False Modesty*

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Abstract

Is it always wise to disclose good news? When both the sender and the receiver have private information about the sender's quality, we find that the worst sender type with good news has the most incentive to disclose it, so reporting good news can paradoxically make the sender look bad. If the good news is attainable by sufficiently mediocre types, or if the sender is already expected to be of a relatively high type, nondisclosure equilibria exist in which good news is withheld. Since the sender has a legitimate fear of looking too eager to reveal good news, having a third party disclose the news, or mandating that the sender disclose the news, can help the sender. The predictions are tested by examining when faculty use titles such as "Dr" and "Professor" in voicemail greetings and course syllabi.

Key words: disclosure, persuasion, communication, verifiable message, countersignaling
JEL codes: D82, C78

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La modestie va bien aux grands hommes. C'est de n'être rien et d'être quand même modeste qui est difficile.

– Jules Renard

Don't be humble, you're not that great.

– Golda Meir

1 Introduction

If you have good news should you disclose it? The standard answer is yes because otherwise people will skeptically assume that you have nothing favorable to report (Viscusi, 1978; Grossman and Hart, 1980; Grossman, 1981; Milgrom, 1981; Milgrom and Roberts, 1986). But in practice people are often unsure about whether to reveal good news, and nondisclosure is frequently observed. For instance, talented students are often reluctant to brag about their grades, highly educated people do not always list their degrees, some donors make anonymous donations, people sometimes withhold favorable arguments to avoid "protesting too much", overachievers often engage in understatement, firms do not always release positive earnings information, and advertisers of high quality products sometimes use a "soft sell" approach.

Most of the literature explains such anomalies by examining why the absence of good news is not always treated skeptically. Answers include that messages are costly (Viscusi, 1978; Jovanovic, 1983; Verrecchia, 1983; Dye, 1986), there are strategic reasons for withholding information (Dye, 1986; Okuno-Fujiwara et al., 1990; Giovannoni and Seidmann, 2002), the sender herself is not always fully informed (Dye, 1985; Farrell, 1986; Okuno-Fujiwara et al., 1990; Shin, 1994, 2003), or the receiver is naïve (Dye, 1998), uninformed (Fishman and Hagerty, 2003), or boundedly attentive (Hirshleifer et al., 2002).

While these approaches explain many cases of nondisclosure, they do not capture the idea that boasting about good news might itself be treated skeptically. To see how revealing good news can paradoxically make one look bad, we consider situations where the sender can reveal good news that is unambiguously favorable and perhaps even the best available, but still not impressive. When good news is relatively common, is boasting about it still a good idea? Or is boasting treated with such skepticism that modesty is the policy?

For instance, consider whether a restaurant should disclose its health department ratings. Starting in 1998, Los Angeles health officials began requiring restaurants to post large hygiene grades at their entrances, with a high proportion of grades being an A (see Jin and Leslie, 2003). Why was it necessary to require even A restaurants to disclose their grade? Suppose diners have their own opinions based on experience or reputation, so good restaurants tend to do well even without disclosure. In this case it is the worst restaurants within the A category who have the strongest incentive to prove that they meet basic hygiene standards. Given this incentive, disclosure of even an A grade can be interpreted by diners unfavorably.

Or consider whether a person with a PhD should use the title "Dr." In many environments PhDs are relatively rare so using a title is a strongly favorable signal of the person's professional credentials and we would expect titles to be used frequently. But in other environments, such as elite universities, PhDs are quite common. In more applied fields faculty interact frequently with non-academics so a PhD might still be worth boasting about, but in more theoretical fields most interactions are between people who expect each other to have the appropriate credentials. In such fields using a title might then be interpreted not just as redundant, but as a signal that the person fears being thought of as unqualified without the title.

To capture the intuition of these examples we relax the assumptions of the standard disclosure model in two ways. First, rather than assuming that only the sender has private information, we allow the receiver to also have private information about sender type. For instance, a diner has her own impression of restaurant quality based on personal experience. Second, rather than assuming that the sender can fully reveal her type with a verifiable message, we assume that the sender can only reveal a range within which her type falls. For instance, a restaurant cannot reveal its exact quality but can reveal its hygiene grade. Or a person can reveal having passed a test or having received a degree, but cannot reveal her exact ability.

With this added realism, we find that disclosure need not be the unique equilibrium. Instead, we find that a nondisclosure equilibrium surviving standard refinements always exists if good news is attainable by sufficiently mediocre types. For instance, in the case of restaurant hygiene cards, the system allows a high proportion of restaurants to receive an A. Similarly, the phenomenon of grade inflation means that a large proportion of moderately serious high school and college students receive primarily A grades. When the best news is attainable even by mediocre types, boasting about the news is not necessarily a positive sign so nondisclosure can be an equilibrium.

From a modelling perspective, these results imply that the standard assumptions of no private receiver information and existence of a verifiable message for each sender type require justification based on the particular situation. For instance, in auctions the seller and the buyers are all likely to have private information (Milgrom and Weber, 1982). The disclosure literature would seem to imply that the seller will reveal any verifiable information to buyers.[1] However, because the buyers have private information, our results imply that this intuition from disclosure games will hold only if the seller's verifiable information is sufficiently favorable or sufficiently fine.[2]

From an empirical perspective, the main testable implication of the model is that the frequency of nondisclosure should be negatively correlated with the rarity (or relative difficulty) of the good news. For instance, in the restaurant example if it became more difficult to receive an A then we would expect more disclosure. Even if the standard for good news does not change, the model predicts that the frequency of disclosure should be negatively correlated with any public signal that is positively correlated with sender type. That is, if the conditional distribution of sender types is weighted toward higher types because of a favorable public signal, then good news is no longer that impressive so disclosure is less likely. In contrast with many sender-receiver models, the predictions can therefore be readily tested using public information.[3]

Based on this implication, we test the model by looking at when PhDs use the title of "PhD",

[1] Information disclosure in auctions is important not just because it helps allocate the good more efficiently but because the "linkage principle" (Milgrom and Weber, 1982) implies that such disclosure will on average help the seller. For an analysis of how a seller can credibly reveal information when it is not verifiable, see Chakraborty et al. (2001).

[2] Bag (2003) shows that a sender will always reveal to all bidders the number of bidders in an auction. Since this number is exact, there is no contradiction with our results.

[3] In a signaling model the size of the signal is normally increasing in the sender's type which is the sender's *private* information. Since sender type is not known by the receiver it is typically not known by the econometrician, so empirical tests often use indirect methods to evaluate the theory (Bedard, 2001). Here we predict that understatement is more likely based on *public* signals of the sender's type.

"Dr" or "Professor" and when they forgo using such a title. In particular we look at the use of these titles in voicemail greetings and course syllabi by PhD-holding professors in the 26 economics departments in the University of California and California State systems. We predict that the use of titles will be more common in the 16 departments without doctoral programs than in the eight departments with doctoral programs for two reasons. First, the proportion of PhD-holding professors in the former group is lower and, until recent years, was substantially lower. Second, professors in the former group are less likely to be research-oriented and therefore more likely to have a higher proportion of their interactions with students and non-academics. For both these reasons, holding a PhD is more likely to represent "good news" for a typical professor in the departments without a doctoral program. We find that, for both voicemail greetings and syllabi, professors in departments with doctoral programs are significantly less likely to use a title.

The model offers insight into several policy issues. First is the long-standing question of when disclosure should be mandatory. The existence of nondisclosure equilibria implies that mandatory disclosure, or having a third party disclose the news, can reduce communication problems due to nondisclosure and to confusion over multiple equilibria.[4] Second is the question of how to set the difficulty of standards, e.g., school grades or other certificates of quality. The literature typically trades off the gains from forcing higher quality among those who meet the standard against the losses of lower rates of attainment (Costrell, 1994). Our model suggests that higher standards have the additional advantage of being less likely to induce a nondisclosure equilibrium. Third is the question of how fine or coarse standards should be, e.g., whether to use numerical grades or letter grades. We show that if the message space is sufficiently fine and accurately measures quality then full disclosure is the unique equilibrium. This follows from the standard "unravelling result" that types with the best news reveal it, so types with the next best news will also reveal it so as not to be thought of as even worse, and so on until all types reveal their information (Viscusi, 1978; Grossman and Hart, 1980; Grossman, 1981; Milgrom, 1981; Milgrom and Roberts, 1986; Okuno-Fujiwara et al., 1990).

