False Modesty When Disclosing Good News Looks Bad

Richmond Harbaugh, Theodore To

Journal of Mathematical Economics 87 (2020) 43-55

1 Introduction

- If you have good news should you disclose it?
- To prevent the perception of worse news, disclosure of mediocre or even bad news is also necessary under the classic "unraveling" result (Viscusi, 1978; Grossman and Hart, 1980; Grossman, 1981; Milgrom, 1981; Milgrom and Roberts, 1986; Okuno-Fujiwara et al., 1990).
- However, people are sometimes unsure whether to reveal good news, and nondisclosure is often observed in practice (Jin, 2005; Xiao, 2010; Luca and Smith, 2015).

- Literature explains these anomalies by examining why the absence of good news does not indicate bad news. What if boasting about good news is considered bad?
  - Consider whether a restaurant should post its hygiene grade from the local health department. According to the unraveling result, all restaurants should post voluntarily, but many, including A grades, choose not to (Bederson et al., 2018).
  - These same concerns are faced by individuals. For instance, in environments where titles such as “Dr,” “Professor,” or “PhD” are common. Even though it is costless to use a title, many faculty actively avoid them, for example substituting “instructor” for “professor” on course syllabus.

- Our analysis of a costless disclosure game with a continuum of sender types and a finite set of verifiable messages explains why boasting about good news can be weak. Using noisy private receiver information about sender type, we show that the classic unraveling result is not robust.

- We develop a new statistical dominance condition that shows when private receiver information indicates that the net gain from disclosure is decreasing as the sender's type increases.

- Supposing that the standard for good news is sufficiently low or that the prior distribution of sender types is sufficiently favorable, such skepticism implies a nondisclosure equilibrium.
    - It is analogous to the behavior in a (costly) signaling game (Feltovich et al., 2002) that lower types that meet the standard disclose, while higher types who could disclose choose not to disclose.
- Best response dynamics converge to the different equilibria depending on initial behavior.
- We find three sufficient conditions that guarantee unraveling up until some point in any equilibrium, including full unraveling.

- First is the long-standing question of when disclosure should be mandatory.
  - The existence of multiple equilibria implies that if senders and receivers fail to coordinate on an informative equilibrium, mandatory disclosure can help reveal information.
- Second is the issue of how difficult it should be to meet different standards, such as those for school diplomas.
  - Higher standards can paradoxically induce higher certification rates because nondisclosure or countersignaling equilibrium is less likely.

- Third, the model offers new insight into how fine or coarse standards should be.
  - According to our results, senders are hesitant to disclose good news, unless disclosure is mandated.
- Finally, the model shows that nondisclosure and countersignaling equilibria can exist based on observable properties of common knowledge distributions.
  - We predict that higher quality senders are less likely to engage in costless self-promotion.

- Failure of unraveling in disclosure games can be explained by the absence of good news not leading to bad news inferences. Reasons include that：
  - messages are costly (Viscusi, 1978; Verrecchia, 1983; Dye, 1986; Levin et al., 2009)；
  - uncertainty over whether the sender has any news (Dye, 1985; Farrell, 1986; Shin, 2003)；
  - the receiver does not fully understand the game (Dye, 1998; Fishman and Hagerty, 2003; Hirshleifer et al., 2004)；
  - not a complete ordering of "good news" (Seidmann and Winter, 1997; Giovannoni and Seidmann, 2007; Mathis, 2008);
  - high quality may not optimally position a product (Board, 2009; Celik, 2014).

2 Related Literature

- It was Teoh and Hwang (1991) who first explored how different information sources can interact to encourage nondisclosure in a two-period game.
- According to Feltovich et al. (2002), private receiver information can lead to a countersignaling equilibrium where only medium types signal.
- Daley and Green (2014) vary the strength of the private receiver information to analyze when full separation or pooling occurs.
- Alós-Ferrer and Prat (2012) investigate this question by varying the rate at which learning about sender type occurs independent of the signal.

- We differ from these approaches in our focus on costless disclosure in a standard one-period disclosure game.
- We also differ from the related disclosure and signaling literature in that we consider a continuum of sender types.
- In our model, nondisclosure by higher types is driven instead by the ex post decision of each type to maximize the receiver's estimate of their type.

- Sender
  - Suppose a sender's quality q has unconditional distribution F with uniform density f on $[0,1]$, and the sender's payoff is her expected quality as estimated by a receiver.
  - Sender types cannot directly reveal their quality q, but if they are above some standard s they can costlessly disclose this fact.
  - Let D be the set of types who are believed to disclose when disclosure is observed, then $D = [s, 1]$. And let N be the set of types who are believed not to disclose when nondisclosure is observed, then $N = [0, s)$.
  - Clearly, $\bar{q}_D(q) > \bar{q}_N(q)$ for all $q \geq s$ who can disclose.

