PUBLIC INFORMATION IN POPULATIONS WITH HETEROGENEOUS INTERESTS

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Extended Abstract

Public signals are well-known to be particularly influential when privately informed agents interact strategically (e.g. Morris and Shin AER 2002). Public signals are by definition common knowledge and that fact makes such signals particularly useful for individual agents who want to predict other agents' actions. However, that a signal is "public" in the common knowledge sense is a much stronger assumption than what is implied by the everyday meaning of the word. Among the vast amount of information that is publicly available, only a small subset is public in the common knowledge sense that everybody knows that everybody knows, and so on, that everybody knows that everybody observed a particular piece of information. In this paper we will argue that it is useful to make a distinction between information that is public in the strong common knowledge sense of the word and information that is merely publicly available.

Below, a simple model is presented in which a large number of agents populate an economy where a large number of events occur. Events are defined as a realization of a latent variable. Agents are heterogenous in the sense that information about some events are more useful (or interesting) to some agents than to others. Agents have a choice between different information providers, where an information provider is defined by a *news selection function*. The news selection function of a particular information provider determines which events the provider will report conditional on the entire set of realized events. The entire set of potentially interesting events is larger than the set of events that can be reported. That is, information providers perform an editorial service for their customers by selecting which events to report.

An individual optimizing agent will choose the information provider that has the news selection function that best suit the individual agent's informational needs. Agents have to choose information providers *ex ante* and this choice can then not be based on the realized events. Instead, an individual agent will choose to get information from the provider that he *expects* to report the most interesting events. The optimal choice will depend on the preferences of the agent, the news selection functions available and the distribution of events.

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The structure of the information provision sector is determined in a market where information providers compete for audiences. The set of news selection functions available to choose from is thus an endogenous object. Unless fixed costs of providing information are very large, there will be several specialized information providers that cater to diverse audiences.

In the model presented below, agents will be able to make probabilistic assessments of whether a given piece of information is widely observed or not. Even though individual agents do not generally observe all publicly available information sources, they will be able to nevertheless infer that some information is almost surely public in the strong common knowledge sense.

Example: The Wall Street Journal has a different content and different audience than the New York Times, yet, there are some events that both newspapers report. The 1987 stock market crash and the terrorist attacks on September 11th 2001 are two events that readers of the New York Times can safely assume that readers of the Wall Street Journal were also reading about (and vice versa). By their extreme nature, knowledge about these events can probably be treated as being common knowledge. For less extreme events, and from the perspective of an individual agent, the probability that readers of both newspapers are aware of an event is somewhere in the interval $(0, 1)$. There will then be a meaningful distinction between information that is merely publicly available, that is, information that is in at least one paper, and information that is public in the strong common knowledge sense. (Note here that it is not sufficient for a piece of information to be in both newspapers. It is also necessary that readers of one newspaper can infer that the piece of information in question must also be reported by the other newspaper.)

In this paper we analyze how market structure interact with heterogenous interests to determine the probability that information about a given event is observed by everybody. We also analyze how market structure affects agents' higher order assessment about this probability. That is, how is an individual agent's subjective probability of information about an event being observed by other agents affected by market structure? We will demonstrate that the common knowledge case corresponds to a particular limit in which everybody observes information about a particular event almost surely and that everybody believes that everybody observed this information almost surely and so on. When the cost of disseminating information falls, a larger number of more specialized information providers will enter the market and generally decrease the "publicness" of information about particular events (of course, ceteris paribus).

There are some assumptions that are important for these results. First, information is lumpy in the sense that there is a minimum amount of information about an event that is needed in order to make it at all useful (and thus actually being "information"). For example, reading only the first word in every newspaper published in a given day is arguably less useful than reading the first article in a single newspaper. Second, observing information is costly. Combined, these assumption make it optimal for consumers of information to limit themselves to a subset of all potential information providers and thus get information about only a subset of all events.

