COLLECTIVE SILENCE AND INDIVIDUAL VOICE:
THE LOGIC OF INFORMATION GAMES

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In its original formulation, the Prisoners' Dilemma concerned the decision whether or not to reveal information: two prisoners being interrogated separately had to decide whether or not to confess to a crime they had both committed. Subsequently, virtually all study of the Prisoners' Dilemma game (and of related formalizations of collective-action problems) has examined two other classes of decision-making, unrelated to decisions to reveal or conceal information.[1] These games have been used to study strategic decisions by parties in conflict, such as price-cutting by competing firms, arms build-ups or military attacks by antagonistic nations, or negative campaigns by candidates for political office; and decisions to undertake costly individual action in support of collective welfare, such as decisions to reduce pollution, restrain exploitation of common resources, or contribute to military alliances.

Olson's primary contribution to these studies was to demonstrate that the strong propensity for voluntary efforts to lead to under-provision of conventional public goods such as open space and clean air also applied to the organization of groups to pursue their political objectives. Thus, despite their strong economic concerns with government policy, neither repairers of automobiles nor consumers of food have found the way to organize themselves to be strongly represented in Washington, DC. Olson also identified two major mechanisms to resolve the problem of under-provision. The first was to bundle the public good with a private good

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provided to contributors. The American Medical Association used this mechanism effectively for many years. Members supported the organization's political activities through their dues, but also gained professional status and a referral network (Olson 1965). The second mechanism was disproportionate provision: those who value the public good the most – in simple formulations, the largest actors – provide the lion's share of it (Olson and Zeckhauser 1966). Examples are the disproportionate spending by the largest corporations to secure influence over public policy through campaign contributions, and the vast military expenditures of the United States (exceeding those of the next six nations combined), which as the sole superpower acts as policeman of the world (U.S. Department of State 1998).

This work on under-provision and the means to cope with it has focused overwhelmingly on the provision of material resources. Often, however, as in the original story of the Prisoners' Dilemma, the critical issue for a group is whether its members reveal or conceal information. This chapter focuses on these situations, which we call "information games." In an information game, there are a number of players – whom we will call "peers" – in similar roles. The peers may be industrial polluters, parties to a crime, faculty members in a department, or partners at a private firm such as Arthur Andersen. Each has private information relevant to some decision to be made, and each must decide whether to reveal or conceal it. Revelation may be to their peers, to a player or players on the opposite side of the table, or to the world at large.

Our purpose in this chapter is to introduce the concept of information games, to identify how they resemble and how they differ from other forms of collective-action games, to undertake a preliminary investigation of their major types, characteristics, and predicted outcomes. While games of information revelation can be as diverse in their payoff structures as any other kind of

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[1] One exception is Scheppele (1988).

games, many prominent information games are filled with issues of mixed motives and tensions between individual and collective interest – problems of the kind that intrigued Olson. The constructs of these games can describe a wide range of settings, from unsavory nations cooperating with U.S. intelligence in the fight on terrorism to fairy-tale children noting the nakedness of the Emperor.

Among information games whose payoff structures resemble traditional collective-action problems, we distinguish two broad classes. In the first, the collective interest of the peer-group is to maintain silence; in the second, it is to promote individual voice. For each type, we identify broad regularities in the pattern of interests and resultant behavior that we expect, and identify numerous real-world examples. Part I places information games in the context of the general literature on collective-action problems, in particular the games of Prisoners' Dilemma, Assurance, and Chicken. Parts II & III discuss the two broad types of information games we highlight, those in which collective silence and individuals speaking up, respectively, provide a collective benefit for the group. Part IV summarizes the principal characteristics of information games, and identifies directions for elaborating the concept further. Table 1 provides a schematic preview of what follows, presenting the main features of our argument in summary form.

Table 1: Information Games vs. Traditional Collective-Action Games: Principal Features

	Standard Public Good Provision	Information Games Where the Collective Good is:	
		Silence	*Voice*
Status Quo	Past Level of Provision	Silence (full cooperation)	Silence (zero cooperation)
Principal Cost of Cooperation	Direct	Indirect	Indirect
Principal Source of Indirect Cost	N/A	Actions by Outsider	Actions by Outsider; Group Norms of Conformity or Obedience
Costs to Cooperate, as Function of Level of Cooperation	Constant	Rising if first few talkers are bribed; Falling if last few silent holdouts are punished	Falling
Collective Costs of Defection, as Function of Level of Defection	Significant Throughout (Shape depends on +/- returns to public good)	Falls Sharply After First Few Defections	Exhibits Critical Level (S-shaped)

I. Prisoners' Dilemma and Assurance Games as Information Games

We treat peers' decisions to reveal or withhold information as binary choices: reveal honestly and completely, or not at all. This allows the information game to be defined simply in terms of peers' payoffs from whose information is and is not revealed. This approach abstracts from a great deal of complexity in the character of information that actors hold and might choose to reveal, and in how others may interpret information that is revealed. With this simplification, we need not describe the character of each agent's information in detail. Similarly, we need not

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concern ourselves with whether the information that actors reveal is accurate or biased, steering

clear of the vast literature on honest revelation in various contexts. Nor do we consider the

possibility that actors will engage in signposting, the partial or selective revelation of accurate

information (Zeckhauser and Marks 1996).

As we will relate the payoff structures of the information games we discuss to the well-

known collective-action structures of Prisoners' Dilemma, Assurance, and Chicken, we briefly

summarize those here, in both their two-player and multi-player forms. In the two-person

Prisoners' Dilemma game, both players have a strictly dominant strategy that yields a jointly

inferior outcome. Each has an individual interest in "defecting" (confessing to the crime),

whether the other is defecting or cooperating (where "cooperating" means with the other

prisoner, i.e., not confessing). But the outcome when both defect is worse for both than the

outcome when both cooperate, if they could only bind themselves to that outcome. Payoffs in the

two-person case are shown in Table 2, with higher numbers denoting more preferred outcomes

and the equilibrium outcome shown in bold.