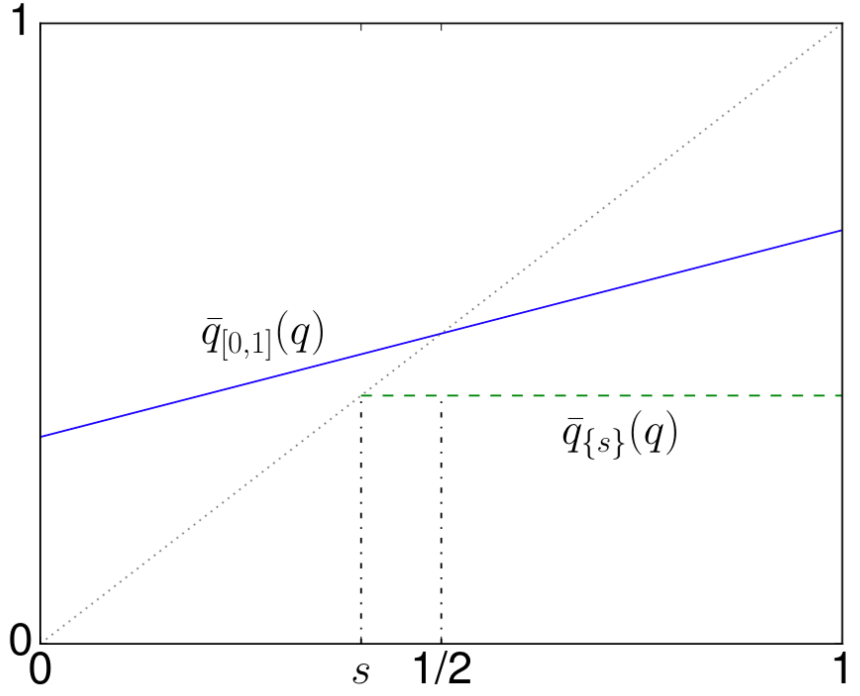
- Receiver
  - Independent of the disclosure decision, higher quality senders are more likely to face a receiver type who views the sender more favorably.
  - To capture this, let the receiver have some private information represented by a noisy binary signal $x \in \{l, h\}$ where $\Pr[h|q]$ is increasing in q so the chance of an h signal is higher for better senders.
  - The conditional distributions be $H(q) = F(q|x = h)$ and $L(q) = F(q|x = l)$.
  - The sender decides to disclose or not based on the average or expected receiver estimate of the sender's quality.

$$\bar{q}_Q(q) = \Pr[h|q\} E_H[q|q \in Q] + \Pr[l|q\} E_L[q|q \in Q]$$

- Suppose that $\Pr[h|q] = q$ and consider a nondisclosure equilibrium where no types disclose, $N = [0,1]$.
  - If a sender follows the strategy of not disclosing then the sender's estimated quality is $E_H[q|q \in [0,1]] = \frac{2}{3}$ if the receiver observes an h signal;
  - and $E_L[q|q \in [0,1]] = \frac{1}{3}$ if the receiver observes an l signal;
  - implying the expected payoff from nondisclosure is

$$\bar{q}_N(q) = q\frac{2}{3} + (1-q)\frac{1}{3} = \frac{1}{3} + \frac{q}{3}$$

  - This is increasing in q so higher types receive a higher nondisclosure payoff than lower types due to the private receiver information.

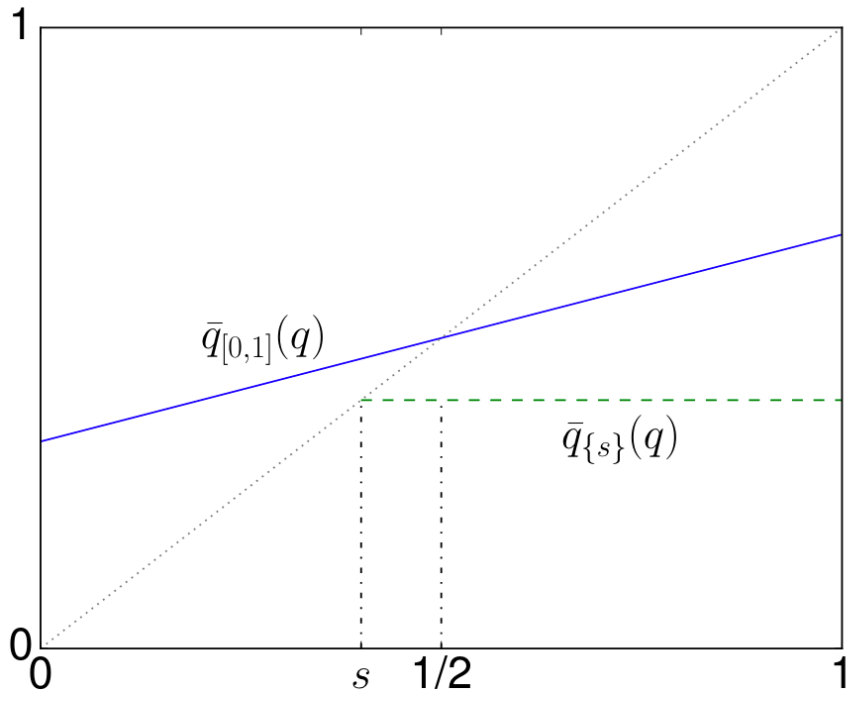


(a) Nondisclosure equilibrium: f uniform, $\Pr(H|q) = q$, $s = 2/5$

- Can types who meet the standard s do even better if they deviate and unexpectedly disclose?
  - If the receiver skeptically believes that $D = \{s\}$ so that any unexpected disclosure came from the worst type;

