Image-Building Persuasion

Carl Heese and Shuo Liu*

October 2023

Abstract

In many economic situations, a sender communicates strategically with a receiver not only to influence the latter's decision-making but also to influence how certain unobserved characteristics of herself (e.g. loyalty, integrity, or smartness) are perceived. To study such strategic interactions, this paper introduces image-building motives into the canonical framework of Bayesian persuasion. We characterize how the sender optimally sacrifices her persuasive influence on the receiver's decision to boost her reputation, by manipulating the communication protocol about a payoff-relevant state. Whether the receiver fares better or worse compared to the pure persuasion setting may depend on the selected equilibrium, and effects can be non-monotone with respect to the sender's characteristics. We illustrate our findings within various classic payoff environments, for instance with quadratic losses or state-independent sender preferences. Finally, we use the model to shed new light on a wide range of applications.

Keywords: persuasion, information design, image concerns, signaling

JEL Classification: C72, D72, D82, M50

*Heese: Business School, Hong Kong University. Liu: Guanghua School of Management, Peking University. Emails: heese@hku.hk and shuo.liu@sm.pku.edu.cn. We are grateful for very helpful comments to Si Chen, Navin Kartik, Daniel Krähmer, Stephan Lauermann, Ming Li and seminar participants at Nanjing University, Peking University, University of International Business and Economics, University of Vienna, the SAET Annual Conference 2022 and the Econometric Society European Summer Meeting 2023. Shuo Liu acknowledges financial support from the National Natural Science Foundation of China (Grant No. 72322006).

1 Introduction

Many economic situations involve a sender with unobserved characteristics supplying information about a payoff-relevant state to a receiver (or receivers). Examples are ubiquitous: voters receive information about the potential impacts of a proposed reform from a politician, whose private gains from the reform's passage are uncertain; workers learn about the difficulty of a task from a manager, without fully knowing the extent to which their preferences align; an agent sees hints about a puzzle that his past-self acquired, while unsure if his present-self has the innate ability to solve it unaided, and so on. In such situations, the receiver (and conceivably some third-party observer) may develop beliefs about both the state and the characteristics – which we shall refer as the type – of the sender, based on the varying communication strategies employed by the latter.

In virtually all applications, the sender (she) is motivated to influence the induced belief about the state, typically because that belief is critical for convincing the receiver (he) to take favorable action. This "persuasion motive" and its impacts on information revelation have been extensively studied in the strategic communication literature (e.g. Crawford and Sobel, 1982; Green and Stokey, 2007; Grossman, 1981; Kamenica and Gentzkow, 2011; Milgrom, 1981). However, the sender may also have an intrinsic interest in the induced belief about her own type. For instance, politicians seek to be perceived as non-corrupt, managers prefer to appear loyal to company values, and individuals desire to maintain the positive self-image of being able to solve difficult problems instinctively. Such "image-building motives", which can stem from practical aims like winning electoral support or getting promotions, as well as psychological needs like boosting self-esteem, have received scant attention in the literature despite their prevalence and potential tension with persuasion incentives.

This paper proposes a model of strategic communication that incorporates both persuasion and image-building motives. In line with the Bayesian persuasion paradigm pioneered by Rayo and Segal (2010) and Kamenica and Gentzkow (2011), we consider a sender who is able to commit to an information structure that maps states to signals before communicating with a receiver. Crucially, our model also endows the sender with a private preference type that differs from the state. This novel feature gives rise to two potentially competing objectives for the sender when designing the information structure: persuading the receiver toward favorable actions based on the realized signal, and cultivating an image as a "good" type based on the information structure itself. We find that the interplay between persuasion and image-

building motives can substantially reshape equilibrium information revelation compared to pure persuasion settings. Furthermore, the receiver's welfare often exhibits non-monotonicity with respect to the relative strength of these two motives.

As a glimpse into the new insights enabled by our model, consider the motivating example from Kamenica and Gentzkow (2011), which involves a prosecutor making a case against a defendant in front of a judge. The judge, who has a prior leaning toward innocence, only wants to convict if the defendant is truly guilty. It is known that the prosecutor can achieve the highest conviction rate through partial disclosure: always revealing the truth when the defendant is guilty but only sometimes so when innocent.

Now suppose that the prosecutor has a private type, wherein higher types are less obsessed with conviction in that they receive less material benefits from a guilty verdict. Additionally, the prosecutor derives utility from being perceived by the judge as a high type, either for instrumental reasons like accruing credibility in future cases, or for purely hedonic reasons like gaining gratification for appearing impartial. Consequently, the prosecutor has incentive to signal to the judge that she is a high type by disclosing information in a way that is costly for lower types to imitate. One intuitive approach to accomplish this is to opt for more transparency when the defendant is truly innocent, which is less attractive for lower types since they have more at stake in terms of material benefits from conviction. When the prosecutor engages in this type of signaling behavior, it facilitates information revelation and benefits the judge by reducing wrongful convictions. However, this approach of separation can work for *all* prosecutor types only if the gain from reputation is not too large. Otherwise, some intermediate type may already be incentivized to furnish the judge with full information. The highest types can then distinguish themselves only by withholding incriminating information about guilty defendants. In other words, an overly strong image-building motive backfires – it leads to less informative communication and more misguided acquittals. Ultimately, a strong enough concern for reputation will drive all types to refrain from providing any information to the judge, allowing the defendant to go free regardless of actual guilt.

Our formal analysis delves into a sender–receiver game with unrestricted state and action spaces, as well as general type distributions. The sender, who privately knows her own preference type, begins by publicly choosing an information structure. Upon obtaining a signal realized from that information structure, the receiver updates his beliefs about the unobservables, and finally takes action. The receiver has a fully flexible utility function over

states and actions.[1] As for the sender, her utility function comprises two components: a *material payoff* determined by the state and the receiver's action, and an *image payoff* based on the sender's true type and what type the receiver expects her to be. We assume that the image payoff increases with the sender's reputation and satisfies the canonical Spence–Mirrlees condition. In the current setting, this condition ensures that higher sender types place a greater premium on enhancing their reputation compared to lower types.

As is typical in signaling games, the lack of discipline imposed by Bayes' rule on off-equilibrium beliefs can lead to a large multiplicity of equilibria. This issue is further complicated by the difficulty that, even in standard persuasion settings absent image considerations, pinpointing the optimal information structure for the sender often proves infeasible. To tackle these challenges, we advance in two steps. First, to rule out equilibria that hinge on implausible or unreasonable off-path beliefs of the receiver, we invoke a well-established equilibrium refinement, namely the D1 criterion due to Cho and Kreps (1987) and Banks and Sobel (1987). Second, rather than directly examining the sender's choice of information structures, we investigate an auxiliary game. In this game, the sender makes choices regarding bundles that encompass the expected material payoff generated by an implementable joint distribution over states and actions, alongside the image payoff derived from the perception of her type. This shift in perspective highlights that the extent to which the sender can mold her image through information design is bounded by the set of material payoffs attainable in a pure persuasion scenario. Moreover, operating in the payoff space provides tractability – it allows us to identify the essential features of D1 equilbria, even when the sender's optimal information structures cannot be expressed in closed form.

Our main characterization result establishes that all equilibria satisfying the D1 criterion manifest as *semi-separating*. Specifically, we demonstrate the existence of a unique cutoff point, below which all sender types adopt information structures that perfectly reveal themselves. In contrast, types exceeding this cutoff effectively pool on the same strategy. As the sender's image concern heightens, the cutoff decreases monotonically, resulting in an equilibrium transition from full separation to complete pooling. Furthermore, higher types necessarily obtain inferior material payoffs in equilibrium. The precise level of material payoff that each below-cutoff type relinquishes for its reputation is pinned down by an envelope

[1] As it will become clear through applications, our framework can be expanded to accommodate settings where the receiver's payoff also depends on the sender's type in a continuation game following the initial strategic interaction.

formula derived from incentive compatibility. In tandem, all types above the cutoff converge to the minimum material payoff. Our characterization thus implies that the sender's interim payoffs, both material and image ones, remain equivalent across all equilibria.

While the sender's payoff-equivalence renders a complete Pareto ranking of the equilibrium set based on the receiver's payoff, this welfare measure can still vary substantially across equilibria. The issue arises from the abundance of information structures – there can be many of them yielding identical sender payoffs yet significantly different receiver payoffs. Therefore, whether the receiver fares better or worse compared to the pure persuasion benchmark may depend on the specific equilibrium chosen. Standard refinements, such as D1, offer no guidance in resolving this issue because they focus on discerning unreasonable payoff incentives of the sender. To advance our understanding nonetheless, we provide sufficient conditions under which the welfare consequences of sender's image concerns will be robust or sensitive to equilibrium selection. In doing so, we also identify some general properties of the Pareto frontier of the equilibrium set. Most notably, we find that the receiver's expected payoff is necessarily quasi-concave (quasi-convex) – but not always monotonic – with respect to the sender's type in any Pareto-optimal (Pareto-worst) equilibrium. This observation suggests that a shift in the balance between the sender's image-building and persuasion motives can have ambiguous effects on receiver welfare.

We complement the general analysis of equilibria by specializing the main results in several classic payoff environments, including quadratic losses (e.g. Crawford and Sobel, 1982; Melumad and Shibano, 1991) and state-independent sender preferences (e.g. Gentzkow and Kamenica, 2016; Lipnowski and Ravid, 2020). These supplementary exercises offer valuable insights into the nature of information structures emerging in equilibrium, an aspect that our "reduced-form" approach falls short in. In particular, we show that in these commonly studied cases, the Pareto frontier of the equilibrium set can often be supported by simple families of information structures, such as censorship, interval disclosure, or a mix between full revelation and total secrecy.

In the last part of the paper, we demonstrate the broad applicability and real-world significance of our theory through three distinct contexts. Importantly, we provide a tangible interpretation of the sender's type and elucidate the origin of image concerns in each instance. To elaborate, our first application considers a self-signaling environment (Bodner and Prelec, 2003) where an agent may gather information to support a forthcoming mental task. Here,

the sender and receiver represent two selves of the agent at different points in time. The sender-self is conscious about the agent's likelihood of successfully completing the task even without any prior information, but the receiver-self is not. The sender-self cares about how this likelihood is perceived by the receiver-self for egotistical reasons. It is shown that, in order to uphold a favorable self-image, the agent would deliberately refrain from acquiring highly informative signals. This finding rationalizes the well-documented phenomenon of information avoidance, without restricting the scope of information acquisition like previous studies (e.g. Bénabou and Tirole, 2002; Grossman and Van der Weele, 2017).

Next, we apply our theory to the realm of organizational economics, focusing on a moral-hazard situation where a manager controls the flow of information accessible to a worker. The manager privately knows the extent to which her preferences concerning the worker's efforts align with the company's leadership, as opposed to the worker. Further, the manager aspires to project an image of compliance with the company's values, recognizing its positive impact on her career prospects. The key discovery here is that the manager may choose to hide information from the worker in an effort to impress superiors, even if it is detrimental to the company's interest. We thus identify a compelling driver of intransparency in hierarchical organizations – the desire to "please the boss". Our result augments Jehiel (2015)'s insights in this domain and sheds light on why many companies nowadays choose to employ committees for performance reviews, rather than relying solely on direct superiors.

Finally, we present an application to political economy. In a seminal paper, Fernandez and Rodrik (1991) contend that the uncertainty surrounding the outcomes of policy changes is a key reason behinds governments' inability to adopt provably welfare-enhancing polices. Our application probes the roots and persistence of this uncertainty. We contemplate a scenario where a politician conveys information about a reform to a group of voters. The politician, whose personal interest in the reform remains concealed from the voters, faces a trade-off: providing information that favors the reform increases its chance of being accepted but may be seen as self-serving. Such perception adversely affects the politician's electability in future campaigns, as voters prefer leaders who act in the public's best interest rather than their own. Our analysis suggests that in situations where electoral outcomes hinge heavily on one's reputation of being "on the people's side" – such as in times of extreme populism – the politician may opt to endorse studies that consistently align with voters' prior skepticism toward the reform, thereby perpetuating their ignorance and causing policy stagnation.

Related literature. Our paper mainly contributes to the rapidly expanding literature of Bayesian persuasion and information design. For an excellent overview of this literature, see Bergemann and Morris (2019) and Kamenica (2019). What sets our paper apart is the introduction of a novel dimension alongside the conventional persuasion motive, namely the image-building motive of the sender. Our general model remains agnostic about the origins of this motive. It could capture the instrumental benefits that individuals gain from their reputation in future interactions (Mailath and Samuelson, 2015), or stem from a wide array of psychological preferences (Geanakoplos, Pearce and Stacchetti, 1989), such as conformity (Bernheim, 1994), social esteem (Bénabou and Tirole, 2006), or self-image concerns (Baumeister, 1998; Bodner and Prelec, 2003; Köszegi, 2006). Regardless of its source, the critical implication of incorporating this motive into our model is that the sender's communication strategy will inherently reflect what she privately knows: her own preference type. While several papers have investigated how private sender information may influence the design of persuasion mechanisms (e.g. Chen and Zhang, 2020; Degan and Li, 2021; Hedlund, 2017; Koessler and Skreta, 2022; Perez-Richet, 2014), they all operate under the assumption that the sender possesses a single preference type, and beliefs regarding the sender's private information only pertain to the receiver's imminent action choice. Hence, these models of Bayesian persuasion with signaling components do not speak to the central trade-off that our paper meticulously examines. Additionally, our work exhibits a clear complementary relationship with recent studies that explore Bayesian persuasion with similar elements situated on the receiver's side, including reputational concerns (Li, 2022; Salas, 2019), psychological preferences (Lipnowski and Mathevet, 2018; Schweizer and Szech, 2018), and private information (Guo and Shmaya, 2019; Hu and Weng, 2021; Kolotilin, Mylovanov, Zapechelnyuk and Li, 2017).

We also make a contribution to the classic literature on signaling games, which originated from Spence (1973)'s seminal work. The semi-separating equilibrium structure, a key feature of our model, has been observed in other signaling contexts in the past (see, e.g., Bernheim, 1994; Cho and Sobel, 1990; Kartik, 2009). However, in those prior studies, the incomplete separation of types is mainly driven by exogenous constraints on the signal space available to the sender. In contrast, this phenomenon emerges in our model due to a payoff boundary that is endogenously determined by the scope of persuasion. More substantially, existing research has primarily treated signaling as a means to influence the receiver's action, whereas our

paper takes on scenarios where a strategic tension arises between signaling and persuasion. This fresh approach not only opens up new applications but also yields intriguing theoretical implications, especially with regard to the receiver's welfare.

Finally, our paper is also related to the literature examining reputation-building behavior in repeated games (Mailath and Samuelson, 2006, 2015). Within this literature, studies have identified various scenarios where reputation can lead to advantageous outcomes (e.g. Fudenberg and Levine, 1989; Kreps and Wilson, 1982; Milgrom and Roberts, 1982) or adverse effects (e.g. Ely, Fudenberg and Levine, 2008; Ely and Välimäki, 2003; Morris, 2001) in terms of welfare consequences. Results from these studies typically involve a rational player (the "normal" type) being motivated to emulate the behavior of a non-strategic player (the "behavioral" or "commitment" type) who adheres to an exogenous decision rule. This contrasts to our model, where the communication strategy is endogenously determined through equilibrium incentives for all sender types.

The remainder of the paper is organized as follows: Section 2 introduces the formal model. Section 3 presents the main theoretical results characterizing equilibria and welfare outcomes, accompanied by specific examples in classic payoff settings. Section 4 details real-world applications of our theory. Finally, Section 5 concludes. Technical proofs and analytical details that support the main text are provided in the Appendix.

2 Model

We study a communication game between a sender (she) and a receiver (he). There is a state space Ω, with a typical state denoted by ω, and an action space A, with a typical action denoted by a. Both A and Ω are compact metric spaces. The players are uncertain about the state at the outset of the game and share a prior $\mu_0 \in \text{int}(\Delta(\Omega))$. The sender moves first by choosing an information structure $\pi : \Omega \to \Delta(A)$, where each signal realization $s \in supp(\pi)$ is interpreted as an action recommended to the receiver. The set of all possible information structures is denoted by Π. The receiver observes the sender's choice of information structure and the signal realization, and finally chooses an action $a \in A$ (which need not coincide with what is recommended by the sender).

Preferences. The receiver has a continuous utility function $u^R(a, \omega)$ that depends on both his action and the state of the world. The sender is endowed with a private type $\theta \in \Theta \equiv [0, 1]$, which is commonly known to be distributed according to an absolutely continuous distribution function Γ with full support. The sender also has a continuous utility function

$$u^S(a, \omega, \theta, \eta) = v(a, \omega) + \phi \cdot w(p(\eta), \theta),$$

where $\eta \in \Delta(\Theta)$ denotes the receiver's belief about the sender's type, and $p(\eta) \equiv \mathbb{E}_\eta[\tilde{\theta}]$ is interpreted as the sender's *image*. Naturally, $\phi > 0$ measures how much the sender cares about the image payoff $w(p, \theta)$ relative to the material payoff $v(a, \omega)$. Further, the function $w(\cdot)$ is continuously differentiable with

$$\frac{\partial w(p, \theta)}{\partial p} > 0 \text{ and } \frac{\partial^2 w(p, \theta)}{\partial p \partial \theta} > 0, \tag{1}$$

meaning that, while all types prefer to be perceived as a high type, such a desire is stronger for higher types.

Strategies and equilibrium. A pure strategy of the sender is a mapping $\sigma : \Theta \to \Pi$ that specifies for each type an information structure. A pure strategy of the receiver is a mapping that specifies an action for every possible information structure and signal realization. We analyze the perfect Bayesian equilibria in pure sender strategies (Fudenberg and Tirole, 1991, p. 333; henceforth equilibrium). In equilibrium, given the sender's choice of information structure and the subsequent signal realization, the receiver forms posteriors beliefs about the state using Bayes' rule, and then takes an action to maximize his expected payoff.[2] At the same time, the receiver may also update his beliefs about the sender's type. In other words, the sender's strategy influences not only the material outcome of the game but also her image in the eyes of the receiver.

