Sales Talk

Selling with evidence (in progress)

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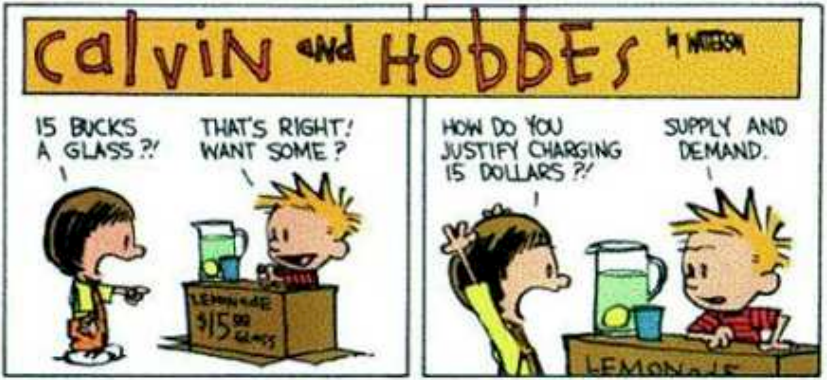

Motivating Example: How to sell house wine?

- Buyer can be one of three types:
  - t_l likes only Lirac
  - t_r likes only Riesling
  - t_i is indifferent between Lirac and Riesling
- Tavern selling house wine: type of wine private information (buyer unable to tell by looking at the carafe/bottle...)
  - s_L house wine is Lirac
  - s_R house wine is Riesling
- Seller wants to maximize expected payment
- Buyer accepts the deal if the expected match is higher than the expected payment

Motivating Example: Match Function

Example

$u(s,t) =$

	t_l	t_r	t_i
s_L	30	0	20
s_R	0	32	20

(uniform priors)

Optimal pooling posted price mechanism: sell at 15 euros to all types

$\rho = (p,x) =$

	t_l	t_r	t_i
s_L	$1,15$	$1,15$	$1,15$
s_R	$1,15$	$1,15$	$1,15$

$\Rightarrow$ interim revenue $X(s) = 15$

Optimal price with full info revelation: sell at 20 euros to $2/3$ of types

$\rho =$

	t_l	t_r	t_i
s_L	$1,20$	$0,0$	$1,20$
s_R	$0,0$	$1,20$	$1,20$

$\Rightarrow X(s) = 20 \times \frac{2}{3} \simeq 13.3 < 15$ worse

Motivating Example: Bilateral Communication

Consider the following scenario:

- seller asks the buyer: "are you t_i?"
- if buyer says yes, seller asks a price of 20, buyer accepts
- if buyer says no, seller tells him whether he is s_L or s_R and asks a price of 30, t_l accepts if seller said s_L, t_r accepts if seller said s_R

This protocol implements a feasible mechanism which is strictly better than posted prices:

$$\rho = \begin{array}{|c|c|c|c|} \hline & t_l & t_r & t_i \\ \hline s_L & 1,30 & 0,0 & 1,20 \\ \hline s_R & 0,0 & 1,30 & 1,20 \\ \hline \end{array} \Rightarrow X(s_L) = X(s_R) = 50/3 \simeq 16.7 > 15$$

A better (ex-ante and interim) mechanism is:

$\rho =$

	t_l	t_r	t_i
s_L	$1, 30$	$0, 0$	$1, 20$
s_R	$0, 0$	$1, 32$	$1, 20$

- Buyer-IC and Buyer-PC are satisfied
- But not Seller-IC: $X(s_R) = 52/3 > X(s_L) = 50/3$

Modified feasible and (ex-ante) equally profitable mechanism:

$\tilde{\rho} =$

	t_l	t_r	t_i
s_L	$1, 15$	$0, 16$	$1, 20$
s_R	$0, 15$	$1, 16$	$1, 20$

$\Rightarrow \tilde{X}(s_L) = \tilde{X}(s_R) = 51/3 > 50/3$

The optimal mechanisms we derive are based on this idea

Remarks on the Example

- posted price is not optimal
  - in contrast to Riley and Zeckhauser (1983), Myerson (1981) (seller has no private information) and Yilankaya (1999) (seller has private information–but buyer's willingness to pay does not depend on it)
- bilateral cheap talk communication with partial information transmission followed by a conditional price is strictly better than posted price
- mediated selling mechanisms are even better
- the seller strictly benefits from having private information
  - in contrast to Maskin and Tirole (1990) and Yilankaya (1999)

Model

- 1 seller, privately known type (product characteristic) $s \in S$
- 1 buyer, privately known type (taste) $t \in T$
- types are independently distributed
- match function (buyer's valuation): $u(s, t) \in \mathbb{R}$
- seller cares only about revenue
- information is soft (hard information / evidence about s: in progress)
- selling procedure–the mechanism–is chosen by the seller

Main Contributions and Results

- An ex-ante optimal mechanism is an equilibrium of the mechanism selection game, but other (sub-optimal) equilibria exist
- The seller (in most cases strictly) benefits from being privately informed
- Characterization of optimal mechanisms for convex match functions
  - Application to a continuous version of the house wine example
  - Sufficient conditions for the ex-ante optimal revenue to be equal to the full-information revenue
- Information certification cannot be ex ante valuable for the seller
- In progress: Equilibria with certifiable information about product characteristics; failure of the unravelling argument

Mechanisms

- Mechanism (direct): $\rho = (p, x) : S \times T \to [0, 1] \times \mathbb{R}$
  - $p(s, t)$: probability of sale
  - $x(s, t)$: expected transfer (price)
- Seller's payoff:

$$x(s, t)$$

- Buyer's payoff:

$$U(s, t) = p(s, t)u(s, t) - x(s, t)$$

Mechanism Selection Game

Is an ex-ante optimal mechanism, that maximizes the seller's ex-ante revenue under (B-IC), (B-PC), (S-IC) and (S-PC), an equilibrium of the mechanism selection game?

Myerson (1983):

Expectational Equilibrium. $\rho = (p, x)$ is an expectational equilibrium iff it is feasible, and for every generalized mechanism M, there exists a belief μ for the buyer, reporting and participation strategy profiles that form a Nash equilibrium given M and μ, with outcome $(\tilde{p}, \tilde{x})$, such that for all $s \in S$:

$$E_T(x(s,t) \mid s) \geq E_T(\tilde{x}(s,t) \mid s)$$

Equilibria

Proposition

An ex-ante optimal mechanism is an expectational equilibrium.

Proof.

Use passive beliefs off the equilibrium path. □

Remark: The set of ex-ante optimal mechanisms also coincides with the set of "core mechanisms" (Myerson 1983).

Proposition

Every feasible mechanism in which the interim revenue is higher than the full-information interim revenue (optimal revenue when the seller's type is known) is an expectational equilibrium.

Proof.

Use extremal beliefs off the equilibrium path. □

In the wine example, the following mechanisms are expectational equilibria

- ex-ante optimal mechanism (revenue $51/3$)
- full-information mechanism (IC for seller): $40/3 \geq 40/3$
- pooling posted price mechanism: $15 \geq 40/3$
- bilateral cheap talk and contingent prices: $50/3 \geq 40/3$

Value of Information

Proposition

The optimal mechanism generates weakly higher ex-ante expected revenue compared to the full-information optimal mechanism.

Seller benefits from having private information because (S-IC) is never binding, and uncertainty about the seller's type relaxes (B-IC) or (B-PC) or both.

A sufficient condition for the irrelevance of the seller's information:

Proposition

Assume that $t^{min}(s) \in \arg\min_t u(s,t)$ *is independent of* s *and* $u(s,t)$ *is convex in* t *for every* $s \in S$. *Then, under a Myerson-type regularity condition, the optimal revenue is equal to the full-information ex-ante revenue.*

Note: Simple examples show that monotonicity of $u(s,t)$ in s or t is not sufficient for information irrelevance

Evidences / Certification about Product Characteristics

The seller and buyer can still submit soft messages, but the seller can also certify information about product through type-dependent messages sets (= certifiability structure)

A revelation principle still applies to characterize feasible mechanisms (Bull and Watson (2007), Deneckere and Severinov (2008), Green and Laffont (1986), and Forges and Koessler (2005))

Proposition

The set of feasible ex-ante revenues of the seller is independent of the certifiability structure. In particular, the ex-ante optimal revenue is independent of the certifiability structure.

