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General Equilibrium in Vertical Market
Structures: Overselling versus
Overbuying

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Abstract

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Richard E. Just* and Gordon C. Rausser⁺

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JEL Classification Codes: D60, L12, L40, and L41

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Introduction

Predatory selling has been evaluated and assessed by antitrust regulators, the courts, and the economics profession.¹ Recently the spotlight has turned to alleged predatory buying.² The criteria for determining in output markets whether monopolists or oligopolists are engaged in predatory actions has been debated and various criteria have been expressed both by courts and professional economists. In the case of monopsonists or oligopolists as buyers in input markets, many have argued that the same criteria used to evaluate predatory selling should also hold for predatory buying.³

The economic literature has long focused the evaluation of predatory conduct on the trade-off between a predator's short run losses and the benefits that might be achieved after its prey is harmed (Telser 1977, Joskow and Klevorick 1979, Easterbrook 1981, Elzinga and Mills 1989 and 1994, McGee 1980, Milgrom and Roberts 1982, Scherer 1976, Williamson 1977). The short run losses suffered by the predator are viewed as an investment incurred that is designed to discipline or eliminate its rivals. This investment is presumed to be motivated by monopoly or monopsony rent seeking. Accordingly, in this two-stage view, the rents or benefits accruing to predatory actions can only be rationalized during some recoupment period as clearly stated by Elzinga and Mills (1994, p. 560):

In simplest terms, conventional predation occurs in two stages. In the first stage the predator prices at nonrenumerative levels to drive rivals or an entrant from the market or to coerce rivals to cede price leadership to the predator. In the second stage the predator flexes its monopolistic muscles by charging supracompetitive prices and recouping the losses sustained during the initial stage.

¹ Areeda and Turner (1975), Areeda and Hovenkamp (Supp. 1993), *Brooke Group v. Brown and Williamson Tobacco Cor.*, (1993), Burns (1986), Easterbrook (1981), Elzinga and Mills (1989), Elzinga and Mills (1994), Joskow and Klevorick (1979), *Matsushita Elec. Indus. C. v. Zenith Radio Corp.* (1986), McGee (1980), Milgrom and Roberts (1982), Scherer (1976), *William Inglis and Sons Baking Co. V. ITT Continental Baking Co* (9th Cir. 1982), and Williamson (1977).

² Blair and Harrison (1993), Carstensen (2004), Kirkwood (2005), Noll (2005), Salop (2005), Zerbe (2005), and *Weyerhaeuser Company v. Ross-Simmons Hardwood Lumber Co, Inc.*, No.05-381 U.S. (9th Cir. 2006); *Khan v. State Oil Co.*, 93 F.3d 1358, 1361 (7th Cir. 1996), 522 U.S. 3 (1997); *Todd v. Exxon Corp.*, 275 F.3d 191, 202 (2nd Cir. 2001); *United States v. Syufy Enters.*, 903 F.2d 659, 663 n.4 (9th Cir. 1990); *Houser v. Fox Theaters Mgmt. Corp.*, 854 F.2d 1225, 1228 and 1231 (3rd Cir. 1988); *Betaseed, Inc. v. U and I Inc.*, 681 F.2d 1203, 1221 (9th Cir. 1982).

³ *Weyerhaeuser Company v. Ross-Simmons Hardwood Lumber Co, Inc.*, No.05-381 U.S. (9th Cir. 2006).

Given the actual availability of data for the first stage, the original focus of both economists and the courts was on the question of measuring losses that occurred during an alleged predatory period. These losses are viewed as a necessary investment to achieve monopoly rents. The measurement of such losses was initially based on the cost benchmark of Areeda and Turner (1975). This benchmark was advanced as a means to separate potential predatory conduct from vigorous competition. As Areeda and Turner note (1975, p. 712), “a monopolist pricing below marginal cost should be presumed to have engaged in a predatory or exclusionary practice.” Given the difficulty of measuring marginal cost, the operational Areeda and Turner test substitutes average variable cost. Under this criterion, short run losses are thus measured as prices unfolding over a predatory period that are below average variable cost.⁴ In essence, whenever a firm fails the cost-based test of Areeda and Turner, it bears the burden of demonstrating that its pricing was not predatory.

A complimentary test for predation has been offered by Elzinga and Mills (1989, 1994). This test recognizes that costs are difficult to measure either as marginal or average variable costs. They instead focus on the second stage, introducing as their benchmark the long run competitive price in the industry.⁵ As a result, the Elzinga-Mills test allows for prices to be above average variable cost but still, in certain circumstances, predatory. Under the Elzinga-Mills test, an analysis of the recoupment period as well as the predatory period is required. As argued by Elzinga and Mills (1989, p. 871), “if a predatory strategy is an economically implausible investment, as judged by the parameters of the recoupment plan, it implies then the alleged predator is exonerated.” This test can only be executed if all of the following are determined: (1) the period of time covering the predatory period, (2) the period of time covering the recoupment period, (3) the long run “but-for” or competitive price, (4) the weighted-average

⁴ Areeda and Turner (1975) recognize that there may be many non-predatory forms of below-cost pricing, e.g., introductory offers and meeting competitor offers.

⁵ Of course, in the long run in a purely competitive industry, prices will be equal to long run marginal cost, which if all factors are variable, will also be equal to long run average variable cost.

cost of capital of the predator, (5) the discount rate required to make returns during the predatory and recoupment periods comparable, (6) a complete structural model including demand and the supply of the firm's rivals, and (7) the prices charged both during the predatory and future recoupment periods. Notably from the standpoint of our paper, this test, as well as the Areeda-Turner test, is implemented in a partial equilibrium framework.

Beginning in the early 1980s, the courts recognized the recoupment standard culminating with *Brooke Group Ltd. v. Brown and Williamson Tobacco Corp.* In this and other Supreme Court decisions, concern has been expressed about false positives, viz, finding a company liable for predatory conduct when it is actually engaged in vigorous competition.⁶ This ruling found that suppliers in output markets are not predatory sellers unless the prices charged are below the seller's cost and, additionally, the seller has a "dangerous probability" of recouping its lost profits once it has driven its competitors from the market. To be sure, the courts have determined that "recoupment is the ultimate objective of an unlawful predatory pricing scheme: it is the means by which a predator profits from predation" (*Brooke Group*, p. 2588). In this ruling, the Supreme Court cited several factors that must be assessed to determine whether an alleged predator can expect to recoup its predatory losses. These factors include (1) the length of the predation period, (2) the extent to which the predator's prices are below cost, (3) the comparative financial strength of the predator versus target firms, (4) the "incentives and will" of predator and prey, (5) the size distribution of firms in the relevant market, (6) entry conditions in the relevant market, and (7) the predator's ability to absorb the output of target firms. These criteria present a substantial hurdle for any effort to prove predatory selling.

Defendants in predatory buying cases have understandably appealed to the safe harbor of the Brooke Group criteria.⁷ As the foundation for this perspective, they argue that monopsony is

⁶ See for example *Matsushita Elec. Indus. C. v. Zenith Radio Corp.*, 475 U.S. 574, 590 (1986) and *Cargill, Inc. v. Monfort of Colo, Inc.*, 479 U.S. 104 (1986). For Matsushita, the court noted, "we must be concerned lest a rule or precedent that authorizes a search for a particular type of pricing behavior end up by discouraging legitimate price competition," (p. 594, 1986).

⁷ *Weyerhaeuser Company v. Ross-Simmons Hardwood Lumber Co, Inc.*, No.05-381 U.S. (2005).

symmetric with monopoly in economic analysis (Noll, p.591). This position has been supported by Salop (2005), and a large group of economists (Baumol et al, 2006) in their filing of an *Amici Curiae* on Weyerhaeuser's appeal of the 9th Circuit ruling of a lower court's decision in *Weyerhaeuser Company v. Ross-Simmons Hardwood Lumber Co, Inc.*, No.05-381 U.S. (2006). A number of courts have also validated this equivalence.⁸ There are, however, dissenters including, *inter alia*, Carstensen (2004), Kirkwood (2005), Jacobson and Dorman (1991, 1992), and Zerbe (2005). Jacobson and Dorman argue for more lenient antitrust treatment when horizontal competitors form joint purchasing organizations. As a direct contradiction, Carstensen argues that mergers among buyers in some markets are more likely to be anticompetitive than is generally the case for mergers among sellers.

Kirkwood (2005) and Zerbe (2005) argue that the Brooke Group criteria should not apply to predatory buying. In this literature along with Salop (2005), the concept of predatory bidding has been introduced, drawing a distinction between overbuying and raising rivals' cost. Overbuying is argued to be equivalent to predatory selling, which is intended to cause harm to input market competitors, ultimately allowing the predatory buying firm to exercise monopsony power. Baumol, et. al (2006, p.6) have argued that "this strategy is the mirror-image of predatory pricing on the seller's side." For raising rivals' cost, however, the mirror image does not hold because the intention is to raise the input cost of the output market competitors and, thus, allow the predatory firm to exercise and enhance its market power as a monopolist. In this recoupment scenario, the predatory firm does not necessarily eliminate its rivals from the output market.

