n\theta_i$ and $E_i(\theta_{j\neq i}) = \theta_i$. The optimal strategy $a_{i,s}$ (with the subscript s for secrecy) for an agent of type i is simply, to align her activity level to her estimation of the fundamental state in the overall economy:

$$a_{i,s} = n\theta_i$$

3.2 The case of transparent communication

The equilibrium can be found by the "Guess and solve"-method. First we take the hypothesis that in equilibrium, the action $a_{i,t}$ (with the subscript t for the transparent case) of a type-i agent is a linear combination of the overall fundamental state expected by an agent of type i, $E_i(\Theta)$, and of the overall fundamental state expected by the public agency X:

$$a_{i,t} = (1 - \lambda_t)E_i(\Theta) + \lambda_t X \qquad (5)$$

with the coefficient λ_t as a still to be determined function of the exogenous parameters of the model. An agent of type i knows that $1/n$th of all agents has the same information set as she has. Under our hypothesis, and observing equation (4), the strategy of an agent i can be expressed as follows:

$$a_{i,t} = (1-r)E_i(\Theta)+r\left(\frac{1}{n}\left((1-\lambda_t)E_i(\Theta)+\lambda_t X\right)+\frac{n-1}{n}\left((1-\lambda_t)E_i(E_{j\neq i}(\Theta))+\lambda_t X\right)\right) \tag{6}$$

For transparent communication, $E_i(\Theta)$ is given by:

$$E_i(\Theta) = \theta_i + \sum_{j\neq i}^{n}\left(\frac{\delta}{\delta+\gamma}\theta_i + \frac{\gamma}{\delta+\gamma}x_j\right) \tag{7}$$

and $E_i(E_{j\neq i}(\Theta))$ by:[5]

$$E_i(E_{j\neq i}(\Theta)) = \frac{\delta}{\delta+\gamma}\theta_i + \frac{\gamma}{\delta+\gamma}x_j + \sum_{k\neq j}^{n}\left(\frac{\delta}{\delta+\gamma}\left(\frac{\delta}{\delta+\gamma}\theta_i + \frac{\gamma}{\delta+\gamma}x_k\right) + \frac{\gamma}{\delta+\gamma}x_k\right)$$

Inserting the expressions for expectations into equation (6) and collecting terms gives (for details see appendix):

$$a_{i,t} = A(r,n,\lambda_t,\gamma,\delta)E_i(\Theta) + B(r,n,\lambda_t,\gamma,\delta)X \tag{8}$$

Solving $A(r,n,\lambda,\gamma,\delta) = 1-\lambda_t$ and $B = \lambda_t$ both give the same result:

$$\lambda_t = \frac{r\gamma(n-1)}{\gamma(n-r)+\delta n(1-r)} \tag{9}$$

Thus, we have found the equilibrium of the game: if all other agents behave according to (5), it is optimal for an agent to use this strategy too.

The equilibrium has plausible properties: the more important acting in close alignment with other agents is, the more closely to the public signal concerning the state

[5] The first two terms on the right equal $E_i(\theta_j)$, and the following sum equals $E_i\left(E_{j\neq i}\left(\sum_{k\neq j}^{n}\theta_{k\neq j}\right)\right)$.

of the overall economy the agent acts ($\partial\lambda_t/\partial r > 0$ and $\lambda_t \to 1$ for $r \to 1$). In addition, a more precise public information γ means that the public information is more important for the action of the agent ($\partial\lambda_t/\partial\gamma > 0$), while the contrary is true for the precision of private information ($\partial\lambda_t/\partial\delta < 0$). Moreover, if there are only a few sectors in the economy, the private information of an agent will help her to estimate the true fundamental state very well and this information will strongly influence her action. Accordingly, the larger the number of sectors n, the more important is the public information ($\partial\lambda_t/\partial n > 0$). For an infinity of sectors, we have

$$\lim_{n\to\infty} \lambda_{t,n} = \frac{r\gamma}{\delta(1-r)+\gamma}$$

In this special case, the strategy of agents is identical to that found in Morris/Shin (2002).[6]

