



# Imperfect public monitoring with a fear of signal distortion

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Received 25 July 2015; final version received 1 December 2017; accepted 9 January 2018

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## Abstract

This paper proposes a model of signal distortion in a two-player game with imperfect public monitoring. We construct a tractable theoretical framework where each player has the opportunity to distort the true public signal and each player is uncertain about the distortion technologies available to the other player. We show that when players evaluate strategies according to their worst-case guarantees—i.e., are ambiguity averse over certain distributions in the environment—perceived continuation payoffs endogenously lie on a positively sloped line. We then provide examples showing that, counterintuitively, identifying deviators can be harmful in enforcing a strategy profile; moreover, we illustrate how the presence of such signal distortion can sustain cooperation when it is impossible in standard settings. We show that the main result and examples are robust to a number of natural modifications to our setting. Finally, we extend our model to a repeated game where our concept is a natural generalization of strongly symmetric equilibria. In this setting, we prove an anti-folk theorem, showing that payoffs under our equilibrium concept are under general conditions bounded away from efficiency.

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*JEL classification:* C72; C73; D83

*Keywords:* Linearity; Imperfect public monitoring; Repeated games; Ambiguity aversion

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## 1. Introduction

Many real-world strategic interactions are mediated by public signals that are possibly random functions of the players' actions, and economists have applied the theory of imperfect public monitoring to study many such situations. Applications include oligopoly games where price is influenced by quantity as well as demand fluctuations (see, for instance, [Green and Porter, 1984](#)), trade agreements with volatile trade volume ([Bagwell and Staiger, 1990](#)), and incentive contracts where workers' actions are unobserved (e.g., [Radner, 1986](#) and [Levin, 2003](#)). In most of these settings as well as in the theoretical work on games with imperfect public monitoring (e.g., [Abreu et al., 1990](#) and [Fudenberg et al., 1994](#)), it is taken for granted that the signal structure—the map from the action played to the public signal generated—is fixed and commonly known among all players. Recent papers (e.g., [Fudenberg and Yamamoto, 2010, 2011](#)) have acknowledged that this assumption is often especially strong and have proposed methods to relax it.

This paper proposes a new method to relax this assumption, based on the observation that in many of the applications above, players may fear that the signal that mediates their interaction can be *distorted* by their opponents. In a partnership game between two workers, say, compensation may be based on various dimensions of quality of an object that the workers produce jointly. Workers may then worry that their colleague may sabotage or otherwise alter the object after work on the project has concluded. In other settings, the signal is determined by a third party. Again in a worker-firm setting, promotions or bonuses may depend on performance evaluations conducted by a manager; a worker may worry about favoritism between his colleague and the manager that may cause the manager to doctor her evaluation in favor of the colleague. Cartel agreements are often based on measures like market share, which are computed by a consulting firm hired by the cartel.<sup>1</sup> Cartel members may worry that the consulting company is in the pocket of one of the firms and may be willing to alter these numbers in favor of this firm—perhaps in return for the promise of future business with this firm.

Signal distortion could directly be modeled as simply a game of imperfect public monitoring—in which players have a richer action space that allows them to affect signals without affecting per-period payoffs. Instead, we take a different and novel approach to modeling signal distortion in this paper. It is natural to believe that in many settings there is a large amount of uncertainty in how one's opponents can distort the signal as well as in how one will be able to distort the signal oneself. As such, in the model we present, we assume that players are unsure about the timing of the distortion as well as the distortion technology itself and are *ambiguity averse*, in the maxmin sense of [Gilboa and Schmeidler \(1989\)](#), over the possibilities. As a result, incentives are determined by “perceived” payoffs given by the preferences of ambiguity-averse agents. Another interpretation is that players choose actions that are “robust” to the elements of the environment over which they are uncertain and thus maximize their worst-case guarantees.

This setting is best described by a simple story involving a partnership game. Suppose two workers are both working on a project, and they can choose to either work hard or shirk. Each worker does not see what his colleague is doing, but their manager does see their actions and writes down performance evaluations about them. The manager will show these performance evaluations to her boss the following day to determine compensation for the workers. So far, the setting has exactly been one of imperfect public monitoring: the decision of whether to work

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<sup>1</sup> One problem such third parties solve in a cartel, for instance, is that firms may be unwilling to share their books with competitors but may be willing to do so with a third party. Section 6.6 of [Marshall and Marx \(2012\)](#) discusses consulting firms and trade associations as potential third-party facilitators and provides many examples.

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