The Protected Profits Benchmark: A Refusal To Deal Metric?

Richard J Gilbert
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A REFUSAL TO DEAL METRIC?

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In an article published in this Journal, Steven Salop proposes the “Protected Profits Benchmark” (PPB) price to evaluate alleged refusals to deal and price squeezes undertaken by an unregulated, vertically integrated firm that is the only supplier of an input used by actual or potential competitors in a downstream market.1 For the case of homogeneous products sold in the downstream market, the PPB is the profit sacrificed by the integrated firm if it sells one more unit of the input to a competitor instead of using the input itself to make and sell the downstream good.

Professor Salop offers the following numerical example. Suppose the vertically integrated firm sells a downstream product for $100. The firm manufactures an input that is essential to the production of the downstream product at a variable cost (“input cost”) of $10 per unit. The firm has other variable costs (“incremental output cost”) of $30 per unit of downstream output. The firm’s “output cost” is $40, equal to its input cost plus its incremental output cost. The integrated firm earns a margin of $60 if it sells one more unit of the downstream good. Alternatively, if the integrated firm sells the input to another firm, it earns a margin equal to the input’s price less its incremental cost of $10. The input price for which the integrated firm is indifferent between selling the input and the downstream good is $70. This is the PPB price.

More formally, the PPB for homogeneous products is (where “monopolist” refers to the vertically integrated firm that is the sole supplier of the input):2

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1 Steven C. Salop, Refusals to Deal and Price Squeezes by an Unregulated, Vertically Integrated Monopolist, 76 ANTITRUST L.J. 709 (2010).

2 Id. at 723. The PPB expression and the example assume constant incremental costs. I use the term “monopolist” for consistency with Salop’s exposition of the PPB. A firm that is the only supplier of an input is not necessarily a monopolist in a relevant market.

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$PPB = \text{Monopolist's input cost} + [\text{Monopolist's output price} - \text{Monopolist's output cost}]$

The first component of the PPB is the direct unit cost of supplying the input. The second component is the lost profit from selling one less unit of the downstream good. For homogeneous products, the PPB is identical to the Efficient Component Pricing Rule (ECPR).³

For the common case in which the vertically integrated firm and a buyer of the input sell differentiated products downstream, Salop defines the PPB as:⁴

$$PPB = \text{Monopolist's input cost} + Div \times [\text{Monopolist's output price} - \text{Monopolist's output cost}],$$

where $Div$ is the diversion ratio, the fraction of sales by the downstream rival that are lost by the integrated firm.⁵ For the case of homogenous products, $Div = 1$ and the PPB is the ECPR.

If the downstream goods sold by the vertically integrated firm and the potential competitor are homogeneous and sold at a fixed price, then the PPB/ECPR correctly measures the private and social opportunity cost of selling a unit of the input to a potential competitor.⁶ However, if these conditions do not hold, the PPB does not measure either the private or social cost of supplying the input. Moreover, the price of an input sold by a vertically integrated firm may exceed the PPB without necessarily excluding an equally efficient competitor from the integrated firm’s downstream market.

The problem with the PPB as a metric for exclusionary pricing is apparent if the buyer of the input does not compete with the vertically integrated firm’s downstream product, so that $Div = 0$. If $Div = 0$, the PPB equals the input’s incremental cost. In the numerical example, the PPB benchmark would identify the firm’s conduct as a potential refusal to deal if the input price exceeds its incremental cost of $10. Yet an input price above $10$ in this example is not a signal of exclusionary conduct because the input buyer and the vertically integrated firm do not compete.


⁴ Salop, *supra* note 1, at 729.

⁵ The Ordover and Willig compensatory price allows for a diversion ratio different from one and, in that respect, is similar to the PPB. See Ordover & Willig, *supra* note 3, at 43.

integrated firm do not compete, and it is normal competitive behavior for a firm with market power to sell a product at a price that exceeds its incremental cost.

