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Comment

Measuring research benefits in an imperfect market

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Voon (1994) recently analyzed the benefits of research in an imperfectly competitive market for an agricultural input. Studies of this type are important because the agricultural industries are becoming more concentrated, and agricultural economists have begun to focus more attention on the implications of imperfect competition in the food and fiber sector. The magnitude and distribution of research benefits under alternative market structures are important from both the perspective of agents' incentives to undertake investments in research, and allocating public monies to support research.

Voon specifically compared the welfare benefit from a cost-reducing innovation for an agricultural input under conditions of monopoly to perfect competition in the supply of the input. The analysis was based on a framework of linear farm demand for the input and linear and rising marginal cost of supplying the input. The key result, based on simulations of the market equilibrium under alternative demand and cost elasticity configurations, was that research benefits were greater under monopoly than under perfect competition. This result is wrong. Specifically for Voon's linear model, we show that research benefits are always greater under perfect competition than under monopoly. We also develop the economic rationale for this formal result, which indicates that the result will remain intact for alternative specifications of demand and cost, and for more general models of imperfect competition as well. Finally, we recast Voon's simulation analysis within the correct model framework to analyze the distributional impacts of research benefits under monopoly vs. perfect competition.

Voon's analytical framework involves a linear inverse demand function, $P(Q) = a - \alpha Q$, for an input. The marginal cost curve for producing the input is also linear, $MC(Q) = b + \beta Q$, and can be interpreted alternatively as a monopolist's marginal cost curve or the aggregate marginal cost (i.e. supply) curve for a group of competitive producers. Research produces a new technology that generates a parallel shift downward in marginal cost to $MC' = c + \beta Q$, where $c < b$. Total welfare in the market is measured as the sum of consumer and producer surplus, where the latter consists of monopoly profits, if any, and quasi rents to fixed inputs.

Although monopoly has implications for the distribution of welfare between producers and consumers, it is well known that the aggregate social loss from monopoly is the so-called dead-

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weight loss, *DWL*. In the case of Voon's linear model, *DWL* can be expressed simply as

$$DWL = 1/2\left[(Q_c - Q_m)(P(Q_m) - MC(Q_m))\right]$$

where subscripts 'c' and 'm' denote competition and monopoly, respectively.

Now consider the cost-reducing innovation. It is straightforward to see that the necessary and sufficient condition for the benefits of the innovation to be greater (less) under monopoly than under perfect competition is that *DWL* decline (increase) as a consequence of the innovation. With a bit of algebra, it is possible to express *DWL* in terms of the four parameters, a, α, b, and β, of Voon's model:

$$DWL = \frac{1}{2}\frac{\alpha^2(a-b)^2}{(2\alpha+\beta)^2(\alpha+\beta)}$$

Differentiating this expression with respect to the cost shift parameter, b, one obtains

$$\frac{\mathrm{d}DWL}{\mathrm{d}b} = \frac{-\alpha^2(a-b)}{(2\alpha+\beta)^2(\alpha+\beta)} < 0$$

DWL is monotonically decreasing in b for all reasonable parameter values, thus formally establishing the result that the benefits from a given cost-reducing innovation are less under monopoly than under perfect competition.

The *DWL* from monopoly is due to a monopolist restricting output relative to the competitive level. *DWL* is a monotonic function of the output differential, $Q^* = (Q_c - Q_m)$. Any comparative static change that increases Q^* will cause *DWL* to increase. The response to the cost reduction from *MC* to *MC'* causes either a monopolist or a competitive industry to expand

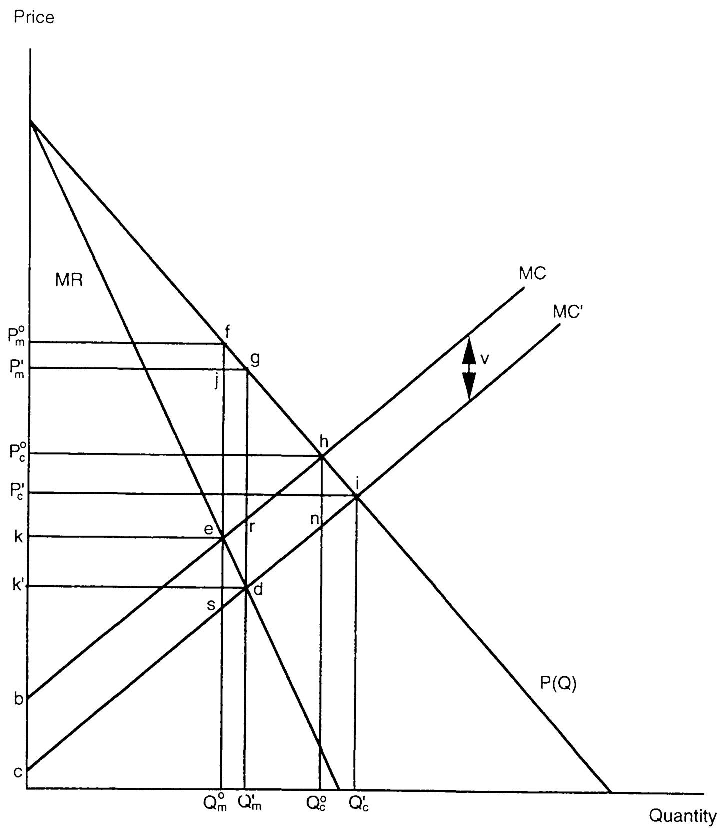

Fig. 1. Welfare effects of a cost-reducing innovation under competition vs. monopoly.