Table 2: The Two-Player Prisoners' Dilemma

		Player 2	
		Cooperate	Defect
Player 1	Cooperate	(3, 3)	(1, 4)
	Defect	(4, 1)	**(2, 2)**

Schelling developed an elegant graphical representation of collective-action problems

with multiple actors, which allows us to illustrate the N-person generalization of the Prisoners'

Dilemma as in Figure 1 (Schelling 1978). In this representation, the vertical axis shows players'

payoffs as a function of their own choice and the aggregated choices of all others. The horizontal axis shows the total number of other players (other than the one whose payoffs are being represented) making the cooperative choice, while the two sloping lines show the payoff to a player who cooperates, and to one who defects, as a function of the number of others cooperating.

As in the two-person case, every player prefers maximal cooperation by others, but for any given level of cooperation by others each one would rather defect than cooperate. The situation might be a group of firms deciding whether to collude on a price increase. Each prefers that the others raise prices, but each prefers not to raise his own price whether the others raise theirs or not. The standard prediction in both the two and N-person cases is that all players will defect – they will reach the lower-right cell of the two-person matrix and point A on the N-person diagram – even though all would rather be at the point of unanimous cooperation, the upper-left cell of the matrix or point B on the N-person diagram. Absent some way to bind themselves, bind each other, or change their payoffs (e.g., lowering the payoff for defecting or increasing that for cooperating), players cannot reach these preferred joint outcomes.

Insert Figure 1 here.

The game of Assurance makes one crucial modification to the Prisoners' Dilemma payoffs. Each player still prefers to defect if the other defects, but now prefers to cooperate if the other cooperates. The game consequently has two equilibrium outcomes, one in which both players cooperate and one in which both defect, and both strictly prefer the equilibrium in which they both cooperate. The generalization to N players makes each player prefer to cooperate if enough others do so. The payoffs for Assurance with 2 and N players are shown in Table 3 and Figure 2 below.

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Table 3: The Two-Person Assurance Game

		Player 2	
		Cooperate	Defect
Player 1	Cooperate	**(4, 4)**	(1, 3)
	Defect	(3, 1)	**(2, 2)**

Insert Figure 2 about here.

In Assurance, both the lower-right and upper-left cells (points A and B in the figure) are equilibria. The preferred equilibrium (the upper-left cell in the table, point B in the figure) gives the best outcome to both players and neither has an incentive to deviate from it. But can the players reach it? This depends on how agents are able to communicate and coordinate their choices; their expectations of how others will think and act; and their willingness to risk bad outcomes. A player who has strong enough doubts about others' cooperation, or who cannot endure any risk of reaching the worst outcome (cooperating when others defect) may rationally choose to defect. An example might be two merchants in a run-down district deciding whether to relocate. If both move, both are better off, but if only one moves the new district does not get established and the mover suffers.[2]

The game of Chicken modifies the Prisoners' Dilemma structure in a manner opposite to that of Assurance, as shown for the two-person case in Table 4 and the N-person case in Figure 3. In this game, each player prefers to cooperate if and only if the other defects, because defection by both is the worst possible outcome (e.g., cars crashing head-on at high speed because neither player would turn off first, as in the test of nerve for which the term "playing chicken" was

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2   The firm that stays behind will gain a larger share of a smaller total volume of business, so the net effect might be a gain or a loss, or perhaps a short-term gain followed by a longer-term loss. Our payoffs show the

invented). With N players, each prefers to Cooperate if and only if few others are doing so, yielding equilibrium C in which some fraction of players cooperate. (Since this formulation does not distinguish among individual players, however, it says nothing about who cooperates at equilibrium.)

Table 4: The Two-Person Chicken Game

		Player 2	
		Cooperate	Defect
Player 1	Cooperate	(3, 3)	**(2, 4)**
	Defect	**(4, 2)**	(1, 1)

Insert Figure 3 about here.

The information games we discuss have important points in common with the problems of providing public goods through costly efforts that were studied so insightfully by Olson. In both, individual rational choice runs counter to the achievement of collective gains. Information games also have significant differences from standard situations of voluntary provision of public goods. In the standard setting, the tension between private and public interests arises because providing the public good or taking action for the common welfare is intrinsically costly. In information games, this tension arises not from the direct cost of either revealing or concealing information, which is usually very small. Rather, it arises indirectly, from the actions that others (members of the peer group or outsiders) are expected to take based on the information revealed. Any player's payoff from revelation of information by any specified set of peers (possibly

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total effect as a gain, but the game remains one of Assurance in either case, since this does not affect either

including herself) reflects her expectations of who will do what based on the information revealed. We take these payoffs to subsume her knowledge of other actors' information, as well as the confidence with which other actors will view it, and the ease with which it can be verified, since these all contribute to her expectations of how others will act in response. Her payoff also reflects some expectation of how her own choices will change in response to the information revealed and others' responses to that information.

As a class, information games are sufficiently rich that they may violate three simplifying assumptions that are essential to Schelling's compact representation of multi-party interactions shown in Figures 1 to 3. That representation assumes that all players are identical, so only the total number of players making a particular choice matters, not their identity; that the order in which players make their choices does not matter; and that the marginal effects of additional players making a particular choice are constant (i.e., the payoff curves are linear). As discussed below, any of these assumptions may be too restrictive.

Situations illustrating the collective-good aspects of information games are numerous, and the associated payoffs can vary greatly. We consider two broad types of information games. In the first, maintaining silence is a collective good for the peers. In the second, individuals provide a collective benefit to their peers by revealing information they hold – or alternatively, by securing information and then revealing it. In both cases, we assume that silence is the status quo, so advancing group welfare requires maintaining the status quo in the first case, and breaking it in the second. It is also possible in either case that what benefits the peer group may harm outsiders, as when captives facing a Prisoners' Dilemma do not confess.