Salop relies on an analysis by Mark Armstrong and John Vickers to justify the PPB rule for differentiated products. Armstrong and Vickers identify the economically efficient access price for an essential input. These authors do not identify a price of the input that is a refusal to deal with competitors. If the supplier of the input does not compete with the buyer, the economically efficient access price is equal to its marginal cost. It does not follow that an input price that exceeds the input’s marginal cost is an anticompetitive refusal to deal.

A pricing metric for a refusal to deal is a screen to identify potentially anticompetitive exclusionary conduct, and further analysis would be warranted if pricing fails the screen. Salop is careful to explain that the PPB is only a suggested first step in a multi-step rule of reason analysis that examines the effects of prices on exclusion and consumer welfare. Specifically, he says that “[i]f the monopolist refuses to sell at this benchmark price, then the plaintiff would need to satisfy the other elements of the rule of reason test, including that the effect of the refusal or price squeeze is to achieve or maintain a durable monopoly and thereby harm consumers.”

Elsewhere he says, “In particular, it also would be necessary to explain how the refusal to deal or price squeeze likely would harm consumers, either in the input market, output market, or a complementary product market. In short, a finding of consumer harm is not inevitable even if the PPB benchmark signals a refusal to deal or price squeeze.”

These qualifications notwithstanding, the PPB is a helpful construct only if an input price that exceeds the PPB is likely to indicate a refusal to deal in relevant real-world circumstances. In this comment, I show that the PPB does not meet this test for differentiated product markets. Furthermore, it is prone to administrative errors that limit its utility as a refusal to deal metric for homogeneous products.

The search for a useful metric to screen for exclusionary conduct should begin with a definition of an input price that may reasonably indicate a refusal

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7 Salop, supra note 1, at 729 & n.68; see Armstrong & Vickers, supra note 6, at 119–20.
8 If the input buyer competes with the vertically integrated firm, the PPB generally exceeds the efficient price of the input because it omits the effect of the input price on the vertically integrated firm’s downstream price. Armstrong & Vickers, supra note 6, at 117.
9 I focus my comments on the evaluation of a refusal to deal. A price squeeze raises similar issues.
10 Salop, supra note 1, at 710.
11 Id. at 728.
to deal. Attempts to define exclusionary conduct abound in the literature and are not without controversy. I focus on three alternative definitions, while noting that none of these alternatives is intended to characterize a legal doctrine for a refusal to deal.

The first definition I propose for a refusal to deal pricing metric for an essential input is the lowest price above which a competitor cannot profitably operate. Without more, this definition leaves unanswered questions, such as whether “profitably operate” should take account of fixed and sunk costs or only incremental costs, whether the test should be based on the costs of the vertically integrated firm that sells the input or the costs of the competing buyer, and how to incorporate non-price characteristics, such as the quality or timeliness of the input. In this comment I suppress these questions and, following Salop, assume constant variable costs with no sunk costs and equal downstream production costs for the vertically integrated firm and its rivals.

The second definition of a refusal to deal pricing metric is the input price at which the vertically integrated firm makes no short-term sacrifice of profit assuming that rivals remain as viable competitors in downstream markets, regardless of whether the rivals earn non-negative profits. Implicit in this second definition is that the integrated firm does not choose an input price with the intent to foreclose rivals because the definition assumes that rivals remain in the market as viable competitors. However, the integrated firm may set an input price recognizing that the price affects the intensity of competition in downstream markets.