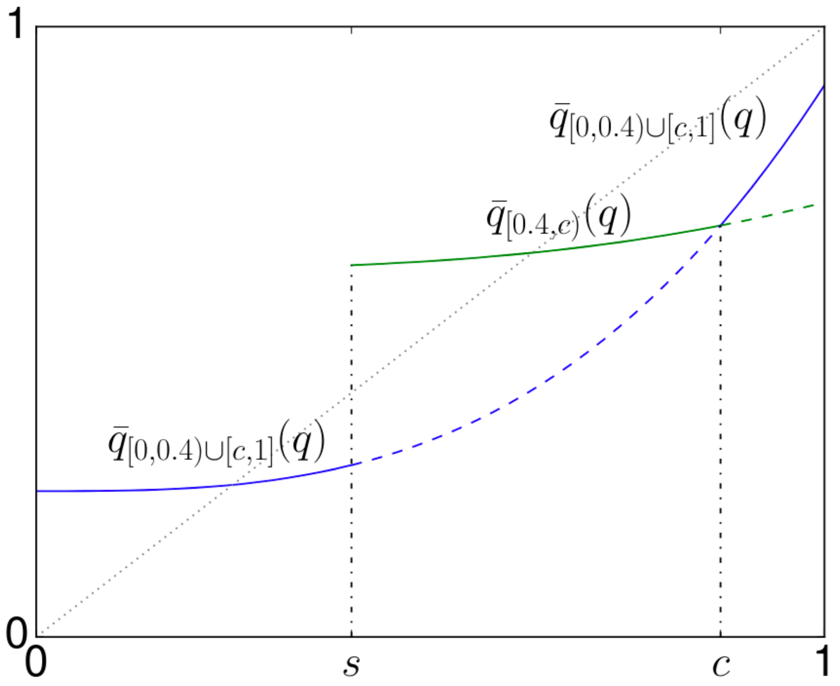
$$\bar{q}_D(q) - \bar{q}_N(q) = s - \frac{1}{3} - \frac{q}{3}$$

  - Therefore, if the standard is sufficiently low, $s < \frac{1}{2}$, the marginal sender $q = s$ loses from disclosure and higher types lose even more, so nondisclosure is an equilibrium.

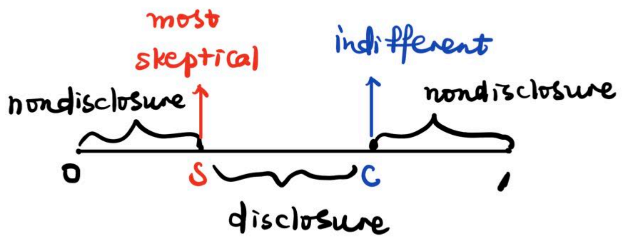


(a) Nondisclosure equilibrium: f uniform, $\Pr(H|q) = q$, $s = 2/5$

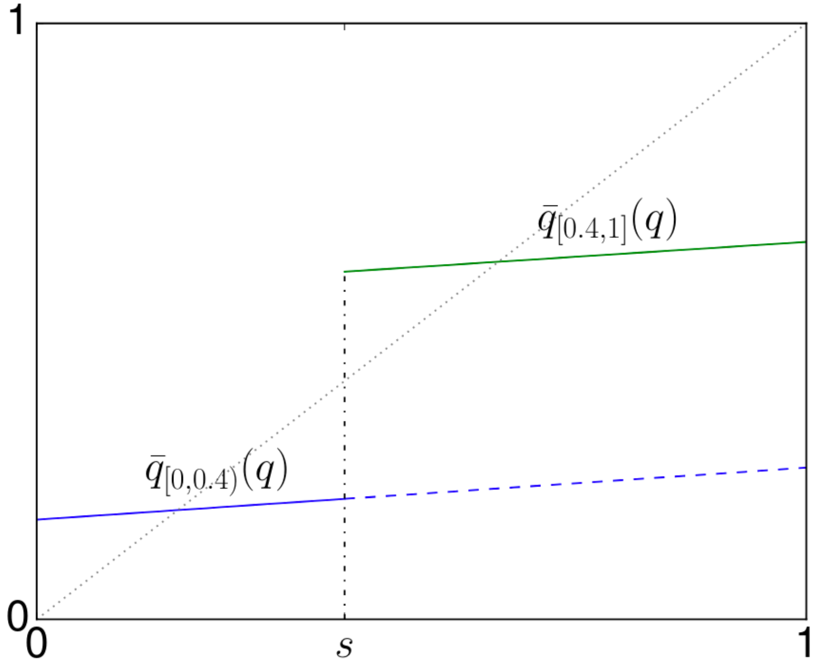
- If the standard s is sufficiently low to permit a nondisclosure equilibrium, it also permits a countersignaling equilibrium.
  - The receiver correctly believes that types $D = [s, c)$ disclose and types $N = [0, s) \cup [c, 1]$ cannot or do not disclose for some type $c \in [s, 1]$ who is just indifferent between disclosing or not.
  - Here, $\Pr[h|q] = q^3$. Types who just meet the standard $s = \frac{2}{5}$ benefit most from disclosure, and the net gain from disclosure $\bar{q}_D(q) - \bar{q}_N(q)$ falls until type $c = 0.87$ is indifferent.



