Triple Marginalization and Consumer Search

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- Should you go to the next shop or stop? Is this a good deal or a rip-off?
- It really depends on how much Canon charges for it in wholesale
- If the wholesale price is £349, then probably there's no point in searching further, but it could also be £249, and then you're being ripped off

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- There is growing literature where (retail) cost is uncertain. Think of gasoline markets as an example. Wholesale gasoline price is fluctuating, common to all retailers, and unknown to consumers.
- Consumers should determine to what extent this is simply an expensive pump or common cost is high

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- So, we introduce vertical relations in a model of sequential consumer search.

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- Imagine what happens if the upstream firm increases its price
- Any retailer wants to pass the cost increase to consumers, but consumers will think that it's this particular retailer ripping them off, so retailer's demand is more elastic than it should be given the market conditions.

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- Triple marginalization may provide insight why in the US car retail market, car dealers inform consumers about the price at which they buy the car from the manufacturer.
- We get interesting comparative statics e.g. with unobserved retail cost prices are the highest when consumer search cost are close to zero (details later)

Literature

- Stahl (1989) and Wolinsky (1986) important models in consumer search: homogeneous and heterogeneous goods
- We build on Stahl (1989) as homogeneous goods model is purest form where double marginalization arises (more on Wolinsky model at the end)
- Random (common) cost models: Benabou and Gertner (1983), Dana (1994), Fishman (1996), Tappata (2009), Janssen, Pichler and Weidenholzer (2011), Chandra and Tappata (2012)
- Consumers observe price, update beliefs on firm's cost and then decide whether or not to continue searching
- No literature (as far as we know) on search in vertical markets

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- If consumer buys at price p she demands $D(p)$, and in most of the analysis we assume for simplicity that $D(p) = 1 - p$.
- The retail monopoly price is denoted by $p^m(c)$.

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2. Given c, each of the retailers i sets price p_i.
3. Consumers engage in optimal sequential search given the equilibrium distribution of retail prices and retailer's cost, not knowing the actual prices set by individual retailers.

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- The pricing behavior of retailers is summarized by $F(p|c)$ and $f(p|c)$ for the distribution (and density function) of retail prices charged by the retailers and $b(c)$, respectively, $\bar{p}(c)$ for the lower- and upper-bound of their support.

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- Expected profit for a retailer who charges $p \in [b(c), \bar{p}(c)]$ is

$$(p-c)D(p)[(1-\lambda)+2\lambda(1-F(p|c))]$$

which should equal to

$$(\bar{p}(c)-c)D(\bar{p}(c))(1-\lambda)$$

Retail pricing when cost is known

Proposition

For $\lambda \in (0,1)$, the equilibrium price distribution for the subgame starting with c is given by

$$F^o(p|c) = 1 - \left(\frac{1-\lambda}{2\lambda} \left[\frac{(\bar{p}(c)-c)D(\bar{p}(c))}{(p-c)D(p)} - 1 \right] \right)$$

with support on $[b(c), \bar{p}(c)]$ where $b(c)$ is the solution to:

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- The upper bound $\bar{p}(c)$ is equal to the minimum between monopoly price $p^m(c)$ and the nonshoppers' reservation price $\rho(c)$.

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- When s is small, $\bar{p}(c) = \rho(c)$, while for larger s it is given by the monopoly price $p^m(c)$. The critical value of s is denoted by $\widehat{s}^o$.

Behaviour of manufacturer

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- For a given c expected profit of the upstream firm is given by:

$$\pi_u^o(c) = \left((1-\lambda) \int_{b(c)}^{\bar{p}(c)} D(p) f^o(p)\, dp + 2\lambda \int_{b(c)}^{\bar{p}(c)} D(p) f^o(p)(1-F^o(p))\, dp \right) c.$$

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- This function is continuously differentiable, and equal to 0 at $c = 0, 1$, it follows that there is an optimal value of $c \in (0,1)$, denoted by c^*, and that this c^* solves

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- In general, both the upstream and downstream firms are able to make profits.

Linear demand

Proposition

Suppose $D(p) = 1 - p$. *For all* λ, *if* $s > \widehat{s}^o$ *so that* $\bar{p}(c) = p^m(c)$, $c^* = 0.5$. *Moreover, when* s *approaches* 0, *then* c^* *approaches* 0.5.