3.3 The case of opaque communication

In the case of opaque communication, the public agency publishes only its overall assessment of the economy X. The "Guess and solve"-method works again, but this time with another hypothesis: in equilibrium, the action $a_{i,o}$ (with the subscript o for opaqueness) of a type-i agent is a linear combination of $n\theta_i$ (this is the value of the overall fundamental state expected by the agent if she had only her private information and not the overall assessment of the agency) and of the overall fundamental state expected by the public agency X:

$$a_{i,o} = (1-\lambda_o)n\theta_i + \lambda_o X \tag{10}$$

6 For $n = \infty$, the weight of θ_i is $(\delta(1-r)/(\delta(1-r)+\gamma)$. This is the expression for the optimal strategy found in Morris/Shin (2002), p.1526.

This means that the optimal strategy can be expressed as follows:

$$a_{i,o} = (1-r)E_i(\Theta)+r\left(\frac{1}{n}\left((1-\lambda_o)n\theta_i+\lambda_o X\right)+\frac{n-1}{n}\left((1-\lambda_o)nE_i(\theta_{j\neq i})+\lambda_o X\right)\right) \tag{11}$$

In order to find the expectation of an agent of type i about the overall economy and about other sectors, we first derive agent i's expectation about the part of the economy she is not expert of: $E_i(\Theta_{-i}) = E_i(\sum_{j\neq i}^{n}\theta_j)$. This is the weighed average of the expectation value that comes from the public information and the expectation value coming from own private knowledge, with the precisions of the two sources of information as weighing factors. The expectation on the basis of private information is given by $(n-1)\theta_i$, and the precision is $\delta/(n-1)$, because

$$\Theta_{-i} = \sum_{j\neq i}^{n}(\theta_i+\varepsilon_j) = (n-1)\theta_i + \sum_{j\neq i}^{n}\varepsilon_j$$

The expectation of public information equals $X-\theta_i$, with precision γ/n, because

$$\Theta_{-i} = X-\theta_i = \sum_{j}^{n}(\theta_j+\eta_j)-\theta_i$$

With these facts in mind, type i's expectation about the part of the economy she is not expert of can be calculated to be (see appendix):

$$E_i(\Theta_{-i}) = \frac{(n-1)(n\delta-\gamma)}{\gamma(n-1)+n\delta}\theta_i + \frac{\gamma(n-1)}{\gamma(n-1)+n\delta}X \tag{12}$$

and type i's expectation about the overall economy is (see appendix):

$$E_i(\Theta) = \frac{n^2\delta}{\gamma(n-1)+n\delta}\theta_i + \frac{\gamma(n-1)}{\gamma(n-1)+n\delta}X$$

Inserting these results into equation (11) (and noting that $E_i(\theta_{j\neq i}) = E_i(\Theta_{-i})/(n-1))$, rearranging according to (8), and solving for $A(r, n, \lambda, \gamma, \delta) = 1-\lambda_o$ and $B = \lambda_o$ give the following result for the equilibrium value of the optimal strategy parameter λ_o for a representative agent in case of opacity:

$$\lambda_o = \frac{\gamma(n-1)}{\gamma(n-1) + \delta n(1-r)} \tag{13}$$

Again, as in the case of transparency, the more important acting in close alignment with other agents is, the more closely to the public signal concerning the state of the overall economy the agent acts ($\partial\lambda_o/\partial r > 0$ and $\lambda_o \to 1$ for $r \to 1$). In addition, a more precise public information γ means that the public information is more important for the action of the agent ($\partial\lambda_o/\partial\gamma > 0$), while the contrary is true for the precision of private information ($\partial\lambda_o/\partial\delta < 0$). Moreover, the larger the number of sectors n, the more important is the public information ($\partial\lambda_o/\partial n > 0$).

