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CHEAP TALK IN BARGAINING GAMES

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Abstract

This paper shows that cheap talk can matter in bargaining. We analyze a two-stage bargaining game in which cheap talk may be followed by serious negotiation. Cheap talk matters because it can affect whether negotiation ensues. The conventional wisdom, that all buyers would claim to have low reservation prices, assumes that participation is determined exogenously, and is incorrect in our model.

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1. Introduction

One Saturday evening, two corporate moguls have a chance encounter at their country club. One mogul's company owns a division that the other mogul's firm may wish to buy. Serious negotiation, involving binding offers and hordes of lawyers, can take place on Monday morning; all that can happen Saturday night is talk. If, based on this talk, the moguls conclude that there is sufficient prospect of gains from trade, then they will send their lawyers into the fray on Monday morning. Otherwise, Saturday evening will be the end of it.

This paper shows that such talk can matter in bargaining. We analyze the moguls' two-stage bargaining problem in a model that avoids two unrealistic features of much recent work on bargaining under incomplete information. These unrealistic features are: First, the sets of "types" of buyers and sellers who negotiate are exogenous, even though (typically) in equilibrium some of these types never trade. And second, most analyses consider only payoff-relevant choices, such as binding offers that the opponent can accept, or moves that impose costs of delay.

These two assumptions complement each other. If the participants are indeed exogenously determined, then it is easy to see that payoff-irrelevant communication (cheap talk) can have no effect: every type of buyer would like the seller to believe that his reservation price is low; and conversely every seller wants the buyer to believe that his valuation is high. Thus, costless messages are never credible if participation is exogenous. This is presumably why cheap talk has not hitherto appeared in the bargaining literature.
But if potential buyers and sellers choose whether or not to take part in serious bargaining, so that the set of participants is not exogenous, then there is a role for cheap talk. People commonly explore mutual interest through completely non-binding, payoff-irrelevant means before undertaking detailed negotiation. Only if there is enough prospect of gains from trade will formal bargaining ensue. In this paper we analyze agents' incentives in this cheap-talk phase, when they must choose how enthusiastic to appear.

For familiar reasons, appearing too keen harms one's bargaining position. Against this, however, seeming too reluctant jeopardizes the continued negotiation and hence risks losing the gains from trade altogether. This tradeoff creates a role for cheap talk. Buyers with high reservation prices are willing to show their eagerness in order to ensure serious negotiation, even at the cost of spoiling their bargaining position. Buyers with low reservation prices are coy: they feign lack of interest in the hope that the seller will cajole them to the bargaining table, where they will enjoy a favorable position.

The body of the paper makes this intuition precise, first with an example and then with some general results. To complete this Introduction, we discuss the relationship between our cheap-talk equilibrium and the related literatures on bargaining and mechanism design.

A cheap-talk equilibrium differs both from equilibrium in a standard bargaining game and from a mechanism (in the sense of Myerson and Satterthwaite (1983)). In most game-theoretic analyses of bargaining (e.g., Fudenberg and Tirole (1983) and Cramton (1985)), communication takes place through actions that (potentially) directly affect payoffs, and therefore can signal private information in the style of Spence (1974). Typically, a communicative action either directly imposes costs of delay, or directly
affects payoffs by constituting an offer that is binding if the other player accepts it, or both. Cheap talk does neither of these things. Of course, in equilibrium, different types have incentives to choose different cheap-talk messages, but no part of these incentives consists of exogenous costs or benefits. It is this that differentiates cheap talk from signaling.

Cheap talk in our sense differs from a Myerson-Satterthwaite mechanism, in which messages without direct costs are used, in that in mechanism design a mediator controls the communication and commits to a choice of outcome as a function of messages. In cheap-talk equilibrium, by contrast, no agent can commit himself to a choice of outcome as a function of messages; rather, the outcome must be a Bayesian equilibrium given the information conveyed by the messages. Moreover, these messages become common knowledge, whereas a Myerson-Satterthwaite mediator can, and typically does, limit the information he passes on to the players. Of course, every cheap-talk equilibrium can be implemented as a mechanism, but the reverse is not true.

