Decision Making under Relational Influence*

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Abstract

In situations where one repeatedly makes decisions under the influence of another, how does the former react to the latter—obey or disobey—in order to change the future exertion of influence? We study a repeated game between a decision maker and an external influence in which the former's regard for the latter is persistent private information. We show that concern for the future leads to more disobedience under negative influence and more obedience under positive influence. The acts of obedience and disobedience that seem irrational from a static perspective are rationalized as costly signals of other-regarding preferences. Our stylized model analysis is applicable to power dynamics between divisions as well as the relationship between individuals.

KEYWORDS: influence, interpersonal behaviors, organizational behaviors, repeated game

1 Introduction

Decision making often takes place under external influence. Teenagers choose their own behaviors but parents can influence their choices by applying psychological pressure. Engineers do the actual work of developing new products but boards of directors can exert influence on it through financing decisions. A decision maker (DM) is in control of a choice itself but an external influence (EI) can alter the choice problem by manipulating the choice outcomes. When the EI biases the choice problem in favor of her preferred alternative, we can categorize the DM's reaction as either obeying (choosing the alternative) or disobeying (choosing another alternative). On certain occasions, such reaction to influence appears irrational. Parents are often puzzled why teenagers disobey them even when there seems no clear benefit. Boards of directors can

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face engineers who seem to be disobeying for no good reason. The opposite observation is possible in different settings; The DM may appear irrationally obedient.

In this paper, we build a stylized model for repeated interactions between the two parties in the absence of contracts. We show that seemingly irrational acts of obedience and disobedience can be rationalized as costly signals that affect the future exertion of influence. We distinguish between negative influence and positive influence. In the case of negative influence, the DM does not want the EI to exert her influence and may show deliberate disobedience to prevent negative influence in the future. In the case of positive influence, the DM wants the EI to exert her influence and may obey despite a short term loss in order to receive positive influence in the future. Thus, the future concern increases the probability of disobedience (obedience) when influence is negative (positive) for the DM.

While past studies have examined the static aspects of influence activities (Milgrom and Roberts, 1988), decision control (Aghion and Tirole, 1997), and the power to enforce obedience (Van den Steen, 2010; Marino et al., 2010) in a one-shot interaction between the two parties, we focus on the dynamic interplay among these notions. Under asymmetric information about the DM's preferences, the exertion of influence in the future period can depend on obedience in the current period, and the location of effective decision control can shift over time as the EI adds or withdraws her influence. If we frame our analysis in an organizational setting, it provides a new perspective on how different divisions behave in the struggle for effective decision control.

In our model, the DM makes a binary choice, after the EI decides whether or not to exert influence by manipulating the choice outcomes in favor of her preferred alternative. The presence of influence becomes crucial to the DM's choice when two players, with positive probability, have a disagreement over which alternative is preferable. We consider two types of influence separately. Positive influence increases the players' payoffs from her preferred alternative, while negative influence decreases the payoffs from the EI's unpreferred alternative. The EI's optimal choice of exerting either sort of influence depends on whether the DM would choose the alternative that conforms with her influence or the alternative opposed to her influence. Whether the DM is obedient or disobedient depends on the DM's regard for the EI's preference, which is initially unknown to the EI.[1] We assume the players interact repeatedly (two periods for the most part). The DM's reaction to influence in the first period makes the EI update

[1]Economists have studied other-regarding preferences primarily in relation to altruism, fairness, and reciprocity. See Fehr and Schmidt (2006) for the literature review. We also cite them to defend our assumption that individuals are heterogeneous with respect to their regard for others. For an insightful discussion on the origins of non-selfish preferences, see Sobel (2005). In the context of an organization, the assumption here concerns how different divisions internalize the profits of each other.

her belief about the DM's type, and in this way the DM's obedience and disobedience in the first period can affect the influence choice in the second period.

In Section 2, we present the model setup and discuss the stage game outcomes. The EI exerts either sort of influence if she believes that the DM is sufficiently likely to obey under the influence. The influence choice generally depends on: (i) the EI's power to manipulate the choice outcomes and (ii) the prior belief about the DM types.

In Section 3, we analyze the two-period model under the assumption that the EI behaves myopic. Proposition 1 shows that disobedience is more likely to be observed under negative influence in the first period than in the stage game. Disobedience becomes more attractive under repeated interactions since it can lead to the withdrawal of negative influence in the future period. After the observation of disobedience, the EI updates her belief about the DM type and becomes discouraged to exert influence in the second period. Surprisingly, the DM may exhibit disobedience as a costly signal even when the player's preferences are aligned, if he strongly desires to get rid of negative influence. With regard to the earlier examples, seemingly irrational disobedient behaviors by teenagers and engineers can be explained as costly signaling that makes parents and boards of directors withdraw their influence. Proposition 2 shows that when influence is positive, obedience is more likely to be observed in the first period than in the stage game. Obedience becomes more attractive under repeated interactions since it can lead to the exertion of positive influence in the future period.[2] After the observation of obedience, the EI updates her belief about the DM type and becomes encouraged to exert influence in the second period. The DM may, even in the absence of influence, exhibit obedience as a costly signal when the preferences are misaligned. The result for positive influence rationalizes seemingly irrational obedience behaviors.

Our study is related to multiple strands of the economics literature. Our main results concern the ideas of obedience and disobedience. In the context of organizations, several authors have studied the power to enforce obedience, or interpersonal authority in the words of Eric Van den Steen.[3] Van den Steen (2010) analyzed how firm managers' power to enforce employee obedience depends on the allocation of control rights and income rights between managers and employees. Van den Steen (2009) investi-

[2]Bernheim (1994) discussed conformism in a model where actions signal dispositions and therefore status. Conformism arises because a departure from the social norm will seriously impair status, which individuals directly care about. In our model, the DM conforms to the EI in order to receive positive influence in the future.

[3]A generic term of authority refers to a multifaceted notion that can be associated with many different ideas. According to Oxford American College Dictionary, it can mean "the power or right to give orders, make decisions, and enforce obedience" and "the power to influence others, especially because of one's commanding manner or one's recognized knowledge about something." See Bolton and Dewatripont (2013) for various meanings of authority used in the literature.

gated the question of when firm managers enforce obedience by directly manipulating decision payoffs and when by providing information. Marino et al. (2010) studied how employee obedience depends on external market conditions when firm managers can replace an unsatisfactory employee with another agent. Our analysis of obedience is complementary to these studies, since we study the dynamic implication of obedience in repeated interactions among a fixed players.