(b) Countersignaling equilibrium: f uniform, $\Pr(H|q) = q^3$, $s = 2/5$

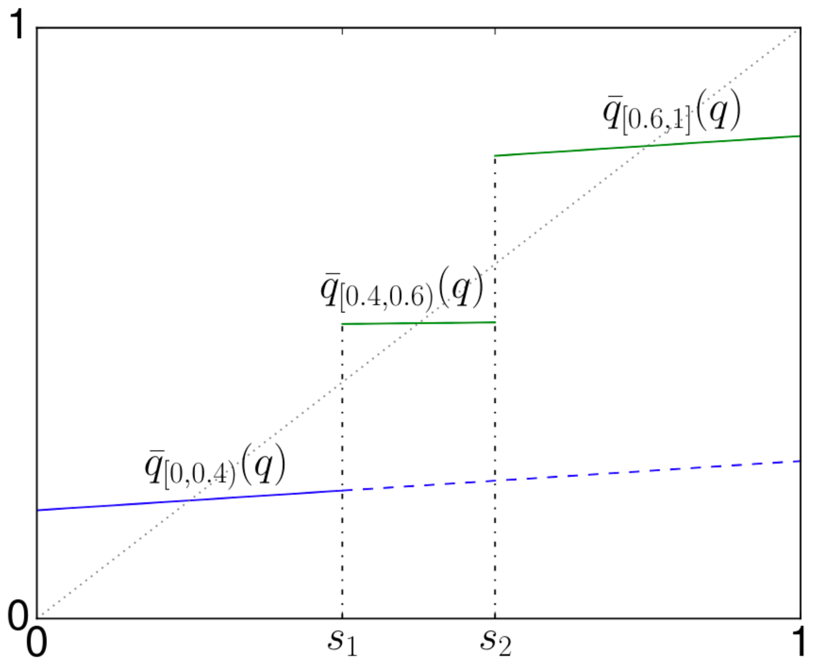


- If the standard s is sufficiently high, or if the prior distribution is sufficiently unfavorable, disclosure is the unique equilibrium.
  - In this case even the most skeptical belief that $D = \{s\}$ makes all types want to disclose, so skepticism is not sustainable in equilibrium.
  - If the prior distribution is $f(q) = 2 - 2q$, then disclosure is the unique equilibrium even for $s = \frac{2}{5}$.

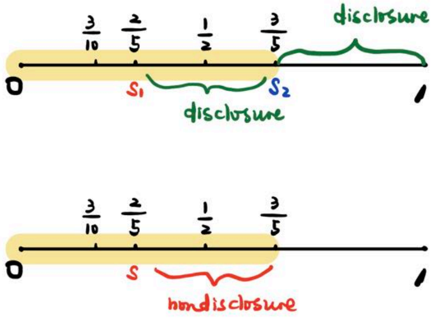


(c) Unique disclosure equilibrium: $f(q) = 2 - 2q$, $\Pr(H|q) = q$, $s = 2/5$

- Disclosure is also ensured if multiple standards divide up the type space sufficiently finely.
  - The prior distribution is uniform, but now there are two standards, $s_1 = \frac{2}{5}$ and $s_2 = \frac{3}{5}$.
  - Based on the prior analysis types $q \geq \frac{3}{5}$ always disclose since the standard they meet is so high.
  - Conditional on being in $[0, \frac{3}{5}]$, the standard $s_1 = \frac{2}{5}$ is now relatively high, so the remaining types $q \in [\frac{2}{5}, \frac{3}{5}]$ disclose even though they would not always disclose with a single standard $s = \frac{2}{5}$.



(d) Unique unraveling equilibrium: f uniform, $\Pr(H|q) = q$, $s_1 = 2/5$, $s_2 = 3/5$



- In this sender-receiver game the sender has quality q distributed according to the smooth distribution F with density f which has support on $[0,1]$.
  - The sender knows the realized value of q and sends a type-restricted message v to the receiver that is potentially informative about q.
  - The receiver does not know q but has his own noisy binary signal $x \in \{l, h\}$ where $\Pr[h|q]$ is smooth and strictly increasing. The conditional distributions $H(q)$ and $L(q)$ given these signals have respective densities $h(q)$ and $l(q)$.

Assumption

$H(q)$ dominates $L(q)$ in the sense that $E_H[q|q \in [a,b]] - E_L[q|q \in [a,b]]$ is strictly decreasing in a and strictly increasing in b, so that the receiver's information has more impact as the interval $[a,b]$ expands.

- Two sufficient conditions for such dominance:
  - $h(q)$ is increasing and $l(q)$ is decreasing;
  - or the generalized failure rate ratio $\left(\frac{h(q)}{H(q')-H(q)}\right)/\left(\frac{l(q)}{L(q')-L(q)}\right)$ is increasing in q for all $q, q' \in [0,1]$.