⁸ The Seventh Circuit, speaking through Judge Posner, has expressly stated that monopsony pricing "is analytically the same as monopoly or cartel pricing and so treated by the law." *Khan v. State Oil Co.*, 93 F.3d 1358, 1361 (7th Cir. 1996), rev'd on other grounds, 522 U.S. 3 (1997). Other courts have reached the same conclusion. *Todd v. Exxon Corp.*, 275 F.3d 191, 202 (2nd Cir. 2001); *United States v. Syufy Enters.*, 903 F.2d 659, 663 n.4 (9th Cir. 1990) ("[m]onopsony and monopsony power are the equivalent on the buying side of monopoly and monopoly power on the selling side"); *Houser v. Fox Theaters Mgmt. Corp.*, 854 F.2d 1225, 1228 and 1231 (3rd Cir. 1988) (applying principles of *Matsushita* and *Monsanto* to monopsony claim); *Betaseed, Inc. v. U and I Inc.*, 681 F.2d 1203, 1221 (9th Cir. 1982) (applying sell-side tying standard to a buy-side tie).

Nevertheless, it is hypothetically able to enhance its monopoly power in the output market, recouping its investment in raising the input prices for its competitors as well as itself.

The lens used by the courts and much of the antitrust literature on these issues, however, is based on partial equilibrium methodology. The purpose of this paper is to determine whether partial equilibrium methodology is robust and can be relied upon in assessments of predatory monopoly or monopsony conduct. The focus is on related markets and the role they play in general equilibrium analysis of such conduct. Does the existence of substitutable versus complimentary products materially change the results implied by a partial equilibrium analysis?

Given the complexity of a general versus partial equilibrium framework, we isolate the impact of related markets in a temporally aggregated analysis. In other words, our results are developed from a static model rather than a two-stage model where the firm with market power first drives out its competitors and then exercises greater market power than previously in an open-ended subsequent recoupment stage. While much of the relevant legal literature and court opinions consider only a two-stage framework as an explanation for overbuying, most such analyses fail to consider the anticompetitive barriers to reversibility that would be required during recoupment, versus the re-entry that would otherwise occur following predation.. In contrast, we show that such conduct is profitably sustainable under certain conditions on a continual basis (or, by implication, with temporal aggregation under reversibility) using a static framework where general equilibrium adjustments are considered. Further, we suggest that such models offer a practical explanation for the substantive impacts of overbuying because two-stage models do not explain well why firms do not re-enter markets just as easily as they leave unless other anticompetitive factors are present.

In the two-stage framework, if a competing firm's best use of its resources is to produce a particular product under competitive pricing but finds switching to production of an alternative to be optimal when a predatory buyer drives up its input price, then its optimal action is to return to its first best use of resources as soon as the predatory behavior is reversed. Thus, unless this

competitive readjustment is artificially prevented, such as by buying up fixed production resources, two-stage predatory behavior cannot be optimal. Thus, proving two-stage predatory behavior should require identification of an artificial barrier to other firms' re-entry or return to previous production levels in the recoupment period. Alternatively, the conditions outlined in this paper would be required for a temporal aggregation of the two-stage problem presuming, of course, that predatory behavior is optimal for any firm.

Fundamentally, we suggest that understanding of the general equilibrium outcomes of the single-stage static model, which implicitly assumes reversibility, is needed before a full understanding of two-stage possibilities can be achieved. In this paper, we present such a static general equilibrium framework. After specifying the general equilibrium model and the competitive equilibrium benchmark, the first formal analysis evaluates market power in output markets. For this case we show that, if a concentrated industry has market power only in the output market and related sectors behave competitively, then overbuying in the input market is not profitable. Here the key to monopoly rents is restricting output, not driving up the prices of an input or, equivalently, overbuying an input. We also show that, under typical conditions, monopolistic firms achieve greater rents or monopoly profits under general equilibrium than they would achieve under typical partial equilibrium models. One of the more interesting implications of the general equilibrium lens is that the existing Department of Justice Merger Guidelines can often give inaccurate results in assessing the profitability of a firm raising its prices by 5 or 10 percent if the analysis is not performed in a general equilibrium framework.

After developing our results under monopoly power in the output market, we turn to distortions in the input market focusing on monopsonistic power. Here we find, contrary to the Ninth Circuit ruling in the *Ross Simmons v Weyerhaeuser* matter that, if a concentrated industry does not have the ability to alter its output price through its input buying behavior, then the industry cannot increase its profits by overbuying the input. Instead, under the general equilibrium lens with reversibility, the traditional monopsony result is obtained where the input

market quantity is restricted. Under the same lens, we also demonstrate that monopsonistic firms may gain more rent than conventional estimates based on partial equilibrium models would suggest just as in the case of monopoly. However, for more likely cases involving developed distribution channels and supply contracts on the supply side, monopsonistic firms will not gain as much as implied by carefully specified partial equilibrium models. Under the latter conditions, a firm has less market power and distorts the price in an input market less when equilibrium adjustments occur in a related industry. We also show that a firm that has the ability to manipulate price by a given amount such as specified by the Department of Justice Merger Guidelines is invalid if done with ordinary or partial equilibrium input supplies.

We then turn to the more general case where a single firm or colluding group of firms has market power in both their input and output markets. Here we develop a number of results that turn on characteristics of technologies of competing industries and the characteristics of input supplies and output demands including the degree of substitutability or complementarity. In these cases we find specific conditions where overbuying can occur profitably. Interestingly, however, profitable overbuying in this model can occur on a continuing basis so that a predatory period may not be evidenced by losses such as are used as a prerequisite for predatory behavior by the courts. Further, we find that a mirror image of this behavior in terms of overselling is not possible. Finally we present the case of *naked overbuying* as a means of exercising market power.

General Equilibrium versus Partial Equilibrium Supply and Demand

To explain the reasons for different results in general equilibrium compared to partial equilibrium, the concepts of general versus partial equilibrium supply and demand relationships in individual markets must be clarified. A supply relationship specifies the quantity of a good that producers will supply at various prices of the good. A partial equilibrium supply of a designated good holds the prices (or quantities) of all other goods constant whereas a general

equilibrium supply allows both prices and quantities in all other markets to adjust in response to changes in the market of the designated good. Similarly, a demand relationship specifies the quantity of a good that consumers will demand at various prices of the good, but a partial equilibrium demand of a designated good holds the prices (or quantities) of all other goods constant whereas a general equilibrium demand allows both prices and quantities in all other markets to adjust in response to changes in the market of the designated good.

Graphically, this relationship is depicted in Figure 1. With no distortion, equilibrium in the market for good y is described by the intersection of supply, $S_y(w_z^0)$, and demand, $D_y(p_z^0)$. By definition, supply and demand for good y are conditioned on prices in other markets represented by w_z^0 and p_z^0 . If w_z^0 represents the general equilibrium prices of factor inputs for producers of good y , then $S_y(w_z^0)$ represents the ordinary supply of y in general equilibrium. Similarly, if p_z^0 represents the general equilibrium prices of other consumer goods, then $D_y(p_z^0)$ represents the ordinary demand for good y in general equilibrium. Accordingly, ordinary supply and demand for good y equate in general equilibrium at quantity y_0 and price p_y^0 for good y and are conditioned on general equilibrium prices in other markets.

Now suppose a distortion is introduced in the y market such as a per unit tax of δ . After adjustment, the price received by producers of good y excluding the tax is p_y^1 and the price paid by consumers including the tax is p_y^2 where $p_y^2 - p_y^1 = \delta$. At a lower output price, producers of y will demand less of their factor inputs, which will cause prices in their factor input markets to decline from w_z^0 to, say, w_z^1 . After adjustment to lower factor input prices, the ordinary supply of good y will be greater, as represented by the outward shift in supply from $S_y(w_z^0)$ to $S_y(w_z^1)$. At the same time, the higher consumer price p_y^2 will cause consumers to switch toward consumption of goods that substitute for good y and away from goods that complement good y . This adjustment will cause prices of substitutes to rise and prices of complements to fall. Both an increase in the price of substitutes and a reduction in the price of complements will cause the ordinary demand for good y to shift outward from $D_y(p_z^0)$ to $D_y(p_z^2)$.

With these shifts (after adjustment of prices to equate respective quantities supplied and demanded in all markets), the new general equilibrium will not be at the quantity y_1 where the vertical difference between the original ordinary demand and ordinary supply is equal to δ . Rather, the new general equilibrium quantity in the y market will be at quantity y_2 where the vertical difference between the new ordinary demand and ordinary supply (conditioned on new general equilibrium prices in all other markets) is equal to δ . Varying the size of the tax thus traces out the general equilibrium supply S^* and general equilibrium demand D^* that take account of adjustment of prices in all other markets in the economy as the tax represented by δ is varied.

