

vGUPPI: SCORING UNILATERAL PRICING INCENTIVES IN VERTICAL MERGERS

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Vertical mergers can raise a variety of competitive concerns, including foreclosure, coordination, and misuse of sensitive competitive information. One key concern is input foreclosure. Input foreclosure involves raising the costs of competitors in the downstream market.¹ For example, a vertical merger between an input supplier and a downstream output manufacturer can create unilateral incentives for the supplier to raise the price of its inputs to one or several “targeted” competitors of the manufacturer.² The higher input prices could raise the costs of the downstream rivals, which could in turn increase the sales and profits of the downstream merger partner. These effects could lead the downstream firms to raise prices and harm consumers.

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¹ *Input* foreclosure is different from *customer* foreclosure, which involves reducing sales opportunities, and hence the revenues, of the upstream input competitors by denying them the ability to sell inputs to the downstream merging firm. For a discussion of both foreclosure concepts in the context of vertical mergers, see Michael H. Riordan & Steven C. Salop, *Evaluating Vertical Mergers: A Post-Chicago Approach*, 63 ANTITRUST L.J. 513 (1995). For other analyses of vertical mergers, see Jeffrey Church, *Vertical Mergers*, in 2 ABA SECTION OF ANTITRUST LAW, ISSUES IN COMPETITION LAW AND POLICY 1455 (W. Dale Collins ed., 2008); Michael H. Riordan, *Competitive Effects of Vertical Integration*, in HANDBOOK OF ANTITRUST ECONOMICS 145 (Paolo Buccirossi ed., 2008), and the sources cited therein. See also European Commission, Guidelines on the Assessment of Non-horizontal Mergers Under the Council Regulation on the Control of Concentrations Between Undertakings, 2008 O.J. (C 265) 6 [hereinafter EC Non-Horizontal Merger Guidelines]. For a general framework, see Thomas G. Krattenmaker & Steven C. Salop, *Anticompetitive Exclusion: Raising Rivals’ Costs to Achieve Power over Price*, 96 YALE L.J. 209 (1986).

² A similar concern applies to complementary product mergers. The merger may lead the merged firms to refuse to deal with or raise the unbundled prices of the complements to competitors that are not integrated.

Vertical mergers also can increase competition by the creation of efficiencies.³ Vertically related firms must cooperate to some degree to bring products to market. This creates greater opportunities for efficiency gains than for horizontal mergers. These efficiencies can involve the creation of superior products and lower costs. The most well-known efficiency benefit is the elimination of double marginalization (EDM).⁴ This efficiency occurs when the merger allows the downstream firm to acquire the upstream merger partner's input at an effective transfer price equal to marginal cost. This gives the downstream merging firm an incentive to reduce the prices of its products after the merger, other things held constant.

Merger-specific EDM is not inevitable, however, because the downstream merging firm may be locked in to inputs provided by other firms or it may be able to pay a price equal to marginal cost absent the merger.⁵ However, where merger-specific EDM does occur, it can offset the incentives to raise the prices of the upstream and downstream merging firms.

In this article, we explain how the upward (or downward) pricing pressure resulting from unilateral incentives following a vertical merger can be scored with vertical gross upward pricing pressure indices (vGUPPIs). There are vGUPPIs for the upstream and downstream merging firms and, in addition, vGUPPIs for the rivals of the downstream firm whose costs are raised as a result of the upstream firm's incentives to increase its input prices. The vGUPPIs provide more direct evidence on unilateral pricing incentives than other metrics commonly used in vertical merger cases, such as concentration indices and foreclosure rates.⁶ They also are simpler to implement and require

³ The activities of firms at different product levels are complementary to one another. Actions to promote products at one level often benefit products at the other level. The activities also often require some degree of cooperation. See E.C. Non-Horizontal Merger Guidelines, *supra* note 1, ¶¶ 13–14; see also Riordan & Salop, *supra* note 1, at 522–23; Church, *supra* note 1, at 1461–63.

⁴ This is referred to as “elimination of double marginalization” because, when the upstream firm in the pre-merger market sets an input price above its marginal cost of the input, the downstream firm then sets an output price that marks up the marginal cost of the input a second time. In contrast, the vertically integrated firm has the incentive to mark up the marginal cost only once. See JEAN TIROLE, THE THEORY OF INDUSTRIAL ORGANIZATION § 4.2 (1988). EDM can also occur for complementary product mergers.

⁵ The downstream merging firm may pay a pre-merger marginal price of the input equal to marginal cost, either as a result of upstream competition, two-part tariffs or other non-linear pricing, or because it would be practical to achieve EDM absent the merger. The merged firm also may have the incentive to transfer inputs internally at price above marginal cost. See Riordan & Salop, *supra* note 1; Chaim Fershtman & Kenneth L. Judd, *Equilibrium Incentives in Oligopoly*, 77 AM. ECON. REV. 927 (1987); Steffen Ziss, *Hierarchies, Intra-firm Competition and Mergers*, 25 INT'L J. INDUS. ORG. 237 (2007).

⁶ The analysis of vGUPPIs also clarifies the proper measurement of foreclosure rates, including the impact of input substitution.

less data than merger simulation models.⁷ Thus, when the U.S. Non-Horizontal Merger Guidelines are revised, the vGUPPIs can be used to help gauge incentives.⁸

The vGUPPI methodology follows the same basic methodology as the horizontal merger GUPPIs, which were adopted in the 2010 Horizontal Merger Guidelines as a metric for scoring unilateral effects concerns in horizontal mergers.⁹ These horizontal merger GUPPIs gauge the post-merger incentives for unilateral price increases by the merged firm. The GUPPIs measure only the “first round” incentives, in that they do not take into account several feedback effects, including the incentives of non-merging firms to respond to the merger by changing their prices, by repositioning their products, or by further entry. Nor do the GUPPIs take into account the impact of merger-induced efficiencies on pricing incentives.

There are several advantages to using vGUPPIs. First, vGUPPIs are “incentive scoring devices” that are premised on the assumption that firms are rational, profit-maximizing entities, an assumption that remains at the core of antitrust.¹⁰ The economic incentives of the firms provide relevant information about the likely outcomes of combinations. While incentive scoring is not the

⁷ For simulation models for vertical mergers, see Kenneth Hendricks & R. Preston McAfee, *A Theory of Bilateral Oligopoly*, 48 ECON. INQUIRY 391 (2010); Michael A. Salinger, *Vertical Mergers and Market Foreclosure*, 103 Q.J. ECON. 345 (1988). These models focus on mergers between firms that are already partially vertically integrated, and thus their mergers have both horizontal and vertical components. These models assume homogeneous products both upstream and downstream, whereas many vertical mergers involve firms that produce differentiated products. (In contrast, the vGUPPIs developed in this article are based on a model with product differentiation both upstream and downstream.) For further discussion on merger simulation models, see Francine Lafontaine & Margaret Slade, *Vertical Integration and Firm Boundaries: The Evidence*, 45 J. ECON. LITERATURE 629 (2007).

⁸ U.S. Dep’t of Justice, Non-Horizontal Merger Guidelines (1984), available at <http://www.justice.gov/atr/public/guidelines/2614.pdf>. The E.C. Non-Horizontal Merger Guidelines, adopted in 2007, explicitly use the concept of input foreclosure analyzed in this article.

⁹ While the Guidelines do not explicitly identify the GUPPI or present the formula, they describe the GUPPI in words. See U.S. Dep’t of Justice & Fed. Trade Comm’n, Horizontal Merger Guidelines § 6.1 (2010) [hereinafter 2010 Guidelines], available at <http://www.justice.gov/atr/public/guidelines/hmg-2010.pdf>; see also Carl Shapiro, *The 2010 Horizontal Merger Guidelines: From Hedgehog to Fox in Forty Years*, 77 ANTITRUST L.J. 701, 722–27 (2010); Steven C. Salop, Serge X. Moresi & John R. Woodbury, *Scoring Unilateral Effects with the GUPPI: The Approach of the New Horizontal Merger Guidelines*, CRA COMPETITION MEMO (Feb. 2011), available at [http://www.crai.com/uploadedFiles/Publications/CRA%20Competition%20Memo%20-%20Comments%20on%20the%20GUPPI_0211\(1\).pdf](http://www.crai.com/uploadedFiles/Publications/CRA%20Competition%20Memo%20-%20Comments%20on%20the%20GUPPI_0211(1).pdf).

¹⁰ See, e.g., 1 PHILLIP E. AREEDA & HERBERT J. HOVENKAMP, *ANTITRUST LAW: AN ANALYSIS OF ANTITRUST PRINCIPLES AND THEIR APPLICATION* ¶ 113, at 140 (3d ed. 2006). This assumption has recently been challenged in several articles. See, e.g., Amanda P. Reeves & Maurice E. Stucke, *Behavioral Antitrust*, 86 IND. L.J. 1527 (2011); Avishalom Tor & William Rinner, *Behavioral Antitrust: A New Approach to the Rule of Reason after Leegin*, 2011 U. ILL. L. REV. 805. For one recent critique of the use of behavioral economics in antitrust, see Joshua D. Wright & Judd E. Stone, *Misbehavioral Economics: The Case Against Behavioral Antitrust*, 33 CARDOZO L. REV. 1517 (2012).

only information relevant for evaluating likely effects, it clearly is useful evidence. Indeed, incentive scoring methodologies are particularly useful when compared to simple structural measures, such as the HHI or other concentration indices.¹¹

Second, the vGUPPIs have the related advantage that they do not require markets to be defined in advance. While market definition is simple in some matters, it raises contentious issues in others.¹² The vGUPPIs can be calculated from observable data and variables that often can be roughly estimated, so they can be used as part of a preliminary analysis to screen vertical mergers that raise input foreclosure or output reduction concerns. The vGUPPI estimates then can be refined as more data is collected and more analysis can be done.

Third, the “vertical arithmetic” methodology currently used to gauge foreclosure concerns has certain limitations.¹³ The vertical arithmetic evaluates the incentive for non-price rationing, but foreclosure concerns often focus on the use of price to foreclose. These are not equivalent methodologies because it generally is more profitable to foreclose by raising price than by refusing to

¹¹ Three different “vertical HHI” measures have been proposed in the economic literature, based on different economic models of the upstream market. See Joshua S. Gans, *Concentration-Based Merger Tests and Vertical Market Structure*, 50 J.L. & ECON. 661 (2007). Like the horizontal HHI, these vertical HHI measures assume homogeneous products and thus are not appropriate in many merger cases involving differentiated products. Furthermore, the HHI is not directly related to unilateral pricing incentives. 2010 Guidelines, *supra* note 9, § 6.1; see also Jonathan B. Baker & Steven C. Salop, *Should Concentration Be Dropped from the Merger Guidelines?*, in ABA SECTION OF ANTITRUST LAW, PERSPECTIVES ON FUNDAMENTAL ANTITRUST THEORY 339; Joseph Farrell & Carl Shapiro, *Antitrust Evaluation of Horizontal Mergers: An Economic Alternative to Market Definition*, B.E. J. THEOR. ECON., vol. 10, no. 1, art. 9, at 23 (2010), <http://www.bepress.com/bejte/vol10/iss1/art41>.

¹² In these cases, the variables used in vGUPPI and GUPPI analysis also are used in market definition analysis and there is a close relationship between GUPPIs and the SSNIP test for market definition. Under linear demand, a GUPPI higher than 10% implies a price increase larger than 5%. Therefore, in horizontal merger cases in which both GUPPIs are higher than 10%, one could define a narrow market that includes only the products of the merging firms, and view the proposed transaction as constituting a “merger to monopoly.” See Serge Moresi, *The Use of Upward Price Pressure Indices in Merger Analysis*, ANTITRUST SOURCE, Feb. 2010, <http://www.abanet.org/antitrust/at-source/10/02/Feb10-Moresi2-25f.pdf>.

¹³ For examples of the use of vertical arithmetic, see David Sibley & Michael J. Doane, *Raising the Costs of Unintegrated Rivals: An Analysis of Barnes & Noble’s Proposed Acquisition of Ingram Book Company*, in MEASURING MARKET POWER 211 (Daniel J. Slottje ed., 2002); Jonathan B. Baker, *Comcast/NBCU: The FCC Provides a Roadmap for Vertical Merger Analysis*, ANTITRUST, Spring 2011, at 36; Daniel Rubinfeld, *The Primestar Acquisition of the News Corp./MCI Direct Broadcast Satellite Assets*, 16 REV. INDUS. ORG. 193 (2000); Steven C. Salop, Carl Shapiro, David Majerus, Serge Moresi & E. Jane Murdoch, Charles River Assocs., *News Corporation’s Partial Acquisition of DIRECTV: Economic Analysis of Vertical Foreclosures Claims* (FCC Submission July 1, 2003) [hereinafter Salop et al., *DIRECTV*], available at <http://apps.fcc.gov/ecfs/document/view.action?id=6514283359>; Steven C. Salop, Stanley M. Besen, John R. Woodbury & E. Jane Murdoch, *An Economic Analysis of Primestar’s Competitive Behavior and Incentives* (FCC Submission Jan. 7, 1998) (on file with authors).

deal or using non-price means to raise competitors' costs. In addition, the vertical arithmetic methodology does not take into account the effects of merger-specific EDM or gauge the direct impact of the merger on the pricing incentives of the downstream merging firm. However, for gauging input foreclosure concerns, the tests are related. The vertical arithmetic can be expressed as a vGUPPI test with a specific safe harbor.