Another recurrent notion in this paper is influence. Milgrom and Roberts (1988) and Milgrom (1988) studied efficient organization design under the assumption that individuals try to influence decisions to their benefits. In contrast to their static analysis, our focus is on characterizing the dynamic relationship between the DM and the EI. For the same reason, our analysis of repeated interactions is different from the studies of how a principal's controlling behaviors of offering monetary rewards (Deci, 1971; Lepper and Greene, 1978) or restricting choice sets (Brehm, 1966; Falk and Kosfeld, 2006) lead to a negative emotional response from an agent. These studies report the consequence of external influence on decision making in experiments that we consider as one-shot interactions. One notable exception is Seabright (2004). He showed how monetary rewards weaken the incentives to signal one's civic value through civic actions, in a setting where a second period is assortative matching with respect to revealed civic values. By contrast, we consider a different type of signaling that takes place when two players repeat the same sort of interaction.

One feature of our results is that the location of effective control shifts over time when the EI changes her influence choice. Aghion and Tirole (1997) were the first to systematically investigate a question of who has a de facto control over a choice alternative. Their main contribution was to distinguish between formal authority—the right to make decisions—and real authority—the power to influence others because of one's recognized knowledge. Many authors (e.g., Aghion et al., 2004; Dessein, 2005) have built on their model framework and discussed the optimal allocation of formal authority under different assumptions. Li et al. (2016) studied how a principal in possession of formal authority delegates real authority—they call it power—to an agent as a reward in an optimal relational contract. In our analysis, formal authority is fixed on the side of agent (DM) and influence is exerted not though information exchange or power allocation but through direct payoff manipulation.

2 A Model of Decision Making under External Influence

2.1 Setup

We study repeated interactions between a decision maker (DM, *he*) and an external influence (EI, *she*). In each period, the DM makes a binary choice $d \in \{X, Y\}$ after the EI makes an influence choice $e \in \mathcal{E}$, where either $\mathcal{E} = \{\emptyset, P\}$ or $\mathcal{E} = \{\emptyset, N\}$. On the one hand, the DM has the inalienable right to choose his preferred alternative. On the other hand, the EI can exert influence on his decision making by increasing the players' payoffs from her preferred alternative ($e = P$) or by decreasing the payoffs from her unpreferred alternative ($e = N$), unless she decides not to exert any influence ($e = \emptyset$).

In each period, a preferred alternative $\theta_i \in \{X, Y\}$ of player $i \in \{D, E\}$ is randomly determined. We assume that their preferences are misaligned ($\theta_D \neq \theta_E$) with probability $\rho \in (0, 1)$ and aligned ($\theta_D = \theta_E$) with probability $1 - \rho$. We can view ρ as a parameter of conflict between the players. In the absence of influence ($e = \emptyset$), each player i associates a value of β_i to his or her preferred alternative being chosen ($d = \theta_i$) and a value of α_i to the preferred alternative of the other player $-i$ being chosen ($d = \theta_{-i}$). In the case of preference alignment ($\theta_D = \theta_E$), their preferred alternative yields each player i the combined value of $\alpha_i + \beta_i$—and the other alternative the value 0. In the case of preference misalignment ($\theta_D \neq \theta_E$), a value for player i is either β_i or α_i depending on whether $d = \theta_i$ or $d = \theta_{-i}$. We assume $\beta_i > \alpha_i > 0$ for each $i \in \{D, E\}$ so that, in the absence of influence, the preference misalignment would lead to disagreement over which alternative should be chosen; Each player i wants their preferred alternative to be chosen ($d = \theta_i$).[4]

The EI can exert influence on the DM's choice either positively or negatively. Positive influence increases the players' values from her preferred alternative θ_E by a factor of $\frac{1}{1-\gamma} \geq 1$ while not affecting the values from the other alternative $\neg\theta_E$. In contrast, negative influence does not affect the values from her preferred alternative θ_E but decreases the values from the other alternative $\neg\theta_E$ by a factor of $(1 - \gamma)$. Both types of influence biases the values from θ_E and $\neg\theta_E$ in the same proportion: $\frac{1}{1-\gamma} : 1 = 1 : 1 - \gamma$. Here it is easy to observe that $\gamma \in (0, 1)$ is a parameter of influence. When $\gamma \simeq 1$, the EI can make the choice of θ_E yield more value to the DM than the choice of $\neg\theta_E$, irrespective of his preferred alternative θ_D. When $\gamma \simeq 0$, the influences have no impact on the values from the alternatives. In sum, player i's value from decision $d \in \{X, Y\}$ when the influence choice is $e \in \{\emptyset, P, N\}$ can be expressed

[4] The assumption that $\alpha_i \notin \{0, \beta_i\}$ for each $i \in \{D, E\}$ is imposed for expositional simplicity.

as:

$$\left[1+\frac{\gamma}{1-\gamma}I_{\{e=P,d=\theta_E\}}-\gamma I_{\{e=N,d=\neg\theta_E\}}\right]\left[\beta_i I_{\{d=\theta_i\}}+\alpha_i I_{\{d=\theta_{-i}\}}\right],$$

where $I_{\{\cdot\}}$ takes 1 if the statement inside the bracket is true and 0 otherwise.[5]

We assume that it costs $\frac{\gamma}{1-\gamma}c>0$ for the EI to exert positive influence. Positive influence can be interpreted as: (i) the irreversible spending of costly resources on the choice of θ_E or (ii) the costly acquisition of information that only enhances the value from the choice θ_E. We normalize the EI's direct cost of exerting negative influence to be zero. However, negative influence can cost her the loss of the value if the DM chooses her unpreferred alternative $\neg\theta_E$ against her attempted influence not to choose it. Negative influence can be interpreted as: (i) the withdrawal of the resources from the choice of $\neg\theta_E$ that cannot be spent effectively otherwise or (ii) the bashing of the choice $\neg\theta_E$ in a way that reduces its value for both players.

We study a two-period model—a one-time repeated game—in which the discounted expected utility of player i at the beginning of the game is $u_i^1+\delta_i u_i^2$, where u_i^t is player i's expected utility in period t and δ_i is their relative weight on the second period. The timing of events in each period is as follows. The EI observes $\theta_E\in\{X,Y\}$ and chooses her influence $e\in\mathcal{E}$. After the observation of the EI's preference θ_E and influence choice e, the DM observes θ_D and chooses his decision $d\in\{X,Y\}$. The DM's preference θ_D and decision d are also observable to the EI. Under these observability assumptions, each player knows: (i) whether their preferences are aligned or misaligned and (ii) whether the DM *obeys* (or *disobeys*) the EI—whether he chooses $d=\theta_E$ (or $d=\neg\theta_E$).