While these general equilibrium concepts of supply and demand for an individual market depend upon the type of distortion that is introduced (see Just, Hueth, and Schmitz 2004 pp. 355-361), this simple illustration reveals that both the impact on market quantity and on the deadweight loss (social efficiency) can be very different when general equilibrium adjustments in related markets are considered. For example, under linearity in Figure 1, the deadweight efficiency loss suggested by partial equilibrium supply and demand analysis is a $(y_0 - y_1)\delta/2$ when the efficiency loss with realistic accounting for general equilibrium adjustment is a much smaller $(y_0 - y_2)\delta/2$.

A Model With Related Input and Output Markets

To illustrate general equilibrium analysis specific to predatory buying or selling, we consider the case where prices of all goods, other than two related goods of interest and their associated output and input markets, are set by competitive conditions elsewhere in the economy. As a result, expenditures on other goods can be treated as a composite commodity, n , which we call the numeraire. Further, to avoid problems where standard willingness-to-pay and willingness-to-accept measures of welfare differ from consumer surplus, we assume demand is

generated by maximization of a representative consumer utility function, $u(y, z) + n$, where y and z are non-negative consumption quantities of the two goods of interest.⁹

Suppose the consumer's budget constraint, which equates expenditures with income, is $p_y y + p_z z + n = m$ where p_y and p_z are prices of the respective goods and m is income.

Substituting the budget constraint, the consumer's problem is to maximize

$u(y, z) + m - p_y y - p_z z$. The resulting mathematical conditions for maximization generate consumer demands satisfying

$$p_y = u_y(y, z) \quad (1)$$

$$p_z = u_z(y, z) \quad (2)$$

where u_y represents the derivative (or slope) of u with respect to y and similarly for u_z . These ordinary demands are necessarily downward sloping. With this representation, the two goods are complements in demand if u_{yz} , which represents the marginal effect of good z consumption on p_y , is positive or are substitutes if negative.

Suppose further that the two goods, y and z , each have one major factor input in the production process. For simplicity and clarity, suppose the quantities of any other inputs are fixed. Thus, the respective production technologies can be represented by

$$y = y(x_y) \quad (3)$$

$$z = z(x_z) \quad (4)$$

where x_y and x_z represent the respective input quantities.¹⁰

Suppose the inputs are related in supply so that the industries or products compete for inputs as well as for sales of total output. To represent the related nature of supply, suppose the

⁹ This type of utility function is quasilinear in the numeraire, as is often used for conceptual analysis. Standard assumptions imply $u_y > 0$, $u_z > 0$, $u_{yy} < 0$, $u_{zz} < 0$, and $u_{yy}u_{zz} - u_{yz}^2 \geq 0$ where subscripts of u denote differentiation. While the weaker assumption of quasi-concavity can be assumed for consumer problems, we use the more restrictive assumption $u_{yy}u_{zz} - u_{yz}^2 \geq 0$ to attain symmetry in the underlying mathematical analysis, which simplifies presentation and enhances intuition.

¹⁰ Standard assumptions imply $y' > 0$, $y'' < 0$, $z' > 0$, and $z'' < 0$, where primes denote differentiation.

respective inputs are manufactured by a third competitive industry with cost function $c(x_y, x_z)$.¹¹

Based on standard duality results in economics, input supplies thus follow

$$w_y = c_y(x_y, x_z) \quad (5)$$

$$w_z = c_z(x_y, x_z) \quad (6)$$

where y and z subscripts of c represent differentiation (or slopes) of c with respect to x_y and x_z , respectively. Standard assumptions imply that marginal cost is increasing at an increasing rate in its arguments. With this representation, the two inputs are substitutes in supply if c_{yz} , which represents the marginal effect of input x_z production on the marginal cost of x_y production, is positive or are complements if negative.¹²

The profit of the z industry is $\pi_z = p_z \cdot z(x_z) - wx_z$. If the z industry always operates competitively as if composed of many firms, then the condition implied by profit maximization is

$$w_z = p_z z'(x_z) \quad (7)$$

where $z'(x_z)$ is the marginal productivity of x_z in the production of z following the production function $z = z(x_z)$. For the y industry, behavior is assumed to maximize profit given by

$$\pi_y = p_y \cdot y(x_y) - w_y x_y. \quad (8)$$

Equations (1)-(7) are sufficient to determine the general equilibrium supply and demand relationships facing the y industry. A variety of cases emerge depending on market structure and the potential use of market power by the y industry.

¹¹ This industry may represent a hypothetical firm formed by aggregating the behavior of many producers under competitive conditions.

¹² We further assume that the cost function is weakly convex. For the special case where $c_{yy}c_{zz} - c_{yz}^2 = 0$, which is not normally admitted in standard convexity conditions, we introduce a concept of perfect substitutes in supply where, in effect, $c(x_y, x_z)$ becomes $c(x_y + x_z)$ and $c(\cdot)$ is a convex univariate function.

Competitive Behavior

If the y industry is composed of many firms that do not collude, then the profit maximization condition for (8) requires

$$w_y = p_y y'(x_y) \quad (9)$$

where $y'(x_y)$ is the marginal productivity of x_y in the production of y following the production function $y = y(x_y)$.

Focusing on the y industry for given x_y , the system composed of (1)-(7) can be reduced to a two equation system that describes the general equilibrium input supply and output demand facing the y industry, viz.,

$$p_y = u_y(y(x_y), z(\hat{c}(w_y, x_y))) \quad (10)$$

$$c_z(x_y, \hat{c}(w_y, x_y)) = u_z(y(x_y), z(\hat{c}(w_y, x_y)))z'(\hat{c}(w_y, x_y)). \quad (11)$$

where $x_z = \hat{c}(w_y, x_y)$ is the inverse function implied by $w_y = c_y(x_y, x_z)$. Equations (10) and (11) define implicitly the general equilibrium supply and demand relationships for the y industry.

From the general equilibrium system (10) and (11), the qualitative effect of an increase in the purchased quantity of the y industry's input on the y industry's output demand via its indirect effect transmitted through the z industry markets can be determined by comparative static analysis as we demonstrate in mathematical detail elsewhere (Just and Raussier, 2006). If more of the y industry's input is purchased, then its input price is bid up, the supply of the competing input produced for the z industry (which is a substitute output for input suppliers) is reduced, the production activity of the z industry is then reduced, and the reduction in z industry output causes the demand for y to increase (decrease) if y and z are substitutes (complements) in demand. This effect can be compared to the direct effect on the price of the y industry's input in maximizing profit where the y industry is a single firm with market power. However, with competitive behavior by the y industry, condition (9) together with (10) and (11) defines the competitive equilibrium output price $p_y = \bar{p}_y$, input price $w_y = \bar{w}_y$, and input quantity $x_y = \bar{x}_y$, where other

equilibrium quantities and prices follow from $\bar{y} = y(\bar{x}_y)$, $\bar{x}_z = \hat{c}(\bar{w}_y, \bar{x}_y)$, $\bar{z} = z(\bar{x}_z)$, $\bar{w}_z = c_z(\bar{x}_y, \bar{x}_z)$, and $\bar{p}_z = u_z(\bar{y}, \bar{z})$.

The Case of Monopoly with Related Goods

The first noncompetitive market structure we consider is the case with market power only in the output market. The y industry would have market power only in the output market if many other industries or many firms in another industry also use the same input, effectively rendering input price w_y unaffected by y industry activity.

The difference in partial and general equilibrium relationships in the case of monopoly when related markets are present is illustrated in Figure 2. To make matters transparent, suppose the firm producing good y has constant marginal cost, represented by MC , as in the case of constant returns to scale when all inputs are variable.¹³ When the producer operates competitively, marginal cost pricing generates output price p_y^0 . Where associated general equilibrium prices in other markets are represented by p_z^0 , the ordinary demand facing the producer of good y is $D_y(p_z^0)$. Accordingly, general equilibrium output quantity is y_0 and the general equilibrium price of y is p_y^0 .

Now suppose the producer recognizes its market power and raises price by restricting the quantity sold. Conventional analysis of monopoly behavior is based on the ordinary demand concept. In the simple case of linearity, the associated marginal revenue follows a line halfway between the ordinary demand and the vertical axis, represented in Figure 2 by $MR(p_z^0)$. This marginal revenue is conditioned on the prices p_z^0 of goods in other markets. Based on this marginal revenue relationship, the standard monopoly solution that maximizes producer profit equates marginal revenue with marginal cost by restricting output to y_1 , which allows the monopolist to raise price to p_y^2 according to the ordinary demand $D_y(p_z^0)$.

¹³ These assumptions are not critical to the results but merely make the diagrammatic explanation simpler.

When the monopolist raises price to p_y^2 , however, consumers will respond by purchasing more substitutes and less complements of good y . As a result, the price of substitutes will tend to be driven up by increased demand and the price of complements will tend to decline due to reduced demand, say, to p_z^2 . Both phenomena cause the demand for y in Figure 2 to shift outward to $D_y(p_z^2)$. Hence, the new price after general equilibrium adjustments in all markets will turn out to be p_y^* rather than p_y^2 . Because of related markets, consumer prices respond to a market power distortion represented by δ in Figure 2 along the general equilibrium demand relationship D_y^* rather than the ordinary demand $D_y(p_z^0)$.