The vGUPPIs measure economic incentives. A vertical merger can create unilateral incentives for the upstream merging firm to raise the prices of its inputs to the competitors of the downstream merger partner and also can create unilateral incentives for the downstream merging firm to reduce prices as a result of vertical efficiencies, particularly EDM. These are the central incentives driving input foreclosure concerns and efficiency rationales in vertical merger cases.

Our analysis also identifies an additional incentive effect—a vertical merger also might give the downstream merging firm a unilateral incentive to raise its price above the pre-merger level (all else equal). By doing so, its sales would decrease. However, if consumer substitution increases the sales of competitors that use the inputs supplied by the upstream merger partner, the profits of the upstream merger partner would rise. Pre-merger, the downstream firm does not take into account this positive effect on the upstream firm, but it would do so post-merger.

We derive three vGUPPI scores: a *vGUPPI_u* for the pricing incentives of the upstream merging firm, a *vGUPPI_d* for the pricing incentives of the downstream merging firm, and a *vGUPPI_r* for the pricing incentives of the targeted downstream rivals. The *vGUPPI_r* results from the *vGUPPI_u*. While GUPPIs are designed to be "gross" measures that do not take efficiencies into account, it might be argued that EDM should be incorporated into the vGUPPI methodology on the grounds that it is an inherent efficiency benefit in vertical mergers. To address this point, we have extended the methodology to derive *vGUPPI_d* measures that adjust for EDM. This adjustment reduces the level of the *vGUPPI_d* and can even lead to a negative value, that is, a first-round incentive to reduce the price of the downstream output of the merged firm.

The fact that the two merging firms operate at different levels in the vertical chain of production adds a complexity to the interpretation of the vGUPPIs. The *vGUPPI_u* of the upstream merging firm involves the merged firm's incentives to raise its *input* price to downstream rivals. In contrast, the *vGUPPI_d* of the downstream merging firm involves its incentive to raise (or reduce) its *output* price post-merger. This is important because even if the upstream firm has the incentive to raise its input price significantly, that price increase may not raise the costs of the downstream competitors very much, if

the input has good substitutes or if it is not a significant cost factor for the downstream competitors (or both). To take an extreme example, suppose that an automobile company were to acquire a spark plug supplier and had the incentive to, say, double the price of spark plugs to its automobile competitors.¹⁴ Because spark plugs are only a small cost item, that doubling may not materially raise the cost of those rivals, and thus may not lead to significant increases in the cost of automobiles.

This analysis shows the relevance of the upward pricing incentives of the downstream rival or rivals whose costs are increased, as measured by the *vGUPPIr*. The *vGUPPIr* score provides a better measure than the *vGUPPIu* of the upward pricing pressure that the targeted downstream rivals would have post-merger. The *vGUPPIr* together with the *vGUPPId* provide evidence of the upward pricing pressure in the output market.

At the same time, it is important to recognize the limitations of the vGUPPIs. First, like the horizontal merger GUPPIs, the vGUPPIs are based on diversion ratios, price-cost margins and price ratios.¹⁵ The vGUPPIs, however, are somewhat more complex than the horizontal GUPPIs.¹⁶ This added complexity would complicate the use of the vGUPPIs as a simple initial screen, rather than as part of a full competitive effects analysis.

Second, like the horizontal GUPPIs, the vGUPPIs do not by themselves comprise a complete competitive effects analysis. Instead, they gauge only first-round incentives to raise prices. The vGUPPIs do not take into account pricing feedbacks between the two merging firms.¹⁷ They also ignore any effect of the merger on the incentives of other input suppliers to change their prices in response to the merger-induced price changes by the merged firm. Accounting for those effects could have a significant impact on the upward pricing pressure placed on the targeted rivals.¹⁸ The vGUPPIs also do not take

¹⁴ This was the type of allegation (without the quantification) underlying the *Ford Autolite* vertical merger complaint. See, e.g., Ford Motor Co. v. United States, 405 U.S. 562 (1972).

¹⁵ In fact, the *vGUPPIu* and *vGUPPIr* (which score the pricing incentives of the upstream merging firm and the targeted downstream competitor) are related to the horizontal GUPPI for a hypothetical merger of the downstream merging firm and the targeted competitor. When there is input substitution, the relationship is more complex.

¹⁶ The *vGUPPIr* also depends on the rate at which upstream cost increases are passed through into input price increases. The importance of the upstream merging firm's input in the costs of the downstream firms also is a relevant factor for calculating the vGUPPIs.

¹⁷ GUPPI analysis for horizontal mergers can be extended to account for feedback effects between the two merging firms. See Jerry Hausman, Serge Moresi & Mark Rainey, *Unilateral Effects of Mergers with General Linear Demand*, 111 ECON. LETTERS 119 (2011); Carl Shapiro, *Mergers with Differentiated Products*, ANTITRUST, Spring 1996, at 23; Gregory J. Werden, *A Robust Test for Consumer Welfare Enhancing Mergers Among Sellers of Differentiated Products*, 44 J. INDUS. ECON. 409 (1996).

¹⁸ For example, an input price increase by the upstream merging firm might induce suppliers of substitute inputs to raise price as well, which would lead to greater upward pricing pressure.

into account pricing reactions of downstream rivals, except for the downstream rivals that are targeted with an input price increase. They also do not take into account the offsetting impact of supply-side factors (e.g., entry and repositioning) and merger-specific efficiencies other than EDM, or the impact of EDM and other efficiencies on the pricing incentives of other input suppliers. Thus, the vGUPPIs are used in conjunction with other evidence of competitive effects and efficiencies in a full competitive effects analysis.

The remainder of the article is organized as follows. Part I provides the basic analytic framework and presents the vGUPPI formulas for the case with no input substitution. Part II extends the analysis to the case with input substitution. These two sections also provide several examples illustrating how to apply and calculate the vGUPPIs. Part III carries out further policy analysis, including the issue of possible vGUPPI safe harbors. Part IV compares the vGUPPI methodology to the vertical arithmetic methodology that has been used to score foreclosure concerns in vertical mergers. Part V concludes with a discussion of the incentive scoring approach and other possible GUPPI metrics that might be developed. A Glossary follows. An Appendix that describes the formal economic model underlying the vGUPPIs and provides technical details for several formulas is available at http://www.americanbar.org/content/dam/aba/publishing/antitrust_law_journal/at_alj_moresi_salop.pdf.

I. BASIC ANALYTICS OF vGUPPIs

The basic GUPPI methodology can be applied to vertical mergers. There are vGUPPIs for input foreclosure and output reduction concerns. There are three vGUPPIs: a *vGUPPI_u* for the input pricing incentives of the upstream merging firm in selling inputs to a targeted downstream rival; a *vGUPPI_r* for the pricing incentives of the foreclosed downstream rival; and a *vGUPPI_d* for the pricing incentives of the downstream merger partner.

For simplicity of analysis and exposition, we will assume that each input supplier produces a single input and each output manufacturer purchases inputs from several suppliers. These suppliers produce a specific type of input, such as, for example, chemical products for use as catalysts in the production process used by the downstream firms, or operating systems for mobile devices. In addition, each manufacturer also uses other types of inputs, such as labor and capital. We assume that the merger has no effect on the prices of these other inputs.

The impact of price increases by other upstream firms has played an important role in the analysis of the anticompetitive effects of vertical mergers. See Janusz A. Ordover, Garth Saloner & Steven C. Salop, *Equilibrium Vertical Foreclosure*, 80 AM. ECON. REV. 127 (1990). For a different example, EDM might lead the downstream merging firm to reduce the price of its output, which would tend to reduce the upstream merging firm's incentive to engage in input foreclosure. See Salop et al., *DIRECTV*, *supra* note 13, app. B.

We generally will assume that the relevant inputs and the downstream products are differentiated products (i.e., imperfect substitutes). This assumption is typically made for unilateral effects GUPPI analysis.¹⁹ We also will assume that each input supplier can charge different prices to its various customers (i.e., the downstream manufacturers). This permits analysis of the impact of a vertical merger on the incentives of the merged firm to raise the price it charges for its input to each downstream competitor separately.²⁰

The simplest scenario occurs where there is no further ability for firms to substitute between the inputs sold by the upstream merging firm and other inputs following an input price increase by the upstream merging firm.²¹ This explicates the basic analysis, which then can be refined to account for the input substitution.

A. *vGUPPI_u*: vGUPPI FOR THE UPSTREAM MERGING PARTNER'S PRICE

A vertical merger can have an impact on the incentives of the merged firm to raise the price of the input that it sells to one or more specific targeted downstream rivals. The *vGUPPI_u* scores the first-round incentive of the merged firm to raise the price it charges for its input to each targeted manufacturer. Because input suppliers can charge different prices to different cus-

¹⁹ Product differentiation includes minor differences in delivery speed, return privileges, customer service, and warranties, as well as technical product differences. When perfect substitution leads to price equal to marginal cost, the vGUPPIs will equal zero.

²⁰ We also make the following technical assumptions. First, the input suppliers simultaneously set their prices to each manufacturer to maximize profits. Second, the downstream manufacturers simultaneously set their output prices to maximize profits. Third, when a downstream manufacturer sets its price, it does not observe the prices that the input suppliers are charging to the other manufacturers. The details of the formal economic model and the derivation of the vGUPPIs are set out in the Appendix, available at http://www.americanbar.org/content/dam/aba/publishing/antitrust_law_journal/at_alj_moresi_salop.pdf.

²¹ The “single monopoly profit” theory (that there is a single monopoly profit that can be achieved in the absence of vertical integration) would not apply, except under very limited circumstances. This is the case even if the input of the upstream merging firm is used in fixed proportions with other inputs, so that the upstream merging firm is a monopolist for the relevant input. In particular, the theory does not apply if the downstream firms sell differentiated products. For example, suppose that the upstream merging firm is the only supplier of the relevant input to a rival of the downstream merging firm and, for simplicity, that the downstream merging firm does not use that input. Suppose further that the downstream firms sell differentiated products. In this case, the upstream merging firm would charge the downstream rival the monopoly input price pre-merger, and it would raise that price further post-merger. This is because the input price increase would induce the downstream rival to raise the price of its products and thus allow the downstream merger partner to earn higher profits. (The formal proof involves a simple economic argument. For a small input price increase, the profit loss of the upstream merging firm is of second-order magnitude, while the profit gain of the downstream merger partner is of first-order magnitude. See Riordan & Salop, *supra* note 1, at 566 (fig. A-1).)

tomers, there is a separate *vGUPPIu* for each downstream competitor that might be targeted.²²

The *vGUPPIu* can be explained using the same economics principles as in the 2010 Merger Guidelines, with the language adjusted to account for the vertical nature of the merger:

Adverse [*input*] price effects can arise when the [*vertical*] merger gives the merged entity an incentive to raise the price of [*the input*] previously sold by [*the upstream*] merging firm [*to a rival of the downstream merging partner*] and thereby divert sales [*of the downstream rival*] to products previously sold by the [*downstream*] merging firm, boosting the profits on the latter products. Taking as given other prices and product offerings, that boost to profits is equal to the value to the merged firm of the sales diverted to those products. The value of sales diverted to a product is equal to the number of units diverted to that product multiplied by the margin between price and incremental cost on that product. . . . If the value of diverted sales is proportionately small, significant [*input*] price effects are unlikely.²³

The Guidelines further explain that the GUPPI can be calculated as follows:

For this purpose, the value of diverted sales is measured in proportion to the lost revenues attributable to the reduction in unit sales resulting from the [*input*] price increase. Those lost revenues equal the reduction in the number of units sold of [*the input*] multiplied by [*the price of the input*].²⁴

Applying this same methodology to vertical mergers, one would calculate the *vGUPPIu* as follows:

$$vGUPPIu = \frac{\text{value of sales diverted to downstream merging partner}}{\text{revenue on volume lost by upstream merging partner}}.$$

The formula for the *vGUPPIu* is the following:

$$vGUPPIu = DR_{UD} \times M_D \times P_D / W_R \quad (1)$$

where DR_{UD} denotes the “vertical” diversion ratio from the upstream merging firm (*U*) to the downstream merger partner (*D*), following a unilateral increase in the input price charged to the targeted downstream rival (*R*) under consideration,²⁵ M_D denotes the downstream merger partner’s percentage incremental

²² For each targeted downstream competitor, the derivation of *vGUPPIu* holds all the other prices constant, except for the output price of the downstream competitor that is subject to the input price increase. We analyze below (in Part I.D) the extension of the *vGUPPIu* formula to account for the fact that the input prices charged to other targeted rivals also would rise.

²³ See 2010 Guidelines, *supra* note 9, § 6.1.

²⁴ *Id.* at 21 n.11.