Last but not least, we assume that the DM's regard for the EI's personal preference, α_D, is his private information and constant over time. The EI's prior belief about α_D is represented by a continuous distribution $F(\alpha_D)$ that has full support on $(0,\beta_D)$.[6]

[5] As an alternative payoff structure, one can consider:

$$\beta_i\left[1+\frac{\gamma}{1-\gamma}I_{\{e=P,d=\theta_E\}}-\gamma I_{\{e=N,d=\neg\theta_E\}}\right]I_{\{d=\theta_i\}}+\alpha_i u_{-i}.$$

We reject this alternative not just because it complicates the analysis without additional insight but because it gives rise to altruistic utility of higher order. Player i's utility would include, through the altruistic part, player $-i$'s altruistic utility, $\alpha_{-i}u_i$. The plausibility of such assumption is, to our knowledge, not clear.

[6] We could alternatively assume that the EI knows α_D but not $\beta_D\in(\alpha_D,\infty)$. We believe that it is much more natural to assume uncertainty about the other-regarding part of preferences than the personal preferences over alternatives. As one relevant study, we mention the work by Iyengar and Lepper (1999). They experimentally showed that the other-regarding preferences are significantly different between Anglo-American children and Asian-American children.

2.2 Stage Game Outcomes

We start our analysis with the discussion of the stage game outcomes when the EI knows the DM's type α_D. In the absence of influence ($e = \emptyset$), the DM chooses his preferred alternative θ_D irrespective of θ_E, and the EI's expected utility is thus $\rho\alpha_E + (1-\rho)(\beta_E + \alpha_E)$. If the EI exerts positive influence ($e = P$), the DM's decision in the preference misalignment case depends on which player has effective control. If $\frac{1}{1-\gamma}\alpha_D \leq \beta_D$, the DM has control ($d = \theta_D$) and the EI's expected utility is $-\frac{\gamma}{1-\gamma}c + \rho\alpha_E + (1-\rho)\frac{1}{1-\gamma}(\beta_E + \alpha_E)$. If $\frac{1}{1-\gamma}\alpha_D > \beta_D$, the EI has control ($d = \theta_E$) and the EI's expected utility is $-\frac{\gamma}{1-\gamma}c + \rho\frac{1}{1-\gamma}\beta_E + (1-\rho)\frac{1}{1-\gamma}(\beta_E + \alpha_E)$. If the EI exerts negative influence ($e = N$), the same threshold $\alpha_D = (1-\gamma)\beta_D$ becomes critical for the location of control in the preference misalignment case. If $\alpha_D \leq (1-\gamma)\beta_D$, the DM has control ($d = \theta_D$) and the EI's expected utility is $\rho(1-\gamma)\alpha_E + (1-\rho)(\beta_E + \alpha_E)$. If $\alpha_D > (1-\gamma)\beta_D$, the EI has control ($d = \theta_E$) and the EI's expected utility is $\rho\beta_E + (1-\rho)(\beta_E + \alpha_E)$.

From the comparison of the EI's expected utilities from $e \in \{\emptyset, P, N\}$, we obtain the following result, where we assume that $(1-\rho)(\beta_E + \alpha_E) < c < \rho\beta_E + (1-\rho)(\beta_E + \alpha_E)$ so that the influence choice is nontrivial when $\mathcal{E} = \{\emptyset, P\}$.

Lemma 1 (Stage game outcomes under symmetric information)**.**
In a unique equilibrium of the stage game under symmetric information:
(i) Assume $\alpha_D > (1-\gamma)\beta_D$. The EI exerts positive (negative) influence if $\mathcal{E} = \{\emptyset, P\}$ (if $\mathcal{E} = \{\emptyset, N\}$), and the DM chooses the EI's preferred alternative θ_E.
(ii) Assume $\alpha_D \leq (1-\gamma)\beta_D$. The EI exerts no influence and the DM chooses his preferred alternative θ_D.

Positive influence increases the DM's expected utility by $\rho\max\{\frac{1}{1-\gamma}\alpha_D - \beta_D, 0\} + (1-\rho)\frac{\gamma}{1-\gamma}(\beta_D + \alpha_D)$, while negative influence decreases it by $\rho\min\{\gamma\beta_D, \beta_D - \alpha_D\}$. For either sort of influence, whether the DM obeys or disobeys in the preference misalignment case depends on whether his regard for the EI's personal preference is high or low: (i) $\alpha_D > (1-\gamma)\beta_D$ or (ii) $\alpha_D \leq (1-\gamma)\beta_D$. We thus say that the DM with condition (i) is of *obedient* type and the one with condition (ii) of *disobedient* type.

We now turn to the stage game outcomes when the EI does not know the DM's type α_D. Let q denote the EI's prior belief that the DM is of disobedient type. The EI's expected utility is: $\rho\alpha_E + (1-\rho)(\beta_E + \alpha_E)$ in the absence of influence ($e = \emptyset$); $-\frac{\gamma}{1-\gamma}c + \rho\left[q\alpha_E + (1-q)\frac{1}{1-\gamma}\beta_E\right] + (1-\rho)\frac{1}{1-\gamma}(\beta_E + \alpha_E)$ with positive influence ($e = P$); and $\rho\left[q(1-\gamma)\alpha_E + (1-q)\beta_E\right] + (1-\rho)(\beta_E + \alpha_E)$ with negative influence ($e = N$). From the comparison of the EI's expected utilities from $e \in \{\emptyset, P, N\}$, we obtain the following result, where $q(\gamma) \equiv F\left[(1-\gamma)\beta_D\right]$.

