Luo, Perrigne, and Vuong (2018)

For comparison to Luo, Perrigne, and Vuong (2018), consider the linear cost re-normalization of Crawford and Shum (2007). There are a few important differences between the two approaches:

Property	CS 2007	LPV 2018
Functional Form $C(q)$	$C(q) = q$ Given zero FC restriction, linearity is a normalization.	$C(q) = \kappa + cq$ Not a normalization because q is unobserved. But may be reasonable in many quantity applications. Result in D'Haultfoeuille & Février (2007) suggests can't do better.
Functional Form $V(\theta, q)$	$V(\theta, q) = \theta\sqrt{2q}$	$V(\theta, q) = \theta v(q)$
Data	price & share	price, share, & q=quantity
Types	discrete $\theta \in \{L, H\}$	continuous $\theta \in \{1, \bar{\theta}\}$
Tariff Menu	Single Observed Tariff.	Each customer faces a unique tariff that is unobserved. Only the chosen price-quality pair is observed. Implicitly allows for some form of horizontal heterogeneity.

Intuition: The marginal price for unit q tells us $V_q(\theta, q)$ for the type θ whose marginal unit is q. This comes from local-IC. The assumption $V = \theta v(q)$ means that we can divide $V_q(\theta, q)/\theta$ to get $v_q(q)$ if we know the mapping of θ to q. The result in the paper then boils down to identifying $\theta(q)$ (the inverse of the allocation). It is perhaps not surprising that this can be backed out from the firm's FOC since the FOC determines the allocation. The approach works with quantile functions $\theta(\alpha)$ and $q(\alpha)$. Normalizing $\underline{\theta} = 1$, the paper shows that firm FOC and local IC ($V_q(\theta, q) = P_q(q)$) imply equation (9) in the paper, which expresses the quantile $\theta(\alpha)$ in terms of observables, including the marginal price P_q, and the quantiles $q(\alpha)$ of the quantity distribution G_q:

$$log\theta(\alpha) = \int_0^{\alpha} \frac{1}{1-x}\left(1 - \frac{c}{P_q(q(x))}dx\right)$$

Then we can find $v_q(q)$ from

$$v_q(q(\alpha)) = \frac{P_q(q(\alpha))}{(\theta(\alpha))}$$

When quality/quantity is observed, this appears to be a nice relaxation of functional form constraints relative to Crawford and Shum (2007). This is valuable because the curvature of $v(q)$ determines outcomes of interest related to quality distortion and welfare.

At the same time, it is still a significant restriction. It rules out, for instance, the case that $V(\theta, q) = v \min\{\theta, q\}$. (Constant value v per minute up to satiation point θ, an example which leads to no quality distortion or DWL.) In particular it enforces that type corresponds to vertical stretching of inverse demand curves. Horizontal stretching or other shifts are not allowed.

Jullien (2000)

In the standard non-linear pricing model we covered last time, in the relaxed problem, a monopolist chooses the allocation to maximize virtual surplus pointwise. Virtual surplus is:

$$\psi\left(q,\theta\right) = V\left(q,\theta\right) - C\left(q\right) - \frac{1-F\left(\theta\right)}{f\left(\theta\right)} V_{\theta}\left(q,\theta\right).$$

The intuition is that surplus is adjusted by an information rent term. The information rent term is weighted by $(1 - F(\theta))$, as this is the fraction of higher types—those who the binding IC constraint dictates will receive higher information rent if type θ receives a larger allocation.

The standard model assumes that all types have the same outside option $\underline{u}$. Hence the participation constraint only binds for the bottom type, and the incentive compatibility constraint determines rents for higher types.

A common reason that we expect outside options to increase in type is that the outside option may be to purchase from a competitor. (For instance from a competitive fringe supplying an imperfect substitute.)