²⁵ Specifically, DR_{UD} is the volume of output gained by Firm *D*, expressed as a fraction of the volume of input sales to Firm *R* lost by Firm *U*. This definition and others are summarized in the Glossary.

profit margin,²⁶ P_D denotes the price of the output sold by the downstream merging firm, and W_R denotes the price of the input (per unit of output) sold by the upstream merging firm to the targeted downstream rival.²⁷

The form of $vGUPPIu$ in equation (1) is very similar to the standard GUPPI used for horizontal mergers. Like the standard GUPPI, the $vGUPPIu$ is the product of a diversion ratio, a profit margin, and a price ratio. The main difference is that the vertical diversion ratio here is not the usual horizontal diversion ratio between two direct (horizontal) competitors, but instead is the diversion ratio from an upstream firm (the upstream merging firm) to a downstream firm (the downstream merger partner). As we discuss shortly, this vertical diversion ratio between the merging parties, DR_{UD} , is closely related to the usual horizontal diversion ratio DR_{RD} between the targeted rival and the downstream merging firm.

The $vGUPPIu$ is a positive number (like the horizontal GUPPI) as long as the margin and the diversion ratio are positive. In this scenario, the downstream merging firm would benefit from an increase in the price charged by the upstream merger partner to the targeted rival, and this fact creates positive upward pricing pressure on the input price. Of course, a positive $vGUPPIu$ by itself does not imply that the merger is anticompetitive.²⁸ The $vGUPPIu$ is larger when the diversion ratio, the downstream profit margin, and the downstream/upstream price ratio are higher.

Example 1: vGUPPIu when there is no input substitution

Suppose the upstream merging firm raises the price of its input to a targeted rival of the downstream merger partner and, as a result, the targeted rival reduces its input purchases from the upstream merging firm by 100 units. In the case with no input substitution, the targeted rival will reduce output by 100 units.²⁹ Suppose the diversion ratio DR_{RD} from the targeted rival to the downstream merging firm is equal to 40%, so that the downstream merging

²⁶ The dollar incremental profit margin of the downstream merging firm is equal to $P_D - C_D$, where C_D denotes the firm's marginal cost of production (including the costs of all other types of inputs). The corresponding percentage profit margin is given by $M_D = (P_D - C_D) / P_D$. The margins of the upstream merging firm and the targeted downstream competitor, M_U and M_R , are defined in a similar way, except that for the upstream merging firm the margin can vary across customers.

²⁷ Diversion ratios, margins and prices are evaluated at their pre-merger values. Equation (1) assumes that 1 unit of output requires 1 unit of input from the upstream merging firm. Thus, the input price W_R must be calculated as being equal to the targeted firm's total payments to the upstream merging firm divided by the targeted firm's total quantity of output (that uses the upstream merging firm's input).

²⁸ Similarly, every horizontal merger raises the HHI.

²⁹ For each downstream firm, we choose measurement units for output and input so that the number of units of input purchased from the upstream merging firm is equal to the number of units of output produced. *See supra* note 27. We also assume constant returns to scale.

firm will capture 40 out of those 100 units. Thus, the diversion ratio DR_{UD} from the upstream merging firm to the downstream merger partner also is equal to 40%. Suppose the margin M_D of the downstream merger partner is equal to 50%, and the output price of the downstream merger partner is twice the input price per unit of output paid by the targeted rival to the upstream merging firm, i.e., $P_D / W_R = 2$. Equation (1) then yields $vGUPPIu = 40\%$ (i.e., $0.4 \times 0.5 \times 2$).

This illustrative example shows that a vertical merger can create a substantial incentive to raise the price of the input to a targeted competitor.³⁰ The $vGUPPIu$ is smaller if the margin and diversion ratios are smaller. For example, if $M_D = 25\%$ and $DR_{UD} = 20\%$, then $vGUPPIu = 10\%$. If the price of the input represents a small fraction of the price of the output, the $vGUPPIu$ could be very large. For example, if the input/output price ratio were 20 instead of 2, then the $vGUPPIu$ in the latter example would rise from 10% up to 100%. This latter point raises the issue of whether one should also score the upward pricing pressure on the output price of the targeted rival (that is implied by the upward pricing pressure on the input price).

B. $vGUPPIr$: IMPLIED $vGUPPI$ FOR THE FORECLOSED RIVAL'S PRICE

An increase in the upstream merging firm's input price would raise the marginal cost of production of the targeted downstream rival, which would give the rival an incentive to raise its own price. This mechanism suggests the relevance of the upward pricing incentives of the downstream rival whose costs would be raised post-merger. The $vGUPPIr$ translates the merged firm's incentive to raise the input price it charges to a targeted downstream rival into the resulting impact on the incentive of the targeted rival to raise its output price. Thus, the $vGUPPIr$ is derived from $vGUPPIu$.

There are two main benefits to calculating the $vGUPPIr$. First, the $vGUPPIr$ is a better predictor than $vGUPPIu$ of the potential impact of the vertical merger on the customers of the targeted downstream rival. Second, the $vGUPPIr$ is comparable to the $vGUPPId$ for the output price of the downstream merging firm, as described in the next section. This is important be-

³⁰ Assuming linear demand, a $vGUPPIu$ of 40% corresponds to a (first-round) input price increase of 20% charged to the targeted rival. Specifically, a $vGUPPIu$ of 40% means that the merged firm would have the same incentive to raise the input price to the targeted downstream rival as the upstream merging firm would have pre-merger if its marginal cost of supplying inputs to that firm increased by an amount equal to 40% of the input price. Translating this upward pricing pressure index into a corresponding increase in the input price requires information about the cost pass-through rate of the upstream merging firm. When demand is linear, the cost pass-through rate equals 50% (all else equal) and thus a $vGUPPIu$ of 40% corresponds to an input price increase of 20%. We use this 50% pass-through rate as a default, absent contrary evidence in a specific case.

cause, in some cases, a vertical merger might create upward pricing pressure upstream and downward pricing pressure downstream. Assessing the net effect of the merger by combining a positive $vGUPPI_u$ and a negative $vGUPPI_d$ is likely to be difficult because $vGUPPI_u$ pertains to the upstream price of the input, while $vGUPPI_d$ pertains to the downstream price of the output. However, combining a positive $vGUPPI_r$ and a negative $vGUPPI_d$ is easier because both pertain to downstream prices.

The formula for the $vGUPPI_r$ is the following:³¹

$$vGUPPI_r = vGUPPI_u \times PTR_U \times W_R / P_R \quad (2)$$

where PTR_U denotes the cost pass-through rate of the upstream merging firm³² and P_R denotes the price of the output sold by the targeted downstream rival.³³

Example 2: $vGUPPI_r$ when there is no input substitution

Consider again Example 1 above, in which the $vGUPPI_u$ equals 40%. Suppose the upstream pass-through rate PTR_U is equal to 50%.³⁴ Suppose further that the output price P_R of the targeted downstream rival is equal to the output price P_D of the downstream merging firm. Thus, the output price of the targeted rival is also twice the input price per unit of output charged to the targeted rival, which implies $W_R / P_R = 0.5$. In this example, therefore, equation (2) yields $vGUPPI_r = 10\%$ (i.e., $0.4 \times 0.5 \times 0.5$).

Example 2 illustrates the fact that $vGUPPI_r$ can be substantially lower than $vGUPPI_u$ (i.e., 10% versus 40%). The difference is largest when the price of the input per unit of output represents a small fraction of the price of the output. For example, if the input/output price ratio in Examples 1 and 2 is 0.1 instead of 0.5, the $vGUPPI_u$ rises to 200%, as calculated above, while the $vGUPPI_r$ remains equal to 10%. This suggests that the $vGUPPI_u$ might be a

³¹ The derivation of equation (2) is as follows. The $vGUPPI_u$ corresponds to a *percentage* input price increase (to the targeted downstream rival) equal to $vGUPPI_u \times PTR_U$, where PTR_U is the cost pass-through rate of the upstream merging firm. See *supra* note 30. Thus, the *nominal* input price increase is equal to $vGUPPI_u \times PTR_U \times W_R$. The $vGUPPI_r$ is equal to this increase in the targeted rival's marginal cost of production, expressed as a percentage of the price of the targeted rival's output. (Translating the $vGUPPI_r$ into a corresponding output price increase would require information as to the cost pass-through rate of the targeted rival manufacturer.)

³² For example, suppose a supplier's marginal cost of serving a customer increases by 25 cents per unit, and this 25-cent cost increase leads the supplier to raise the price it charges to the customer by 20 cents. In this example, the cost pass-through rate would equal 80% (i.e., 20/25).

³³ The $vGUPPI_r$ can be related directly to the horizontal GUPPI for a hypothetical merger between the targeted rival and the downstream merging firm. This is not surprising. By acquiring the upstream firm, the downstream firm is able to raise the price of the rival *indirectly* by raising the price of the input that the upstream merging firm charges to that rival. Specifically, we have $vGUPPI_r = GUPPI_r \times PTR_U$, where $GUPPI_r = DR_{RD} \times M_D \times P_D / P_R$.

³⁴ This result follows from linear demand and is commonly used in discussing horizontal GUPPIs.

less useful screen than the *vGUPPIr* for scoring potential input foreclosure concerns.

C. *vGUPPId*: vGUPPI FOR THE DOWNSTREAM MERGING PARTNER'S PRICE

A vertical merger also can have an impact on the incentives of the merged firm to increase (or possibly decrease) the output price charged by the downstream merger partner. The downstream merging firm may have a unilateral incentive to raise the price of its output above the pre-merger level. This is because consumer substitution away from the firm to rivals increases the input sales that the upstream merger partner makes to rivals, which tends to increase the profits of the upstream merger partner. This upward pricing pressure is the only downstream incentive effect if the downstream merging firm does not use the input produced by the upstream merger partner. In this case, the incremental profits of the upstream merger partner (resulting from the incremental input sales to downstream rivals) give the downstream firm an incentive to raise price that it does not have absent the merger.

However, if the downstream merging firm also uses the input of the upstream merger partner, then the downstream firm also may have a unilateral incentive to *reduce* its output price below the pre-merger level. This is the EDM effect. An output expansion by the downstream firm increases the input sales that the upstream firm makes to the downstream firm, which tends to increase the profits of the upstream firm.

We first consider a scenario that does not reckon EDM into the *vGUPPId*. This scenario is appropriate when EDM is not found to be merger-specific.³⁵ We refer to the vGUPPI measure for this scenario as *vGUPPId1*. Following again the GUPPI methodology described in the 2010 Merger Guidelines, we calculate *vGUPPId1* as follows:

$$vGUPPId1 = \frac{\text{value of sales diverted to upstream merging partner}}{\text{revenue on volume lost by downstream merging partner}}$$

which yields a positive number for *vGUPPId1* that can be written as:

$$vGUPPId1 = DR_{DU} \times M_U \times W_U / P_D \quad (3)$$

where DR_{DU} denotes the vertical diversion ratio from the downstream merging firm to the upstream merger partner, W_U and M_U denote the upstream merging firm's price and percentage profit margin (on average across all the customers of the upstream merging firm, excluding the downstream merger partner), and P_D denotes the downstream merger partner's output price.

³⁵ See *supra* note 5.

The vertical diversion ratio DR_{DU} can be related to the horizontal diversion ratios from the downstream merging firm to its rivals. For example, if all the rivals of the downstream merging firm purchase the input sold by the upstream merger partner (and one unit of output requires one unit of that input), then DR_{DU} is equal to the “market recapture percentage” (or “aggregate diversion ratio”) following a unilateral price increase by the downstream merging firm.³⁶ This can be illustrated with the following example.

Example 3: vGUPPI_d when there is no EDM

Suppose the downstream merging firm unilaterally raises the price of its output and, as a result, its unit sales fall by 100 units. Suppose further that the market recapture percentage is 75% so that the other downstream firms capture 75 out of those 100 units. Suppose also that one-third of those 75 units (i.e., 25 units) require the input of the upstream merging firm. Thus, the diversion ratio from the downstream merging firm to the upstream merger partner is $DR_{DU} = 25\%$. Suppose the upstream merging firm earns a margin M_U of 50% on input sales to rivals of the downstream merger partner and the input price per unit of output is half the output price of the downstream merger partner, i.e., $W_U / P_D = 0.50$. From equation (3), $vGUPPI_{d1} = 6.25\%$ (i.e., $0.25 \times 0.50 \times 0.50$).

In this analysis, the input prices of the upstream merger partner are held constant at the pre-merger level. Thus, $vGUPPI_{d1}$ scores the first-round incentive to raise the output price of the downstream merging firm *before* any increase in the input price charged to any targeted downstream rivals. Specifically, it does *not* take into account the impact of raising rivals’ costs on the pricing incentives of the downstream merging firm.

The $vGUPPI_{d1}$ also does not take into account any potential downward pricing pressure from merger-specific EDM. Accounting for EDM will reduce the $vGUPPI_{d1}$ and possibly make it negative. Suppose that the downstream merging firm is unable to substitute away from inputs purchased from rival suppliers with inputs from the upstream merger partner. Even here, merger-specific EDM could reduce its marginal cost. This leads to the following formula, which we denote as $vGUPPI_{d2}$:

$$vGUPPI_{d2} = vGUPPI_{d1} - M_{UD} \times W_D / P_D \quad (4)$$

³⁶ The market recapture percentage is the fraction of the output lost by the downstream merging firm that would be recaptured by all the other output manufacturers (including the targeted rivals). The 2010 Guidelines, *supra* note 9, § 4.1.3, use the market recapture percentage in the context of market definition.

where $vGUPPId1$ is given in equation (3), and M_{UD} and W_D denote the margin and price of the upstream merging firm on input sales to the downstream merging firm.