Note that the definition of private receiver information includes cases where the receiver's information is not actually private but arrives after the sender's decision to disclose or not. Therefore the model applies to sender-receiver games where the sender has to decide on a disclosure policy before knowing the exact environment, e.g., a professor decides to use "Dr" on a namecard knowing that this same namecard will be handed out in many different situations where the receiver has different information about the professor. In some situations the namecard recipient will already have a high impression of the professor based on information that is public to both sides, while in other cases the public information will be less favorable. Since the professor must make a decision of how to print the namecard based on the likely distribution of the public information, the situation fits our model.

A related interpretation of our model is that the quality of the sender is correlated with how frequently the sender interacts with more "elite" receivers who expect the sender to have good news. For instance, the news that a person has a PhD makes a bigger impression on students and non-

[4] By allowing the sender to enjoy the benefits of favorable information without looking overly anxious to disclose it, such disclosure can also have positive incentive effects. For instance Jin and Leslie (2003) found that restaurant hygiene, as measured by inspectors and also as reflected in the incidence of food-related illnesses, improved after restaurants were forced to post their grades. Similarly, if students are reluctant to brag about their grades, then directly posting their grades ensures that the information is released, thereby increasing study incentives for students.

academics than it does on people who themselves have PhDs and interact mostly with other PhDs. Therefore using the title “Dr” reveals some favorable information about a person’s status, but at the same time it also suggests that the person is often in an environment where having a PhD is considered to be unusually good news. Because of these conflicting effects, the results of our model apply and nondisclosure equilibria can arise.

The idea that an eagerness to show off can reflect unfavorably on the sender was first formalized by Teoh and Hwang (1991) who analyzed a two-period game in which a firm decides whether or not to immediately disclose news that will eventually be made public anyway. They show that holding back on good news is a signal of confidence that hurts a firm temporarily, but eventually separates a high quality firm from a low quality firm which is less likely to have additional good news in the future.[5] Our approach differs in that we consider a standard disclosure game in which there is only one period and the receiver does not learn of news that is withheld.[6]

Since we allow the receiver to have some private information, the approach is similar to that of Feltovich et al. (2002) who analyze how private receiver information in signaling games can allow for “countersignaling” equilibria in which high types do not signal in order to show their confidence. The current paper differs in that we consider a disclosure game with a restricted message space of free and truthful messages, rather than a signaling game with an unrestricted space of increasingly expensive messages that depend on their cost for their credibility. The paper also differs in that we concentrate on pooling equilibria in which the fear of looking too anxious to disclose good news leads all types with the same news or worse news to not disclose. Equilibria in which medium types disclose while high types and low types do not disclose can also exist in disclosure games due to the existence of private receiver information, but depend more on specific distributional assumptions than do the monotonic nondisclosure equilibria that we concentrate on.

Despite these differences, the intuition is very close to that of countersignaling in that the fear of looking too anxious to show off leads high types to modestly withhold favorable information. The difference is that in the Feltovich et al. (2002) model senders who are of high quality based on their own private information are understated, while in this model senders who are already expected to be of high quality based on common knowledge information are understated. Therefore this model more clearly captures the simple intuition that those who are already thought to be of high quality are less likely to engage in self-promotion.

In addition to Teoh and Hwang (1991) and Feltovich et al. (2002), the question of understatement in sender-receiver games is investigated in several other papers. O’Neill (2002) shows how countersignaling can arise when multiple receivers have different information. Other models consider why signals might not be monotonically increasing in type when the costs and benefits of signals are viewed more generally, e.g., there are opportunity costs of education (Orzach and Tauman, 2005; Spence, 2001), or additional benefits of education from learning about one’s own abilities (Hvide, 2003). Understatement in one dimension can also arise when there are multi-dimensional signals,

[5] In addition to the assumption that the sender’s news is eventually revealed independently of the sender’s disclosure decision, Teoh and Hwang’s two-period game has two additional assumptions that reflect the institutional environment they consider. First, the sender receives a payoff both immediately after the choice to disclose and later after the original news and any additional news is revealed. The equilibrium depends on the rate at which the second payoff is discounted. Second, the sender’s news has a direct effect on sender payoffs beyond the usual indirect effect via receiver estimates of the sender’s type.

[6] Of course in many situations aspects of both games will be present. For instance, there might be a positive probability that the news will be released independently of the sender’s action. If for some reason this probability is increasing in the sender’s type, then worse senders will have more incentive to disclose than better senders.

e.g., the combination of high prices and modest advertising can signal high quality (Orzach et al., 2002), and the combination of high prices and low observable quality can signal high unobservable quality (Clements, 2002).[7]

In the following section we describe a simple model following the PhD example. In Section 3 we develop a model with multiple levels of good news that allows us to address more aspects of the problem. In Section 4 we provide an empirical test of the model based on how titles are used by academic economists and in Section 5 we conclude the paper.

2 An example

To see how private receiver information undermines the standard result that good news is disclosed, consider the example of an instructor (the sender) and a student (the receiver). For simplicity assume that instructor quality q is distributed uniformly on $[0, 1]$ and that the instructor's payoff is just her expected quality. Assume that instructors with quality above some cutoff q^* have a PhD while others do not. Instructors cannot directly reveal their quality q, but they can choose to reveal the less informative signal that they have a PhD if in fact they have one.

First consider the case where the student does not have any private information. If the student expects the instructor to reveal her PhD if she has one, then an instructor's payoff is $E[q \mid q \geq q^*] = (1+q^*)/2$ from disclosure but only $E[q \mid q < q^*] = q^*/2$ from nondisclosure. So clearly an instructor with a PhD is better off revealing it and disclosure is an equilibrium. Can nondisclosure also be an equilibrium without private receiver information? Since revealing good news is not expected, no information is disclosed by the absence of disclosure and the instructor's payoff is $E[q] = \frac{1}{2}$. Whether the instructor can do better by deviating depends on what the student believes if the instructor unexpectedly discloses. For instance, in the extreme the student might believe that the instructor is as low as type $q = q^*$ or as high as type $q = 1$. The equilibrium refinements literature argues that receiver beliefs should reflect the relative incentives of different types to deviate. In this example all types of instructors have an equal incentive to deviate for any payoffs they might receive, so the student has no reason to change her prior belief that the instructor's quality is distributed uniformly on $[q^*, 1]$.[8] Given such beliefs, the instructor's payoff from disclosure is, as before, $E[q \mid q \geq q^*] = (1 + q^*)/2$ which is greater than $E[q] = 1/2$ so all instructors will deviate and nondisclosure is not an equilibrium.

Now consider how this game changes if we allow the student to also have private information about the instructor's type. By private information, we mean information available to the student at the time of evaluating the instructor, but not known by the instructor at the time of making the disclosure decision. For instance, the student could form an impression of the instructor's ability over the course of the semester. Or the student could with some probability learn from another source whether or not the professor has a PhD. We are interested in cases where this information is noisy, so that the student learns something about the instructor, but does not learn so much that the disclosure decision is irrelevant.

[7] Dynamic principal-agent models where high types try to pool with low types, e.g., ratchet effect models (Weitzman, 1981), can also be thought of as capturing an incentive to be understated. Avoiding jealousy is of course another reason to be understated.

[8] Such beliefs are often referred to as passive beliefs or passive conjectures (Rasmusen, 1994). In the cheap talk literature such beliefs are the basis for neologism proofness (Farrell, 1993).

