"DESIGN FLEXIBILITY IN MONOPSONISTIC INDUSTRIES"

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DESIGN FLEXIBILITY

IN MONOPSONISTIC INDUSTRIES

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ABSTRACT:

A monopsonist can either let its suppliers compete on both the attributes and the price of a product, or it can fix the attributes it wants and make manufacturers compete on the basis of price only.

When its utility function is publicly known, a monopsonist would favor price/attributes competition between suppliers having flexibility in product design (FPD). When its preference structure is unknown to producers, however, a monopsonist may find price/attributes competition undesirable because one of the producers could then find a niche and capture a large portion of its rent. In this case, the presence of a monopsony would yield a fixed-attributes standardized product and so discourage the adoption of FPD.

Keywords: Bidding and procurement, flexible manufacturing, standards.

1. INTRODUCTION

The economics of flexible manufacturing systems (FMS) - in particular of such systems with flexibility in product design (FPD) - have now been examined from various angles. Marschak and Nelson (1962), for instance, compute the value of flexibility for a price-taking firm; Tombak (1988) analyzes the diffusion of FMS/FPD in a duopoly; Milgrom and Roberts (1988) study the impact of FMS/FPD on organizational strategy and structure; de Groote (1987) focuses on the trade off between economies of scale and production flexibility; Tombak and De Meyer (1988) survey the managers' concerns about FMS/FPD; ... This list is not exhaustive, and the interested reader may wish to consult the bibliography of these papers for more references.

All these articles, however, seem to overlook the monopsony case. But in many industries (e.g. weaponry, energy, public services, furniture, ...) one can observe that several manufacturers compete to get a single big client. Are producers then likely to adopt FPD? The obvious answer is that it largely depends on the monopsonist's attitude. By accepting to consider offers that differ in price <u>and</u> in other dimensions, a monopsonist would enhance design flexibility among the competing producers. By committing itself to specific needs, on the other hand, a monopsonist would promote standard product lines. Which of these two postures - acceptance of multi-dimensional offers or commitment to some product requirements - would a monopsonist

then take?

In this paper we provide a partial response to this question. When its exact preferences are publicly known, a monopsonist would favor multi-dimensional offers and FPD. When its preference structure is unknown to producers, however, a monopsonist may find undesirable to accept offerings on both price and other attributes because one of the producers could then find a niche and capture a large portion of its rent; hence, it may require a fixed-attributes, standardized product and so discourage design flexibility.

The next section is devoted to presenting the model that drives these propositions. It is a simple bidding model involving one buyer and several sellers.[2] We believe a bidding model to be appropriate here, since we are considering a consumer that is strong enough to determine the rules of trade and competition is on the producer's side only.

We state, prove and discuss our results in the third and fourth section. The upshot is that, <u>in monopsonistic industries, discretion or ambiguity about demand is likely to yield a trading environment that deters producers from design flexibility</u>.

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[2] For a review of the literature that underlies this precise model, see Sinclair-Desgagné (1988).

2. THE MODEL

In a purchase setting, allow offers, or bids, b to have two dimensions: an index number for non-price attributes q in R_+ (For instance, q might refer to the quantity of goods, or it might measure product quality.) and a price p in R_+. Concisely, we shall write b = (q,p). A monopsonist can now choose between either one of the following two purchasing policies:

i) Competition over price only (CP):

Under this rule, the monopsonist first establishes some requirement or standard q°. It then buys from the supplier who made the lowest-cost proposal for producing a good with attributes q°.

ii) Competition over both price and attributes (CPA):

In such a rule the monopsonist requests offers with several dimensions. A manufacturer wins the sale when he proposes a product description (q^*,p^*) that best satisfies the monopsonist. He then has to produce a good that agrees with the description he submitted.

Suppose there are a fixed number $n > 1$ of risk-neutral manufacturers. Each one has a linear profit function p-cq, where the marginal cost c of non-price attributes is a privately known characteristic. From the monopsonist's and the other producers'

point of view, however, the parameter c is drawn independently from the uniform distribution on the open interval (0,1).[3]

The monopsonist's preferences can be represented by a utility function that shows no income effect, nonsatiation and decreasing marginal satisfaction for non-price attributes. Formally, this utility function at (q,p) in R^2_+ can be written as $V(q)-p$, where $V(0) = 0$, $V'(0) = +\infty$, $V'(\infty) = 0$ and $V''(q) < 0$. Note that such a utility function can represent preferences that smoothly emphasize some specific attributes level, meaning that the monopsonist would most enjoy a particular kind of good for its compatibility, say, or other "network externalities"[4]. Two useful lemmas can now be deduced from the general properties of the function $V(\cdot)$.