Lemma 2 (Stage game outcomes under asymmetric information)**.**
In a unique equilibrium of the stage game under asymmetric information:
(i) Assume $\mathcal{E} = \{\emptyset, P\}$*. If* $q(\gamma) < 1 - \frac{c-(1-\rho)(\beta_E+\alpha_E)}{\rho\left[\frac{1}{1-\gamma}\beta_E-\alpha_E\right]} \equiv \bar{q}(\gamma)$*, the EI exerts positive influence and the DM chooses the EI's preferred alternative* θ_E *if and only if* $\alpha_D > (1-\gamma)\beta_D$*. If* $q(\gamma) \geq \bar{q}(\gamma)$*, the EI exerts no influence and the DM chooses his preferred alternative* θ_D*.*
(ii) Assume $\mathcal{E} = \{\emptyset, N\}$*. If* $q(\gamma) < \frac{\beta_E-\alpha_E}{\beta_E-(1-\gamma)\alpha_E} \equiv \bar{\bar{q}}(\gamma)$*, the EI exerts negative influence and the DM chooses the EI's preferred alternative* θ_E *if and only if* $\alpha_D > (1-\gamma)\beta_D$*. If* $q(\gamma) \geq \bar{\bar{q}}(\gamma)$*, the EI exerts no influence and the DM chooses his preferred alternative* θ_D*.*

The EI exerts influence if she believes that the DM is sufficiently more likely to be obedient ($q(\gamma) < \bar{q}(\gamma)$ or $q(\gamma) < \bar{\bar{q}}(\gamma)$); Otherwise, exerting either sort of influence is not worth its cost. See Figure 1 for the illustration. When $\mathcal{E} = \{\emptyset, P\}$, since $q(\gamma)$ is decreasing from $q(0) = 1$ to $q(1) = 0$ while $\bar{q}(\gamma)$ is increasing from $\bar{q}(0) < 1$ to $\bar{q}(1) = 1$, there exists $\bar{\gamma} \in (0,1)$ such that the EI exerts positive influence if and only if $\gamma > \bar{\gamma}$. When $\mathcal{E} = \{\emptyset, N\}$, both $q(\gamma)$ and $\bar{\bar{q}}(\gamma)$ are decreasing, and the influence choice generally depends on the shape of distribution $F(\alpha_D)$. However, since $\bar{\bar{q}}(1) > 0 = q(1)$, there exists $\bar{\bar{\gamma}} \in (0,1)$ such that the EI exerts negative influence if $\gamma > \bar{\bar{\gamma}}$.

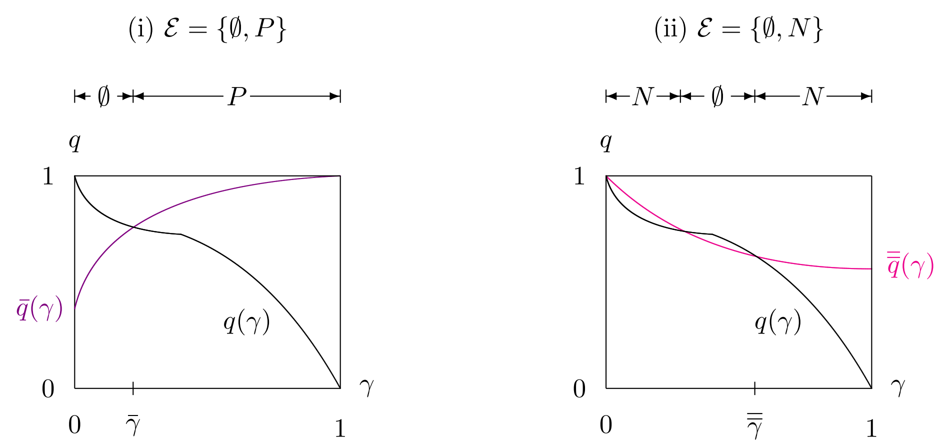

Figure 1: The static influence choice under asymmetric information

3 Decision and Influence in Repeated Interactions

In this section we discuss how decision and influence in the repeated game differ from those in the stage game. We study the case of negative influence ($\mathcal{E} = \{\emptyset, N\}$) in Section 3.1 and the case of positive influence ($\mathcal{E} = \{\emptyset, P\}$) in Section 3.2.[7] In these sections we characterize the dynamic relationship between the DM and the EI by assuming that the latter is myopic in the sense that each period she chooses her influence choice to maximize her expected period utility. This is the same as assuming $\delta_E = 0$.

3.1 Negative Influence

Assume $\mathcal{E} = \{\emptyset, N\}$. As we have seen in Lemma 2 (ii), the EI exerts negative influence in the stage game if and only if $q(\gamma) < \overline{\overline{q}}(\gamma)$. We first characterize the conditions under which the repeated game outcomes differ from the stage game outcomes. Then we discuss our main prediction that the DM is more likely to show disobedience to negative influence in the first period of the repeated game than in the stage game.

Let $\tilde{F}$ be the EI's posterior belief distribution about α_D at the beginning of the second period, and let $\tilde{q}$ denote $\tilde{F}\left[(1-\gamma)\beta_D\right]$, the EI's posterior belief that the DM is of disobedient type. Now suppose $F\left[(1-\gamma)\beta_D\right] \geq \overline{\overline{q}}(\gamma)$. From Lemma 2 (ii), the EI does not exert influence and the DM chooses his preferred alternative θ_D. Since the DM's reaction in the first period is not informative about his type, the EI's prior belief is carried over to the second period. Thus $\tilde{F}\left[(1-\gamma)\beta_D | d = \theta_D\right] \geq \overline{\overline{q}}(\gamma)$, and it follows that the EI does not exert influence in the second period as well.

Suppose instead $F\left[(1-\gamma)\beta_D\right] < \overline{\overline{q}}(\gamma)$ so that the EI exerts negative influence in the first period. We first discuss the DM's reaction in the preference misalignment case. If all the DM types behave as if this is a one-shot interaction, his first-period reaction would lead to the EI's belief $\tilde{q} = 0$ in the case of obedience and $\tilde{q} = 1$ in the case of disobedience. Under this hypothesis, let us consider strategic thinking of type $\alpha_\varepsilon = (1-\gamma)\beta_D + \varepsilon$ for small $\varepsilon > 0$. If this type disobeys with an immediate loss of ε, the EI will withdraw negative influence in the second period, yielding the DM a discounted expected gain of $\delta_D \rho(\beta_D - \alpha_\varepsilon) = \delta_D \rho(\gamma\beta_D - \varepsilon)$. If ε is sufficiently small, type α_ε would be better off disobeying. As more types switch from obedience to disobedience, the EI's posterior belief conditional on disobedience decreases from $\tilde{q} = 1$.[8]

[7] We start with the negative influence case because we find the results and applications more interesting than those in the positive influence case.