In general equilibrium, the monopolist thus actually realizes a marginal revenue that responds along the general equilibrium marginal revenue relationship MR^* rather than $MR(p_z^0)$. This marginal revenue is not the marginal revenue associated with either the ordinary demand relationship before or after equilibrium adjustments. Rather, by analogy with the conventional single-market monopoly problem, it is the marginal revenue associated with the general equilibrium demand, D_y^* , which describes how the price of good y responds with equilibrium adjustments throughout the economy in response to changes in the market power distortion δ in the market for good y .

In the special case where both general and partial equilibrium demands are linear and marginal cost is constant, this leads to the same monopolist choice of output at y_1 as if the marginal revenue associated with the ordinary demand were equated to marginal cost. If demand is not linear, the choice of output recognizing general equilibrium adjustments may be either greater or less than suggested by the ordinary demand at the competitive general equilibrium depending on the relative curvatures of $D_y(p_z^0)$ and D_y^* .

A fundamental implication of this case is that if the y industry does not have the ability to alter industry z activity, for example, by profitably driving up the price of its input, then the y industry cannot profitably increase its output demand by overbuying the input, nor profitably increase the supply of its input by overselling the output. In other words, under the market

structure in (1)-(8), if the concentrated industry has market power only in the output market then neither input overbuying nor output overselling are profitably sustainable. Output is simply restricted to increase the output price. This is the case where the effects of predation on a related industry are reversible during an ensuing recoupment period along the same production and cost curves. This implies that predatory behavior is not profitable under reversibility if the predator has market power only in its output market. In other words, a claim of predation (overselling) is not valid unless irreversibility of production and cost relationships is proven.¹⁴

Even though this result and its intuition is similar to the typical monopoly pricing outcome, the same equilibrium does not arise as suggested by conventional partial equilibrium monopoly analysis. In fact, partial equilibrium analysis can err in two alternative ways depending on how it is conditioned on the circumstances of other markets. To see this, note that the traditional partial equilibrium monopoly pricing rule equates the monopolist's marginal cost and marginal revenue based on the ordinary output demand. To compare with partial equilibrium optimization, two alternative approaches to specification of the ordinary partial equilibrium demand can be considered. With the approach suggested by (1), the ordinary demand is conditioned on z market activity as represented by the quantity z . We call this the *quantity-dependent ordinary demand*, meaning that it is conditioned on quantities in related markets.

For this specification (not shown in Figure 2), the general equilibrium demand is more elastic or less steep than the ordinary demand. Intuitively, the quantity-dependent ordinary demand does not allow the consumer to shift consumption to the z market as the price of y is increased, which accounts for the less elastic nature of the ordinary demand compared to the

¹⁴ The classical assumption of reversibility is used in the bulk of the modern literature on production and cost. It implies that production can be expanded or contracted along a common production function, $z = z(x_z)$, which implies it can also be expanded or contracted along a common cost function, $\zeta(w_z, z) = \min_{w_z} \{w_z x_z \mid z = z(x_z)\}$. More generally, for the case where predation has the goal of disinvestment by competitors, consider an additional input, k_z , that is fixed in the short-run. For this specification, reversibility implies the same common applicability for the longer-run production function, $z = z^*(x_z, k_z)$, and the accompanying cost function, $\zeta^*(w_z, v_z, z) = \min_{w_z, v_z} \{w_z x_z + v_z k_z \mid z = z^*(x_z, k_z)\}$ where v_z is the price in the fixed input. Irreversibility would imply that different functions apply for expansion than apply for contraction, which is a rare but occasionally entertained hypothesis in the production economic literature.

general equilibrium demand. Accordingly, given the market structure in (1)-(8), if the concentrated industry has market power only in the output market, then the concentrated industry maximizes profit by introducing a smaller monopoly distortion in price than associated with partial equilibrium monopoly analysis conditioned on quantities in the related market, regardless of whether the output are complements or substitutes in demand.

More commonly, however, ordinary partial equilibrium demands are specified and estimated as conditioned on prices rather than quantities in other markets. We call the ordinary demands conditioned on prices rather than quantities in related markets *price-dependent ordinary demands*. The properties of such ordinary demands can be found by comparative static analysis of (1) and (2). This yields the interesting result that general equilibrium demand is less elastic or steeper than the typical price-dependent ordinary demand conditioned on other market prices. This is the case depicted in Figure 2.¹⁵

Intuitively, the price-dependent ordinary demand allows the consumer to shift consumption to the z market as the price of y is increased. However, it ignores the upward movement of the price of z that occurs in general equilibrium, which is why the general equilibrium demand for y is less elastic than the price-dependent ordinary demand. This implies that monopolistic firms can gain greater monopoly profits than traditional estimates with price-dependent partial equilibrium models would suggest. Also, the monopoly distortion in prices will be greater in general equilibrium than suggested by ordinary demand. The reason is that general equilibrium demands that embody price adjustments in other markets are less elastic than ordinary demands holding prices in related markets constant suggest.

As in conventional monopoly models, both consumer welfare and overall social efficiency are harmed by monopoly behavior. However, with either linearity or where the market quantity is smaller with monopoly in general equilibrium than indicated by partial equilibrium

¹⁵ For a complete mathematical analysis of both the price-dependent and quantity-dependent cases of general equilibrium monopoly, see Just and Rausser (2006).

calculations, the general equilibrium deadweight efficiency loss will be larger than represented by the conventional partial equilibrium monopoly case.

Perhaps surprisingly, one of the most interesting implications of the general equilibrium lens is that the ability to exploit a market is increased by having a related sector regardless of whether the related good is a complement or a substitute product. The Department of Justice Guidelines provide a rule for determining the relevant market that depends on the ability of a firm to profit from raising price by 5 percent or 10 percent. Our results show that this ability may be possible given equilibrium adjustments in related markets even though it is not present under the price-dependent ordinary partial equilibrium demand facing the firm. Thus, many more cases may pass the Guidelines rule if equilibrium adjustments in other markets are considered appropriately while successful defenses against the Guidelines based on partial equilibrium analysis are invalid.

The Case of Monopsony with Related Goods

Next consider the case where the producer of good y has market power only in the market for its key factor input represented by x_y . A producer would have market power only in its major factor input market if other industries or many firms in other industries produce the same output using factor inputs other than x_y , effectively rendering output price and the prices of other inputs unaffected by y industry activity. This might be the case if only one firm, either by patents or trade secrets, has a unique process that uses input x_y to produce y .

The difference in partial and general equilibrium relationships in the case of monopsony when related markets are present is illustrated in Figure 3. To simplify the figure, suppose the producer of good y has constant marginal revenue product for input x_y represented by MRP , as in the case of constant returns to scale where all inputs are variable.¹⁶ Suppose that the ordinary

¹⁶ These assumptions are not critical to the results but merely make the diagrammatic explanation simpler. In this case, marginal revenue product and marginal value product coincide. More generally, if output demand for the producer is not perfectly elastic as in the case of a competitive output market, marginal revenue product must be used to maximize profits in order to account for declining output price as more of the input is used.

supply of x_y in general equilibrium is $s_y(x_z^0)$ as conditioned on general equilibrium quantities in other markets represented by x_z^0 . If the producer operates competitively, then profit maximization equates the input price to marginal revenue product so that input quantity x_y^0 is purchased at price w_y^0 as conditioned on all other markets at their general equilibrium quantities represented by x_z^0 . Accordingly, x_y^0 and w_y^0 are the general equilibrium market quantity and price of x_y .

Now suppose the producer recognizes market power in the input market and lowers the input price by restricting the quantity purchased. Conventional analysis of monopsony behavior is based on the ordinary supply concept. In the simple case of linearity, the associated marginal outlay for the input follows a line halfway between the ordinary supply and the vertical axis, represented in Figure 3 by $MO(x_z^0)$. This marginal outlay is conditioned on the quantities x_z^0 of goods in other markets. Based on this marginal outlay relationship, the standard monopsony solution that maximizes producer profit equates marginal revenue product with marginal outlay by restricting purchases to x_y^1 , which allows the monopsonist to lower the price paid for the input to w_y^1 according to the ordinary supply $s_y(x_z^0)$.

When purchases of x_y are reduced, however, input suppliers who can produce alternative outputs will have a lower marginal cost for producing substitute outputs and a higher marginal cost of producing complementary outputs such as by-products of the process that produces x_y . As a result, the price of input suppliers' substitute outputs will tend to be driven down by competition and the price of complementary outputs will tend to rise, say, to x_z^1 . Both phenomena cause the ordinary supply of x_y in Figure 3 to shift leftward to $s_y(x_z^1)$. Hence, the new price of x_y after general equilibrium adjustments in all markets will be w_y^* rather than w_y^1 . Because of related markets, the price of x_y thus responds to a market power distortion represented by δ in Figure 3 along the general equilibrium supply relationship s_y^* rather than the ordinary demand $s_y(x_z^0)$.