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firm's preferred choice given the other's choice.

II. When Silence is a Collective Good

In many situations silence can be a collective good for the peer group. Perhaps information that is revealed can be used against the group by an outside authority or adversary with interests opposed to those of the group. For example, such information might concern past or present wrongdoing by some or all members of the group. Individual members of the group may have various reasons for wanting to reveal their information, but doing so is likely to harm the other members of the group. This is the problem faced by individuals involved in a conspiracy deciding whether to turn states' evidence in criminal prosecutions, and by firms deciding whether to reveal potential environmental or health risks that are not yet known to regulators or the public.

Similarly, supporters of a group engaged in a conflict must decide whether or not to reveal errors or wrongs of their group that might jeopardize its support. Supporters of the U.S. Democratic Party faced such a choice in deciding whether to censure President Clinton's personal misconduct. The need to stand with the President, the Party, or the nation in a time of conflict can be a powerful tool to suppress both internal criticism and external revelation of wrongdoing. As Lyndon Johnson once put it, "I'm the only President you've got." Individuals' information can also give an outside adversary an advantage in future dealings with the group, even if there was no past misconduct. For example, regulators can use information about individual firms' technological capabilities to tighten requirements on the industry, while procurement authorities or other major customers can use information about firms' costs to bargain harder on future contracts.

The collective benefit of silence can also arise from the way revelation affects members of the peer-group themselves, either through their actions if the information is revealed, or

through changes in their shared ideology, self-image, behavioral norms, or trust relations. One such group of situations, commonly known as "opening a can of worms," concerns controlling the agenda for contentious group decision-making. If a group has settled, or provisionally settled, some controversial issue – frequently involving the distribution of benefits or burdens – many individuals or sub-groups might wish they had gained more favorable treatment. But reopening the issue would pose the risk of extended conflict or deadlock as many individuals and sub-groups try to claim more favorable outcomes for themselves, sacrificing the often substantial collective benefits that accrue to the group from having an agreement – any agreement – in place. Prominent examples include any comprehensive constitutional negotiations, such as proposals to amend the Charter of the United Nations. Re-opening the Charter to pursue even a single high-priority change, such as adding new permanent members to the Security Council to reflect postwar shifts in national importance, would risk an extended deadlock as all parties try to add the rule changes that they want to the agenda.

Individuals' revelation of information can also cause group harm directly, by harming group-level assets such as reputation, self-image, or trust, important components of the group's social capital. This case is close in spirit to those in which the harms follow from the response by authorities or other outside actors, but differs from them in the mechanism through which the group harm occurs. Individual revelation can cause such harms by exposing hypocrisy and undercutting widely endorsed (but violated) principles that provide the social glue needed to restrain the much more extreme violations that would occur if the principles were publicly discredited.

These "silence is golden" situations can have a diverse range of payoff structures. Indeed, they may not always represent collective-action problems at all. If there are no conditions under

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which any individual's interest in revealing his information outweighs his share of the collective harm from breaking silence, then there is no conflict between individual and collective interests and we would expect peer groups to maintain silence.

When individuals do derive larger benefits from revealing, these are likely to arise in two distinct ways. In the first case, most of the group damage is done by the first few revelations. Additional revelations cost the group little, but can substantially benefit the individuals who make them if it is costly or dangerous to be in a small minority of non-revealers. If all but a few conspirators or parties to a shameful secret are confessing, those few will face much more pain than those who are confessing, whether from prosecutorial pressure or moral censure. In this case the information-revelation game is a game of Assurance, in which all individuals prefer collective silence, but prefer to speak if more than some critical number of others have broken their silence.

In the second case, a single revealer or small group may be able to draw some reward that is depleted if larger numbers speak. Such a reward may be offered by an outside adversary, such as a prosecutor or regulatory authority seeking to promote revelation. Alternatively, an individual who threatens to reveal might be able to exact a reward from the rest of the peer group as the price of his silence. This will be especially significant when the value of unanimity is large, either because even a single revelation greatly harms the group in its dealings with an outside adversary, or because some group norms or decision rules mean that any voicing of dissent or complaint greatly impairs the group's ability to function. These situations can all be formalized in terms of the power of various sub-coalitions of the whole peer group. When a single defector can greatly harm the group or greatly benefit an outside adversary, the remaining coalition of (N-1) players may be too weak to prevent such exploitation – particularly when many individuals are

in the position to make such demands. In these cases the information-revelation game can be a game of Chicken, in which individuals prefer to reveal their information (or equivalently, demand a reward for not doing so) if few others are doing the same. Further revelations may bring additional harm to the group but, critically, offer no benefit to individuals to tempt them to reveal.

In the Assurance and Chicken payoff structures, individuals prefer to reveal under specific conditions of others revealing. In Assurance, they prefer to reveal when many others are doing so. In Chicken, they prefer to reveal when few or none are doing so. A Prisoners' Dilemma structure – where each individual strictly prefers to reveal regardless of how many (or few) others are doing so – could occur if processes similar to both the Assurance and Chicken cases were in operation: sole or minority revealers gain large rewards, and minority non-revealers suffer censure or punishment. The combination of these conditions, and consequently the Prisoners' Dilemma structure, may be relatively uncommon in real-world information games despite the Prisoners' Dilemma being the best known model of collective-action problems.