3.4 Comparing equilibrium strategies in the cases of transparency and opacity

The equilibrium strategies were shown to be linear combinations of the overall public information X and, in the case of transparency, of the value of the overall state expected by the representative agent $E_i(\Theta)$ or, in case of opacity, of the private information the agents has, θ_i. Thus, the values of the weights λ_t and λ_o are not directly comparable. What is comparable, however, are the weights with which the private information θ_i enters into the activity parameter a_i, $W_t(\theta_i)$ and $W_o(\theta_i)$. They can be calculated with help of equations (5),(7) and (9) for the transparent case and similarly for the opaque case and are given by

$$W_t(\theta_i) = \frac{n(1-r)(\gamma + n\delta)}{\gamma(n-r) + n\delta(1-r)}$$

$$W_o(\theta_i) = \frac{n^2\delta(1-r)}{(n-1)\gamma + n\delta(1-r)}$$

The following can be shown:

Proposition 1 *For a finite number of sectors n, and for $0 \leq r < 1$, the weight with which the private information θ_i enters into the activity level a_i is always larger in case of a transparent communication policy than in case of an opaque communications policy: $W_t(\theta_i) > W_o(\theta_i)$.*

Proof: see appendix.

For example, in the case of $n = 2$ sectors and $\gamma = \delta = 1$ and $r = 1/2$, the weight of θ_i is 1.2 for transparency and 1 for opacity.[7] Only for $n \to \infty$, the strategies become identical for the two cases: $W(\theta_i) = n\delta(1-r)/(\delta(1-r)+\gamma))$. For $r \to 1$, agents are solely interested in coordination, and for this objective, private information is useless.

At first glance, this result might be surprising because, in principle, a transparent communications policy gives more public information to the agents, and therefore, a natural guess might be that agents with more public information rely more heavily on it and less on private information than in the case of an opaque policy. The additional information in case of transparency, however, does not make common knowledge X about the state of the overall economy Θ more precise, but it helps every single agent in better utilizing her private information in the estimation of Θ.

[7] Note that the weights larger 1 are natural because we have defined the activity level of the overall economy to be the sum of the levels of the single sectors instead of a weighed average.

4 Welfare effects of different communication policies

Since the equilibrium strategies under different communication policies have now been derived, it is possible to analyze the welfare effects of these policies. As discussed in section 2, it is assumed in this paper that agents benefit from aligning their action to that of other agents only insofar as, like in Keynes' beauty contest, they do this better than the average of agents. Therefore, from a social point of view, only the benefit stemming from the first part of (1) enters the welfare function (2) the public agency should maximize.

In the case of transparency, equation (2) becomes (see appendix):

$$V_t(a,\Theta) = -\frac{(n-1)n\left[\gamma(n+r(r-2)) + n\delta(1-r)^2\right]}{(\gamma(n-r)+n\delta(1-r))^2} \tag{14}$$

Sensible properties of this welfare function can easily be checked for some limit cases: the loss that stems from agents not fully aligning their activity level to the fundamental state of the overall economy decreases for higher precision of public information γ or private information δ, and it vanishes for $\gamma \to \infty$ or $\delta \to \infty$. The aspect of strategic interaction vanishes as well if γ or δ are 0. In the first case, only the precision of private information matters for welfare ($V_t(a,\Theta) = -(n-1)/\delta$), in the second, only the precision of public information is relevant ($V_t(a,\Theta) = -n/\gamma$). If agents were only interested in coordination (if $r \to 1$), they would focus just on the public signal and welfare would depend just on γ: $V_t(a,\Theta) = -n/\gamma$.