In general equilibrium, the monopolist thus actually realizes a marginal outlay that responds along the general equilibrium marginal outlay relationship MO^* rather than $MO(x_z^0)$. This marginal outlay is not the marginal outlay associated with either the ordinary supply relationship before or after equilibrium adjustments. Rather, by analogy with the conventional single-market monopsony problem, it is the marginal outlay associated with the general equilibrium supply, s_y^* , which describes how the price of x_y responds with equilibrium adjustments throughout the economy in response to changes in the market power distortion δ in the market for good x_y .

Just and Rausser (2006) show that if the y industry does not have the ability to alter its output price by indirectly affecting industry z activity, for example, by profitably driving down the price of its output, then the y industry cannot profitably increase its output demand by overbuying the input, nor profitably increase the supply of its input by overselling the output.. Because the general equilibrium supply of its input is upward sloping in its input quantity, a rather traditional monopsony result is obtained where the input market quantity is restricted. As in the case of monopoly, this is the case when the effects of predation on a related industry are reversible during an ensuing recoupment period along the same production and cost curves. This implies that predatory behavior is not profitable under reversibility if the predator has market power only in its input market. In other words, a claim of input market predation (overbuying) is not valid unless irreversibility of production and cost relationships is proven.

Even though this result and its intuition are similar to the typical monopsony pricing result, the same equilibrium does not occur if the y industry optimizes its profit in the conventional partial equilibrium sense. To see this, note that the traditional partial equilibrium monopsony pricing rule equates the monopsonist's value marginal product and marginal outlay where the marginal outlay is based on the ordinary input supply. As in the case of demand, two alternative approaches can be used to specify the ordinary partial equilibrium supply. With the quantity-dependent ordinary demand defined by (5), the relationship of p_y and x_y in the y market

is conditioned on activity in the z market as represented by input quantity x_z . We call this the *quantity-dependent ordinary supply*, which is the case depicted in Figure 3.

For this conditioning on quantities in the related markets, if the concentrated industry has market power only in the input market, then the concentrated industry maximizes profit by introducing a smaller monopsony distortion in price than associated with conventional partial equilibrium monopsony regardless of whether the inputs are complements or substitutes in supply. This means that monopsonistic firms cannot gain as much monopsony profit as conventional estimates based on partial equilibrium models would suggest. The reason is that general equilibrium supplies that account for adjustments in other markets are more elastic than ordinary supplies that hold quantities constant in related markets. Intuitively, when input suppliers can switch to or from supplying other input markets, then their response in supplying the y industry is greater.

Alternatively, the ordinary partial equilibrium supply can be specified as conditioned on the price w_z rather than the quantity x_z . We call this the *price-dependent ordinary supply*. In this case, the properties of the supply of x_y are found by comparative static analysis of (5) and (6). The general equilibrium supplies that embody price adjustments in other markets are more elastic than ordinary supplies that hold prices constant in related markets. Specifically, with the market structure in (1)-(8), if the concentrated industry has market power only in the input market, then the concentrated industry maximizes profit by introducing a larger monopsony distortion in price than associated with partial equilibrium monopsony analysis based on price data from the related market, regardless of whether the inputs are complements or substitutes in supply.¹⁷

Intuitively, much like the monopoly case, the price-dependent ordinary supply allows input suppliers to shift toward supplying inputs to the z industry as the price of x_y is reduced, which accounts for the more elastic nature of the ordinary supply compared to the quantity-

¹⁷ A complete mathematical analysis of both the price-dependent and quantity-dependent cases of general equilibrium monopsony is also available in Just and Rausser (2006).

dependent case. However, it ignores the upward or downward movement of the price of x_z that occurs in general equilibrium, which is why the general equilibrium supply of x_y is less elastic with the price-dependent ordinary supply.

The critical question is which specification of the ordinary supply is appropriate for comparison. The answer to this question depends on the circumstances of application. To contrast the implications of general equilibrium analysis with typical partial equilibrium analysis, the question comes down to how a typical business manager assesses his input supply, or how typical economists, lawyers, and the courts estimate supply relationships in analyzing monopsony behavior.

While typical specifications of supply systems derived with the popular profit function approach of modern economics depend on prices rather than quantities of other outputs, such analyses are typically infeasible because of data limitations in supply analyses. Price-dependent analysis on the demand side typically can be conditioned on prices because final goods price data are relatively abundant and observable. However, supply side analysis is often severely hampered by unavailability of proprietary price data even though trade organizations often publish some form of quantity data.¹⁸ Further, given the pervasiveness of supply contracts in primary goods markets (as compared with final goods markets), quantity dependence may be more appropriate for input supply analysis. Even in absence of contracting, the threat of competitive retaliation may make input markets function more as if supply contracts were present, making prices more flexible than quantities. For these reasons, a supply specification used for practical purposes may tend to control for the conditions in related markets with quantities rather than prices.

Because the price conditioned case is basically the mirror image of the monopoly comparison of the previous section, we focus the graphical analyses in Figures 2 and 3 and most of our discussion on what we regard as the practical cases where ordinary output demand is

¹⁸ While lawyers and expert witnesses may have access to the proprietary data of their clients or opponents in legal proceedings, access to the proprietary data of indirectly related industries is unlikely.

conditioned on output price data from related output markets but ordinary input supply is based quantities in related input markets.

Thus, intuitively in the case of complements in supply, reducing the price of x_y by restricting purchases reduces the supply and increases price w_z for the z industry. In turn, in general equilibrium, the z industry reduces purchases of x_z , which reduces the ordinary supply of x_y to the y industry, thus making the general equilibrium supply facing the y industry more elastic than the ordinary supply that holds z industry quantity constant. In the case of substitutes, reducing the price of x_y by restricting purchases increases the supply and reduces price w_z for the z industry. As a result, in general equilibrium, the z industry increases purchases of x_z , which reduces the ordinary supply of x_y to the y industry, thus making the general equilibrium demand facing the y industry more elastic than the ordinary supply that holds z industry quantity constant. This is why the y industry has less market power and distorts the price in the x_y market less considering equilibrium adjustments of the related industry than in the case of partial equilibrium optimization.

In the final analysis, our results demonstrate an interesting contrast between the monopoly and monopsony cases when price data on related consumer markets are available but only quantity data on related input markets are available or appropriate. Under such circumstances, partial equilibrium analysis overestimates the actual ability of a firm to exploit an input market and underestimates the actual ability of a firm to exploit an output market when there is a related sector. These results demonstrate that showing a firm has the ability to manipulate price by a given amount, such as specified by the Department of Justice Guidelines, is not valid in either case if done with ordinary partial equilibrium analysis.

Market Power in Both Input and Output Markets

Finally, we consider the case where the y industry consists of a single firm or colluding firms that have market power in both their input and output markets. To be sure, the strategic

opportunities available to the y industry under such a vertical market structure expand dramatically in this case. To provide a flavor for the kind of strategic opportunities that exist for industry y , consider Figure 4. In this figure, there are four graphs that relate to each of the input and output markets. Initially, all four markets are in ordinary equilibrium as part of a general equilibrium where the y industry is selling monopolistically in the y industry output market, and the other three markets operate competitively with equilibrium prices and outputs denoted by '0' superscripts. In the y industry output market (lower left diagram), the y industry equates its marginal revenue, $MR(p_z^0)$, to its marginal cost of output, $S_y(w_y^0)$, which would be its ordinary supply under competitive output pricing, so that the equilibrium quantity is y_0 , which permits charging price p_y^0 according to the ordinary demand $D_y(p_z^0)$ conditioned on the general equilibrium price in the other output market.

Now suppose the y industry, realizing market power also in its input market considers overbuying (*ob*) its input by increasing the quantity purchased from x_y^0 to x_y^{ob} , which drives up the price of x_y from w_y^0 to w_y^{ob} (upper left diagram). With this overbuying, if x_y and x_z are substitutes in supply, the higher price and quantity for input x_y causes an inward shift in the supply schedule of the related input x_z (upper right diagram) from $s_z(x_y^0)$ to $s_z(x_y^{ob})$. Equilibrium adjustment in the z industry input market thus causes a rise in the price of x_z from w_z^0 to w_z^{ob} . The increase in its input price causes the z industry to reduce its output supply as represented by an inward shift in its output supply schedule (lower right diagram) from $S_z(w_z^0)$ to $S_z(w_z^{ob})$. Equilibrium adjustment in the z industry output market thus raises the price of z from p_z^0 to p_z^{ob} . The next step is to evaluate the indirect consequences of input overbuying for the y industry output market. If z and y are substitutes, the increase in the price of z causes consumers to reduce consumption of good z and increase demand for good y as represented by an outward shift in the demand for good y (lower left diagram) from $D_y(p_z^0)$ to $D_y(p_z^{ob})$. This causes the accompanying marginal revenue schedule to shift outward from $MR(p_z^0)$ to $MR(p_z^{ob})$. Also, the higher input price for x_y due to overbuying causes the y industry's marginal cost schedule to rise from $S_y(w_y^0)$

to $S_y(w_y^{ob})$. As a result, both the monopolistic output sold and price received, which equate marginal revenue with marginal cost, increase from y^0 and p_y^0 to y^{ob} and p_y^{ob} , respectively.