We will assume that it is possible for information providers to base their decision of what to provide information about on a larger set of *realized* events than what can be

reported. Example: Newspapers get information from wire services such as Associated Press etc about a very large number of events every day. Only a fraction of these events are considered newsworthy enough to be included in a given edition of a newspaper. Allowing for this possibility makes it generally optimal for information providers to indeed condition the decision of what to report on actual outcomes. Specialized media have a specialized audience that are particularly interested in certain topics (or sectors of the economy etc). However, there are some topics that would normally only be of interest to a specialized audience that at certain times become interesting to a wider audience and then also reported by non-specialized media. For instance, most newspapers outside the specialized industry press did not allocate much column space to sub-prime mortgages until the crisis made that particular sector interesting to a wider audience.

Allowing for information providers to condition their news selection on the realized events means that agents can infer some information also about those variables that they did not get any explicit information about. That is, by the knowledge of the news selection function, some realizations of non-reported latent variables can be ruled out. That is, "no news can be good news" if bad news are always reported.

To sum up, this paper provides a theory of what type of information becomes common knowledge among populations with heterogenous interests. The theory can be used to characterize the implications of the editorial function of information providers for agents' posterior beliefs and equilibrium actions.

1. A simple model

1.1. **Basic set up:**

- Two agents (i.e. information consumers) with pay-offs that depend on their own action, a vector of latent variables and the action of the other agent.
- Two specialized information providers defined by a "news selection function" that each cater to one information consumer.

1.2. **Information consumers.** Agent $i \in \{1,2\}$ has preferences defined by the utility function

$$\begin{aligned} U_i &= -(1-r)\,\lambda_i\,(x_i - a_i)^2 \\ &\quad -(1-r)\,(1-\lambda_i)\,(x_{-i} - a_i)^2 \\ &\quad -r\,(a_{-i} - a_i)^2 \end{aligned}$$

where x_1 and x_2 are latent fundamentals and a_i is the action chosen by agent i. The optimal action of agent i is given by

$$a_i = (1-r)\,\lambda_i E_i x_i + (1-r)\,(1-\lambda_i)\,E_i x_{-i} + r E_i a_{-i}$$

Agents have a strategic motive governed by the parameter r.

1.3. **Information providers.** News selection function $S_i(U_i, x, S_{-i})$ of provider i:

- Chooses whether to report the realized value of x_1 or x_2
- Maximizes the utility of its audience, taking the strategy of other information providers as given.

Stylized way to capture that there are two many events occurring to report on everything.

1.4. **Case I: Perfectly heterogeneous interests and no strategic interaction.** Substituting in $r = 0$ and $\lambda_i = 1$ into the utility function and the optimal action

$$\begin{aligned} U_i &= -(1-r)(x_i - a_i)^2 \\ a_i &= E_i x_i \end{aligned}$$

Clearly, we then have that

$$S_i = x_i$$

always.
The average action defined as $a \equiv \frac{1}{2}(a_1 + a_2)$ is then simply

$$a = \frac{1}{2}(x_1 + x_2)$$

1.5. **Case II: Partially common interests and no strategic interaction.** Substituting in $r = 0$ and $0 < \lambda_i < 1$ into the utility function and optimal action

$$\begin{aligned} U_i &= -\lambda_i (x_i - a_i)^2 - (1-\lambda_i)(x_{-i} - a_i)^2 \\ a_i &= (1-r)\lambda_i E_i x_i + (1-\lambda_i) E_i x_{-i} \end{aligned}$$

implies that

$$\begin{aligned} S_i &= x_i \text{ if } \lambda_i x_i^2 > (1-\lambda_i) x_{-i}^2 \\ S_i &= x_{-i} \text{ otherwise} \end{aligned}$$