Equation (4) implies that if market demand is perfectly price inelastic and downstream firms are symmetric, then $vGUPPId2 = 0$. (The downstream firms are symmetric if each of them purchases the input of the upstream merging firm and if the upstream merging firm earns the same dollar margin on input sales to each downstream firm.) This key result follows because a price increase by the downstream merging firm has no effect on total market output (since market elasticity is zero) and also no effect on the total input sales and profits of the upstream merger partner (since the latter earns the same margin on sales to *all* the downstream firms). Thus, the merger does not create any incentive for the downstream merging firm to change the price of its output, i.e., $vGUPPId2 = 0$.³⁷

In fact, if instead market demand is not perfectly inelastic (or if some downstream firms are not customers of the upstream merging firm) and there is symmetry among the customers of the upstream firm, then $vGUPPId2 < 0$ and there is a strict incentive for the downstream firm to reduce its price. For example, consider again Example 3 where $vGUPPId1 = 6.25\%$. Suppose the upstream merging firm also earns a margin of 50% on input sales to the downstream merging firm, and the input/output price ratio also equals 0.5 for the downstream firm. Then, $vGUPPId2 = -18.75\%$ (i.e., $0.0625 - 0.5 \times 0.5$). This is because a price reduction by the downstream merging firm expands output and increases its input purchases from the upstream merger partner by more than it reduces the rivals' input purchases. Therefore, in this case, the merger on balance creates downward pricing pressure on the downstream merging firm, *ceteris paribus*.

In short, merger-specific EDM can make a substantial difference to the analysis, even if there is no potential for input substitution.³⁸ If $vGUPPId < 0$, it will mitigate and possibly reverse the impact of $vGUPPIr > 0$, which would lead to a lower likelihood of significant adverse effects. The first-round *net* incentive effect on downstream prices then might be gauged roughly by calculating a weighted average of $vGUPPIr$ and $vGUPPId$.³⁹

³⁷ Formally, zero market elasticity and symmetry imply $DR_{DU} = 1$, $W_U = W_D$ and $M_U = M_{UD}$. Equations (3) and (4) then imply $vGUPPId2 = 0$.

³⁸ Input substitution is discussed in Part II.

³⁹ A different approach might be to construct a full-blown vertical merger simulation model. See *supra* note 7.

D. MULTIPLE TARGETED DOWNSTREAM RIVALS

The $vGUPPI_u$ and $vGUPPI_r$ analyzed above evaluated the merged firm's incentives to raise the input prices charged to downstream rivals "one at a time." That is, for each targeted downstream competitor, the $vGUPPI_u$ formula was derived holding the input prices charged to any other targeted competitors constant at their pre-merger level. This is a conservative approach because the incentive to raise the input price to any given targeted rival is higher if the merged firm simultaneously raises price also to other rivals.

This is an important issue because the merged firm may have the incentive to foreclose multiple firms simultaneously, which can significantly increase the profitability and the incentives to raise input prices further. Relying solely on the $vGUPPI_u$ (or the $vGUPPI_r$) calculated for a targeted price increase to a single rival can ignore significant interaction effects from simultaneous price increases and, therefore, lead to significant under-prediction of adverse effects.⁴⁰

The $vGUPPI_u$ and $vGUPPI_r$ formulas can be extended to account for these interaction effects. When the merged firm raises the input price to multiple downstream rivals, there is more diversion to the downstream merger partner (than when it raises the input price to just one rival). For example, suppose that the upstream firm were to raise the input prices simultaneously to all its downstream rivals. If so, then a greater percentage of the sales lost by each rival would be diverted to the downstream merger partner because the downstream merger partner would be the only firm that did not experience a price increase. This analysis can be illustrated with the following example.

Example 4: Simultaneously targeting multiple downstream rivals

Consider again Examples 1 and 2 above in which the diversion ratio between the targeted downstream rival and the downstream merger partner was equal to 40%. That is, if the merged firm raises the input price to that rival only, the downstream merger partner captures 40% of the output that the rival loses as the result of the input price increase. Given the margin and price data

⁴⁰ The same issue arises in horizontal merger cases involving multi-product firms, if the GUPPIs for the multiple products sold by one merging firm are calculated separately for each product and one at a time. It is noteworthy that the Guidelines seem to instruct practitioners to evaluate the upward pricing pressure for each individual product separately. See 2010 Guidelines, *supra* note 9, § 6.1 ("Adverse unilateral price effects can arise when the merger gives the merged entity an incentive to raise *the price of a product* previously sold by one merging firm and thereby divert sales to *products* previously sold by the other merging firm, boosting the profits on the latter *products*.") (emphasis added). However, the Guidelines do not indicate whether the upward pricing pressure for each individual product sold by the same merging firm should be evaluated one at a time or simultaneously (i.e., whether the other prices charged by that firm should be held constant at their pre-merger level or should be assumed to rise as well).

in these examples, the $vGUPPIu$ and $vGUPPIr$ were 40% and 10%, respectively. Suppose there is an identical second rival that also purchases the input of the upstream merging firm and thus also can be targeted for input foreclosure by the merged firm. One conservatively could apply the same vGUPPIs of 40% and 10% to the second targeted rival as well. However, if the merged firm raises the input price to both rivals simultaneously, suppose the downstream merger partner would capture 50% of the sales lost by the two rivals.⁴¹ This increase in the diversion ratio from 40% to 50% leads to an increase in the $vGUPPIu$ from 40% to 50% and a corresponding increase in the $vGUPPIr$ from 10% to 12.5%.

II. ACCOUNTING FOR INPUT SUBSTITUTION

The basic analysis above assumes that there is no ability for downstream rivals to substitute away from the input sold by the upstream merging firm if it raises its price. As a result, the only constraint on the upstream firm's incentive to raise prices is the fact that higher input prices will lead to higher output prices, which will choke off demand for the products of the targeted firms and the inputs that they require. The lack of input substitution also limited the magnitude of potential merger-specific EDM.

The analysis changes when there is a potential for input substitution.⁴² When downstream firms have access to production technologies that permit them to substitute away from the input of the upstream merging firm to other suppliers, the market power of the upstream merging firm will be lessened, both before and after the merger. This substitution will mitigate (or possibly even eliminate) the cost increase and the associated increase in the price of the targeted firm's output. As a result, diversion to the downstream merging firm

⁴¹ This is consistent with a 20% diversion ratio between the two targeted rivals. As a general matter, if all the targeted downstream rivals are symmetric, so that the input price increases would be the same for each targeted rival and each targeted rival would have the same incentive to raise its own price, and if the downstream firms face linear demand, then the $vGUPPIu$ and $vGUPPIr$ can be calculated by replacing the standard diversion ratio DR_{RD} for a single targeted rival (calculated holding the prices of other targeted rivals constant) with the "overall" diversion ratio $DR_{RD}^* = DR_{RD} / (1 - DR_{RR})$, where DR_{RR} denotes the aggregate diversion ratio from a targeted rival to all the other targeted rivals (following a unilateral price increase by a targeted rival). For example, suppose there are three targeted rivals and, if any one of them were to raise price unilaterally and lose 100 units of sales, then the downstream merging firm would capture 30 units (i.e., $DR_{RD} = 30\%$) and each of the other two targeted rivals would capture 20 units (i.e., $DR_{RR} = 40\%$). (The remaining 30 units would be diverted to non-targeted rivals and outside goods.) With linear demand, if all three targeted rivals simultaneously raise price equally, then each of them loses 100 units "initially" and then recaptures 40 units when the other two targeted rivals also raise price. Thus, the three targeted rivals lose a total of 180 units when they raise price simultaneously. The downstream merging firm captures 90 units (i.e., 30 units from each targeted rival) and thus the overall diversion ratio equals 50% (i.e., 90/180). That is, $DR_{RD}^* = DR_{RD} / (1 - DR_{RR}) = 0.3 / (1 - 0.4) = 0.5$.

⁴² Formal analysis is provided in the Appendix, available at http://www.americanbar.org/content/dam/aba/publishing/antitrust_law_journal/at_alj_moresi_salop.pdf.

from the input price increase also will be reduced. These effects will reduce the incentive to engage in input foreclosure, perhaps very substantially. This input substitution can be reckoned into the *vGUPPI* analysis.

A. *vGUPPIu*

In the presence of input substitution, the *vGUPPIu* formula is given as follows:

$$vGUPPIu = \frac{DR_{RD} \times M_D \times P_D / W_R}{1 + M_R \times E_{SR} / E_p} \quad (5)$$

The numerator in equation (5) is the *vGUPPIu* in the absence of input substitution, and the denominator is the adjustment to be made to account for input substitution. Since the denominator exceeds unity, input substitution tends to reduce the *vGUPPIu* (all else equal). The magnitude of the denominator—and the incentive to raise the input price to the targeted rival—depends on two elasticities, E_{SR} and E_p .⁴³ (E_{SR} measures the extent to which the targeted rival can substitute away from the upstream merging firm's input to other input suppliers.⁴⁴ E_p measures the extent to which the targeted rival passes through an increase in the upstream merging firm's input price into its output price).⁴⁵

Example 5: vGUPPIu when there is input substitution

Consider again the assumptions of Example 1. If there is no input substitution ($E_{SR} = 0$), the *vGUPPIu* equals 40% (i.e., the numerator in equation (5) equals 40%). Suppose instead that there is input substitution and assume $E_{SR} = 2.5$, $E_p = 0.25$ and $M_R = 50\%$. Thus, the denominator in equation (5) equals 6 (i.e., $1 + 0.5 \times 2.5 / 0.25$). It follows that input substitution reduces the *vGUPPIu* from 40% to about 6.7% (i.e., 40% divided by 6). This shows the large impact that input substitution can have on the incentive to raise post-merger input prices.

⁴³ We will discuss the estimation and the properties of these elasticities in Part II.D below.

⁴⁴ We use S_{UR} to denote the upstream merging firm's share of the targeted rival's total purchases of the relevant input. This share pertains to the relevant inputs under consideration (e.g., chemical products used as catalysts) and ignores all other types of inputs (e.g., other chemicals, labor, and fuel). E_{SR} denotes the elasticity of S_{UR} with respect to an increase in the input price W_R that the upstream merging firm charges to the rival. For example, suppose a supplier raises the price of its input to a manufacturer by 10% and, as a result of the input price increase, the supplier's share of the manufacturer's total input purchases falls by 25%, say from 60% to 45%. In this example, E_{SR} would equal 2.5 (i.e., 25% divided by 10%).

⁴⁵ E_p denotes the elasticity of the price of the targeted rival (P_R) with respect to an increase in the input price that the rival must pay to the upstream merging firm (W_R). For example, suppose a supplier raises the price of its input to a manufacturer by 10% and, as a result of the input price increase, the manufacturer raises the price of its output by 2.5%. In this example, E_p would equal 0.25 (i.e., 2.5% divided by 10%).

Despite the additional complexity created by input substitution, the signs of the various terms in equation (5) make intuitive sense. A higher value of E_{SR} implies that the targeted rival will substitute a larger share of inputs previously purchased from the upstream merging firm with purchases from other suppliers (as opposed to raising its output price) and thus implies that the merged firm will have a weaker incentive to raise the input price to the targeted rival. Conversely, a higher value of E_p implies that the targeted rival will have an increased propensity to pass through an input price increase in its output price (as opposed to substituting input purchases from the upstream merging firm with input purchases from other suppliers) and thus implies that the merged firm will have a stronger incentive to raise the input price to the targeted rival. Finally, a higher value of M_R implies that the targeted rival faces a more inelastic demand and, therefore, the targeted rival loses fewer sales when it raises its output price in response to an input price increase. This in turn implies that the volume of sales diverted from the foreclosed rival to the merger partner is smaller, and hence the merged firm will have a weaker incentive to raise the input price to the targeted downstream rival.

B. $vGUPPIr$

When there is input substitution, the $vGUPPIr$ formula is given as follows:

$$vGUPPIr = vGUPPIu \times PTR_U \times \frac{W_R}{P_R} \times \frac{S_{UR}^{post}}{S_{UR}} \quad (6)$$

where $vGUPPIu$ is given in equation (5) and:

$$\frac{S_{UR}^{post}}{S_{UR}} = 1 - vGUPPIu \times PTR_U \times E_{SR}. \quad (7)$$

These two equations show that input substitution has two effects that tend to reduce the $vGUPPIr$. First, as indicated by equation (7), the fraction S_{UR}^{post} / S_{UR} is smaller than unity and accounts for the fact that the targeted rival would respond to an increase in the input price by reducing the share of its input purchases from the upstream merging firm.⁴⁶ Second, the value of $vGUPPIu$ in equation (6) is smaller when there is input substitution, which accounts for the fact that the input price increase by the upstream merging firm would be smaller to begin with.

Example 6: $vGUPPIr$ when there is input substitution

Consider again Example 5 where input substitution reduces $vGUPPIu$ from 40% to about 6.7%. From equation (7), input substitution also reduces the

⁴⁶ Equation (7) could yield a negative value because it is an approximation. If so, $vGUPPIr$ likely would be negligible and should be set equal to zero.

fraction S_{UR}^{post} / S_{UR} from 1 to 0.917 (since $vGUPPI_u \times PTR_U \times E_{SR} = 0.067 \times 0.5 \times 2.5 = 0.083$). It then follows from equation (6) that input substitution reduces $vGUPPI_r$ from 10% to about 1.5% (i.e., $0.067 \times 0.5 \times 0.5 \times 0.917$).