2. An Example

We consider a model of bilateral trade under incomplete information. If the parties do meet on Monday, they play the following extensive-form game (following Chatterjee and Samuelson (1983)). Buyer and seller name prices $p_b$ and $p_s$ respectively, and trade takes place at price $(p_b + p_s)/2$ if $p_b \geq p_s$; otherwise, there is no trade.¹

On Saturday, however, the parties can engage in cheap talk. We consider the simplest possible language: each party can claim either to be "keen" or
to be "not keen". We also assume for simplicity that these claims are made
simultaneously. We emphasize that these claims do not directly affect
payoffs: they work only through affecting the other player’s beliefs. In
particular, they are not commitments nor are they verifiable.

To summarize, the extensive form is as follows. First, the parties
simultaneously announce whether they are "keen" or "not keen"; these
announcements do not directly affect either party’s payoff. After observing
the pair of announcements, the parties simultaneously decide whether to go to
the bargaining table. If both parties arrive at the bargaining table, then
they play the Chatterjee-Samuelson game described above; otherwise, the game
ends and payoffs are zero for both players. If trade takes place at price \( p \)
in the Chatterjee-Samuelson game, then a buyer with valuation \( v_b \) achieves
payoff \( v_b - p \) and a seller with valuation \( v_s \) achieves payoff \( p - v_s \); if trade
does not occur then payoffs again are zero.

In choosing this extensive form, we have decided against a related model
in which each bargainer incurs the cost \( c \) if he goes to the bargaining table
on Monday morning. This cost might be the wages paid to the bargainer’s
horde of lawyers, or the (expected) opportunity cost of foregone alternative
negotiations. After we describe the cheap-talk equilibrium in our zero-cost
model, we explain our preference for it over this positive-cost alternative.

In our game, as in every cheap-talk game, there is an uncommunicative
equilibrium: if cheap talk is taken to be meaningless, then parties are
willing to randomize un informatively over the possible messages. There are
also two more interesting equilibria in which cheap talk is meaningful. In
one, serious bargaining takes place only if both parties claim to be "keen";
in the other, a single such claim suffices. In both of these equilibria, we take it that serious bargaining cannot occur if neither party claims to be "keen".²

In the first of these equilibria with meaningful cheap talk, the Chatterjee-Samuelson equilibrium reappears: everyone claims to be "keen" except those types who are sure not to trade.³ In this equilibrium, cheap talk is credible, but does not affect the equilibrium outcome: the outcome is the same as in the Chatterjee-Samuelson equilibrium without cheap talk.

In the other equilibrium, however, cheap talk really matters: low-value buyers and high-value sellers are willing to jeopardize continued negotiation so as to improve their bargaining position; those who have more at stake cannot afford this risk. We focus on this equilibrium.

We analyze our equilibrium in the standard case in which \( v_s \) and \( v_b \) are independently and uniformly distributed on \([0,1]\). In the appendix, we show that the following strategies are a perfect Bayesian equilibrium. In the cheap-talk phase, buyers above the critical type

\[
y = \frac{22 + 12/2}{49} = .795
\]

say "keen" while those below say "not keen". Sellers below \((1-y)\) say "keen", while those above say "not keen".

If both parties say "not keen" then the negotiation ends. If at least one party says "keen" then the bargaining continues with a (possibly asymmetric) Chatterjee-Samuelson game. If, for instance, the seller says "not keen" and the buyer says "keen" then it becomes common knowledge that the seller's type is above \(1-y\) and the buyer's type is above \(y\), and negotiation proceeds on that basis. Similarly, if the seller says "keen" and
the buyer says "not keen" then it becomes common knowledge that the seller's type is below 1-y and the buyer's type is below y. In both of these cases, we use the linear Chatterjee-Samuelson equilibrium to solve the resulting bargaining game. Finally, if the buyer and the seller both say "keen" then it becomes common knowledge that the seller's type is below 1-y and the buyer's type is above y. In this case, the Chatterjee-Samuelson analysis breaks down; we invoke symmetry to assume that trade occurs with certainty at a price of 1/2.

One weakness of this equilibrium in our zero-cost model is that there remains a small prospect of trading even when both parties say "not keen", so it is not the case that the parties voluntarily stop negotiating because each is too pessimistic about the other's type: in equilibrium, y > 1-y, so trade would occur with positive probability if negotiation continued. Moreover, if the time and place of Monday's meeting are given exogenously, then this equilibrium relies on weakly dominated strategies: no type of either party ever suffers a negative payoff in the Chatterjee-Samuelson game, so showing up weakly dominates not doing so. This is not an appealing feature of the equilibrium, but we do not find it unpalatable because if there are any costs of showing up on Monday then staying home is no longer a weakly dominated strategy. We now describe our intuition about equilibrium in such a positive-cost model, explain why we have chosen to analyze our zero-cost model in its stead, and then return to the zero-cost model to compare our cheap-talk equilibrium to the ex-ante efficient equilibrium described by Chatterjee and Samuelson.