LEMMA 2.1. On R_+, the function $V(V'^{-1}(x)) - xV'^{-1}(x)$ is

i) decreasing; ii) convex.

PROOF. At $x > 0$, the first-order derivative of the function is

$$\frac{V'(V'^{-1}(x))}{V''(V'^{-1}(x))} - \frac{x}{V''(V'^{-1}(x))} - V'^{-1}(x) = -V'^{-1}(x) < 0 .$$

---

[3] We assume a uniform distribution on (0,1) in order to lighten the exposition. It is straightforward, however, to derive our results when the marginal costs of quality are independently uniformly distributed on (a,b), $0 \leq a < b$.

[4] Some good examples of network externalities and the advantages of standardization are presented in Kindleberger (1983).

This demonstrates i). To prove ii), just note that the second derivative of the function at $x > 0$ is

$$\frac{-1}{V''(V'^{-1}(x))} > 0 .$$

▒

Note that in proving part ii) of the assertion, we also showed that $V'^{-1}(\cdot)$ was a monotone decreasing function on R_+.

LEMMA 2.2. Take $\alpha > 0$. The function $V(V'^{-1}(\cdot)) - \alpha V'^{-1}(\cdot)$ attains its global maximum at α.

PROOF. The first-order derivative of the function at a point x is

$$\frac{x - \alpha}{V''(V'^{-1}(x))} .$$

One can now see that the function is increasing at $x < \alpha$, stationary at $x = \alpha$, and decreasing at $x > \alpha$. This proves the lemma. ▒

With the above lemmas, we are now equipped to establish the main propositions.

3. WHEN DESIGN FLEXIBILITY SHOULD OCCUR

Assume for now that the <u>the buyer's utility</u> $V(q)-p$ at any (q,p) in R^2_+, <u>is publicly known</u>. As we will see, this assumption implies that imposing standards instead of allowing manufacturers

to specify the product is an inferior purchasing policy for a monopsonist.

Consider competition on price only (CP): all suppliers must offer a good of quality q, say. In this case, a manufacturer incurs a total cost cq that is, from everybody else's point of view, distributed uniformly on (0,q). Suppose each supplier proposes a price p(cq) that increases with his private cost cq. Then one wins provided he has the lowest total cost. By independence, the probability of winning of a manufacturer with cost cq is then $(1-cq/q)^{n-1}$. Hence, given that he makes a profit p(cq)-cq if he gets the sale and 0 if he does not, a producer's expected benefit is precisely

$$(p(cq)-cq)(1-cq/q)^{n-1} .$$

Clearly, an optimal bidding function p(·) must satisfy

i) $p'(cq) = (n-1)\dfrac{(p(cq)-cq)/q}{(1-cq/q)}$: a seller with private cost cq maximizes his expected benefit by proposing p(cq);

ii) p(q) = q: a seller with the highest cost just hopes to recover this cost, for he cannot ask a higher price than q to the buyer.

One can check that the function p(·) given by

$$p(cq) = [c+(1-c)/n]q \equiv b(c)q$$

satisfies these conditions. The function b(·) so defined satisfies in turn the differential equation with initial condition [5]

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[5] This differential equation characterizes the symmetric increasing equilibrium strategy of a first-price sealed-bid auction. See McAfee and McMillan (1987) for more details on this

$$b'(c) = (n-1)(b(c)-c)/(1-c) \quad , \quad b(1) = 1. \tag{1}$$

A monopsony's expected price for a product with non-price attributes q can now be computed as

