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Vertical mergers without foreclosure

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Abstract

The typical concern about vertical mergers is the foreclosure of downstream rivals. In a vertically related industry where downstream firms have a common supplier, margins can reveal whether upstream competition constrains that supplier. I develop a test (based on margins) to identify whether the supplier is constrained premerger and, consequently, cannot raise input prices postmerger. However, even without foreclosure in equilibrium, vertical mergers can harm consumers. Vertical mergers increase consumer prices and benefit all firms, including downstream rivals, when downstream (horizontal) competition weakens sufficiently. This theory of harm differs from typical theories, which pit the merged entity against downstream rivals.

1 | INTRODUCTION

Vertical merger policy is debated hotly in the United States. In 2020, the U.S. Department of Justice (DOJ) and Federal Trade Commission (FTC) released new vertical merger guidelines, but the FTC rescinded them in 2021 due to disagreements among its commissioners.[1] In December 2023, the DOJ and FTC issued new merger guidelines (for all merger types). Whereas many economists viewed the 2020 guidelines as too lax, that is, failing to protect consumers sufficiently, many view the 2023 guidelines as too interventionist, that is, overly limiting economic freedom.[2]

A typical concern of antitrust authorities about vertical mergers, and a focus of the related academic literature, is foreclosure.[3] In this paper, foreclosure means that the merged entity increases the input price at which it sells to its downstream competitor. This strategy is sometimes called raising rivals' costs (RRC). Overall, vertical mergers have three effects.[4] First, they eliminate double marginalization: the merged entity obtains the input at a lower cost postmerger (Cournot, 1838).[5] Second, the merged entity may foreclose downstream competitors (Ordover et al., 1990; Salinger, 1988; Salop & Scheffman, 1983, 1987).[6] Third, the merged entity competes less intensely downstream because it profits from the sales of its downstream competitor (Chen, 2001). I call this the "stakeholder effect."[7] The elimination of double marginalization (EDM) intensifies competition, lowers prices, and benefits consumers, whereas foreclosure and the stakeholder effect weaken competition, increase prices, and harm consumers. The overall effect of vertical mergers is seldom clear.[8]

This paper makes two contributions. First, I develop a practicable, transparent, and simple test to identify whether a proposed merged entity would be unable to foreclose its downstream competitors. The test leverages observable, premerger margin data, which antitrust authorities "typically collect as part of merger investigations" (Sheu & Taragin, 2021, p. 598). The literature is rich on incentives to foreclose, but these incentives are inconsequential without the ability to foreclose. To my knowledge, this paper develops the first tool to assess the ability to foreclose. One can use the test to verify whether a model is consistent with industry facts in assuming an ability to foreclose. Second, I show that vertical mergers that do not lead to foreclosure in equilibrium can harm consumers, and I provide a condition to

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identify whether such mergers benefit or harm consumers in equilibrium. Contrary to the typical theory of consumer harm (in, e.g., Rey & Tirole, 2007), here, mergers can benefit all firms, including unintegrated downstream rivals.

The baseline model is standard. In a vertically related industry, downstream firms A and B compete with a differentiated product and need one unit of an input per unit of output. There are several upstream producers of that input; each has a constant unit cost of production. In stage 1, every upstream producer sets a unit price to every downstream firm (producers can engage in third-degree price discrimination). In stage 2, the two downstream firms observe each other's input price, hence marginal cost, and then simultaneously set their respective price. Finally, consumers purchase, and each downstream firm orders inputs to satisfy its (log-concave) demand.

To develop the test, I build on findings from Kadner-Graziano (2023a) and relate upstream to downstream dollar margins (rather than percentage margins). The present paper shows that if a supplier is unconstrained in the price it sets to one of several competing downstream firms, then the supplier earns a higher dollar margin on sales to that downstream firm than the dollar margin of that downstream firm. To see why, imagine that a monopolist supplier increases the input price to firm B premerger. Several effects materialize. First, holding the price of firm A fixed, downstream firm B absorbs some of the price increase (i.e., its pass-through rate is less than 100%, see Amir et al., 2004).[9] Therefore, the elasticity of demand upstream is lower than downstream. Consequently, by the intuition for the Lerner index (Lerner, 1934), the margin upstream must be bigger than downstream.[10] Second, because firm B increases its price, some demand diverts to firm A. Consequently, the supplier's elasticity of total quantity sold, that is, of units sold to both downstream firms, is even lower. This further raises the monopoly margin upstream relative to the downstream margin. Third, if input contracts are observable, downstream firm A increases its price in equilibrium in response to firm B's input price increase. Therefore, after accounting for firm A's reaction, the supplier loses fewer sales to firm B from an input price increase. This again raises the monopoly margin upstream relative to the downstream margin.