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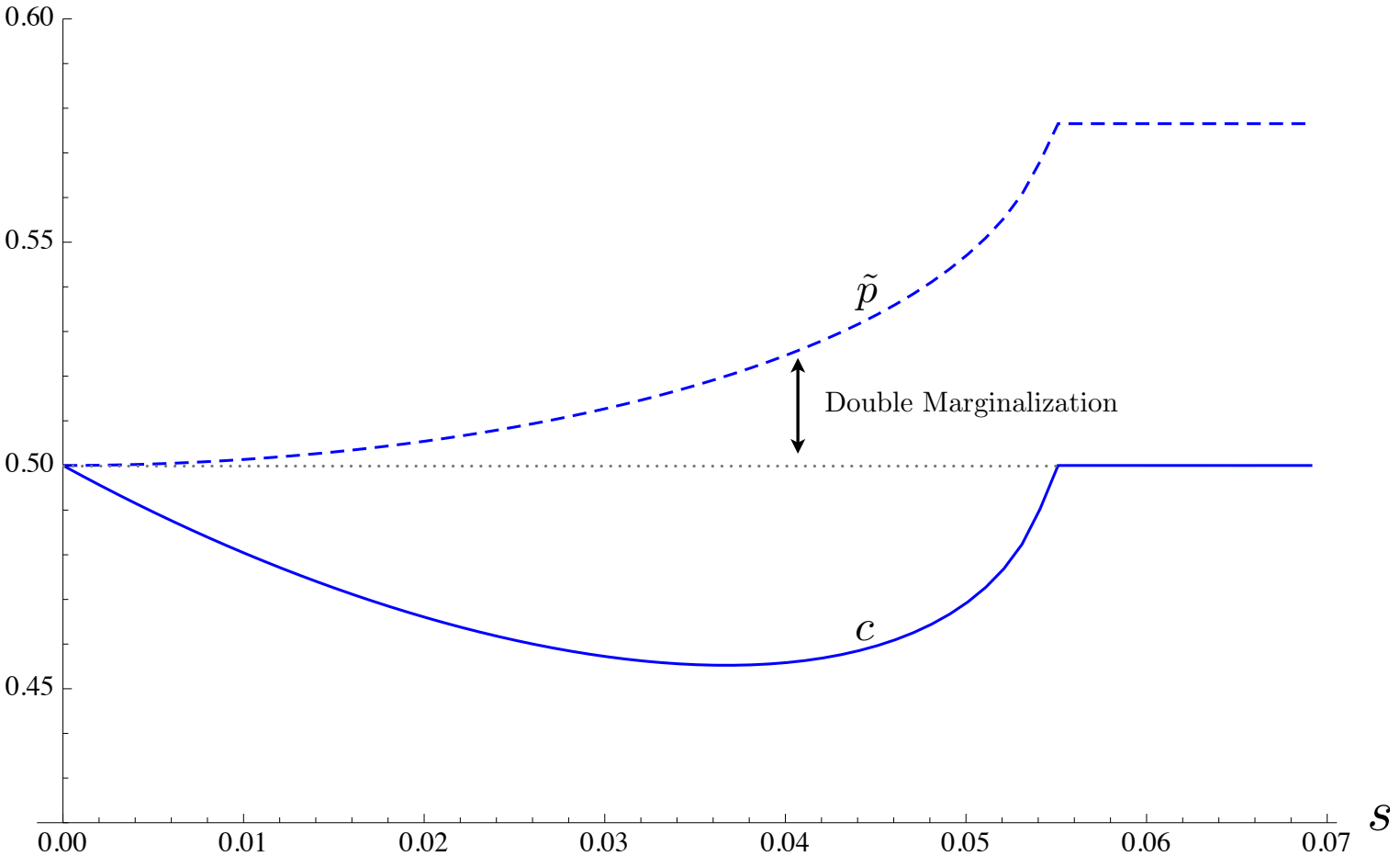
- High search cost result follows from special relationship between upper and lower bound of the price distribution for linear demand.
- When search cost approaches 0, the non-shoppers' reservation price converges to retailers' cost. As this cost is known to consumers, they effectively demand $1 - c$ and therefore, the upstream monopolist's profit function is simply $c(1 - c)$, which is maximized at 0.5.