(# sellers)[average payment to each seller]

$$= n \int_0^1 b(c)q(1-c)^{n-1}dc$$

$$= 2q/(n+1).$$

A rational monopsonist would then require standards that maximize its expected utility

$$V(q) - 2q/(n+1). \tag{2}$$

Taking the first-order conditions for a maximum of (2) yields

$$q^\circ = V'^{-1}(2/(n+1)) \tag{3}$$

and the expected level of utility

$$V(V'^{-1}(2/(n+1)) - \frac{2}{(n+1)} V'^{-1}(2/(n+1)) \ . \tag{4}$$

Let us now compare this situatiom with the one where it is up to manufacturers to specify both the price and the non-price attributes. Assume that two suppliers having an identical cost parameter c will make the same quality-price proposal (q(c),p(c)) leading to the same net satisfaction level $\underline{V}$ of the monopsonist. Optimal offers can then be computed by backward reasoning. Figure 1 illustrates the sequence of steps.

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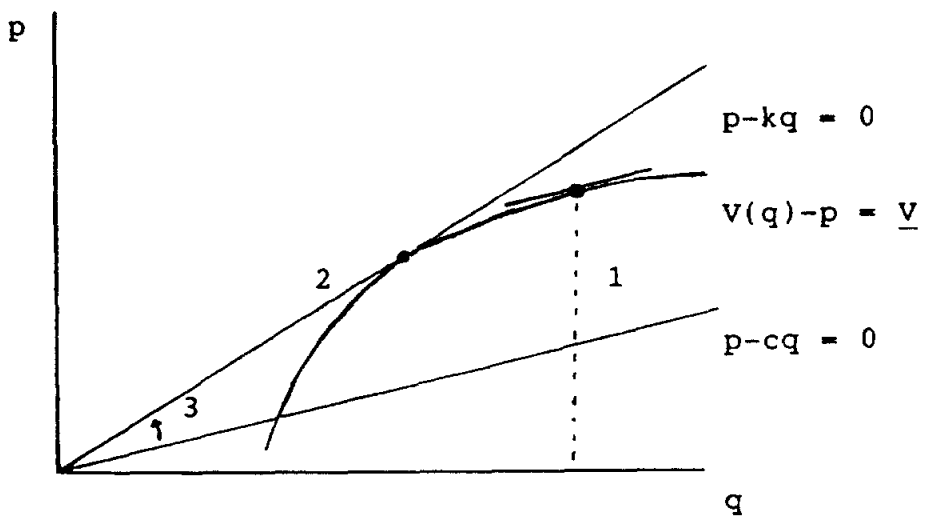
and for an accessible survey of the literature on auctions and bidding.

<u>step 1</u>: An offer $(q(c),p(c))$ should maximize a seller's profit provided the monopsonist achieves a given level of satisfaction $\underline{V}$.

Formally,
$$(q(c),p(c)) = \arg\max_{p,q} \; p-cq$$
$$\text{subject to: } V(q)-p \geq \underline{V}$$



<u>Figure 1</u>. Steps for computing the producers' offers in CPA.

<u>step 2</u>: The proposed utility level $\underline{V}$, which determines the probability of winning the sale, should be the highest level of satisfaction the monopsonist could achieve if the producer revealed a marginal cost k for attributes and got no profit; i.e.
$$\underline{V} = \max \; V(q)-p$$
$$\text{s/t} \;\; p-kq = 0.$$

From these two steps, it is now possible to describe the two-dimensional bid of a supplier with cost parameter c. We have:

$$q(c) = V'^{-1}(c) \quad \text{from step 1,}$$

$$p(c) = V(q(c)) - \underline{V} \quad \text{from step 1}$$

$$= kV'^{-1}(k) + [V(V'^{-1}(c) - V(V'^{-1}(k))] \quad \text{from step 2.}$$

Also, from step 2, a monopsonist gets a satisfaction level

$$\underline{V} = V(V'^{-1}(k)) - kV'^{-1}(k). \tag{5}$$

This leads to

<u>step 3</u>: An opportunistic supplier must now pick a k that best shades his true cost parameter c. Suppose that this k is an increasing function of c. Clearly then, by (5) and lemma 2.1i, the producer with lowest cost will offer the highest satisfaction level to the monopsonist and will therefore get the sale. Thus, the expected profit of a producer with private cost c is

[Benefit from selling](Probability of getting the sale)

$$= [V(V'^{-1}(c)) - V(V'^{-1}(k(\underline{c}))) + k(\underline{c})V'^{-1}(k(\underline{c})) - cV'^{-1}(c)](1-\underline{c})^{n-1} \tag{6}$$