C. $vGUPPI_d3$

If EDM is merger-specific and cognizable and the downstream merging firm also has some ability to substitute inputs from rival suppliers with inputs from the upstream merger partner, then the $vGUPPI_d$ formula is given as follows:

$$vGUPPI_d3 = vGUPPI_d2 - E_{SD} \times (M_{UD})^2 \times W_D / P_D \quad (8)$$

where $vGUPPI_d2$ is given in equation (4) and E_{SD} denotes the premerger elasticity of the upstream merging firm's share of the downstream merging firm's input purchases with respect to the price that the upstream firm charges to the downstream firm. As equation (8) shows, $vGUPPI_d3$ is lower than $vGUPPI_d2$. The input substitution further reduces the upward pricing pressure and more likely will result in downward pricing pressure.

Example 7: $vGUPPI_d$ when there is EDM and input substitution

Consider again Example 3 where, in the absence of EDM and input substitution, $vGUPPI_d1$ is equal to 6.25%. Assuming that the upstream merging firm earns a margin of 50% on input sales to the downstream merging firm, i.e., $M_{UD} = 50\%$, and that the input price per unit of output is half the output price of the downstream merging firm, i.e., $W_D / P_D = 0.5$, we found $vGUPPI_d2 = -18.75\%$. Thus, in this illustrative example, accounting for cognizable EDM was sufficient to turn a positive $vGUPPI_d1$ into a negative $vGUPPI_d2$. If we also account for input substitution by the downstream merging firm, the EDM effect becomes even stronger. To illustrate, suppose that the downstream merging firm has the same ability as the targeted rival to substitute inputs between the upstream merging firm and other suppliers, i.e., $E_{SD} = 2.5$. Then, equation (8) implies $vGUPPI_d3 = -50\%$ (i.e., $-18.75 - 2.5 \times 0.5^2 \times 0.5$).

D. DATA REQUIREMENTS AND CALIBRATION

In order to calculate the vGUPPIs when there is no input substitution, it is necessary to have information similar to what is needed to calculate standard horizontal GUPPIs. These data include the margins and prices of the upstream merging firm and the downstream firms, as well as the diversion ratios among the downstream firms. In addition, the analyst requires an estimate of the cost pass-through rate of the upstream merging firm.

Certain variables might need to be estimated. To account for potential input substitution between the input of the upstream merging firm and other suppliers of the relevant input, it is necessary to estimate the elasticities E_{SR} and E_P for each targeted rival. In addition, it is necessary to estimate the elasticity E_{SD} for the downstream merging firm to account for merger-specific EDM resulting from input substitution. These elasticities might be estimated from data in public or proprietary documents from the merging firms or from natural experiments.

These elasticities also may be inferred from other variables and the assumption of profit-maximization.⁴⁷ In particular, if one assumes for simplicity that downstream firms are symmetric, then profit-maximization by the upstream merging firm implies:

$$E_{SR} = E_{SD} = 1 / M_U - E \times E_P \quad (9)$$

where E denotes the elasticity of downstream market demand with respect to an increase in the downstream market price. If an estimate of the market elasticity E is available, then equation (9) can be used together with an estimate of the input price pass-through elasticity E_P to “calibrate” the values of E_{SR} and E_{SD} . If instead an estimate of E is not available, one can assume $E = 1$, and if an estimate of E_P is not available then one can use the approximation:⁴⁸

$$E_P = PTR_R \times W_R / P_R \quad (10)$$

where PTR_R is the standard cost pass-through rate that applies when a downstream firm incurs an increase in its marginal cost of production (and does not expect any changes in its competitors’ prices).⁴⁹

Example 8: Calibrating the values of E_{SR} and E_{SD}

Assuming that $PTR_R = 0.5$ and $W_R / P_R = 0.5$, then equation (10) implies that $E_P = 0.25$ (i.e., 0.5×0.5). Assuming a 50% margin and a market elastic-

⁴⁷ See, e.g., Joseph Farrell & Carl Shapiro, *Improving Critical Loss Analysis*, ANTITRUST SOURCE, Feb. 2008, http://www.americanbar.org/content/dam/aba/publishing/antitrust_source/Feb08_Farrell_Shapiro.pdf.

⁴⁸ By definition, $E_P = PTR_R \times (\Delta C_R / \Delta W_R) \times W_R / P_R$. Equation (10) thus might overstate the value of E_P because it implicitly assumes that $\Delta C_R / \Delta W_R = 1$. This assumption is correct when there is no input substitution.

⁴⁹ When there are multiple targeted downstream rivals, the elasticity E_P also could be higher as well as the diversion ratio. See *supra* Part I.D. This depends on whether each targeted rival expects that the other targeted rivals also will face an input price increase and raise their prices as a result. The simpler approach would hold the beliefs and strategies of all non-merging firms (including the targeted downstream firms) constant and thus the same as their pre-merger beliefs and strategies, which would not lead to a higher E_P . This is the approach used for horizontal GUPPIs and therefore the most straightforward extension of the GUPPI methodology to vertical mergers.

ity of 1 (i.e., $M_U = 50\%$ and $E = 1$), equation (9) implies $E_{SR} = E_{SD} = 1.75$ (i.e., $1 / 0.5 - 1 \times 0.25$).

III. FURTHER POLICY ANALYSIS

Implementation of the vGUPPI methodology by the agencies would involve several additional policy decisions. First, the agencies would need to decide whether to focus on the *vGUPPIu* or the *vGUPPIr*. Second, they would want to decide whether or not to apply a safe harbor, and if so, at what level.

A. *vGUPPIu* VERSUS *vGUPPIr*

In horizontal mergers, there is a GUPPI for each product sold by the merging firms. We have calculated three basic vGUPPIs, one for the output price of the downstream merging firm (*vGUPPId*), one for the input price charged by the upstream merging firm to a rival of the downstream merging firm (*vGUPPIu*), and one for the output price of the downstream rival targeted for the input price increase (*vGUPPIr*). While it is clear that *vGUPPId* should be used to score the merger impact on the pricing incentives of the downstream merging firm, there could be a policy debate about *vGUPPIu* and *vGUPPIr*. Competitive effects analysis (and any safe harbor or anticompetitive presumptions) could be based on the *vGUPPIr* of the targeted downstream rival instead of, or in addition to, the *vGUPPIu* of the upstream firm.

In our view, there is a good policy rationale to prefer the use of the *vGUPPIr* instead of *vGUPPIu*. The *vGUPPIr* is more relevant to gauging harm to the consumers that purchase the downstream product. Even if the *vGUPPIu* is large, the input may be sufficiently unimportant that it would not lead to significant effects downstream. However, there are arguments that it would be inappropriate to eliminate a policy role for *vGUPPIu*. It might be argued that harm to the downstream targeted rivals is or should be sufficient harm to be cognizable. That is, these targeted downstream rivals also might be “consumers” for the purposes of vertical merger enforcement.

There are competing doctrinal threads here. On the one hand, *Aspen Skiing* makes it clear that it is necessary to show consumer harm, not simply harm to a rival.⁵⁰ Vertical restraints cases like *Jefferson Parish* that allege exclusionary effects from exclusive dealing are treated similarly.⁵¹ However, on the other hand, the 2010 Guidelines take the approach that it is not necessary to show adverse effects on consumers in downstream markets for mergers of compet-

⁵⁰ *Aspen Skiing Co. v. Aspen Highlands Skiing Corp.*, 472 U.S. 585, 608–09 (1985). See also Krattenmaker & Salop, *supra* note 1.

⁵¹ *Jefferson Parish Hosp. Dist. No. 2 v. Hyde*, 466 U.S. 2 (1984); see also *United States v. Dentsply, Int'l, Inc.* 399 F.3d 181 (3d Cir. 2005).

ing buyers that raise buy-side competitive concerns.⁵² It appears that the Agencies intend that harm to the sellers would be sufficient to render the merger anticompetitive. Thus, this remains a policy issue for any revision of the U.S. Non-Horizontal Merger Guidelines.

B. SAFE HARBORS

In light of the numerous policy issues raised in this article, it is premature for us to recommend specific vGUPPI levels for use in a preliminary safe harbor, or indeed whether to implement safe harbors.⁵³ Instead, we merely will highlight a number of discussion issues that will be relevant in making that determination. First, there is the issue of whether to specify the safe harbor in terms of the *vGUPPIr* or the *vGUPPIu*. The *vGUPPIu* better predicts the harm to the downstream competitors who are customers of the upstream merging firm. However, harms to the customers of the downstream competitors are better predicted by the *vGUPPIr*.

Second, there is the issue of whether to specify safe harbors based on the simplest vGUPPIs derived for an input price increase that targets a single rival, or whether to take into account the potential or likelihood of multi-rival targeting of post-merger input price increases. The latter clearly predicts a greater incentive to foreclose.⁵⁴

Third, there is the issue of which *vGUPPId* to specify for the safe harbor. The most restrictive approach would be to use *vGUPPId1* where it is not clear whether EDM will be a cognizable efficiency benefit, but use the *vGUPPId2* or *vGUPPId3* where it likely would be cognizable.

Fourth, there is the issue of whether to reduce the data requirements of an initial screen by relying on assumed values for the pass-through rate PTR_U and assuming no input substitution, as set out in Part I, *supra*. For example, one

⁵² 2010 Guidelines, *supra* note 9, § 12 (“Nor do the Agencies evaluate the competitive effects of mergers between competing buyers strictly, or even primarily on the basis of effects in the downstream markets in which the merging firms sell.”) This analysis seems to assume no merger efficiencies. If there are efficiencies, then there could be a trade-off between harm to the sellers and benefits to consumers. See Steven C. Salop & Serge Moresi, *Updating the Merger Guidelines: Comments* (Public Comment to Horizontal Merger Guidelines Review Project, Nov. 2009), available at <http://www.ftc.gov/os/comments/horizontalmergerguides/545095-00032.pdf>.

⁵³ The 2010 Guidelines, *supra* note 9, § 6.1, suggest a horizontal GUPPI safe harbor when “the value of diverted sales is proportionately small.” A subsequent speech by then-deputy AAG Carl Shapiro explicitly specified the safe harbor level as a GUPPI less than 5%. Carl Shapiro, Deputy Assistant Att’y Gen., Antitrust Div., U.S. Dep’t of Justice, Remarks Before the ABA Section of Antitrust Law Fall Forum: Update from the Antitrust Division 24 (Nov. 18, 2004), available at <http://www.justice.gov/atr/public/speeches/264295.pdf>. (“Put differently, unilateral price effects for a given product are unlikely if the gross upward pricing pressure index for that product is less than 5%.”) This GUPPI safe harbor presumably is premised on a certain level of presumed efficiency benefits, along with other competitive effects factors and uncertainty.

⁵⁴ See *supra* Part I.D.

simple approach would be to assume $PTR_U = 50\%$ and assume further that there is no input substitution or EDM.⁵⁵ It might be argued that basing the safe harbor on no EDM or input substitution could lead to an overly intrusive standard. The argument on the other side is that a safe harbor is intended to be narrow. Moreover, the actual value of PTR_U might be expected sometimes to exceed the default level of 50%. Finally, concerns about over- or under-intrusiveness also can be eliminated by changing the safe harbor level rather than the assumptions on which it is based.

IV. COMPARING *vGUPPIu* TO THE VERTICAL ARITHMETIC METHODOLOGY

“Vertical arithmetic” is another methodology that has been used to score foreclosure incentives in vertical mergers.⁵⁶ The vGUPPIs and vertical arithmetic have similar goals and the calculations share a common approach. In fact, the vertical arithmetic can be expressed as a *vGUPPIu* test with a specific safe harbor.

However, there are several differences. First, the vertical arithmetic gauges only the likelihood of withholding the input. Unlike the vGUPPIs, it does not gauge the impact on prices paid by consumers in the downstream market. Second, and related, the vertical arithmetic does not take into account the impact of EDM, whereas the *vGUPPId* does. Third, the vertical arithmetic evaluates the incentive for non-price rationing through a partial or total refusal to deal, whereas the vGUPPIs evaluate pricing incentives.

For mergers in markets where the input price is fixed at a regulated level, the vertical arithmetic can be used to evaluate the incentives for non-price exclusion (i.e., denying, delaying, or degrading access) from a facility that is used as an input by downstream competitors and is controlled by the upstream merging partner. For example, it would apply to telephony mergers where the price of access to the local ILEC network is regulated. However, in markets where input prices are not regulated but are set by the upstream merging firms, the *vGUPPIu* has advantages, even aside from EDM or gauging downstream effects. Increasing input prices is generally a more profitable way of

⁵⁵ The assumption of $PTR_U = 50\%$ is consistent with linear demand functions in the downstream output market and fixed-proportion demand functions in the upstream input market. With variable proportions, the upstream cost pass-through rate PTR_U can be smaller than 50% (e.g., if downstream demand functions are linear).