An application of the revelation principle reveals that it is without loss to focus on equilibria in which the receiver follows the sender's recommendation. Therefore, we can identify an equilibrium with an *incentive compatible* sender strategy $\sigma = \{\pi_\theta\}_{\theta \in \Theta}$ and a belief system $H = \{\eta(\pi)\}_{\pi \in \Pi}$ such that each $\eta(\pi) \in \Delta(\Theta)$ is consistent with Bayes' rule given σ. Here, incentive compatibility requires that for every $\theta \in \Theta$, the associated information structure π_θ

[2] We assume that whenever the receiver is indifferent between multiple actions and one of them is recommended by the sender, he will choose that action.

is a solution to the following utility maximization problem:

$$\max_{\pi \in \Pi^*} U^S(\pi, \theta; \sigma) \equiv \mathbb{E}_\pi[v(s, \omega)] + \phi \cdot w(p(\eta(\pi), \theta), \tag{2}$$

where

$$\Pi^* \equiv \left\{ \pi \in \Pi : s \in \arg\max_{a \in A} \mathbb{E}\left[u^R(a, \omega) | s; \pi\right] \ \ \forall s \in supp(\pi) \right\}.$$

That is, given the receiver's system of beliefs and the constraint that following the sender's recommendation is indeed optimal for the receiver, no sender type can be strictly better off by deviating from the strategy σ.[3]

Equilibrium refinement. Since Bayes' rule does not put any restriction on the receiver's out-of-equilibrium beliefs about the sender's type, the usual equilibrium multiplicity of signaling games also arises in our model. We follow the literature and invoke a standard equilibrium refinement, the D1 criterion due to Cho and Kreps (1987) and Banks and Sobel (1987). The core idea is to restrict the receiver's out-of-equilibrium beliefs to the sender types that are "most likely" to benefit from the deviation to the off-path choice. Formally, given a sender strategy σ and an associated belief system of the receiver, we define, for any $(\pi, \theta) \in \Pi^* \times \Theta$,

$$D^0(\pi, \theta) \equiv \{\tilde{\eta} \in \Delta(\Theta) : \mathbb{E}_\pi[v(s, \omega)] + \phi \cdot w(p(\tilde{\eta}), \theta) \geq U^S(\pi_\theta, \theta; \sigma)\}$$

and

$$D(\pi, \theta) \equiv \{\tilde{\eta} \in \Delta(\Theta) : \mathbb{E}_\pi[v(s, \omega)] + \phi \cdot w(p(\tilde{\eta}), \theta) > U^S(\pi_\theta, \theta; \sigma)\}.$$

Then, an equilibrium (σ, H) is selected by the D1 criterion if for any $\pi \in \Pi^*$ that is not used by any sender type under σ, and for any sender types θ and θ',

$$D^0(\pi, \theta) \subsetneq D(\pi, \theta') \implies \theta \notin supp(\eta(\pi)). \tag{3}$$

[3]Note that restricting the sender's choice to the set $\Pi^* \subsetneq \Pi$ (i.e., the set of information structures with which the receiver would find it optimal to always follow the sender's recommendation) is without loss of generality. To see this, take any $\pi \in \Pi \setminus \Pi^*$ and suppose that it induces the receiver to use some (sequentially rational) decision rule $\hat{a} : supp(\pi) \to A$. By relabeling every signal realization $s \in supp(\pi)$ as $\hat{s} = \hat{a}(s)$, we obtain an information structure $\hat{\pi} \in \Pi^*$. Then, it is clear that we can always set $\eta(\pi) = \eta(\hat{\pi})$ to make sure that π is sub-optimal for the sender whenever (2) holds.

In words, condition (3) requires that if, for a type θ, there is another type θ' that has a strict incentive to deviate to the off-path choice $\pi \in \Pi^*$ whenever θ has a weak incentive to do so, then the receiver's out-of-equilibrium beliefs upon observing this choice of the sender shall not put any weight on θ.[4] An equilibrium that passes this test is a *D1 equilibrium*; henceforth, often simply called equilibrium if no misunderstanding is possible.

3 Analysis

3.1 A Reduced-Form Characterization of Equilibria

Kamenica and Gentzkow (2011) analyze the benchmark scenario in which the sender does not have image concerns ($\phi = 0$), that is, she is purely guided by the persuasion motive. It is known that, even in that special setting, the equilibrium information structure is often intractable. This problem does not get any easier, if not more difficult, in our model, because the sender's persuasion motive may be entangled with her signaling motive. To make progress, we simplify the infinite-dimensional maximization problem (2) of the sender by moving the analysis to the interim stage. In particular, instead of information structures directly, we focus on the expected material payoff that the sender obtains by the choice of an information structure. Similar "reduced-form approaches" have proven useful in a variety of mechanism design settings (e.g., Ben-Porath, Dekel and Lipman, 2014; Che, Kim and Mierendorff, 2013).

We start by observing that, when viewing the game at the interim stage, it exhibits a number of useful properties. First, the interim game is monotonic in the sense of Cho and Sobel (1990), because, holding the expected material payoff fixed, all sender types share the same ordinal preferences over their images in the eyes of the receiver.[5] Second, the set of expected material payoffs that the sender can implement, formally defined by $\mathcal{V} \equiv \{V \subset \mathbb{R} :$

[4]Considering also the off-path choices $\pi \in \Pi \setminus \Pi^*$ will not change the set of equilibria selected by the D1 criterion. To see this, fix an equilibrium and a sender strategy σ. Note that for a given belief $\tilde{\eta} \in \Delta(\Theta)$ and any $\pi \in \Pi \setminus \Pi^*$, there is $\hat{\pi} \in \Pi^*$ that yields the same interim expected payoff to the sender. Specifically, $\hat{\pi}$ can be constructed by relabeling the support of π (see footnote 3) . Hence, in the spirit of Banks and Sobel (1987) and Cho and Kreps (1987), a sender strategy passes the test required by the D1 criterion at π if and only if it passes the test at $\hat{\pi}$.

[5]This property implies that our equilibrium selection is robust to alternative criteria such as Universal Divinity (Banks and Sobel, 1987) and Never-a-Weak-Best-Response (Kohlberg and Mertens, 1986), as they are equivalent to D1 in monotonic games (see Proposition 1 of Cho and Sobel, 1990).

$\exists\, \pi \in \Pi^*$ such that $V = \mathbb{E}_\pi[v(s,\omega)]\}$, is a compact interval. To see this, consider the payoffs

$$\bar{V} \equiv \max_{\pi \in \Pi^*} \mathbb{E}_\pi[v(s,\omega)] \quad \text{and} \quad \underline{V} \equiv \min_{\pi \in \Pi^*} \mathbb{E}_\pi[v(s,\omega)], \tag{4}$$

and let $\bar{\pi}$ and $\underline{\pi}$ be the information structures that give rise to $\bar{V}$ and $\underline{V}$, respectively.[6] It is clear that $\mathcal{V} \subseteq [\underline{V}, \bar{V}]$. Since any $V \in [\underline{V}, \bar{V}]$ can be implemented by appropriately mixing the information structures $\bar{\pi}$ and $\underline{\pi}$, the converse relationship $\mathcal{V} \supseteq [\underline{V}, \bar{V}]$ also holds.[7] Hence, $\mathcal{V} = [\underline{V}, \bar{V}]$. Third, as we formally show in the Appendix (Lemma A1), the sender's interim payoff has the following single-crossing property: for any $(V, \eta), (V', \eta') \in \mathcal{V} \times \Delta(\Theta)$ with $V < V'$, if type θ weakly prefers (V, η) over (V', η'), then (V, η) will be strictly preferred over (V', η') by all types $\theta' > \theta$.

The above properties allow us to apply techniques from the costly signaling literature (e.g. Cho and Sobel, 1990; Mailath, 1987; Ramey, 1996) to partially characterize the set of D1 equilibria. Given a sender strategy σ, we define $V(\theta;\sigma) \equiv \mathbb{E}_{\pi_\theta}[v(s,\omega)]$ and $p(\theta;\sigma) \equiv \mathbb{E}[\tilde{\theta}|\tilde{\theta} : \sigma(\tilde{\theta}) = \sigma(\theta)]$, i.e., the expected material payoff and the perceived image that the strategy induces for each type θ, respectively. We say that a type θ is *separating* under the strategy σ if $\sigma(\theta') \neq \sigma(\theta)$ for all $\theta' \neq \theta$ (in which case we necessarily have $p(\theta;\sigma) = \theta$). Otherwise, we say that θ is *pooling*. Our main result shows that there exists a *unique* cutoff $\hat{\theta}$ such that all types $\theta < \hat{\theta}$ ($\theta \geq \hat{\theta}$) will be separating (pooling) in any equilibrium that satisfies D1.[8] Moreover, although the D1 criterion may not select a unique equilibrium, it fully pins down the equilibrium payoff of the sender.

Theorem 1. *There is a unique cutoff $\hat{\theta} \in [0,1) \cup +\infty$ such that any strategy $\sigma = \{\pi_\theta\}_{\theta \in \Theta}$ of the sender with $\pi_\theta \in \Pi^*$ for all $\theta \in [0,1]$ is part of a D1 equilibrium if and only if the following two conditions are both satisfied:*

[6] Since we can always break the tie by selecting the action that gives the highest payoff to the sender, the value function of the maximization problem in (4) is upper semi-continuous, which guarantees that its solution is well-defined. Similarly, since we can always break the tie by selecting the action that gives the lowest payoff to the sender, the value function of the minimization problem in (4) is lower semi-continuous, so a solution is guaranteed to exist as well.

[7] Take any solutions $\bar{\pi}$ and $\underline{\pi}$ of the sender's max- and minimization problems in (4), respectively. Then, to implement the payoff $V = \lambda \underline{V} + (1-\lambda)\bar{V}$ for some $\lambda \in [0,1]$, we may use the following "grand" information structure $\hat{\pi}$: with probability λ, the sender draws a signal s according to $\underline{\pi}$, and with probability $1-\lambda$, according to $\bar{\pi}$. It is straightforward to check that $\hat{\pi} \in \Pi^*$ and $\mathbb{E}_{\hat{\pi}}[v(s,\omega)] = V$, i.e., $\hat{\pi}$ indeed implements V.

[8] We assume that if a type (e.g., the cut-off type $\hat{\theta}$ when $\hat{\theta} \in (0,1)$) is indifferent between separating herself or pooling with some higher types, she would break the tie in favor of the latter. With a continuous type distribution, this tie-breaking rule is inconsequential.

(i) All types $\theta < \hat{\theta}$ are separating, with

$$V(\theta;\sigma) = \bar{V} - \phi \cdot \int_0^{\theta} \frac{\partial w(x,x)}{\partial p} dx; \tag{5}$$

(ii) All types $\theta \geq \hat{\theta}$ are pooling, with $V(\theta;\sigma) = \underline{V}$ and $p(\theta;\sigma) = \mathbb{E}[\tilde{\theta}|\tilde{\theta} \geq \hat{\theta}]$.

Theorem 1 implies the existence of a D1 equilibrium — one can always construct a strategy that satisfies (i) and (ii) (recall the property that $\mathcal{V} = [\underline{V}, \bar{V}]$). Exactly which strategy is chosen among the qualified ones is immaterial for the sender, because from her perspective all of them are equivalent in terms of payoffs. As a consequence, the set of D1 equilibria can be Pareto-ranked according to the welfare of the receiver. In later analysis, we will provide examples and applications which also feature payoff equivalence for the receiver, or which permit an analytical description of the equilibria that are extremal in the Pareto ranking.

In what follows, we prove the only-if part of Theorem 1, i.e., that all D1 equilibria necessarily satisfy conditions (i) and (ii), which is instructive as it highlights how the equilibrium outcome is shaped by the tension between the conflicting motives of the sender. The proof of the if-part of the theorem, i.e., that all strategies satisfying (i) and (ii) are part of a D1 equilibrium, is relegated to the Appendix as it is rather mechanical: Plainly, types would not want to mimic each other because conditions (i) and (ii) will be derived (among others) from the on-path incentive compatibility constraints. With attention to detail, one can further construct the appropriate out-of-equilibrium beliefs that prevent off-path deviations and satisfy D1.

Monotone strategies and incomplete separation. To begin with, we derive some qualitative features of the sender's strategy from her equilibrium incentives. Recall that the sender's central trade-off is between the material persuasion motive and her image concerns. In particular, it is clear that the sender will be willing to sacrifice her material payoff only if that can boost her reputation. Further, since the image concern $w(\cdot)$ satisfies the Spence-Mirrlees (or increasing difference) condition in (1), such a "money-burning" incentive will be strictly higher for higher types. Lemma 1 below exploits this property and shows that any equilibrium must be monotone in the sense that the interim material payoff of higher types is lower, while their interim image is higher.

Lemma 1. *In any equilibrium, $V(\theta;\sigma)$ is decreasing in θ and $p(\theta;\sigma)$ is increasing in θ.*

Next, we show that a type cannot be pooling unless its associated material payoff is already minimal.

Lemma 2. *In any equilibrium that satisfies the D1 criterion, $\forall \theta \neq \theta'$, if $\sigma(\theta) = \sigma(\theta')$, then $V(\theta;\sigma) = V(\theta';\sigma) = \underline{V}$.*

The intuition behind Lemma 2 is as follows. Given the single-crossing property of the sender's interim preferences, a higher type in a pooling set will be more likely to benefit from an off-path choice that slightly reduces her material payoff than any type lower than her. To be consistent with the D1 criterion, such an unexpected move must convince the receiver that the sender's type is higher than anyone in that pooling set. As a consequence, a pooling type can obtain a discrete gain in image payoff by sacrificing an arbitrarily small amount of material payoff. Plainly, this kind of deviation is not a threat to the equilibrium if and only if the material payoff is already "used up" by the pooling types: they are receiving $\underline{V}$, the lowest possible material payoff, so undercutting is simply not feasible.

Lemmas 1 and 2 jointly imply that, in any D1 equilibrium, when choosing the interim allocation the sender must use a strategy where all types below a cutoff $\hat{\theta}$ separate by monotonically decreasing their material payoff, while all types above $\hat{\theta}$ pool at the lower bound of the material-payoff space. Similar incomplete separation at the top has been established in other contexts (Bernheim, 1994; Kartik, 2009). Indeed, Cho and Sobel (1990) show that this semi-separating structure is inherent to the equilibria selected by D1 in a large class of costly signaling games where the sender faces a compact signal space. However, a key distinction is that there are no exogenous signaling costs in our framework. Rather, the sender's signaling costs arise endogenously from how the receiver reacts under varying information structures.

The cost of reputation. We now proceed to characterize the endogenous cost of signaling (i.e., the extent to which one's material payoff needs to be sacrificed) for types in the separating interval $[0, \hat{\theta})$. Here, the central idea is to leverage that the sender's utility function is quasi-linear with respect to her reputation. This payoff structure reminds of the standard mechanism design setting with transfers. Thus, naturally, we advance the analysis by applying the classical envelope theorem argument to the (local) incentive compatibility constraints

of the sender.[9]

Take any $\theta \in [0, \hat{\theta})$. Note that for sufficiently small $\epsilon > 0$, we have $\theta + \epsilon \in [0, \hat{\theta})$ as well. Incentive compatibility for the type-θ sender implies that

$$\phi \cdot [w(\theta + \epsilon, \theta) - w(\theta, \theta)] \leq V(\theta; \sigma) - V(\theta + \epsilon; \sigma). \tag{6}$$

That is, the image gain for type θ from mimicking $\theta + \epsilon$ is weakly smaller than the associated loss in material utility. Similarly, incentive compatibility for the type $\theta + \epsilon$ implies that

$$\phi \cdot [w(\theta + \epsilon, \theta + \epsilon) - w(\theta, \theta + \epsilon)] \geq V(\theta; \sigma) - V(\theta + \epsilon; \sigma). \tag{7}$$

Combining (6) and (7) and dividing them by ϵ, we have

$$\frac{\phi \cdot [w(\theta + \epsilon, \theta) - w(\theta, \theta)]}{\epsilon} \leq \frac{V(\theta; \sigma) - V(\theta + \epsilon; \sigma)}{\epsilon} \leq \frac{\phi \cdot [w(\theta + \epsilon, \theta + \epsilon) - w(\theta, \theta + \epsilon)]}{\epsilon}.$$

Since $w(\cdot)$ is continuously differentiable, it follows from the squeeze theorem that

$$V'(\theta; \sigma) \equiv \lim_{\epsilon \to 0} \frac{V(\theta + \epsilon; \sigma) - V(\theta; \sigma)}{\epsilon} = -\phi \cdot \frac{\partial w(\theta, \theta)}{\partial p}. \tag{8}$$

Hence, $V(\cdot; \sigma)$ is also continuously differentiable.

Further, whenever $\hat{\theta} > 0$, the type $\theta = 0$ is in the separating interval and gets the lowest possible image payoff. Thus, incentive compatibility also requires that this type must be earning the highest possible material payoff, i.e., $V(0; \sigma) = \bar{V}$. By combining this boundary condition with the differentiable equation (8), we immediately obtain the payoff formula (5) and conclude that it must hold for all $\theta \in [0, \hat{\theta})$ in any D1 equilibrium.

Uniqueness of the equilibrium cutoff. To complete the proof of Theorem 1, it remains to show that the cutoff $\hat{\theta}$ is unique across all D1 equilibria. The characterization of the equilibrium payoffs on $[0, \hat{\theta})$ implies that the following indifference condition must hold for an *interior* cutoff type $\hat{\theta} \in (0, 1)$:

$$\left(\bar{V} - \phi \cdot \int_0^{\hat{\theta}} \frac{\partial w(x, x)}{\partial p} dx \right) + \phi \cdot w(\hat{\theta}, \hat{\theta}) = \underline{V} + \phi \cdot w\left(\mathbb{E}[\tilde{\theta} | \tilde{\theta} > \hat{\theta}], \hat{\theta} \right). \tag{9}$$

[9] See, e.g., Proposition 23.D.2 in Mas-Colell, Whinston and Green (1995). The (exogenous) image concerns play here a role similar to that of "quasi-money" in other design settings (e.g., Kolotilin *et al.*, 2017).

Intuitively, if condition (9) does not hold, then by continuity either some pooling type $\hat{\theta}+\epsilon$ would have a strict incentive to mimic, e.g., the separating type $\hat{\theta}-\epsilon$, where $\epsilon>0$ is sufficiently small, or vice versa. We rewrite (9) as

$$\frac{\bar{V}-\underline{V}}{\phi}=I(\hat{\theta}) \tag{10}$$

where the mapping $I(\cdot)$ is given by

$$I(\theta)=\int_0^{\theta}\frac{\partial w(x,x)}{\partial p}dx\ +w(\mathbb{E}[\tilde{\theta}|\tilde{\theta}>\theta],\theta)-w(\theta,\theta)$$

for all $\theta\in[0,1]$. Note that I is strictly increasing.[10] Also, I is continuous in $\hat{\theta}$ because $w(\cdot)$ is continuously differentiable and because the type distribution Γ is absolutely continuous.

We distinguish three cases. First, if

$$I(0)<\frac{\bar{V}-\underline{V}}{\phi}<I(1), \tag{11}$$

an application of the intermediate value theorem implies that (10) admits an interior solution $\hat{\theta}\in(0,1)$, and this solution is unique due to the strict monotonicity.

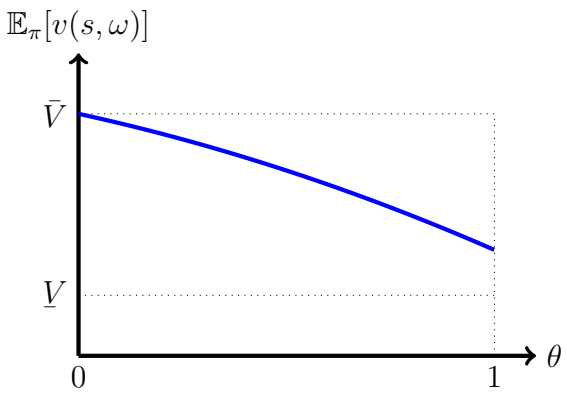
Second, consider the case $(\bar{V}-\underline{V})/\phi\geq I(1)$ or, equivalently, $\phi\leq\underline{\phi}\equiv(\bar{V}-\underline{V})/I(1)$. Suppose that there would be an equilibrium with cutoff $\hat{\theta}<1$. Then, all types $\theta<1$ would strictly prefer separating to pooling with higher types, which contradicts with $\hat{\theta}<1$. As a result, any equilibrium selected by D1 must be fully separating and we can write $\hat{\theta}=+\infty$ without loss of generality.