Linear demand

Weighted average of retail price $\tilde{p} = \lambda E \min(p_1, p_2) + (1 - \lambda) Ep,$



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- Consumers form beliefs about c, and in equilibrium, these beliefs are correct.
- As retailer's know c, their decision about retail price remains dependent on c.

Reservation price equilibrium (formally)

Definition

A *reservation price equilibrium* is a price c^*, a set of retail price distributions $F^{no}(p|c)$,, and non-shoppers' reservation price ρ^* such that

1. manufacturer chooses c^* to maximize expected profit (which depends on $F^{no}(p|c)$ and ρ^*);
2. retailers use price strategy $F^{no}(p|c)$ to maximize expected profit, given the actual cost, the rival's price strategy, and non-shoppers' reservation price ρ^*;
3. non-shoppers' reservation price ρ^* is such that they search optimally given their beliefs about c and $F(p|c)$; shoppers buy at lowest retail price.
4. In equilibrium non-shoppers' beliefs about c and $F^{no}(p|c)$ are correct.

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- Above is only true for $\rho < p^m(c)$, otherwise everything should be as with observed c.

Behaviour of manufacturer under linear demand)

Proposition

In case consumers do not observe the upstream price c, it is the case that for all λ there exists a $\widehat{s}^{no}(\lambda)$ such that for all $s > \widehat{s}^{no}(\lambda)$ $c^* = 0.5$.

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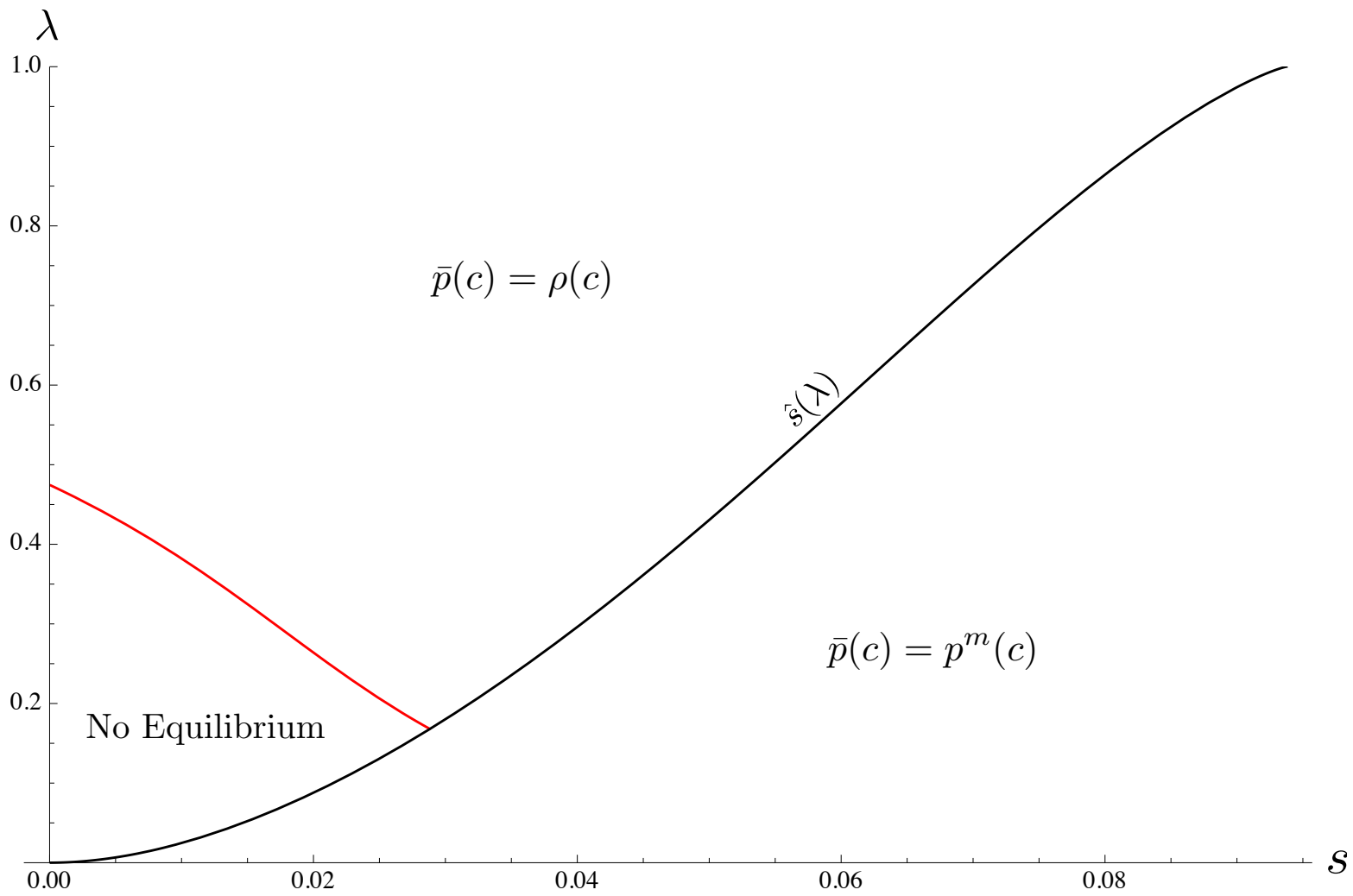
- If search cost is high and upper bound of retailers' price distribution equals monopoly price, the observed and unobserved models yield identical results.