We strongly suspect that the analog of our cheap-talk equilibrium exists in the positive-cost model but does not involve weakly dominated strategies. We expect that it has the following form. Given a value of c, there are two
critical buyer-types, \( z(c) \) and \( y(c, z) \). In equilibrium, the buyer says "keen" if and only if \( v_b > y \), as before. In addition, if the seller claims to be "not keen" then the buyer goes to the bargaining table if and only if \( v_b > z \); a buyer below \( z \) prefers not to go because the expected gain from bargaining does not cover the cost \( c \).

We expect \( z(c) \) to increase in \( c \) and \( y(c, z) \) to decrease in \( z \). For \( c=0 \), \( z=0 \) and \( y=1 \). For small positive values of \( c \), \( 0 < z < y < 1 \), and a buyer between \( z \) and \( y \) says "not keen" but goes to the bargaining table even if the seller says "not keen". This behavior does not arise in our cheap-talk equilibrium in the zero-cost model, but is by no means inconsistent with our basic message that cheap talk can matter in bargaining. Also, we expect that some value of \( c \) satisfies \( z(c) = y(c, z) \), so that no buyer-type chooses to go to the bargaining table if both parties say "not keen".

Part of the intuition behind this positive-cost equilibrium is borrowed from the zero-cost case: a buyer above \( y \) is willing to sacrifice his bargaining position to ensure that negotiation will continue; he says "keen" to entice the seller to the bargaining table when \( v_s > 1-z \). Thus, cheap talk matters because it affects whether negotiation ensues. This seems fundamental to the bargaining problem.

Unfortunately, in the positive-cost model this role for cheap talk is confounded with another role which has been understood for some time: the presence of costs creates a coordination game between the parties; both parties wish to avoid their costs if the prospects for trade are too bleak.\(^5\) We strongly suspect that these two motives for cheap talk are inseparable in the positive-cost model. Since we wish to emphasize only the first of the two, we tolerate the weakly dominated equilibrium strategies in our zero-cost model as the price we pay for isolating this new role for cheap talk.
We now return to the zero-cost model in order to compare our cheap-talk equilibrium to the ex-ante efficient equilibrium. Calculation shows that the cheap-talk equilibrium yields buyer-type $v_b$ an interim payoff, evaluated before the cheap-talk phase, of:

$$
W_b(v_b) = \begin{cases} 
0 & \text{if } v_b \leq \frac{1}{4} \\
\frac{1}{2} \left( v_b - \frac{1}{4} \right)^2 & \text{if } \frac{1}{4} < v_b \leq 1 - \frac{3}{4} \\
(1-y)(v_b - \frac{1}{2} + \frac{1}{4}y) & \text{if } 1 - \frac{3}{4} < v_b \leq y, \\
\frac{1}{2} \left( v_b - \frac{1}{4} \right)^2 - \frac{1}{2} \left( \frac{7}{4}y - 1 \right)^2 & \text{if } v_b > y.
\end{cases}
$$

An immediate consequence is that if $y/4 = .199 < v_b < 1/4$, then buyer-type $v_b$ is strictly better-off in our cheap-talk equilibrium than in Chatterjee-Samuelson's. In fact, many other types are better-off in our equilibrium than in Chatterjee-Samuelson. Equating our $W_b(v_b)$ to the Chatterjee-Samuelson equivalent $W_{CS}^b(v_b) = \frac{1}{2} (v_b - 1/4)^2$ yields a crossover point in the range $1 - \frac{3}{4} y < v_b < y$, given by the solution to

$$(1-y)(v-\frac{1}{2}+\frac{1}{4}y) = \frac{1}{2} (v-\frac{1}{4})^2,$$

which is approximately equal to $.599$, and indeed is between $1 - \frac{3}{4} y = .404$ and $y = .795$. Thus, all buyer-types in (.199, .599), and all seller-types in the analogous interval, are better off with cheap talk. In fact, exactly as many types strictly prefer our equilibrium as strictly prefer Chatterjee-Samuelson.