My third alternative metric for a refusal to deal is the vertically integrated firm’s profit-maximizing price assuming that the firm ignores the effects of the input price on competition in its downstream market. This assumption imposes a significant constraint on the firm’s conduct, requiring the firm to set an input price that may not maximize its profits even if it has no intent to

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12 See, for example, the references cited in Salop, supra note 1, at 710 n.5, 725 n.59.
13 Following Salop, I focus on circumstances in which a vertically integrated firm offers an input to all buyers at the same price. The question is whether the price is so high that it amounts to a refusal to deal. I do not address conduct where a firm sells a product in arm’s-length transactions to some customers but refuses to sell the same or similar product to other customers.
14 I follow Salop’s implicit definition of an essential input as an input without which a downstream firm cannot profitably operate.
15 To see how differential costs affect the test for exclusion, suppose that the vertically integrated firm uses an input with an incremental cost of $10 and sells a downstream product for $100 that incurs an additional incremental cost of $30. Rival buyers are more efficient and can produce the downstream product with an additional incremental cost of only $20. If competition prevents mark-ups in the downstream market, the vertically integrated firm would maximize its profit by selling the input at a price equal to $80. This would be efficient, but it would violate the PPB, which is $70 in this example.
16 See the profit-sacrifice test in Ordover & Willig, supra note 3, at 13.
exclude rivals from the downstream market. However, I include this alternative as an example of pricing by the integrated firm that does not adversely affect competition in its downstream market.

For the special case of homogeneous products, constant returns to scale in downstream and upstream products, and equally efficient firms, these three definitions yield the same metric for a refusal to deal. The input price that maximizes the vertically integrated firm’s profit is also the lowest price above which a competitor cannot profitably operate. Furthermore, the profit-maximizing input price is independent of whether the firm takes account of competition in the downstream market, because demand for the input would evaporate if the firm sets a price above the price that maximizes its short-term profit. These prices correspond to the ECPR, which is equal to the PPB in this special case.17

With product differentiation in the downstream market, I show that the PPB may be higher or lower than the input price corresponding to the first metric, i.e., the price above which rivals cannot profitably operate. If the integrated firm has market power in the market for the input, I show that the PPB is always less than the price corresponding to the second metric, i.e., the input price at which the vertically integrated firm makes no short-term sacrifice of profit, assuming that rivals remain as viable competitors in downstream markets. I also show that the PPB may be higher or lower than the price corresponding to the third metric, i.e., the integrated firm’s profit-maximizing input price assuming that the firm ignores the effects of the input price on competition in its downstream market.

Salop objects to a profit-sacrifice standard and, in a different article published in this Journal, he suggests a consumer welfare test to evaluate exclusionary conduct.18 He correctly notes that a profit-sacrifice test may fail to catch conduct that harms consumers by excluding competitors and may condemn conduct that benefits consumers. However, a consumer welfare test presents a formidable standard for pricing conduct because a firm with market power generally does not choose prices that maximize consumer welfare. Even if profit-maximizing prices have no exclusionary effects on competition, consumers generally would be better off with lower prices.

As Salop has noted in his extensive publications, a vertically integrated firm that sells an input to its downstream competitors has an incentive to soften downstream competition by increasing the input price to raise its rivals’

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17 See Armstrong & Vickers, supra note 6. The assumption of constant returns to scale implies that these conclusions hold for any level of input supply and not only for supply on the margin.
costs, and that such pricing can be consistent with profit-maximization even if it does not eliminate rivals from the downstream market.\textsuperscript{19} Salop has argued that such pricing has exclusionary effects that warrant antitrust scrutiny.\textsuperscript{20} However, a refusal to deal arguably requires a price of an input that is higher—or at least no lower—than the price that corresponds to raising rivals’ cost.

I. DIFFERENTIATED PRODUCTS

Neither the PPB nor the ECPR is a reliable metric if the definition of a refusal to deal is the lowest input price above which a rival cannot profitably operate. Rivals can operate profitably with an input price above the ECPR or the PPB (which is generally lower than the ECPR for differentiated products)\textsuperscript{21} if consumers value rivals’ downstream products more than the vertically integrated firm’s downstream product.\textsuperscript{22} An input price below the PPB (and below the ECPR) can be sufficient to exclude competition if consumers value rivals’ downstream products less than the vertically integrated firm’s downstream product.\textsuperscript{23}

With differentiated products the PPB also fails under the second metric for a refusal to deal, namely the vertically integrated firm’s profit-maximizing input price assuming that rivals remain as viable downstream competitors but recognizing that the input price affects competition in the downstream market. I show in the Appendix, and report below, that the PPB is always less than this profit-maximizing price, and can be much less. Under some circumstances, the PPB fails the third and less permissive metric, \textit{viz.}, the profit-maximizing input price ignoring downstream competitive effects.

