

# For Qualified Buyers Only

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# Motivation: endogenous info about buyers

Hard information about buyers is taken as given in standard monopoly pricing models:

- ▶ **First-degree**: value known.
- ▶ **Third-degree**: type known.
- ▶ **Uniform pricing and Second-degree**: nothing known.

This paper endogenizes the seller's hard info about the buyer, effectively endogenizing the market segments in third-degree p.d.

# Exogenous or endogenous information?

The assumption of exogenous information sometimes is reasonable:

- ▶ *a priori known*: e.g. employee discounts.
- ▶ *costless to observe*: e.g. “ladies’ night” at nightclubs.
- ▶ *costless to disclose*: e.g. Kama’aina rate for Hawaiians.

Other times, pricing-relevant information about the buyer is costly.

- ▶ *disclosing information*: the buyer may find it inconvenient or embarrassing to share information about himself.
- ▶ *acquiring information*: the seller may find it costly to investigate the buyer.
- ▶ *advertising channel access*: the seller and/or the buyer may have to pay to utilize an advertising channel.

# Outline of talk

- ▶ **Motivating examples**
- ▶ Model & preview of results
- ▶ Special case: perfectly informative types
- ▶ Optimal sales mechanism with costly disclosure
- ▶ Remarks

## Motivating example: financial aid

Middlesex School, an elite private high school in Massachusetts, charged tuition \$35,450 for its day students in 2009-2010.

About 30% of students received financial aid, with an average tuition reduction of about \$32,000 to families receiving aid.

Income Level	> \$30,000	\$15,000 – \$30,000	< \$15,000
\$0 – \$50,000	17	1	1
\$50,000 – \$100,000	16	4	2
\$100,000 – \$200,000	17	21	1
over \$200,000	0	11	4

Table: Distribution of family income and tuition grants

## Motivating example: drug pricing

Avastin extends life on average by 4.7 months in patients with colorectal cancer, at cost  $\sim$  \$50,000.

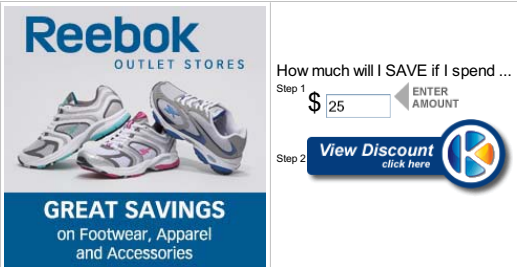
“Avastin Access Solutions” is a service offered by Genentech to offer customized discounts to patients who claim hardship and share details of their coverage and financial situation.

Offering such help is costly to Genentech, but allows them to avoid pricing out sick potential customers. This cost is avoided with patients who pay full “sticker price”.

# Motivating example: Keycode.com

Keycode.com allows sellers to offer customized coupons based on information maintained on the website.

## Make A Custom Printable Coupon for Reebok



The image shows a coupon interface for Reebok Outlet Stores. On the left, there is a promotional graphic with the Reebok logo and 'OUTLET STORES' text, featuring a pair of sneakers and the text 'GREAT SAVINGS on Footwear, Apparel and Accessories'. On the right, there is a form titled 'How much will I SAVE if I spend ...'. Step 1 involves entering an amount into a text box with a dollar sign and a '25' value, with an arrow pointing to the box labeled 'ENTER AMOUNT'. Step 2 is a blue button labeled 'View Discount click here' with a circular icon containing a stylized 'K'.

# Motivating example: Keycode.com

“We generate sales in-store and online for retail clients on a pay-per-sale basis ... through a unique (and patent-pending) form of dynamic offer generation”.

This keycode made at



**Reebok**  
OUTLET STORES



**5.00 OFF** any purchase of \$50.00 or more  
**10.00 OFF** any purchase of \$65.00 or more

Please print & present this coupon at time of purchase to receive discount. Valid only at Reebok and Rockport Outlet Stores. Cannot be combined with any other coupon, group offer, or with Footwear Search Program. Not valid on prior purchases or on the purchase of gift certificates. Limit one per customer.

**GREAT SAVINGS**  
on Footwear, Apparel  
and Accessories


\$5.00 off \$50.00 or more  
\$10.00 off \$65.00 or more

8888657      8888658      Expires 12/24/2009

This keycode made at



**Reebok**  
OUTLET STORES



**20.00 OFF** any purchase of \$100.00 or more

Please print & present this coupon at time of purchase to receive discount. Valid only at Reebok and Rockport Outlet Stores. Cannot be combined with any other coupon, group offer, or with Footwear Search Program. Not valid on prior purchases or on the purchase of gift certificates. Limit one per customer.