In particular, assume the student has a binary private signal L or H where $\Pr[H \mid q] = q$ so that the chance of an H signal is higher for better instructors.[9] This information does not affect the existence of the disclosure equilibrium in which types $q \geq q^*$ reveal their good news, but what about a nondisclosure equilibrium in which instructors never disclose their PhD? In such an equilibrium if the student has an H signal the instructor's expected quality is $E[q \mid H] = \int_0^1 q \Pr[H \mid q]dq / \int_0^1 \Pr[H \mid q]dq = 2/3$, and if the student has an L signal the instructor's expected quality is $E[q \mid L] = \int_0^1 q \Pr[L \mid q]dq / \int_0^1 \Pr[L \mid q]dq = 1/3$. Therefore, an instructor of type q has an expected payoff of $qE[q \mid H] + (1-q)E[q \mid L] = q\frac{2}{3} + (1-q)\frac{1}{3}$, which is increasing in q.

Since the expected payoff from disclosing is increasing in the instructor's type q, it is no longer clear that a student should react agnostically to an instructor who unexpectedly reveals having a PhD. For instance if $q^* = \frac{1}{3}$, then the worst type with a PhD ($q = q^*$) will deviate and announce their PhD if the payoff is greater than $\frac{1}{3}\frac{2}{3} + (1 - \frac{1}{3})\frac{1}{3} = 4/9$, while the best type with a PhD ($q = 1$) will do so only if the payoff is greater than $1\frac{2}{3} + (1-1)\frac{1}{3} = 2/3$. Since the worst instructor with good news will deviate for a wider range of rationalizable payoffs than other instructors, standard refinements say that more weight should be put on that type deviating. For instance, D1 says that all weight should be put on type $q = q^*$ (Cho and Kreps, 1987; Cho and Sobel, 1990; Ramey, 1996), implying that the payoff from deviating is 1/3. But when deviation is viewed so skeptically, the payoff from deviating is less than from nondisclosure, $1/3 < 4/9$, so nobody will deviate and the nondisclosure equilibrium survives.[10]

This is seen in Figure 1(a) where the return from nondisclosure is increasing in sender type. Among those who can disclose, for any q^* type $q = q^*$ receives the lowest payoff from nondisclosure so she has the most incentive to deviate. Therefore, as shown more formally in the next section, skepticism regarding types who unexpectedly disclose is appropriate based on standard belief refinements. Figure 1(b) shows the disclosure equilibrium for $q^* = 1/3$ in which all types with good news disclose, and Figure 1(c) shows a countersignaling equilibrium[11] for $q^* = 1/3$ in which only medium types within the range $[1/3, .885)$ disclose. The countersignaling equilibrium arises because the highest types expect to be partially separated from low types due to the receiver's private information. As seen in Figure 1(d), in this example the disclosure equilibrium offers all types $q \geq q^*$ a higher payoff, but in general the payoffs cannot be ranked.[12]

Given the multiplicity of equilibria, confusion over whether one should disclose, and who might have disclosed if disclosure is observed, is clearly understandable. With respect to deviations from the nondisclosure equilibrium, note that strong, D1-like refinements play the opposite role in this model than they do in standard signaling games. In particular, D1 always eliminates pooling equilibria in standard signaling games because better types have lower signaling costs so they are willing to deviate for a larger range of payoffs. In this model the presence of private receiver information and the absence of signaling costs reverses the incentives to deviate. Better types do not have any lower

[9] This structure can also capture the case where the student independently learns with some probability whether the instructor has a Ph.D. For instance H can represent the case where the student learns $q \geq q^*$ and L the case where the student learns nothing.

[10] The nondisclosure equilibrium also survives the Intuitive Criterion (Cho and Kreps, 1987) because any type is willing to deviate if it will be perceived as the best type by doing so, implying that no type can be ruled out as the source of a deviation.

[11] We use this terminology due to the equilibrium's similarity to the type of countersignaling equilibria emphasized by Feltovich et al. (2002) in signaling games.

[12] For instance if $\Pr[H \mid q] = q^3$, then some types $q \geq q^*$ prefer the nondisclosure equilibrium to the countersignaling equilibrium, and the highest types prefer the countersignaling equilibrium to the disclosure equilibrium.

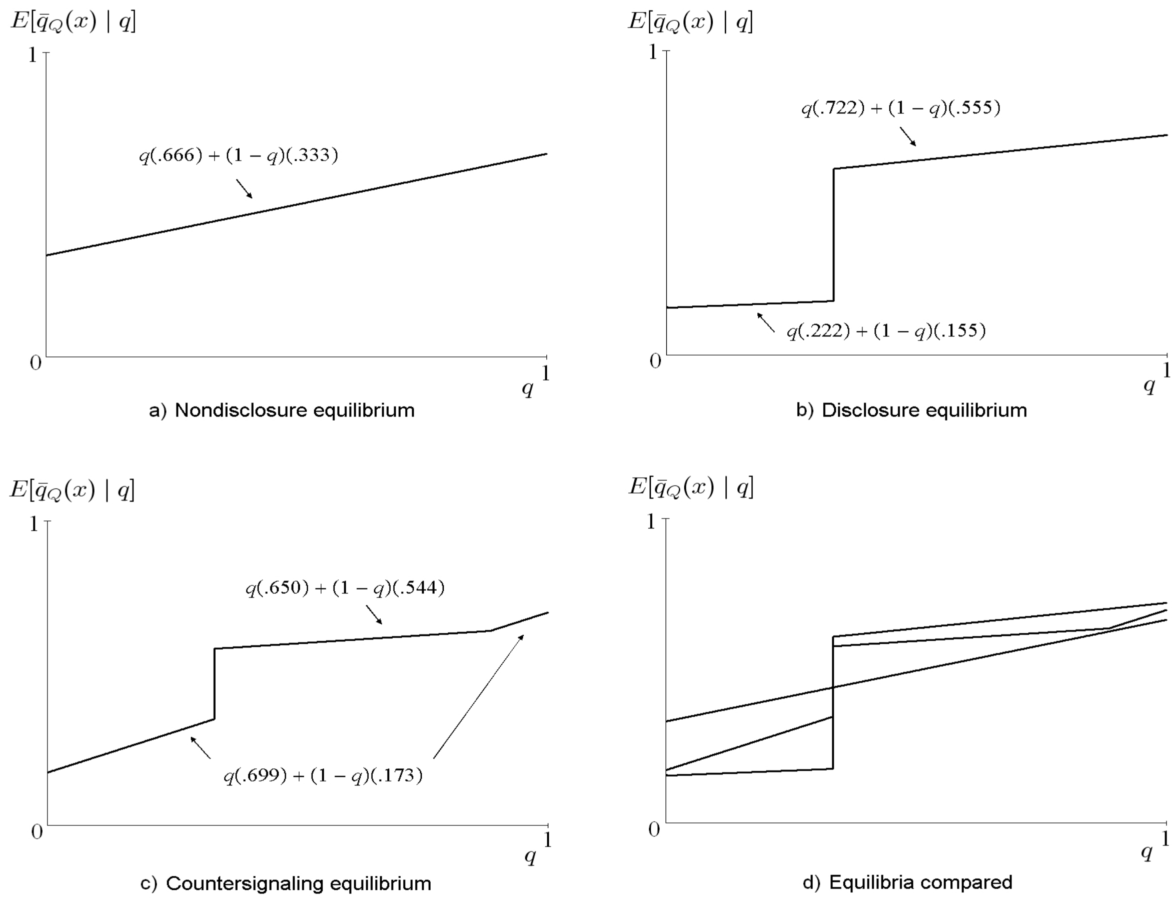

Figure 1: Expected payoffs as a function of q for different equilibria.

costs of disclosing so they are no more eager to deviate than worse types. Instead, because of the private receiver information, better types expect to be evaluated more favorably in the nondisclosure equilibrium, so they must be given a larger payoff to induce them to deviate. Therefore, skeptical beliefs are not just permitted under D1 but are actually *required*.[13]

As this simple example highlights, private receiver information changes disclosure games considerably when the sender's quality cannot be fully revealed by the verifiable message. As a result, the question is not just identifying conditions under which nondisclosure equilibria can exist, but finding reasonable conditions under which nondisclosure equilibria can be ruled out. For instance if the cutoff q^* for receiving a PhD is high enough then even if the student viewed disclosure of a PhD with complete skepticism and thought the instructor was of type q^*, the payoff from disclosure would still be higher than from nondisclosure. In the following section we develop a more general model with multiple levels of good news to examine when nondisclosure of some form is an equilibrium and when disclosure is the unique equilibrium.