Specifically, let $\hat{a}$ represent the vertically integrated firm’s profit-maximizing input price assuming that rivals remain as viable downstream competitors but recognizing that the input price affects competition in the downstream market.


\textsuperscript{20} Salop, supra note 18, at 315.

\textsuperscript{21} The PPB equals the ECPR if $Div = 1$ and is less than the ECPR if $Div < 1$, which is generally the case for differentiated products. However, the diversion ratio can be unity with differentiated products if the integrated firm would lose all of its sales of the input in response to a small increase in its price.

\textsuperscript{22} For example, suppose consumers are willing to pay $80 for one unit of the downstream good sold by the integrated firm and $100 for one unit of the downstream good sold by a rival. Suppose costs are zero. The ECPR input price is $80, which does not exclude the rival. The PPB is $80 or less, depending on the diversion ratio.

\textsuperscript{23} Reverse the above example and assume that consumers are willing to pay $100 for one unit of the downstream good sold by the integrated firm and $80 for one unit sold by a rival. The ECPR is $100, but an input price greater than $80 would exclude the rival.
market. I show in the Appendix that \( \hat{a} \) is related to the PPB according to the following expression:

\[
\frac{\hat{a} - \text{PPB}}{\hat{a}} = \frac{1}{\eta},
\]

where \( \eta \) is the magnitude of the elasticity of demand for rivals’ downstream products with respect to the price of the input. The PPB correctly measures the integrated firm’s opportunity cost of the input. This opportunity cost is the direct cost of the input plus the firm’s lost profit from selling the input rather than using it for its own production. The vertically integrated firm rationally marks up this opportunity cost by a factor that depends on the input’s price-elasticity of demand. The lower is this elasticity, the greater is the markup of the input price above its opportunity cost.\(^{24}\) Equation (1) is the usual pricing rule for a firm with market power, with the PPB taking on the role of the firm’s marginal cost. For example, if PPB = $70 and \( \eta = 2 \), then the profit-maximizing input price is \( \hat{a} = $140 \).

The input price that solves Equation (1) is the second metric for a refusal to deal, \( \text{viz.} \), the input price at which the vertically integrated firm makes no sacrifice of profit assuming that rivals remain as viable competitors in the downstream market.\(^{25}\) If the integrated firm has market power over its input, corresponding to a finite elasticity of demand, then this second metric is strictly larger than the PPB. Requiring the firm to charge a price for the input that is lower than the price that solves Equation (1) would force the firm to sacrifice short-term profits.

The seller of an input typically has market power when the downstream products that employ the input are differentiated from its own downstream product.\(^{26}\) Under these circumstances, the fact that the PPB is always less than

\(^{24}\) The elasticity of demand for the input is infinite at a price equal to the ECPR if the downstream products sold by the vertically integrated firm and rivals are perfect substitutes at the prevailing downstream prices, because rivals would not supply anything if \( \hat{a} > \text{ECPR} \) and would take over the market if \( \hat{a} < \text{ECPR} \). If so, the PPB is equal to the ECPR and is equal to the profit-maximizing input price.

\(^{25}\) It is possible that the profit-maximizing input price corresponding to Equation (1) excludes rivals from the downstream market. However, the profit-maximizing price assumes that rivals remain viable and is not predicated on rival exit from the downstream market. This is in contrast to an input price that sacrifices short-term profits in order to exclude rivals.