[8] As the reader can see in the proof of Proposition 1, the EI's withdrawal of negative influence occurs with probability less than 1, if too many obedient types switch their reactions from disobedience to

We now turn to the DM's reaction in the preference alignment case. In the stage game all the DM types would obey since the EI's preferred alternative is his preferred alternative as well. In the first period of the repeated game, however, the DM may show disobedience to negative influence if he strongly wants the EI to withdraw negative influence in the second period. The cost of disobedience is $\beta_D + \alpha_D$, while its benefit is $\delta_D \rho p_d(\beta_D - \max\{\alpha_D, (1-\gamma)\beta_D\})$, where p_d is the probability that DM withdraws negative influence in the second period after having observed disobedience. A simple cost-benefit analysis shows that the DM with lower regard α_D for the EI's personal preference has higher incentives to disobey. Disobedience is observed with positive probability in the alignment case if $\beta_D < \delta_D \rho \gamma \beta_D$.

The following proposition formalizes the discussions above.[9]

Proposition 1.
(i) The DM's first-period reaction affects the EI's second-period influence choice if and only if the EI exerts negative influence in the first period.
Under negative influence in the first period:
(ii) The DM disobeys if and only if $\alpha_D \leq \alpha_m \in ((1-\gamma)\beta_D, \beta_D)$ in the misalignment case and $\alpha_D \leq \alpha_a \in [0, \beta_D)$ in the alignment case. Disobedience leads to the withdrawal of negative influence with positive probability, while obedience leads to the continuation of negative influence with probability 1.
(iii) The ex-ante probability of disobedience is strictly greater than the corresponding probability in the stage game.
(iv) Disobedience is more likely to be observed when: (1) the conflict is severer (ρ is higher); (2) the influence is stronger (γ is higher) given that $\gamma > \overline{\overline{\gamma}}$; and (3) the future interaction is more important (δ_D is higher).

Proof. In Appendix. □

Proposition 1 provides us many insights about the DM's attitude toward the EI who has the power to exert negative influence on his decision making. First, the DM behaves differently in repeated interactions than in a one-shot interaction when the EI exerts negative influence, which is certainly the case if $\gamma > \overline{\overline{\gamma}}$ as we have seen in Lemma 2 (ii).[10] When negative influence is present, the DM must disobey to have it removed in the second period. Figure 2 illustrates the difference of the DM's

obedience.

[9]Our prediction is unique with the use of the D1 refinement introduced by Cho and Kreps (1987). The refinement is used only for the prediction of the preference alignment case.

[10]Note that the condition $\alpha_E \in (0, \beta_E)$ is also necessary here. Since $\overline{\overline{q}}(\gamma) = 1$ for all $\gamma \in [0,1)$ if $\alpha_E = 0$, and $\overline{\overline{q}}(\gamma) = 0$ for all $\gamma \in [0,1)$ if $\alpha_E = \beta_E$, the EI, irrespective of her belief, exerts negative influence if $\alpha_E = 0$, and does not exert influence if $\alpha_E = \beta_E$.

reactions between in the stage game and in the first period of the repeated game when $\beta_D < \delta_D \rho \gamma \beta_D$.

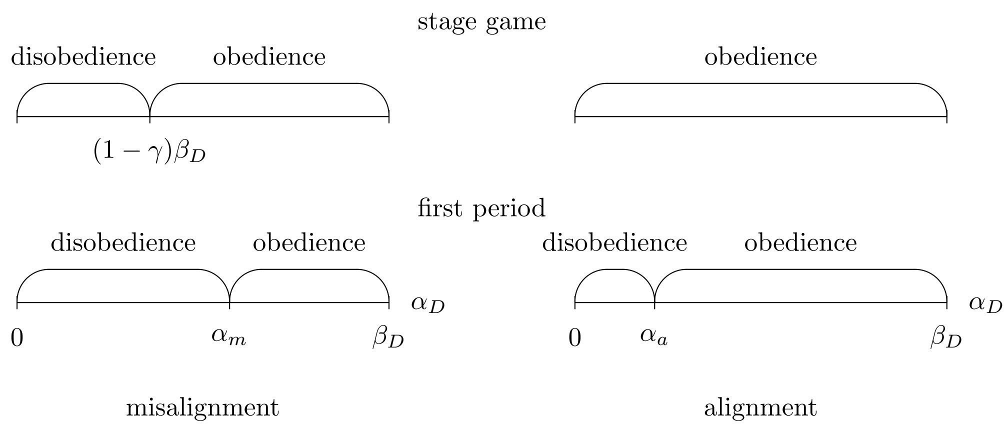

Figure 2: The DM's reaction to negative influence

Second, disobedience as a costly signal occurs because of preference conflict. The threshold type α_m (α_a) in the misalignment (alignment) case increases strictly (weakly) with the degree of conflict ρ. When $\rho = 0$, $\alpha_m = (1-\gamma)\beta_D$ and $\alpha_a = 0$. Costly signaling in the first period is worthwhile if the presence of negative influence is sufficiently significant for the DM. Negative influence matters to the DM only when the preferences are misaligned. Third, costly disobedience is more likely if the EI has a greater power to decrease the values from her unpreferred alternative, provided that an increase in γ does not change the influence choice in the first period. Fourth, costly disobedience is more likely if the future relationship represented by the second period is relatively more important. We note that costly signaling in the misalignment case occurs without any restriction on $\delta_D > 0$, while the result is not smooth with respect to δ_D in the alignment case. The DM's disobedience in the alignment case is only observed when the signaling incentives are sufficiently strong.

Proposition 1 offers a reasonable explanation about why some teenagers blatantly disobey parents. What causes confusion for some parents is the fact that some teenagers do the opposite of what their parents say when they are clearly better off following the instructions. Our model analysis shows that such disobedient behavior is completely rational as a costly signal in the alignment case. While many different factors contribute to adolescent rebellion (e.g., the need to build personal identity by breaking the norm, and the peer pressure to stand up against authority), our signaling theory is consistent with common explanations that psychologists provide. Teenagers disobey because they want to get rid of parents' intervention and to have freedom over their own behaviors in the future. Disobedience is more likely if parents are more authoritative (γ high), if preferences differ more (ρ high), and if teenagers have less respect for their parents (α_D low).

Another application is organizational conflicts. Inside a firm, we can consider its board of directors as the EI and its engineering department as the DM. In general, the board and the engineers would not always have aligned objectives regarding what type of new products they bring to the market. The former would emphasize profitability while the latter would pay more attention to the innovativeness of products. While engineers are ultimately responsible for the creation of products, the board may be able to exert negative influence through financing decisions. When the board exerts negative influence, engineers may show disobedience even when they do not have any real disagreement.