Whether overbuying is profitable for the y industry depends on how profits are affected. In the initial general equilibrium with monopoly in the output market, profit for the y industry (aside from fixed cost) is measured by area $abcp_y^0$. With overbuying, after all equilibrium adjustments represented by shifts in supplies and demands in Figure 4, profit for the y industry (aside from fixed cost) is measured by area $defp_y^{ob}$.¹⁹ Whether overbuying is profitable depends on how these two levels of profit compare. Obviously, if the shift in the y industry's marginal cost is large and the indirect effect of overbuying on the demand for the y industry's output is small, overbuying is not profitable. The extent of the shift in marginal cost depends on the marginal productivity of x_y in producing y . The extent of the indirect shift in the y industry's demand caused by overbuying its input depends on three critical relationships: (i) the degree of substitutability of inputs x_y and x_z , which determines how much the z industry's input supply is altered by a given change in the price of the y industry's input, (ii) the marginal productivity of the z industry, which determines how much the z industry's output supply is altered by a given change in the price of its input, and (iii) the degree of substitutability of outputs y and z , which determines how much the y industry's output demand is altered by a given change in the price of the z industry's output. Overbuying is more likely to be profitable if marginal productivity in the z industry is high relative to the y industry and both inputs and outputs are highly substitutable or highly complementary.

The more critical question, however, is not how the two levels of y industry profit represented in Figure 4 relate, but how the profit under overbuying represented in Figure 4 relates to the profit that could be earned if the y industry simultaneously sells its output

¹⁹ In the previous paragraph, the shifts in supplies and demands are discussed as immediate impact effects. In reality, the consequent price changes will cause further secondary shifts. For the discussion in this paragraph, the shifts in Figure 4 are assumed to represent the new general equilibrium after all subsequent equilibrating effects are realized. Also, note that the higher cost of buying the input in the y industry input market is reflected by the shift in the marginal cost curve, denoted by s_y in the upper left-hand part of Figure 4, and would amount to double counting if added to the change in profit reflected in the lower left-hand part of Figure 4. See Just, Hueth, and Schmitz (2004).

monopolistically and buys its input monopsonistically. In this case, one could consider a marginal outlay in the y industry input market (upper left diagram of Figure 4) as in Figure 3. While typical partial equilibrium wisdom might suggest that this action would achieve greater profit than the initial equilibrium depicted in Figure 4 with competitive pricing in the input market, general equilibrium adjustments provide further clarifications. In point of fact, the alternative of monopsonistic input market behavior in the y industry input market in Figure 4 could cause the opposite result due to indirect effects. That is, where both inputs and outputs are substitutes, lowering the price for x_y by standard monopsonistic purchasing would cause the supply of x_z to shift outward, causing in turn an outward shift in the supply of z and a consequent inward shift in the demand for y . In other words, the indirect effects of adjustments in the related sector would act to reduce the potential monopoly profits in the output market and the consequent contraction of industry y production would tend to further reduce the profit potential from traditional monopsonistic buying.

A complete mathematical analysis of these possibilities (Just and Rausser, 2006) shows that, under certain conditions, overbuying can, in fact, be more profitable than competitive input purchasing with monopolistic selling. Moreover, the indirect general equilibrium effects cause the joint monopoly-monopsony pricing strategy to generate less profit for the y industry than competitive input purchasing in exactly the same circumstances where overbuying is more profitable. Further, similar results are also possible where both inputs are complements in supply and outputs are complements in demand. (In this case, all that changes in Figure 4 is that both input supply and output supply for the z industry shift outward rather than inward while the qualitative changes in the y industry input and output markets are the same.)²⁰

²⁰ If outputs are complements when inputs are substitutes, then the reduced output and higher price of z in Figure 4 would reduce the demand for y so that no benefits could be gained by overbuying the input. If inputs were complements when outputs are substitutes, then bidding up the price of x_y causes the supply of x_z to shift outward, which would shift the supply of z outward and reduce the demand for y so that overbuying would not be profitable.

One of the interesting results of a complete mathematical analysis of the model in (1)-(8) is that the optimality of predatory behavior depends on having general equilibrium relationships with adverse slopes, e.g., an upward sloping general equilibrium demand. While upward sloping demands are generally counterintuitive according to accepted economic wisdom, this possibility exists with general equilibrium adjustment when the effects of adjustment are transmitted more effectively through the competitive z industry than through the concentrated y industry. Consider the case where the y industry increases production and input use from the competitive level represented by the initial case in Figure 4. Intuitively, when inputs are substitutes, increasing input purchases causes a reduction in supply of inputs to the z industry and thus a reduction in z industry output, which, if y and z are substitutes, causes an increase in demand for y . If this transmission of effects through the z industry is sufficiently effective, e.g., because marginal productivity in the y industry is relatively low, then this upward pressure on the demand for y can be greater than the downward pressure on p_y caused by the increase in y output. If so, then the general equilibrium demand for y is upward sloping because the price of y can be increased as output is increased (as depicted in the lower left diagram of Figure 4).

As in the case of general equilibrium demand, downward sloping supplies are also generally counterintuitive according to accepted economic wisdom but also deserve serious assessment in the general equilibrium case. Consider the case where the y industry increases production and input use. Intuitively, when outputs are substitutes, increasing the output quantity causes a reduction in demand for the output of the z industry and thus a reduction in z industry input use, which, if x_y and x_z are substitutes, causes an increase in supply of x_y . If this transmission of effects through the z industry is sufficiently effective, then this upward pressure on the supply of x_y might be greater than the downward pressure on w_y caused by the increase in the quantity of input use by the y industry. If so, then the general equilibrium supply of x_y is downward sloping. In the case of indirect effects from output markets to input markets, a low marginal productivity causes the effects of a given output market change to be more dramatic in

the input market, and therefore a low marginal productivity in the z industry relative to the y industry makes the indirect effects through the z sector more likely to dominate the direct effects of increasing production and input use in the y industry. This case is not shown diagrammatically, but is roughly a mirror image of Figure 4.

Given the possibility of adverse slopes of general equilibrium supplies and demands, two mathematical results are important. First, a negative sloped general equilibrium supply and positively sloped general equilibrium demand cannot occur simultaneously because the conditions on marginal productivities in the two cases are mutually exclusive. Second, the slopes of the general equilibrium output demand and input supply are always such that supply cuts demand from below regardless of unconventional slopes of either.

Conceptually, the optimality of predatory activity can be simply investigated as follows once the slopes or elasticities of the general equilibrium supply and demand in equations (10) and (11) are determined. Where y industry profit is $\pi_y = p_y \cdot y(x_y) - w_y x_y$, the condition for maximization is

$$w_y = (dp_y/dx_y)y + p_y y' - (dw_y/dx_y)x_y$$

where dw_y/dx_y represents the slope of the y industry's general equilibrium input supply and dp_y/dx_y represents the slope of the y industry's general equilibrium output demand (with the latter translated to an input price equivalent). In terms of Figure 1, the price distortion δ is

$$\delta = -(dp_y/dx_y)y + (dw_y/dx_y)x_y.$$

Analyzing the sign of δ is sufficient to determine whether the equilibrium input quantity (or output quantity) of the concentrated sector is larger or smaller than in the competitive equilibrium. Given that the general equilibrium supply cuts the general equilibrium demand from below, determining whether equilibrium production in the y industry is above or below the competitive equilibrium is simply a matter of determining whether δ is positive or negative (at the competitive equilibrium if otherwise ambiguous) as suggested by Figure 1.

Because the input quantity and output quantity of the y industry have a monotonic relationship, both will be above the competitive level if either is, or both will be below the competitive level if either is. If $\delta > 0$, as in the cases of either monopoly or monopsony alone (Figures 2 and 3), then the y industry maximizes profit by reducing its production and input use. However, if $\delta < 0$, then the y industry maximizes profit by expanding production and input use beyond the competitive equilibrium. If this occurs because the general equilibrium demand for y is upward sloping, then the firm with market power in both its input and output markets maximizes profit by overbuying. Bidding up the price of its input, by buying more than in the competitive equilibrium, indirectly increases its demand sufficiently that the increase in its revenue with monopoly pricing more than offsets the cost of buying its input (and more of it) at a higher input price (as suggested by Figure 4).²¹ ²²

If $\delta < 0$ occurs because the general equilibrium supply of x_y is downward sloping, then the firm with market power in both its input and output markets maximizes profit by overselling, i.e., bidding down the price of its output by selling more than in the competitive equilibrium. While the mathematical results for this case parallel the overbuying case, suggesting that overbuying is a mirror image of the overselling case, further analysis reveals that overselling occurs only when profit is negative.²³ In contrast, overbuying can occur when profit is positive.