\(^{26}\) The seller of the input has market power if the elasticity of demand for the input is finite. Under the assumption that a fixed amount of the input is required for each unit of the downstream product, the elasticity of demand for the input is the product of the elasticity of demand for the rivals’ downstream product with respect to its price and the elasticity of the rivals’ price with respect to the input price. The second elasticity is finite. The first is typically finite if the firms’ downstream products are differentiated. See, e.g., Richard S. Higgins & William F. Shughart II, *Input Market Definition Under Department of Justice Merger Guidelines*, Rev. Indus. Org., Fall 1989, at 99.
the price that corresponds to profit-maximizing behavior by a vertically integrated firm assuming that rivals remain as viable downstream competitors implies that the PPB is an inappropriately stringent standard under the second definition of a refusal to deal. The only way that a vertically integrated firm facing differentiated competitors would pass the PPB is if the firm sets an input price that is strictly below its profit-maximizing price when it does not intend to foreclose downstream rivals.

The solution to Equation (1) takes into account the effect of the vertically integrated firm’s input price on competition in the downstream market. This downstream competition effect generally causes the integrated firm to increase its input price in order to raise its rivals’ costs. Thus, the second pricing metric for a refusal to deal permits the integrated firm to engage in raising rivals’ costs behavior that is consistent with profit-maximization without triggering potential liability for a refusal to deal.

The third pricing metric for a refusal to deal is the integrated firm’s profit-maximizing price when it ignores the effect of its input price on competition in the downstream market. This third pricing metric does not allow for conduct to raise rivals’ cost and therefore is generally lower than the price corresponding to the second metric for a refusal to deal. Nonetheless, I show that this third pricing metric can exceed the PPB.

The PPB sends a false signal of exclusionary pricing when the buyers of the vertically integrated firm’s input do not compete with the vertically integrated firm in its downstream market. If buyers of the input do not compete with the vertically integrated firm, then $Div = 0$ and the PPB is the vertically integrated firm’s incremental input cost. If $c$ is the input’s incremental cost, the profit-maximizing input price solves the following expression

$$\frac{\hat{a} - c}{\hat{a}} = \frac{1}{\eta},$$

where $\eta$ is the magnitude of the elasticity of demand for the input. If $\eta$ is finite, corresponding to market power for the input, the profit-maximizing input price that solves Equation (2) exceeds the PPB when $Div = 0$. For example, if $c = $10 and $\eta = 2$, then from Equation (2), $\hat{a} = $20. The PPB is $10 in this example with $Div = 0$. If the seller of the input has any market power, the profit-maximizing input price will fail the PPB for a refusal to deal even though the vertically integrated firm has no incentive to exclude buyers because they do not compete with the integrated firm in the downstream market. Indeed, if the elasticity of demand for the input is sufficiently small, the profit-maximizing input price can exceed the vertically integrated firm’s price of its downstream product.
Equation (2) above also determines the vertically integrated firm’s profit-
maximizing input price assuming that the firm ignores the effect of its input
price on competition in the downstream market, even if its downstream profits
would be reduced by this competition. The difference between Equation (1)
and Equation (2) is that the latter replaces PPB with the integrated firm’s
incremental cost of the input, \( c \). The PPB accounts for the effect of competi-
tion in the downstream market by augmenting the integrated firm’s direct in-
cremental cost of the input by a factor that measures lost profits in the
downstream market from the sale of another unit of the input. Replacing PPB
with the cost \( c \) in Equation (2) gives an expression for the integrated firm’s
profit-maximizing input price when it ignores these downstream competitive
effects.

Thus, the solution to Equation (2) is also the input price that corresponds to
my third alternative definition of a refusal to deal. The price corresponding to
this definition is less than the price corresponding to my second metric, \( \text{viz.} \),
the integrated firm’s profit-maximizing input price assuming that rivals re-
main as viable competitors in downstream markets. Nonetheless, it is clear
that if the elasticity of demand for the input (\( \eta \)) is sufficiently small, the input
price that solves Equation (2) can be large and can exceed the PPB. In other
words, the PPB is not a reliable metric even if antitrust policy compels the
integrated firm to set a price for the input that ignores competitive effects in
downstream markets.