Non-existence



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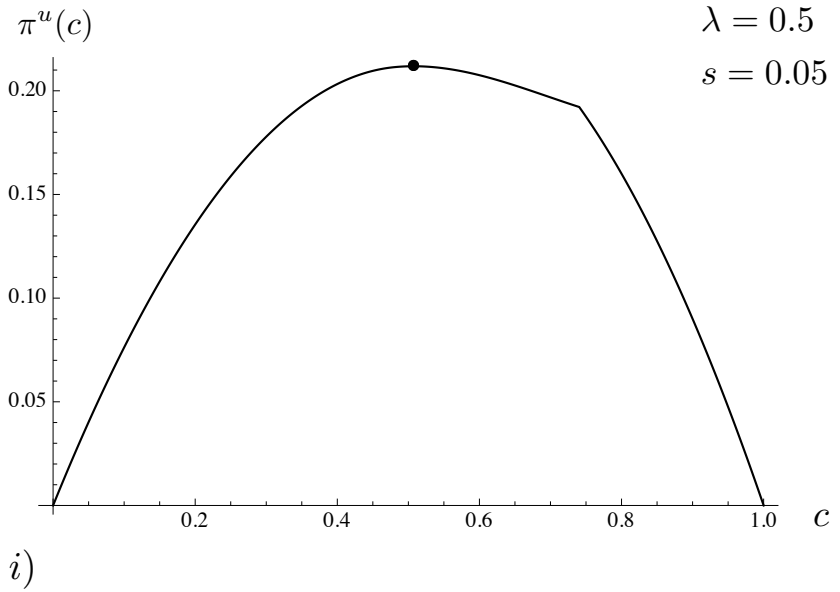
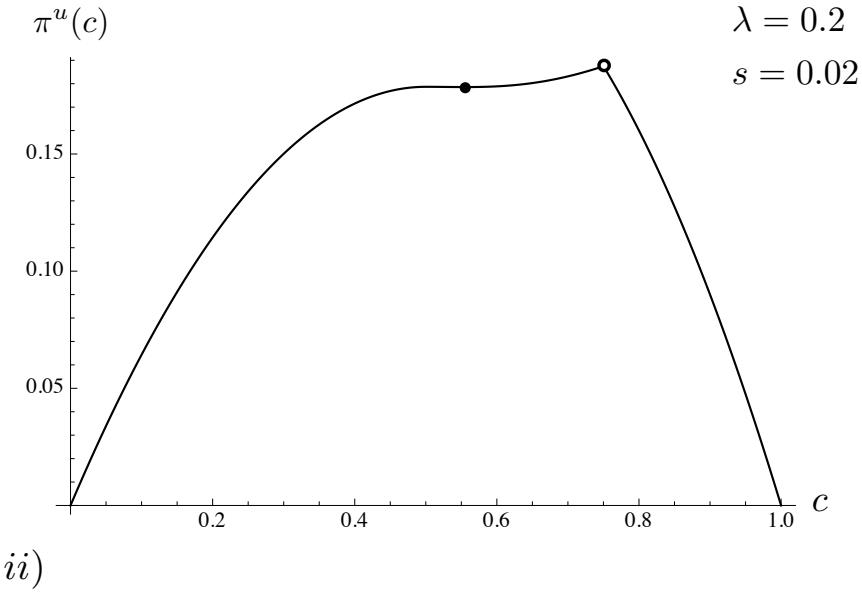