With these results, the cases of overbuying and overselling are not mirror images of one another as asserted by many on the basis of arguments by Noll (2005). The remarkable result about overbuying in this paper is that it can be profitably sustainable (because it holds in a static framework) and thus does not require a separate period of predation with a subsequent period of

²¹ Just and Rausser (2006) show that this case of $\delta < 0$ can occur only if the marginal productivity of the z industry is greater than the marginal productivity of the y industry.

²² As an example of this case, Just and Rausser (2006) consider the case where either both inputs and outputs are perfect substitutes or both are perfect complements with those of a competitive sector and the technology of the competitive sector is approximately linear. Overbuying of the input relative to the competitive equilibrium then maximizes profit if the marginal productivity of the competitive sector is both greater than marginal productivity of the concentrated industry and less than the average productivity of the concentrated industry.

²³ Just and Rausser (2006) show that this case of $\delta < 0$ can occur only if the marginal productivity of the z industry is less than the marginal productivity of the y industry.

recoupment. In contrast, overselling cannot be profitable in a static framework and thus requires a two-stage framework that dominates previous literature. However, we underscore the qualification that the two-stage framework applies only under irreversibility – a requirement not currently required in typical standards of proof used by the courts. A further asymmetric implication of these results is that profitability of overbuying does not require incurring losses over any period of time as is commonly required in court standards such as the Brooke Group criteria. Because the indirect effects of enhanced output demand are realized as soon as equilibrium adjustments occur in response to bidding up prices in the input market (which may well be in the same time period), profits may only increase.

Naked Overbuying as a Means of Exercising Market Power

Another form of predatory behavior that can be examined in a general equilibrium framework is naked overbuying where the firm with market power buys amounts either of its own input or that of its competitor that are simply discarded. To analyze this case, we consider only buying amounts of the competitors input, which is equivalent to buying additional amounts of its own input in the case of perfect substitutes, and is a more efficient way to influence the market in the case of less-than-perfect substitutes. In this case, equation (6) is replaced by

$$w_z = c_z(x_y, x_z + x_0) \quad (6^*)$$

where x_0 is the amount of the competitors' input bought and discarded by the firm with market power. For this case, the system composed of (1)-(5), (6^{*}), and (7) can be solved for

$$p_y = u_y(y(x_y), z(\hat{c}(w_y, x_y) - x_0)) \quad (10^*)$$

$$c_z(x_y, \hat{c}(w_y, x_y)) = u_z(y(x_y), z(\hat{c}(w_y, x_y) - x_0))z'(\hat{c}(w_y, x_y) - x_0), \quad (11^*)$$

which define the general equilibrium supply and demand.

For this general equilibrium supply and demand, naked overbuying of the related industry's input unambiguously causes the related industry's input price to increase while it

causes the industry's own input price to increase (decrease) if inputs are substitutes (complements). Demand for the concentrated industry increases if (i) outputs are complements or (ii) outputs are perfect substitutes and the marginal cost of producing the competitive industry's input is increasing.

The firm with market power evaluating naked overbuying maximizes profit given by $\pi_y = p_y y - w_y x_y - w_z x_0$ with respect to x_y and x_0 . Analysis of this problem reveals that, if both inputs and outputs are complements, then the concentrated industry overbuys the input because the beneficial effects on its output market dominates the increased cost of input purchases. The intuition is that the concentrated industry is better off because it does not have to use the increased purchase of inputs to relax the monopoly-restricted size of its output market. On the other hand, if inputs are complements and outputs are substitutes then buying the competitive sector's input and discarding it both increases the supply of the concentrated industry's input and, because of indirect effects though discouraging z industry activity, increases the concentrated industry's demand. These effects tend to improve the concentrated industry's ability to exploit both its input and output markets. By comparison, if inputs are substitutes then buying the competing sector's input and discarding it not only raises the input price of the competing sector but also the input price of the concentrated sector. In this case, the output market effect of causing a contraction in z industry activity must be greater to make such action profitable.

Conclusion

This paper has developed a framework to evaluate static explanations for predatory overbuying in input markets and predatory overselling in output markets. The intent is to fully understand predatory behavior that is profitably sustainable and establish a framework that can be used to analyze two-stage predation in general equilibrium. Much can be learned from this comparative static analysis in presence of related industries before developing the two-stage

predatory formulation where optimality depends on a first-stage predation period and a second-stage recoupment period.²⁴

While the literature on predatory behavior has drawn a distinction between raising rivals' costs and predatory overbuying that causes contraction of a related industry, our results show that optimal behavior can involve a simultaneous combination of the two.²⁵ In the case of substitutes in a static model, raising rivals' costs is the means by which contraction of the related industry is achieved. Given the existence of a related competitive industry, a firm with market power in both its input and output markets can be attracted to overbuy its input as a means of raising rivals' costs so as to take advantage of opportunities to exploit monopoly power in an expanded output market. Interestingly, this can be attractive even though a similar (single-stage) explanation for overselling is not applicable. That is, overbuying can be profitably sustainable whereas overselling appears to require a two-stage explanation with irreversibility. In contrast to the Supreme Court ruling in *Brooke Group Ltd. v. Brown and Williamson Tobacco Corp.*, 509 US 209 (1993) and *Weyerhaeuser Co. v. Ross-Simmons Hard Wood Lumber Co., Inc.*, 549 US ____ (2007), these results show that (i) predatory buying in input markets will not necessarily lead to short-run costs above prices because the output market is exploited to increase output prices relatively more, and that (ii) a second-stage recoupment period after driving competitors from the market is not necessary to make this behavior profitable.

Moreover, such action may result in raising prices to consumers, which not only causes loss in overall economic efficiency, but also loss in consumer welfare in particular (thus satisfying the narrower legal definition of efficiency, Salop 2005). But this loss in consumer

²⁴ The conceptual results of this paper apply for various time horizons. As previously noted in the introduction section, any substantive difference in a two-stage model will depend on having irreversible costs of expansion and contraction that differ from one another. If the costs of expansion and contraction follow standard production and cost relationships over longer time periods and are reversible as in classical theory of short- and intermediate-run cost curves, then the model of this paper is applicable and two-stage issues are inapplicable. So understanding of how two-stage results differ from classical theory depends on understanding how marginal costs of expansion differ from marginal costs of contraction.

²⁵ We recognize that much of the literature on predatory overbuying is based on the presumption that overbuying causes firms to exit, as in a two-stage case of recoupment. However, proof is required in this case as well that such firms will not re-enter when market circumstances are reversed.

welfare may occur either through higher prices for the primary consumer good or by causing a relatively higher price for a related consumer good.

A further set of results in this paper apply to the case of complements. While apparently not considered in the legal literature defining predatory behavior, overbuying can reduce costs to a related industry in the case of complements, and thus increase the ability to exploit an output market if the related output is also a complement. The general equilibrium model of this paper reveals that the case where both inputs and outputs are complements is virtually identical in effect to the case where both are substitutes. While the case of complements is less common in reality, it seems that any legal standard should treat the cases symmetrically.

With the analytical understanding provided by the framework of this paper, the four-step rule proposed by Salop (2005) is shown to relate to a special case. That is, overbuying can be associated with Salop's first step of artificially inflated input purchasing. However, in the case of complements, this will not lead to injury to competitors according to Salop's second step. Yet, market power may be achieved in the output market (Salop's third step), which may cause consumer harm in the output market if outputs are also complements (Salop's fourth step).

Our results also show that issues in "buy-side" monopsony cases are not simply a mirror image of issues in "sell-side" monopoly cases when related industries are present, especially when proprietary restrictions on data availability cause the partial equilibrium analysis of monopsony to be conditioned on quantities rather than prices in related markets. Further, a sustainable form of overbuying in the input market is possible in absence of the typical two-stage predation-recoupment approach, which distinctly departs from the overselling literature, and perhaps more importantly cannot be detected by a period when marginal costs exceed output prices. These issues have previously been understood as mirror images of one another in the conventional partial equilibrium framework. However, once the equilibrium effects of market power and typical data availability are considered, partial equilibrium analysis of monopoly turns

out to understate the true distortionary effects while partial equilibrium analysis of monopsony overstates the true distortionary effects.