The pairs $(v_b, v_s)$ who trade in our equilibrium are illustrated in Figure 1, which also shows the corresponding region for Chatterjee-Samuelson.

Calculation shows that the (ex-ante) probability of $(v_b, v_s)$ falling into the
trading region for our equilibrium is approximately .244, somewhat less than
the corresponding probability (.281) for the Chatterjee-Samuelson
equilibrium: our equilibrium involves less trade. Similarly, the ex-ante
expected total gains from trade in our equilibrium are .124, less than
Chatterjee-Samuelson's figure of .140.

Both of these results are special cases of Myerson and Satterthwaite's
(1983) general result that the Chatterjee-Samuelson linear equilibrium
maximizes both ex-ante probability of trade and ex-ante gains from trade.
Myerson (1985), however, convincingly argues that such ex-ante efficiency is
often irrelevant, because there is seldom an opportunity to make binding
arrangements ex-ante (that is, before either player knows his "type").
Myerson gives an example of an incentive-compatible mechanism (for the
independent, uniform case) in which even high-value sellers (and low-value
buyers) trade with positive probability, and therefore are better-off than in
the Chatterjee-Samuelson equilibrium. Our cheap-talk equilibrium is in the
same spirit, but is derived from an extensive-form game that does not require
a mediator in its cheap-talk phase.6

3. General Results

The intuition given in the Introduction does not depend on anything as
specific as the linear equilibrium in the Chatterjee-Samuelson game. We now
formally confirm that the cheap-talk equilibrium just described exists quite
generally. To keep things simple, we impose symmetry and assume that types
are uniformly distributed on intervals contained in [0,1], but we suspect
that these assumptions are not necessary.

Consider an extensive-form bargaining game and a sequential equilibrium
in that game. Keeping the bargaining rules fixed, we will be interested in
the interim payoffs to players of various types as these types and the
associated type spaces vary. Since bargaining games often have multiple
equilibria, varying the type-spaces generates a correspondence from type-
spaces to sets of equilibria, and hence to sets of interim payoff functions.
We will assume that a selection can be made from this correspondence that has
certain reasonable properties, described below.

In what follows, we refer to this selection as the **bargaining**
environment, and make assumptions about the resulting payoff functions rather
than about the underlying extensive form and equilibrium. This simplifies
the exposition a great deal, for instance by allowing us to skip the tedious
caveat that symmetric extensive forms can have asymmetric equilibria. More
importantly, focusing on the interim payoff functions emphasizes the main
point of the paper: cheap talk works by affecting the players' beliefs about
each other's types, and thus (via our selection) indirectly affecting their
payoffs.

A necessary condition for our cheap-talk equilibrium to exist is that
the buyer-type denoted by \( y \) above is indifferent between saying "keen" and
saying "not keen". Denote the analogous value of \( v_s \) by \( x \). Denote the
interim payoff to buyer-type \( v_b \) when the types are uniformly distributed on
\([v_b', \bar{v}_b']\) and \([v_b', \bar{v}_b']\) by \( U_b(v_b; [v_s', \bar{v}_s'], [v_b', \bar{v}_b'])\), and denote the analogous
seller's interim payoff by \( U_s(v_s; [v_s', \bar{v}_s'], [v_b', \bar{v}_b'])\). Then \( x \) and \( y \) must
satisfy

\[
x U_b(y; [0, x], [y, 1]) + (1-x) U_b(y; [x, 1], [y, 1])
\]

\[
= x U_b(y; [0, x], [0, y]), \text{ and}
\]

\[
(1-y) U_s(x; [0, x], [y, 1]) + y U_s(x; [0, x], [0, y])
\]

\[
= (1-y) U_s(x; [x, 1], [y, 1]).
\]
We now make several assumptions on the bargaining environment that guarantee that these indifference conditions have a symmetric solution \( y \in \{1/2, 1\} \) and \( x = 1 - y \), and that a cheap-talk equilibrium of the form we describe exists.

**Definition:** A bargaining environment with types \( v \in [v_b, \bar{v}_b] \) and \( s \in [s_b, \bar{s}_b] \) is symmetric if

\[
U_b(v; [v_s, \bar{v}_s], [v_b, \bar{v}_b]) = U_s(1-v; [1-v_b, 1-v_b], [1-v_s, 1-v_s])
\]

for every \( v \in [v_b, \bar{v}_b] \).

**Assumptions:**

(A1) The bargaining environment is symmetric.