[13] Feltovich et al. (2002) find that in the presence of private receiver information D1 can lose its power to ensure a unique equilibrium in signaling games. However, D1 still implies a unique equilibrium in signaling games if the private receiver information is not too important and signaling costs are decreasing in type at a sufficient rate. In disclosure games the role of signaling costs is not present so the effect of private receiver information dominates.

3 The model

In this sender-receiver game there are three sources of information: a nonverifiable signal $q \in [0,1]$ observed by the sender (the sender's type or quality), a nonverifiable signal $x \in X$ observed by the receiver, and a verifiable signal $v \in V$ observed by the sender. To ensure that the receiver's signal is informative about q, we assume that $X \subset \mathbb{R}$ has at least two elements and that the joint distribution $F(q,x)$ has full support on and displays strict affiliation on $[0,1] \times X$.[14] To allow analysis of how the varying coarseness of verifiable information affects disclosure, we assume that $V = \{v_1, \ldots, v_N\}$ where each element corresponds to a subinterval of the sender's typespace. In particular we assume that $P = \{q_0^*, q_1^*, q_2^*, \ldots, q_{N+1}^*\}$ defines a partition of $[0,1]$ into $N+1$ adjacent, non-empty, sub-intervals $[q_j^*, q_{j+1}^*)$ for $j = 0, 1, \ldots, N$ where $q_0^* = 0$ and $q_{N+1}^* = 1$.[15] Assume that $v = v_j$ if $q \in [q_j^*, q_{j+1}^*)$ for $j = 1, 2, \ldots, N$. Note that senders of type $q \in [0, q_1^*)$ have no verifiable information, i.e. the sender cannot verify the absence of any news.[16]

The timing of the game is the sender learns her private information q and verifiable signal v and then sends a message m. The receiver learns his private information x either before or after hearing the sender's message m. After learning x and hearing m the receiver takes an action a. We assume that the sender can send the message v or no message at all, so $m(q) \in \{v, \phi\}$ is the sender's message profile. We say a type "discloses" when it sends message v. For senders $q \in [0, q_1^*)$ without verifiable information $m(q) = \phi$. To simplify the presentation, we make the standard assumption that the receiver maximizes his payoff when the action a equals his estimate of the sender's type and that the sender's payoff equals this estimate. That is, we assume that the receiver's payoff function takes the quadratic loss form $u^R = -(q-a)^2$ and the sender's payoff function takes the linear form $u^S = a$.[17] Note that in this disclosure game neither x nor v has a direct impact on either player's payoff.[18] Their only influence is via the receiver's estimate of q and consequent action a.

We consider only pure strategy equilibria so a strategy is a mapping between types and messages. Let the function $\mu(q \mid x, m)$ be a conditional probability measure representing receiver beliefs about the sender's type given the message m and private information x. Our equilibrium concept is that of a pure-strategy perfect Bayesian equilibrium.

Definition 1 *A* pure-strategy perfect Bayesian equilibrium *is given by a verifiable message profile $m(q)$, a receiver action profile $a(x,m)$, and receiver beliefs $\mu(q \mid x, m)$ where:*

1. *For all q, $m(q) \in \arg\max_{m'} E[u^S(a(x,m')) \mid q]$;*
2. *For all x and m, $a(x,m) = \arg\max_{a'} E_\mu[u^R(q,a') \mid x, m]$;*
3. *$\mu(q \mid x, m)$ is updated from the sender's strategy and F using Bayes' rule whenever possible.*

[14] Affiliation, also known as total positivity of order 2, is a strong form of correlation (Milgrom and Weber, 1982).

[15] For notational convenience, throughout the paper we follow convention and ignore the open/closed set distinction for the final subinterval $[q_N^*, q_{N+1}^*]$.

[16] For instance, the sender has a certificate to prove they passed an exam but nothing to prove that they failed it.

[17] Based on Theorem 2 of (Athey, 2002), it can be shown that affiliation of x and q implies that our results hold as long as the receiver's payoff function $u^R(q,a)$ satisfies the single-crossing property and the sender's payoff function $u^S(a)$ is strictly increasing in a. The model can also be generalized to allow for messages and actions by multiple players following Okuno-Fujiwara et al. (1990).

[18] In this respect disclosure games are similar to cheap talk games Crawford and Sobel (1982). Disclosure games differ from cheap talk games in that the sender has verifiable messages.

Condition (1) requires that the sender's message is a best response to the receiver's expected actions. Condition (2) requires that the receiver's action is a best response to the sender's message. Condition (3) requires that for any information set that can be reached on the equilibrium path, the receiver's beliefs are consistent with Bayes' rule and the equilibrium sender strategy. We are often interested in the simple case where the receiver believes that a certain subset of types either disclose or do not disclose. Therefore we define the expected quality of the sender given x and given that the sender is believed to be in set $Q \subset [0,1]$ as $\bar{q}_Q(x) = E[q \mid x, q \in Q]$.

In this model it is always an equilibrium for all types who can disclose to disclose. The proof (and all subsequent proofs) is in the Appendix.

Proposition 1 *A full disclosure equilibrium always exists.*

In standard disclosure models without private receiver information and with a verifiable message for each type, full disclosure is the unique equilibrium due to "unravelling." Since types with the best news will always reveal it, types with the next best news will therefore also reveal it, and so on until all news has been revealed. In the example of Section 2 with only binary news, it was shown that unravelling in our model can fail at the very first step—even the types with the best available news might not reveal it. We are interested in conditions under which the best types will in fact reveal their news and, when their are multiple levels of news, how far unravelling will continue.

To this end, for any $0 < q' \leq q'' \leq 1$, define

$$q^\circ(q', q'', q) = \sup_Q \{E[\bar{q}_Q(x) \mid q] : [0, q') \subset Q \subset [0, q'')\}. \tag{1}$$

This can be interpreted as the maximum possible nondisclosure payoff for sender q given that the receiver believes senders $q < q'$ never disclose and senders $q \geq q''$ always disclose.[19] Note that $q^\circ(q', q'', q)$ is nonincreasing in q' since higher q' implies a tighter restriction on Q, and nondecreasing in q'' since higher q'' implies a weaker restriction on Q. And $q^\circ(q', q'', q)$ is strictly increasing in q since $E[\bar{q}_Q(x) \mid q]$ is strictly increasing in q for all non-singleton Q by strict affiliation of q and x.

No matter how skeptically the sender views disclosure, a sender who discloses v_j is at worst of type $q = q_j^*$. Therefore it would seem that for q_j^* large enough the sender will receive a higher payoff from disclosure than from any other outcome which involves pooling with lower types who cannot disclose. To see this define

$$\tilde{q}_j = \max\{q : q^\circ(q_1^*, q_{j+1}^*, q) = q\} \tag{2}$$

where the existence of $\tilde{q}_j$ follows from the fact that $q^\circ(q', q'', q)$ is continuous in q and falls in the range $[0, 1]$. This corresponds to the highest intersection between q and the highest payoff from nondisclosure when receiver beliefs are restricted to believing that types $q < q_1^*$ cannot disclose and types $q \geq q_{j+1}^*$ disclose.[20]

First consider the simplest case where $N = 1$. Since the worst possible payoff from disclosure is q_1^*, if $q_1^* > \tilde{q}_1$ the sender will do better from disclosure than from any possible payoff under

[19] This excludes cases where the receiver believes that the sender plays mixed strategies, but this is of no consequence as any expected mixed-strategy payoff can be attained through the appropriate choice of Q.