Although the PPB is only a first step in a rule of reason analysis to identify
a potentially anticompetitive refusal to deal, for differentiated products it is
not a useful first step under the first definition of a refusal to deal because it is
not a reliable indicator of a price that excludes competition. The PPB also is
not useful under the second definition because the vertically integrated firm’s
profit-maximizing input price exceeds the PPB even though it is pricing under
the assumption that rivals remain as viable competitors in the downstream
market. Finally, the PPB can fail to be a useful indicator under the third metric
for a refusal to deal, even though this metric burdens the integrated firm with
the requirement that it ignore downstream competitive effects when it sets its
input price.

II. PRICE DISCRIMINATION

A vertically integrated firm may choose prices for its downstream product
and for an input it sells to others with the objective to discriminate between
buyers of its downstream product and buyers of the input. This strategy,
which involves segmenting markets to price discriminate, may result in prices
for the input that exceed the PPB and may exclude competition. Nonetheless,
such a price discrimination strategy need not have an adverse effect on total
economic welfare.
To illustrate the price discrimination strategy, suppose the vertically integrated firm’s downstream product has a constant incremental cost \( c_d \), comprised of the cost \( c \) of an input and other costs \( c_0 \). The vertically integrated firm sets the price \( \hat{p} \) of its downstream product to satisfy

\[
\frac{\hat{p} - c_d}{\hat{p}} = \frac{1}{\eta_i},
\]

where \( \eta_i \) is the magnitude of the elasticity of demand in the downstream market.

Buyers purchase the input to produce the same product in a separate geographic market. Suppose the elasticity of demand for the input has magnitude \( h_2 \), which depends on the elasticity of demand for the buyers’ products in their geographic market and the input’s share of the total incremental cost of the buyers’ products. Given the input’s incremental cost \( c \), the vertically integrated firm will set the price of the input to satisfy

\[
\frac{\hat{a} - c}{\hat{a}} = \frac{1}{\eta_2}.
\]

The PPB in this example is \( c \) because the integrated firm and the buyers of the input operate in separate markets, so that \( \text{Div} = 0 \). The profit-maximizing input price exceeds the PPB if the seller of the input has market power, corresponding to a finite elasticity \( \eta_2 \). Moreover, if \( \eta_2 \) is sufficiently small relative to \( \eta_i \), no equally efficient buyer of the input can profitably compete in the market for the vertically integrated firm’s downstream product, because the price of the input \( \hat{a} \) plus the other costs \( c_0 \) would exceed the vertically integrated firm’s downstream price \( \hat{p} \). \(^{27}\) Yet the vertically integrated firm is not sacrificing profits to exclude competition. The vertically integrated firm is maximizing its profits by setting prices for the input and for its downstream product that correspond to the different elasticities of demand in the two markets.

Specifically, suppose \( c_d = $20, c = $10, \) and \( \eta_i = 3 \). The vertically integrated firm’s profit-maximizing downstream price is \( \hat{p} = $30 \). If \( \hat{a} > $20 \), which corresponds to \( \eta_i < 2 \), equally efficient buyers of the input would be unable to compete by selling their products in the geographic market in which the integrated firm sells its downstream product.

The example corresponds to the vertical price squeeze in Alcoa, cited by Salop.\(^{28}\) Martin Perry explained how selective vertical integration into a mar-

\(^{27}\) Equations (3) and (4) imply that this condition is \( c_d(\eta_2 - 1) < c(\eta_i - 1) \).