$i)$



$ii)$

● Solution of FOC ○ Profit Maximizer

Comparison

1. With linear demand $\widehat{s}^{o}(\lambda) = \widehat{s}^{no}(\lambda) = \widehat{s}(\lambda)$. Thus, when s is large, two models yield identical results
2. If search cost is smaller, the optimal upstream price is higher when retailers' costs are unobserved:

Proposition

If a reservation price equilibrium exists and the upper bound of the price distribution in both models is given by the reservation price and for all $p \in (0, p^m), \pi_r''(p)\pi_r(p) - (\pi_r'(p))^2 < 0$, *where* $\pi_r(p) = (p-c)D(p)$, *then the optimal upstream price in case retailers' cost is unobserved is larger.*

Comparison small search cost

Proposition

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- With small search cost, the reservation price of non-shoppers will be close to the expected retail cost Ec.

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- When s approaches zero, the behaviour of the upstream firm can be understood as if it is maximizing

$$c\left[\lambda(1-c)+(1-\lambda)(1-Ec)\right],$$

where shoppers' demand reacts to real cost, whereas nonshoppers react to expected cost .

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  where shoppers' demand reacts to real cost, whereas nonshoppers react to expected cost .
- Maximizing gives $1-2\lambda c-(1-\lambda)Ec=0$. As in equilibrium, $Ec=c^*$, it follows that c^* approaches $1/(1+\lambda)$ when s gets small.

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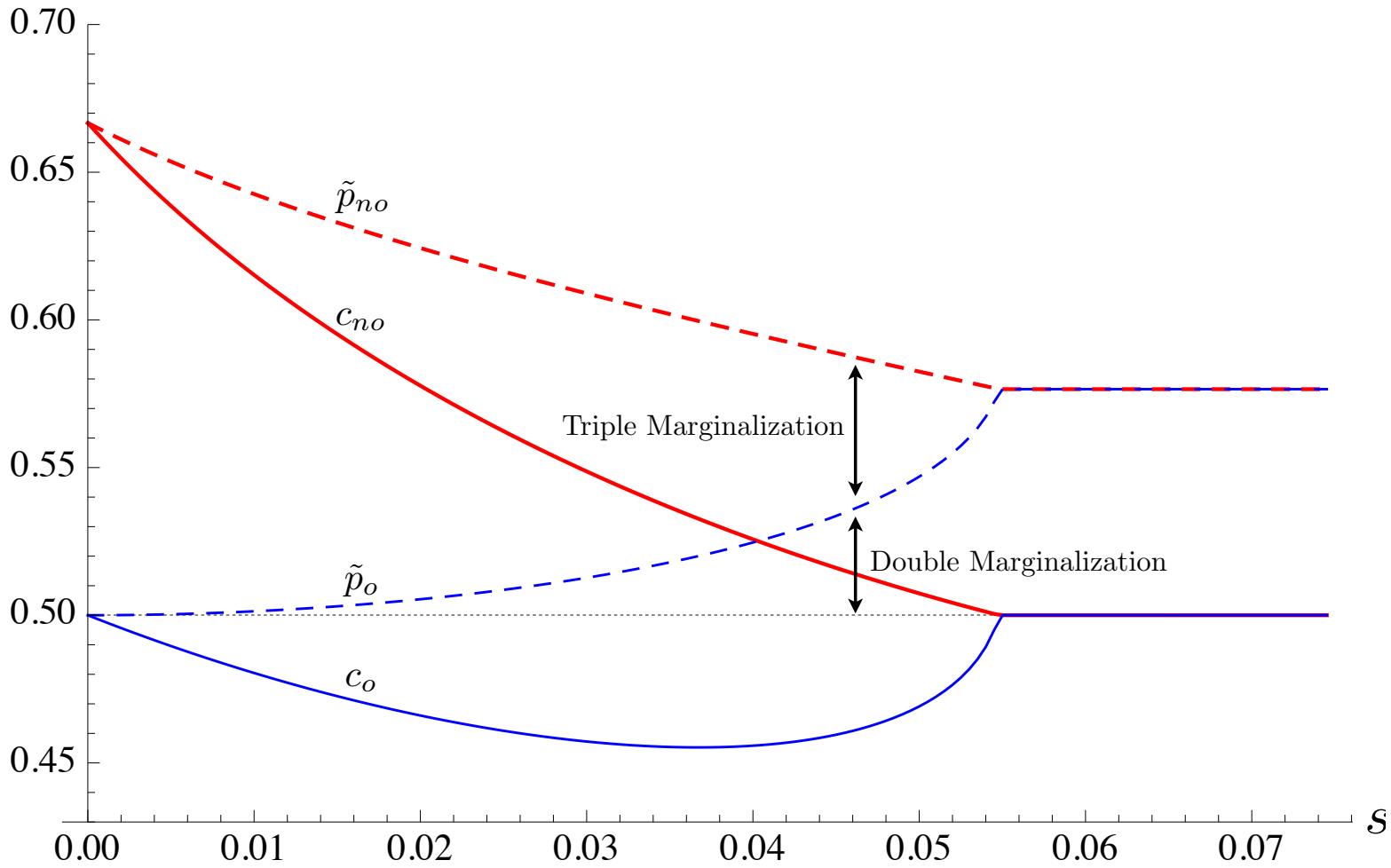
- In equilibrium, actual choice of the upstream price equals price expected by consumers, but this can only arise at very high upstream price levels.
- The triple marginalization problem (quantitatively significant; often outweighs the double marginalization effect)
- Weighted average retail price, $\tilde{p}$, behaves differently in the two models as function of s. When consumers do not observe retailers' cost, it is decreasing in s.
- Main intuition: when search cost increase, retailers can pass on marginal cost increase to consumers more. upstream firm internalizes this effect and charges significantly lower prices.