[20] Since $q^\circ(q', q'', q)$ is nondecreasing in q'', it follows from Theorem 1 of Milgrom and Roberts (1994) that $\tilde{q}_j$ is nondecreasing in j.

nondisclosure so disclosure is the unique equilibrium. For instance, from the example of Section 2, computations indicate that $\tilde{q}_1 = 0.52$. When there are more verifiable messages, clearly they will also be disclosed if the cutoff for each of them is above $\tilde{q}_N$, i.e. news v_j will be disclosed if $q_j^* > \tilde{q}_N$. Therefore the simplest sufficient condition for full disclosure to be the unique equilibrium is just $q_1^* > \tilde{q}_N$. In this case even the least impressive news is still better than no news at all.

We are interested in a weaker sufficient condition that gives a role for unravelling. If $q_N^* > \tilde{q}_N$ then types with the best news v_N will disclose, which means that the attractiveness of nondisclosure by types with news v_{N-1} decreases. So they will always disclose under the weaker condition that $q_{N-1}^* > \tilde{q}_{N-1}$. If they then disclose then this same logic applies to types with news v_{N-2}, etc. Because the $\tilde{q}_j$ are nondecreasing in j, unravelling implies that the standard for impressiveness becomes less strict as unravelling progresses from the best news down. For instance, if a Ph.D. is sufficiently rare that it is disclosed, then it becomes more likely that an M.A. is disclosed, in which case it is also more likely that a B.A. is disclosed.

The following proposition uses these arguments to show when any equilibrium must involve a certain degree of disclosure. Unlike the classic unravelling results, this proposition does not imply that full unravelling or even any unravelling at all will necessarily occur. Instead, it gives the conditions under which different levels of news are sufficiently favorable that they are always disclosed. Essentially it says that a given level of news will be disclosed if it is sufficiently impressive conditional on higher levels of news being disclosed because they too are sufficiently impressive.

Proposition 2 *If $q_k^* > \tilde{q}_k$ for all $k \geq j$ then in any equilibrium news $v \geq v_j$ is disclosed.*

This proposition shows that full disclosure can be an equilibrium if the verifiable news is sufficiently favorable. The following result extends the unravelling argument to show that full disclosure is the unique equilibrium if the verifiable information is sufficiently fine. When the verifiable messages separate the different types sufficiently well, the highest types have an incentive to disclose their (exceptionally) good news v_N even if they are thought of as being only of type q_N^* rather than from the range $[q_N^*, 1]$. Given that the highest types disclose v_N, the next highest types have an incentive to disclose v_{N-1} even under skeptical beliefs as well, and the unravelling continues until all news is disclosed.[21]

Proposition 3 *Given q_1^*, if the partition defined by P is sufficiently fine then full disclosure is the unique equilibrium.*

So far we have examined when full disclosure is the unique equilibrium or when any equilibrium must involve disclosure by those with sufficiently good news. Now consider nondisclosure. We expect that nondisclosure arises when q_j^* is relatively low so revealing good news is not so impressive. The following proposition shows that nondisclosure is an equilibrium if the standard for good news is insufficiently high. We look at the simplest case of a monotone nondisclosure equilibrium in which it is always the relatively bad news that is withheld. In particular, sufficient conditions are given on the size of q_j^* such that an equilibrium exists in which v_j and any worse news is not disclosed.[22] To

[21] Note that the proof is for a given q_1^*. Having some mass of the lowest types who never disclose even as the partition becomes finer is necessary to ensure that disclosure eventually dominates nondisclosure for higher types.

[22] In general nondisclosure behavior need not be monotonic in v and moreover, given a particular v_j, need not even be monotonic within Q_j as seen from the countersignaling equilibrium in Section 2.

see this, let $\hat{q}_j$ be given by

$$\hat{q}_j = \min\{q : E[\bar{q}_{[0,q^*_{j+1})}(x) \mid q] = q\} \tag{3}$$

where the existence of $\hat{q}_j$ follows from the fact that $E[\bar{q}_{[0,q^*_{j+1})}(x) \mid q]$ is continuous in q and falls in the range $[0, 1]$.[23]

Proposition 4 *If $q^*_j \leq \hat{q}_j$ then an equilibrium in which news $v \leq v_j$ is not disclosed exists and survives both the Intuitive Criterion and D1.*

Note that this result implies that a full nondisclosure equilibrium exists if $q^*_N < \hat{q}_N$. In the example of the Section 2 where $N = 1$, $\hat{q}_1$ is just the point where the minimum assured payoff from disclosure equals the expected payoff from nondisclosure. This is the intersection of the nondisclosure payoff line in Figure 1(a) with the 45° line, or $\hat{q}_1 = 1/2$. Because $\tilde{q}_j$ allows for a wider range of receiver beliefs than $\hat{q}_j$, in general $\hat{q}_j \leq \tilde{q}_j$ so that the condition from Proposition 2 assuring that disclosure is the unique equilibrium is stricter than the condition from this proposition assuring existence of a nondisclosure equilibrium. This reflects the fact that both conditions are sufficient rather than necessary,[24] and that there may be other more complex equilibria such as countersignaling equilibria.[25]

Regarding refinements, the nondisclosure equilibria examined in Proposition 4 assume that the receiver skeptically believes that a sender who deviates from nondisclosure is of the lowest type who could deviate. So the question is whether such beliefs are reasonable based on "forward induction" arguments about which types have the strongest incentive to deviate. The most common refinements that restrict beliefs on this basis are the Intuitive Criterion and D1-like refinements. The Intuitive Criterion states that the receiver should put zero probability on a type having deviated if it would not benefit from deviation under the most favorable possible beliefs about who deviates. Clearly the Intuitive Criterion does not restrict any type from disclosing since every type would be very happy to disclose if they would be thought of as the highest type by doing so. So skeptical beliefs supporting a nondisclosure equilibrium cannot be ruled out. D1 states that if one type benefits from deviation for a smaller set of rationalizable payoffs than another type, zero weight should be put on the first type (Cho and Kreps, 1987; Cho and Sobel, 1990; Ramey, 1996). In a nondisclosure equilibrium higher types expect to be evaluated more favorably than lower types because of the private receiver information, so they must be given a larger payoff to induce them to deviate. Therefore, not only does D1 have no power to refine away the nondisclosure equilibrium, it actually reinforces it by dictating that *out-of-equilibrium actions must be viewed skeptically.*

Proposition 2 shows that if standards are set high enough then nondisclosure cannot be an equilibrium. Proposition 4 shows that if standards are set low enough then nondisclosure is always an equilibrium. The following proposition uses these results to show how the distribution of sender types affects the potential for nondisclosure equilibria. In particular it shows that if there is any common knowledge information that makes the conditional distribution more favorable, then the

[23] Since $E[\bar{q}_{[0,q^*_{j+1})}(x) \mid q]$ is strictly increasing in j, it follows from Theorem 1 of Milgrom and Roberts (1994) that $\hat{q}_j$ is strictly increasing in j.

[24] The necessary condition for a monotone nondisclosure equilibrium just replaces min with max in equation (2) and has the same properties as $\hat{q}_j$.

[25] When $N = 1$, q is distributed uniformly, and X is binary, it can be shown that a countersignaling equilibrium exists in which types $q \in [q^*_1, q']$ disclose while types $q \in (q', 1]$ do not for some $q' \in (q^*_1, 1)$ if $q^*_1 < \hat{q}_1$. Moving beyond this special case, sufficient conditions for such equilibria are difficult to attain.