- The sender first learns her type q and then sends the message v.
- After learning x and hearing v the receiver then takes an action α.
- Following standard assumptions in the sender-receiver game literature:
  - the receiver's payoff $u^R(q, \alpha)$ is maximized when the receiver's action α equals the receiver's estimate of the sender's type;
  - the sender's state-independent payoff, u^S, is strictly increasing in α.

- We consider only pure strategy equilibria so a strategy is a mapping between types and messages.
- Let the conditional cumulative distribution function $\mu(q|x,v)$ represent receiver beliefs about the sender's type given the message v and private information x.

Definition 1

A pure-strategy perfect Bayesian equilibrium is given by a verifiable message profile $v(q)$, a receiver action profile $\alpha(x,v)$ and receiver beliefs $\mu(q|x,v)$ where:

i) For all q, $v(q) \in argmax_{v'} E[u^S(\alpha(x,v'))|q]$;

ii) For all x and v, $\alpha(x,v) = argmax_{\alpha'} E_\mu[u^R(q,\alpha')|x,v]$;

iii) $\mu(q|x,v)$ is updated from the sender's strategy and F using Bayes' rule whenever possible.

- We assume that there is a "blank" message v_0 for nondisclosure and message v_1 for disclosure.
- Message v_0 is always sent by types $q \in [0, s)$ and either v_0 or v_1 may be sent by types $q \in [s, 1]$.

- Sender best responses for any receiver beliefs involve:
  - no types disclose --- nondisclosure;
  - types in an interval $[s, c)$ disclose for some $c < 1$ --- countersignaling;
  - types in an interval $[d, 1]$ disclose for some $d \in [s, 1]$ --- full disclosure.
- Case (iii, $d > s$) cannot arise in equilibrium since, with the corresponding beliefs, every type will prefer to disclose.
- Hence (i), (ii) and (iii, $d = s$) are the only pure strategy equilibrium strategies that are possible.

5.1 Nondisclosure Equilibrium

- For existence of a nondisclosure equilibrium, consider the most pessimistic beliefs about who unexpectedly discloses, so $D = \{s\}$ and $N = [0,1]$ and $\bar{q}_D(q) - \bar{q}_N(q) = s - \bar{q}_{[0,1]}(q)$. Let:

$$\hat{q} = \min\{q: q = \bar{q}_{[0,1]}(q)\}$$

- If $s \leq \hat{q}$ then type s will not want to disclose and all higher types have even less incentive to disclose since $\bar{q}_{[0,1]}(q)$ is increasing in q, so nondisclosure is an equilibrium.

- Regarding existence of a countersignaling equilibrium, in such an equilbrium $N = [0, s) \cup [c, 1]$ and $D = [s, c)$. Suppose that $s < \hat{q}$, which holds if s is sufficiently small.
  - for c sufficiently close to 1, since $s < \bar{q}_{[0,1]}(q)$, it must be that $\bar{q}_D(c) < \bar{q}_N(c)$;
  - for c sufficiently close to s, since $\bar{q}_{[s,1]}(c) > \bar{q}_{[0,s)}(c)$, it must be that $\bar{q}_D(c) > \bar{q}_N(c)$;
  - By continuity, these imply that there exists some $c \in (s, 1)$ such that:

$$\bar{q}_{[s,c)}(c) = \bar{q}_{[0,s)\cup[c,1]}(c)$$

- Given the indifference of type c, $\bar{q}_{[s,c)}(q) - \bar{q}_{[0,s)\cup[c,1]}(q)$ is decreasing in q, if s is sufficiently small that a disclosure equilibrium exists, then so does a countersignaling equilibrium.

5.3 Disclosure Equilibrium

- For sufficiently large s, the sender's expected payoff from non-disclosure in any candidate non-disclosure or countersignaling equilibrium is strictly bounded above by s but for any s, the sender's disclosure payoff is bounded below by s.
- Hence if s is sufficiently close to 1 then every sender $q \geq s$ prefers to disclose and neither nondisclosure nor countersignaling can be an equilibrium.
- Since disclosure, nondisclosure and countersignaling are the only possible pure strategy equilibria with a single standard, disclosure is unique.

- Note that a sufficiently high s for a given F is equivalent to a sufficiently large $F(s)$ for a given s. Similarly a sufficiently weak standard is equivalent to a sufficiently favorable prior distribution. The following proposition collects these results:

Proposition 1 (Existence)

(i) A nondisclosure equilibrium exists if s or $F(s)$ is sufficiently small.
(ii) A countersignaling equilibrium exists if a nondisclosure equilibrium exists.
(iii) A disclosure equilibrium always exists and is unique if s or $F(s)$ is sufficiently large.
(iv) No other pure strategy equilibria are possible.

- D1 requires, in our context, that if one type benefits from a deviation for a set of rationalizable receiver best responses, that type should be given zero weight. (Cho and Kreps, 1987; Cho and Sobel, 1990; Ramey, 1996).
- Since Nondisclosure on and off the equilibrium path is reasonably inferred to be from higher types, so D1 does not refine away any of the equilibria.

Proposition 2 (Refinements)

The nondisclosure, countersignaling and disclosure equilibria are all robust to the Intuitive Criterion and D1.