**GREAT SAVINGS**  
on Footwear, Apparel  
and Accessories

\$20.00 off \$100.00 or more

8888659      Expires 12/24/2009

# Motivating example: Restaurants.com

Restaurants.com charges \$10 for \$25 coupons at its partner restaurants, thereby “verifying” that the buyer uses the site.

[Start Search](#) > 90024 >

119 restaurants within 5 Miles of 90024 [Refine](#)

Sort By: Relevance

View restaurants per page: 10 | [25](#)

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## ★ NEW IN YOUR AREA



AMERICAN | STEAK HOUSE

### [Ketchup](#)

8590 Sunset Boulevard  
West Hollywood, CA 90069  
(310) 289-8590

Ketchup takes classic American cuisine and catapults the dishes into the modern age.

[MENU](#)

🍷 **\$25 Gift Certificate** | Your Price \$10

🍷 **\$50 Gift Certificate** | Your Price \$20

[Add to Cart](#)

Sunday-Thursday with a minimum purchase of \$50. Dine in only. Dinner only. Not valid with other offers or promos. 18% gratuity added before discount.

## ★ RECOMMENDED IN YOUR AREA



CALIFORNIAN | FRENCH

### [Cafe Fabien](#)

214 S. Robertson Blvd.  
Beverly Hills, CA 90211  
(310) 659-6877

Restaurant critics, neighborhood regulars, and first time visitors always agree about Cafe Fabien: the atmosphere is great, the food is superb, and the service is outstanding.

[MENU](#) | [FREE RESERVATION](#)

🍷 **\$10 Gift Certificate** | Your Price \$4

🍷 **\$25 Gift Certificate** | Your Price \$10

🍷 **\$50 Gift Certificate** | Your Price \$20

[Add to Cart](#)

Valid with a minimum food purchase of \$35. Dine-in only. 18% gratuity added to pre-discounted check amount.

# Outline of talk

- ▶ Motivating examples
- ▶ **Model & preview of results**
- ▶ Special case: perfectly informative types
- ▶ Optimal sales mechanism with costly disclosure
- ▶ Remarks

# Model: buyer value and type

Single, indivisible, perishable good for sale to a risk-neutral buyer having unknown value  $v$ .

Buyer's value  $v$  has conditional cdf  $F(v|t)$ , and continuously differentiable pdf  $f(v|t)$ . Type  $t$  has pdf  $g(t)$ .

**Assumption 1:**  $v - \frac{1-F(v|t)}{f(v|t)}$  strictly increasing in  $v$  for all  $t$ .

# Model: sales mechanisms with costly disclosure

A sales mechanism with costly disclosure specifies:

- ▶ Message space  $M = X \times (T \cup \{\emptyset\})$ , where  $X$  is cheap talk and  $T$  is set of types. (Only messages  $M_\emptyset = X \times \{\emptyset\}$  and  $M_t = X \times \{t\}$  are feasible for a buyer of type  $t$ .)
- ▶ Allocation probability  $q(m)$  for all messages  $m$
- ▶ Payment  $z(m)$  for all messages  $m$

# Model: costs of disclosure

Disclosure can be costly.

1. **enabling disclosure.**

The seller pays upfront cost  $d_S(t)$  to enable the buyer to disclose type  $t$  (additive over types).

2. **disclosing / “processing” disclosures.**

Should the buyer disclose type  $t$ , the buyer incurs cost  $c_B(t) \geq 0$  while the seller incurs cost  $c_S(t) \geq 0$ . Let  $c = c_B + c_S$ .

**Assumption [[current draft only]]:**  $d_S(t) = 0$ ,  $c_B(t) = c_B \geq 0$ , and  $c_S(t) = c_S \geq 0$  for all  $t$ .

*Aside:* The analysis here does *not* address situations in which the seller chooses whether to “audit” the buyer, or in which the seller can avoid its share of the disclosure cost.

# Model: price-list mechanisms

A price-list mechanism is a sales mechanism with costly disclosure characterized by a list of take-it-or-leave-it prices.:

- ▶ “sticker price”  $p(\emptyset)$  for any buyer who does not disclose
- ▶ “discounts”  $p(t)$  for all  $t \in D$ , for some  $D \subset T$ .
- ▶ without loss, prices satisfy  $p(t) \leq p(\emptyset) - c_B$  for all  $t \in D$

# Preview of main results

The optimal sales mechanism with costly disclosure is a price-list mechanism (Thm 1).

Three conditions characterize the optimal price-list mechanism (Thm 2).

Unambiguous welfare comparative statics in limiting special case in which type is fully informative of the buyer's value (Prop 2):

- ▶ Ex post buyer welfare  $\uparrow$  in  $c$
- ▶ Expected seller profit  $\downarrow$  in  $c$
- ▶ Discounts lower [buyer welfare + seller profit] whenever they are offered sufficiently rarely.