Third, consider the case when $(\bar{V}-\underline{V})/\phi\leq I(0)$ or, equivalently, $\phi\geq\bar{\phi}\equiv(\bar{V}-\underline{V})/I(0)$. Suppose that there would be an equilibrium with cutoff $\hat{\theta}>0$. Then, all types $\theta<1$

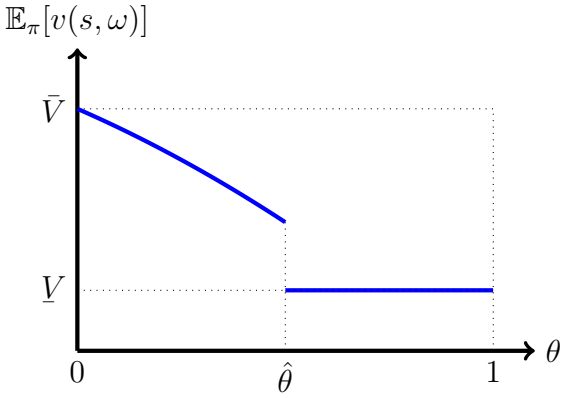
[10] For all $\theta,\theta'\in[0,1]$ with $\theta'<\theta$, we have

$$\begin{aligned}
I(\theta)-I(\theta') &= \int_{\theta'}^{\theta}\frac{\partial w(x,x)}{\partial p}dx+\int_{\theta}^{\mathbb{E}[\tilde{\theta}|\tilde{\theta}>\theta]}\frac{\partial w(x,\theta)}{\partial p}dx-\int_{\theta'}^{\mathbb{E}[\tilde{\theta}|\tilde{\theta}>\theta']}\frac{\partial w(x,\theta')}{\partial p}dx\\
&> \int_{\theta'}^{\theta}\frac{\partial w(x,\theta')}{\partial p}dx+\int_{\theta}^{\mathbb{E}[\tilde{\theta}|\tilde{\theta}>\theta]}\frac{\partial w(x,\theta')}{\partial p}dx-\int_{\theta'}^{\mathbb{E}[\tilde{\theta}|\tilde{\theta}>\theta']}\frac{\partial w(x,\theta')}{\partial p}dx\\
&= \int_{\mathbb{E}[\tilde{\theta}|\tilde{\theta}>\theta']}^{\mathbb{E}[\tilde{\theta}|\tilde{\theta}>\theta]}\frac{\partial w(x,\theta')}{\partial p}dx\\
&\geq 0,
\end{aligned}$$

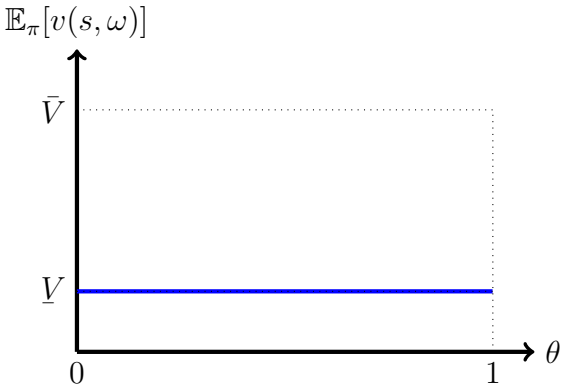
where the strict inequality follows since $w(\cdot)$ has strictly increasing differences, and the weak inequality holds because $w(p,\theta')$ is strictly increasing in p and $\mathbb{E}[\tilde{\theta}|\tilde{\theta}>\theta]\geq\mathbb{E}[\tilde{\theta}|\tilde{\theta}>\theta']$.



(a) $\phi = 0.3$, fully separating



(b) $\phi = 0.6$, semi-separating



(c) $\phi = 1.2$, fully pooling

Figure 1: Sender's expected material payoff as a function of her type in a D1 equilibrium, with $\theta \sim \mathcal{U}[0,1]$, $w(p,\theta) = p \cdot (\theta + 1)$, $\bar{V} - \underline{V} = 0.6$, and different ϕ.

would strictly prefer pooling with higher types than separating (except that type 0 may be indifferent), which contradicts with $\hat{\theta} > 0$. This implies that all types must be pooling in any equilibrium, and consequently, we have $\hat{\theta} = 0$ as the unique cutoff. □

We close this section with a graphical illustration of the main findings of Theorem 1. Figure 1 presents all three types of the sender's strategy that could emerge in an equilibrium satisfying the D1 criterion. That is, the cases $\phi \leq \bar{\phi}$ (Panel a), $\underline{\phi} < \phi < \bar{\phi}$ (Panel b), and $\phi \geq \bar{\phi}$ (Panel c).

3.2 Equilibrium Multiplicity and Pareto (In)efficiency

As mentioned, Theorem 1 implies that the sender's interim payoffs are equivalent across all D1 equilibria. In particular, the theorem specifies explicitly the level of material payoff that each

sender type will give up in order to separate herself from lower types. Given the abundance of possible information structures, there are, however, manifold ways how types can make such sacrifices. In other words, Theorem 1 does not give a very sharp prediction on which information structure will be used by the sender, which also means that the payoff of the receiver is not necessarily pinned down by the D1 criterion. Since there is no a priori reason to restrict attention to a specific class of information structures, we proceed by (i) providing simple sufficient conditions under which the implications of the sender's image concerns for the receiver's welfare will (or will not) be robust to equilibrium selection, and (ii) analyzing the Pareto-frontier of the equilibrium set.

To simplify the discussion, we make two additional mild assumptions. First, information is valuable to the receiver: $\bar{U} \equiv \mathbb{E}_{\mu_0}\left[\max_{a\in A} u^R(a,\omega)\right] > \underline{U} \equiv \max_{a\in A} \mathbb{E}_{\mu_0}\left[u^R(a,\omega)\right]$. Second, in the benchmark scenario in which the sender has *no* image concern, the receiver's equilibrium payoff – which we denote by U^* – is uniquely defined.

3.2.1 When will the sender's image concerns be harmful?

When will the presence of the sender's image concerns only do harm to the receiver's welfare, irrespective of which D1 equilibrium is selected? An obvious sufficient condition is that the receiver would be earning his full-information payoff when the sender does not have any image concern. Our next result summarizes this simple observation and goes beyond it by identifying what the best- and worst-case scenarios for the receiver may look like within the set of D1 equilibria.

Theorem 2. *If $U^* = \bar{U}$, the receiver can never benefit from the presence of the sender's image concerns. Moreover,*

(i) provided that $\phi < \bar{\phi}$ (so that we have a cutoff type $\hat{\theta} > 0$), there exists a D1 equilibrium in which the receiver is strictly worse off compared to the case without image concerns;[11]

(ii) in any Pareto-optimal D1 equilibrium, the receiver's expected payoff is strictly decreasing with respect to the sender's type;

(iii) in any Pareto-worst D1 equilibrium, the receiver's expected payoff is quasi-convex with respect to the sender's type.

[11] The statement remains valid when $\phi \geq \bar{\phi}$ under the additional assumption that an information structure $\pi \in \Pi^*$ satisfying $\mathbb{E}_\pi[v(s,\omega)] = \underline{V}$ and $\mathbb{E}_\pi[u^R(s,\omega)] < \bar{U}$ exists.

Intuitively, the conditions of Theorem 2 imply that a no-disclosure protocol is suboptimal for the sender when she is purely guided by material interests since otherwise, the receiver would not have been able to enjoy his full-information payoff. Therefore, an image-concerned sender can always separate herself from those very low types by occasionally sending a completely uninformative signal to the receiver, which obviously engenders a negative "side-effect" on the receiver's payoff. As for the properties of the Pareto-extremal equilibria, our proof mainly exploits the convexity of the set of payoff profiles that can be implemented via information design: For instance, suppose, within the separating interval of a D1 equilibrium, the receiver's payoff implied by the strategy of a type θ is lower than that of a higher type $\theta' > \theta$. This equilibrium cannot be Pareto-optimal, because of the following argument: Replacing the communication protocol that type θ initially chooses with an appropriate mix of those used by types 0 and θ' will not change the sender's payoff, but will strictly improve the payoff of the receiver. A similar constructive argument (which involves the no-disclosure protocol instead of the one used by type 0) shows that any Pareto-worst D1 equilibrium must be either decreasing or U-shaped with respect to the sender's type. Otherwise, it would have been feasible to further reduce the receiver's payoff without altering the sender's.

In what follows, we exemplify the insights of Theorem 2 within various classic settings from the literature on sender-receiver games.

Example 1: Congruent preferences. Suppose that the preferences of the players are *congruent* with each other in the sense that they agree on the ex-post optimal actions in every state $\omega \in \Omega$:

$$a^* \in \max_{a \in A} u^R(a, \omega) \Longleftrightarrow a^* \in \max_{a \in A} v(a, \omega). \tag{12}$$

When (12) holds, it is clear that the material payoff of the sender is maximized when she provides full information to the receiver. Hence, we have $U^* = \bar{U}$, and Theorem 2 applies.

An obvious setting with congruent preferences is when players' material interests are *perfectly aligned*. Namely, when there exists a strictly increasing function $\Psi : \mathbb{R} \to \mathbb{R}$, such that $u^R(a, \omega) = \Psi(v(a, \omega))$ for all $(a, \omega) \in A \times \Omega$. Panel (a) in Figure 2 depicts the set of implementable material payoff profiles for the case of $\Psi(\cdot)$ being a linear function. In this case, the mapping between the *expected payoffs* of the two players is also a linear one. Consequently, the D1 equilibria are not only payoff-equivalent to the sender (as already

asserted by Theorem 1), but also to the receiver. A particularly simple equilibrium is one in which the sender always commits to an information structure that either reveals everything (i.e., recommending an ex-post optimal action) or reveals nothing (i.e., recommending an ex-ante optimal action) to the receiver, with the frequency of the former action decreasing in the sender's type. Restricting to this class of equilibrium information structures, a more image-concerned sender (captured by either a higher θ or ϕ) will transmit less information to the receiver, therefore intensifying the negative impact on the latter's welfare.

Perfect alignment of material interests is by far not the only setting that implicates congruent preferences. We illustrate this point by considering a special case with $A = \Omega = \{-1, 0, 1\}$ and the following material payoff functions of the players:

$$u^R(a,\omega) = \begin{cases} 1 & \text{if } a = \omega, \\ 0 & \text{otherwise,} \end{cases} \quad \text{and} \quad v(a,\omega) = \begin{cases} 1 & \text{if } a = \omega, \\ 0 & \text{if } a \neq \omega \text{ and } a \neq -1, \\ -1 & \text{if } a \neq \omega \text{ and } a = -1. \end{cases} \tag{13}$$

The interpretation of the above payoff specification is that the material interests of the players are *almost* perfectly aligned. Both players would like to match the action to the true state. However, the action $a = -1$ is somewhat riskier than others for the sender, because she will be additionally punished when the receiver takes it by mistake. By contrast, the receiver is indifferent between different types of errors. Despite the discrepancy in the payoff functions, the congruency condition (12) is satisfied.

Panel (b) in Figure 2 identifies the set of implementable material payoff profiles under some specific prior distribution (see Appendix A.6.1 for the formal construction). Especially, the upper curve in red (the lower curve in blue) pins down, for any given level of the sender's payoff $V \in [\underline{V}, \bar{V}]$, the maximal (minimal) payoff that the receiver can obtain. Thus, in any Pareto-extremal equilibrium, different sender types will "line up" along these curves to forgo their material utilities, giving rise to the patterns of monotonicity/quasi-convexity highlighted by Theorem 2.

Example 2: Quadratic loss. Let $A = \Omega = [0, 1]$, $u^R(a,\omega) = -(a-\omega)^2$, and $u^S(a,\omega,\theta,\eta) = -(a - a^*(\omega,\theta))^2 + \phi \cdot w(p(\eta),\theta)$. Specifically, the sender's bliss point is given by $a^*(\omega,\theta) = f(\theta) \cdot \omega + g(\theta)$. Communication games in which players' preferences take the form of such a quadratic loss function were popularized by the seminal work of Crawford and Sobel (1982),

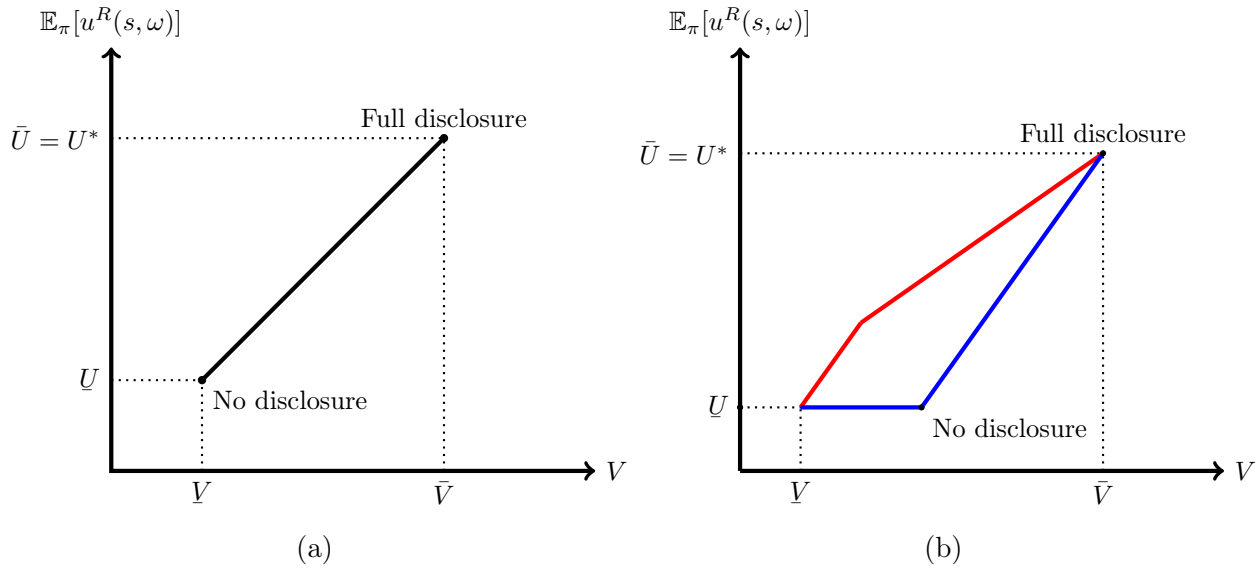


Figure 2: The equilibrium set of implementable payoffs in settings with $U^* = \bar{U}$. Panel (a) represents a game where the preferences of the players are perfectly aligned, with $u^R(a,\omega) = v(a,\omega)$, $\bar{V} = 0.5$ and $\underline{V} = 0.1$. Panel (b) represents a game where the preferences of the players are almost perfectly aligned, with $A = \Omega = \{-1, 0, 1\}$, $\Pr(\omega = 1) = \Pr(\omega = 0) = 0.4$, $\Pr(\omega = -1) = 0.2$ and the payoff functions given by (13). The upper curve (colored in red) in the graph depicts the utility-frontier of the Pareto-optimal D1 equilibria, while the lower curve (colored in blue) corresponds to the utility-frontier of the Pareto-worst D1 equilibria.

and they have received considerable attention in the information design literature (see, e.g., Galperti, 2019; Jehiel, 2015; Kamenica and Gentzkow, 2011; Smolin and Yamashita, 2022; Tamura, 2018). In the classic information design setting without image concerns, the players' incentives are purely governed by their disagreement over the optimal action plan: while the receiver wants to exactly match the state ($a = \omega$), the sender may have a systematically different target ($a = a^*(\omega, \theta)$). The current example, as well as Example 5 in the next subsection, examine the conditions under which introducing image concerns would mitigate or amplify the above misalignment of preferences and consequently lead to more or less information transmitted in equilibrium.

In Appendix A.6.2, we show that if $f(\theta) > 0.5\ \forall \theta \in [0,1]$ is satisfied, then the initial quadratic-loss game is equivalent to one in which the sender has the material payoff function $v(a,\omega) = u^R(a,\omega)$ and the image payoff function $\hat{w}(p(\eta),\theta) = w(p(\eta),\theta)/(2f(\theta) - 1)$. This transformation manifests that the players' interests are sufficiently aligned under the current specification, insomuch that a sender purely guided by material interests would be willing to share all information with the receiver. However, if function $\hat{w}(\cdot)$ satisfies the key condition (1) – which can be the case, for instance, if $f'(\cdot) < 0$, meaning that higher types put less

weight on the state-dependent term relative to the state-independent target $g(\cdot)$ – then both Theorem 1 and Theorem 2 apply. They jointly imply that all types (except possibly type 0) will withhold information from the receiver for signaling purposes. Moreover, given that $v(a,\omega) = u^R(a,\omega)$, the equilibrium payoffs of both the sender and the receiver are uniquely pinned down by the D1 criterion.

Theorem 2 and the examples following it are related to the literature on "bad reputation" in repeated games (see, e.g., Ely *et al.*, 2008; Ely and Välimäki, 2003). An overarching finding of this literature is that reputational concerns harm a long-lived player who repeatedly interacts with short-lived players if they are based on a desire to separate from a bad type rather than to mimic a good commitment type (see the discussion in Mailath and Samuelson, 2006). The forces behind our results are quite different and more subtle: the sender tries to separate herself from the type that is *least image-concerned*, which requires her to avoid taking the strategy that would be *endogenously* chosen by the latter. In the current set-up, that strategy happens to be the one that maximizes the material payoffs of both players.

3.2.2 When will sender's image concerns be beneficial?

We now study when the presence of image concerns can only be beneficial. Analogous to the previous subsection, we focus on settings in which the following simple sufficient condition holds: a sender who acts out of pure material interest will implement the *no-information payoff* for the receiver. Theorem 3 below summarizes some key properties of the equilibrium set in such settings.

Theorem 3. *If $U^* = \underline{U}$, the receiver can never be harmed by the presence of the sender's image concerns. Moreover,*

(i) provided that $\phi < \bar{\phi}$ (so that we have a cutoff type $\hat{\theta} > 0$), there exists a D1 equilibrium in which the receiver is strictly better off compared to the case without image concerns;[12]

(ii) in any Pareto-optimal D1 equilibrium, the receiver's expected payoff is quasi-concave with respect to the sender's type;

[12] This statement remains valid when $\phi \geq \bar{\phi}$ under the additional assumption that an information structure $\pi \in \Pi^*$ satisfying $\mathbb{E}_\pi[v(s,\omega)] = \underline{V}$ and $\mathbb{E}_\pi[u^R(s,\omega)] > \underline{U}$ exists.

(iii) in any Pareto-worst D1 equilibrium, the receiver's expected payoff is increasing with respect to the sender's type.

Both the proof and the intuition of Theorem 3 are analogous to Theorem 2, and therefore omitted to avoid repetition. Below, we illustrate the main insights of the theorem through several examples.