- In our model with a continuum of types, the cutoff for nondisclosure by high types is endogenously determined, so its stability remains a question.
- Our existing cases can be ranked in terms of “modesty” by who discloses:
  - nondisclosure is most modest;
  - countersignaling behavior is less modest and decreasingly modest for higher c and hence a larger disclosure range $[s, c]$;
  - full disclosure by all $q \in [s, 1]$ is least modest.
- Thus consider $c \in [s, 1$ to be our inverse measure of modesty where $c = s$ represents the highest level of modesty and $c = 1$ represents the least.

➢ With this measure of modesty we have the following convergence result based on initial play by the sender that is a best response to any receiver beliefs.

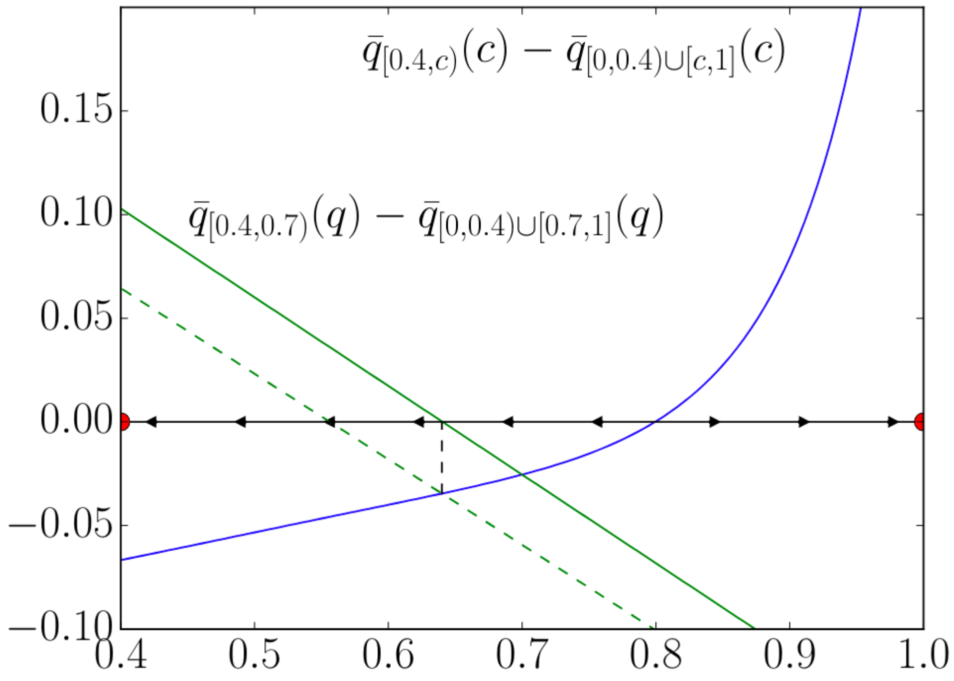
Proposition 3 (Convergence)

If nondisclosure, countersignaling, and disclosure equilibria coexist, then for initial behavior $D = [s, c)$,

- play converges to the nondisclosure equilibrium if initial behavior is sufficiently modest, i.e., c is sufficiently close to 1;
- (ii) play converges to a countersignaling equilibrium only if the private receiver information is not too weak and initial behavior is intermediate;
- (iii) play converges to the disclosure equilibrium if initial behavior is sufficiently immodest, i.e., c is sufficiently close to 1.

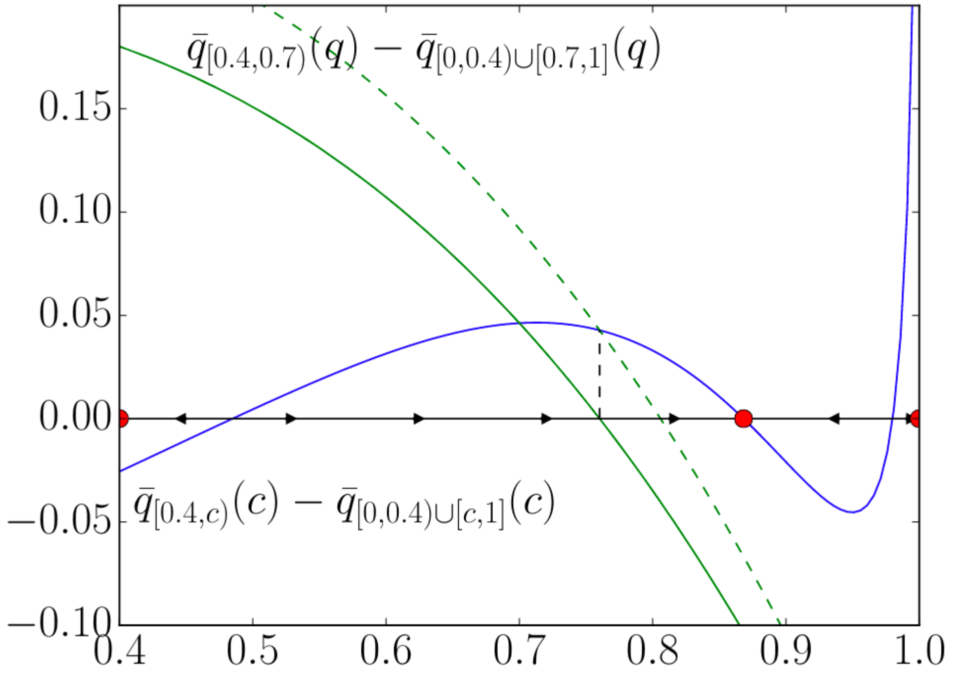
- If initial behavior that is modest, it will induce more medium types to countersignaling, leading to more pessimistic beliefs and less disclosure, until no types disclose.