Several factors will determine which of these payoff structures apply in realistic situations. First, when the peer-group's payoffs are determined by its interaction with an outside actor, this actor's ability and willingness to manipulate payoffs to individual group members will be crucial. Second, the symmetry or asymmetry of individuals' payoffs from revelation will also be crucial: Do all oppose revelation to an equal degree, or do some care less, not care at all, or actively prefer to reveal? Such asymmetries may be intrinsic to the interests of differently situated individuals, or they may arise from the order in which individuals reveal. When an outside actor has some ability to manipulate individual payoffs he may seek to augment such asymmetries, focusing inducements on those who are most inclined to reveal. Expected outcomes

may also be significantly influenced by peers' knowledge – and uncertainty – about others' payoffs, and by any history of similar interactions among these peers in the past, which will contribute to the shared sense of the status quo for the interaction in question. The following sections consider how these factors can interact to determine the peers' payoff structure.

External Manipulation of Individual Payoffs

When the group's collective interest in silence arises as a consequence of its adversarial interaction with an outside actor, that outside actor can frequently tailor its response to individuals who reveal information. For example, prosecutors routinely grant immunity from criminal prosecution, or at least reduced sentences, to those who turn states' evidence. They may even provide elaborate protection for witnesses who fear reprisals from their peers. Similarly, a regulatory agency has discretion over the details of regulatory requirements, and can frequently craft or enforce these requirements so as to vary the burden imposed on particular industries or firms. Discretion in such regulatory matters, like prosecutorial discretion, can be used to reward players that come forward with information.

If the outside authority is able to tailor its response, it should be most willing to do so when its marginal benefit from different individuals' revealing is not constant. Sometimes one peer's information will serve as a close substitute for any other person's information. For example, any party to a crime may be able to provide the same testimony or identify the same evidence, while firms in the same business, using the same technology, are likely to have fairly similar information about risks, costs, and potential alternatives. In the extreme, a single revelation might give the outsider all it needs to prevail against the group. In these cases, if allowed, the outsider would reward one party or a few for speaking but not offer similar terms to

others even if they did reveal. If, on the other hand, the strength of the outsider's case or its ability to craft an appropriate response increases with further revelations, or depends on the specific identity of who reveals, we would expect the outsider's disbursements of benefits to adjust accordingly. In any case, since what the outsider is offering is a limitation or modification of its pursuit of its own goals, these benefits can be offered to at most a few individuals. No prosecutor offers immunity to all conspirators in return for their confessions, since the purpose of eliciting confessions is to use them to convict other, more important conspirators. If the peer group has some ability to distribute benefits internally, it may attempt to do so to prevent initial defections, particularly when the cost of the first breach of unanimous silence is high.

More complex situations arise when there are multiple outsiders, who are not unified or indeed necessarily opponents of the group. They may even be unaware of when information is revealed. Consider two high-tech firms seeking to protect their products. Each amply rewards its employees for technological breakthroughs. This creates a situation where secret-tellers from rival organizations have an incentive to collude, promoting their careers at the expense of their organizations. Thus, two engineers from high-tech competitors may help each other with their company-specific technical problems, but in the process some proprietary information is spilled, possibly even to the general marketplace (Schrader 1991). It has even been alleged that members of national intelligence organizations sometimes trade secrets, so each looks like he is bringing home good information (Epstein 1989).

Asymmetries among Peers

Although we have stipulated that the players in an information game are peers, their payoffs from silence and revelation need not be identical. It is easiest to maintain silence under

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complete symmetry of interests, but such symmetry is uncommon in reality. Even when peers'

payoffs are the same, the group's efforts to maintain silence will depend on what peers know and

guess about each other's payoffs. Efforts to maintain silence may be thwarted if peers are

sufficiently uncertain about each other's payoffs. For example, if the peers' true payoffs are all

those of an Assurance game (Figure 2), then all prefer to maintain silence if enough others do.

But if some or all peers are not confident about others' payoffs and think that others may strictly

prefer to reveal, they may seek to avoid the risk of loss from being one of few non-revealers by

revealing preemptively. Carrying the analysis one level deeper, they also have to be concerned

about their peers' confidence about their payoff structure, and so on ad infinitum.

More frequently, peers' interests will truly be asymmetric. All conspirators may be

implicated in a past crime, but to different degrees. A group of firms may all employ the same

environmentally harmful technology, but may differ in size or in the fraction of their business

that depends on the technology, or have disparate opportunities to replace it with alternatives.

The firm that can reduce pollution at lowest cost may prefer to reveal information that will

promote regulation, expecting to gain a competitive advantage. In the extreme, the asymmetry of

benefits from silence may be so strong that some peers strictly prefer to reveal, because their

individual benefit exceeds their share of the group harm. This may have been the case, for

example, when the smallest and most financially precarious U.S. tobacco company, the Liggett

Group, reached a deal with state Attorneys-General in 1997 to release long-secret studies on the

health harms and addictiveness of cigarettes (New York Times 1997).[3]

Similarly, in the 1975 controversy over environmental harm from certain chemicals used

as propellants in aerosol spray cans (chlorofluorocarbons, or CFCs), firms marketing aerosol

products initially tried to maintain a uniform front denying the harm. But when consumer activism began to cut sales of all aerosol products – both those using CFCs and other propellants – the Johnson's Wax Company broke with the industry by announcing that it was eliminating CFC propellants from its products. While some other firms, particularly marketers of toiletries, used CFC propellants in nearly all their products, Johnson's Wax Company was able to gain marketing and PR advantages at nearly no cost, as it used CFCs in only two of the dozens of aerosol products it marketed (Dotto and Schiff 1978).

When such asymmetries are strong, a group that wishes to enforce silence on all its members needs selective internal incentives strong enough to outweigh individuals' interests in revealing. Groups might achieve this by bribing the members most tempted to reveal, or by threatening punishment to those who do reveal. In Figure 2, these possibilities correspond to shifting the payoff upward for those for not revealing (co-operating), and downward for those revealing (defecting). If the group seeks to defend itself by bribing potential defectors to stay, then the group can benefit from asymmetry. Only if individuals are highly asymmetric can the few most inclined to defect be bribed not to do so without risking that the group's solidarity will unravel completely in the face of a cascade of demands for equivalent payments by others.