The function $k(\cdot)$ is an optimal shaded marginal cost if the above expression is maximized at $\underline{c} = c$. The first-order conditions for optimizing (6) lead to the following characterization of $k(\cdot)$:

$$k'(c) = \frac{(n-1)[V(V'^{-1}(c)) - V(V'^{-1}(k(c))) + k(c)V'^{-1}(k(c)) - cV'^{-1}(c)]}{V'^{-1}(k(c))(1-c)}, \tag{7}$$

$$k(1) = 1.$$

We can now deduce from (7) that the shading parameter $k(c)$ is never greater than the bidded marginal cost $b(c)$ of CP.

LEMMA 3.1. $k(\cdot) \leq b(\cdot)$ on $(0,1)$.

PROOF. Equation (7) can be reduced to

$$k'(c) = \frac{(n-1)(k(c)-c)}{(1-c)} + \frac{(n-1)[V(V'^{-1}(c))-cV'^{-1}(c)-V(V'^{-1}(k(c)))+cV'^{-1}(k(c))]}{(1-c)V'^{-1}(k(c))}.$$

If $k(c) > b(c)$ at some c in $(0,1)$, then $k'(c) > b'(c)$ on $(c,1)$ by lemma 2.2 and the last equation. So the difference between $k(\cdot)$ and $b(\cdot)$ is positive and increasing on $(c,1)$. But $k(1) = b(1)$. This contradiction establishes the lemma. ▒

Lemma 3.1 will now help establish the main result of this section.

PROPOSITION 3.2. If its preferences are publicly known, a monopsonist gets a higher expected utility from price/attributes competition than from competition over price only.

PROOF: Let P_n be the expectation operator with respect to the nth-order statistic of the uniform distribution on $(0,1)$; i.e. P_n is the expectation operator with respect to the random variable $c = \min[z_1,\ldots,z_n]$, where z_i obeys to the uniform distribution law on $(0,1)$. Note that the density of the nth-order statistic in this context is $n(1-z_i)^{n-1}$.

Now the monopsonist's expected utility in (CPA) is given by

$$
\begin{aligned}
P_n\, V(V'^{-1}(k(c)))-k(c)V'^{-1}(k(c)) \\
&= \int_0^1 [V(V'^{-1}(k(c)))-k(c)V'^{-1}(k(c))]n(1-c)^{n-1}\, dc \\
&> V(V'^{-1}(P_n k(c))) - (P_n k(c))V'^{-1}(P_n k(c)) \\
&\qquad \text{by lemma 2.1ii and Jensen's inequality} \\
&\geq V(V'^{-1}(P_n b(c))) - (P_n b(c))V'^{-1}(P_n b(c)) \\
&\qquad \text{by lemma 2.1i and lemma 3.1} \\
&= V(V'^{-1}(2/(n+1))) - (2/(n+1))V'^{-1}(2/(n+1)),
\end{aligned}
$$

and the last expression is precisely the monopsonist's expected utility in (CP). ▒

This theorem establishes that a monopsonist whose utility is known by the producers would dislike rigid standards that reduce the spectrum of possible products to a single definite one. A monopsonist would rather solicit offers of products with various price and non-price attributes. This presupposes, however, that manufacturers would compete over all possible characteristics of the product. Hence, manufacturers should be driven towards design flexibility.

4. WHEN STANDARDIZATION IS LIKELY TO OCCUR

Suppose now that <u>the suppliers do not know the monopsonist's utility function</u>. They only know, perhaps, a set of plausible utility functions and they have beliefs, in the form of a

probability distribution, on that set. This new assumption could fit many situations, like defense procurement, where product complexity and communication costs prevent producers from knowing or forecasting with absolute precision the buyer's preference structure. In this context, we will illustrate how standards may benefit a monopsonist by enhancing competition between its suppliers.

To simplify, let there be only two manufacturers and assume the distribution of their marginal cost is degenerate at c in (0,1). For these producers, the monopsonist's utility can be

either $V_1(q)-p$ with probability $0 < \alpha < 1$,

or $V_2(q)-p$ with probability $(1-\alpha)$.