Example 3: No gain from persuasion. Kamenica and Gentzkow (2011) characterize when a sender purely driven by material interests can benefit from persuasion. That is when she can do *strictly* better than providing no information (or always recommending an ex-ante optimal action) to the receiver. When this is *not* the case, $U^* = \underline{U}$ obviously holds, so Theorem 3 applies.

A concrete setting where the sender would not want to share any information in the absence of image concerns is when players have *opposite* material interests. Namely, when there exists a strictly *decreasing* function $\Psi : \mathbb{R} \to \mathbb{R}$, such that $u^R(a, \omega) = \Psi(v(a, \omega))$ for all $(a, \omega) \in A \times \Omega$. Panel (a) in Figure 3 depicts the set of implementable material payoff profiles in such a game. Similar to Example 1, the function $\Psi(\cdot)$ is chosen to be linear, which gives rise to the linear mapping between the players' expected payoffs as we see from the figure. This property ensures that all D1 equilibria are payoff-equivalent to both the sender and the receiver. A particularly simple equilibrium is one in which the sender always commits to an information structure that reveals either everything or nothing about the true state, with the frequency of the former action increasing in the sender's type. In this case, a more image-concerned sender (captured by either a higher θ or ϕ) will transmit more information to the receiver, therefore boosting the positive impact on the latter's welfare.

Example 4: Quadratic loss (continued). Consider again the quadratic-loss games that we introduced in the previous subsection. In Appendix A.6.2, we show that under the condition $f(\theta) < 0.5$ $\theta \in [0, 1]$, the initial game will be strategically equivalent to one in which the sender has the material function $v(a, \omega) = (a - \omega)^2$ and the image payoff function $\hat{w}(p(\eta), \theta) = \mathbb{E}_\eta[\tilde{\theta}]/(1 - 2f(\theta))$. Thus, $v = -u^R$ and we effectively have a game with strictly opposed interests. Provided that condition (1) holds for $\hat{w}(\cdot)$ – which can be the case, for instance, if the interests of higher types are more aligned with the receiver in the sense that $f'(\theta) > 0$ $\forall \theta \in [0, 1]$ – then both Theorem 1 and Theorem 3 apply. Thus, the presence

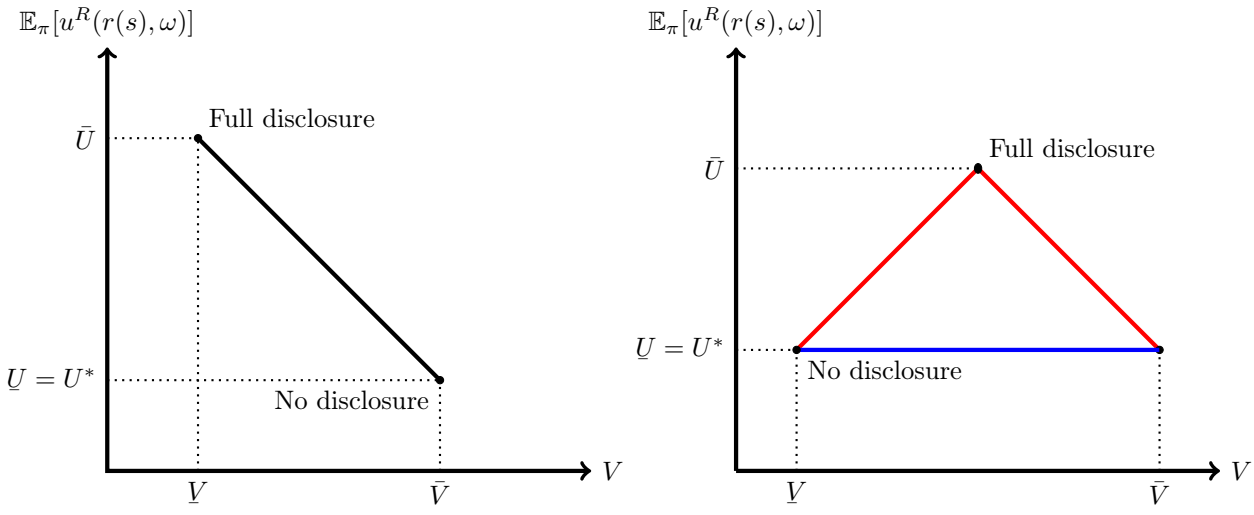


Figure 3: The equilibrium set of implementable payoffs in settings with $U^* = \underline{U}$. Panel (a) represents a game where the players have exactly opposite interests over the material outcomes, with $u^R(a,\omega) = -v(a,\omega)$, $\bar{V} = 0.5$ and $\underline{V} = 0.1$. In panel (b), we have a game with partially conflicting interests as described in Example 5. The upper curve (coloured in red) in the graph depicts the utility-frontier of the Pareto-optimal D1 equilibria, while the lower curve (coloured in blue) corresponds to utility frontier of the Pareto-worst D1 equilibria.

of image concerns will trigger all sender types (except possibly type 0) to share information with the receiver, which they would be reluctant to do otherwise. In addition, because $u^R(a,\omega) = -v(a,\omega)$, the payoff equivalence implied by the D1 criterion holds not only for the sender but also for the receiver.

Next, we introduce two widely-studied examples in which the sender would partially disclose the state if only the persuasion motive is present, yet the receiver's payoff remains to be minimal. This demonstrates that the applicability of Theorem 3 is *not* limited to settings in which the sender would not share any information in the absence of image concerns. Intuitively, the optimality of partial disclosure may be compatible with the premise $U^* = \underline{U}$ of Theorem 3, because having access to partial information does not guarantee that the receiver can do *strictly* better *on average* than taking his prior-optimal action. This observation is important and may prove useful beyond the examples because it is known that partial disclosure is optimal in many pure persuasion settings. For instance, Jehiel (2015) shows that this is typically the case when the information of the sender is higher dimensional than the action space of the receiver; Kolotilin and Wolitzky (2020) and Kolotilin, Corrao and Wolitzky (2022a) provide similar results in a setting that allows utilities of the sender and

receiver to be non-linear in the state.[13]

Example 5: State-independent sender preferences, I. Suppose that $A = \Omega = \{0, 1\}$, $v(a, \omega) = a$, and $u^R(a, \omega) = \mathbb{1}_{a=\omega}$. Thus, while the receiver wants to match the state, the sender's preference over material outcomes is state-independent: she always prefers the receiver to take the high action. This persuasion setting is most vividly embodied by the prosecutor-judge example in Kamenica and Gentzkow (2011). Since the state space is binary, we use μ_0 to denote the prior likelihood of the state being $\omega = 1$. We assume $\mu_0 \in (0, 0.5)$ so that $a = 0$ is the receiver's optimal action given the prior. Clearly, releasing no information minimizes the sender's material payoff. At the same time, Kamenica and Gentzkow (2011) show that partial information disclosure is optimal for the sender when she has no image concerns. Nevertheless, under the optimal disclosure policy, the receiver weakly prefers his prior-optimal action regardless of the signal realization, so her expected payoff is the same as under no information (i.e., $U^* = \underline{U}$). Hence, all results of Theorem 1 and Theorem 3 apply.

We present two simple classes of information structures that one may use to describe the Pareto-optimal and the Pareto-worst D1 equilibria in closed form, respectively. For every $q \in [0, 2\mu_0]$, define an information structure $\bar{\pi}^q$ as follows: Conditional on the true state, the signal $s = 1$ is drawn with probability

$$\bar{\rho}(\omega; q) = \begin{cases} \min\left\{\frac{q}{\mu_0}, 1\right\} & \text{if } \omega = 1, \\ \max\left\{\frac{q-\mu_0}{1-\mu_0}, 0\right\} & \text{if } \omega = 0. \end{cases} \tag{14}$$

With the remaining probability $1 - \bar{\rho}(\omega; q)$, the signal $s = 0$ is sent to the receiver. One can check that $\bar{\pi}^q$ is incentive-compatible, and it induces the receiver to choose the action $a = 1$ exactly with probability q. While there can be other information structures that induce the same marginal distribution of actions, all of them will be Pareto-dominated by $\bar{\pi}^q$ (see Appendix A.6.3 for a formal proof). For instance, consider the information structure $\underline{\pi}^q$

[13] See, e.g., Theorem 2 in Kolotilin and Wolitzky (2020). Optimal partial disclosure has been shown to take the form of censorship (Kolotilin, Mylovanov and Zapechelnyuk, 2022b), nested intervals (Guo and Shmaya, 2019), (p)-pairwise signals (Kolotilin and Wolitzky, 2020; Terstiege and Wasser, 2022), or conjugate disclosure (Nikandrova and Pancs, 2017).

defined as follows: Conditional on the true state, the signal $s = 1$ is drawn with probability

$$\underline{\rho}(\omega; q) = \begin{cases} \frac{q}{2\mu_0} & \text{if } \omega = 1, \\ \frac{q}{2(1-\mu_0)} & \text{if } \omega = 0. \end{cases} \tag{15}$$

With the remaining probability $1 - \underline{\rho}(\omega; q)$, the signal $s = 0$ is sent to the receiver. With this information structure, the sender can also nudge the receiver to choose the high action with probability q. However, the probability that the receiver takes the *right* action is just $1 - \mu_0$ under $\underline{\pi}^q$, which he could also achieve by simply sticking to his prior-optimal action $a = 0$. This is clearly the worst possible outcome for the receiver, so he would clearly prefer $\bar{\pi}^q$ over $\underline{\pi}^q$. All things considered, there must exist a Pareto-optimal (Pareto-worst) equilibrium in which each sender type θ uses the information structure $\bar{\pi}^{q(\theta)}$ ($\underline{\pi}^{q(\theta)}$), and in which $q(\theta)$, the total probability that the receiver would take the action $a = 1$, is decreasing in the sender's type. Panel (b) in Figure 3 depicts the receiver welfare in both equilibria, delineating the whole set of implementable payoff profiles for the receiver.

A salient feature of the Pareto-optimal equilibrium is that the receiver's welfare can be non-monotone in the sender's type. This non-monotonicity arises as follows: lower type can signal their type and separate by releasing more information about the state. However, the cost of separation for these low types may be so high that already an intermediate type is required to provide full information in order to separate. Then, even higher types can only signal their type by sacrificing further material utility in ways that also harm the receiver. By contrast, in the Pareto-worst equilibrium, all sender types minimize the receiver's payoff to his reservation utility $\underline{U}$.

Example 6: State-independent sender preferences, II. Let $A = \{0, 1\}$, $\Omega = [0, 1]$, $v(a, \omega) = a$ and $u^R(a, \omega) = a \cdot \omega + (1 - a) \cdot \underline{u}$, where $\underline{u} \in (0, 1)$ can be interpreted as the value of the receiver's outside option. We assume that $\underline{u} > \mathbb{E}_{\mu_0}[\omega]$. Thus, the receiver's default action is $a = 0$, and $\underline{u}$ will also be his expected payoff under no information. Further, in the absence of image concerns, the optimal strategy of the sender would extract all the surplus from the receiver (see Section V. B in Kamenica and Gentzkow (2011)). Taken together, we have $U^* = \underline{U} = \underline{u}$, so both Theorem 1 and Theorem 3 can be applied to study this example.[14]

[14]Under the additional assumption that ω is uniformly distributed, we can construct two simple classes of information structures to describe the Pareto-extremal equilibria in closed form. These structures involve disclosing whether the true state falls within a particular interval. Specifically, for every $q \in [0, 2-2\underline{u}]$, consider

3.2.3 When will the welfare implications be ambiguous?

In general, the receiver's payoff may be strictly between his full- and no-information payoffs in the canonical setting without image concerns. Our last formal result confirms that in this case, whether the sender's image concerns will be beneficial or detrimental for the receiver is likely to be uncertain.

Theorem 4. *If $U^* \in (\underline{U}, \bar{U})$, it can depend on the selected equilibrium and the type distribution if the receiver benefits from the presence of the sender's image concerns or if he is harmed by it. In particular, provided that ϕ is sufficiently small, there always exist both (i) a D1 equilibrium in which the receiver is strictly better off and Blackwell-more information is transmitted and (ii) a D1 equilibrium in which the receiver is and strictly worse-off and Blackwell-less information is transmitted, relative to the setting without image concerns.*[15]

As we alluded before, the ambiguous effect of image concerns is largely due to that standard refinements, including the D1 criterion, do not fully pin down the structure of the sender's equilibrium strategy, although they necessitate that the sender's interim payoffs are equivalent across all equilibria. The vital obstacle is that standard refinements depend on discerning unreasonable payoff incentives of the sender, e.g., the D1 criterion rules out equilibria with off-path beliefs that put mass on types who gain less from deviation. However, the abundance of possible information structures allows diverse choices that lead to the same payoff for the sender. Thus, these choices of information structures cannot be further differentiated by standard refinements, notwithstanding the possibility of having vastly different implications for the receiver's welfare.

---

the following two information structures. The first, denoted as $\bar{\pi}^q$, generates a deterministic signal s contingent on the true state: $s = 1$ if $\omega \geq 1 - q$, and $s = 0$ otherwise. The second information structure, denoted as $\underline{\pi}^q$, also follows a deterministic signal-generating rule: $s = 1$ if $\omega \in [\underline{u} - q/2, \underline{u} + q/2]$, and $s = 0$ otherwise. It can be verified that (i) both $\bar{\pi}^q$ and $\underline{\pi}^q$ can induce the receiver to choose the non-default action $a = 1$ with a probability of q, and (ii) $2 - 2\underline{u}$ represents the maximum probability the sender can induce. Furthermore, $\bar{\pi}^q$ ($\underline{\pi}^q$) yields the highest (lowest) expected payoff to the receiver among all information structures capable of implementing the same marginal distribution of actions: For instance, if an information structure $\pi \in \Pi^*$, which induces $\Pr(a = 1) = q$ like $\bar{\pi}^q$, advises the receiver to choose $a = 0$ with some positive probability when $\omega \geq 1 - q$, it must also suggest $a = 1$ in certain situations when $\omega < 1 - q$. By exchanging these two recommendations, we can create an information structure that increases the receiver's payoff while keeping his total probability of choosing $a = 1$ unchanged. Hence, similar to Example 5, there exists a Pareto-optimal (Pareto-worst) D1 equilibrium in which each type θ chooses the information structure $\bar{\pi}^{q(\theta)}$ ($\underline{\pi}^{q(\theta)}$), where $q(\theta)$ represents the probability that type θ would induce the receiver to take action $a = 1$.

[15] Note that the proof of part (iii) of Theorems 2 does not depend on the condition $U^* = \bar{U}$. Hence, the quasi-convexity property of the Pareto-worst equilibrium continues to hold even when $U^* < \bar{U}$. Likewise, the quasi-concavity property of the Pareto-optimal equilibrium, as identified by Theorem 3, remains valid here despite the condition $U^* > \underline{U}$.

Remark on optimal information structures. We view the multiplicity of equilibrium information structures in our model as a qualification of the information design approach rather than as a drawback. Following Schelling (1980), one may interpret the multiplicity as a manifestation of different cultures of communication. As Myerson (2009) emphasizes, selecting among multiple equilibria is a "fundamental social problem", and recognizing this problem "can help us to better understand the economic impact of culture".

Applying Schelling's approach to information design, external factors and details of a specific application can be used to qualify a class of information structures and thereby select an equilibrium. For example, in many settings, the manipulation of data is constrained by monitoring efforts, plausibility, or potential social and legal consequences. Therefore, outright fabrication of new data may be infeasible or prohibitively costly. However, partial omissions and deletions may not be detected easily and be feasible. In such settings, it might be natural to assume that the sender is restricted to strategies that *censor* the information, and we should therefore focus on the equilibrium in which the sender indeed uses such strategies. We will further elaborate on this point within the application in Section 4.2, where a mid-manager of a firm can censor the information flow to subordinate employees.

On a related note, our reduced-form characterization of equilibria adds to the recent discussion of a common critique of the information design approach. The design approach distinguishes itself from other theories of sender-receiver games by allowing the sender to choose (and commit to) *any* information structure. The critique, as summarized by Kamenica, Kim and Zapechelnyuk (2021), is that "optimal information structures can be infeasible or difficult to implement in practice". A strand of the information design literature has addressed the above issue by identifying sufficient conditions for simple information structures to be optimal among all information structures (e.g. Ivanov, 2021; Kolotilin *et al.*, 2022b; Kolotilin and Wolitzky, 2020). We show that a class of simple information structures (e.g. the censoring of available information) is consistent with equilibrium requirements in an extended game, under the condition that it can fully implement all possible material payoffs of the sender. Hence, this condition can serve as a formal justification for focusing on some specific class of information structures in applications.

4 Applications

4.1 Self-Signaling and Willful Ignorance

Since the sender and the receiver can be interpreted as two selves of the same agent, our model applies to situations of self-signaling (Bodner and Prelec, 2003). In a typical self-signaling situation, an individual forms beliefs about her own abilities (Köszegi, 2006; Schwardmann and Van der Weele, 2019), moralities (Bénabou and Tirole, 2006; Chen and Heese, 2023; Grossman and Van der Weele, 2017) or other inner characteristics such as self-control (Bénabou and Tirole, 2002, 2004) based on her past conduct, from which she may also derive a direct flow of utility.