Equilibria with Product Information Certification

A necessary equilibrium condition:

Proposition

Under own-type certifiability, in any expectational equilibrium the interim payoff of the seller is higher than the full-information interim payoff of the seller.

Proof.

Seller can always deviate to a posted price mechanism and fully certify his type; this deviation is *safe* (IC whatever the buyer's belief) □

Is a feasible mechanism with interim revenues higher than the full-information interim revenues always an equilibrium?

- With posted prices only, the full-information mechanism is *always* an equilibrium, and it is the unique one when u is monotonic in s (Milgrom, 1981; Koessler and Renault, 2012)

BUT full-information optimal mechanisms may NOT be equilibria of our mechanism selection game, even when u is monotonic in s ($s \simeq$ quality)

The UNRAVELLING argument Fails!

Example

$u(s,t) =$

	t_1	t_2
s_1	5	3
s_2	1	2

Full-information optimal mechanism:

$M^{FI} =$

	t_1	t_2
s_1	$1,3$	$1,3$
s_2	$1,1$	$1,1$

or $M^{FI} =$

	t_1	t_2
s_1	$1,3$	$1,3$
s_2	$1,2$	$1,0$

Full information interim revenues: $X^{FI}(s_1) = 3$, $X^{FI}(s_2) = 1$

Consider the following deviation:

$\widehat{M} =$

	t_1	t_2
s_1	$1, 0.5$	$1, 4.2$
s_2	$1, 4.4$	$1, 0.7$

Whatever the buyer's belief about s he never rejects (he either reports t_1 or t_2)

But then, whatever the probability distribution of the buyer's report on $\{t_1, t_2\}$, either $s = s_1$ or $s = s_2$ gets more than $X^{FI}(s)$

$\Rightarrow$ profitable deviation whatever the belief and (sequentially) rational strategy of the buyer

Open Question: Sufficient equilibrium conditions when seller's type is certifiable?

Thank You!

References

BULL, J. AND J. WATSON (2007): "Hard Evidence and Mechanism Design," *Games and Economic Behavior*, 58, 75–93.

DENECKERE, R. AND S. SEVERINOV (2008): "Mechanism design with partial state verifiability," *Games and Economic Behavior*, 64, 487–513.

FORGES, F. AND F. KOESSLER (2005): "Communication Equilibria with Partially Verifiable Types," *Journal of Mathematical Economics*, 41, 793–811.

GREEN, J. R. AND J.-J. LAFFONT (1986): "Partially Verifiable Information and Mechanism Design," *Review of Economic Studies*, 53, 447–456.

KOESSLER, F. AND R. RENAULT (2012): "When Does a Firm Disclose Product Information?" *Rand Journal of Economics*, forthcoming.

MASKIN, E. AND J. TIROLE (1990): "The principal-agent relationship with an informed principal: The case of private values," *Econometrica: Journal of the Econometric Society*, 379–409.

MILGROM, P. (1981): "Good News and Bad News: Representation Theorems and Applications," *Bell Journal of Economics*, 12, 380–391.

MYERSON, R. (1981): "Optimal Auction Design," *Mathematics of Operations Research*, 6, 58.

——— (1983): "Mechanism design by an informed principal," *Econometrica: Journal of the Econometric Society*, 1767–1797.

RILEY, J. AND R. ZECKHAUSER (1983): "Optimal selling strategies: When to haggle, when to hold firm," *The Quarterly Journal of Economics*, 98, 267–289.

YILANKAYA, O. (1999): "A note on the seller's optimal mechanism in bilateral trade with two-sided incomplete information," *Journal of Economic Theory*, 87, 267–271.