If the group seeks to defend itself by punishing, or threatening to punish, defectors, the incentives can include some combination of the approval or disapproval of other group members, and real material rewards and punishments (Loury 1993). When peers identify strongly with the group, the border between these measures blurs, as group disapproval can be very painful and can carry direct material harms as second-order consequences. "Codes of silence" have long been used by criminal organizations to suppress revelation, with punishment of death to "canaries"

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3   The terms of the settlement also gave Liggett certain advantages in its search for a merger partner.

who "sing." The entire Boston neighborhood of Charlestown followed such a code of silence prior to the early 1990s, as fearful residents refused to share information with the police about crimes by local gang members (U.S. Department of Justice 1994; U.S. v. Houlihan, 1996). Sanctions that are similar in style, although less draconian, are used by various social groups. For example, some religious groups have used threats of exclusion or denial of rites to enforce conformity or obedience to community authorities, and to prevent individuals opposed to or harmed by the group's practices from going public with their complaints. Examples include the shunning of deviants by Jehovah's Witnesses, persecution of apostates by Moonies and Scientologists, social sanctions against deviant and outspoken Mormons in the Church's Utah heartland, and the Catholic Church's demands for silence about clerical pedophilia. These mechanisms can be extremely subtle, both in how the borders of acceptable dissent are drawn and in how violators are treated. For example, American political parties harbor legislators with such divergent views that they may appear to be in disarray, but nevertheless manage to secure party unity on particular important votes. In contrast to the use of bribes, punishments of shame and exclusion will in general be most effective when peers are most similar, and will grow less effective as the asymmetry among peers increases.

In regulatory settings, an outside actor may be particularly able to benefit from the asymmetric interests of the peers it oversees. A firm might learn that its products or processes (and those of its competitors) carry risks to health, safety, or the environment that were not previously realized, or may learn of some potential alternative to present conduct that could reduce an already recognized harm. Regulators seek to exploit the resultant asymmetries to elicit information about risks and capabilities from the firms with the least to lose from potential controls, or those that might even stand to gain – at least in relative terms.

A firm that learns of a previously unrecognized risk of its operations must decide whether to continue or revise its practices, and whether to conceal or reveal its new knowledge. Being first to learn of a risk may hold the prospect of competitive advantage, but only if this early knowledge gives the firm a lead in developing less risky alternatives. Moreover, the discovery itself may imply an increased liability risk, since the firm may later be judged liable for harms done during the period when it knew but did not act. Changing the risky practice without explicitly revealing the information may not be feasible, since the behavior change itself may be taken as a signal that something is known to be wrong. For example, marketers of aerosol hair-care products containing vinyl chloride decided not to switch to available alternatives, judging that since the alternatives were known to be costlier, regulators and potential litigants would infer from the switch that the manufacturer had discovered a health risk from vinyl chloride.

Conversely, a firm may hold information about technological or managerial ways it can change present operations and reduce a known external risk or harm.[4] Although an industry may be collectively served by silence – in this case, maintaining the status quo position that any change in operations will be difficult and costly – a firm that learns more about a benign alternative to present practices may perceive a competitive advantage in revealing what it knows and encouraging regulation based on this new capability that will differentially burden its competitors. It may even expect a regulation to bring new revenues, if other firms are forced to license its innovation. For example, U.S. automakers for many years resisted federal requirements for the installation of air bags, but when Chrysler Corporation perceived a competitive advantage in such safety systems in the late 1980s, it broke from the other

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[4] If no associated risk is yet known, then information about such options has no collective significance.

manufacturers, began installing air bags on most of its models, and shared its engineering performance data with the government.

In regulatory settings, exploitable asymmetries of interest may also arise simply because firms differ in their judgments of the likelihood that collective resistance against regulations will succeed. When resistance begins to appear futile, second-order interests in being perceived as a good citizen and having some influence over regulatory details can override the preference for no regulation at all. Hence, it will not be just the firms least dependent on present practices and most confident of their ability to develop alternatives that are most inclined to reveal information, but also those least confident in the success of the industry's collective efforts to oppose regulation.

Effects of the Order of Revelation

Our formulations above have assumed that all cooperators receive the same payoff, as do all defectors, however they settle on their strategy. Thus, either the order of choice did not matter, or all players had to choose simultaneously. Simultaneous choice could be imposed through a deadline, suggesting that players might not know what others were choosing, or as part of an equilibrium process, where no choice becomes final until no player wishes to change. Though simultaneous-play processes are sometimes observed in the real world, and their study forms the backbone of traditional game theory, for many information games the order of choice matters.

Even if peers' interests in silence and revelation are symmetric or close to it, the game is much more complex if players' payoffs depend upon the order in which they reveal. The outside authority might make special deals with those who speak first, but exhaust its ability or willingness to do so as more speak. Similarly, the group's ability to deploy payoffs for maintaining silence or punishments for breaking it may be limited in total, with the strongest

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incentives – positive or negative – being applied to those who move first. If the first to speak benefits the most from outside inducements, then the threat to speak can be used to extort a special internal accommodation. This possibility compounds the group's difficulty in enforcing collective silence, since peers who are unsure how much they can rely on each other's silence, or who fear there will be no resources left to accommodate them, may rush to avoid being a late speaker.

The opposite situation, in which it is preferable to speak last, will ease the group's problem of maintaining silence, since even players with dominant strategies to reveal may delay in the hope of gaining an even larger payoff if others reveal first. This situation is likely to be less common than that in which early speakers gain the most, since early speech will usually reveal the most. When this situation does occur, however, it will make it easier for the group to maintain silence in both Assurance and Prisoners' Dilemma situations.