⁵⁶ Vertical arithmetic calculations have been carried out for a number of vertical mergers and joint ventures. *See supra* note 13.

rationing demand than is withholding input sales at a constant price. This greater profitability normally leads to a greater incentive to foreclose.⁵⁷

The relationship of the incentives for non-price rationing expressed by the vertical arithmetic methodology and the pricing incentives expressed by the *vGUPPIu* is straightforward to explain. Suppose the upstream merging firm were to withhold one unit of the input from a targeted rival of the downstream merger partner but maintain the same input price for the remaining units sold. In that case, the upstream firm's profits would be reduced by its dollar incremental profit margin $M_U W_R$. Faced with this loss of a unit of the input, the targeted downstream rival would attempt to substitute to other possibly less efficient or more costly inputs. Either way, it might also have the incentive to raise its price. As a result, the downstream rival likely would lose some sales to other downstream firms, including the downstream merger partner. In the simplest vertical arithmetic scenario, it is assumed that these other downstream firms do not raise their prices, but simply absorb the sales diverted to them at their original prices.⁵⁸

Suppose that the input is used in fixed proportions, for example, one unit of input for each unit of output. Suppose that in response to the withholding of one unit of the input by the upstream merging firm, the downstream merging firm obtains a fraction DR_{UD} of a unit of additional sales. Suppose that it earns a dollar profit margin $M_D P_D$ on each of these sales and, therefore, incremental profits of $DR_{UD} M_D P_D$.

The other downstream firms also obtain additional sales (except of course the foreclosed rival). Those firms also may use the input supplied by the upstream merging firm, and they will purchase more of it as their sales expand post-foreclosure. This diversion to the downstream merging firm and the non-targeted rivals in turn allows the upstream merging firm to recapture a fraction F of the withheld unit from sales to other firms, including the downstream merging firm.⁵⁹ Thus, assuming that the upstream merging firm earns the

⁵⁷ However, in the case of non-price foreclosure that must be lumpy (e.g., all or nothing refusals to deal or discrete quality degradation), non-price foreclosure could end up being more severe than price foreclosure.

⁵⁸ The same assumption also applies to *vGUPPIu*.

⁵⁹ Assuming fixed proportions (i.e., each downstream firm purchases one unit of the upstream merging firm's input for each unit of output produced), $F = R_R$, where R_R is the aggregate diversion ratio, that is, the fraction of the sales lost by the targeted rival that are diverted to the downstream merging firm and the other non-targeted rivals in the market, following a unilateral price increase by the targeted rival. If one assumes that the downstream firms have the same aggregate diversion ratio (R) to their competitors, then $F = R = 1 - ME$, where E is the downstream market elasticity and M is the average margin of the downstream firms. See Serge Moresi, Diversion Ratios and Market Elasticity: Some Useful Formulas (2011) (unpublished paper), available at http://crai.com/uploadedFiles/RELATING_MATERIALS/Publications/LAE/Antitrust_and_Competition_Economics/Diversion_Ratios_and_Market_Elasticity_Some_Useful_Formulas.pdf.

same dollar margin from all its customers, the net loss in margin of the upstream merging firm is equal to $(1 - F)M_U W_R$.

Comparing the profit gains by the downstream merging partner to the profit losses by the upstream merging partner, the withholding would be profitable on balance, if and only if:

$$DR_{UD}M_D P_D > (1 - F)M_U W_R \quad (11)$$

This can be rewritten in terms of the *vGUPPIu*. Using equation (1), withholding one unit of input would be profitable if and only if:

$$vGUPPIu > (1 - F)M_U \quad (12)$$

For example, suppose that *vGUPPIu* = 15% and $(1 - F)M_U$ = 20%, so that equation (9) would not be satisfied. In this case, vertical arithmetic would lead to the conclusion that (non-price) foreclosure is not profitable. In contrast, if the input price is not regulated, the *vGUPPIu* of 15% would indicate that it is profitable for the merged firm to raise the input price. This difference in the profitability conditions flows from the fact that when the input price is raised, the customer pays a higher price on all the units it continues to purchase. However, the vertical arithmetic assumes that the merged firm withholds input sales to a downstream rival but does not raise its price on the units that the downstream rival continues to purchase. Thus, the withholding strategy of the vertical arithmetic methodology is less profitable than is the price-increasing strategy of the *vGUPPIu*.

One can view of the vertical arithmetic as a *vGUPPIu* test with an effective safe harbor level set equal to $(1 - F)M_U$. This means that use of the vertical arithmetic could lead to a more or less permissible policy, depending on the *vGUPPIu* safe harbor used by the agency. For example, if M_U = 50% and F = 60%, then the use of the vertical arithmetic effectively would amount to a *vGUPPIu* safe harbor of 30%.

V. CONCLUSION

This article has applied the basic GUPPI methodology to encompass pricing incentives in vertical mergers. It has formulated vGUPPIs for scoring the merged firm's incentives to engage in input foreclosure and reduce output. It also has analyzed several ways to take EDM into account. The vGUPPIs thus can be used for the evaluation of vertical mergers in the same way that standard GUPPIs are used for horizontal mergers.

This analysis of vGUPPIs is part of a larger project to design a menu of "incentive scoring" methodologies for various competitive concerns raised in merger policy. The standard GUPPIs can be used to score the incentives for

unilateral price increases in horizontal mergers. The basic GUPPI methodology can be extended for firms that compete in quantities or capacity instead of price,⁶⁰ bidding markets,⁶¹ and markets with congestion issues.⁶² It also can be applied to acquisitions of partial ownership interests.⁶³

The vGUPPIs here are used to score the incentives for input foreclosure and downstream unilateral price increases in vertical mergers. We (and our co-authors) have also designed an analogous coordination price pressure index (CPPI) methodology to score the incentives and ability for leading firms in a market to engage in parallel accommodating conduct in the context of horizontal mergers.⁶⁴

The use of these incentive scoring methodologies represents a significant advance in the economic evaluation of competitive effects analysis for mergers and joint ventures, in particular in the early phase of an investigation. Antitrust analysis is premised on the assumption that firms are rational, profit-maximizing entities. Thus, the economic incentives of the firms provide relevant information about the likely outcomes of these combinations. While incentive scoring is not the only information relevant for evaluating likely effects, it clearly is useful evidence.

Incentive scoring methodologies are more informative than simple structural measures such as the HHI or other concentration indices. The increase in the HHI generally does not relate directly to the change in unilateral incentives caused by a merger. As a matter of economic analysis, those concentration indices are particularly relevant for some types of conduct but not others.⁶⁵ Thus, economic analysis does not support concentration having the primary predictive role ascribed to it in cases like *Philadelphia National Bank*.⁶⁶ This shortcoming of concentration as a predictor has now been recognized in cases like *Baker Hughes*.⁶⁷ Incentive scoring methodologies like the GUPPI, vGUPPI and CPPI can help fill the gap.

⁶⁰ Moresi, *supra* note 12.

⁶¹ *Id.*

⁶² See Robert Willig, *Unilateral Competitive Effects of Mergers: Upward Pricing Pressure, Product Quality, and Other Extensions*, 39 REV. INDUS. ORG. 19 (2011).

⁶³ 2010 Guidelines, *supra* note 9, § 13; Daniel P. O'Brien & Steven C. Salop, *Competitive Effects of Partial Ownership: Financial Interest and Corporate Control*, 67 ANTITRUST L.J. 559 (2000).

⁶⁴ Serge X. Moresi, David Reitman, Steve C. Salop & Yianis Sarafidis, *Gauging Parallel Accommodating Conduct Concerns with the CPPI* (2011) (unpublished manuscript), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1924516.

⁶⁵ See Robert E. Dansby & Robert D. Willig, *Industry Performance Gradient Indexes*, 69 AM. ECON. REV. 249 (1979).

⁶⁶ United States v. Phila. Nat'l Bank, 374 U.S. 321, 362–63 (1963).

⁶⁷ United States v. Baker Hughes Inc., 908 F.2d 981, 984 (1990).

Additional incentive scoring methodologies also are needed. The *vGUPPIu* is designed primarily to address input foreclosure concerns in vertical merger cases. A somewhat different analysis likely is needed to evaluate the incentives to engage in customer foreclosure. Similarly, the CPPI is designed to address coordinated price increases through parallel accommodating conduct. A somewhat different analysis likely is needed to evaluate the incentives to engage in collusive conduct that relies on detection and punishment of defections from tacitly agreed-upon terms of coordination.⁶⁸ We hope that this article helps create further momentum to move antitrust analysis forward in this direction.

⁶⁸ Analysis of the incentives to engage in coordination also may differ if firms interact in multiple markets. See, e.g., B. Douglas Bernheim & Michael D. Whinston, *Multimarket Contact and Collusive Behavior*, 21 RAND J. ECON. 1 (1990).

GLOSSARY

Firm U, Firm D, Firm R: The upstream merging firm (U), the downstream merging firm (D) and the downstream rival (R) targeted for input foreclosing price increases.

Diversion Ratio DR_{UD} : The fraction of Firm U 's sales lost (when Firm- U raises its price) that are gained by Firm- D .

Diversion Ratio DR_{RD} : The fraction of Firm R 's sales lost (when Firm- R raises its price) that are gained by Firm D .

Diversion Ratio DR_{DU} : The fraction of Firm D 's sales lost (when Firm- D raises its price) that are gained by Firm U .

Upstream Prices W_R and W_D : Input prices charged by Firm U to Firm R and Firm D , respectively.

Upstream Average Price W_U : Average input price charged by Firm U to all downstream firms, excluding Firm D .

Downstream Prices P_D and P_R : Output prices charged by Firm R and Firm D , respectively.

Average Upstream Margin M_U : Firm U 's average variable profit margin (i.e., its average price charged to all firms except Firm D less its variable cost, $W_U - C_U$) expressed as a percentage of its average price. That is, $M_U = (W_U - C_U) / W_U$.

Upstream Margin M_{UD} : Firm U 's variable profit margin on input sales to Firm- D .

Downstream Margin M_D : Firm D 's variable profit margin (i.e., its price less its variable cost, $P_D - C_D$) expressed as a percentage of its price. That is, $M_D = (P_D - C_D) / P_D$.

Downstream Margin M_R : Firm- R 's variable profit margin (i.e., its price less its variable cost, $P_R - C_R$) expressed as a percentage of its price. That is, $M_R = (P_R - C_R) / P_R$.

Upstream Pass-Through Rate PTR_U : The absolute (i.e., dollar) increase in the input price charged to Firm R (ΔW_R) following an absolute increase in Firm- U 's marginal cost of serving Firm R (ΔC_U), expressed as a percentage of the increase in marginal cost. That is, $PTR_U = \Delta W_R / \Delta C_U$.

Downstream Pass-Through Rate PTR_R : The absolute (i.e., dollar) increase in the output price charged by Firm- R (ΔP_R) following an absolute increase in Firm- R 's marginal cost of production (ΔC_R), expressed as a percentage of the increase in marginal cost. That is, $PTR_R = \Delta P_R / \Delta C_R$.

Downstream Pass-Through Elasticity E_P : The percentage increase in Firm- R 's output price caused by a one-percent increase in Firm- U 's input price charged to Firm- R . That is, $E_P = (\Delta P_R / P_R) / (\Delta W_R / W_R)$. Equivalently, $E_P = PTR_R \times (\Delta C_R / \Delta W_R) \times W_R / P_R$.

Market Elasticity E : The percentage reduction in downstream market demand caused by a one-percent increase in the downstream market price.

Purchase Share S_{UR} : Firm- U 's share of Firm- R 's total purchases of the relevant input.

Purchase Share Ratio S_{UR}^{post} / S_{UR} : The ratio of Firm- U 's share of Firm- R 's input purchases after the target price increase to the share before the input price increase.

Purchase Share Elasticities E_{SR} and: E_{SR} is the elasticity of the purchase share S_{UR} with respect to an increase in the input price W_R that Firm- U charges to Firm- R . Similarly, E_{SD} is the elasticity of Firm- U 's share of the input purchases of Firm- D with respect to an increase in the input price W_D that Firm- U charges to Firm- D .

vGUPPI: SCORING UNILATERAL PRICING INCENTIVES IN VERTICAL MERGERS

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APPENDIX

I. THE TECHNICAL UNDERPINNINGS OF vGUPPI ANALYSIS

The vGUPPIs can be derived from a formal economic model of upstream competition among input suppliers and downstream competition among output manufacturers.

A. BASIC MODEL WITH DIFFERENTIATED INPUTS AND DIFFERENTIATED PRODUCTS

The formal model is a three-stage game involving N input suppliers and M output manufacturers. In the first stage, the suppliers simultaneously set the prices of their inputs and each supplier can set different prices to different manufacturers.¹ In the second stage, each manufacturer observes *only* the input prices at which it will be able to purchase inputs from the suppliers; it does not observe the input prices that the suppliers are charging the other manufacturers. The manufacturers then simultaneously set their product prices. These prices determine each manufacturer's product demand, that is, the orders that the manufacturer receives from its own customers. In the third stage, each manufacturer chooses how many inputs to purchase from each supplier, given the volume of orders received and the input prices set by the suppliers. Production and delivery then occur, and the game ends.

¹ We assume suppliers set linear prices and manufacturers have no bargaining power over input prices.