3.2 Positive Influence

Assume $\mathcal{E} = \{\emptyset, P\}$. As we have seen in Lemma 2 (i), the EI exerts positive influence in the stage game if and only if $q(\gamma) < \bar{q}(\gamma)$. Unlike in the case of negative influence, the DM's first-period reaction can matter to the EI's second-period influence choice in equilibrium, irrespective of whether the EI exerts positive influence in the first period. This difference comes from the fact that all the DM types are content with hiding their identities from the EI in the absence of negative influence, while some DM types have strong incentives to reveal their types to the EI in the absence of positive influence.

Suppose first that $F\left[(1-\gamma)\beta_D\right] \geq \bar{q}(\gamma)$, or $\gamma \leq \bar{\gamma}$. From Lemma 2 (i), the EI does not exert influence. In the preference misalignment case, all the DM types would disobey in the stage game. In the first period of the repeated game, however, the DM may obey to reveal that he is of obedient type, asking for positive influence in the second period. The cost of obedience is $\beta_D - \alpha_D$, while its benefit is $\delta_D \tilde{p}_o \left[\rho \max\{\frac{1}{1-\gamma}\alpha_D - \beta_D, 0\} + (1-\rho)\frac{\gamma}{1-\gamma}(\beta_D + \alpha_D)\right]$, where $\tilde{p}_o$ is the probability that DM exerts positive influence in the second period after having observed obedience. The argument here implies that the obedient types with α_D sufficiently close to β_D obey in equilibrium.

In the preference alignment case, it may be possible that the DM disobeys in order to affect the EI's future influence choice, just as we have observed disobedience in the alignment case under negative influence. In the case of positive influence, however, such costly signaling is less intuitive since it is the obedient types who would disobey to reveal their identity.[11] We thus exclude the possibility of such costly signaling from

[11] Furthermore, we are not sure if such costly signaling is actually feasible. We have not yet proved

our equilibrium prediction.

Suppose instead that $F\left[(1-\gamma)\beta_D\right] < \bar{q}(\gamma)$, or $\gamma > \bar{\gamma}$ so that the EI exerts positive influence in the first period. In the misalignment case, suppose, hypothetically, that all the DM types behave as if this is a one-shot interaction. In this case, disobedience would lead to the posterior belief $\tilde{q} = \tilde{F}\left[(1-\gamma)\beta_D\right] = 1 > \bar{q}(\gamma)$, under which the EI will withdraw positive influence in the second period. Type $\alpha_\varepsilon = (1-\gamma)\beta_D - \varepsilon$ for sufficiently small $\varepsilon > 0$ would be then better off obeying, since an immediate loss of $\frac{\varepsilon}{1-\gamma}$ is more than compensated for by a discounted expected gain of $\delta_D \tilde{p}_o (1-\rho)\frac{\gamma}{1-\gamma}(\beta_D + \alpha_D)$. The argument here implies that some of disobedient types obey and the EI will continue positive influence in the second period. In the alignment case, all the DM types obey, choosing the common preferred alternative $\theta_E = \theta_D$. Since the DM's reaction in the first period is not informative about his type, the EI's prior belief is carried over to the second period and the DM is content with the continuation of positive influence in the second period.

The following proposition formalizes the discussions above and Figure 3 illustrates the DM's reaction in the misalignment case.

Proposition 2.
(i) The DM's first-period reaction affects the EI's second-period influence choice when the preferences are misaligned, irrespective of whether the EI exerts positive influence in the first period.
(ii) In the absence of positive influence in the first period ($\gamma \leq \bar{\gamma}$), the DM obeys in the misalignment case if and only if $\alpha_D > \alpha'_m \in (0,1)$. Under positive influence in the first period ($\gamma > \bar{\gamma}$), the DM obeys in the misalignment case if and only if $\alpha_D > \alpha''_m \in (0,(1-\gamma)\beta_D)$. Obedience leads to the exertion of positive influence with positive probability, while disobedience leads to no influence with probability 1.
In either case:
(iii) The ex-ante probability of obedience is strictly greater than the corresponding probability in the stage game.
(iv) Obedience is more likely to be observed when: (1) the conflict is less severe; (2) the influence is stronger; and (3) the future interaction is more important.

Proof. In Appendix. □

Proposition 2 provides us many insights about the DM's attitude toward the EI who has the power to exert positive influence on his decision making. First, the DM behaves differently differently in repeated interactions than in a one-shot interaction only when the preferences are misaligned. Second, obedience as a costly signal is

its existence. We are still working on this part.

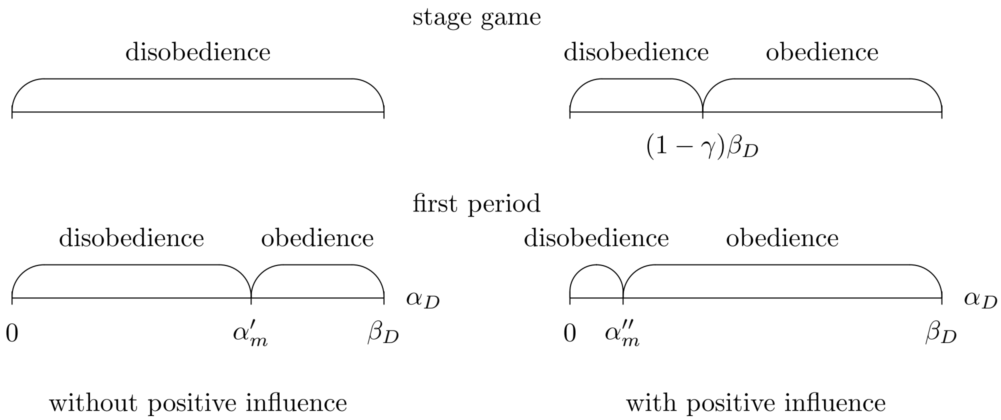

Figure 3: The DM's reaction in the misalignment case

more likely to be observed when preference conflict is less severe (ρ is lower). This is so because the DM benefits from influence in the alignment case if and only if the influence is positive. When preference conflict is surely expected ($\rho \simeq 1$), obedience as a costly signal does not occur in the misalignment case with positive influence in the first period. This is because positive influence in the second period will not be valuable for the obedient types who would engage in costly signaling otherwise. Third, costly obedience is more likely when the influence is stronger (γ is larger) and when the future relationship is more important (δ is larger).

Proposition 2 provides one possible explanation for overly obedient behaviors. When individuals show obedience by sacrificing their personal interests, we can rationalize such behaviors as a costly signal of how much they care about other concerned individuals. By showing how obedient they are to the influence, they expect to receive positive influence in the future.