As the foregoing discussion suggests, the effects of both intrinsic asymmetry of interests among peers and order-of-revelation effects are increased when outside actors can split the group by tailoring their responses to different players. Outside authorities will wish to target weak links. For example, prosecutors of criminal conspiracies gain the most from their ability to grant immunity if they target the informants with the strongest individual interests in revealing (whether due to moral scruples, disgruntlement at their treatment within the group, or lesser guilt). If they succeed, prosecutors gain the information they need to obtain the convictions they most value, while foregoing prosecutions of lower value that represent the least reduction in enforcement effectiveness.

To summarize, we make the following conjectures regarding situations in which silence is both the status quo and a collective good for the peer group. If revealing information imposes

net costs on the revealer, the group will usually succeed in maintaining silence. If revealing can bring individual net benefits to the revealer at the group's expense, then the group must create incentives to maintain collective silence. Outside actors seeking to break the group's silence may deploy opposing incentives, such as selective individual rewards to those who reveal. In general, groups in which the peers' interests and perceptions are more symmetric will be better able to maintain silence. The less confident peers are that they all share the collective interest against revealing, the more likely that some will reveal. Particularly if individual interests are structured as an Assurance game, attempts to increase confidence through mutual reassurance may be thwarted, because the communication between peers that this requires can itself reveal at least some of the information that the group wishes to conceal. As peers' interests grow more asymmetric, maintaining silence grows more difficult, as some individuals have stronger intrinsic interests in revealing, more susceptibility to inducements from an outside actor, less susceptibility to the threat of internal group sanctions, and less commitment to group norms. The only countervailing effect is that the group is better able to maintain silence by bribing potential revealers if asymmetry means that bribes need only be offered to the few individuals most likely to reveal. If payoffs to those who reveal also depend on the order of revelation, then revelation grows more likely if, as seems likely, those who reveal first benefit most.

III. When Revelation is a Collective Good

Sometimes voice -- the revelation of individually held information -- provides a collective benefit for the peer group.[5] Privately held information may be needed to guide a group decision, perhaps to prevent herding to sub-optimal collective choices based on limited information. For

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[5]   In using the term voice in this context, we follow the lead of Hirschman (1970).

example, some individuals may purchase Product A, though their personal information suggests that B is better, because A's purchase by many others suggests that it is superior. But if even a few doubters expressed their thoughts, the whole group might tip to Product B. Herding to an inferior equilibrium can even occur in two-player games. A mutually unsatisfactory romantic relationship may persist because neither party is willing to take the lead in revealing their unhappiness.

In most such situations, the information held by different individuals will be distinct, but will reflect on common issues. Thus, each revelation will bring additional, usually declining, marginal benefit for the group. Even multiple revelations of nearly identical information can bring collective benefits, if they establish conditions of common knowledge that are necessary for better group decisions. These may take the form of helping a latent group to identify, organize, or empower itself, or of allowing the revision or abandonment of a dearly valued collective endeavor whose results do not merit the sacrifices being made for it. As discussed above for maintaining group silence, encouraging individual voice can be a collective-action problem if the individuals who speak bear a cost from doing so.

A common situation in which revelation is collectively beneficial concerns research and innovations. The creators of such works provide collective benefits by revealing them, indeed, by disseminating them widely. In order to profit from their creation, however, they must be able to control subsequent use and reproduction; absent this opportunity, many desirable innovations would never be produced. This problem is so widespread and important that it has been addressed through the creation of rights in intellectual property, such as patents. Few such situations have been so systematically addressed, however. The individual costs that obstruct

revelation can come from several sources, and can be imposed by actors outside the group, or by the peers.

Sometimes an individual's voice enhances the group's identity, empowerment, or reputation, while an outside authority wishes to suppress the group. For example, if individuals are deciding whether to identify themselves as members of a group that opposes a repressive regime, the risk to those who speak comes from the outside authority. Even if the authority lacks the power to punish the whole group, those who speak – or more particularly, those who speak first – can bear substantial personal cost. In such situations, asymmetries can be crucial in promoting the revelation of collectively beneficial information. Kuran (1991) has argued that the 1989 revolutions in Eastern Europe gained momentum from asymmetry in individuals' willingness to take the risk of speaking out against the regimes, and from the visibility of even small demonstrations. The numbers grew day by day as more citizens became willing to risk participating, producing a rapid tipping phenomenon.

Alternatively, the cost of revealing can come from actions of the group itself or of some of its members, or from norms that individuals have internalized that act as surrogates for a narrow or partial view of the group's interests. These situations typically arise when individuals' information implies the need for an uncomfortable change in the group's conduct or self-image. Individuals may, for example, present unfavorable factual news about the group's performance or prospects, specific challenges it faces, or the strength of its adversaries. The way the group or its leaders express chagrin at the content of the bad news – at least initially – might be to "kill the messenger." As in some of the collective silence situations discussed above, this is an Assurance game, with the difference that the status quo equilibrium of silence is inferior. Anyone who speaks out suffers costs, unless enough others also do so. Moreover, participating in punishing

the messenger may also be an Assurance game. Others might know the messenger is right and prefer to spare him, but fear they cannot do so lest they be taken to endorse his message – and share his fate. If punishment of deviance is the norm, then not only is courage required to speak out, but so to a lesser extent is courage required to argue that someone who has spoken out should not be punished.

In related situations, individuals may face such costs when they ask the group to take note of comfortably shared delusions, erroneous conventional truths, or bad conduct. The group may greatly benefit from having these exposed and corrected, but may still forbid or discourage individuals from doing so or punish those who do – or individuals may police themselves in the same way. Those who speak up suffer costs from breach of social norms, shame, or censure, or alternatively from concrete punishments against deviance applied by the group, its leaders, or the members most strongly opposed to the revelation and its implications. A contemporary analogue to the ancient treatment of diplomatic messengers is the treatment of whistle-blowers who "betray" their peers by exposing illegal or unethical conduct by their organizations. Whistle-blowers suffer substantial personal and professional costs, including widespread hostility and mistrust – even when the conduct they report is egregious, and despite the existence of laws seeking to protect them and principles declaring that they have done right. These costs are smaller when more people blow the whistle, but coordinating such a group of defectors can also be risky since the first to propose doing so exposes himself nearly as much as if he had gone to the authorities by himself.