(A2) Trade occurs with positive probability when the type spaces are

\[
[y, \bar{v}], [y, \bar{v}].
\]

(A3) The seller (buyer) never trades at a price below (above) his type.

(A4) The interim payoff functions are continuous in all their arguments.

(A5) For each \( v_b \in [v_b, \bar{v}_b] \), \( U_b(v_b; [v_s, \bar{v}_s], [v_b, \bar{v}_b]) \) is monotone decreasing in \( v_s, \bar{v}_s, v_b, \) and \( \bar{v}_b \).

**Proposition 1:** Given (A1)-(A5), there exists an equilibrium in which cheap talk plays the role described above.

**Proof:** Substituting \( x = 1 - y \) into the indifference conditions and invoking the symmetry assumption (A1) shows that \( y \) must solve \( F(y) = 0 \), where

\[
F(y) = (1-y)U_b(y; [0,1-y],[y,1]) + y U_b(y; [1-y,1],[y,1])
\]

\[
- (1-y)U_b(y; [0,1-y],[0,y]).
\]
For \( y > 1/2 \), the subgame with type spaces \([0,1-y],[y,1]\) is problematic. As described earlier, we choose the equilibrium in which trade occurs with certainty at a price of \(1/2\). Hence
\[
U_b(y; [0,1-y],[y,1]) = y - \frac{1}{2},
\]
Because of the continuity assumption (A4), a suitable \(y \varepsilon (1/2,1)\) exists if \(F(1) > 0 > F(1/2)\). This holds because (A2) and (A5) guarantee that \(U_b(1; [0,1],[1,1])\) and \(U_b(1/2; [0, 1/2],[0, 1/2])\) are positive (because \(U_b\) is an increasing function of \(v_b\)), and (A3) ensures that
\[
U_b(1/2; [1/2,1],[1/2,1]) = 0.
\]
It remains to check that buyer-types above \(y\) prefer to say "keen", and those below prefer to say "not keen". We do this by showing that
\[
G(y') \equiv (1-y)U_b(y'; [0,1-y],[y,1]) + yU_b(y'; [1-y,1],[y,1])
\]
\[- ((1-y)U_b(y'; [1-y],[0,y])
\]
is positive for \(y' > y\) and negative for \(y' < y\).

For type spaces \(I_s\) and \(I_t\), the derivative of \(U_b(v_b; I_s,I_t)\) with respect to \(v_b\) is the probability that \(v_b\) trades in that bargaining environment. (To see this, apply the envelope theorem: we can assume that when \(v_b\) increases slightly, the buyer names the same price \(p_b\).) Now the probability of trade in the first subgame is 1 for all buyer-types above the equilibrium price, which (by symmetry) is 1/2. Therefore the first term dominates the third, and so for \(y' > 1/2\), \(G(\cdot)\) is increasing. Since \(G(y) = 0\) and \(y > 1/2\), this proves that \(G(y') > 0\) for all \(y' > y\), and that \(G(y') < 0\) for \(1/2 < y' < y\). When \(y' < 1/2\), the first term in \(G(\cdot)\) vanishes, and the second term also
vanishes because of (A5) and the argument that the price is 1/2 in the
subgame $\{[0,1-y],[y,1]\}$. Therefore $G(y') \leq 0$ for $y' \leq 1/2$. Q.E.D.

We can also generalize our finding in the Chatterjee-Samuelson example
that low-value buyers prefer the cheap-talk equilibrium to the no-cheap-talk
equilibrium. Intuitively, this is not surprising: with cheap talk, a low-
value buyer can improve his bargaining position by sacrificing the chance to
trade with high-value sellers—-and this sacrifice is costless or almost
costless to him, while imitating the "not keen" message is very costly for
high-value buyers.

To give our general result, we must define notation for ex-post payoffs
as a function of true types and of beliefs in the bargaining game. Thus, let

$$u_b(v_b, v_s; [v_s', \bar{v}_s], [v_b', \bar{v}_b])$$

be the ex-post payoff to buyer-type $v_b$ when the true seller-type is $v_s$ and
when it is common knowledge that the buyer's beliefs about $v_s$ are uniform on
$[v_s', \bar{v}_s]$, and that the seller's beliefs about $v_b$ are uniform on $[v_b', \bar{v}_b]$.