Table 1
Gains from cost-reducing research under monopoly vs. perfect competition

Price elasticities	Producers ($)	Consumers ($)	Producer share (%)	*DWL*
	Surplus gain under perfect competition			Change in *DWL* ($)
$\epsilon=-0.5, e=2.0$	0.0204	0.0816	20.00	0.0202
$\epsilon=-0.5, e=5.0$	0.0093	0.0930	9.09	0.0232
$\epsilon=-1.0, e=2.0$	0.0344	0.0689	33.33	0.0165
$\epsilon=-1.0, e=5.0$	0.0174	0.0868	16.67	0.0215
	Surplus gain under monopoly			ΔDWL as % of competitive surplus gain
$\epsilon=-0.5, e=2.0$	0.0567	0.0252	69.23	19.80
$\epsilon=-0.5, e=5.0$	0.0536	0.0255	67.76	22.68
$\epsilon=-1.0, e=2.0$	0.0620	0.0248	71.43	15.97
$\epsilon=-1.0, e=5.0$	0.0568	0.0258	68.77	20.63

output. However, the output expansion is always less under monopoly because the monopolist recognizes the price implications of expanding output, whereas the competitive industry does not. Thus, relative to a competitive industry, a monopoly will in general respond less to a cost reduction. [1] Q^* and deadweight loss will rise as a consequence, and the benefit from cost-reducing research will be less under monopoly than under perfect competition. [2]

Voon's Fig. 1, adapted and reproduced here for convenience, helps to establish the intuition for this result. The marginal benefit from expanding output under competition from the initial equilibrium value, Q_c°, is just the value of the cost reduction $(b-c)$. However, under monopoly the comparable benefit is $(b-c)$ plus the marginal value of the monopoly distortion, $P(Q_m^\circ) - MC(Q_m^\circ)$. Thus, the benefit per unit from expanding output under monopoly is greater than under competition, but the amount of output expansion is less under monopoly. Geometrically, the net welfare change from the output expansions are the areas sfgd under monopoly and nhi under competition (Fig. 1). The final piece of the welfare change puzzle is the parallelogram drhn. This area measures the cost savings foregone from monopoly restriction of output. Thus, in a very real sense, monopoly 'wastes' a part of the value of a cost-reducing innovation.

Finally, to investigate the distributional impacts of an innovation under monopoly vs. perfect competition, we reconstruct Voon's simulation analyses using the correct procedures. The original simulations are in error because Voon utilized the same normalization of $(P,Q)=(1,1)$ for the monopoly and the competitive cases. These normalizations, plus assumptions about the price elasticity of the demand and marginal cost/supply curve, uniquely identify the four parameters of the linear model. However, in contrast to the situation depicted in his figure and to the correct procedure, Voon's simulation approach results in different demand and marginal cost/supply curves for the competitive vs. the monopoly case, thus rendering the comparison between the two cases meaningless.

The simulation results in Table 1 employ the normalization $(P_c,Q_c)=(1,1)$ and the same price elasticities of demand and supply (ϵ and e, re-

[1] Note that qualitatively similar behavior characterizes most models of oligopoly competion. For example, under the popular Cournot model, a seller recognizes the impact of her own sales on market price but takes no account of rivals' potential reaction. This behavior will restrict the output expansion in the Cournot equilibrium relative to the competitive equilibrium.

[2] This result is consistent with the general principle articulated by Alston et al. (1988) that the benefits from research in the presence of a distortion are equal to the benefits in the absence of the distortion minus the increase in the costs of the distortion due to the supply curve shift.

spectively) utilized by Voon. The demand and supply/marginal cost curves derived from this information are then used to compute the producer and consumer benefits from a per-unit cost reduction of 0.1 for both the monopoly and perfect competition cases.

The results for competition are the same as Voon's, but a smaller surplus gain is indicated for monopoly. The input producer's share under the correct monopoly computations are similar to those computed by Voon and illustrate, not surprisingly, that monopoly enables the supplier to capture the lion's share of the benefits from the cost reduction. The most important column is the last, wherein the change in *DWL* is reported both as an absolute number and as a percentage of the surplus gain under competition. The increase in *DWL* represents the benefits of the cost reduction foregone owing to monopoly. For the parameters in Voon's simulation, the relative loss due to monopoly ranges from 16 to 23% of the benefits attainable under perfect competition.

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