As before, the functions $V_i(\cdot)$, $i = 1,2$, are such that $V_i(0) = 0$, $V_i'(0) = \infty$, $V_i'(\infty) = 0$ and $V_i''(q) < 0$. There also exists a pair (p_0,q_0) different from (0,0) such that

$$V_1(q_0)-p_0 = V_2(q_0)-p_0 = 0.$$

In this setting it is possible that the manufacturers find niches where they capture all the monopsonist's rent. For instance, suppose that

i) $\alpha(V_1(V_1'^{-1}(c))-cV_1'^{-1}(c)) = (1-\alpha)(V_2(V_2'^{-1}(c))-cV_2'^{-1}(c))$ and

ii) $\alpha(V_1(V_1'^{-1}(c))-cV_1'^{-1}(c)) \geq V_1(q_0) - cq_0$.

Figure 2 represents such a situation, with $\alpha = 1/2$. One can see immediately that the multi-dimensional offers

$$\Phi \equiv (V_1'^{-1}(c),V_1(V_1'^{-1}(c))) \text{ and } \Theta \equiv (V_2'^{-1}(c),V_2(V_2'^{-1}(c)))$$

constitute an equilibrium when there is competition over price and attributes: no supplier has interest to change his offer

given his competitor's bid. At this equilibrium, however, the monopsonist's ex post utility is zero.

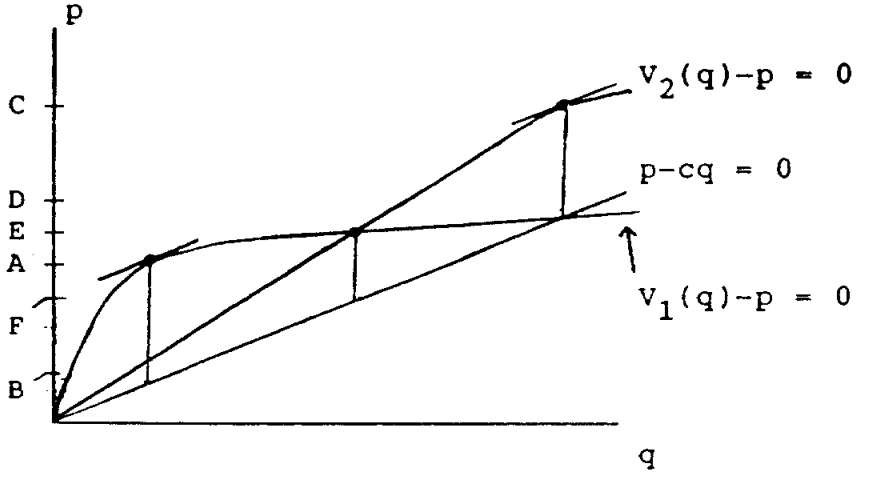


Figure 2. Producers have found niches! [8]

In this case, a wise monopsonist could improve its position by announcing some quality requirements before bidding starts. If, for instance, standard non-price attributes $q^* = V_1'^{-1}(c)$ were imposed, i.e. if both sellers had to offer a product with non-price attributes q^*, competition would bring the price down to cq^*, so the monopsonist's satisfaction would be maximized when its true utility function is $V_1(\cdot)-p$. This proves the following assertion.

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[8] Assumption i) just says that $\alpha(AB) = (1-\alpha)(CD)$ and assumption ii) that $\alpha(AB) \geq (EF)$. ▒

PROPOSITION 4.1. If a monopsonist's preferences are not publicly known, there are circumstances where its expected utility is higher under competition over price only than under price/attributes competition.

Obviously, if a standard product is asked for and competition is on the basis of price only, there is no need for manufacturers to spend money on design flexibility.

5. CONCLUSION

The nature of competition should have an impact on the degree of design flexibility chosen by producers: price/attributes competition should favor flexible in product design, while competition over price only for a standardized product should entail dedicated production lines.

In monopsonistic industries, competition is determined by the buyer's commitment to a particular purchasing policy. This paper presented a simple (bidding) model that yields testable predictions about this commitment:

> **A monopsonist always chooses price/attributes competition rather than competition over price only for a standardized product if, and only if, its preferences are publicly known.**

Verifying these predictions is now an interesting empirical issue.

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