We assume that each supplier and manufacturer chooses its price to maximize profits,² and that manufacturers also choose inputs to minimize their costs.³ The equilibrium concept considered in this analysis is *perfect Bayesian equilibrium*.⁴ We thus analyze the model using *backward induction*.⁵

1. Manufacturers' Purchases of Inputs

Each manufacturer faces a standard cost-minimization problem (in stage 3). Specifically, manufacturer m must fulfill a given volume Q_m of orders (that it received in stage 2) and faces given input prices $W_m^1, W_m^2, \dots, W_m^N$ from supplier 1, supplier 2, ..., supplier N , respectively (that the suppliers set in stage 1). We assume that the manufacturer must purchase from the N suppliers a total volume of inputs equal to $A_m Q_m$, that is, one unit of output of manufacturer m requires A_m units of input.⁶ We further

² We assume no coordination both before and after the merger.

³ An alternative model specification would be to assume that different inputs are used to create multiple differentiated products. Input substitution patterns would involve the interaction of customers' preferences and output prices (as opposed simply to manufacturers' technologies and input prices). We expect that this specification would lead to similar qualitative results.

⁴ Because manufacturers do not observe the input prices offered to their competitors, each manufacturer must form beliefs about the input prices paid by other manufacturers. In equilibrium, those beliefs must be correct. In general, there are many perfect Bayesian equilibria because there are many different ways that beliefs can be specified following an unexpected (off equilibrium) input price offer. In this paper, we assume that each manufacturer has "passive beliefs" about the input prices offered to its competitors. This means that, when a supplier contemplates raising the price of its input to a given manufacturer, the supplier expects that the manufacturer will not change its beliefs with respect to the input prices that the supplier is offering to its competitors (and hence that the manufacturer also will not change its beliefs with respect to the output prices that its competitors will set in the downstream market). This assumption of passive beliefs affects the manufacturer's response to an input price increase, and hence the equilibrium level of input prices. See Patrick Rey & Jean Tirole, *A Primer on Foreclosure*, in 3 HANDBOOK OF INDUSTRIAL ORGANIZATION 2145, § 2.1.2 (Mark Armstrong & Robert H. Porter eds., 2007).

⁵ For a formal treatment of the concepts of perfect Bayesian equilibrium and backward induction, see, for example, ROBERT GIBBONS, GAME THEORY FOR APPLIED ECONOMISTS (1992).

⁶ The value of the scale factor A_m depends on the choice of units of measurement for the manufacturer's output and the relevant inputs purchased by the manufacturer. With no loss of generality,

assume that the manufacturer's cost of production can be reduced by purchasing inputs from multiple suppliers, so that the manufacturer's cost-minimization solution is to purchase inputs from several of the N suppliers.⁷

$S_m^j(W_m^1, W_m^2, \dots, W_m^N)$ denotes supplier j 's share of the total volume of inputs purchased (from the N suppliers) by manufacturer m . Thus, the volume of inputs purchased by manufacturer m from supplier j is given by $S_m^j(W_m^1, W_m^2, \dots, W_m^N)A_mQ_m$. We assume that the function S_m^j is decreasing in W_m^j and increasing in W_m^k for $k \neq j$. That is, supplier j will get a smaller share of the manufacturer's input purchases if it raises the price it charges the manufacturer for its input, and it will get a higher share if another supplier raises its price. We use $C_m(W_m^1, W_m^2, \dots, W_m^N)$ to denote the marginal cost of production of manufacturer m . We assume that the function C_m is increasing in the input prices $(W_m^1, W_m^2, \dots, W_m^N)$ faced by manufacturer m . (The marginal cost of production C_m also includes the incremental costs of other types of inputs.) We assume that the manufacturers' production technologies exhibit constant returns to scale, and thus the functions S_m^j and C_m do not depend on the level of output (Q_m).

2. Competition Among Manufacturers in the Downstream Market

Assuming a standard model of Bertrand competition with differentiated products, manufacturer m takes the equilibrium prices charged by the other manufacturers as given and chooses its price P_m to maximize its profit,

we will set the value of A_m so that, at the pre-merger equilibrium, the manufacturer purchases from the upstream merging firm a quantity of input equal to the manufacturer's quantity of output. *See also infra* note 12.

⁷ We assume each manufacturer faces a cost-minimization problem similar to that in Roman Inderst & Tommaso Valletti, *Incentives for Input Foreclosure*, 55 EUR. ECON. REV. 820 (2011).

$$(P_m - C_m)D_m(P_m, P_{-m}) \quad (\text{A1})$$

where P_{-m} is the vector of equilibrium prices of all the other manufacturers and D_m is the demand function for the product sold by manufacturer m .⁸ The first-order condition (FOC) for the price of manufacturer m to be profit-maximizing is:

$$D_m + (P_m - C_m) \frac{\partial D_m}{\partial P_m} = 0 \quad (\text{A2})$$

Solving this equation for P_m , the equilibrium price strategy of manufacturer m is a function of the manufacturer's marginal cost, or $P_m(C_m)$.⁹ Note that this pricing strategy is actually a function of the input prices that suppliers charge to manufacturer m since C_m depends on those prices (see Section I.A.1 above). For this reason, we sometimes write $P_m(W_m^1, W_m^2, \dots, W_m^N)$ instead of $P_m(C_m)$.

⁸ We focus on vertical mergers where the upstream and downstream merging firms are not vertically integrated. See SergeMoresi & Steven C. Salop, *vGUPPI: Scoring Unilateral Pricing Incentives in Vertical Mergers*, 79 ANTITRUST L.J. 185, 187 n.7, 188 n.11 (2013).

⁹ This function implicitly also depends on the equilibrium prices of the other manufacturers. See *supra* note 4.

3. Competition Among Suppliers in the Upstream Market

Consider input supplier n and the price W_i^n that it charges to manufacturer i . In equilibrium, supplier n sets W_i^n to maximize its total profits holding all other prices constant, except for the price of manufacturer i , i.e., P_i .¹⁰ We thus write the profit function of supplier n as:

$$(W_i^n - C_i^n)S_i^n(W_i^n)A_iD_i(P_i(W_i^n)) + \sum_{k \neq i}^M (W_k^n - C_k^n)S_k^n A_k D_k(P_i(W_i^n)) \quad (\text{A3})$$

where C_k^n is the marginal cost of supplier n of producing inputs for manufacturer k . This profit function adds up all the profits that supplier n obtains from all the manufacturers.

The FOC for W_i^n is:

$$(W_i^n - C_i^n)A_i \left(S_i^n \frac{\partial D_i}{\partial P_i} \frac{\partial P_i}{\partial W_i^n} + D_i \frac{\partial S_i^n}{\partial W_i^n} \right) + \text{other terms} = 0 \quad (\text{A4})$$

The first term in (A4) is negative and represents the loss from reduced sales to manufacturer i that supplier n would incur if it raised the price W_i^n that it charges to manufacturer i . Specifically, manufacturer i would reduce its purchases from supplier n for two reasons. First, manufacturer i would increase the price of its product by the amount $\partial P_i / \partial W_i^n$ and this would lead to a reduction in its volume of sales equal to $(\partial D_i / \partial P_i)(\partial P_i / \partial W_i^n)$. If manufacturer i were to hold supplier n 's share of its total input purchases constant (i.e., if S_i^n did not change), this would reduce supplier n 's input sales to manufacturer i by the amount $A_i S_i^n (\partial D_i / \partial P_i)(\partial P_i / \partial W_i^n)$. Second, manufacturer i

¹⁰ The supplier takes the equilibrium prices charged by the other manufacturers as given because they do not observe the input price that the supplier is charging to the manufacturer under consideration.

actually would reduce S_i^n by the amount $\partial S_i^n / \partial W_i^n$ and this would lead to a further reduction in supplier n 's input sales to manufacturer i equal to $A_i D_i (\partial S_i^n / \partial W_i^n)$.

The “other terms” in (A4) are positive and represent two sources of profit gains to supplier n following an increase in the price charged to manufacturer i . First, supplier n would be earning a higher margin on the volume of inputs that manufacturer i would continue to purchase from supplier n . Second, supplier n would be selling larger volumes of inputs to the other manufacturers because some of the customers of manufacturer i would be switching to other manufacturers. To simplify the exposition, we do not show these profit gains explicitly in (A4) and instead denote them as “other terms.” (These other terms do not matter for the derivation of the vGUPPIs, as will be shown below.)

In (perfect Bayesian) equilibrium, (A4) and (A2) are satisfied for all input prices and all output prices respectively.

B. UNILATERAL EFFECTS OF A VERTICAL MERGER ON PRICING INCENTIVES

We analyze the potential unilateral effects on pricing incentives from a vertical merger of supplier 1 and manufacturer 1.

1. *vGUPPI_U for the Upstream Merging Firm*

The vertical merger of supplier 1 and manufacturer 1 can give supplier 1 a unilateral incentive to raise the price of the input to manufacturer 2, a rival of the downstream merger partner. A similar unilateral incentive exists for each downstream rival that might be targeted with an input price increase.

We write the profit function of the merged firm as follows:

$$(P_1 - C_1)D_1(P_1, P_{-1}) + \sum_{k=1}^M (W_k^1 - C_k^1)S_k^1 A_k D_k(P_1, P_{-1}) \quad (\text{A5})$$

where $C_1 = C_1(W_1^1, \dots, W_1^N)$ is the pre-merger marginal cost of manufacturer 1 since here we are holding constant both the prices faced by manufacturer 1 and the behavior of manufacturer 1. We analyze the incentives of supplier 1 to raise the input price to manufacturer 2. The post-merger FOC with respect to W_2^1 can be written as:

$$(P_1 - C_1) \frac{\partial D_1}{\partial P_2} \frac{\partial P_2}{\partial W_2^1} + (W_2^1 - C_2^1) \left[A_2 \left(S_2^1 \frac{\partial D_2}{\partial P_2} \frac{\partial P_2}{\partial W_2^1} + \frac{\partial S_2^1}{\partial W_2^1} D_2 \right) \right] + \text{other terms} = 0 \quad (\text{A6})$$

This FOC says that at the post-merger equilibrium the merged firm's incentive to increase W_2^1 must be zero. Instead of solving for the equilibrium of the model, we follow the GUPPI methodology and evaluate the merged firm's incentive to increase W_2^1 , beginning at the pre-merger equilibrium. That is, we evaluate the left-hand side of (A6) at the pre-merger equilibrium strategies. Therefore, in (A6), the downstream price of each manufacturer m is the same function $P_m(W_m^1, W_m^2, \dots, W_m^N)$ as pre-merger, and all input prices are the same prices as pre-merger.

Using (A4), the left-hand side of (A6) reduces to $(P_1 - C_1)(\partial D_1 / \partial P_2)(\partial P_2 / \partial W_2^1)$, since all the other terms add up to zero. This term is positive and thus the merged firm has an incentive to raise W_2^1 above its pre-merger level. Intuitively, an increase in the price charged to manufacturer 2 (W_2^1) leads manufacturer 2 to raise the price of its output (P_2) and that in turn leads to an increase in the sales of manufacturer 1 (D_1). This has a positive effect on the profits of manufacturer 1 (the downstream merging firm) and thus creates upward pricing pressure on supplier 1 (the upstream merger partner) to raise the input price W_2^1 charged to manufacturer 2.

The GUPPI methodology quantifies this upward pricing pressure as follows. One first divides the incentive effect identified in the previous paragraph by the expression in square brackets in (A6). This allows us to interpret and measure the upward pricing pressure on the input price W_2^1 as being equivalent to an increase in supplier 1's marginal cost of supplying the input to manufacturer 2. It then expresses this "equivalent input marginal cost increase" as a percentage of the input price.

It follows that $vGUPPIu$ (i.e., the vGUPPI for the input price that supplier 1 charges to manufacturer 2) is given by:

$$vGUPPIu = \frac{(P_1 - C_1) \frac{\partial D_1}{\partial P_2} \frac{\partial P_2}{\partial W_2^1}}{\left(-S_2^1 \frac{\partial D_2}{\partial P_2} \frac{\partial P_2}{\partial W_2^1} - \frac{\partial S_2^1}{\partial W_2^1} D_2 \right) A_2 W_2^1} \quad (\text{A7})$$

This is the standard GUPPI ratio described in the 2010 Merger Guidelines. The numerator is the "value of sales diverted" to the merger partner, that is, the profit gained by manufacturer 1 following an increase in the input price charged to manufacturer 2. The denominator is the "lost revenues attributable to the reduction in unit sales [to manufacturer 2] resulting from the input price increase [to manufacturer 2]."¹¹

Dividing both the numerator and the denominator by $-(\partial D_2 / \partial P_2)(\partial P_2 / \partial W_2^1)$ and then using the FOC for P_2 (i.e., $P_2 - C_2 = -D_2 / (\partial D_2 / \partial P_2)$), one obtains:

$$vGUPPIu = \frac{DR_{21} M_1 P_1}{(1 + M_2 E_{SR} / E_P) S_2^1 A_2 W_2^1} \quad (\text{A8})$$

where $DR_{21} = -(\partial D_1 / \partial P_2) / (\partial D_2 / \partial P_2)$ is the diversion ratio from manufacturer 2 to manufacturer 1, $M_m = (P_m - C_m) / P_m$ is the percentage profit margin of manufacturer m ,

¹¹ U.S. Dep't of Justice & Fed. Trade Comm'n, Horizontal Merger Guidelines § 6.1 (2010), available at <http://www.justice.gov/atr/public/guidelines/hmg-2010.pdf>.