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# Assumptions: perfectly informative types

Suppose that  $t = v$ , and let  $F(v)$  be cdf. I will maintain alternative hazard-rate condition for this part of talk:

**Assumption 1'**:  $v - \frac{1-F(v)}{f(v)}$  strictly increasing in  $v$ .

Also, suppose for simplicity that  $c_B = 0$  and  $c_S = c$ .

# Review: Marginal Revenue

Selling to type  $v$  creates total surplus  $f(v)v$ , but increases surplus of higher types by  $(1 - F(v))$ . In terms of “virtual values”:

$$\text{Marginal revenue } MR(v) = f(v) \left( v - \frac{1-F(v)}{f(v)} \right) = f(v)VV(v)$$

- ▶ Optimal to sell to type  $v$  when  $VV(v) > 0$ , and not otherwise.

# Net Revenue

If type  $v$  is not pooled at the sticker price, the alternative now is no longer zero revenue. Type  $v$  can be induced to reveal his type and pay price  $p^*(v) = v$ , for “net value”  $NV(v) = v - c$ .

- ▶ Optimal to sell to type  $v$  at sticker price when  $VV(v) > \max\{0, NV(v)\}$ .
- ▶ Optimal to sell to type  $v$  at customized price when  $NV(v) > \max\{0, VV(v)\}$ .

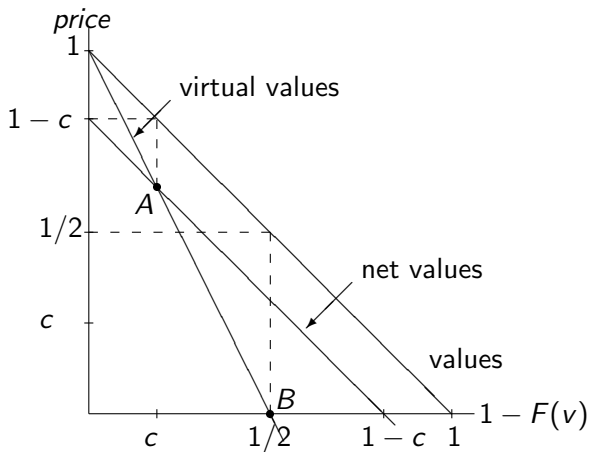
# Optimal price-list mechanism

**Proposition 1:** The optimal price-list mechanism has disclosure set  $D^* = (c, p^*(\emptyset))$ , customized prices  $p^*(v) = v$  for all  $v \in D^*$ , and sticker price

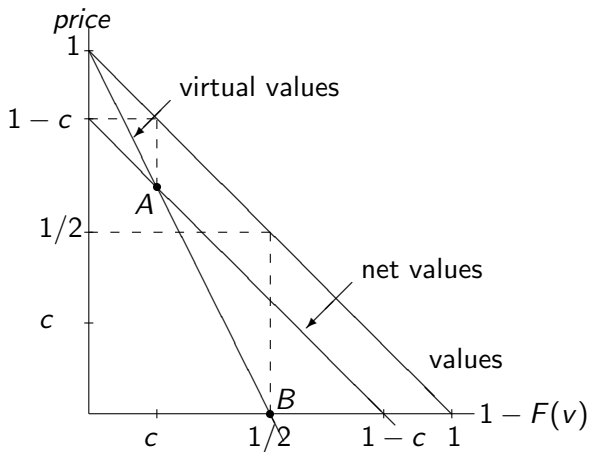
$$p^*(\emptyset) \in \arg \max_p \left( \int_p^\infty f(v) \left( v - \frac{1 - F(v)}{f(v)} \right) dv \right. \quad (1) \\ \left. + \int_{\min\{p, c\}}^p f(v)(v - c) dv \right).$$

**Corollary:** Suppose that  $\frac{1 - F(v)}{f(v)}$  is strictly decreasing in  $v$ . Then the optimal sticker price  $p^*(\emptyset)$  is uniquely determined by  $\frac{1 - F(p^*(\emptyset))}{f(p^*(\emptyset))} = \min\{p^*(\emptyset), c\}$ .