In the case of opacity, equation (2) becomes (see appendix):

$$V_o(a,\Theta) = -\frac{(n-1)n\left[\gamma(n-1) + n\delta((1-r)^2\right]}{(\gamma(n-1)+n\delta(1-r))^2} \tag{15}$$

The results for the transparent case concerning $\gamma \to \infty$, $\delta \to \infty$, $\gamma = 0$, $\delta = 0$ and $r \to 1$ hold for opacity as well. For the case of $r = 0$, welfare is higher for transparency: $V_t(a,\Theta) = -(n-1)/(\gamma+\delta) > V_o(a,\Theta) = -(n-1)n/((n-1)\gamma + n\delta)$. This is not a surprising result, because there is no negative externality if agents are only interested in aligning their activity level to the fundamental state of the overall economy: in this case, giving more information to them is clearly welfare enhancing. However, it can be shown that the result holds in general:

Proposition 2 *The transparent communication policy leads always to welfare that is at least as high as in the case of an opaque communication policy. Sufficient conditions for transparency leading to strictly higher welfare are $r < 1$, $\gamma > 0$, $\delta > 0$,* and $n \geq 2$.

Proof: see appendix.

Thus, as long as agents are not only interested in aligning their strategies to each other, it is not a good idea for the public agency to give opaque information. Instead, it is better to be transparent or, in some cases, to give no information at all: the welfare in case of secrecy is

$$V_s(a,\Theta) = -E(a_i - \Theta)^2 = -E\left[\theta_i + \sum_{j\neq i}^{n}(\theta_i + \varepsilon_j) - \sum_{j\neq i}^{n}\theta_j - \theta_i\right]^2 = -\frac{n-1}{\delta}$$

If coordination is very important to agents[8], and if public information has quite poor precision γ for a given level of precision for private information δ, it might be better for the public agency to be secret in order to prevent agents from coordinating on a public signal that gives less information about the overall state of the economy than the private information of agents does. Figure 1 shows for which parameter

8 More exactly, a necessary condition is that $r > 2 - \sqrt{2} \approx 0.58$ for $n = 2$ or $r > 0.5$ for $n \to \infty$. Derivations of these results may be obtained from the author on request. Svensson (2006) argues that the parameter range for which transparency is damaging in the Morris/Shin (2002) model is small. Because our model resembles the Morris/Shin-case for $n \to \infty$, Svensson's point is even more valid in our context.

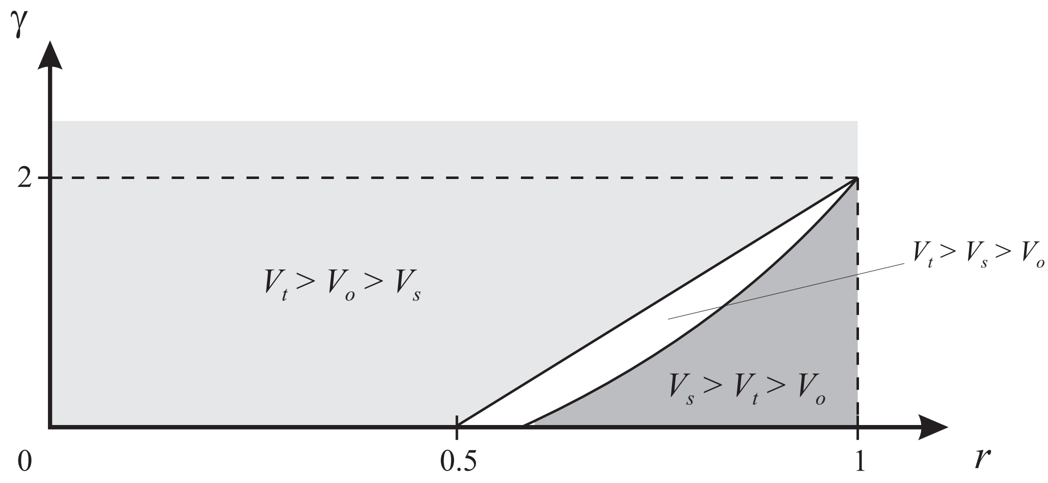

Figure 1: Welfare effects of communication strategies V_t, V_o, V_s for $n = 2$ sectors and precision of private information $\delta = 1$