Comparison


0.70
0.65
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0.50
0.45
0.00
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0.02
0.03
0.04
0.05
0.06
0.07
s
$\tilde{p}_{no}$
c_{no}
Triple Marginalization
Double Marginalization
$\tilde{p}_o$
c_o

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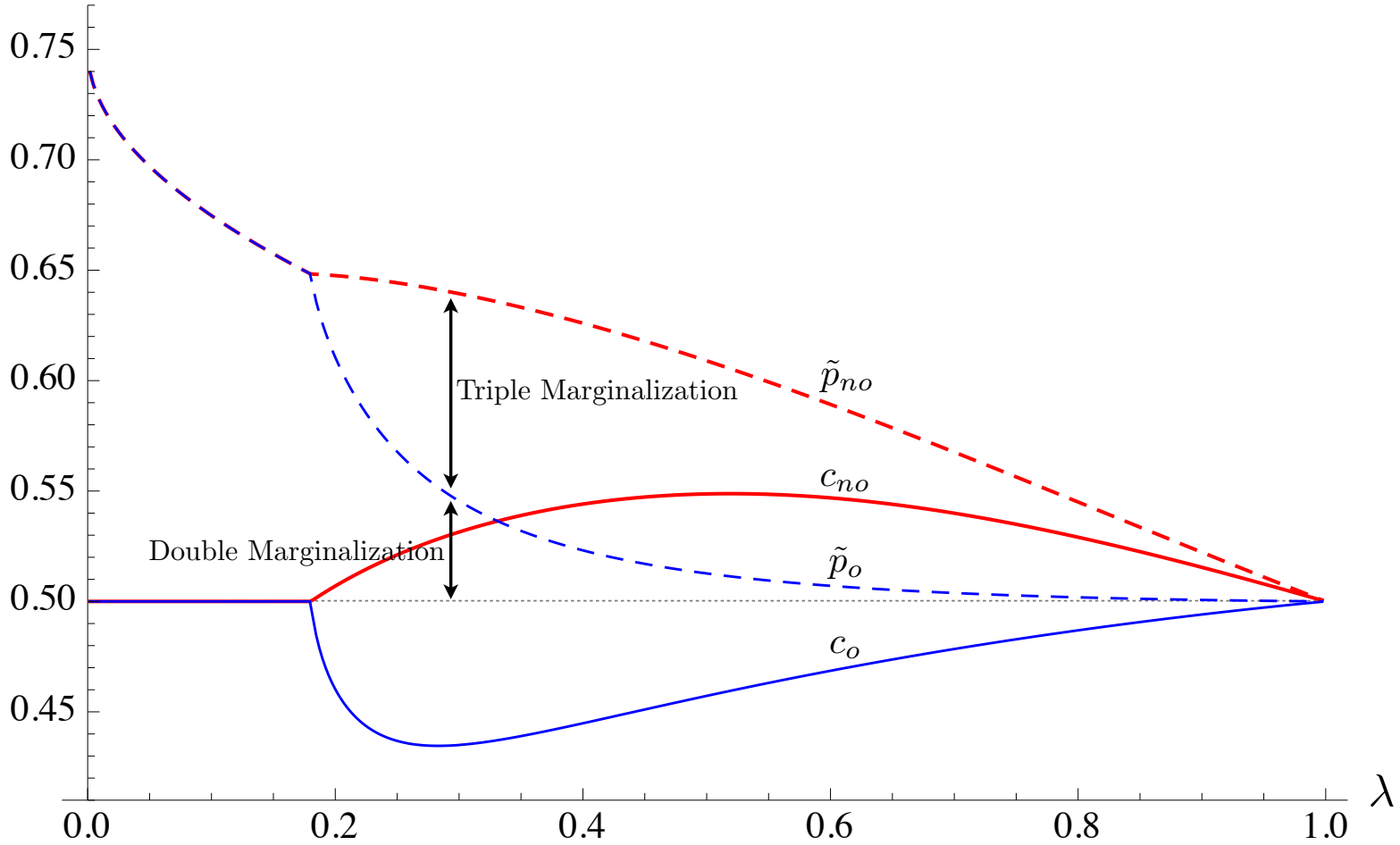
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.0
0.2
0.4
0.6
0.8
1.0
λ
Triple Marginalization
Double Marginalization
$\tilde{p}_{no}$
c_{no}
$\tilde{p}_o$
c_o

Table: Equilibrium for observed and unobserved c, $D(p) = 1 - p$ and $\lambda = 0.5$

s	c	$\bar{p}$	$\tilde{p}$	π_u	$2\pi_r$	$\pi_u + 2\pi_r$	CS	W
0.001	0.498	0.502	0.500	0.249	0.001	0.250	0.125	0.375
0.02	0.466	0.552	0.505	0.231	0.019	0.250	0.122	0.372
0.05	0.469	0.688	0.547	0.213	0.034	0.247	0.103	0.350
0.07	0.500	0.750	0.577	0.212	0.031	0.243	0.090	0.333

s	c	$\bar{p}$	$\tilde{p}$	π_u	$2\pi_r$	$\pi_u + 2\pi_r$	CS	W
0.001	0.661	0.667	0.664	0.222	0.001	0.223	0.057	0.280
0.02	0.578	0.688	0.624	0.217	0.017	0.234	0.071	0.305
0.05	0.507	0.740	0.582	0.212	0.030	0.242	0.088	0.330
0.07	0.500	0.750	0.577	0.212	0.031	0.243	0.090	0.333

Comparative Statics

Tables convey two important messages

1. When consumers do not observe retailers' cost, an increase in search cost is good for total industry profit and for consumers.
2. Comparing the observed cost case to the unobserved cost case reveals that all market participants benefit when retailers' cost are observed by consumers.

If market participants can credibly commit to publishing retailers 'cost, as they try to do in the US automobile industry, they have incentives to do so.