# Uniform demand example: sticker $p^*(\emptyset) = 1 - c$ .

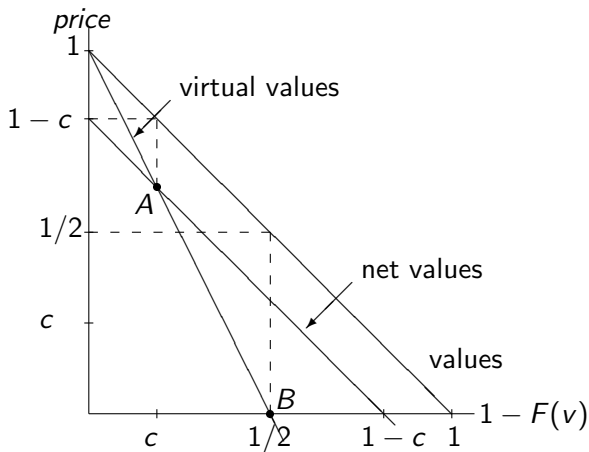


# Uniform demand example: sticker $p^*(\emptyset) = 1 - c$ .



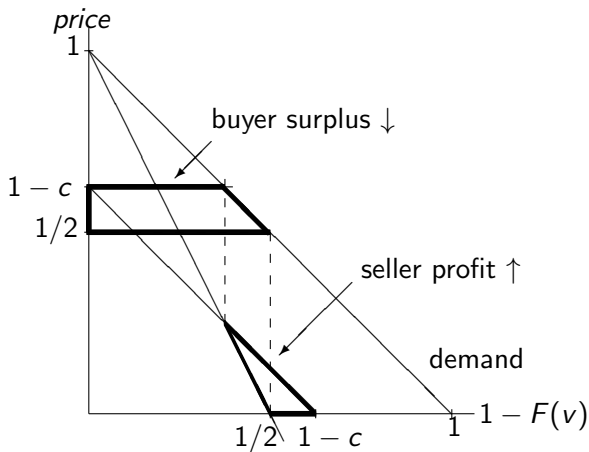
Buyer ex post surplus non-decreasing in  $c$ .

# Uniform demand example: sticker $p^*(\emptyset) = 1 - c$ .



Seller expected surplus non-increasing in  $c$ .

# Uniform demand example: sticker $p^*(\emptyset) = 1 - c$ .



When  $c = 1/2 - \epsilon$ , disclosure yields second-order gain to seller & first-order loss to buyer.

# Welfare effects

## Proposition 2:

- ▶ The seller's expected profit is non-increasing in  $c$ .
- ▶ The buyer's ex post surplus is non-decreasing in  $c$ .
- ▶ As long as the buyer is offered a discount sufficiently rarely, total welfare is strictly lower under optimal sticker pricing than under optimal uniform pricing.

# Outline of talk

- ▶ Motivating examples
- ▶ Model & preview of results
- ▶ Special case: perfectly informative types
- ▶ **Optimal sales mechanism with costly disclosure**
  - ▶ Review: Optimality of a posted price absent disclosure
  - ▶ Optimality of a posted price list
  - ▶ Properties of optimal price list
  - ▶ Remarks

# Optimality of a posted price, absent disclosure

**Theorem (Riley Zeckhauser):** When disclosure is not possible, the expected profit-maximizing sales mechanism (subject to interim IR and interim IC) is a posted price.

1. **Revelation Principle**
  2. Envelope Theorem
  3. Zero surplus to zero-value buyers
  4. Marginal revenue
  5. Posted price interpretation
- ▶ Without loss, consider direct-revelation mechanisms.
  - ▶ Buyer expected surplus  $S(v) = vq(v) - z(v)$ . [ $q(\cdot)$  = allocation probability,  $z(\cdot)$  = payment.]

# Optimality of a posted price, absent disclosure

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1. Revelation Principle
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▶ IC requires  $S(v) = \max_{v'} vq(v') - z(v') \Rightarrow$  Envelope Theorem implies that  $S(v) = S(0) + \int_0^v q(v')dv'$ .

$$R(q(\cdot), S(0)) = \int_0^\infty \left( vq(v) - \int_0^v q(v')dv' \right) f(v)dv - S(0)$$

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1. Revelation Principle
  2. Envelope Theorem
  3. **Zero surplus to zero-value buyers**
  4. Marginal revenue
  5. Posted price interpretation
- ▶ Expected revenue is decreasing in  $S(0)$ , so zero-value buyer must get zero surplus in any optimal mechanism.

# Optimality of a posted price, absent disclosure

**Theorem (Riley Zeckhauser):** When disclosure is not possible, the expected profit-maximizing sales mechanism (subject to interim IR and interim IC) is a posted price.

1. Revelation Principle
  2. Envelope Theorem
  3. Zero surplus to zero-value buyers
  4. **Marginal revenue**
  5. Posted price interpretation
- ▶ Increasing allocation probability to buyer  $v$  has two effects: (i) raises ex ante revenue from them ( $+f(v)v$ ); (ii) increases surplus of all higher types ( $-(1 - F(v))$ )
  - ▶ Allocate to buyer  $v$  iff “virtual value”  $v - \frac{1-F(v)}{f(v)} > 0$ .