values γ and r which strategy is best for the case of $n = 2$ and $\delta = 1$. For the area where $V_t > V_s > V_o$, a communication policy that is opaque leads to agents attaching too much importance to public information, but what the agency should do is not switching to secrecy, but giving more detailed information; this will enable agents to better utilize their private information. For more sectors than 2, the border between the region $V_t > V_s > V_o$ and $V_s > V_t > V_o$ is closer to the border between $V_t > V_s > V_o$ and $V_t > V_o > V_s$. If n approaches infinity, the region for which welfare under secrecy is between welfare under transparency and welfare under opacity vanishes.

5 Conclusions

This paper has analyzed the welfare effects of different communication strategies of public agencies if strategies of private agents are strategic complements. In our framework, a detailed account on the information which has led to the assessment of the public agency makes the agents' private information more valuable. A consequence is that private agents put more weight on their private information in the case of *transparent communication* than in the case of *opaque communication*, although the former gives more public information than the latter does. Therefore, for a specific range of parameter values, the appropriate measure against overreliance on public signals in the case of opaque communication is to give more detailed information to the public instead of denying any access to public information. If, however, complementarities are strong and the precision of public information is low relative to the precision of private information, *secrecy* is best. Thus, opaqueness is always dominated by one or both of the other communication strategies.

Of course, the model presented still appears quite detached from information procecessing on real world markets. Two ways for coming closer to reality shall be mentioned: first, it may be worth analyzing what happens to an optimal communication policy if several public agencies with seperate information exist and if they face coordination problems. Second, it would be nice if a central assumption of our approach, namely that agents want to coordinate their action but that this coordination is not welfare enhancing, could explicitly be derived from some market failure. The basic argument of this paper, however, should still hold in a more complex setting: a more transparent information policy makes private information of agents more valuable.

A Appendix

A.1 Exact form of equation (8)

The exact form of equation (8) is given by:

$$a_i = E_i(\Theta)\left\{(1-r) + r\left(\frac{1-\lambda_t}{n} + \frac{n-1}{n}(1-\lambda_t)\frac{\delta}{\delta+\gamma}\right)\right\} + X\left\{r(1-\lambda_t)\frac{n-1}{n}\frac{\gamma}{\delta+\gamma} + \lambda_t r\right\} \tag{16}$$

A.2 Deriving $E_i(\Theta_{-i})$ and $E_i(\Theta)$

As to $E_i(\Theta_{-i})$, the weighed average of the expectation value that comes from the public information and the expecation value relying on private knowledge is given by:

$$E_i(\Theta_{-i}) = (n-1)\theta_i \frac{\delta(n-1)}{\frac{\delta}{n-1} + \frac{\gamma}{n}} + (X - \theta_i)\frac{\gamma/n}{\frac{\delta}{n-1} + \frac{\gamma}{n}}$$

Rearrangement and simplification yield equation (12). From this it is easy to derive $E_i(\Theta)$, because $E_i(\Theta) = E_i(\Theta_{-i}) + \theta_i$

A.3 Proof of proposition 1

For $W_o(\theta_i) - W_t(\theta_i)$ we get, after rearranging,

$$W_o(\theta_i) - W_t(\theta_i) = \frac{(n-1)n(r-1)\gamma^2}{[\gamma(1-n) + n\delta(r-1)]\,[\gamma(r-n) + n\delta(r-1)]} < 0$$

for $0 \leq r < 1$ for $\infty > n > 1$ (because $\gamma, \delta > 0$).