Our model is similar to, e.g., Bénabou and Tirole (2002) and Grossman and Van der Weele (2017), in that the signaling is via the sender-self's information choice. The main difference is that we do not restrict the sender-self's choice to a prespecified class of information structures. The assumption that the sender can fully commit to any information structure, which plays a central role in the Bayesian persuasion literature and is often considered as somewhat extreme, can be quite natural in the dual-self setting. It simply captures that the information acquisition is public, that is, the sender-self cannot distort information or knowingly lie to the receiver-self. This point is most evident with a binary state because it has been shown that in such settings Bayesian persuasion is equivalent to a dynamic information acquisition game where information arrives according to a drift-diffusion process (e.g. Chen and Heese, 2023; Henry and Ottaviani, 2019; Morris and Strack, 2019).[16]

To showcase the applicability of our model in situations of self-signaling, consider an agent who is faced with a mental task. Both selves of the agent share a state-dependent material payoff $v(a, \omega)$ from an action choice. Ultimately, the receiver-self of the agent will decide which action a to take. Nevertheless, the sender-self can "cheat" by acquiring some information about the state. Formally, she can choose a joint distribution of the state and signal, and then make action recommendations to the receiver-self. The sender-self also has a private type θ that captures the agent's ability to figure out the solution to the task without any informational assistance. Specifically, the sender-self knows that, with probability $f(\theta)$, the receiver-self will be able to directly observe the true state in the action-taking stage,

[16]The drift-diffusion model is a well-established model of information processing in neuroeconomics and psychology. See, e.g., Fehr and Rangel (2011); Fudenberg, Newey, Strack and Strzalecki (2020); Krajbich, Oud and Fehr (2014); Ratcliff, Smith, Brown and McKoon (2016) and the references therein.

regardless of which information structure the sender-self has chosen. The probability $f(\theta)$ is strictly increasing in θ, reflecting the idea that higher types are associated with higher abilities. The agent further derives a "diagnostic utility" $\psi \cdot \mathbb{E}_\eta[\tilde{\theta}]$ from being perceived as a high type by her receiver-self, where $\psi > 0$. It is straightforward to verify that this dual-self game fits into our general model by specifying that the sender has the utility function $u^S(a, \omega, \theta, \eta) = v(a, \omega) + (\delta f(\theta) + \psi \cdot \mathbb{E}_\eta[\tilde{\theta}])/(1 - f(\theta))$, where $\delta \equiv \mathbb{E}_{\mu_0}[\max_{a \in A} v(a, \omega)]$ is a constant, while the receiver has the utility function $u^R(a, \omega) = v(a, \omega)$.[17]

Our previous results for such common-value settings (see Example 1 in Section 3.2.1) are quite clear-cut. In equilibrium, the higher types will "self-handicap" by acquiring less accurate information, for the goal of boosting their egos. Such handicapping behavior, which was similarly found in Bénabou and Tirole (2002), unambiguously reduces the material payoff of the agent. This result contributes to the growing body of research on information avoidance, which studies the widely-documented phenomenon that decision makers may willfully abstain from obtaining free and useful information for, e.g., psychological or cognitive reasons. For an excellent survey on this topic, see Golman, Hagmann and Loewenstein (2017).[18]

4.2 On Transparency in Organizations

We revisit the question of transparency in organizations, as studied by Jehiel (2015). More specifically, the question is when a manager (sender) of an organization prefers being opaque about what she knows in a moral hazard interaction with a worker (receiver). In what follows, we identify a new force that drives intransparency in organizations, which rests on the reputational concerns of the manager.[19]

Reputational concerns in organizations might arise internally from the norms or guidelines of a company and the explicit or implicit incentives of employees to signal compliance. To make this point concrete, we follow Jehiel (2015)'s motivating example and formulate the moral hazard interaction through a preference setting with $A = \Omega = [0, 1]$ and quadratic

[17] A sender of type θ chooses $\pi \in \Pi^*$ to maximize $(1-f(\theta)) \cdot \mathbb{E}_\pi[v(s, \omega)] + \mathbb{E}_{\mu_0}[\max_{a \in A} v(a, \omega)] \cdot f(\theta) + \psi \cdot \mathbb{E}_\eta[\tilde{\theta}]$ (subject to the obedience constraints from the action recommendations s). This is equivalent to maximizing $\mathbb{E}_\pi[v(s, \omega)] + (\delta f(\theta) + \psi \cdot \mathbb{E}_\eta[\tilde{\theta}])/(1 - f(\theta))$. Note that the function $w(p, \theta) = (\delta f(\theta) + \psi p)/(1 - f(\theta))$ is continuously differentiable and satisfies our condition (1).

[18] Our result is also related to a strand of literature in social psychology, which documents that individuals exhibit a wide array of behavior that is factually bad for them but presumably useful for self-presentation; see, e.g, Crocker and Park (2004); Schlenker (2012).

[19] Jehiel (2015) focuses on two distinct forces that make full transparency suboptimal, which concern either the sensitivity or the concavity of the players' utilities over actions in different states.

losses à la Crawford and Sobel (1982). The worker's utility function is $u^R(a,\omega) = -(a-\omega)^2$, so his effort bliss point equals exactly to the state ($a = \omega$). However, from the viewpoint of the company's senior management, the effort bliss point is $\beta \cdot \omega$, where $\beta > 1$. Thus, the ideal level of effort is systematically higher for the senior management than for the worker. The (mid-level) manager's preferences over effort extrapolate between those of her boss and her subordinate, and this is captured by a material payoff function $v(a,\omega,\theta,\eta) = -(a-f(\theta)\cdot\omega)^2$, where $f(\theta) \equiv (\beta-1)\cdot\theta+1$. Note that $f(\cdot)$ is strictly increasing and satisfies $f(0) = 1$ and $f(1) = \beta$, reflecting the idea that higher types have internalized the senior management's point of view more strongly. Last, the manager likes to be perceived as a high type, that is, as being "compliant" to the preferences of the higher-ups. Formally, the manager receives an image payoff $\phi \cdot \theta \cdot \mathbb{E}_\eta[\tilde{\theta}]$, where η is interpreted as the senior management's belief about the manager's type. Overall, our payoff specification posits that higher types care more about the impression that they leave to the boss. This seems reasonable because, presumably, these are the types that are more committed to a career in the current company.

What do the incentives of signaling compliance to the higher-ups imply in terms of transparency and organizational performance? Similar to Jehiel (2015), we have a fully transparent benchmark in the current quadratic-loss setting: If the manager has no reputational concerns ($\phi = 0$), then all manager types would fully communicate all information about the state to the worker.[20] However, Theorems 1 and 2 jointly imply that, when the manager worries about the (explicit or implicit) review of her compliance by the senior management, she will almost necessarily involve in strategies that hide information from the worker. Thus, the motive of "pleasing the boss" can be a compelling source of intransparency in organizations. This lack of transparency, in turn, harms organizational performance, because in expectation the worker's effort choice will be further away from the company's bliss point, i.e. the senior management's, compared to the fully transparent case.

It is perhaps unrealistic to think that the desire to establish a reputation among one's colleagues would always have an unequivocally negative effect on the transparency of the organization. For instance, instead of signaling compliance to the higher-ups, in some workplaces managers may want to signal altruism to their subordinates (Ellingsen and Johannesson, 2008). In those settings, it might seem natural to expect that the concern for reputation would encourage the manager to share more information with the workers, therefore enhanc-

[20] See Kamenica and Gentzkow (2011). For details specific to our setting, see also Appendix A.6.2 and the analysis of Example 2 in Section 3.2.1.

ing the transparency of the organization. The caveat here is that one must consider what the manager would have done in the absence of such reputational concerns. It is possible that, with pure persuasion motives, the manager would disclose partial information about the state to the worker. Then, according to Theorem 4, whether the manager's reputational concerns will drive a more or less transparent organization may hinge on equilibrium selection, which, in turn, can be determined by factors such as social norms and/or the corporate culture of the organization. Such informal factors of organizations are superbly surveyed and discussed in, e.g. Hermalin (2001) and Kreps (1990).

Taken together, the application in this section provides insights into a recent debate on the downsides of hierarchical structures in organizations. Specifically, there are concerns that since attention will naturally be directed up the hierarchy, performance in traditional hierarchical organizations may suffer from the managers focusing too much on "pleasing their bosses" rather than "helping their teams" (Dillon, 2017). To this end, our application provides a game-theoretic model in which pleasing-one's-boss schemes arise and are shown to harm the organization. Our model also offers a novel rationale for why many (but certainly not all) companies nowadays rely on committees to conduct performance evaluations instead of delegating these decisions solely to direct superiors.[21] Intuitively, such arrangements should mitigate the managers' signaling concerns, which, according to our theory, can potentially enhance transparency and improve the performance of the organization.

4.3 Populist Sentiments and Policy Stagnation

In a seminal study, Fernandez and Rodrik (1991) address why governments often fail to adopt reforms considered efficiency-enhancing by experts, which they describe as "one of the fundamental questions of political economy". Indeed, this question is particularly puzzling in the current era, where political leaders emphasize the importance of science and evidence-based policy making for progress and growth.[22] Fernandez and Rodrik (1991) demonstrate that such policy stagnation may occur when voters are uncertain about the idiosyncratic impacts of the reform ex ante, therefore rejecting it even though the reform for sure will benefit a *majority* of the democratic public ex post and is welfare-enhancing overall. However,

[21] In 2011, the Society for Human Resource Management surveyed 510 organizations with 2,500 or more employees and found that a majority (54%) of these organizations use formal committees as part of their performance evaluation process.

[22] See, e.g., Mallapaty (2022), Prillaman (2022), and the article "Politics will be poorer without Angela Merkel's scientific approach" by the editorial board of *Nature* (2021) .

it remains unclear why such uncertainty persists, as the government could in principle seek to educate voters about the potential consequences of the reform, especially given the increasing availability of data and development of information technology. In what follows, we use our framework to show that this phenomenon can be rationalized by the (over-)disciplining effect of policy-maker's reputation concerns.

To this end, we describe a stylized model of politics in which information first flows from experts to a politician, and further to a democratic public (represented as a group of voters) who then accept or reject a reform accordingly. The public's prior opinion is marked by reform skepticism. That is, absent persuasive new information about the potential consequences, the public would reject the reform outright, leading to policy stagnation as in Fernandez and Rodrik (1991). The politician could ask experts to provide those information to the public in principle. At the same time, the politician faces reputational concerns: the public may perceive her advocacy for the reform as driven by personal interests, hurting her chances in future elections.[23] One may expect these reputation concerns to encourage information sharing, as the politician tries to appear neutral. Yet paradoxically, we demonstrate that these very concerns can perpetuate an uninformed equilibrium. In particular, the public may remain anchored in their initial skepticism towards the reform even when implementing it would actually benefits *all* voters and when the politician could have committed to share that information.

The formal model is as follows. In the first stage, the politician can acquire information about a binary state $\omega \in \Omega = \{0, 1\}$, which is payoff-relevant for a proposed reform being publicly debated. To obtain this information, the politician can commission a study π that specifies a distribution of results for each possible state. For instance, the politician may appoint an unbiased expert who truly knows the subject to lead the study, which would allow her to always uncover the true state. Alternatively, the politician could select an expert who is known to be biased, e.g. towards the reform, to investigate the matter, in which case a result supporting the reform probably would be less informative (relative to a result opposing it).

In the second stage, the politician observes the result of the study and then chooses whether to keep it private or disclose it to the public in the form of a verifiable report. Implementing the reform ($a = 1$) enhances every voter's welfare by 1 if $\omega = 1$, but reduces

[23]The effect of election incentives on politicians' conduct is a prominent focus in the literature on electoral accountability, as comprehensively surveyed by Ashworth (2012) and Duggan and Martinelli (2017).

welfare by 1 if $\omega = 0$, relative to maintaining the status quo ($a = 0$). The public is initially skeptical of the reform, with a common prior belief $\mu_0 \equiv \Pr(\omega = 1) \in (0, 0.5)$. Thus, only when the disclosed result is sufficiently compelling to overcome these predispositions, the politician's communication is effective in generating support for the reform. The politician receives a state-independent payoff $w_1(\theta) > 0$ if the reform is adopted, where $w_1(\cdot)$ is strictly decreasing in her private type $\theta \in [0, 1]$; otherwise, her payoff at this stage is zero. The interpretation is that θ is linked to the private interest that the politician has in the reform or, more broadly, how "corrupt" she is, as manifested by her willingness to push actions against the interest of the public (e.g. advocating $a = 1$ when $\omega = 0$). Higher values of θ reflect greater alignment with public interest, consistent with lower private benefits from the adoption of the reform.

The third and last stage introduces reputational concerns of the politician. In this stage, the politician runs against another candidate in an election. Each voter receives a payoff $\alpha\theta + \epsilon$ if a politician of type θ is elected to office, where $\alpha > 0$ is a parameter and ϵ is a common preference shock (e.g. changes in the economic environment) drawn according to a continuous cumulative distribution function G with full support. This specification could be justified by the intuitive notion that more corrupt politicians are more likely to act against the public's interest once elected. Alternatively, it may simply reflect that voters intrinsically desire more "ethical" politicians in office. We fix voters' expected payoff from electing an opposing candidate as $\underline{u}$, which satisfies $G(\underline{u}) \in (0, 1)$. Voters observe the preference shock ϵ, but not the politician's type θ. However, they make a Bayesian inference about θ based on the politician's "past record", which in our model amounts to whether and how she previously attempted to influence public opinion about the reform through information design. Thus, voters will support the politician if and only if $\alpha p + \epsilon \geq \underline{u}$, where p is the former's posterior expectation regarding the latter's type. Accordingly, the likelihood of the politician winning the election is $1 - G(\underline{u} - \alpha p)$. Finally, the politician's payoffs upon winning and losing the election are given by $w_2(\theta)$ and $w_3(\theta)$, respectively. We assume that the ratio $(w_2(\theta) - w_3(\theta))/w_1(\theta)$ is continuously differentiable and strictly increasing in θ, so that the relative importance between the election and the reform is higher for less corrupt types.[24] This monotonicity assumption ensures that the desired single-crossing property holds, creating

[24]Given that $w_1(\cdot)$ is strictly decreasing, the desired monotonicity holds if all types are purely office-motivated (i.e., $w_2(\cdot) - w_3(\cdot)$ is a constant function), a setting commonly studied in the literature on electoral competition (Persson and Tabellini, 2002). Moreover, as we formally show in Appendix A.8.1, this monotonicity assumption can also be derived from a setting where the politician is both office- and policy-motivated.

the potential for the politician to impress voters through strategic communication.[25]

In Appendix A.8.2, we demonstrate in detail how this political economy model can be solved in reduced form with the previous analysis. Specifically, we show that the equilibrium incentives of the politician can be mapped into a specialized setting of Example 5 studied in Section 3.2. Consequently, in equilibrium, higher types necessarily commission studies less favorable to the reform, expressing fewer and/or weaker endorsements of the reform to the public. This equilibrium outcome and its key driving force can be intuitively understood in terms of "populist sentiments": the politician seeks to position herself in the debate surrounding the reform – through strategically commissioning and revealing study results – in a way that appeals to the public she is "on their side" (i.e., not corrupt). Indeed, this interpretation aligns with the standard political science definition of populism as "a political philosophy supporting [...] the people in their struggle against the privileged elite" (see the corresponding item in the American heritage dictionary).[26]

The key insight from our analysis is that the effect of populism on the politician's communication strategy is ambivalent, and does not necessarily translate monotonically into the welfare of the public. Specifically, consider an increase in α, which could represent heightened populist sentiment among the public, whereby voters become more concerned about the politician's corruption when deciding their electoral support. As we formally show in Appendix A.8.3, this parallels the effect of increasing ϕ – the relative weight that the sender places on image versus material payoffs – in the general model. Intuitively, a larger α strengthens the signaling motives of the politician because her public image becomes more decisive for the election outcome. Thus, similar to the results from Section 3.2, the public's welfare is non-monotone in α. In particular, when α is sufficiently small, all equilibria are fully separating – meaning voters can fully distinguish between corrupt and non-corrupt politicians – and the payoff from reform choices increase in α in the Pareto optimal equilibrium (see Panel (b) of Figure 3 and the discussion surrounding Example 5). However, when α is large, reputational incentives may "over-discipline" the politician. In the extreme, all politician types conform to the public's prior skepticism by recommending the status quo with probability one, regardless of the state. As such, the public learns nothing about either the reform or the politician's

[25]In comparison, if $((w_2(\cdot) - w_3(\cdot))/w_1(\cdot))' < 0$ holds, then more corrupt types have higher incentives to be elected. In this case, the disciplining effect of the election concerns disappears – the unique equilibrium is such that all types promote the reform in the same way as in the benchmark game with $\phi = 0$.

[26]See also Mudde (2004), Acemoglu, Egorov and Sonin (2013), and the recent VoxEU debate on populism (available at https://cepr.org/debates/populism).

integrity. Critically, even when the reform would enhance welfare for all parties involved, the public's equilibrium belief remains equal to their skeptical prior, so the status quo persists and policies stagnate.

5 Conclusion

We have developed a novel framework that enables studying the strategic disclosure of information as jointly determined by two counterveiling forces: the standard motive to persuade an audience towards actions preferred by the sender, and the relatively underexplored motive to manage impressions regarding the sender's private characteristics. Our main results delineate the Pareto frontier of the equilibrium set, demonstrating that the sender's information choices and the receiver's welfare can exhibit intriguing non-monotonicity with respect to the relative strength of the two motives. Since image-building motives admit diverse interpretations ranging from psychological preferences to reputational concerns in dynamic interactions, our model offers broad applicability. We demonstrate this versatility across multiple contexts, generating new insights into a number of issues that have received considerable attention from researchers and practitioners. These include information avoidance in self-signaling situations, harmful intransparency stemming from managers' desire to please superiors, and how heightened populism can engender policy stagnation.

We close by suggesting two directions for future research, each of which relaxes some restrictions made in our current framework. First, our model assumes that the sender's payoff is separable with respect to the material allocations and her type-specific gains from reputation. This quasi-linear structure – which is commonly employed in applied works – greatly simplifies our analysis, as it ensures that the desired single-crossing property holds at the interim stage. Plainly, the analysis continues to hold if one directly imposes this single-crossing property on the sender's interim payoff. However, this assumption remains restrictive, because it requires the payoff difference between any pair of *probability distributions* over ex post allocations to be single-crossing in the sender's type. As discussed by Kartik, Lee and Rappoport (2022) (and see also Kushnir and Liu, 2019), only a limited set of ex post payoff specifications could generate this property. Nevertheless, Chen, Ishida and Suen (2022) recently provide a general analysis for costly signaling under double-crossing preferences, which nest single-crossing as a special case. By identifying environments where the double-crossing

property naturally arises at the interim stage, one could combine our techniques and those by Chen *et al.* (2022) to obtain additional insights.

Second, our model precludes any correlation between the state and the sender's type, which may limit its suitability for some settings and merits further study. For instance, the alignment of preferences between managers and their supervisors may vary across states, and the necessity of reform could correlate with the corruptness of the incumbent politician. Such correlations naturally lead to an informed principal problem, which is known to be difficult in the literature (Myerson, 1983). Although a comprehensive analysis tackling this challenging issue is beyond the scope of our paper, we note that there have been several exciting works recently aiming to develop a toolkit for studying informed principal problems in the context of information design (e.g. Koessler and Skreta, 2022; Zapechelnyuk, 2023). Integrating these cutting-edge approaches with our framework provides fertile ground for new applications.

Appendix

A.1 The Single-Crossing Property

Lemma A1. *Take any two expected material payoffs $V, V' \in \mathcal{V}$ with $V > V'$ and any two receiver beliefs $\eta, \eta' \in \Delta(\Theta)$. If $\theta \in [0,1]$ is indifferent between (V, η) and (V', η'). then*

(a) all types $\theta' < \theta$ strictly prefer (V, η) over (V', η),

(b) all types $\theta' > \theta$ strictly prefer (V', η') over (V, η).