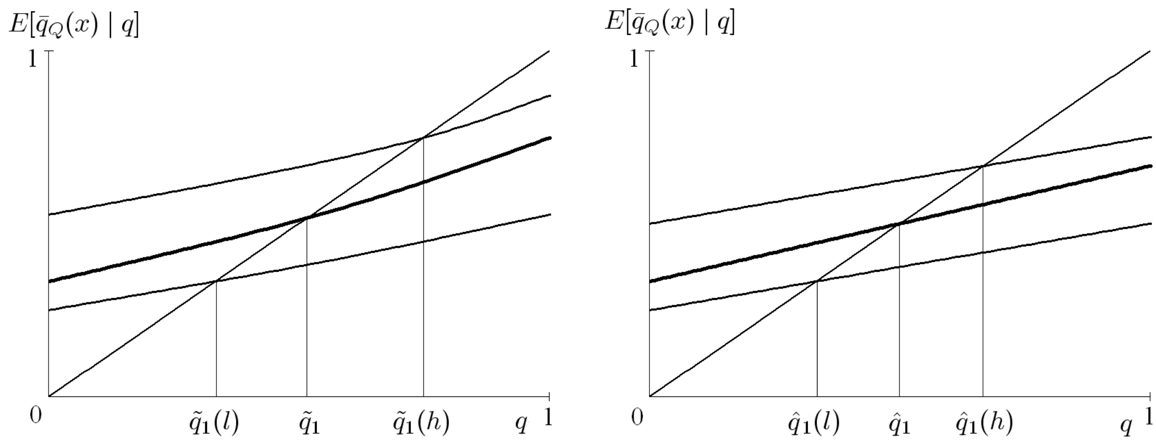

Figure 2: Impact of extra information y on $\tilde{q}_1$ and $\hat{q}_1$.

conditions for the uniqueness of disclosure equilibria become stricter and the conditions for the existence of nondisclosure equilibria become less strict. It then shows that if this information is sufficiently favorable then the existence of nondisclosure equilibria is assured, while if it is sufficiently unfavorable then any equilibrium involves some disclosure.

Proposition 5 *Let y be a random variable that is common knowledge. (i) If y is strictly affiliated with q then $\tilde{q}_j$ and $\hat{q}_j$ are strictly increasing in y. (ii) If $F(q_j^* \mid y)$ is sufficiently large then news $v > v_j$ is disclosed in any equilibrium. (iii) If $F(q_j^* \mid y)$ is sufficiently small then an equilibrium surviving the Intuitive Criterion and D1 exists in which news $v \leq v_j$ is not disclosed.*

Note that part (ii) implies that full disclosure is the unique equilibrium if the information y is so unfavorable about the sender that $F(q_N^* \mid y)$ is sufficiently large, and part (iii) implies that full nondisclosure is an equilibrium if the extra information y is so favorable that $F(q_1^* \mid y)$ is sufficiently small.

One way to test the model is through observing how behavior changes when q_j^* changes. For instance, in the restaurant example if grading standards change so that an A becomes more common then that is equivalent to q_N^* decreasing. This makes it less likely that $q_N^* > \tilde{q}_N$ so that disclosure is assured, and more likely that $q_N^* < \hat{q}_N$ so that a nondisclosure equilibrium exists. Alternatively, Proposition 5 shows that, even if standards do not not change, $\tilde{q}_j$ and $\hat{q}_j$ change based on any public information. For example, the public information might be whether or not a faculty member works at an elite university. The more favorable is this public information the higher are $\tilde{q}_j$ and $\hat{q}_j$, so the less likely it is that $q_j^* > \tilde{q}_j$ and the more likely it is that $q_j^* < \hat{q}_j$.

To see how public information produces testable implications of the model, consider the example from Section 2 where $N = 1$ and assume there is an additional signal $y \in \{l, h\}$ where $\Pr[y = h \mid q] = q$ and y is independent of x conditional on q. If $y = h$ ($y = l$) is observed by both the sender and receiver, then the distribution of types conditional on this information is weighted upwards (downwards), so for any non-degenerate Q, $E[\bar{q}_Q(x) \mid q, y = h] > E[\bar{q}_Q(x) \mid q] > E[\bar{q}_Q(x) \mid q, y = l]$, thereby implying $\tilde{q}_1$ and $\hat{q}_1$ are higher for $y = h$ and lower for $y = l$ as shown in Proposition 5(i). Figure 2 shows $\tilde{q}_1$ and $\hat{q}_1$ for the example from Section 2. The left panel shows the highest possible payoff to nondisclosure for any receiver beliefs about who discloses, and the right panel shows the payoff to nondisclosure when no types are expected to disclose. In each case the middle line is for the base case without extra public information, the top line is when $y = h$, and the bottom line is when $y = l$. The point where these lines intersect the 45° line determine $\tilde{q}_1$ and $\hat{q}_1$. When $y = l$ the receiver starts with such a low opinion of the sender that there is a good chance that $q_1^* > \tilde{q}_1$ so the sender will always disclose even relatively mediocre news. But when $y = h$ the receiver starts with a more favorable opinion and there is a good chance that $q_1^* < \hat{q}_1$ so that nondisclosure is an equilibrium.

4 Empirical test

We now examine a simple test of the model's predictions following the example of title usage discussed in the introduction. In particular we are interested in when professors use the title "Dr", "PhD", or "Professor" and when they go by their names alone. This decision arises in many contexts including curricula vitae, business cards, office doors, web sites, email signatures, etc. We have chosen to look at two cases where a sufficiently large sample is obtainable and where the choice is likely to be completely within the control of the professor—office voicemail greetings and class syllabi.

To minimize regional variation we look at all state universities in California, and to minimize the impact of different traditions in different disciplines we restrict attention to economics departments. In particular we consider tenure-track faculty (assistant, associate, and full professors which we refer to collectively as "faculty") with PhDs at all 26 universities in the University of California and California State University systems with economics departments.[26] Eight of these have doctoral programs ("doctoral universities") and 18 do not ("non-doctoral universities").[27]

Excluding faculty whose web pages indicated a primary position in another department, office, institute, or university, in total we consider 430 professors, 226 at doctoral universities and 204 at non-doctoral universities. In many cases voicemail was not working, was automated without a personal greeting, or was recorded by a secretary. We were able to obtain usable voicemail greetings data for about three-fifths of the faculty in both doctoral and non-doctoral universities. For course syllabi we followed links available on faculty pages and used the first listed undergraduate syllabus.[28] Many faculty did not have links to syllabi or their syllabi were password protected. We were able to obtain syllabi for about half of the faculty at doctoral universities and about a third of the faculty at non-doctoral universities.

Proposition 5 provides formal support for the intuition that faculty are most likely to use titles when their status as a PhD or a professor represents more positive news relative to expectations. In non-doctoral universities it was once common for many faculty to not have a PhD, while in doctoral universities it has long been standard in most disciplines for almost all faculty to have a PhD.[29]

[26] We excluded from the analysis one university which listed only one regular faculty member (the chair) in the economics department.

[27] We make this distinction based only on the presence of a doctoral program in economics. Many of the "non-doctoral universities" have doctoral programs in other fields.

[28] When a syllabus for a given class was in multiple formats, we chose the format most likely to be handed out in class, e.g., the .pdf or .doc format over the .html format.

[29] As recently as 1987 the fraction of all full-time faculty with PhDs at non-doctoral universities in the sample averaged only 72%. At this same time at least 95% of the full-time faculty at each doctoral university in the sample had a PhD. Numbers are from *America's Best Colleges*, 1988 edition, by *US News and World Report*.

	Non-Doctoral Universities	Doctoral Universities
Title	33	5
No Title	87	125
Fisher Exact		p<.0001
Wilcoxon-Mann-Whitney		p<.0005
Robust Rank Order		p<.0005

Voicemail

	Non-Doctoral Universities	Doctoral Universities
Title	54	65
No Title	15	59
Fisher Exact		p<.0005
Wilcoxon-Mann-Whitney		p<.05
Robust Rank Order		p<.05

Syllabus

Table 1: Differential use of titles in economics departments.