The baseline version of the test states: if the supplier's margin on sales to downstream firm B is smaller than downstream firm B's margin premerger, then the supplier is constrained, and the proposed merged entity (consisting of the supplier and firm A) could not sell to firm B at a higher price postmerger. Section 4 generalizes the test to more complex industry settings. The crux in developing the test is identifying whether competitors constrain the supplier premerger. To distinguish between constrained and unconstrained corresponds to the dichotomy of Lerner and Tirole (2004, p. 693), where either "the competition margin binds" (the supplier would lose the supply contract if it increased its price, i.e., it is constrained) or "the demand margin binds" (the supplier can but does not want to obtain a higher price because it would lose too much demand, i.e., it is unconstrained).

The second contribution highlights the possibility of consumer harm absent foreclosure and provides a condition to identify whether the merger benefits or harms consumers in the postmerger equilibrium. Intuitively, harm arises when the EDM effect is small (when the supplier earns a low margin on firm A premerger) and the stakeholder effect is large (when the supplier earns a high margin on firm B relative to firm A premerger). Consumer harm absent foreclosure is clearest in diagonal mergers (where the downstream merging party does not source from the upstream firm it integrates with premerger and therefore, there is no EDM).[11] For example, suppose Samsung buys a supplier to Apple without sourcing from that supplier. Publicly-available data indicates that each of Apple's suppliers is constrained (Kadner-Graziano, 2023a). Absent foreclosure, a diagonal merger causes only the stakeholder effect. Both Samsung and Apple would benefit from weakened competition to the detriment of consumers.

As noted, this paper develops the first tool to assess the *ability* to foreclose. However, there already exist tools to assess the *incentive* of a merged entity to raise rivals' costs (see Moresi & Salop, 2013, on the vGUPPI and, e.g., Froeb et al., 2018, on merger simulation) and to stop supplying rivals (see Pittman, 2017; Zenger, 2020, on "vertical arithmetic"). In Section 3.4, I suggest a screening process that involves these existing tools on incentives and the new, complementary results on ability and consumer welfare. I compare upstream to downstream margin data to assess the ability to foreclose. Bresnahan and Reiss (1985) and Adachi and Ebina (2014a) already compare upstream to downstream margins but not in a merger environment.[12] Inderst and Valletti (2011) analyze the premerger margins of merging parties and show that these are insufficient to predict postmerger incentives.

Vertical mergers with constrained suppliers resemble horizontal mergers: they increase efficiency (here, via the EDM) but weaken horizontal competition (here, via the stakeholder effect). See Riordan (1998), Chen (2001), Baker et al. (2019), and Moresi and Salop (2021) on similarities between horizontal and vertical mergers. This resemblance highlights that vertical mergers can further concentrate markets. This has significant implications for empirical research: studies of market concentration should encompass not only common ownership and cross-ownership but also ownership of suppliers to competitors. See, for example, Azar et al. (2018) on empirical studies of common ownership. Azar et al. (2022) analyze, in addition, cross-ownership.

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Chen (2001) first identified the stakeholder effect (which he called the "collusive effect"). I call it the "stakeholder effect" because the merged entity competes more softly due to its stake in its competitor and because the effect is unilateral (the merged entity competes more softly even if its competitor would not). Moreover, Chen (2001) first identified an effect whereby the unintegrated downstream firm no longer wants to order inputs from the cheapest source. I detail this latter effect in Section 5.2.