These beliefs might be incorrect, as when the parties are off the equilibrium
path. But when they are correct, the expectation of $u_b$ gives the interim
payoff $U_b$:

$$U_b(v_b; [v_s', \bar{v}_s], [v_b', \bar{v}_b]) = \mathbb{E}[u_b(v_b, v_s; [v_s', \bar{v}_s], [v_b', \bar{v}_b]|v_s[v_s', \bar{v}_s])]$$

To prove the result, we need an extra assumption: given the true seller-type,
the buyer becomes better-off if his beliefs about the seller become at once
more optimistic and more precise:

**Assumption:**

(A6) $u_b(v_b, v_s; [v_s', \bar{v}_s], [v_b', \bar{v}_b])$ decreases monotonically in $\bar{v}_s$ provided that
$v_s[v_s', \bar{v}_s]$. 
We now have:

**Proposition 2:** Given (A1), (A3), (A5), and (A6), all buyer-types \( v_b \leq 1-y \) (and all seller-types \( v_s \geq y \)) are better-off in our cheap-talk equilibrium than they are in the same bargaining environment without cheap talk.

**Proof:** We need to show that, when \( v_b \leq 1-y \),

\[
U_b(v_b; [0,1],[0,1]) \leq (1-y) U_b(v_b; [0,1-y],[0,y]).
\]

We first prove that

\[
U_b(v_b; [0,1],[0,1]) \leq (1-y) U_b(v_b; [0,1-y],[0,1]).
\]

By iterated expectation,

\[
U_b(v_b; [0,1],[0,1]) = \mathbb{E}[u_b(v_b,v_s; [0,1],[0,1]) | v_s \in [0,1]]
\]

\[
= (1-y) \mathbb{E}[u_b(v_b,v_s; [0,1],[0,1]) | v_s \in [0,1-y]]
\]

\[
+ y \mathbb{E}[u_b(v_b,v_s; [0,1],[0,1]) | v_s \in [1-y,1]].
\]

But by hypothesis \( v_b \) never trades with seller-types above \( 1-y \), so the second term disappears. Now apply (A6) inside the expectation in the first term: a change in the buyer's beliefs from "\( v_s \in [0,1] \)" to "\( v_s \in [0,1-y] \)" makes him better-off ex-post for all true types \( v_s \in [0,1-y] \). Therefore

\[
U_b(v_b; [0,1],[0,1]) \text{ is less than or equal to } (1-y)U_b(v_b; [0,1-y],[0,1]).
\]

To conclude the proof, note that

\[
U_b(v_b; [0,1-y],[0,1]) \leq U_b(v_b; [0,1-y],[0,y]),
\]

because of (A5). Q.E.D.
4. Conclusion

This is in part a polemical piece. We believe that the economic importance of costless, non-verifiable, informal communication is much greater than its role in the literature suggests. The seminal work, by Crawford and Sobel (1982), is justly famous, but applications have been slow to appear.

This paper introduces cheap talk to bargaining games. Crawford and Sobel show that cheap talk may be credible if agents' interests are not completely opposed. In bargaining, agents are in conflict over the price if trade occurs, but have common interests in consummating trade when the buyer's value exceeds the seller's.

In general, cheap-talk games have multiple equilibria. Ours is no exception. Unfortunately, standard refinement techniques such as that of Cho and Kreps (1985) have no effect. Farrell (1986a) has taken the first steps towards a refinement technique for cheap-talk games, but it is not yet clear whether this helps in our problem.

Cheap talk can be important in economic settings other than bargaining. Farrell (1986b), for instance, studies cheap talk between potential entrants in a natural monopoly, Farrell and Saloner (1985) consider cheap talk between potential adopters of a new technology, Gibbons (1986) models conventional arbitration as a cheap-talk game, and Sobel (1985) develops a theory of credibility in finitely repeated relationships. The fundamental insight that cheap talk can be credible in variable-sum games, combined with the ubiquity of such talk, suggests that a rich collection of other applications lies ahead.
Appendix

In this appendix we adapt the Chatterjee-Samuelson analysis to suit our purposes, and then use the results to derive the equilibrium value of \( y \).

Chatterjee and Samuelson consider a bargaining game with seller-type \( v_s \) uniformly distributed on \([v_{-s}, v_s]\) and buyer-type \( v_b \) independently and uniformly distributed on \([v_{-b}, v_b]\). Both parties name prices, \( p_s \) and \( p_b \), and trade occurs at the average of the two prices if the buyer's price exceeds the seller’s.