Jullien (2000) relaxes the homogeneous outside option assumption, and allows $\underline{u}$ to be type dependent. He shows that under assumptions that guarantee no bunching in allocation—such that the relaxed solution solves the full problem—the virtual surplus function is adjusted to:[1]

$$\psi\left(q,\theta\right) = V\left(q,\theta\right) - C\left(q\right) - \frac{\gamma(\theta)-F\left(\theta\right)}{f\left(\theta\right)} V_{\theta}\left(q,\theta\right).$$

This expression differs from the standard case only in that the weight on the information rent term $(1 - F(\theta))$ is replaced by $(\gamma(\theta) - F(\theta))$ where $\gamma(\theta)$ is like a cumulative distribution function (nondecreasing from 0 to 1) and measures the shadow value of relaxing the participation constraint for all types $\in [\underline{\theta}, \theta]$. $\gamma(\theta)$ is discontinuous when participation binds at discrete types. (This is ruled out except at $\underline{\theta}$ and $\bar{\theta}$ to preclude bunching). Further, $d\gamma(\theta)$ gives the shadow value of the constraint for type θ. (So $d\gamma$ is zero and γ is constant at θ where IR does not bind.)

Suppose that γ is $1/2$ on $[0, 0.5]$ and 1 on $[0.5, 1]$, reflecting that the participation constraint binds at 0 and $1/2$ but not elsewhere. Then for types below $1/2$ the information rent has a lower weight $(1/2 - F(\theta)$. The intuition is that increasing q for θ in this region only

[1] These are the potential separation (PS), homogeneity (H), and full participation (FP) assumptions.

raises the information rent to types $\in [\theta, 1/2]$, because at 1/2 the rent is pinned at zero by the binding IR. (This is an imperfect example because it violates the no-bunching condition.)

It is possible that $\gamma(\theta) < F(\theta)$, in which case quantity is distorted upwards above first best rather than downwards below first best.

Attanasio and Pastorino (2018)

See slides.

Competition

- My lectures focus on monopoly non-linear pricing but there is a substantial literature on the effects of competition on non-linear pricing. For example, see Busse and Rysman (2005), Borzekowski, Thomadsen, and Taragin (2009), and Seim and Viard (2011). Note that Borzekowski, Thomadsen, and Taragin (2009) have a particularly nice literature overview.

- Competition may increase or decrease price discrimination

  - competition may increase or decrease dispersion in customer WTP

    * Competition can decrease dispersion in WTP: Suppose that $U_{ij} = V_i - p_j$ and utility from the outside good is $U_{i0} = 0$. If there is a monopolist, everyone has an outside option of 0 due to the outside good. WTP is then V_i which may be very heterogeneous. In a duopoly, however, the outside option to firm 1 is firm 2 and vice-versa. Thus the WTP at firm 1 is $V_i - (V_i - p_2) = p_2$, which is the same for all customers. Hence there is no scope for price discrimination.
    * Competition can increase dispersion in WTP: Suppose that there are two types of customers, loyal customers and non-loyal customers. The WTP of loyal customers is V. The WTP of non-loyal customers is V under monopoly, but only p_2 if a second firm enters with $p_2 < V$. Thus entry leads to two levels of WTP rather than only one. (Chen, Narasimhan, and Zhang, 2001)

  - competition may increase or decrease the returns to paying the fixed cost of introducing an additional menu item

    * Competition may decrease the returns to paying the fixed cost of introducing an additional menu item: If dispersion in WTP decreases, the value of charging different prices may fall. Given fixed costs to offering different prices, it may then make sense to offer fewer menu items.
    * Competition may increase the returns to paying the fixed cost of introducing an additional menu item: Offering additional menu items may be a good way of stealing customers from competitors, and they may be strategic complements, so they may increase with competitive pressure.

- Findings (not a comprehensive list)

- Competition lowers all prices, but lowers high prices more than low prices, thereby increasing menu concavity and quantity discounting. Documented in yellow pages advertising (Busse and Rysman, 2005), cellular phone service (Seim and Viard, 2011), and elsewhere (see Borzekowski, Thomadsen, and Taragin (2009) for other citations). Note that Borzekowski, Thomadsen, and Taragin (2009) point out that increased curvature may make markups more similar, so does not necessarily correspond to "more" price discrimination.
- Competition leads to larger menus of mailing list subsets Borzekowski, Thomadsen, and Taragin (2009) and of cellular calling plans Seim and Viard (2011).

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