# Optimality of a posted price, absent disclosure

**Theorem (Riley Zeckhauser):** When disclosure is not possible, the expected profit-maximizing sales mechanism (subject to interim IR and interim IC) is a posted price.

1. Revelation Principle
2. Envelope Theorem
3. Zero surplus to zero-value buyers
4. Marginal revenue
5. **Posted price interpretation**

- ▶ Let  $v^*$  be threshold value with zero virtual value.
- ▶  $z(v) = v - S(v) = v^*$  for all  $v > v^*$  while  $z(v) = 0$  for all  $v < v^* \Rightarrow$  posted price equal to  $v^*$ !

# Subtleties introduced by disclosure

What new issues arise when the buyer can disclose his type?

1. **Revelation Principle**
  2. Envelope Theorem
  3. Zero surplus to zero-value buyers
  4. Marginal revenue
  5. Posted price interpretation
- ▶ Revelation Principle does not directly apply.
  - ▶ Even assumption that buyer sends a single message is not obviously without loss, since the buyer might only sometimes disclose.

# Subtleties introduced by disclosure

What new issues arise when the buyer can disclose his type?

1. Revelation Principle
  2. **Envelope Theorem**
  3. Zero surplus to zero-value buyers
  4. Marginal revenue
  5. Posted price interpretation
- ▶ Buyers *of the same type* can only distinguish themselves through cheap talk.
  - ▶ Envelope Theorem implies that  $S(v, t) = S(0, t) + \int_0^v q(v', t)dv'$  for all types  $t$ , but does not constrain buyer surplus across types.

# Subtleties introduced by disclosure

What new issues arise when the buyer can disclose his type?

1. Revelation Principle
  2. **Envelope Theorem**
  3. Zero surplus to zero-value buyers
  4. Marginal revenue
  5. Posted price interpretation
- ▶ Novel “disclosure IC constraint” links surplus across types.
  - ▶ Buyer  $(v, t)$  must always disclose if  $S(v, t) > \min_{t'} S(v, t)$ .

# Subtleties introduced by disclosure

What new issues arise when the buyer can disclose his type?

1. Revelation Principle
  2. Envelope Theorem
  3. **Zero surplus to zero-value buyers**
  4. Marginal revenue
  5. Posted price interpretation
- ▶ No longer obvious that offering  $S(0, t) > 0$  decreases expected revenue:
    - ▶ (-) Lowers revenue from type- $t$  buyers
    - ▶ (-) Seller must induce disclosure by buyer  $(0, t)$
    - ▶ (+) May slacken disclosure IC constraint of buyer  $(v, t')$  for some  $v$  and  $t' \neq t$ .

# Optimality of posted price list

**Theorem 1:** The expected profit-maximizing sales mechanism with costly disclosure (subject to interim IR and interim IC) is a price-list mechanism.

*Outline of proof:*

1. Show optimal mechanism has non-random disclosure.
2. Establish properties of IC mechanisms with non-random disclosure.
3. Characterize optimal IR mechanism having these properties.
4. Check that resulting mechanism is IC and corresponds to a posted price list.

# Non-random disclosure: part 1

Let  $M(v, t)$  be the *set* of messages sometimes sent by buyer  $(v, t)$ , and let  $m(v, t)$  be any element of  $M(v, t)$ .

By the Envelope Theorem, buyer surplus  $S(v, t)$  in any IC mechanism is

$$S(v, t) = S(0, t) + \int_0^v q(m(v, t)) dv.$$

In particular,  $q(m_1) = q(m_2)$  for all  $m_1, m_2 \in M(v, t)$  and the buyer's payment *net of disclosure costs* is the same for all messages in  $M(v, t)$ :

$$z(m(v, t)) = vq(v, t) - \int_0^v q(v', t) dv' - S(0, t) - c_B * \mathbf{1}_{m(v, t) \in M_t}.$$

## Non-random disclosure: part 2

Suppose f.s.o.c. that there exists  $m_1, m_2 \in M(v, t)$  such that  $m_1 \in M_\emptyset$  and  $m_2 \in M_t$ .

Seller can increase expected profit by inducing buyer  $(v, t)$  to send only non-disclosing  $m_1$ :

- ▶ payment from buyer increases by  $c_B$
- ▶ seller avoids paying cost  $c_S$
- ▶ no other buyer has any new incentive to deviate, since non-disclosing message  $m_1$  was already available

# IC mechanisms with non-random disclosure

Let  $D = \{t \in T : \text{buyer } (v, t) \text{ discloses for some } v\}$ . Let  $\bar{D} = T \setminus D$  be those types that never disclose. ( $D^*$  and  $\bar{D}^*$  are optimal such sets.)