As Chatterjee-Samuelson show, an essential part of the equilibrium is the solution of a linked pair of differential equations, and one solution (on which we and they focus) is linear:

\[
\tilde{p}_s(v_s) = \frac{2}{3} v_s + \frac{1}{4} v_b + \frac{1}{12} v_s, \text{ and}
\]

\[
\tilde{p}_b(v_b) = \frac{2}{3} v_b + \frac{1}{4} v_s + \frac{1}{12} v_b.
\]

When these functions imply that no type of either party is sure to trade (that is, \( \tilde{p}_b(v_b) < \tilde{p}_s(v_s) \) and \( \tilde{p}_s(v_s) > \tilde{p}_b(v_b) \)), then the equilibrium strategies are \( p_s(v_s) = \tilde{p}_s(v_s) \) and \( p_b(v_b) = \tilde{p}_b(v_b) \).

If, on the other hand, these functions make one party sure to trade, then there is an incentive to deviate, and the equilibrium is modified as follows: If some type of some player is not sure to trade, then the buyer-type \( v_b \) names the price \( p_b(v_b) = \min(\tilde{p}_b(v_b), \tilde{p}_s(v_s)) \) and the seller-type \( v_s \) names the prices \( p_s(v_s) = \max(\tilde{p}_s(v_s), \tilde{p}_b(v_b)) \). If all types of both players are sure to trade, however, then the Chatterjee-Samuelson analysis breaks down, and a continuum of equilibria exist in which all types of both parties
name any price in the interval \([\bar{v}_s, \bar{v}_b]\). We deal with this case below.

When no seller-type is sure to trade, calculation shows that the buyer's interim payoff is:

$$U_b(v_b; [v_s, \bar{v}_s], [\bar{v}_b, v_b]) = \begin{cases} 
0 & \text{if } v_b \leq \underline{\bar{v}}, \\
\frac{(v_b - \underline{\bar{v}})^2}{2(\bar{v}_s - v_s)} & \text{if } \underline{\bar{v}} < v_b \leq \bar{\beta}, \\
v_b - \bar{\beta} + \frac{\bar{v}_s - v_s}{2} & \text{if } v_b > \bar{\beta},
\end{cases}$$

where \(\Delta = (\bar{v}_b - v_s)/4\), \(\underline{\bar{v}} = v_s + \Delta\), and \(\bar{\beta} = \bar{v}_s + \Delta\). (In this notation, no seller-type is sure to trade when \(v_b < \underline{\bar{v}}\).) The three cases in (2) correspond to the cases in which the buyer, given \(v_b\) and the supports of the players' types, is sure not to trade, might trade, or is sure to trade, respectively. When some but not all seller-types are sure to trade (i.e., \(\underline{\bar{v}} < v_b < \bar{\beta}\)), an interval of seller-types trade with the lowest buyer-type. The interim payoff to \(v_b\) is then

$$U_{-b}(v_b; [v_s, \bar{v}_s], [\bar{v}_b, v_b]) = \frac{(v_b - v_s - \Delta)^2}{\bar{v}_b - v_s - \Delta}$$

and the interim payoff for other buyer types is

$$U_b(v_b; [v_s, \bar{v}_s], [\bar{v}_b, v_b]) = \begin{cases} 
\frac{(v_b - v_s - \Delta)^2}{2(\bar{v}_s - v_s)} - \frac{1}{2} U_b & \text{if } v_b \leq \bar{\beta}, \\
v_b - \bar{\beta} - \frac{1}{2} U_b + \frac{\bar{v}_s - v_s}{2} & \text{if } v_b > \bar{\beta}.
\end{cases}$$
Finally, when all seller-types are sure to trade \( \bar{s} < v_b \), then all buyer-types also are sure to trade, and the Chatterjee-Samuelson analysis break down: the bids given by (1) are irrelevant, and the strategies \( p_b(v_b) = \tilde{p}_b(v_b) \) and \( p_s(v_s) = \tilde{p}_s(v_s) \) are not an equilibrium. Without proposing a general theory for this problem, we note that the subgame \([v_s \in [0,1-y], v_b \in [y,1]]\) is symmetric about \( \frac{1}{2} \) and so (when \( y > \frac{1}{2} \)) it is natural to assume that trade will occur with certainty at a price of \( \frac{1}{2} \). Then a buyer-type \( v_b > \frac{1}{2} \) gets a payoff \( (v_b - \frac{1}{2}) \).