Proof. Indifference of type θ means

$$V - V' = \phi \cdot [w(p(\eta'), \theta) - w(p(\eta), \theta)]\,. \tag{16}$$

Since $\partial w(p, \theta)/\partial p > 0$ and $V - V' > 0$, it is necessary that $p(\eta) < p(\eta')$. Then, given that $w(\cdot)$ has strictly increasing differences, the indifference condition (16) implies

$$V - V' > \phi \cdot [w(p(\eta'), \theta') - w(p(\eta), \theta')]$$

for all $\theta' < \theta$, and

$$V - V' < \phi \cdot [w(p(\eta'), \theta) - w(p(\eta), \theta)]$$

for all $\theta' > \theta$. □

A.2 Proof of Lemma 1

Let σ be an equilibrium strategy. To simplify a bit the expression, we further denote the sender's interim image as $p(\theta; \sigma) \equiv \mathbb{E}[\tilde{\theta} | \tilde{\theta} \in \Theta^*(\theta; \sigma)]$. Incentive compatibility implies that, for all sender types $\theta, \theta' \in \Theta$ with $\theta' < \theta$,

$$V(\theta; \sigma) + \phi \cdot w(p(\theta; \sigma), \theta) \geq V(\theta'; \sigma) + \phi \cdot w(p(\theta'; \sigma), \theta) \tag{17}$$

and

$$V(\theta'; \sigma) + \phi \cdot w(p(\theta'; \sigma), \theta') \geq V(\theta; \sigma) + \phi \cdot w(p(\theta; \sigma), \theta'). \tag{18}$$

Summing up (17) and (18), we obtain (with some rearrangement)

$$w(p(\theta;\sigma),\theta) - w(p(\theta';\sigma),\theta) \geq w(p(\theta;\sigma),\theta') - w(p(\theta';\sigma),\theta'). \tag{19}$$

Since $\theta > \theta'$ and $w(\cdot)$ has strictly increasing differences, (19) implies that $p(\theta;\sigma) \geq p(\theta';\sigma)$. Given that the sender always prefers higher images, we also have $w(p(\theta;\sigma),\theta') \geq w(p(\theta';\sigma),\theta')$. Hence, for (18) to hold it is necessary that $V(\theta;\sigma) \leq V(\theta';\sigma)$. □

A.3 Proof of Lemma 2

Take an equilibrium with σ and suppose that it satisfies D1. Suppose that there exists a non-singleton $J \subseteq [0,1]$ such that all types $\theta \in J$ choose the same $\pi \in \Pi^*$ with $\mathbb{E}_\pi[v(s,\omega)] = V > \underline{V}$. Take an information structure $\pi^\varepsilon \in \Pi^*$ that satisfies $\mathbb{E}_{\pi^\varepsilon}[v(s,\omega)] = V - \varepsilon$, which must exist for sufficiently small $\varepsilon > 0$ (see footnote 7).

Let $\mathbb{E}[\tilde{\theta}|\pi^\varepsilon;\sigma]$ be the receiver's posterior expectation about the sender's type upon observing the latter player chooses π^ε. We argue that in equilibrium, $\mathbb{E}[\tilde{\theta}|\pi^\varepsilon;\sigma] \geq \sup J$ must hold. To prove this argument, we distinguish two cases. First, suppose that π^ε is a choice on the equilibrium path under the strategy σ, i.e., there exists $\theta \notin J$ such that $\sigma(\theta) = \pi^\varepsilon$. Then, by Lemma 1, we have $\theta \geq \sup J$. Since the choice of θ was arbitrary and the receiver's on-path beliefs must satisfy Bayes' rule, the claim $\mathbb{E}[\tilde{\theta}|\pi^\varepsilon;\sigma] \geq \sup J$ immediately follows.

Second, suppose that no types will choose π^ε under the strategy σ. In this case, take any $\theta \in J$ with $\theta < \sup J$. By continuity of $w(\cdot)$, for sufficiently small $\varepsilon > 0$ there must exist a posterior expectation $\hat{p} \in [0,1]$ such that if the receiver would hold a belief with this expectation and be obedient to the realization of the signal upon observing π^ε, then the type-θ sender would be indifferent between choosing π and π^ε. Moreover, given that $V - \varepsilon < V$, any sender with $\theta' > \theta$ would strictly prefer π^ε to π whenever type θ is being indifferent between these two pairs, while a sender with $\theta' < \theta$ would hold the exact opposite preference. Hence, due to this single-crossing property (Lemma A1), the D1 criterion requires that the receiver assigns zero weight to types $\theta' \leq \theta$ upon observing that π^ε was chosen by the sender. As a result, we have $\mathbb{E}[\tilde{\theta}|\pi^\varepsilon;\sigma] > \theta$. Since the choice of $\theta < \sup J$ was arbitrary, it again follows that the claim $\mathbb{E}[\tilde{\theta}|\pi^\varepsilon;\sigma] \geq \sup J$ must hold.

Next, since the type distribution $\Gamma(\cdot)$ has full support, we further have

$$\mathbb{E}[\tilde{\theta}|\pi^{\varepsilon};\sigma] \geq \sup J > \mathbb{E}[\tilde{\theta}|\tilde{\theta} \in J].$$

Then, for sufficiently small $\varepsilon > 0$, the expected payoff from π^{ε} will be strictly higher than that from π for all types $\theta \in J$:

$$(V - \varepsilon) + \phi \cdot w\left(\mathbb{E}[\tilde{\theta}|\pi^{\varepsilon};\sigma], \theta\right) > V \cdot f(\theta) + \phi \cdot w\left(\mathbb{E}[\tilde{\theta}|\tilde{\theta} \in J], \theta\right),$$

using that $w(\cdot)$ is strictly increasing in its first argument. This contradicts with σ being an equilibrium strategy. □

A.4 Proof of Theorem 1: The If-Part

To prove the if-statement of Theorem 1, we verify that for any strategy $\sigma = \{\pi_\theta\}_{\theta\in\Theta}$ that satisfies $\pi_\theta \in \Pi^*$ for all $\theta \in [0,1]$ and both conditions (i) and (ii), there is a system of beliefs $H = \{\eta(\pi)\}_{\pi\in\Pi}$ of the receiver so that (σ, H) constitute a D1-equilibrium. The belief system is such that, for any $\pi \in \Pi^*$ publicly chosen by the sender:

- if $\mathbb{E}_\pi[v(s,\omega)] \geq \bar{V} - \phi \int_0^{\min\{\hat{\theta},1\}} \frac{\partial w(x,x)}{\partial p} dx$, the receiver assigns probability one to the unique type $\theta \in [0, \min\{\hat{\theta}, 1\}]$ for which $\mathbb{E}_{\pi_\theta}[v(s,\omega)] = \mathbb{E}_\pi[v(s,\omega)]$;
- if $\bar{V} - \phi \int_0^{\min\{\hat{\theta},1\}} \frac{\partial w(x,x)}{\partial p} dx > \mathbb{E}_\pi[v(s,\omega)] > \underline{V}$, the receiver assigns probability one to type $\min\{\hat{\theta}, 1\}$;
- if $\mathbb{E}_\pi[v(s,\omega)] = \underline{V}$, the receiver updates his belief by restricting the type space to the subset $[\min\{\hat{\theta}, 1\}, 1]$ and invoking Bayes' rule.

Finally, the out-of-equilibrium beliefs $\eta(\pi)$ for $\pi \in \Pi \setminus \Pi^*$ can be completed by following the procedure that we described in footnote 3.

Sequential Rationality. Note that, given H, any π and π' that give rise to the same material payoff will be equally preferred by the sender, as they will also lead to the same posterior beliefs about the sender's type. In addition, when $\hat{\theta} \in (0,1)$ (i.e., the cut-off type is in the interior), any information structure that induces a material payoff V with $\bar{V} - \phi \int_0^{\hat{\theta}} \frac{\partial w(x,x)}{\partial p} d\, x < V < \underline{V}$ will be sub-optimal for the sender, as she could always obtain

a higher material payoff without undermining her image. Hence, to verify the sequential rationality of the sender's strategy, it suffices to show that no type $\theta \in [0,1]$ of the sender can strictly benefit from mimicking another type $\theta' \in [0,1]$. Since all types $\theta, \theta' < \hat{\theta}$ are separating according to σ, we have

$$\begin{aligned}
&V(\theta;\sigma) + \phi \cdot w(\theta,\theta) \\
=&V(\theta';\sigma) + \phi \cdot w(\theta',\theta) + [V(\theta;\sigma) - V(\theta';\sigma)] + \phi \cdot [w(\theta,\theta) - w(\theta',\theta)] \\
=&V(\theta';\sigma) + \phi \cdot w(\theta',\theta) - \int_{\theta}^{\theta'} V'(x;\sigma)dx - \phi \cdot \int_{\theta}^{\theta'} \frac{\partial w(x,\theta)}{\partial p} dx \\
=&V(\theta';\sigma) + \phi \cdot w(\theta',\theta) + \int_{\theta}^{\theta'} \left[\frac{\partial w(x,x)}{\partial p} - \frac{\partial w(x,\theta)}{\partial p}\right] dx \\
>&V(\theta';\sigma) + \phi \cdot w(\theta',\theta),
\end{aligned}$$

where the second equality follows condition (i), and the strict inequality follows since $w(\cdot)$ has strictly increasing differences. Thus, no type in $[0,\hat{\theta})$ would want to mimic another type in the same interval. In addition, since all types in $[\hat{\theta},1]$ will get the same material payoff and image payoff according to σ, none of them can benefit from mimicking others in the same interval. Lastly, if $\hat{\theta} \in (0,1)$ (so that both separating and pooling types exist), then by construction the cut-off type $\hat{\theta}$ is indifferent between pooling with higher types (by choosing some $\bar{\pi}$ that yields the minimal material payoff $\underline{V}$) and separating herself (by choosing some π that gives rise to $\mathbb{E}_{\pi}[v(s,\omega)] = \bar{V} - \phi \int_0^{\hat{\theta}} \frac{\partial w(x,x)}{\partial p} d\,x$). Hence, Lemma A1 implies that the types in the separating interval $[0,\hat{\theta})$ cannot benefit from mimicking those in the pooling interval $[\hat{\theta},1]$, and vice versa.

D1 criterion. Take an off-path communication protocol $\pi' \in \Pi^*$. For any type θ, provided that $D^0(\pi',\theta)$ (i.e., the set of beliefs for which θ weakly prefers to deviate from her choice π_θ to π') is not empty, we define

$$\underline{p}(\pi',\theta) = \inf_{\eta \in D^0(\pi',\theta)} \mathbb{E}_{\eta}[\tilde{\theta}].$$

Note that since $\partial w(p,\theta)/\partial p > 0$, we have $\eta \in D^0(\pi',\theta) \iff \mathbb{E}_{\eta}[\tilde{\theta}] \geq \underline{p}(\pi',\theta)$ and $\eta \in D(\pi',\theta) \iff \mathbb{E}_{\eta}[\tilde{\theta}] > \underline{p}(\pi',\theta)$.

We distinguish two cases. First, suppose that there is $\theta \in [0,1]$ such that $\mathbb{E}_{\pi'}[v(s,\omega)] = V(\theta;\sigma)$, which implies that $\underline{p}(\pi',\theta) = \mathbb{E}[\tilde{\theta}|\pi_\theta;\sigma]$. Consider any type θ' with $\pi_{\theta'} \neq \pi_\theta$. We have

already shown that this type has *strict* incentives *not* to mimic θ. This implies $\underline{p}(\pi', \theta') > \underline{p}(\pi', \theta)$, and therefore $D^0(\pi', \theta') \subsetneq D(\pi', \theta)$. Conversely, for any type θ'' with $\pi_{\theta''} = \pi_\theta$, clearly $\underline{p}(\pi', \theta'') = \underline{p}(\pi', \theta)$, and therefore $D^0(\pi', \theta'') = D^0(\pi', \theta) \supsetneq D(\pi', \theta)$. Thus, the D1 criterion requires that the receiver restricts his out-of-equilibrium belief to those types θ'' with $\pi_{\theta''} = \pi_\theta$. However, our belief system was just chosen this way.

Second, suppose that there is no $\theta \in [0, 1]$ such that that $\mathbb{E}_{\pi'}[v(s, \omega)] = V(\theta; \sigma)$. If $\hat{\theta} = +\infty$ (i.e., the strategy σ is fully separating), then it is necessary that $\mathbb{E}_{\pi'}[v(s, \omega)] < V(1; \sigma)$. In this scenario, on-path incentive compatibility guarantees that $D^0(\pi', \theta) = \emptyset$ for all $\theta \in [0, 1]$, so we can freely choose the out-of-equilibrium beliefs of the receiver for such communication protocols. If $\hat{\theta} \in [0, 1)$ (i.e., the strategy σ is semi-separating), then it is necessary that

$$\underline{V} < \mathbb{E}_{\pi'}[v(s, \omega)] \leq \bar{V} - \phi \int_0^{\hat{\theta}} \frac{\partial w(x, x)}{\partial p} dx. \tag{20}$$

Hence, for all $\theta < \hat{\theta}$, we have

$$\begin{aligned} V(\theta; \sigma) + \phi \cdot w(\theta, \theta) &> \bar{V} - \phi \int_0^{\hat{\theta}} \frac{\partial w(x, x)}{\partial p} dx + \phi \cdot w(\hat{\theta}, \theta) \\ &\geq \mathbb{E}_{\pi'}[v(s, \omega)] + \phi \cdot w\left(\underline{p}(\pi', \hat{\theta}), \theta\right), \end{aligned}$$

where the strict inequality follows condition (i), and the weak inequality is jointly implied by (20), the indifference condition of the cut-off type $\hat{\theta}$, and Lemma A1. It is then clear that $\underline{p}(\pi', \theta) > \underline{p}(\pi', \hat{\theta})$ for all $\theta < \hat{\theta}$. Further, since

$$\underline{V} + \phi \cdot w\left(\mathbb{E}[\tilde{\theta} | \tilde{\theta} \geq \hat{\theta}], \hat{\theta}\right) = \mathbb{E}_{\pi'}[v(s, \omega)] + \phi \cdot w\left(\underline{p}(\pi', \hat{\theta}), \hat{\theta}\right),$$

Lemma A1 and (20) jointly imply that

$$\underline{V} + \phi \cdot w\left(\mathbb{E}[\tilde{\theta} | \tilde{\theta} \geq \hat{\theta}], \theta\right) > \mathbb{E}_{\pi'}[v(s, \omega)] + \phi \cdot w\left(\underline{p}(\pi', \hat{\theta}), \theta\right)$$

for all $\theta > \hat{\theta}$. As a result, we also have $\underline{p}(\pi', \theta) > \underline{p}(\pi', \hat{\theta})$ for all $\theta > \hat{\theta}$. In sum, we can conclude that $D^0(\pi', \theta) \subsetneq D(\pi', \hat{\theta})$ for all $\theta \neq \hat{\theta}$, so the D1 criterion requires that the receiver assigns probability one to type $\hat{\theta}$ when he observes π'. However, our belief system was just chosen this way. $\square$

A.5 Proof of Theorem 2

Part (i): Take any information structure $\pi^N \in \Pi^*$ that conveys no information about the state to the receiver, and let $V^N = \mathbb{E}_{\pi^N}[v(s,\omega)]$. By assumption, $U^* = \bar{U}$ is uniquely defined and $\bar{U} > \underline{U}$, so it is necessary that $\bar{V} > V^N$. Take an arbitrary D1 equilibrium strategy $\sigma = \{\pi_\theta\}_{\theta\in[0,1]}$. For every type $\theta \in (0,\hat{\theta})$, recall that her expected payoff $V(\theta;\sigma)$ will be uniquely pinned down by the envelope formula (5). Therefore, there must exist a non-empty interval $(0,\check{\theta}) \subseteq (0,\hat{\theta})$ such that $V(\theta;\sigma) \geq V^N$ holds for all $\theta \in (0,\check{\theta})$.

Now, let $\bar{\pi}$ be an information structure that yields the expected payoff $\bar{V}$ to the sender. For each $\theta \in (0,\check{\theta})$, consider the following information structure $\check{\pi}_\theta$: with probability $\lambda(\theta) = (V(\theta;\sigma) - V^N)/(\bar{V} - V^N) < 1$, the receiver observes a signal s drawn according to $\bar{\pi}$; with the remaining probability $1-\lambda(\theta)$, the signal is generated according to π^N. It is straightforward to verify that $\check{\pi}_\theta \in \Pi^*$, $\mathbb{E}_{\check{\pi}_\theta}[v(s,\omega)] = V(\theta;\sigma)$, and

$$\mathbb{E}_{\check{\pi}_\theta}[u^R(s,\omega)] = \lambda(\theta)\cdot\bar{U} + (1-\lambda(\theta))\cdot\underline{U} < \bar{U}. \tag{21}$$

Next, define a strategy $\check{\sigma}$ for the sender as follows: for all $\theta \in (0,\hat{\theta})$, $\check{\sigma}(\theta) = \check{\pi}_\theta$; for all other θ, let $\check{\sigma}(\theta) = \sigma(\theta)$. By Theorem 1, $\check{\sigma}$ is part of a D1 equilibrium. Moreover, since the type distribution Γ is continuous and has full support, (21) implies that the ex-ante expected payoff of the receiver must be strictly lower than U^*, meaning that he is harmed by the presence of the sender's image concerns.

Part (ii): Let $\sigma = \{\pi_\theta\}_{\theta\in[0,1]}$ be the sender's strategy in a Pareto-optimal D1 equilibrium. Assume, for the sake of contradiction, that the receiver's expected payoff is not decreasing everywhere. Then, there must exist $\theta, \theta' \in [0,1]$ such that $\theta < \theta'$ and

$$\mathbb{E}_{\pi_\theta}[u^R(s,\omega)] < \mathbb{E}_{\pi_{\theta'}}[u^R(s,\omega)] \leq \bar{U}. \tag{22}$$

If $V(\theta;\sigma) = V(\theta';\sigma)$, we could simply ask type θ to adopt the same information structure as type θ', thereby increasing the welfare of the receiver without affecting the sender's. Hence, without loss of generality, we may focus on the scenario $\bar{V} \geq V(\theta;\sigma) > V(\theta';\sigma)$. Now consider the following information structure $\check{\pi}_\theta$: with probability $\lambda = (V(\theta;\sigma) - V(\theta';\sigma))/(\bar{V} - V(\theta';\sigma)) \in [0,1]$, the information structure generates a signal s according to $\bar{\pi}$; with the remaining probability $1-\lambda$, the signal is generated according to $\pi_{\theta'}$. It is straightforward to

check that $\check{\pi}_\theta \in \Pi^*$, $\mathbb{E}_{\check{\pi}_\theta}[v(s,\omega)] = V(\theta;\sigma)$, and

$$\mathbb{E}_{\check{\pi}_\theta}[u^R(s,\omega)] = \lambda \cdot \bar{U} + (1-\lambda) \cdot \mathbb{E}_{\pi_{\theta'}}[u^R(s,\omega)] > \mathbb{E}_{\pi_\theta}[u^R(s,\omega)]. \tag{23}$$

Therefore, it is possible to construct a D1 equilibrium strategy $\check{\sigma}$ that always yields a weakly higher payoff to the receiver than σ, and this payoff difference will even be strict when the sender's type is θ. Hence, the strategy σ cannot be Pareto-optimal if the associated payoff for the receiver is not decreasing everywhere within the interval $[0,1]$.

Part (iii): To prove quasi-convexity, it suffices to demonstrate that the receiver's payoff is either monotonically decreasing or U-shaped with respect to the sender's type. Let $\sigma = \{\pi_\theta\}_{\theta\in[0,1]}$ represent the sender's strategy in a Pareto-worst D1 equilibrium. Define V^N_{min} and V^N_{max} as the minimum and maximum material payoffs that the sender may obtain when the receiver acts under no information, respectively. Note that these two values may differ due to the tie-breaking rules that the receiver adopts. Let π^N_{min} and π^N_{max} be the information structures that lead to these two material payoffs for the sender, respectively. Also, let $\theta^N_{min} = \sup\{\theta \in [0,1] : V(\theta;\sigma) \geq V^N_{max}\}$ and $\theta^N_{max} = \inf\{\theta \in [0,1] : V(\theta;\sigma) \leq V^N_{min}\}$.