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Figure 1. General Versus Partial Equilibrium Supply and Demand

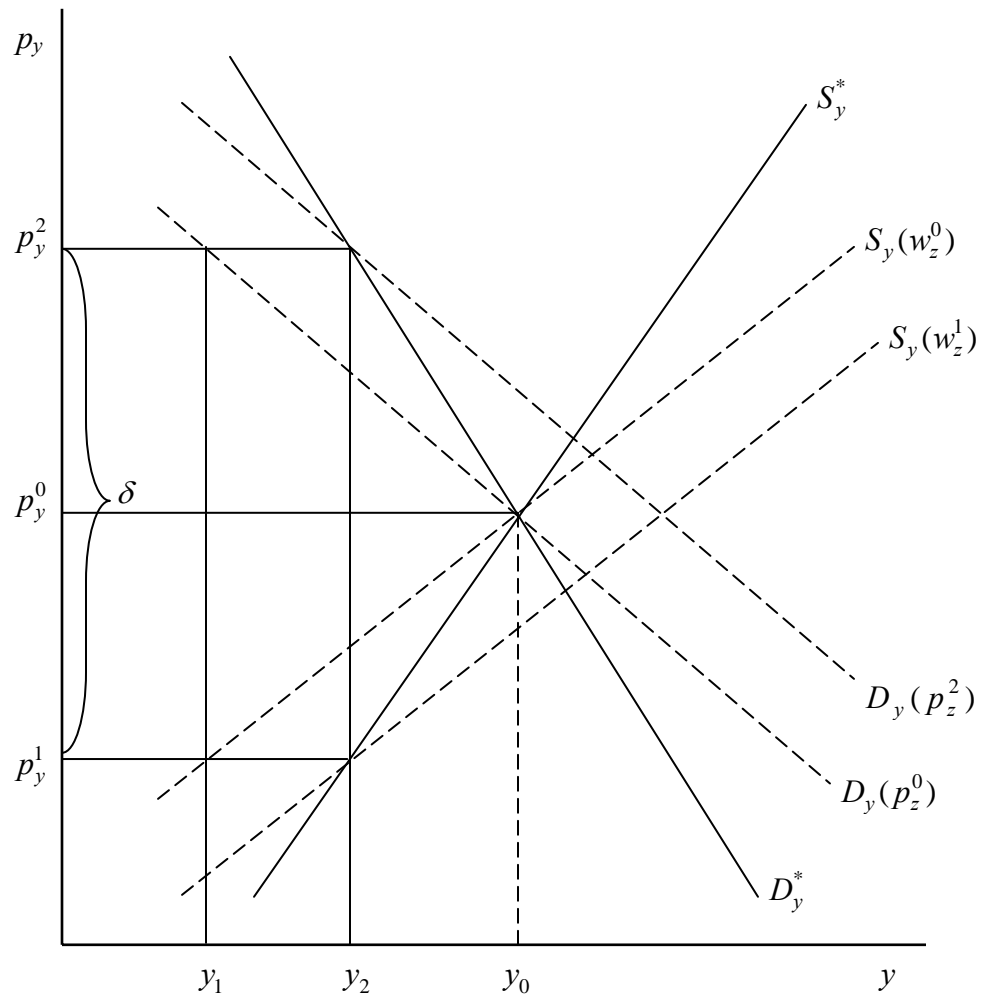


Figure 2. Equilibrium Effects of Monopoly with a Related Market.

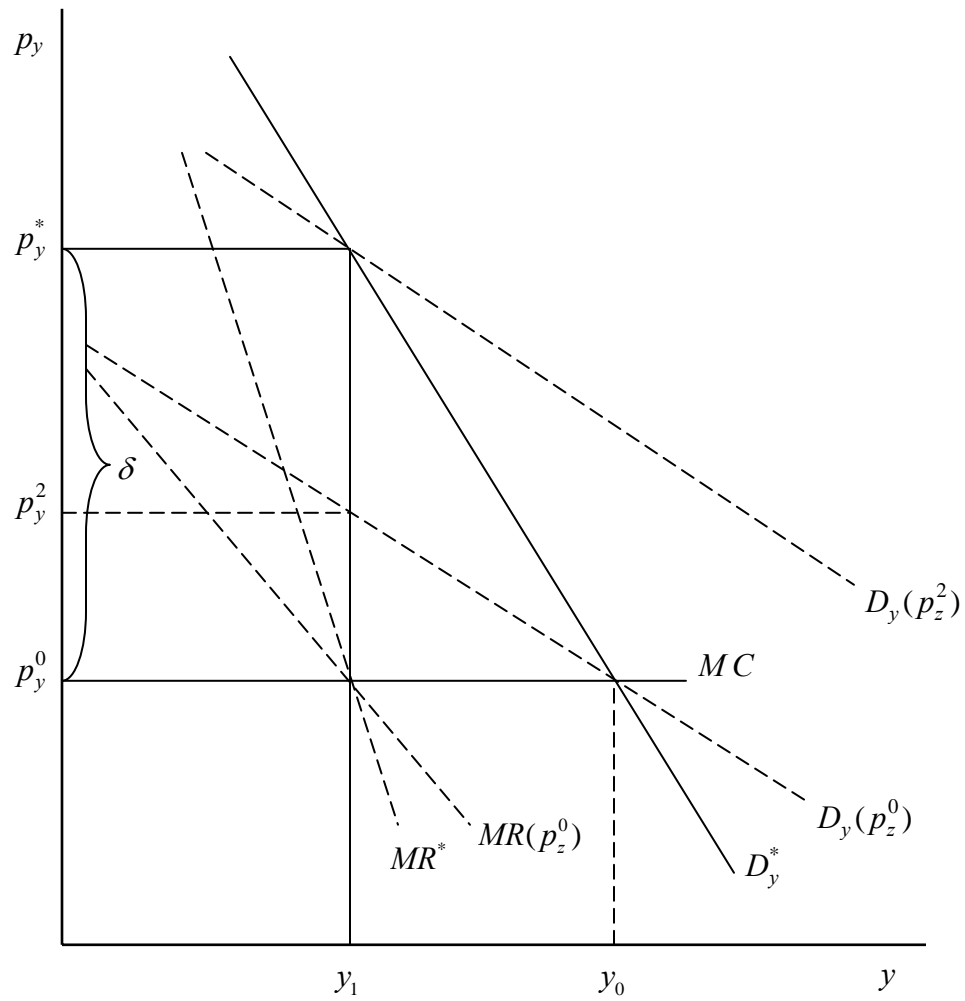


Figure 3. Equilibrium Effects of Monopsony with a Related Market.

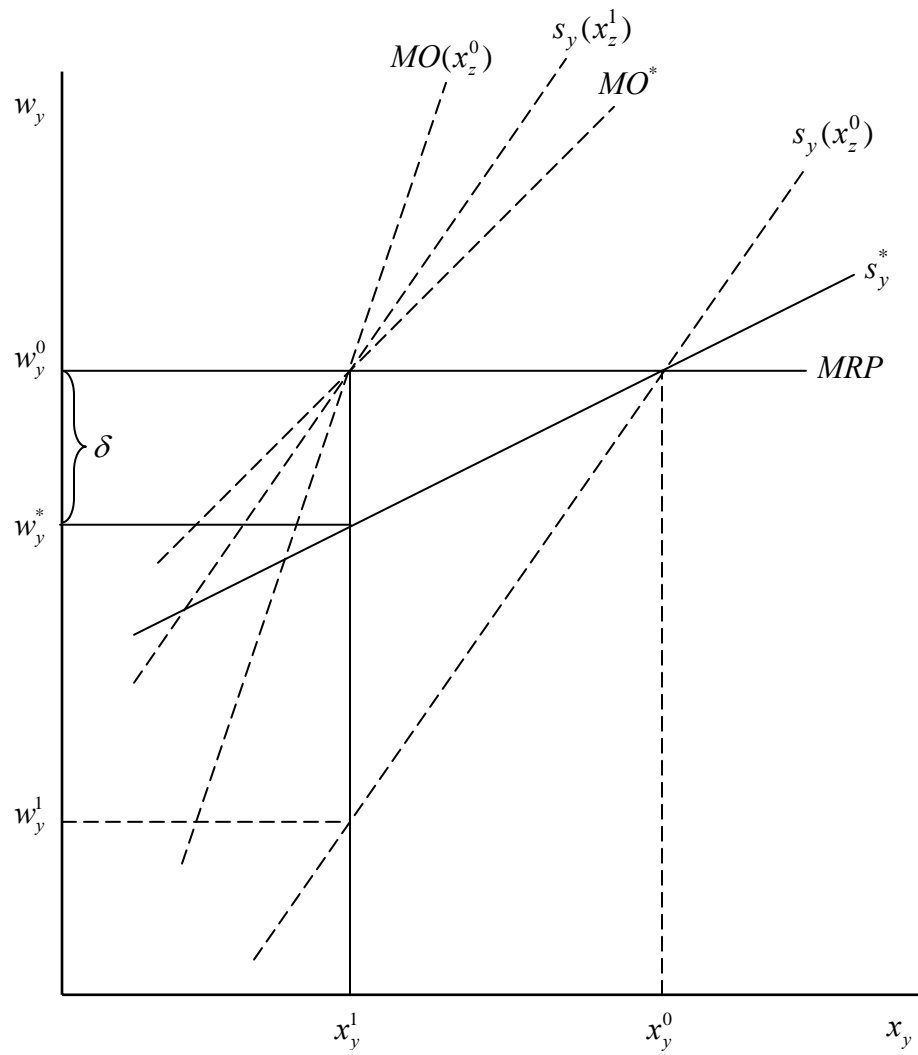


Figure 4. Overbuying with Related Input and Output Markets: The Case of Substitutes