Similarly, many faculty at non-doctoral universities are part-time lecturers, while almost all faculty at doctoral universities are full-time faculty members.[30] Therefore, in terms of Proposition 5, we can think of being at a non-doctoral university as an unfavorable signal y that lowers expectations, and of being at a doctoral university as a favorable signal y that raises expectations. As illustrated in Figure 2, these differential expectations imply that faculty in non-doctoral universities will be more likely to advertise good news about themselves.

Table 1 provides evidence that is consistent with this prediction. For voicemail greetings, the use of a title is far more common at non-doctoral universities. Overall about 27% of faculty use a title at non-doctoral universities while less than 4% use a title at doctoral universities. In syllabi a similar pattern holds. More than 78% of faculty at non-doctoral universities use either title while only about 52% do at doctoral universities.[31]

The differences in faculty behavior at doctoral and non-doctoral universities presented in Table 1 are all highly significant under the assumption that each professor's behavior is independent. Looking at the one-sided p-values generated by the non-parametric Fisher exact test, $p < 0.0001$ for different use of a title in voicemail greetings and $p < 0.0005$ for different use of a title in syllabi. However, the assumption of independence is strong because there may be university- or department-specific factors that push all professors in a department in one or another direction. For instance, since there are multiple equilibria in our model, it may simply be "focal" for professors in a department to present themselves in a certain way.

To allow for this possibility, we drop the independence assumption at the university level and treat each university as a single data point. To do this we consider the fraction of the professors in each university who use a title and rank these fractions across universities. The non-parametric Wilcoxon-Mann-Whitney test generates p-values for the null hypothesis that there are no differences in these fractions between doctoral and non-doctoral universities. Looking at these one-sided values, $p < 0.0005$ for different use of a title in voicemail greetings, and $p < 0.05$ for different use of a title in syllabi. A problem with this test is that it assumes the underlying distributions (higher order

[30] In 2003 the percent of all faculty that were full-time ranged from 64% to 83% at non-doctoral universities in the sample, and from 89% to 94% at doctoral universities in the sample. Numbers are from *America's Best Colleges*, 2004 edition, by *US News and World Report*.

[31] We do not have a theory for which particular titles faculty will use. Empirically, faculty at doctoral universities have a strong tendency to substitute "Professor" for "Dr" and "PhD." Only one faculty member used "Dr" or "PhD" in a voicemail greeting and only one used such a title in a syllabus. In contrast, at non-doctoral universities 10 faculty used such a title in voicemail greetings and 29 faculty used such a title in syllabi.

moments) are the same. Hence it can reject the null hypothesis based on differences in variances even if the means are not significantly different. We therefore consider the robust rank-order test which requires only that the distributions be symmetric. Continuing to look at one-sided p-values for the null hypothesis of no differences between title usage in doctoral and non-doctoral universities, we again find that $p < 0.0005$ for voicemail greetings and $p < 0.05$ for syllabi.[32]

It may seem that an alternative explanation for the differences in voicemail greetings is that the likely callers at doctoral and non-doctoral universities are different. For instance a caller to a doctoral university is probably more likely to be a professor who expects that the answerer is also a professor with a PhD. As explained in the introduction, our model incorporates such cases where the sender determines a disclosure decision in knowledge of the likely distribution of receivers. If callers to a doctoral university have a higher expectation that the answerer is a professor with a PhD this is equivalent to there being more favorable public information about the seller as examined in Proposition 5. In particular, as explained in the introduction, the model can be interpreted as the caller using information from the professor's greeting to estimate how frequently the professor receives calls from students and from professors under the assumption that higher quality professors receive more calls from other professors.

An alternative explanation for the differences in both voicemail greetings and syllabi is that using a title is not entirely costless so it is not worthwhile for professors at doctoral universities to use titles given their small information content. However, in many cases a simple title is as easy or easier to state than other formulations. For instance, in voicemail greetings faculty often inform the listener that "you have reached the office of X" in place of simply stating "this is Professor X." And in course syllabi faculty often substitute "Instructor" for "Professor." Moreover, failure to use a title is itself costly in terms of misunderstandings by poorly informed students and others.[33] If it were not for the negative inferences that can arise from promoting one's own status, it seems unlikely that so many professors would avoid titles.[34]

5 Conclusion

A large body of research in accounting, finance, and economics concludes that costless disclosure of good news should benefit the sender. In this paper we consider a standard disclosure game assuming that good news does not fully reveal the sender's quality and that the receiver also has private information about sender quality. We show that the presence of *any* private receiver information, no matter how weak, implies that equilibria with nondisclosure by some or all types exist unless the good news is restricted to sufficiently high quality senders. From a policy perspective the model supports the setting of higher and more finely distinguished standards in order to reduce the scope for nondisclosure equilibria. It also provides support for mandatory or third-party disclosure of

[32] For voicemail greetings, $\grave{U} = -6.357$, $m = 8$, and $n = 18$. For class syllabi, $\grave{U} = -2.009$, $m = 8$ and $n = 17$. Critical values are from Feltovich (2005).

[33] For instance, use of "Assistant Professor" on a syllabus has been known to induce unhappy students to demand to see the "real" professor.

[34] Consistent with the result that disclosure by a third party does not suffer from the same problems as self-promotion, faculty seem happy to let others refer to them by titles. In the 23 instances of voicemail greetings recorded by staff, either "Dr" or "Professor" was used 13 times, and there was no difference between usage in doctoral and non-doctoral universities. Similarly, faculty don't seem to object to the use of titles on department pages for faculty, but usually avoid them on their own home pages. Because of the difficulty of determining the authorship of home pages, we did not formally analyze this difference.

information as a way to reduce the damage that "false modesty" can have on communication.

Appendix

Proof of Proposition 1: In the full disclosure outcome the receiver believes the sender to be of type $q \in [0, q_1^*)$ when nondisclosure is observed and of type $q \in [q_j^*, q_{j+1}^*)$ when message v_j is observed. Therefore, since $\bar{q}_{[q_j^*, q_{j+1}^*)}(x) > \bar{q}_{[0,q_j^*)}(x)$ for all x, $E[\bar{q}_{[q_j^*, q_{j+1}^*)}(x) \mid q] > E[\bar{q}_{[0,q_j^*)}(x) \mid q]$ for all $q \in [q_j^*, q_{j+1}^*)$, so full disclosure is an equilibrium. ■

Proof of Proposition 2: Starting with the highest types, if $q_N^* > \tilde{q}_N$ then types $q \in [q_N^*, 1]$ strictly prefer to disclose v_N by the definition of $\tilde{q}_N$. In this case if $q_{N-1}^* > \tilde{q}_{N-1}$ then types $q \in [q_{N-1}^*, q_N^*)$ strictly prefer to disclose v_{N-1} by the definition of $\tilde{q}_{N-1}$. The unraveling continues until types $q \in [q_j^*, q_{j+1}^*)$ disclose v_j. ■

Proof of Proposition 3: Let $P_i = \{q_{i,1}^*, q_{i,2}^*, \ldots q_{i,N_i}^*, q_{i,N_i+1}^*\}$ define a partition of $[0, 1]$ where $q_{i,1}^* = q_1^*$ and $q_{i,N_i+1}^* = 1$ for any i. Let the sequence $(P_i)_{i=1}^{\infty}$ be such that if $i > i'$, $P_{i'} \subsetneq P_i$ and $\lim_{i\to\infty} \max_j \{q_{i,j}^* - q_{i,j+1}^*\} \to 0$.