**Lemma 2:** In any interim IC mechanism with non-random disclosure:

$$S(v, t) = \int_0^v q(v', t) dv' + S(0, t) \quad (2)$$

$$v' > v \Rightarrow q(v', t) \geq q(v, t) \quad (3)$$

$$(v, t) \in \bar{D} \Rightarrow S(v, t) \leq S(v, t') \text{ for all } t' \in T \quad (4)$$

# Virtual values formulation of seller profit

Assigning the good to buyer  $(v, t)$  without disclosure:

- ▶ increases total surplus by  $vf(v|t)g(t)$
- ▶ increases surplus of  $(v', t)$  buyers for all  $v' > v$ , to the tune of  $(1 - F(v|t))g(t)$
- ▶ may increase surplus of  $(v, t')$  buyers for some  $t' \neq t$  and hence surplus of  $(v', t')$  buyers for  $t' \neq t$  and  $v' > v$

Putting aside the effect on disclosure incentives, the net contribution to seller's expected profit is just the standard "virtual value"  $VV(v, t)$  times relevant density, where

$$VV(v, t) = v - \frac{1 - F(v|t)}{f(v|t)}.$$

# Virtual values formulation of seller profit

Assigning the good to buyer  $(v, t)$  with disclosure:

- ▶ increases total surplus by  $(v - c)f(v|t)g(t)$
- ▶ increases surplus of  $(v', t)$  buyers for all  $v' > v$ , to the tune of  $(1 - F(v|t))g(t)$
- ▶ has no effect on other types' disclosure incentives

The net contribution to seller's expected profit is “net virtual value”  $VV(v, t) - c$  times relevant density.

# Virtual values formulation of seller profit

Overall, the seller's expected profit can be expressed as:

$$\begin{aligned} & \int_{(v,t) \in D} q(v,t) (VV(v,t) - c) g(t) f(v|t) dv dt \\ & + \int_{(v,t) \in \bar{D}} q(v,t) VV(v,t) g(t) f(v|t) dv dt - E[S(0,t)] \end{aligned} \quad (5)$$

subject to the (usual) monotonicity constraint and the (novel) disclosure constraint:

$$(v,t) \in \bar{D} \text{ only if } S(v,t) = \min_{t' \in T} S(v,t').$$

# Outline of rest of proof

1.  $(v, t) \in D^*$  iff  $S^*(v, t) > \min_{t'} S^*(v, t)$ .
2.  $(v, t) \in D^*$  implies  $(v', t) \in D^*$  for all  $v' > v$ .
3.  $(v, t) \in D^*$  implies  $q^*(v, t) = 1$ .
4. Buyers with zero value get zero surplus. (Not immediate!!)
5. All buyers who disclose face “take-it-or-leave-it price”.
6. All buyers who do not disclose face “take-it-or-leave-it price”.
7. Optimal mechanism satisfying necessary conditions is indeed IC, and is a price-list mechanism.

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  - ▶ **Properties of optimal price list**
- ▶ Remarks

# Properties of optimal price-list mechanism

**Theorem 2:** The set of disclosing types  $D^*$  and the schedule of prices  $p^*(.)$  in an optimal price-list mechanism satisfy:

$$p^*(\emptyset) = \arg \max_p \int_{t \in \overline{D}^*} p(1 - F(p|t)) g(t) dt \quad (6)$$

$$p^*(t) = \arg \max_p (p - c_S)(1 - F(p + c_B|t)) \text{ for all } t \in D^* \quad (7)$$

$$t \in \overline{D}^* \Leftrightarrow p^*(\emptyset)(1 - F(p^*(\emptyset)|t)) > \max_{p \leq p^*(\emptyset) - c_B} (p - c_S)(1 - F(p + c_B|t)) \quad (8)$$

# Disclosure constraint is non-binding

$$p^*(\emptyset) = \arg \max_p \int_{t \in \bar{D}^*} p(1 - F(p|t)) g(t) dt$$

$$p^*(t) = \arg \max_p (p - c_S)(1 - F(p + c_B|t)) \text{ for all } t \in D^*$$

These are optimal segment prices, taking disclosure set as given:

- ▶ the cost of disclosure is not sunk when the seller sets  $p^*(t)$ , or when the buyer decides whether to purchase at that price
- ▶ thus, seller acts *as if* facing demand  $v - c_B$  and *as if* marginal cost  $c_S$

The disclosure constraint is non-binding:

- ▶ suppose f.s.o.c. that  $p^*(t) = p^*(\emptyset) - c$
- ▶ seller can increase profit by withdrawing type- $t$  buyers' eligibility for a discount

# “Separability” of decision to induce disclosure

$$t \in \bar{D}^* \Leftrightarrow p^*(\emptyset) (1 - F(p^*(\emptyset)|t)) \\ > \max_{p \leq p^*(\emptyset) - c_B} (p - c_S) (1 - F(p + c_B|t))$$

Type- $t$  buyers are eligible for a discount iff, *when faced with these buyers only*, the seller prefers to sell at customized price  $p^*(t)$  with disclosure than at sticker price  $p^*(\emptyset)$  without disclosure.