\(^{28}\) United States v. Aluminum Co. of Am. (Alcoa), 148 F.2d 416 (2d Cir. 1945).
ket with more elastic demand may allow a firm to achieve third-degree price discrimination. As a result, some consumers pay more while others pay less than they would if they all purchased at a single uniform price. In a literal sense, the conduct is a refusal to deal because input buyers cannot profitably compete in the vertically integrated firm’s downstream market; however, the resulting price discrimination is not facially anticompetitive. Indeed, price discrimination may allow the firm to profitably supply the more price-elastic market when it would not do so if it had to choose a single price.

III. ADMINISTRABILITY

Salop defends the PPB as an administrable tool that is no more complex than the predatory pricing standard advanced in _Brooke Group_, which adopts a firm’s variable cost as the benchmark to assess predatory conduct. While the PPB may not be significantly more complex than the _Brooke Group_ standard, the PPB is likely to give false signals of exclusionary pricing for differentiated products, and for homogeneous products it is much more likely than the _Brooke Group_ standard to incorrectly signal exclusionary pricing when costs or prices are measured with error.

For differentiated products the PPB is not a reliable metric under any of the three standards I have proposed to identify a possible refusal to deal. The PPB (and ECPR) correctly identifies a price that represents a refusal to deal under all of these standards in the special case of homogeneous products, constant incremental costs, and equally efficient competitors. The PPB is also the firm’s profit-maximizing price for the input in this special case. Consequently, if either the PPB or the input price, or both, is estimated with error that is equally likely to overstate or understate the true value, then there is a 50 percent probability that a fact-finder will conclude that the vertically integrated firm’s price exceeds the PPB standard when the firm sets an input price that maximizes its profits.

In contrast, the _Brooke Group_ standard includes a cushion against measurement errors because a dominant firm typically charges a profit-maximizing price that substantially exceeds its variable cost. While the firm may lower its price-cost margin for strategic reasons (which may or may not include predatory intent), absent these strategic objectives the static profit-maximizing price-cost margin reduces the likelihood that measurement errors would lead to a conclusion that a firm is violating the _Brooke Group_ standard by pricing below its variable cost. Compared to the _Brooke Group_ standard for predation, the PPB has a much higher probability of false positives when the inte-

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grated firm sets a profit-maximizing price for the input with no intent to exclude competition.

Simplicity is not a virtue if the PPB is not a reliable metric for a refusal to deal. Moreover, if the desired standard for a refusal to deal is a price above the profit-maximizing price assuming that rivals remain as viable competitors in downstream markets, such a metric is given precisely by Equation (1). In addition to the PPB, this equation includes the elasticity of demand for the input. Although a measure of the elasticity of demand may require a complicated estimation, it is better to include such an estimate in the pricing metric than to ignore it entirely and to assume implicitly that the seller of the input has no market power.

IV. CONCLUSION

The identification of a metric to signal a refusal to deal by a vertically integrated firm must first address the definition of a refusal to deal. For the special case of homogeneous products, constant returns to scale, and equally efficient competitors, the PPB is a useful metric if a refusal to deal is defined by a price so high that a rival cannot profitably operate, or by a price that exceeds the vertically integrated firm’s profit-maximizing price assuming downstream rivals remain viable, or by the profit-maximizing input price ignoring downstream competitive effects. The PPB is equal to the ECPR in this special case. However, the PPB/ECPR is prone to false positives from measurement errors because a profit-maximizing firm typically would set the input price at this level, and any error that underestimates the PPB/ECPR or overstates the input price would trigger potential liability.

For differentiated products, the PPB does not measure the lowest price above which rival firms cannot profitably operate. Furthermore, the PPB is always less than the vertically integrated firm’s profit-maximizing input price assuming downstream rivals remain as viable competitors. Moreover, the PPB can be less than the integrated firm’s profit-maximizing input price if the firm ignores downstream competition. Therefore, under any of these three standards, the PPB is not a useful screen for a refusal to deal for the common case in which the vertically integrated firm and its downstream rivals sell differentiated products. Furthermore, the PPB does not recognize that vertically integrated firms may have incentives to price-discriminate by segmenting markets in ways that do not necessarily lower total welfare.
APPENDIX
COMPARISON OF THE PPB TO A VERTICALLY INTEGRATED FIRM’S PROFIT-MAXIMIZING PRICE

A vertically integrated firm sells an input to one or more firms that sell a product in the integrated firm’s downstream market. The rival firms’ products are homogeneous and an imperfect substitute for the vertically integrated firm’s downstream product.