First, we argue that the receiver's expected payoff must be decreasing everywhere on $[0, \theta^N_{min}]$. To prove this, suppose by contradiction that there exist $\theta, \theta' \in [0, \theta^N_{min}]$ such that $\theta < \theta'$ and

$$\underline{U} \leq \mathbb{E}_{\pi_\theta}[u^R(s,\omega)] < \mathbb{E}_{\pi_{\theta'}}[u^R(s,\omega)]. \tag{24}$$

If $V(\theta;\sigma) = V(\theta';\sigma)$, we could simply ask type θ' to adopt the same information structure as type θ, which clearly decreases the welfare of the receiver without affecting the sender's. Hence, without loss of generality, we may focus on the scenario $V(\theta;\sigma) > V(\theta';\sigma) \geq V^N_{max}$. Next, consider the following information structure $\check{\pi}_{\theta'}$: with probability $\lambda' = (V(\theta';\sigma) - V^N_{max})/(V(\theta;\sigma) - V^N_{max}) \in [0,1]$, the information structure generates a signal s according to π_θ; with the remaining probability $1-\lambda'$, the signal is generated according to π^N_{max}. It is straightforward to check that $\check{\pi}_{\theta'} \in \Pi^*$, $\mathbb{E}_{\check{\pi}_{\theta'}}[v(s,\omega)] = V(\theta';\sigma)$, and

$$\mathbb{E}_{\check{\pi}_{\theta'}}[u^R(s,\omega)] = \lambda' \cdot \mathbb{E}_{\pi_\theta}[u^R(s,\omega)] + (1-\lambda') \cdot \underline{U} < \mathbb{E}_{\pi_{\theta'}}[u^R(s,\omega)]. \tag{25}$$

Therefore, it is possible to construct a D1 equilibrium strategy $\check{\sigma}$ that always gives the receiver

a weakly lower payoff to the receiver than σ, and this payoff difference will even be strict when the sender's type is θ'. Hence, the receiver's expected payoff $\mathbb{E}_{\tilde{\pi}_\theta}[u^R(s,\omega)]$ must be monotonically decreasing in θ within the interval $[0, \theta^N_{min}]$.

Second, for types $\theta \in [\theta^N_{min}, \theta^N_{max}]$, it is clear that they will not let the receiver have a payoff strictly higher than the no-information benchmark. Thus, the receiver's expected payoff will stay constant at $\underline{U}$ within this interval.

Lastly, we argue that the receiver's expected payoff must be increasing everywhere on $[\theta^N_{max}, 1]$. Suppose not. Then, there must exist $\theta, \theta' \in [\theta^N_{max}, 1]$ such that $\theta < \theta'$ and

$$\underline{U} \leq \mathbb{E}_{\pi_{\theta'}}[u^R(s,\omega)] < \mathbb{E}_{\pi_\theta}[u^R(s,\omega)]. \tag{26}$$

If $V(\theta;\sigma) = V(\theta';\sigma)$, it would be feasible to have type θ adopt the same information structure as type θ', which clearly decreases the welfare of the receiver without altering the sender's. Hence, without loss, we may focus on the scenario $V(\theta';\sigma) < V(\theta;\sigma) \leq V^N_{min}$. Using a similar construction of "grand" information structures involving π^N_{min}, it can be shown that there exists a D1 equilibrium strategy that always gives a weakly lower payoff to the receiver than σ, and this payoff difference will even be strict when the sender's type is θ. Hence, the receiver's expected payoff must be increasing on $[\theta^N_{max}, 1]$. This concludes our proof of the receiver's expected payoff being quasi-convex in the whole interval $[0, 1]$. □

A.6 Results and Proofs Related to the Examples

A.6.1 The Utility-Frontier with Almost-Perfectly-Aligned Preferences

Consider the game with almost perfectly aligned preferences, which we introduced in Example 1. Let the prior distribution μ_0 be such that $\Pr(\omega = 1) = \Pr(\omega = 0) = 0.4$ and $\Pr(\omega = -1) = 0.2$. It is clear that $\bar{V} = \bar{U} = 1$ and $\underline{U} = 0.4$. To solve $\underline{V}$, first note that the sender's expected material payoff depends mainly on two things: (i) the total probability that the receiver will take the right action, $\Pr(a = \omega)$; (ii) the total probability that the receiver will wrongly take the action $a = -1$, $\Pr(a = -1|\omega \neq -1)$. Regardless of which information structure $\pi \in \Pi^*$ is used by the sender, it is necessary that $\Pr(a = \omega) \geq 0.4$, because the receiver cannot do strictly worse than sticking to his prior-optimal action. At the same time, 0.4 is also an upper bound for $\Pr(a = -1|\omega \neq -1)$: If $\Pr(a = -1|\omega \neq -1) > 0.4$, the receiver would necessarily hold a posterior with $\Pr(\omega = -1|s = -1) < 1/3$, which means that it cannot be rational for

him to take recommended action -1.

Now consider an information structure $\underline{\pi} \in \Pi^*$ which recommends the action $a = -1$ with probability 1 in state $\omega = -1$, and it recommends $a = 1$ or $a = -1$ with equal probabilities in the other two states. It can be checked that $\underline{\pi}$ achieves the above two bounds on the receiver's decision-making probabilities simultaneously. Since the sender is worse off when the receiver less often takes the right action and more often chooses the action $a = -1$ in the wrong states, $\underline{\pi}$ must give the lowest possible payoff to the sender among all information structures, which is $\underline{V} = 0$.

We, therefore, know that the set of implementable payoff profiles, formally defined as $\mathcal{W} = \{(V, U) : \exists\, \pi \in \Pi^* \text{ such that } V = \mathbb{E}_\pi[v(s, w)] \text{ and } U = \mathbb{E}_\pi[u^R(s, w)]\}$, must lie in the rectangle $[\underline{V}, \bar{V}] \times [\underline{U}, \bar{U}] = [0, 1] \times [0.4, 1]$. In addition, $\mathcal{W}$ is closed and convex (Zhong, 2018). Hence, to characterize $\mathcal{W}$, it suffices to answer the following question: for a given level of the receiver's payoff $U \in [\underline{U}, \bar{U}]$, what are the maximal and the minimal material payoffs that the sender can achieve by using some information structure $\pi \in \Pi^*$, respectively? Note that the receiver's expected payoff equals exactly the ex-ante probability that he takes the right action. Hence, the question reduces to identifying the set of $\Pr(a = -1|\omega \neq -1)$ that the sender may induce without violating the requirement $\Pr(a = \omega) = U$.

For $U \in [0.4, 0.6]$, the previous upper bound on $\Pr(a = -1|\omega \neq -1)$ can still be achieved. This is made possible by the information structure $\underline{\pi}^U \in \Pi^*$ characterized by the following conditional probabilities (of recommending different actions in different states): $\underline{\pi}^U(-1|-1) = 1$, $\underline{\pi}^U(1|1) = \underline{\pi}^U(-1|1) = \underline{\pi}^U(-1|0) = 0.5$, $\underline{\pi}^U(0|0) = (U - 0.4)/0.4$, and $\underline{\pi}^U(1|0) = (0.8 - U)/0.4$. The resulting payoff to the sender, $U - 0.4$, is the minimal one across all information structures that induce the receiver to choose $a = -1$ with probability U. Consequently, for all $U \in [0.4, 0.6]$, $(U - 0.4, U)$ is on the boundary of $\mathcal{W}$, which corresponds to a point on the red curve (below the kink) in Panel (b) of Figure 2. As for $U \in (0.6, 1]$, the highest probability that the receiver will wrongly choose $a = -1$ becomes $1 - U$. This (revised) upper bound can be achieved by an information structure $\underline{\pi}^U \in \Pi^*$ with $\underline{\pi}^U(-1| - 1) = 1$, $\underline{\pi}^U(1|1) = \underline{\pi}^U(0|0) = (U - 0.2)/0.8$, and $\underline{\pi}^U(-1|1) = \underline{\pi}^U(-1|0) = (1 - U)/0.8$. Thus, for each $U \in (0.6, 1]$, $(2U - 1, U)$ is on the boundary of $\mathcal{W}$, and it corresponds to a point on the red curve (this time above the kink) in the figure.

Finally, for all $U \in [0.4, 1]$, the maximal payoff of the sender is necessarily achieved when she *never* chooses $a = -1$ in states $\omega \in \{0, 1\}$. Hence, every payoff profile (U, U) with

$U \in [0.4, 1]$ is in the boundary of $\mathcal{W}$. In addition, since both $(0.4, 0)$ and $(0.4, 0.4)$ are implementable and $\underline{U} = 0.4$, any payoff profile $(V, 0.4)$ with $V \in (0, 0.4)$ is also an boundary point of $\mathcal{W}$. Taken together, we obtain the blue curve depicted in the figure.

A.6.2 Transforming the Quadratic-Loss Games

Consider the quadratic-loss game that we discussed in Examples 2 and 4. Given the sender's choice of information structure π, the receiver has a unique best response for every signal realization $s \in \text{supp}(\pi)$: $\hat{a}(s) = \mathbb{E}[\omega|s]$. As a result, the expected material loss of a type-θ sender is

$$\begin{aligned}
&\mathbb{E}_\pi\left[(\hat{a}(s) - a^*(\omega,\theta))^2|s\right] \\
=&\mathbb{E}_\pi\left[(\mathbb{E}[\omega|s])^2|s\right] + \mathbb{E}_\pi\left[(a^*(\omega,\theta))^2|s\right] - 2\mathbb{E}_\pi\left[\mathbb{E}[\omega|s]\cdot(f(\theta)\cdot\omega + g(\theta))|s\right] \\
=&\mathbb{E}_\pi\left[(\mathbb{E}[\omega|s])^2\right] + \mathbb{E}_{\mu_0}\left[(a^*(\omega,\theta))^2\right] - 2f(\theta)\cdot\mathbb{E}_\pi\left[(\mathbb{E}[\omega|s])^2\right] - 2g(\theta)\cdot\mathbb{E}_{\mu_0}[\omega] \\
=&(1-2f(\theta))\cdot\mathbb{E}_\pi[\mathbb{E}[\omega|s]^2] + K(\theta),
\end{aligned}$$

where the second equality follows the law of iterated expectation, and we use $K(\theta) \equiv \mathbb{E}_{\mu_0}\left[(a^*(\omega,\theta))^2\right] - 2g(\theta)\cdot\mathbb{E}_{\mu_0}[\omega]$ to collect all the (θ-specific) constant terms. In addition, we have $\mathbb{E}_\pi\left[(\hat{a}(s)-\omega)^2|s\right] = -\mathbb{E}_\pi[\mathbb{E}[\omega|s]^2] + \mathbb{E}_{\mu_0}[\omega^2]$.

Now, suppose that $f(\theta) > 0.5\ \forall\theta \in [0,1]$ and compare the following two utility functions of the sender: $u^S(a,\omega,\theta,\eta) = -(a-a^*(\omega,\theta))^2 + \phi\cdot w(p(\eta),\theta)$, and $\hat{u}^S(a,\omega,\theta,\eta) = -(a-\omega)^2 + \phi\cdot\hat{w}(p(\eta),\theta)$, where $\hat{w}(p(\eta),\theta) = w(p(\eta),\theta)/(2f(\theta)-1)$. We claim that, taking the receiver's best response $\hat{a}(\cdot)$ as given, these two utility functions represent the same preference over the pairs (π,η) for all types $\theta \in [0,1]$. This is because, for all $\theta \in [0,1]$ and all (π,η) and (π',η'), we have

$$\begin{aligned}
&\mathbb{E}_\pi[u^S(\hat{a}(s),\omega,\theta,\eta)|s] \geq \mathbb{E}_{\pi'}[u^S(\hat{a}(s),\omega,\theta,\eta')|s] \\
\iff&(2f(\theta)-1)\cdot\left[\mathbb{E}_\pi[\mathbb{E}[\omega|s]^2] - [\mathbb{E}_{\pi'}[\mathbb{E}[\omega|s]^2]\right] + \phi\cdot[w(p(\eta),\theta) - w(p(\eta'),\theta)] \geq 0 \\
\iff&\mathbb{E}_\pi[\mathbb{E}[\omega|s]^2] - [\mathbb{E}_{\pi'}[\mathbb{E}[\omega|s]^2] + \phi\cdot[\hat{w}(p(\eta),\theta) - \hat{w}(p(\eta'),\theta)] \geq 0 \\
\iff&\mathbb{E}_\pi[\hat{u}^S(\hat{a}(s),\omega,\theta,\eta)|s] \geq \mathbb{E}_{\pi'}[\hat{u}^S(\hat{a}(s),\omega,\theta,\eta')|s].
\end{aligned}$$

Hence, under the current parametric assumption, the quadratic-loss game in Example 2 has the same equilibrium set as a game where the receiver's utility function remains unchanged,

but the sender's utility function is instead given by $\hat{u}^S(\cdot)$.

Similarly, if $f(\theta) < 0.5\ \forall \theta \in [0,1]$, then, as described in Example 4, we effectively have a quadratic loss game where the sender's material payoff function is given by $v(a,\omega) = -(a-\omega)^2$, while her image payoff function is given by $\hat{w}(p(\eta),\theta) = w(p(\eta),\theta)/(1-2f(\theta))$.

A.6.3 Receiver-Optimality with State-Independent Sender Preferences

Consider our first example of state-independent sender preferences (Example 5), where both the state and the action spaces are binary. Recall the information structure $\bar{\pi}^q$, which is defined according to (14) for each $q \in [0, 2\mu_0]$. We argue that, among all information structures that induce the receiver to choose the high action with probability q, $\bar{\pi}^q$ is the one that gives the highest payoff to the receiver.

To prove our claim, note that, under the information structure $\bar{\pi}^q$, the receiver's payoff is given by

$$\mathbb{E}_{\bar{\pi}^q}[u^R(s,\omega)] = \begin{cases} 1-\mu_0+q & \text{if } q \in [0,\mu_0], \\ 1+\mu_0-q & \text{if } q \in (\mu_0, 2\mu_0]. \end{cases}$$

Now take any other information $\pi \in \Pi^*$ such that may induce the receiver to choose the high action with probability q, and let $\pi(a|\omega)$ be the conditional probability that it recommends action a when the state is ω. Then, it is necessary that

$$\mu_0 \cdot \pi(1|1) + (1-\mu_0) \cdot \pi(1|0) = q. \tag{27}$$

Therefore, the receiver's expected utility under π is given by

$$\begin{aligned} \mathbb{E}_{\pi}[u^R(s,\omega)] &= \mu_0 \cdot \pi(1|1) + (1-\mu_0) \cdot \pi(0|0) \\ &= q - (1-\mu_0) \cdot \pi(1|0) + (1-\mu_0) \cdot (1-\pi(1|0)) \\ &= 1 - \mu_0 + q - 2(1-\mu_0) \cdot \pi(1|0). \end{aligned}$$

Since $\pi(1|0) \geq 0$, we have $\mathbb{E}_{\pi}[u^R(s,\omega)] \leq 1-\mu_0+q$, so $\bar{\pi}^q$ is clearly receiver-optimal when $q \in [0,\mu_0]$. At the same time, note that, using (27), the receiver's expected utility can also

be written as

$$\mathbb{E}_\pi[u^R(s,\omega)] = 1 + (2\pi(1|1) - 1) \cdot \mu_0 - q.$$

Then, since $\pi(1|1) \leq 1$, we also have $\mathbb{E}_\pi[u^R(s,\omega)] \leq 1 + \mu_0 - q$. Hence, $\bar{\pi}^q$ is also receiver-optimal when $q \in (\mu_0, 2\mu_0]$.

A.7 Proof of Theorem 4

Since we can always concentrate the mass of the type distribution to sufficiently small types, the first statement of the theorem is implied by the second.[27] To prove the second statement, take any information structure $\pi^N \in \Pi^*$ ($\pi^F \in \Pi^*$) that conveys no (full) information about the state to the receiver. Let V^N and V^F be the expected material payoffs of the sender under π^N and π^F, respectively. Since $U^* \in (\underline{U}, \bar{U})$ is uniquely defined, it is necessary that $\bar{V} > \max\{V^N, V^F\}$.

If ϕ is sufficiently small, all D1 equilibria will be fully separating, and the interim payoff of the highest type will satisfy $V(1;\sigma) > \max\{V^N, V^F\}$ irrespective of the which D1 equilibrium strategy σ is selected. In particular, there exists a D1 equilibrium in which each type θ uses a "grand" information structure that mixes appropriately between the sender-optimal information structure $\bar{\pi}$ absenting image concerns and the information structure π^N. Clearly, the receiver is strictly worse off in this equilibrium relative to the equilibrium without image concerns. Similarly, there also exists a D1 equilibrium in which the sender's strategy is always a combination of $\bar{\pi}$ and π^F. It is straightforward to verify that the receiver must be strictly better off in this equilibrium relative to the equilibrium without image concerns. □

A.8 Additional Details of the Application in Section 4.3

A.8.1 Micro-Founding the Monotonicity Assumption in Section 4.3

In this subsection, we provide a setting of electoral competition which endogenizes the key assumption in Section 4.3, namely, that the ratio $(w_2(\cdot) - w_3(\cdot))/w_1(\cdot)$ is strictly increasing. We suppose that, in the third stage, the incumbent politician described in Section 4.3 – who

[27] Note that as the type distribution converges to a degenerate distribution at $\theta = 0$, $I(0)$ will converge to zero. Hence, sufficiently small types will necessarily be separating in equilibrium when the type distribution puts sufficiently large mass on them.

we now call candidate A – competes with another candidate B (challenger) for an election. Each candidate $j = A, B$ has a private type $\theta_j \in [0, 1]$, which is independently distributed with a mean denoted by $\bar{\theta}_j$.

The candidate who wins the election will get to choose a policy $y \in \mathbb{R}$. The voters have a common preference over policies, represented by $-|y - y^*|$. For each candidate $j = A, B$, with probability θ_j, she will have the same policy preference as the voters. With the remaining probability $1 - \theta_j$, the candidate's preference will be $-|y - (y^* + 1)|$. Thus, the higher θ_j (i.e., the less corrupt the candidate), the more likely that the candidate will act perfectly according to the voters' interest once elected.

Recall that the voters may update their belief about candidate A's type upon observing the latter's choices in previous stages (whereas the belief about candidate B is given by the prior). Let ϵ be the common preference shock that directly adds to each voter's utility whenever A is elected, and p is the public posterior about A's type. It is straightforward to show that voters would support candidate A if and only if $\epsilon \geq \bar{\theta}_B - p$. The winning probability of candidate A is then given by $1 - G\left(\bar{\theta}_B - p\right)$.