Chen (2001) analyzes a similar model to that analyzed here but with two key differences. First, his model features commitment power and a different timing structure: downstream firms can commit to order from a given supplier before setting consumer prices. (This feature is essential for downstream firms not to choose the cheapest source of supply, as I explain in Section 5.2.) Second, downstream firms pay the same input price premerger in his model, whereas I allow for asymmetry.[13] Asymmetry allows the stakeholder effect to outweigh the EDM effect. In Chen (2001), vertical mergers (i) only occur when they lead to EDM, (ii) always harm the unintegrated downstream firm, and (iii) would always benefit consumers without switching costs (i.e., without commitment power).[14] In contrast, here, vertical mergers (i) do not need EDM to be profitable, (ii) can benefit the unintegrated downstream firm in equilibrium because of the stakeholder effect, and (iii) can harm consumers because of the stakeholder effect and even absent foreclosure. My results imply that effects on competitors and consumers need not align: an antitrust authority can rightly be concerned even if competitors do not complain about a proposed merger. I focus on developing conditions to test for foreclosure and consumer harm using observable data.

The rest of the paper is structured as follows. Section 2 presents the baseline model and relates upstream to downstream margins premerger. Section 3 develops the merger test, analyzes consumer welfare effects, and relates results to existing antitrust tools. Section 4 lays out the general model with, among others, unobservable input contracts. Section 5 discusses different settings. Section 6 concludes.

2 | PREMERGER SETTING AND A RELATION BETWEEN MARGINS

2.1 | Baseline model

In a vertically related industry with four firms, there are two downstream and two upstream firms. Downstream, firms A and B compete with differentiated goods. Each firm uses one unit of an input per unit of output (each has a Leontief production function). Upstream, firm S has no costs whereas the second-most efficient firm has unit production costs $c_A \geqslant 0$ and $c_B \geqslant 0$ to supply firms A and B, respectively. (Results in the paper are unchanged if c_A and c_B denote, additionally or alternatively, the downstream firms' respective unit costs to produce in-house.)

In stage 1, upstream producers simultaneously set unit prices to firms A and B, at which they offer to supply any quantity of the input. Third-degree price discrimination is possible: every upstream firm can offer a different price to every downstream firm. In stage 2, downstream firms observe each other's input price hence marginal cost, v_A and v_B, and simultaneously set their unit consumer price, P_A and P_B. Finally, every downstream firm orders inputs to satisfy its consumer demand $Q_i(P_i, P_{-i})$, for $i \in \{A, B\}$.[15] Firm i earns profit $\Pi_i = (P_i - v_i)Q_i(P_i, P_j)$. In equilibrium, the most efficient input producer (firm S) supplies both downstream firms and earns profit $\Pi_S = \sum_i v_i Q_i(P_i, P_j)$.

Downstream firm i's demand $Q_i(P_i, P_j)$ is strictly decreasing and log-concave in P_i (Section 4 generalizes results to log-convex demands) and strictly increasing in P_j. In addition, let demands satisfy the three assumptions below. Assumptions 1 and 2 are standard, see, for example, Miklós-Thal and Shaffer (2021).[16] Assumption 1 states: at the equilibrium, demand for each consumer good decreases if all consumer prices increase by the same small amount. Assumption 2 ensures that the supplier's profit is strictly concave in v_i for any v_j. Assumption 3 is not necessary but made for conciseness of the algebraic exposition.[17] Finally, I assume complete information and relax this in Section 4.

Assumption 1 (Gross substitutes). At equilibrium prices P_i^* and P_j^*, $|\frac{\partial Q_i}{\partial P_i}| > \frac{\partial Q_i}{\partial P_j}$.

Assumption 2 (Concave profit). The Hessian of $\Pi_S(v_i, v_j)$ is negative definite.

Assumption 3 (Additively separable). $\frac{\partial^2 Q_i}{\partial P_i \partial P_j} = 0$.

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2.2 | Premerger equilibrium

The game is solved by backwards induction. Last, each downstream firm orders inputs from its cheapest source. In stage 2, downstream firms observe each other's input price and set profit-maximizing consumer prices. Downstream firm $i \in \{A, B\}$ has first-order condition[18]

$$\frac{\partial \Pi_i}{\partial P_i} = Q_i(P_i, P_j) + (P_i - v_i)\frac{\partial Q_i(P_i, P_j)}{\partial P_i} = 0. \tag{1}$$

In stage 1, upstream producers simultaneously set input prices. The most efficient upstream producer, firm S, sets prices v_A and v_B. Let v_i^u denote the unconstrained (or monopoly) price: the price firm S would set to downstream firm i if firm S were unconstrained by competition (i.e., by c_i). In the premerger equilibrium, firm S is either unconstrained and sets v_i^u or constrained and sets c_i (the unit cost of the second-most efficient producer) to downstream firm i.

$$v_i^* \equiv \underset{v_i}{\text{argmax}}\, \Pi_S = \min\left\{v_i^u, c_i\right\}. \tag{2}$$

Definition 1. The supplier is *unconstrained* in the price at which it sells to downstream firm i if $v_i^* = v_i^u$ but *constrained* if $v_i^* \neq v_i^u$.