As described in the text, an equilibrium value of \( y \) must satisfy

\[
(5) \quad (1-y)U_b(y; [0,1-y],[y,1]) + y U_b(y; [1-y,1],[y,1]) = (1-y)U_b(y; [0,1-y],[0,1]),
\]

since the left-hand side represents \( y \)'s expected payoff if he says "keen" and the right-hand side represents his payoff if he says "not keen".

Now the first term in (5) is strictly less than the right-hand side, because the only difference is that the seller is more optimistic about the buyer's type. Therefore the second term is strictly positive, so the buyer of type \( y \) trades at least sometimes in that subgame (\( y > \bar{s} = 1 - \frac{3}{4}y \), or \( y > \frac{4}{7} \)), and some seller-types trade for sure. On the other hand, since in this subgame \( \bar{s} > 1 \), not all seller-types trade for sure. Thus (3) applies in the second term of (5).

In the third term, which involves the subgame \([v_s \in [0,1-y], v_b \in [0,y]]\), the critical type \( \bar{s} = 1 - \frac{3}{4}y \), so \( y \) trades for sure in that subgame, since \( y > \frac{4}{7} \) implies \( y > \bar{s} \). But \( v_b = 0 < \bar{s} = \frac{1}{4}y \), so no seller-type is sure to trade and the bottom case of (2) applies.

Finally, in the first term, involving the subgame \([v_s \in [0,1-y], \)
\( v_b \epsilon[y,1] \) (in which both players are keen), \( \frac{5}{4} - y \). So if \( y > \frac{5}{4} - y \), or \( y > \frac{5}{8} \), then \( y \) trades for sure when both agents are keen. This means that all types of both agents trade for sure, and the Chatterjee-Samuelson analysis breaks down, so we impose trade with certainty at price \( \frac{1}{2} \). Substituting this the other formulae into (5) yields

\[
(1-y)(y - \frac{1}{2}) + \frac{1}{3}y(\frac{7}{4}y-1)^2 = \frac{1}{2}(1-y)(\frac{5}{4}y - \frac{1}{2}),
\]

which has solutions

\[
y = \frac{\sqrt{2} \pm 12}{49}
\]

\[
= .103 \text{ or } .795
\]

Since the analysis of the second term proves that \( y > \frac{4}{7} \), the solution is \( y = .795 \), which exceeds \( \frac{5}{8} \), confirming that both parties trade for sure when both are keen.
FIGURE 1
For those who miss the lawyers, consider the commitment necessary to play even this simple game: what, for instance, stops one party from reneging on his offer in order to capitalize on the information conveyed by the other party's offer? This is part of a more general point made in footnote 6.

One justification for this is that the parties need to coordinate on when and where to meet on Monday, and an attempt to arrange a meeting belies a party's claim that he is "not keen". Note that this is not the same as saying that talk determines whether the parties can meet; such talk would not be cheap talk. Here the set of times and places available for a meeting is independent of the talk. Although we find this coordination-problem interpretation realistic, it involves two rounds of cheap talk and gets rather cumbersome, so we do not rely on it.

In the familiar case in which the equilibrium strategies are linear and both buyer's value $v_b$ and seller's value $v_s$ are independently and uniformly distributed on $[0,1]$, all buyers with $v_b > 1/4$ and all sellers with $v_s < 3/4$ claim to be "keen". Strictly, the other types of buyers and sellers, who will not trade, may say anything. But if there are any costs of serious bargaining, then they must say "not keen".

We wonder whether this feature would disappear in an equilibrium of a new game with either more rounds of cheap talk or (equivalently) one round with a richer language.

Consider, for instance, Schelling's (1960) famous coordination problem, in which two parties wish to meet in New York City, either at the Empire State Building or at Grand Central Station. Each party receives a payoff of 1 if they meet and 0 if they do not. Clearly, the problem is interesting only if cheap talk is not possible.

Of course, the subsequent Chatterjee-Samuelson bargaining game does require a mediator, both to accept simultaneous reports and to force the parties to walk away if trade is not prescribed (even if trade would be efficient). But such a game is hardly central to our analysis, as the general results in Section 3 show. Indeed, these results may cover bargaining games that do not need mediators for either of the reasons given above. See Cramton (1985) for more on such games.
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