Define the following terms:

\[ a = \text{the input price} \]
\[ p = \text{the vertically integrated firm’s price of its downstream product} \]
\[ r = \text{the rival firms’ price of their downstream product} \]
\[ c_d = \text{the vertically integrated firm’s total constant marginal cost of the downstream product} \]
\[ c = \text{the vertically integrated firm’s constant marginal cost of the input} \]
\[ x(p,r) = \text{the vertically integrated firm’s demand in the downstream market} \]
\[ y(r,p) = \text{the rival firms’ demand in the downstream market} \]

The outputs depend on the prices with \( \frac{dx}{dp} < 0, \frac{dx}{dr} > 0, \frac{dy}{dr} < 0, \) and \( \frac{dy}{dp} > 0. \) Furthermore \( \frac{dr}{da} > 0, \) an increase in the price of the input increases the price of the rival firms’ product.

Following Armstrong and Vickers, the vertically integrated firm’s profit (ignoring fixed costs) is

\[ \Pi = (p - c_d)x(p,r) + (a - c)y(r,p). \]

The profit-maximizing input price \( \hat{a} \) satisfies \( \frac{d\Pi}{da} = 0. \) Since the integrated firm’s downstream price maximizes its profits, the necessary condition for \( \frac{d\Pi}{da} = 0 \) is

\[ \frac{d\Pi}{da} = y(r,p) + (a - c)\frac{dy}{dr} \frac{dr}{da} + (p - c_d)\frac{dx}{dr} \frac{dr}{da} = 0, \]

which implies

\[ 31 \text{ See Armstrong & Vickers, supra note 6.} \]
\[ \hat{a} = c + \text{Div}(p - c_d) + \frac{\hat{a}}{\eta_y \eta_r} . \] (A.1)

In Equation (A.1),

\[ \text{Div} = -\frac{\frac{dx}{dr}}{\frac{dy}{dr}} \]

is the diversion ratio, the fraction of sales lost by rivals as a result of a price increase that are won by the integrated firm, \( \eta_y \) is the magnitude of the elasticity of demand for the rivals’ product with respect to its price, and \( \eta_r \) is the elasticity of the rivals’ price with respect to the input price. The product \( \eta_y \eta_r \) is the percentage change in the demand for the rivals’ products resulting from a small percentage change in the price of the input.

The first two terms in Equation (A.1) measure the opportunity cost of supplying another unit of the product. The sum of these two terms is equal to the PPB. However, the PPB omits the third term, which is positive if the elasticity of demand for the rivals’ product is finite.\(^{32}\) It follows that the PPB is less than the vertically integrated firm’s profit-maximizing price of the input. Note that there is no payoff to the vertically integrated firm from refusing to supply the input to competitors in this formulation of the problem other than the incentive to raise rivals’ costs. That is, the implicit assumption is that rivals remain as viable downstream competitors.

Rearranging terms and using the definition of the PPB, Equation (A.1) can be written as

\[ \frac{\hat{a} - \text{PPB}}{\hat{a}} = \frac{1}{\eta} , \]

where \( \eta = \eta_y \eta_r \), the magnitude of the elasticity of demand for rivals’ downstream products with respect to the input price. This is the usual monopoly pricing formula for an input when the PPB is interpreted as the input’s opportunity cost.

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\(^{32}\) Note that if the downstream products are perfect substitutes at prevailing prices so that \( \text{Div} = 1 \), then \( \eta \) is infinite and Equation (A.1) implies \( \hat{a} = c + (p - c_d) \), which is the ECPR.