The most efficient producer, firm S, has profit

$$\Pi_S = v_i Q_i\left(P_i^*(v_i, v_j), P_j^*(v_j, v_i)\right) + v_j Q_j\left(P_j^*(v_j, v_i), P_i^*(v_i, v_j)\right), \tag{3}$$

where $P_i^*(v_i, v_j)$ is firm i's stage-game equilibrium consumer price given first-stage input prices. Suppose the supplier is unconstrained in the price it sets to downstream firm i. Then, it sets the price v_i^u, which solves the first-order condition[19]

$$\frac{\partial \Pi_S}{\partial v_i} = Q_i + v_i^u\left[\frac{\partial Q_i}{\partial P_i}\frac{dP_i^*}{dv_i} + \frac{\partial Q_i}{\partial P_j}\frac{dP_j^*}{dv_i}\right] + v_j\left[\frac{\partial Q_j}{\partial P_j}\frac{dP_j^*}{dv_i} + \frac{\partial Q_j}{\partial P_i}\frac{dP_i^*}{dv_i}\right] = 0. \tag{4}$$

2.3 | Constrained or unconstrained? What premerger margins reveal

I aim to identify whether a supplier is constrained. Rearranging (4), the supplier's unconstrained unit dollar margin on sales to downstream firm i is[20]

$$m_{Si}^u = v_i^u = -\frac{Q_i}{\frac{\partial Q_i}{\partial P_i}\frac{dP_i^*}{dv_i} + \frac{\partial Q_i}{\partial P_j}\frac{dP_j^*}{dv_i}} - v_j\frac{\frac{\partial Q_j}{\partial P_j}\frac{dP_j^*}{dv_i} + \frac{\partial Q_j}{\partial P_i}\frac{dP_i^*}{dv_i}}{\frac{\partial Q_i}{\partial P_i}\frac{dP_i^*}{dv_i} + \frac{\partial Q_i}{\partial P_j}\frac{dP_j^*}{dv_i}}. \tag{5}$$

The supplier is constrained if and only if its margin in the premerger equilibrium, m_{Si}^*, is smaller than the margin given in (5). However, this equivalence is not helpful in identifying whether a supplier is constrained because the numerous derivatives in (5) are difficult to estimate in practice. Therefore, I find a simple sufficient condition to develop a practical merger test. My approach is to compare the margin in (5) to the margin of downstream firm i. Rearranging (1), the unit dollar margin of downstream firm i is

$$m_i^* = P_i^* - v_i = -\frac{Q_i}{\partial Q_i/\partial P_i}. \tag{6}$$

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Comparing the margins in (5) and (6), which involves calculating the total derivatives $\frac{dP_i^*}{dv_i}$ and $\frac{dP_j^*}{dv_i}$, yields the following key result.

Theorem 1 (Relation of margins). *A supplier's unconstrained margin on sales to downstream firm i weakly exceeds downstream firm i's margin:* $m_{Si}^u \geqslant m_i^*$.

The relation of upstream to downstream margins in Theorem 1 is simple. Nevertheless, the intuition and effects which underlie the result are intricate. In stage 1, the supplier sets profit-maximizing prices to downstream firms by accounting for stage 2 downstream equilibrium effects. Consider an increase in input price v_A. This has three effects.

First, keeping the price of downstream firm B fixed, downstream firm A passes through less than 100% to consumers (it absorbs some of the input price increase) because demand is log-concave. Holding P_B fixed, the elasticity of demand is therefore lower upstream than downstream and, by the intuition for the Lerner index, the equilibrium margin must be bigger upstream than downstream.