$E_{SR} = -(\partial S_2^1 / \partial W_2^1)(W_2^1 / S_2^1)$ is the elasticity of supplier 1's share of manufacturer 2's total input purchases with respect to an increase in the input price W_2^1 charged by supplier 1 to manufacturer 2, and $E_p = (\partial P_2 / \partial W_2^1)(W_2^1 / P_2)$ is the elasticity of the price of the output of manufacturer 2 with respect to an increase in the input price W_2^1 charged by supplier 1 to manufacturer 2.¹²

Note that the $vGUPPIu$ formula in (A8) depends on the pre-merger profit margin ($P_1 - C_1$) of the downstream merger partner. This could suggest that a higher profit margin should be used in the $vGUPPIu$ formula if manufacturer 1 will obtain the input of supplier 1 at cost after the merger. However, this would not be correct because the cost savings of manufacturer 1 will be offset by a corresponding reduction in the revenues of supplier 1.¹³

2. *vGUPPId for the Downstream Merging Firm*

The vertical merger also affects the unilateral pricing incentives of merging manufacturer 1. The merger creates two opposing effects. On the one hand, manufacturer 1 will take into account that an increase in the price of its output, P_1 , would

¹² Equations (1) and (5) in the article text are derived from (A8). With no loss of generality, we assume that units of measurement are such that, at the pre-merger equilibrium, $S_2^1 A_2 = 1$, i.e., each targeted rival purchases a quantity of input from the upstream merging firm equal to the quantity of output that it produces. This simply means that the input price W_2^1 must be calculated as the cost of the input purchased from the upstream merging firm per unit of output produced by the targeted rival.

¹³ As explained above in Parts I.C and II.C of the article, the merger may lead to a reduction in the marginal cost of production of manufacturer 1 for two reasons. First, manufacturer 1 will obtain the input of supplier 1 at a price equal to marginal cost (instead of a marked-up price). This is the standard EDM effect of vertical mergers. The $vGUPPIu$ accounts for this effect. Second, there can be an additional reduction in the marginal cost of production of the merged firm if manufacturer 1 can substitute inputs purchased from other suppliers with inputs produced by the upstream merger partner. Accounting for this second type of “vertical efficiency” would increase the $vGUPPIu$. This would introduce a “perverse effect” of this type of efficiency that is similar to that discussed in Farrell & Shapiro. Joseph Farrell & Carl Shapiro, *Antitrust Evaluation of Horizontal Mergers: An Economic Alternative to Market Definition*, B.E. J. THEOR. ECON., vol. 10, no. 1, art. 9, at 23 (2010), <http://www.bepress.com/bejte/vol10/iss1/art41>.

lead other manufacturers to increase output and thus purchase more inputs from supplier 1 (the upstream merger partner). This creates upward pricing pressure on P_1 . On the other hand, to the extent that manufacturer 1 purchases inputs from supplier 1 at a marginal price that exceeds marginal cost, manufacturer 1 will take into account that a reduction in the price of its output would lead it to increase output and purchase more inputs from supplier 1, thereby increasing the profits of supplier 1. This creates downward pricing pressure on P_1 .

The profit function of the merged firm can be written as:

$$(P_1 - C_1)D_1(P_1, P_{-1}) + \sum_{k=2}^M (W_k^1 - C_k^1)S_k^1 A_k D_k(P_1, P_{-1}) \quad (\text{A9})$$

where $C_1 = C_1(C_1^1, W_1^2, \dots, W_1^N)$ is the post-merger marginal cost of manufacturer 1 since supplier 1 will provide the input to manufacturer 1 at cost, i.e., $W_1^1 = C_1^1$. For later use, we denote by ΔC_1 the post-merger reduction in the marginal cost of production of manufacturer 1:

$$\Delta C_1 = C_1(W_1^1, W_1^2, \dots, W_1^N) - C_1(C_1^1, W_1^2, \dots, W_1^N) \quad (\text{A10})$$

The first-order condition with respect to P_1 reads:

$$D_1 + (P_1 - C_1) \frac{\partial D_1}{\partial P_1} + \sum_{k=2}^M (W_k^1 - C_k^1) S_k^1 A_k \frac{\partial D_k}{\partial P_1} = 0 \quad (\text{A11})$$

or equivalently:

$$D_1 + (P_1 - C_1 - \sum_{k=2}^M S_k^1 A_k D R_{1k} M_k^1 W_k^1) \frac{\partial D_1}{\partial P_1} = 0 \quad (\text{A12})$$

where $D R_{1k} = -(\partial D_k / \partial P_1) / (\partial D_1 / \partial P_1)$ is the diversion ratio from manufacturer 1 to manufacturer k (following a unilateral price increase by manufacturer 1) and

$M_k^1 = (W_k^1 - C_k^1)/W_k^1$ is the percentage profit margin that supplier 1 earns on sales to manufacturer k .

Comparing (A2) and (A12) (evaluated at the pre-merger equilibrium point), it follows that the merger affects the pricing incentives of manufacturer 1 (i.e., the merger partner that operates downstream) in two ways. First, the merger increases the “effective marginal cost” of manufacturer 1 by the amount $\sum_{k=2}^M S_k^1 A_k DR_{1k} M_k^1 W_k^1$. Intuitively, suppose that manufacturer 1 unilaterally reduces its price and increases output by 1 unit. This increases the production cost of manufacturer 1 (by C_1) and reduces the profits of supplier 1 (i.e., the merger partner that operates upstream). This is because the increase in output of manufacturer 1 leads to a reduction in output by manufacturer k equal to DR_{1k} units, and therefore to a reduction $S_k^1 A_k DR_{1k}$ in the amount of input that manufacturer k purchases from supplier 1. This in turn decreases the profit of supplier 1 by an amount equal to $S_k^1 A_k DR_{1k} M_k^1 W_k^1$. Since a similar effect occurs with respect to each of the rivals of manufacturer 1, the total loss of supplier 1 is equal to $\sum_{k=2}^M S_k^1 A_k DR_{1k} M_k^1 W_k^1$. This loss to the upstream merger partner becomes an “opportunity cost” of expanding manufacturer 1’s sales post-merger, and thus creates upward pricing pressure on the output price P_1 of manufacturer 1.

Second, the merger might reduce the marginal cost of production faced by manufacturer 1 by the amount ΔC_1 , what is commonly referred to as EDM (i.e., elimination of double marginalization). Merger-specific EDM creates a downward pricing pressure on the output price P_1 of manufacturer 1.

It then follows that the vertical GUPPI for the price of manufacturer 1, which we denote $vGUPPId$, is equal to:

$$vGUPPId = vGUPPId1 - \frac{\Delta C_1}{P_1} \quad (\text{A13})$$

where

$$vGUPPId1 = \sum_{k=2}^M S_k^1 A_k D R_{1k} M_k^1 W_k^1 / P_1 \quad (\text{A14})$$

is the vertical GUPPI for the price of manufacturer 1 in the absence of EDM.

This analysis can be simplified by (i) assuming that supplier 1 happens to charge the same price to all the rivals of manufacturer 1, i.e., $W_k^1 = W_{-1}^1$, (ii) assuming that supplier 1 earns the same margin on all the sales to the rivals of manufacturer 1, i.e., $M_k^1 = M_{-1}^1$, and (iii) defining the diversion ratio from manufacturer 1 to supplier 1 equal to $D R_1^1 = \sum_{k=2}^M S_k^1 A_k D R_{1k}$. In this case, (A13) reduces to:

$$vGUPPId = \frac{D R_1^1 M_{-1}^1 W_{-1}^1 - \Delta C_1}{P_1} \quad (\text{A15})$$

In the main text of the article, we use (A15) and measure each of M_{-1}^1 and W_{-1}^1 by its average value across all the rivals of manufacturer 1. In addition, we approximate the reduction in manufacturer 1's marginal cost using:

$$\Delta C_1 = (S_1^1 + \Delta S_1^1) A_1 M_1^1 W_1^1 \quad (\text{A16})$$

where ΔS_1^1 is the increase in supplier 1's share of the total inputs used by manufacturer 1 post-merger. This implicitly assumes that pre-merger all the suppliers charge the same

input price to manufacturer 1, i.e., $W_1^{-1} = W_1^1$. Thus, manufacturer 1 saves an amount

equal to $W_1^1 - C_1^1$ on each unit of input obtained from supplier 1 post-merger.¹⁴

The *vGUPPId1* formula in (3) corresponds to (A15) with $\Delta C_1 = 0$ (i.e., there is no EDM and no input substitution), while the *vGUPPId2* formula in (4) corresponds to (A15) and (A16) under the assumption that $\Delta S_1^1 = 0$ (i.e., there is EDM but there is no input substitution).

II. DERIVATION OF THE vGUPPIS WHEN THERE IS INPUT SUBSTITUTION

When there is input substitution, several of the derivations change.¹⁵

A. EQUATION (5)

Input substitution breaks the equality between DR_{UD} and DR_{RD} as follows:

$$DR_{UD} = \frac{DR_{RD} \times E_P / M_R}{E_P / M_R + E_{SR}}. \quad (\text{B1})$$

Intuitively, from the Lerner condition, the demand elasticity faced by the downstream rival is equal to $1/M_R$. It follows that E_P / M_R measures the elasticity of the rival's total purchases of inputs with respect to the input price paid to the upstream merging firm. The numerator of (B1) thus represents the volume of sales gained by the downstream merging firm; it depends on both the extent to which the targeted rival will lose sales (E_P / M_R) and the extent to which lost sales by the targeted rival are diverted to the downstream merging firm (DR_{RD}). The denominator represents the volume of sales (to

¹⁴ Equation (A15) is an approximation because it assumes that the downstream merging firm can substitute some of the inputs purchased from other suppliers with inputs from the upstream merger partner without incurring any additional costs.

¹⁵ In this Appendix, we use the notation from the article text, that is, the subscript “*U*” refers to the upstream merging firm and the subscripts “*D*” and “*R*” refer to the downstream merging firm and targeted rival, respectively.

the targeted rival) lost by the upstream merging firm; the first term (E_P / M_R) measures the extent to which the targeted rival will reduce its purchases from the upstream merging firm because the targeted rival will raise price and thus reduce output; the second term (E_{SR}) measures the extent to which the targeted rival will reduce its purchases from the upstream merging firm because the targeted rival will substitute inputs from the upstream merging firm with inputs from other suppliers. Equations (1) and (B1) then imply (5).

B. EQUATIONS (6) AND (7)

All else equal, the percentage increase in the input price charged to the targeted rival would be equal to $vGUPPIu \times PTR_U$.¹⁶ If there is input substitution, however, the expression $vGUPPIu \times PTR_U \times E_{SR}$ is the percentage reduction in the upstream merging firm's share (S_{UR}) of the targeted rival's input purchases. Therefore, post-merger the upstream firm's share of the targeted rival's total input purchases falls to the level S_{UR}^{post} given by:

$$S_{UR}^{post} = (1 - vGUPPIu \times PTR_U \times E_{SR}) \times S_{UR} \quad (\text{B2})$$

and the rival's marginal cost rises by $\Delta C_R = vGUPPIu \times PTR_U \times W_R \times S_{UR}^{post} / S_{UR}$.¹⁷

Equation (B2) can be written as equation (7). The $vGUPPIr$ is by definition equal to $\Delta C_R / P_R$, which leads to equation (6).

C. EQUATIONS (4) AND (8)

As explained above, the $vGUPPId$ formula (A13) can be written as:

¹⁶ See Sonia Jaffe & E. Glen Weyl, *The First-Order Approach to Merger Analysis*, 5 AM. ECON. J.: MICROECON. 188 (2013).

¹⁷ This is an approximation because it assumes that the targeted downstream rival can substitute some of the inputs purchased from the upstream merging firm with inputs from other suppliers without incurring any additional costs. In addition, (B2) is a linear approximation.

$$vGUPPId = vGUPPIdI - \frac{\Delta C_D}{P_D} \quad (B3)$$

where $vGUPPIdI$ is given in equation (3) and ΔC_D is given in (A16), which we rewrite with different notation as follows:¹⁸

$$\Delta C_D = (1 + \frac{\Delta S_{UD}}{S_{UD}}) \times M_{UD} \times W_D. \quad (B4)$$

If there is no input substitution, $\Delta S_{UD} = 0$. Thus, (B3) and (B4) lead to (4). If there is input substitution, we use the approximation $\Delta S_{UD} = M_{UD} \times E_{SD} \times S_{UD}$. Combining this with (B3) and (B4) leads to the equation for $vGUPPId3$ in (8).

D. EQUATION (9)

Assuming symmetric downstream firms, the profit function (A3) of the upstream merging firm can be written as:

$$(W - C)S(W)AD(P(W)). \quad (B5)$$

Here, W denotes the input price charged by the upstream firm to each downstream firm, C denotes the upstream firm's marginal cost, $S(W)$ is the upstream firm's share of the total input purchases of the downstream firms, $P(W)$ is the output price charged by each downstream firm, $D(P)$ is total output of the downstream firms, and A is a scale factor.

The first-order condition of the maximization of (B5) with respect to W can be written as equation (9).

¹⁸ *Supra* note 12.