- Conversely, if initial behavior is such that the countersignaling region is small, then beliefs are sufficiently optimistic, and more types disclose until the disclosure equilibrium is reached.



(a) Nondisclosure and disclosure: f uniform, $s = 2/5$, $\Pr[\hbar | q] = q$

- In this example, countersignaling plays an important role, but play converges to either disclosure or nondisclosure.
- Play converges to the nondisclosure equilibrium if initial play is sufficiently modest, and to the disclosure equilibrium if initial play is sufficiently high, 0.98 or higher.
- Within this broad range, play converges to the middle countersignaling equilibrium where only types [0.4,0.87) disclose.



(b) Nondisclosure, countersignaling and disclosure: f uniform, $s = 2/5$, $\Pr[\hbar|q] = q^3$

- We now allow for $N \in \mathbb{N}^+$ verifiable messages that disclose a subinterval of the sender's typespace, e.g., a system of certificates or letter grades.
- We assume that the typespace is partitioned into $N + 1$ nonempty subintervals by a set of strictly increasing standards $\{s_1, s_2, \dots, s_N\}$:
  - Message v_0 is always sent by types $q \in [0, s_1]$.
  - Message profile $v(q) \in \{v_0, v_j\}$ can be sent and when $q \in [s_j, s_{j+1}]$ for $j = 1, 2, \dots, N$.
- Given the multitude of equilibria, we focus on sufficient conditions for when a type must disclose and for when nondisclosure exists.

6 Multiple Standards---Existence

- Extending the argument for the single standard case, we look for sufficient conditions on s_j such that an equilibrium exists in which v_j and any worse news is not disclosed.
- Consider the minimum value of q such that the expected payoff for a sender of type q is equal to q when news of v_j and lower is not disclosed. Generalizing (2), let

$$\hat{q}_j = \min\{q: q = \bar{q}_{[0,s_{j+1}]}(q)\}$$

- If the receiver skeptically believes that a sender who deviates from nondisclosure is of the lowest type who could deviate, then the highest payoff from disclosure of news v_k for $k \leq j$ is s_k.
- Therefore, nondisclosure is clearly an equilibrium if $s_j \leq \hat{q}_j$.

Proposition 4 (Existence-multiple standards)

i) An equilibrium with nondisclosure by types $q \in [0, s_{j+1})$ exists if standard j is sufficiently low, $s_j \leq \hat{q}_j$. ii) A full disclosure equilibrium always exists.

- We are interested in conditions under which the best types will always reveal their news and, when there are multiple levels of news, how far unraveling will continue.
- Consider the set of beliefs where the receiver believes that for $q \in [s_{j+1}, 1]$ the sender discloses but for $q \in [s_1, s_{j+1})$ the sender may either disclose or not disclose.
- Define $\check{q}_j$ for $j = 1, 2, \dots, N$ to be the maximal payoff for nondisclosure under any such beliefs.

- Now consider unraveling.
- If $s_N > \check{q}_N$ then types with the best news v_N will disclose.
  - Since $q \in [s_N, 1]$ are known to disclose, the attractiveness of nondisclosure by types with news v_{N-1} decreases.
  - Thus types $q \in [s_{N-1}, s_N)$ will always disclose under the weaker condition that $s_{N-1} > \check{q}_{N-1}$.
- If these types disclose then this same logic applies to types with news v_{N-2}, etc. Because the $\check{q}_j$ are nondecreasing in j, unraveling implies that the standard for impressiveness becomes less strict as unraveling progresses from the best news down.

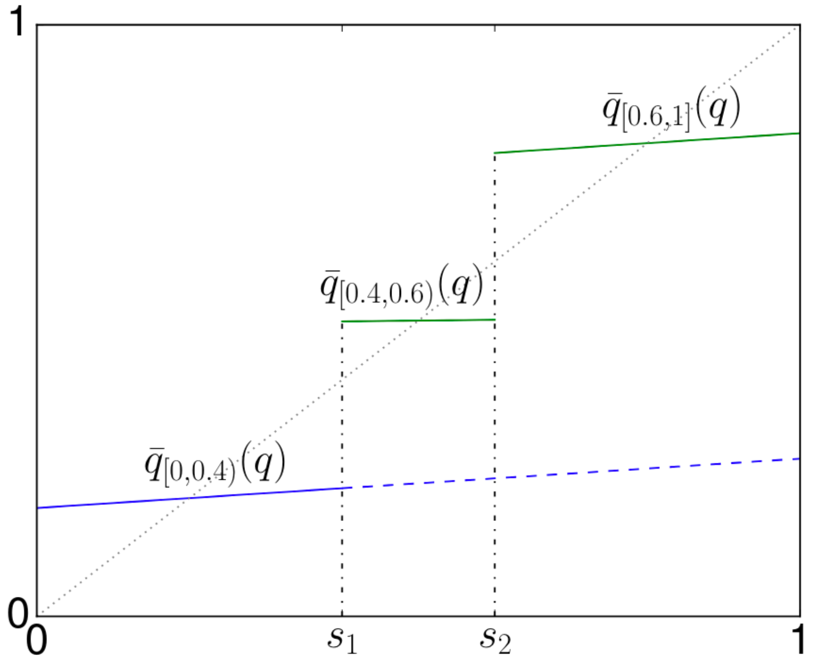
6 Multiple Standards---Unraveling

Proposition 5 (Unraveling due to high standards)

Types $q \in [s_j, 1]$ disclose in any equilibrium if standards s_k for $k \geq j$ are sufficiently high, $s_k \geq \check{q}_k$.