Similar forces discourage individuals from adopting unpopular positions when they are among the first to recognize that the group's long-term welfare requires taking costly action that others would prefer to avoid or delay. Even raising doubting questions can be costly. Ibsen's play

"An Enemy of the People" describes the persecution of a local physician who tries to alert his town to dangerous contamination in a local mineral spring. Similarly, in the recent Argentine economic crisis, it was obvious for months (or longer) that the fixed-exchange system had to be abandoned, but whichever political leader said so and acted accordingly was bound to be sacrificed. In the Japanese financial crisis, a similar fate confronted those who declared the widely known fact that many banks were already bankrupt under mountains of bad debt, and that fixing the problem would require a shakeout in which many banks would fail. A common theme in these situations is that the group fails to act in accordance with its true interests. The group is served by revelation, yet acts to discourage it.[6]

These forces that repress dissenting voices can be magnified when the group is in a situation of conflict or adversity. Self-censorship or collective censorship can extend to the point that group members refuse to acknowledge things that are obviously true and known, but are favorable to the adversary. That is one reason why mutually destructive wars of attrition, whether military or political, can persist for so long. When the shared belief of the group has a strong normative character, the problem is more severe. For example, a group may hold strong and perhaps simplistic views of who is good and who is bad, or who or what is responsible for ills the group is suffering. Group sanctions against individuals who deny or question these beliefs, and individuals' inclination to avoid these sanctions through self-censorship, can operate especially strongly. Parties to conflict can thereby not only obstruct beneficial decisions and opportunities for mutually beneficial accommodation with their adversaries, but can also discredit themselves in the eyes of outside authorities or neutral third parties. When the possibility of outside neutral intervention or the importance of the opinion of neutrals is uncertain, groups in conflict then face

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[6] This is similar to the problem of "groupthink" discussed by Janis (1972)

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a classic strategic dilemma: Should they continue to maintain cohesion and inflame supporters through simplistic propaganda to demonize their opponents, or should they compete to be at least minimally more reasonable than the opponents (or to trick the opponent into being more extreme) in dealings with outside neutrals or potential arbitrators? Both Ariel Sharon and Yassir Arafat have extreme factions on their sides whose support they must retain, but each must also try to maneuver to appear more reasonable and less belligerent than the other, so that the greater censure and pressure from external parties falls on his adversary.

Even if the group does not punish people who speak out, desirable revelation can be suppressed simply if individuals holding information anticipate a cost from revealing, even one as minor as the embarrassment of saying something incorrect or foolish in public. Such weak anticipated costs can have force, particularly when individuals are not fully confident of their information. A classic fictional treatment of this phenomenon is Hans Christian Andersen's story "The Emperor's New Clothes" (1837, 1948), in which all the courtiers and citizens saw (or thought they saw) that the Emperor was naked but feared to say so. The swindlers who sold the Emperor his nonexistent robe anticipated how the game would play out. They announced at the outset that those who were stupid or unfit for their office would be unable to see the robe. Given such expectations, the plausibility of the mechanism that kept all the adults from saying what they saw gains force. Not only did they doubt their own eyes when they heard everyone else praising the beauty of the robe, but they feared that revealing they saw nothing would also reveal (or be taken to reveal) that they were stupid or unfit for their office. Each individual's information would have gained credibility had people known how many others were seeing the same thing, but they could only gain this knowledge at the price of exposing themselves to ridicule or shame. This was a straightforward example of herding behavior. No citizen had

enough information to overcome what was implicitly learned from others' silence. Only the child, who presumably understood neither the game nor the inference process, was willing to state the obvious.

Whether the collective interest in voice comes from the group's identifying and organizing itself or from overcoming a shared delusion, the marginal benefits the group derives from voice are likely to be first increasing, then decreasing. When very few people are speaking, not only are the speakers more likely to suffer harms but they are unlikely to attain the force or volume required for the group to overcome its collective inferior state. At some higher level of voice, the speakers will succeed at making their case heard or mobilizing the group, bring a sharp increase in collective benefits. Beyond that point, the group's benefit is largely achieved and further voices bring little additional gain. This structure of collective benefits suggests an S-shaped curve.

A common theme in these situations is that the payoffs to speakers are likely to depend on the order of speaking, even more strongly here than in the cases discussed above where silence is the collective good. Many people may perceive the group's need for voice, or may even wish to speak themselves, but be unwilling to bear the cost of being among the first to do so. Early speakers may bear especially high costs because they are conspicuous, individually identified, and easy to isolate for reprisals. The first person to flout an external authority is more likely to be punished than the fifth or the twenty-fifth (and is also usually less confident that others will follow). The first to question a dearly held group view is especially likely to suffer censure or stronger punishments. In a far less consequential but structurally similar example, the first person to move onto an empty dance floor may simply suffer embarrassment (or more aptly, expect that they will when considering whether to move or not). The typical result is that the

dance floor is empty for a long time. Ultimately, the most confident dancers venture out, after which the floor rapidly fills. The analogy extends to groups awaiting voice. They hold to old behaviors, arguments, and beliefs long after these have ceased to be functional. Once a critical mass for change is achieved -- possibly quite small -- they suddenly convert.