A.4 Deriving the welfare function for transparency

We express the welfare function (2) as that part of type i's expected utility function that is welfare relevant, $-E_i(a_i - \Theta)^2$. Inserting equations (5) and (9) gives:

$$V_t(a, \Theta) = -E\left[(1-\lambda_t)\left(\theta_i + (n-1)\frac{\delta}{\delta+\gamma}\theta_i + \sum_{j\neq i}^{n}\frac{\gamma}{\delta+\gamma}x_j\right) + \lambda_t \sum_{j}^{n} x_j - \sum_{j}^{n}\theta_j\right]^2$$

Note that $\theta_{j\neq i} = \theta_i + \varepsilon_j$ and $x_j = \theta_j + \eta_j$. Therefore,

$$V_t(a, \Theta) = -E\left[\left(\frac{\gamma + \lambda_t\delta}{\delta+\gamma}\right)\sum_{j\neq i}^{n}\eta_j + \lambda_t\eta_i - (1-\lambda_t)\sum_{j\neq i}^{n}\frac{\delta}{\delta+\gamma}\varepsilon_j\right]^2$$

This means that

$$-V_t(a, \Theta) = \left(\frac{\gamma+\lambda_t\delta}{\delta+\gamma}\right)^2\frac{n-1}{\gamma} + \frac{\lambda_t^2}{\gamma} + (n-1)\left(\frac{(1-\lambda_t)\delta}{\delta+\gamma}\right)^2\frac{1}{\delta}$$

Rearrangement of terms gives equation (14).

A.5 Deriving the welfare function for opacity

The procedure is basically the same as for transparency. Inserting equations (10) and (13) into $E_i(a_i - \Theta)^2$ gives:

$$V_o(a, \Theta) = -E\left[(1-\lambda_o)\, n\theta_i + \lambda_o X - \sum_{j}^{n}\theta_j\right]^2$$

Note that $\theta_{j\neq i} = \theta_i + \varepsilon_j$ and $x_j = \theta_j + \eta_j$. Therefore,

$$V_o(a, \Theta) = -E\left[(1-\lambda_o)\sum_{j\neq i}^{n}\varepsilon_j + \lambda_o\sum_{j}^{n}\eta_j\right]^2$$

This means that

$$-V_o(a,\Theta) = (1-\lambda_o)^2\,\frac{n-1}{\delta} + \frac{n\lambda_o^2}{\gamma}$$

Inserting the equilibrium value for λ_o and rearrangement of terms gives equation (15).

A.6 Proof of proposition 2

We show that $V_o - V_t < 0$ for $r < 1$, $\gamma > 0$, $\delta > 0$, and $n \geq 2$. Subtracting equation (14) from equation (15), finding the common denominator and factoring gives the following:

$$V_o - V_t = \frac{(n-1)n(r-1)\gamma Z}{Y}$$

with

$$Y = (\gamma(n-1) + n\delta(1-r))^2(\gamma(n-r) + n\delta(1-r))^2$$

(thus, $Y > 0$) and

$$Z = \alpha\gamma^2 + \beta\gamma\delta + \zeta\delta^2$$

Because $r < 1$ and $\gamma, n > 0$ we have to show that $Z > 0$ for $r < 1$, $\gamma > 0$, $\delta > 0$. For α we have

$$\alpha = -n + n^2 + 2r - 3nr + n^2 r$$

It can be shown that $\alpha > 0$ for $n \geq 2$ and $0 < r < 1$. As for β:

$$\beta = n(-1 - r + 3r^2 - r^3 + n(2 - 2r))$$

Again it can be shown that $\beta > 0$ for $n \geq 2$ and $0 < r < 1$. Finally,

$$\zeta = n^2(1 - 3r + 3r^2 - r^3)$$

It can easily be shown that $(1 - 3r + 3r^2 - r^3) > 0$ for $0 < r < 1$. This completes the proof. Moreover, with help of the equations given above, it is now easy to see that $V_o - V_t \leq 0$ for $n \geq 2$ $r \leq 1$ even if $\delta = 0$ or $\gamma = 0$.

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