Proposition 6 (Unraveling due to fine standards)

Given $N \geq 2$ and s_1, types $q \in [s_j, 1]$ disclose in any equilibrium if standards are sufficiently fine, i.e., $max_{k \geq j}\{s_{k-1} - s_k\}$ is sufficiently small.



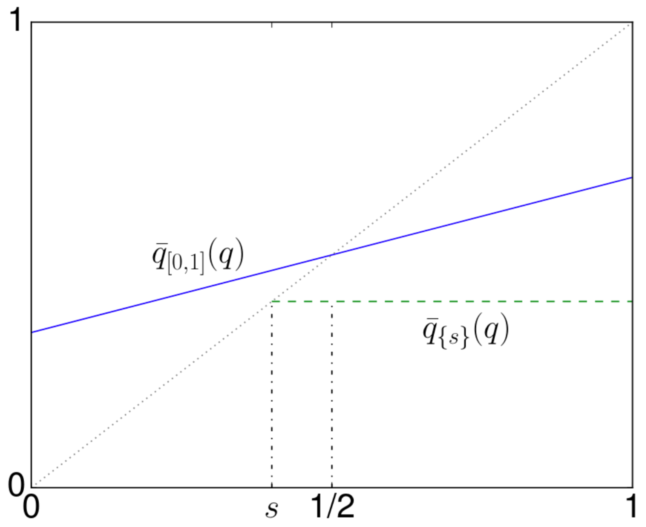
(d) Unique unraveling equilibrium: f uniform, $\Pr(H|q) = q$, $s_1 = 2/5$, $s_2 = 3/5$

Proposition 7 (Unraveling due to low expectations)

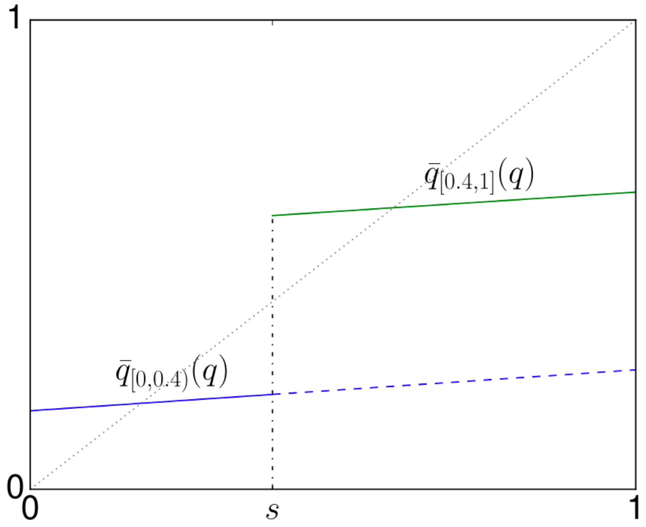
(i) Types $q \in [s_j, 1]$ disclose in any equilibrium if prior expectations are sufficiently unfavorable, i.e., $F(s_j)$ is sufficiently large.

(ii) If expectations are less favorable ($F(q)$ is MLR dominated by $G(q)$), the necessary and sufficient conditions for disclosure in any equilibrium are weaker ($\check{q}_j^F \leq \check{q}_j^G$ and $\hat{q}_j^F \leq \hat{q}_j^G$).

- This result shows how different public information affects disclosure.
- Looking back at Figure 1, the more favorable distribution in Figure 1a permitted nondisclosure and countersignaling equilibria, while the less favorable distribution in Figure 1c had a unique disclosure equilibrium.



(a) Nondisclosure equilibrium: f uniform, $\Pr(H|q) = q$, $s = 2/5$



(c) Unique disclosure equilibrium: $f(q) = 2 - 2q$, $\Pr(H|q) = q$, $s = 2/5$

7 Conclusion

- A large body of research concludes that costless disclosure of good news should benefit the sender, but in practice senders often withhold good news.
- In this paper we consider a disclosure game when the receiver also has private information about sender quality.
  - We show that the presence of any private receiver information, even if only slightly informative, implies that equilibria with nondisclosure by some or all types exist unless the standard for good news is restricted to sufficiently high quality senders or the prior distribution of types is sufficiently unfavorable.
  - When there are multiple standards for news, such as letter grades, we find that the standard unraveling result holds if standards are sufficiently high or fine, but need not hold generally.
- These results provide support for mandatory or third-party disclosure of information as a way to reduce the damage that “false modesty” can have on communication.

Thank You !