In this sense, the seller's decision about whom to offer a discount is “separable” across types.

# Constructing the optimal price-list mechanism

For any sticker price  $p(\emptyset) = p$ , construct a candidate disclosure set  $D(p)$  by the criteria that  $t \in D(p)$  iff the seller prefers optimal customized pricing over selling at sticker price  $p$ .

- ▶ the *optimal* disclosure set  $D^* = D(p^*(\emptyset))$ .

For any disclosure set of form  $D(p)$ , construct a candidate sticker price  $p(D(p))$  to satisfy the first-order condition (6).

- ▶ the *optimal* sticker price  $p^*(\emptyset) = p(D(p^*(\emptyset)))$ .

In other words, the optimal sticker price  $p^*(\emptyset)$  is a fixed point of the mapping  $p \circ D : \mathbf{R}_+ \rightarrow \mathbf{R}_+$ .

## Example

- ▶ Buyer's type  $t \sim U[0, 1]$ .
- ▶ Buyer's value  $v|t \sim U[0, t]$  conditional on type  $t$ .
- ▶  $c_B = 0$  and  $c_S = c$ . [Different than paper.]

**Proposition 3:** In the optimal price-list mechanism, the seller offers sticker price  $p^*(\emptyset)$  as well as customized prices  $p^*(t) = \frac{t+c}{2}$  to buyers who disclose types  $t \in D^* = (c, t^*)$ , where  $(p^*(\emptyset), t^*)$  solve the following system of equations:

$$p^*(\emptyset) = \frac{1 - t^*}{-2 \ln t^*} \quad (9)$$

$$t^* = 2p^*(\emptyset) + c - 2\sqrt{p^*(\emptyset)c} \quad (10)$$

# Summary

This paper has provided a tractable model of monopoly pricing with costly “disclosure”.

Relatively simple numerical procedure to compute optimal price-list mechanism.

Unambiguous welfare effects in the limiting case of perfectly informative types.

# Outline of talk

- ▶ Motivating examples
- ▶ Model & preview of results
- ▶ Special case: perfectly informative types
- ▶ Optimal sales mechanism with costly disclosure
- ▶ **Remarks**

# Overview of remarks

- ▶ **What sorts of cost are not captured here?**
- ▶ Extension – finite type-space
- ▶ Related literature
- ▶ Disclosure vs audits
- ▶ Disclosure in relationships?
- ▶ Empirical implications?

# What costs not covered? – sunk

The analysis presented today abstracts from costs paid before buyer values are realized, e.g. advertising a price to all buyers of type  $t$

- ▶ Catalog mailings.
- ▶ Newspaper coupons.

I am currently in the process of extending the analysis to allow for this possibility.

# What costs not covered? – fixed

Model abstracts from other fixed costs associated with the infrastructure of disclosure.

- ▶ “Listing cost” for each posted price.

*Interesting open question:* Suppose seller pays listing cost that depends on number of distinct outcomes  $(q(m), z(m))$ .

- ▶ What is the optimal sales mechanism? Is it a price-list mechanism?
- ▶ Is there a clean characterization of the optimal *partition* of types into discount-eligibility classes?

## Extension – finite type-space

Results can be re-interpreted to apply to settings with finitely many types  $T$ .

Consider for the moment an augmented type-space in which the buyer also receives a payoff-irrelevant “label” in  $[0, 1]$ .

- ▶ Paper characterizes optimal sales mechanism as a price-list mechanism in which **seller is never indifferent** between customized vs sticker price for any “type” (Thm 2)
- ▶ So, in optimal mechanism, the buyer must be offered the same price (sticker or discount) regardless of his label.
- ▶ Conclusion: the optimal mechanism in finite-type model with labels remains optimal when there are no labels.

▶ See Thm 2.

## Some related literature

**Optimal mechanism design.** Riley Zeckhauser (1983)

**3rd-degree price discrimination.** Schmalensee (1981), Varian (1985)

**Monopoly rent-seeking.** Posner (1975), Fisher (1975)

**Consumer self-selection.** [too huge to cite adequately]

**Disclosure, Mechanisms w/ verifying information.** Grossman (1981), Milgrom (1981), Green Laffont (1986), Bull Watson (2005)

**Costly state verification.** Townsend (1979), Border Sobel (1987), Deneckere and Severinov (2007)

## Example: hybrid self-selection schemes

- ▶ The Baptiste Power Vinyasa Yoga Institute is the dominant provider of “hot yoga” in the Boston area.
- ▶ In 2005, Baptiste offered an unlimited monthly pass for \$99 to anyone who identified themselves as a “raw beginner”.
- ▶ All others had to pay \$12 per class.