In sum, we make the following conjectures regarding situations in which revelation is a collective good for the peer group. In these situations, we still presume that silence is the status quo, so the group's problem is to motivate individuals to change their behavior. Early speakers are likely to suffer the most severe costs, while the group's benefits from voice increase slowly at first until some critical level is reached. In contrast to the silence case, asymmetry of interests makes the group's problem easier, because it can lead to "cascading revelation," starting with those who bear the smallest cost from revealing, or who are the most disgruntled, the most inclined to seek fame or notoriety, or the least risk-averse.

IV. Elaborations and Conclusion

Information games, which are widely found in our society, bear strategic similarities with the more commonly studied games where direct actions are costly, but they have distinctive elements as well. We have only sketched some characteristics of information games, some conjectures about expected outcomes, and some applications to real settings. Our principal findings were summarized at the outset in Table 1, which outlines typical but not exclusive patterns in different types of collective-action games. Here we lay out four areas for future development.

First, study of information games should enrich the characterization of the information that agents hold, and the range of choices they have regarding its revelation. Actors may hold

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information of different levels of accuracy and precision, may attempt to shade information to their advantage in choosing what to reveal, or may selectively reveal accurate information (Zeckhauser and Marks 1996).

Second, the treatment of actors' knowledge and uncertainty about others' information and payoffs must be enriched. Players should be allowed to have uncertainty about what information others hold, and consequently the expected consequences of others' decisions to reveal it. In addition, players might be uncertain about others' payoffs, for example over whether others have Assurance-game payoffs or prefer to reveal regardless of what others do.

Third, we have dealt only with the two polar cases in which silence and voice respectively are the collective good. There are also mixed situations, where some peers desire silence and others voice, or where voice and silence are beneficial over different portions of some range. To illustrate the latter, consider the insider peers who know about an excellent but out-of-the-way restaurant. If the secret stays too well kept, the restaurant may die, but once it becomes widely known the restaurant is likely to become both congested and more expensive. Voice is desirable only until an appropriate scale is reached, at which point the (now enlarged) peer group will desire silence. Metaphorically this subtle game resembles many information games, where peer membership shifts and consists of those who are informed.

Fourth, we can consider cases in which more than one level of aggregation of actors into groups is important, and the collective payoffs of different groups go in different directions. One major consequence of asymmetric interests is that the same action can have opposite values for two groups, even when they are closely related to each other. For example, a division of an organization might benefit from silence, while the whole organization benefits from revelation; a gang might prefer silence, while the neighborhood in which it operates prefers revelation. As we

have framed the relationship between the peer group and an outside actor in this chapter, the outside actor wants the group not to solve its collective-action problem, whether that problem is maintaining silence or encouraging voice. A more interesting case arises when individual interests go one way, group interests the other, and the outside authority has the same interest as the individual: For example, individuals want to talk; the gang wants silence; the neighborhood (and the authorities) want revelation. The larger group or its agents are the "outside authority" trying to extract information from the smaller group.

In the reverse situation, the group of oppressed citizens wants speech, but the state wants to keep them silent. Individuals remain silent out of fear of punishment by the state. In reply, the group deploys internal norms and sanctions to foster speech. Recognizing this, the outside authority tries to identify those with strongest interest in maintaining silence, and encourages them with rewards to go along with punishments to those who speak. The outcome may well be a tussle between the group and the outside authority to identify critical focal points in Assurance game situations.

In his most famous work, *The Logic of Collective Action* (1965), Mancur Olson was primarily concerned with groups mobilizing for political action. Olson's principal focus was the provision of resources to the group, most easily thought of as money or effort. Frequently, however, groups seeking collective action, including those promoting political agendas, are most concerned with the concealment or revelation of information.

We have looked at situations where collective benefits came from silence (concealment) or voice (revelation). In some instances, the spirit of Olson's primary observations – notably under-provision of a public good that is costly for each to provide – are directly applicable. For example, if a new product is coming on the market, the advertising (voice) of one firm may bring

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positive spillovers for competing producers. However, for a range of additional situations, information games yield different results than resource provision games, even though the information or its absence is a public good.

Information settings require generalizing Olson's results. In these settings, private actors' decisions to produce information, and to reveal, bias, or conceal what they hold, will reflect their calculated attempts to influence the knowledge and perceptions of other group members and outside authorities to promote decisions that avoid costs or bring them benefits. Judged from the standpoint of the peers, the essence of the problem is to align individual and group interests.

Asymmetry of size was the primary determinant of individual willingness to contribute to collective goods in Olson and Zeckhauser's (1966) formulation of alliance theory. In information games, the effects of asymmetries are both stronger and more diverse than in conventional collective-action problems, and the range of possible interests in revelation, at both the group and individual level, are much broader. The group's interest may be in either concealment or revelation. Individuals' interests in revelation can range from large benefits to large costs, since these are consequences of the reactions of others and are not bounded by the direct cost of revelation, which is usually very small. Consequently, the relationship of individual to collective interests can range from being strongly aligned to strongly opposed.

Asymmetries in the quality of individuals' information or their capability to acquire it can further broaden the range of possible outcomes. If those best able to produce collectively beneficial information have interests that are strongly opposed to the consequences of its being revealed, then the problem of getting socially efficient revelation to support policy-making may be even more severe. This situation may be common in regulatory contexts, as the best technical

information relevant to crafting regulatory standards is often held by the firms that are the potential targets of regulation.

The resolution of the group's problem in information games still requires aligning individual and collective payoffs, as in Olson's classic result. When the group benefits from revelation this means rewarding early revealers, or at least reducing their expected penalty so revealing becomes their individually preferred choice. When the group wants silence, this means penalizing early talkers, or bribing those most at risk of talking to keep them silent. When there is an outside actor opposed to the group's silence, that actor will want to deploy opposing individual incentives. While conferring private rewards on early talkers may look like corruption or regulatory capture, it may be advantageous in social-welfare terms if the improvement in outcome for the society at large (e.g., enacting socially beneficial regulation of an externality that would otherwise not be feasible) is worth more than any costs of the payoff.

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