Second, downstream firm B raises its price in equilibrium because downstream prices are strategic complements. This dampens the supplier's loss of quantity sold to downstream firm A from an increase in v_A. The increase in P_B generates a feedback increase in P_A, but overall, the change in P_B and the feedback effect on P_A necessarily dampen (rather than exacerbate) the loss of demand at downstream firm A (because downstream firm A changes its price only "as a reaction" to downstream firm B's price change). As a result, after accounting for these changes in equilibrium downstream prices, the elasticity of demand is even lower upstream than downstream and the unconstrained margin upstream is even higher than the margin downstream.

Third, the supplier earns a profit on any sales diverted from downstream firms A and B because it also supplies downstream firm B. Hence, the supplier's elasticity of total quantity sold, that is, of units sold to firms A and B, is lower still. This effect further increases the margin upstream relative to downstream.

Let m_{Si}^* denote the supplier's unit margin on sales to downstream firm i in equilibrium. Corollary 1 follows directly from Theorem 1. It provides a simple and transparent sufficient condition to identify a constrained supplier. A supplier can be constrained even if it has a large competitive advantage and margin.

Corollary 1 (Constrained supplier). *If* $m_{Si}^* < m_i^*$, *then the supplier is constrained in the price at which it sells to downstream firm i.*

3 | VERTICAL MERGER

Consider a merger between firm S, the most efficient upstream producer, and firm A. (A merger between the second-most efficient producer and firm A could be used to foreclose firm B by competing less intensively upstream but would have no other effect.) In this section, I develop a practical test to identify whether the merged entity will be unable to sell the input to firm B at a higher price than the supplier did premerger. For cases where the merger does not change firm B's input price in equilibrium, I develop a condition to identify whether the merger benefits or harms consumers.

3.1 | Postmerger equilibrium

If the merged entity M, which consists of firms A and S, continues to supply the unintegrated firm B, it has profit function $\Pi_M = P_A Q_A + v_B Q_B$.[21] Firm B's profit function remains unchanged: $\Pi_B = (P_B - v_B)Q_B$.

The game is again solved by backwards induction. In stage 2, firm B's first-order condition is still given by (1), but the merged entity's first-order condition—shown in (7)—differs from (1). For a given v_B, there are two countervailing merger effects on the consumer price P_A. The merged entity competes more aggressively downstream because its input cost is zero (the EDM effect) but less aggressively because it earns v_B per unit sold by its downstream competitor (the stakeholder effect).

$$\frac{\partial \Pi_M}{\partial P_A} = Q_A(P_A, P_B) + P_A \frac{\partial Q_A(P_A, P_B)}{\partial P_A} + v_B \frac{\partial Q_B(P_B, P_A)}{\partial P_A} = 0. \tag{7}$$

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In stage 1, the merged entity is either constrained at c_B or unconstrained and prices at v_B^{uM}. Its profit-maximizing price is

$$v_B^{*M} \equiv \underset{v_B}{\text{argmax}}\, \Pi_M = \min\left\{v_B^{uM}, c_B\right\}.$$

The unconstrained suppliers' first-order condition (4) differs from the merged entity's first-order condition for v_B (shown below) in two ways. First, the merged entity earns P_A rather than v_A on any diverted downstream sales.[22] Second, an increase in v_B allows the merged entity to increase its own downstream price P_A, from which it benefits for any given quantity level Q_A.

$$\frac{\partial \Pi_M}{\partial v_B} = Q_B + v_B\left(\frac{\partial Q_B}{\partial P_B}\frac{dP_B^*}{dv_B} + \frac{\partial Q_B}{\partial P_A}\frac{dP_A^*}{dv_B}\right) + P_A^*\left(\frac{\partial Q_A}{\partial P_A}\frac{dP_A^*}{dv_B} + \frac{\partial Q_A}{\partial P_B}\frac{dP_B^*}{dv_B}\right) + \frac{dP_A^*}{dv_B}Q_A = 0.$$

3.2 | The test

I now develop a new test for vertical mergers. The test serves to identify whether the merged entity is unable to foreclose its downstream competitor by selling to it at a higher price than the supplier did premerger. It follows from Theorem 1 and Corollary 1.