Since $\lim_{i\to\infty} \max_j \{q_{i,j}^* - q_{i,j+1}^*\} \to 0$, there is some i_1 such that $q_{i_1,N_{i_1}}^* > q^\circ(q_1^*, 1, 1)$. Moreover, for any $i > i_1$, $q_{i,N_i}^* > q^\circ(q_1^*, 1, 1)$. Let $z_1 = \min_j \{q_{i_1,j} \mid q_{i_1,j} > q^\circ(q_1^*, 1, 1)\}$. It follows that for any $q_{i_1,j} \geq z_1$, if $q \in [q_{i_1,j}^*, q_{i_1,j+1}^*)$ then $E[\bar{q}_{[q_{i_1,j}^*, q_{i_1,j+1}^*)}(x) \mid q] > q^\circ(q_1^*, 1, 1)$ so that all senders with $q \geq z_1$ strictly prefer to disclose.

Following the above arguments, there is some $i_2 \geq i_1$ such that there is some j where $q^\circ(q_1^*, 1, 1) > q_{i_2,j} > q^\circ(q_1^*, z_1, z_1)$. Let $z_2 = \min_j \{q_{i_2,j} \mid q_{i_2,j} > q^\circ(q_1^*, z_1, z_1)\}$. It follows that for any $q_{i_2,j} \in [z_2, q^\circ(q_1^*, 1, 1))$, if $q \in [q_{i_2,j}^*, q_{i_2,j+1}^*)$ then $E[\bar{q}_{[q_{i_2,j}^*, q_{i_2,j+1}^*)} \mid q] > q^\circ(q_1^*, z_1, z_1)$ so that all senders with $q \geq z_2$ strictly prefer to disclose.

Repeat for $k = 3, 4, \ldots$ until $z_k = q_1^*$. Since $[0, q_1^*)$ has positive mass, this must happen for finite k. Denote the stopping point as K. For any $i \geq i_K$, the partition defined by P_i will be such that if $q \geq q_1^*$ then $E[\bar{q}_{[q_{i,j}^*, q_{i,j+1}^*)} \mid q] > q^\circ(q_1^*, q_1^*, q_1^*)$ so that all senders with $q \geq q_1^*$ strictly prefer to disclose. ■

Proof of Proposition 4: Consider the particular equilibrium in which news $v \leq v_j$ is not disclosed while news $v > v_j$ is disclosed. First consider senders $q \in [q_k^*, q_{k+1}^*)$ for $k \leq j$. Assume that following an unexpected disclosure of v_k for $k \leq j$, the receiver skeptically believes that $\mu(q \mid x, v_k) = 0$ for $q > q_k^*$. This yields the lowest possible out of equilibrium payoff of q_k^*. Since $q_k^* \leq \hat{q}_j$, it follows by the definition of $\hat{q}_j$ that $E[\bar{q}_{[0,q_{j+1}^*)}(x) \mid q = q_k^*] \geq q_k^*$. Since $E[\bar{q}_{[0,q_{j+1}^*)}(x) \mid q]$ is strictly increasing in q it then follows that $E[\bar{q}_{[0,q_{j+1}^*)}(x) \mid q] \geq q_k^*$ for all $q \in [q_k^*, q_{k+1}^*)$. Therefore the payoff from nondisclosure is weakly more than the payoff from disclosure of v_k.

Now consider senders $q \in [q_k^*, q_{k+1}^*)$ for $k > j$. The expected equilibrium payoff from disclosure for these senders is bounded below by $q_k^* \geq q_{j+1}^*$, while the expected nondisclosure payoff is strictly bounded above by q_{j+1}^*. Therefore the payoff from nondisclosure is strictly less than the payoff from disclosure of v_k and the proposed equilibrium holds.

Regarding the Intuitive Criterion, the question is whether the beliefs $\mu(q \mid x, v_k) = 0$ for $q \in (q_k, q_{k+1})$ and $k \leq j$ are permissible based on the criterion. The least upper-bound on the out-of-equilibrium payoff to a sender of type $q \in [q_k^*, q_{k+1}^*)$ is q_{k+1}^*. That is, for out-of-equilibrium beliefs that put sufficient weight on the upper end of $[q^*_k, q^*_{k+1})$, the sender's payoff can be made arbitrarily close to q^*_{k+1}. Let $\bar{Q} = \{q \in [q^*_k, q^*_{k+1}) : E[\bar{q}_{[0,q^*_{j+1})}(x) \mid q] \geq q^*_{k+1}\}$. If $\bar{Q} = [q^*_k, q^*_{k+1})$ then no type would ever deviate under the most favorable beliefs so there is no restriction on beliefs. If, however, $\bar{Q} \neq [q^*_k, q^*_{k+1})$, then the Intuitive Criterion requires out-of-equilibrium beliefs must put zero probability on the event that a sender of type $q \in \bar{Q}$ deviated by disclosing v_j. Therefore, for the equilibrium to fail the Intuitive Criterion, it must be that $q^*_k \in \bar{Q}$ and $\bar{Q} \neq [q^*_k, q^*_{k+1})$. However, since $E[\bar{q}_{[0,q^*_{k+1})}(x) \mid q]$ is increasing and continuous in q, if $\bar{Q}$ is nonempty, it must be an interval of the form $[\bar{q}, q^*_{k+1})$ for some $\bar{q}$ so this is impossible.

Regarding the D1 refinement, under D1 beliefs must put zero weight on any type which is willing to deviate for a strictly smaller range of rationalizable payoffs than another type. Since $E[\bar{q}_{[0,q^*_{k+1})}(x) \mid q]$ is strictly increasing in q, the set of rationalizable payoffs that dominate a sender's equilibrium nondisclosure payoff is either empty or is the interval $[E[\bar{q}_{[0,q^*_{k+1})}(x) \mid q], q^*_{k+1})$. Since $E[\bar{q}_{[0,q^*_{k+1})}(x) \mid q]$ is increasing in q, this set is largest for type $q = q^*_k$, so D1 implies skeptical beliefs where $\mu(q \mid x, d) = 0$ for all $q > q^*_k$. ■

Proof of Proposition 5: (i) Regarding $\tilde{q}_j$, strict affiliation implies that $E[\bar{q}_Q(x) \mid q, y]$ is strictly increasing in y for all non-singleton Q. Therefore $\sup_Q\{E[\bar{q}_Q(x) \mid q, y] : [0, q') \subset Q \subset [0, q'')\}$ is strictly increasing in y, so $q^\circ(q', q'', q)$ is strictly increasing in y. Since $q^\circ(q', q'', q) - q$ is continuous in q and $q^\circ(q', q'', q) \in [0, 1]$ for all q and y, the conclusion follows directly from Theorem 1 of Milgrom and Roberts (1994). Similarly, regarding $\hat{q}_j$, $E[\bar{q}_{[0,q^*_{j+1})}(x) \mid q, y] - q$ is continuous in q and strictly increasing in y and $E[\bar{q}_{[0,q^*_{j+1})}(x) \mid q, y] \in [0, 1]$ for all q and y. So again the conclusion follows directly from Theorem 1 of Milgrom and Roberts (1994). (ii) The question is whether, if the mass of F is sufficiently concentrated below a given q^*_j, it is assured that $\tilde{q}_j < q^*_j$. Consider the set of $\tilde{q}_j$ arising from the partition defined by P. If $F(q^*_j \mid y)$ is sufficiently close to 1, $q^\circ(q^*_1, q^*_{j+1}, q) < q^*_j$ for all q since there is full support and nearly all of the mass is below q^*_j. Thus $\tilde{q}_j < q^*_j$. (iii) The question is whether, if the mass of F is sufficiently concentrated above a given q^*_j, it is assured that $\hat{q}_j > q^*_j$. Consider the set of $\hat{q}_j$ arising from the partition defined by P. If $F(q^*_j \mid y)$ is sufficiently close to 0, $E[\bar{q}_{[0,q^*_{j+1})}(x) \mid q] > q^*_j$ for all q since there is full support and nearly all of the mass is above q^*_j. Thus $\hat{q}_j > q^*_j$. ■

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