*Interesting open question:* What is the optimal sales mechanism when the seller can combine menu pricing with credible disclosure?

# Disclosure vs audits

A key assumption here is that the buyer “initiates” disclosure, and that the seller cannot avoid its share of the disclosure cost.

*Interesting open question:* What is the optimal mechanism with **costly auditing** of buyer type? The model I have in mind:

- ▶ Buyer sends cheap-talk message
- ▶ Seller decides with what probability to audit buyer

# Overview of remarks

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## Example: experience goods

Sellers of experience goods often offer first-time buyer discounts

- ▶ Nationwide tanning salon L.A. Tan offers a “Free \$50 tanning value” coupon to new customers only.

To implement such a discount, the seller must maintain a database of all past buyers.

If such a database allows the seller to provide more valuable services in the future, “total disclosure cost” is negative.

*Interesting potential future direction:* endogenize content and timing of disclosure in relationships.

# Empirical implications?

Any exogenous change in seller costs will change the composition of demand as well as the price  $\Rightarrow$  complicates traditional approach to estimate demand elasticity and hence unobserved marginal costs from observed market outcomes.

Here I sketch an alternative approach, under assumptions:

1. We observe sticker price and probability of sale as a function of observable exogenous covariates that (only) shift the seller's marginal production cost.
2. The set of buyer types is finite.
3. Constant demand elasticity for each type
4. Constant marginal production cost (MPC)
5. Constant marginal disclosure cost (MDC)

# Identification of demand

Any change in the composition of buyer types at the sticker price will [generically] result in a *discontinuity* in the probability of a sale.

As long as one can estimate the probability of a sale as a function of covariates, one can identify when the seller decided to add/remove some type to the pool paying sticker price.

- ▶ if the set of types paying sticker price does not change  $\Rightarrow$  estimate **elasticity of pooled segment**, as usual
- ▶ the magnitude of any discontinuity can be used to infer quantity of new type paying sticker  $\Rightarrow$  infer **elasticity of “new type”** from discontinuity in estimated elasticity of new pool.

# Identification of cost

Given estimated elasticity of entire pool, **marginal production cost** (MPC) can be estimated as usual from mark-down condition.

- ▶ recall that sticker price is optimal monopoly price against pool that is only offered sticker price

Seller must be indifferent against the “new type” between selling at sticker or at optimal customized price with disclosure.

- ▶ given constant MPC, can compute profitability at sticker price
- ▶ given new type has constant demand elasticity, can compute profits at optimal customized price given any **marginal disclosure cost** (MDC)  $\Rightarrow$  infer MDC





# Properties of optimal price-list mechanism

**Theorem 2:** The set of disclosing types  $D^*$  and the schedule of prices  $p^*(.)$  in an optimal price-list mechanism satisfy:

$$p^*(\emptyset) = \arg \max_p \int_{t \in \bar{D}^*} p(1 - F(p|t)) g(t) dt \quad (11)$$

$$p^*(t) = \arg \max_p (p - c_S)(1 - F(p + c_B|t)) \text{ for all } t \in D^* \quad (12)$$

$$t \in \bar{D}^* \Leftrightarrow p^*(\emptyset)(1 - F(p^*(\emptyset)|t)) > \max_{p \leq p^*(\emptyset) - c_B} (p - c_S)(1 - F(p + c_B|t)) \quad (13)$$

▶ Go back

# Motivating example: retail credit

Retail Credit Solutions helps small businesses to offer store credit:

- ▶ 24x7 credit approval and transaction authorizations
- ▶ statement production and payment processing
- ▶ collections
- ▶ customer service

RCS accesses and analyzes consumer's credit history, but most of the costs associated with offering credit are likely *not* from “learning” about the buyer.

When appropriately adapted, this paper's analysis can capture all such “customization costs” of making a sale not at sticker price.

# Motivating example: fairness concerns

Consumers may protest certain types of price discrimination as unfair, if discovered:

- ▶ Amazon.com, 2000: abandoned “test” in which new customers were offered lower prices
- ▶ BestBuy.com, 2007: faced CT AG investigation when a reporter discovered that in-store prices differed from those offered online.
- ▶ At restaurants, consumers view weekday/weekend pricing and table location pricing as unfair, though not coupons or lunch/dinner pricing (Kimes Wirtz 2003).

## Motivating example: legal liability

Under the Robinson-Patman Act, a retailer can sue its wholesaler if the wholesaler offers a discount to any of its competitors (unless the discount can be justified on cost).

Each sale at a customized price creates additional litigation risk.