4 Conclusion

We conclude with some discussion of avenues for further research. First, we are currently extending the repeated game analysis from two periods to infinitely many periods without assuming that the EI is myopic. In the infinitely repeated game, we can characterize the nonstationary equilibria. This change will come in the next version of this working paper.

Second, we did not investigate the strategic choice between positive and negative influence due to analytical intractability. A question of how the EI switches between different modes of influence is worth an independent question and model.

Third, we hope to see a static model that formalizes a theory of psychological reactance by Brehm (1966) and explains the experimental data collected by social psychologists and experimental economists (Brehm, 1966; Falk and Kosfeld, 2006). Our conjecture is that the modeling of psychological states about freedom is necessary for such a model. We believe that a successful model would also account for the idea of Fromm (1941) as well.

Finally, our model of negative influence could be applied to political conflicts (e.g, Padró i Miquel and Yared, 2012). In his 1849 essay, *Resistance to Civil Government*, Henry David Thoreau argued that it was the duty of conscientious citizens to resist the unjust government even if that meant breaking the law. His philosophy of civil disobedience and its massive implementations by Mahatma Gandhi and Martin Luther King seem to share the idea of disobedience as costly signaling.

A Proofs

A.1 Proof of Proposition 1

(i) The necessity of $F\left[(1-\gamma)\beta_D\right] < \overline{\overline{q}}(\gamma)$ is obvious from the discussion in the main text. Its sufficiency follows from the following arguments.

(ii) Assume $F\left[(1-\gamma)\beta_D\right] < \overline{\overline{q}}(\gamma)$. The DM exerts influence in the first period. Let p_o and p_d be the respective probability that the EI withdraws influence in the second period after having observed obedience and disobedience in the first period. We first show that $p_o = 0 < p_d$ in equilibrium. Suppose, for contradiction, that $p_o \geq p_d$. In this case, if some disobedient type obeys, all the obedient types must also be obeying. This implies that, after obedience, $\tilde{F}\left[(1-\gamma)\beta_D | d = \theta_E\right] \leq F\left[(1-\gamma)\beta_D\right] < \overline{\overline{q}}(\gamma)$. But then $p_o = 0 \geq p_d$. In this case, the only disobedient types disobey in the first period. This means that, after disobedience, $\tilde{F}\left[(1-\gamma)\beta_D | d \neq \theta_E\right] = 1$. But then $p_d = 1$, a contradiction. Hence $p_o < p_d$. Now suppose that $p_o > 0$. This implies that $\tilde{F}\left[(1-\gamma)\beta_D | d = \theta_E\right] \geq \overline{\overline{q}}(\gamma)$ and $\tilde{F}\left[(1-\gamma)\beta_D | d \neq \theta_E\right] \geq \overline{\overline{q}}(\gamma)$. But this cannot be consistent with the Bayes' rule given that $F\left[(1-\gamma)\beta_D\right] < \overline{\overline{q}}(\gamma)$. Hence $p_o = 0$.

Now consider the misalignment case for the first period. Given that $p_o = 0 < p_d$, some of the obedient types as well as all the disobedient types disobey. Let $\alpha_\varepsilon = (1-\gamma)\beta_D + \varepsilon$ for $\varepsilon > 0$. Type α_ε would be better off disobeying if and only if $\varepsilon < \delta\rho p_d(\beta_D - \alpha_\varepsilon)$ or $\varepsilon < \frac{\delta\rho p_d}{1+\delta\rho p_d}\gamma\beta_D$.[12] Thus, the DM disobeys if and only if $\alpha_D \leq (1-\gamma)\beta_D + \frac{\delta\rho p_d}{1+\delta\rho p_d}\gamma\beta_D \equiv \alpha_m$. Given p_d, the posterior belief after disobedience is such that $\tilde{F}\left[(1-\gamma)\beta_D | d \neq \theta_E\right] = \frac{F[(1-\gamma)\beta_D]}{F(\alpha_m)} \equiv \tilde{q}_m(p_d)$, where $\tilde{q}_m(p_d)$ is decreasing

[12] We use δ for δ_D.

in p_d with $\tilde{q}_m(0) = 1$. If $\tilde{q}_m(1) \geq \overline{\overline{q}}(\gamma)$, then $p_d = 1$ at equilibrium. Otherwise, $p_d \in (0,1)$ such that $\tilde{q}_m(p_d) = \overline{\overline{q}}(\gamma)$.

In the alignment case, type α_D will be better off disobeying if and only if $\beta_D + \alpha_D < \delta\rho p_d(\beta_D - \max\{\alpha_D, (1-\gamma)\beta_D\})$. Thus, the DM disobeys if and only if $\alpha_D \leq \alpha_a$, where $\alpha_a = (\delta\rho p_d\gamma - 1)\beta_D$ when $\delta\rho \leq \frac{2-\gamma}{p_d\gamma}$ and $\alpha_a = \frac{\delta\rho p_d - 1}{\delta\rho p_d + 1}\beta_D$ otherwise. Given p_d, the posterior belief after disobedience is such that $\tilde{F}\left[(1-\gamma)\beta_D | d \neq \theta_E\right] = \frac{\min\{F(\alpha_a), F[(1-\gamma)\beta_D]\}}{F(\alpha_a)} \equiv \tilde{q}_a(p_d)$. If $\delta\rho \leq \frac{2-\gamma}{p_d\gamma}$, then $\alpha_a \leq (1-\gamma)\beta_D$. Then $\tilde{q}_a(p_d) = 1 > \overline{\overline{q}}(\gamma)$, which implies that $p_d = 1$. Suppose $\delta\rho > \frac{2-\gamma}{\gamma}$. If $\tilde{q}_a(1) \geq \overline{\overline{q}}(\gamma)$, then $p_d = 1$ at equilibrium. Otherwise, $p_d \in (0,1)$ such that $\tilde{q}_a(p_d) = \overline{\overline{q}}(\gamma)$.

(iii) The ex-ante probability of disobedience is $\rho F(\alpha_m) + (1-\rho)F(\alpha_a)$, which is strictly greater than the corresponding probability $\rho F\left[(1-\gamma)\beta_D\right]$.

(iv) The comparative statics results follow from the fact that α_m (α_a) is strictly (weakly) increasing in ρ, γ, and δ. A minor qualification of $\gamma > \overline{\overline{\gamma}}$ is needed with respect to γ, since otherwise an increase in γ may shift the first-period influence choice from N to $\emptyset$.