Overall, for candidate A, her expected payoff from the electoral competition is

$$G\left(\bar{\theta}_B - p\right) \cdot [-\theta_A(1 - \bar{\theta}_B) - (1 - \theta_A)\bar{\theta}_B] = -G\left(\bar{\theta}_B - p\right) \cdot (w_2(\theta_A) - w_3(\theta_A)),$$

where $w_2(\theta_A) = 0$ and $w_3(\theta_A) = -\theta_A - \bar{\theta}_B + 2\bar{\theta}_B\theta_A$ captures the payoffs upon winning and losing the election, respectively. Given that $w_1(\cdot)$ is strictly decreasing, it is easy to check that $(w_2(\cdot) - w_3(\cdot))/w_1(\cdot)$ is strictly increasing whenever $\bar{\theta}_B < 0.5$ is additionally satisfied.

A.8.2 Reduced-Form Description of the Equilibrium of the Dynamic Game

We explain that the dynamic game as in 4.3 has a reduced-form description in terms of the model in Section 2. We begin by arguing that in any equilibrium, the politician will always disclose the result of the study, regardless of whether it is positive about the reform or not.

To see this, let Θ_π be the set of types that choose the study π in an equilibrium. Note that disclosing any result s with $\pi(s|1)/\pi(s|0) \geq \ell_0 \equiv (1 - \mu_0)/\mu_0$ will for sure lead to the adoption of the reform. This implies that, for a type $\theta \in \Theta_\pi$ to prefer keeping this result private, non-disclosure must lead to a higher reputation than disclosing s. By virtue of the single-crossing property, all types $\theta' \in \Theta_\pi$ with $\pi' < \pi$ would strictly prefer non-disclosure

to disclosure. But then, the highest type among the non-disclosing ones would have a strict incentive to deviate, and the classic unraveling argument applies. Hence, in any equilibrium, all results s with $\pi(s|1)/\pi(s|0) \geq \ell_0$ will necessarily be disclosed. An analogous argument establishes that any result s with $\pi(s|1)/\pi(s|0) < \ell_0$ will also be disclosed.

Given that the politician would always disclose what she learns from the study, (on the equilibrium path) the voters' posterior belief about the politician's type would only depend on the chosen study. Consequently, a type-θ politician obtains the following payoff from choosing a study π:

$$\Pr(\pi(s|1)/\pi(s|0) \geq \ell_0) \cdot w_1(\theta) + (1 - G(\underline{u} - \alpha p)) \cdot w_2(\theta) + G(\underline{u} - \alpha p) \cdot w_3(\theta), \tag{28}$$

where $p = \mathbb{E}[\theta|\pi]$. Without loss of generality, suppose that each politician type chooses a study that only gives rise to a binary result – either positive ($s = 1$) or negative ($s = 0$) about the reform. Naturally, disclosing the positive result is equivalent to making a recommendation to pass the reform, while disclosing the negative result is the same as recommending to maintain the status quo. Thus, for each type of politician, maximizing (28) is equivalent to

$$\max_{\pi} \Pr(s = 1 \,|\, \pi) + \frac{w_2(\theta)}{w_1(\theta)} - G(\underline{u} - \alpha p) \cdot \frac{w_2(\theta) - w_3(\theta)}{w_1(\theta)},$$

subject to the constraints that $\pi(1|\omega), \pi(0|\omega) \in [0, 1]$ and $\pi(0|\omega) + \pi(1|\omega) = 1 \; \forall \, \omega \in \{0, 1\}$, and $\pi(1|1)/\pi(1/0) \geq \ell_0$. Thus, the equilibrium problem of the current application maps into our setting by specializing Example 5 of Section 3.2 with

$$u^R(a, \omega) = \mathbb{1}_{a=\omega}, \;\; v(a, \omega) = \mathbb{1}_{a=1}, \;\; \phi = 1, \;\; \text{and} \;\; w(p, \theta) = \frac{w_2(\theta)}{w_1(\theta)} - G(\underline{u} - \alpha p) \cdot \frac{w_2(\theta) - w_3(\theta)}{w_1(\theta)}.$$

A.8.3 Non-Monotone Welfare Effects of Populism

We argue that a change in α can have a non-monotone effect on the welfare of the public. For this purpose, we parameterize the reduced-form version of the dynamic game with $w_2(\theta) = 0$, $w_3(\theta)/w_1(\theta) = -\theta - 1$, and ϵ is uniformly distributed on $[0, 1]$. Assume also that $1 > \underline{u} > \alpha$ always holds. Taken together, we have

$$w(p, \theta) = -(\underline{u} - \alpha p) \cdot (\theta + 1) \;\; \text{and} \;\; \frac{\partial w(p, \theta)}{\partial p} = \alpha(\theta + 1).$$

It then follows from Theorem 1 and our analysis of Example 5 that in any D1 equilibrium, all types θ below a unique cutoff $\hat{\theta}$ are separating, and each $\theta < \hat{\theta}$ will commission a study that implements the reform with the following probability:

$$q(\theta) = 2\mu_0 - \int_0^\theta \alpha(x+1)dx = 2\mu_0 - \alpha\left(\frac{\theta^2}{2} + \theta\right).$$

In contrast, all types $\theta \geq \hat{\theta}$ will opt for a completely uninformative study, in which case the reform will for sure be rejected by the public. Additionally, it can be verified that

- $\hat{\theta} = +\infty$ when $\alpha < 4\mu_0/3$;
- $\hat{\theta} \in (0,1)$ and is strictly decreasing in α when $4\mu_0/3 \leq \alpha < 2\mu_0/\mathbb{E}_\Gamma[\tilde{\theta}]$;
- $\hat{\theta} = 0$ when $\alpha \geq 2\mu_0/\mathbb{E}_\Gamma[\tilde{\theta}]$.

Now consider the Pareto-optimal equilibrium which, as shown in Example 5, can be sustained by using the family of information structures (14). When α is sufficiently small, the equilibrium is fully separating, and higher types provide more information about the reform to the public. In this case, a local increase in α will benefit the public by incentivizing the politician to be even more honest. However, a large α could hurt the public by incentivizing the politician to provide less information (when some types are already recommending against reforms that are beneficial) and/or hindering the learning of the politician's true type (when pooling occurs in equilibrium).

References

Acemoglu, D., Egorov, G. and Sonin, K. (2013). A political theory of populism. *The Quarterly Journal of Economics*, **128** (2), 771–805.

Ashworth, S. (2012). Electoral accountability: Recent theoretical and empirical work. *Annual Review of Political Science*, **15** (1), 183–201.

Banks, J. S. and Sobel, J. (1987). Equilibrium selection in signaling games. *Econometrica*, **55** (3), 647–661.

Baumeister, R. F. (1998). The self. In D. Gilbert, S. Fiske and G. Lindzey (eds.), *The Handbook of Social Psychology*, vol. 1, McGraw-Hill, pp. 680–740.

Ben-Porath, E., Dekel, E. and Lipman, B. L. (2014). Optimal allocation with costly verification. *American Economic Review*, **104** (12), 3779–3813.

Bénabou, R. and Tirole, J. (2002). Self-confidence and personal motivation. *The Quarterly Journal of Economics*, **117** (3), 871–915.

— and Tirole, J. (2004). Willpower and personal rules. *Journal of Political Economy*, **112** (4), 848–886.

— and Tirole, J. (2006). Incentives and prosocial behavior. *American Economic Review*, **96** (5), 1652–1678.

Bergemann, D. and Morris, S. (2019). Information design: A unified perspective. *Journal of Economic Literature*, **57** (1), 44–95.

Bernheim, B. D. (1994). A theory of conformity. *Journal of Political Economy*, **102** (5), 841–877.

Bodner, R. and Prelec, D. (2003). Self-signaling and diagnostic utility in everyday decision making. In I. Brocas and J. D. Carrillo (eds.), *The Psychology of Economic Decisions*, vol. 1, Oxford University Press, pp. 105–123.

Che, Y.-K., Kim, J. and Mierendorff, K. (2013). Generalized reduced-form auctions: A network-flow approach. *Econometrica*, **81** (6), 2487–2520.

Chen, C.-H., Ishida, J. and Suen, W. (2022). Signaling under double-crossing preferences. *Econometrica*, **90** (3), 1225–1260.

Chen, S. and Heese, C. (2023). Fishing for good news: Motivated information acquisition, CRC TR 224 Discussion Paper No. 223.

Chen, Y. and Zhang, J. (2020). Signalling by Bayesian persuasion and pricing strategy. *The Economic Journal*, **130** (628), 976–1007.

Cho, I.-K. and Kreps, D. M. (1987). Signaling games and stable equilibria. *The Quarterly Journal of Economics*, **102** (2), 179–221.

— and Sobel, J. (1990). Strategic stability and uniqueness in signaling games. *Journal of Economic Theory*, **50** (2), 381–413.

Crawford, V. P. and Sobel, J. (1982). Strategic information transmission. *Econometrica*, **50** (6), 1431–1451.

Crocker, J. and Park, L. E. (2004). The costly pursuit of self-esteem. *Psychological Bulletin*, **130** (3), 392–414.

Degan, A. and Li, M. (2021). Persuasion with costly precision. *Economic Theory*, **72** (3), 869–908.

Dillon, K. (2017). New managers should focus on helping their teams, not pleasing their bosses. *Harvard Business Review*.

Duggan, J. and Martinelli, C. (2017). The political economy of dynamic elections: Accountability, commitment, and responsiveness. *Journal of Economic Literature*, **55** (3), 916–84.

Editorials (2021). Politics will be poorer without Angela Merkel's scientific approach. *Nature*, **597** (7922), 304–304.

Ellingsen, T. and Johannesson, M. (2008). Pride and prejudice: The human side of incentive theory. *American Economic Review*, **98** (3), 990–1008.

Ely, J., Fudenberg, D. and Levine, D. K. (2008). When is reputation bad? *Games and Economic Behavior*, **63** (2), 498–526.

Ely, J. C. and Välimäki, J. (2003). Bad reputation. *The Quarterly Journal of Economics*, **118** (3), 785–814.

Fehr, E. and Rangel, A. (2011). Neuroeconomic foundations of economic choice – Recent advances. *Journal of Economic Perspectives*, **25** (4), 3–30.

Fernandez, R. and Rodrik, D. (1991). Resistance to reform: Status quo bias in the presence of individual-specific uncertainty. *American Economic Review*, **81** (5), 1146–1155.

Fudenberg, D. and Levine, D. K. (1989). Reputation and equilibrium selection in games with a patient player. *Econometrica*, **57** (4), 759–778.

—, Newey, W., Strack, P. and Strzalecki, T. (2020). Testing the drift-diffusion model. *Proceedings of the National Academy of Sciences*, **117** (52), 33141–33148.

— and Tirole, J. (1991). *Game Theory*. MIT Press.

Galperti, S. (2019). Persuasion: The art of changing worldviews. *American Economic Review*, **109** (3), 996–1031.

Geanakoplos, J., Pearce, D. and Stacchetti, E. (1989). Psychological games and sequential rationality. *Games and Economic Behavior*, **1** (1), 60–79.

Gentzkow, M. and Kamenica, E. (2016). A Rothschild-Stiglitz approach to Bayesian persuasion. *American Economic Review, Papers & Proceedings*, **106** (5), 597–601.

Golman, R., Hagmann, D. and Loewenstein, G. (2017). Information avoidance. *Journal of Economic Literature*, **55** (1), 96–135.

Green, J. R. and Stokey, N. L. (2007). A two-person game of information transmission. *Journal of Economic Theory*, **135** (1), 90–104.

Grossman, S. J. (1981). The informational role of warranties and private disclosure about product quality. *Journal of Law and Economics*, **24** (3), 461–483.

Grossman, Z. and Van der Weele, J. J. (2017). Self-image and willful ignorance in social decisions. *Journal of the European Economic Association*, **15** (1), 173–217.

Guo, Y. and Shmaya, E. (2019). The interval structure of optimal disclosure. *Econometrica*, **87** (2), 653–675.

Hedlund, J. (2017). Bayesian persuasion by a privately informed sender. *Journal of Economic Theory*, **167**, 229–268.

Henry, E. and Ottaviani, M. (2019). Research and the approval process: The organization of persuasion. *American Economic Review*, **109** (3), 911–55.

Hermalin, B. E. (2001). Economics and corporate culture. In S. Cartwright, P. C. Earley and C. L. Cooper (eds.), *The International Handbook of Organizational Culture and Climate*, New York: John Wiley & Sons, pp. 217–261.

Hu, J. and Weng, X. (2021). Robust persuasion of a privately informed receiver. *Economic Theory*, **72**, 909–953.

Ivanov, M. (2021). Optimal monotone signals in Bayesian persuasion mechanisms. *Economic Theory*, **72** (3), 955–1000.

Jehiel, P. (2015). On transparency in organizations. *The Review of Economic Studies*, **82** (2), 736–761.

Kamenica, E. (2019). Bayesian persuasion and information design. *Annual Review of Economics*, **11**, 249–272.

— and Gentzkow, M. (2011). Bayesian persuasion. *American Economic Review*, **101** (6), 2590–2615.

—, Kim, K. and Zapechelnyuk, A. (2021). Bayesian persuasion and information design: Perspectives and open issues. *Economic Theory*, **72** (3), 701–704.

Kartik, N. (2009). Strategic communication with lying costs. *The Review of Economic Studies*, **76** (4), 1359–1395.

—, Lee, S. and Rappoport, D. (2022). Single-crossing differences in convex environments. Mimeo.

Koessler, F. and Skreta, V. (2022). Informed information design. *Journal of Political Economy*, forthcoming.

Kohlberg, E. and Mertens, J.-F. (1986). On the strategic stability of equilibria. *Econometrica*, **54** (5), 1003–1037.

Kolotilin, A., Corrao, R. and Wolitzky, A. (2022a). Persuasion as matching, mimeo.

—, Mylovanov, T. and Zapechelnyuk, A. (2022b). Censorship as optimal persuasion. *Theoretical Economics*, **17** (2), 561–585.

—, —, — and Li, M. (2017). Persuasion of a privately informed receiver. *Econometrica*, **85** (6), 1949–1964.

— and Wolitzky, A. (2020). Assortative information disclosure, UNSW Economics Working Paper 2020-08.

Köszegi, B. (2006). Ego utility, overconfidence, and task choice. *Journal of the European Economic Association*, **4** (4), 673–707.

Krajbich, I., Oud, B. and Fehr, E. (2014). Benefits of neuroeconomic modeling: New policy interventions and predictors of preference. *American Economic Review: Papers & Proceedings*, **104** (5), 501–506.

Kreps, D. M. (1990). Corporate culture and economic theory. In J. E. Alt and K. A. Shepsle (eds.), *Perspectives on Positive Political Economy*, Cambridge: Cambridge University Press, pp. 90–143.

— and Wilson, R. (1982). Reputation and imperfect information. *Journal of Economic Theory*, **27** (2), 253–279.

Kushnir, A. and Liu, S. (2019). On the equivalence of Bayesian and dominant strategy implementation for environments with nonlinear utilities. *Economic Theory*, **67** (3), 617–644.

Li, H. (2022). Transparency and policymaking with endogenous information provision. ArXiv preprint arXiv:2204.08876.

Lipnowski, E. and Mathevet, L. (2018). Disclosure to a psychological audience. *American Economic Journal: Microeconomics*, **10** (4), 67–93.

— and Ravid, D. (2020). Cheap talk with transparent motives. *Econometrica*, **88** (4), 1631–1660.

Mailath, G. J. (1987). Incentive compatibility in signaling games with a continuum of types. *Econometrica*, **55** (6), 1349–1365.

— and Samuelson, L. (2006). *Repeated Games and Reputations: Long-Run Relationships*. Oxford University Press.

— and — (2015). Reputations in repeated games. In H. P. Young and S. Zamir (eds.), *Handbook of Game Theory with Economic Applications*, vol. 4, Elsevier, pp. 165–238.

Mallapaty, S. (2022). What Xi Jinping's third term means for science. *Nature*, **611** (7934), 20–21.

Mas-Colell, A., Whinston, M. D. and Green, J. R. (1995). *Microeconomic Theory*. Oxford University Press.

Melumad, N. D. and Shibano, T. (1991). Communication in settings with no transfers. *The RAND Journal of Economics*, **22** (2), 173–198.

Milgrom, P. and Roberts, J. (1982). Predation, reputation, and entry deterrence. *Journal of Economic Theory*, **27** (2), 280–312.

Milgrom, P. R. (1981). Good news and bad news: Representation theorems and applications. *The Bell Journal of Economics*, pp. 380–391.

Morris, S. (2001). Political correctness. *Journal of Political Economy*, **109** (2), 231–265.

— and Strack, P. (2019). The wald problem and the relation of sequential sampling and ex-ante information costs, available at SSRN: https://ssrn.com/abstract=2991567.

Mudde, C. (2004). The populist zeitgeist. *Government and Opposition*, **39** (4), 541–563.

Myerson, R. B. (1983). Mechanism design by an informed principal. *Econometrica*, **51** (6), 1767–1797.

— (2009). Learning from Schelling's *Strategy of Conflict*. *Journal of Economic Literature*, **47** (4), 1109–25.

Nikandrova, A. and Pancs, R. (2017). Conjugate information disclosure in an auction with learning. *Journal of Economic Theory*, **171**, 174–212.

Perez-Richet, E. (2014). Interim Bayesian persuasion: First steps. *American Economic Review: Papers & Proceedings*, **104** (5), 469–74.

Persson, T. and Tabellini, G. (2002). *Political Economics: Explaining Economic Policy*. MIT Press.

Prillaman, M. (2022). Billions more for US science: How the landmark spending plan will boost research. *Nature*, **608**, 249.

Ramey, G. (1996). D1 signaling equilibria with multiple signals and a continuum of types. *Journal of Economic Theory*, **69** (2), 508–531.

Ratcliff, R., Smith, P. L., Brown, S. D. and McKoon, G. (2016). Diffusion decision model: Current issues and history. *Trends in Cognitive Sciences*, **20** (4), 260–281.

Rayo, L. and Segal, I. (2010). Optimal information disclosure. *Journal of Political Economy*, **118** (5), 949–987.

Salas, C. (2019). Persuading policy-makers. *Journal of Theoretical Politics*, **31** (4), 507–542.

Schelling, T. C. (1980). *The Strategy of Conflict*. Harvard University Press.

Schlenker, B. R. (2012). Self-presentation. In M. R. Leary and J. P. Tangney (eds.), *Handbook of Self and Identity*, The Guilford Press, pp. 492–518.

Schwardmann, P. and Van der Weele, J. (2019). Deception and self-deception. *Nature Human Behaviour*, **3** (10), 1055–1061.

Schweizer, N. and Szech, N. (2018). Optimal revelation of life-changing information. *Management Science*, **64** (11), 5250–5262.

Smolin, A. and Yamashita, T. (2022). Information design in concave games, available at arXiv: https://arxiv.org/abs/2202.10883.

Spence, M. (1973). Job market signaling. *The Quarterly Journal of Economics*, **87** (3), 355–374.

Tamura, W. (2018). Bayesian persuasion with quadratic preferences, working paper.

Terstiege, S. and Wasser, C. (2022). Competitive information disclosure to an auctioneer. *American Economic Journal: Microeconomics*, **14** (3), 622–64.

Zapechelnyuk, A. (2023). On the equivalence of information design by uninformed and informed principals. *Economic Theory*, forthcoming.

Zhong, W. (2018). Information design possibility set, working paper.