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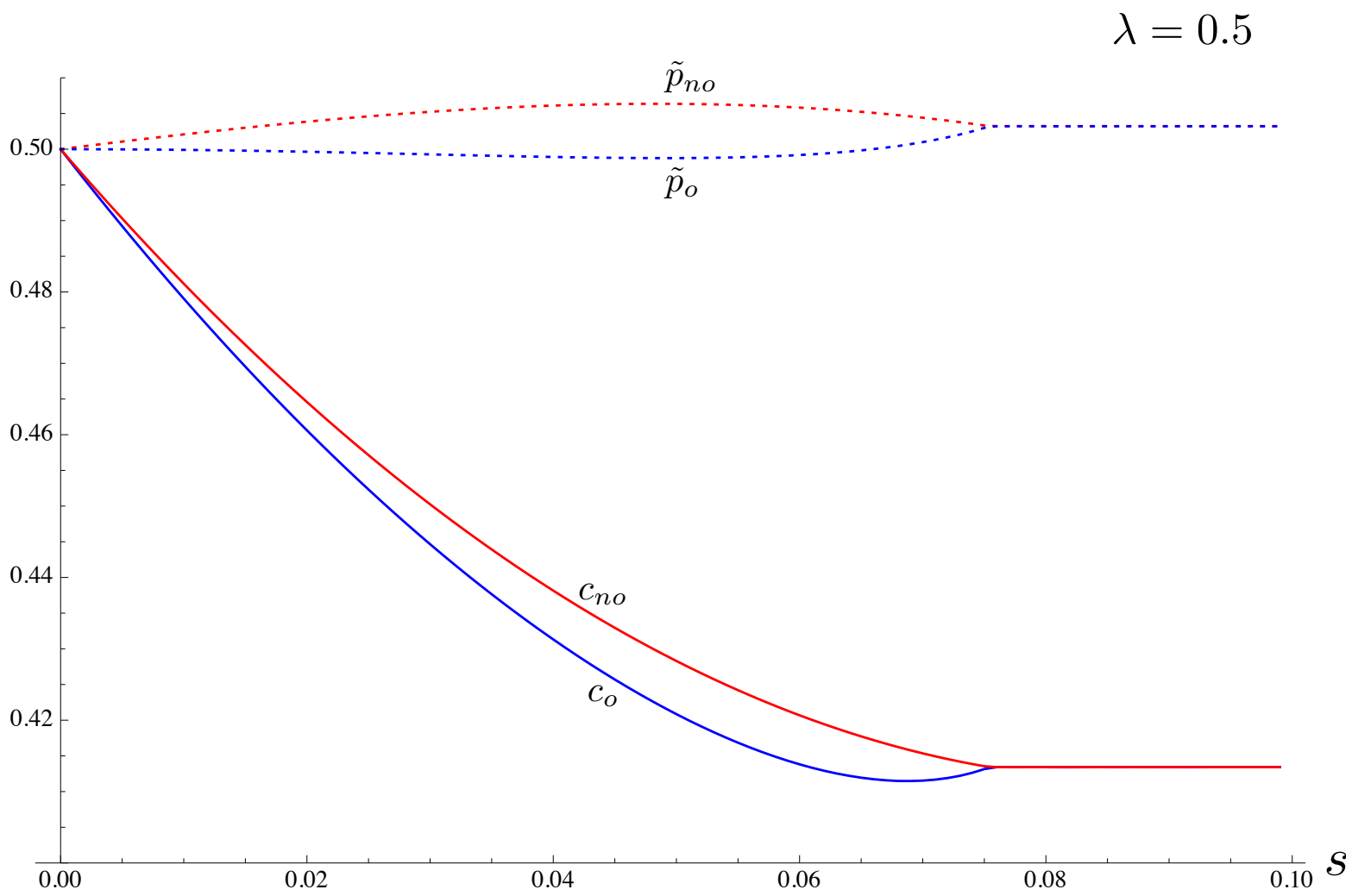
- Now the upstream firm maximizes total industry profits, extracts everything from the retailers via fixed fee
- Unobserved retail cost still increases prices, but the effect is much smaller
- The old incentive to squeeze retailers is gone, but now the upstream firm want to decrease variance of retail prices, with leads to the same qualitative effect

Two-part tariffs



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- For uniform, logistic and normal in the unobserved case prices go up, for exponential both cases coincide

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  - Quantitatively, welfare can be 20% larger in markets where retailers' cost are observed.
- Given our findings, we expect that other results in the consumer search literature may get exacerbated once vertical market structures are incorporated.