A.2 Proof of Proposition 2

(i) All the DM types obey in the alignment case for the reasons discussed in the main text. The fact that the DM's first-period reaction affects the EI's second-period influence choice in the misalignment case is proved below.

(ii) Let $\tilde{p}_o$ and $\tilde{p}_d$ be the respective probability that the EI exerts positive influence in the second period after having observed obedience and disobedience in the first-period misalignment case. We first show that $\tilde{p}_o > 0 = \tilde{p}_d$ in equilibrium, irrespective of the first-period influence choice. Suppose, for contradiction, that $\tilde{p}_o \leq \tilde{p}_d$. Then, all the DM types would disobey, and $\tilde{F}\left[(1-\gamma)\beta_D | d \neq \theta_E\right] = F\left[(1-\gamma)\beta_D\right] \geq \bar{q}(\gamma)$, which implies $\tilde{p}_d = 0$. But, the D1 refinement requires that if the DM obeys, the EI would believe that the deviator is of obedient type. This means that $\tilde{p}_o = 1$, a contradiction. Now suppose that $\tilde{p}_d > 0$. This implies that $\tilde{F}\left[(1-\gamma)\beta_D | d \neq \theta_E\right] < \bar{q}(\gamma)$. When $F\left[(1-\gamma)\beta_D\right] \geq \bar{q}(\gamma)$, this cannot be consistent with the Bayes' rule. When $F\left[(1-\gamma)\beta_D\right] < \bar{q}(\gamma)$, $\tilde{p}_o > \tilde{p}_d$ implies that all the obedient types obey and $\tilde{F}\left[(1-\gamma)\beta_D | d \neq \theta_E\right] = 1$. Hence $\tilde{p}_d = 0$ in either case.

Assume $F\left[(1-\gamma)\beta_D\right] \geq \bar{q}(\gamma)$, or $\gamma \leq \bar{\gamma}$ so that the DM does not exert influence in the first period. Given that $\tilde{p}_o > 0 = \tilde{p}_d$, the obedient types with α_D sufficiently close to 1 obey. Type α_D would be better off obeying

$$\beta_D - \alpha_D < \delta p_o \left[\rho \max\{\frac{1}{1-\gamma}\alpha_D - \beta_D, 0\} + (1-\rho)\frac{\gamma}{1-\gamma}(\beta_D + \alpha_D)\right].$$

This implies that there exists a unique threshold type α'_m such that the DM obeys if and only if $\alpha_D > \alpha'_m$. If $\delta(1-\rho) \leq \frac{1-\gamma}{2-\gamma}$, then $\alpha'_m \geq (1-\gamma)\beta_D$ and $\tilde{p}_o = 1$ (by the Bayes' rule), where

$$\alpha'_m = \frac{1+\delta\left[\rho - (1-\rho)\frac{\gamma}{1-\gamma}\right]}{1+\delta\left[\rho\frac{1}{1-\gamma} + (1-\rho)\frac{\gamma}{1-\gamma}\right]}\beta_D.$$

If $\delta(1-\rho) > \frac{1-\gamma}{2-\gamma}$, then $\alpha'_m < (1-\gamma)\beta_D$, where

$$\alpha'_m = \frac{1-\delta\tilde{p}_o(1-\rho)\frac{\gamma}{1-\gamma}}{1+\delta\tilde{p}_o(1-\rho)\frac{\gamma}{1-\gamma}}\beta_D.$$

Given p_o, the posterior belief after obedience is such that $\tilde{F}\left[(1-\gamma)\beta_D | d = \theta_E\right] = \frac{F[(1-\gamma)\beta_D] - F(\alpha'_m)}{1-F(\alpha'_m)} \equiv \tilde{\tilde{q}}_m(\tilde{p}_o)$, where $\tilde{\tilde{q}}_m(\tilde{p}_o)$ is increasing in $\tilde{p}_o$ with $\tilde{\tilde{q}}_m(\underline{p}) = 0$ for some $\underline{p} \in (0,1)$. If $\tilde{\tilde{q}}_m(1) \leq \bar{q}(\gamma)$, then $\tilde{p}_o = 1$ at equilibrium. Otherwise, $\tilde{p}_o \in (0,1)$ such that $\tilde{\tilde{q}}_m(\tilde{p}_o) = \bar{q}(\gamma)$.

Assume $F\left[(1-\gamma)\beta_D\right] < \bar{q}(\gamma)$, or $\gamma > \bar{\gamma}$ so that the DM exerts positive influence in the first period. Let $\alpha_\varepsilon = (1-\gamma)\beta_D - \varepsilon$ for $\varepsilon > 0$. Type α_ε would be better off obeying if and only if $\frac{\varepsilon}{1-\gamma} < \delta\tilde{p}_o(1-\rho)\frac{\gamma}{1-\gamma}(\beta_D + \alpha_D)$ or $\varepsilon < \delta\tilde{p}_o(1-\rho)\gamma(\beta_D + \alpha_D)$. Thus, the DM obeys if and only if $\alpha_D > (1-\gamma)\beta_D - \delta\tilde{p}_o(1-\rho)\gamma(\beta_D + \alpha_D) \equiv \alpha''_m$. Given p_o, the posterior belief after obedience is such that $\tilde{F}\left[(1-\gamma)\beta_D | d = \theta_E\right] = \frac{F[(1-\gamma)\beta_D] - F(\alpha''_m)}{1-F(\alpha''_m)} \equiv q^*_m(\tilde{p}_o)$, where $q^*_m(\tilde{p}_o)$ is increasing in $\tilde{p}_o$ with $q^*_m(p^*) = 0$ for some $p^* \in (0,1)$. If $q^*_m(1) \leq \bar{q}(\gamma)$, then $\tilde{p}_o = 1$ at equilibrium. Otherwise, $\tilde{p}_o \in (0,1)$ such that $q^*_m(\tilde{p}_o) = \bar{q}(\gamma)$.

(iii) When $\gamma \leq \bar{\gamma}$, the ex-ante probability of obedience is $\rho[1 - F(\alpha'_m)] + (1-\rho)$, which is strictly greater than the corresponding probability $1-\rho$ in the stage game. When $\gamma > \bar{\gamma}$, the ex-ante probability of obedience is $\rho[1 - F(\alpha''_m)] + (1-\rho)$, which is strictly greater than the corresponding probability $\rho\left[1 - q(\gamma)\right] + (1-\rho)$ in the stage game.

(iv) The comparative statics results follow from the fact that α'_m and α''_m are strictly increasing in ρ while strictly decreasing in γ and δ_D.

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