The average action with $r = 0$ and $0 < \lambda_i < 1$ is then

$$\begin{aligned} a &= \frac{1}{2}(x_1 + x_2) \text{ if } x_1^2 > \frac{(1-\lambda_1)}{\lambda_1} x_2^2 \text{ and } x_2^2 > \frac{(1-\lambda_2)}{\lambda_2} x_1^2 \\ a &= \frac{1}{2}(x_1 + x_1) \text{ if } x_1^2 > \frac{(1-\lambda_1)}{\lambda_1} x_2^2 \text{ and } x_2^2 < \frac{(1-\lambda_2)}{\lambda_2} x_1^2 \\ a &= \frac{1}{2}(x_2 + x_2) \text{ if } x_1^2 < \frac{(1-\lambda_1)}{\lambda_1} x_2^2 \text{ and } x_2^2 > \frac{(1-\lambda_2)}{\lambda_2} x_1^2 \end{aligned}$$

We have some of the features we wanted:

- Larger realizations are more likely to become common knowledge
- Larger realizations have a more than proportional impact on average action

But its all a little bit mechanical.

1.6. **Case III: Perfectly heterogeneous interests and strategic complementarities.** Activate strategic complementarities

$$\begin{aligned} U_i &= -(1-r)(x_i - a_i)^2 - r(a_{-i} - a_i)^2 \\ a_1 &= (1-r)E_1 x_1 + rE_1 a_2 \\ a_2 &= (1-r)E_2 x_2 + rE_2 a_1 \end{aligned}$$

Find solution $\{a_1(x_1), a_2(x_1)\}$for $S = \{x_1, x_1\}$

- From symmetry, this special case covers all individual decision rules

If $S_2 = x_1$ then $p_{11}(x_1) = 1$ so that

$$\begin{aligned} a_1(x_1) &= \frac{1-r}{1 - r^2 p(S_2 = x_1 \mid x_1)} x_1 \\ a_2(x_1) &= r a_1(x_1) \end{aligned}$$

where

$$\begin{aligned} & p(S_2 = x_1 \mid x_1) \\ = \; & p\left(|x_2| < \frac{1-r}{1 - r^2 p(S_2 = x_1 \mid x_1)} \sqrt{\frac{r}{1-r}} |x_1| \right) \end{aligned}$$

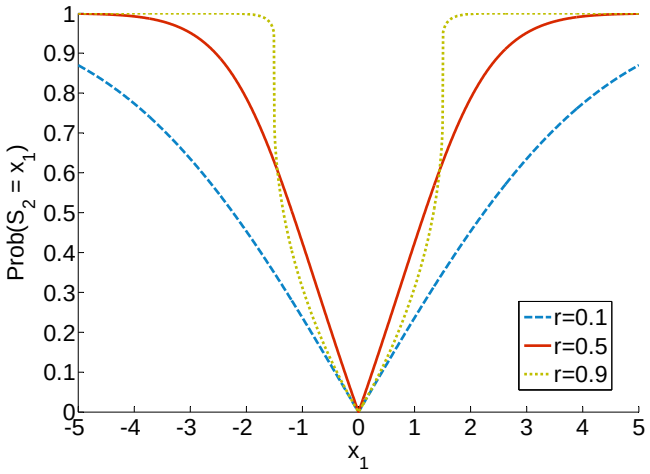

FIGURE 1. The probability that Agent 2 observes x_1

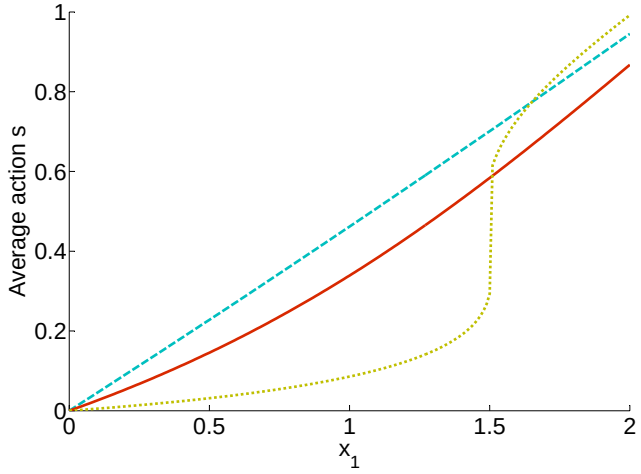

FIGURE 2. The expected average action in response to x_1