Proposition 1 (Test). *If $m_{SB}^* < m_B^*$ premerger, the merged entity cannot sell to the unintegrated firm* B *at a higher price v_B than premerger.*

The test provides a practical, simple, and transparent sufficient condition. It relies on premerger data only. Intuitively, if the merged entity were able to obtain a higher price from the unintegrated firm, the supplier would have obtained a higher price premerger already. In this way, premerger margins can reveal constraints and inform on merger effects.[23] Profit margins are "information that the antitrust agencies typically collect as part of merger investigations" (Sheu & Taragin, 2021, p. 598). Indeed, merger simulation, the vGUPPI, and "vertical arithmetic" need data on margins and other parameters. Therefore, the test developed in Proposition 1 requires less data than these three existing tools.

Remark 1. A different strategy from raising the input price is stopping to supply firm B. In such a case, the second-most efficient producer charges firm B more than c_B. (The merged entity has no incentive to halt supplying if this strategy does not affect firm B's cost, e.g., if there exists a competitive fringe with unit production cost c_B.)

3.3 | Consumer welfare when the merged entity is constrained

Consider a vertical merger where the merged entity is constrained: It would like to but cannot sell to firm B at a higher price. Then, the vertical merger does not lead to foreclosure in equilibrium but can harm consumers nonetheless. Absent a change in v_B, firm B changes its price in the same direction as the change in price P_A (as consumer prices are strategic complements). Whether all consumer prices decrease or increase in the postmerger equilibrium depends on which of the EDM and stakeholder effects outweighs the other.

At the premerger prices v_B and P_A, the first-order condition (7) simplifies to

$$\frac{\partial \Pi_M}{\partial P_A} = v_A\frac{\partial Q_A(P_A, P_B)}{\partial P_A} + v_B\frac{\partial Q_B(P_B, P_A)}{\partial P_A} \tag{8}$$

and consumer prices increase postmerger if the above exceeds zero.[24] Let D_{AB} denote the diversion ratio from firms A and B (where $D_{AB} < 1$ by Assumption 1):

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$$D_{AB} \equiv -\frac{\partial Q_B(P_B, P_A)/\partial P_A}{\partial Q_A(P_A, P_B)/\partial P_A}.$$

Proposition 2 (Consumer welfare). *If the merged entity is constrained, the merger benefits (harms) consumers in equilibrium if and only if the EDM effect outweighs (is outweighed by) the stakeholder effect, that is, if and only if premerger margins satisfy* $m^*_{SA} > (<)\ D_{AB} \times m^*_{SB}$.

Intuitively, consumer prices increase when the merged entity finds it profitable to raise its downstream price, thereby losing v_A on sales lost at its own downstream entity but gaining v_B on sales diverted to firm B. The only merger effect is the stakeholder effect and consumer prices increase if $v_A = 0$ and $v_B > 0$ premerger, for example, in diagonal mergers, where a downstream firm integrates with a competitor's supplier without sourcing from that supplier. Conversely, the only merger effect is the EDM effect and consumer prices decrease if $v_A > 0$ and $v_B = 0$ premerger.

The condition on consumer welfare in Proposition 2 requires data on a diversion ratio in addition to margins. In practice, diversion ratios among firms are often estimated using market shares during merger proceedings absent other information.[25]

Example 1. Figure 1a illustrates Proposition 2. It provides examples of vertical mergers without foreclosure in equilibrium. Let downstream firm $i \in \{A, B\}$ face Shubik–Levitan demand $Q_i = 1 - P_i + D \times P_{-i}$ with diversion ratio $D = 0.5$.[26] Then, the supplier sets profit-maximizing input prices $v_A = 1$ and $v_B = 1$ if it is unconstrained by both c_A and c_B. If the supplier is unconstrained by c_A but constrained by c_B, the supplier charges less than one to both firms and sets $v_B = c_B$ and $v_A = v^u_A(v_B)$—depicted by the solid blue line in Figure 1. Similarly, the dashed blue line depicts the supplier's profit-maximizing price $v^u_B(v_A)$ when it is unconstrained by c_B but constrained at $v_A = c_A$. (Hence, the supplier never sets input price combinations inside the top left and bottom right white triangles premerger.) Now consider any point inside the green and red areas. There, both constraints bind premerger: $\left(v^*_A, v^*_B\right) = (c_A, c_B)$. Postmerger, v_A drops to zero (the EDM effect) and the merged entity cannot raise v_B (there is no foreclosure in equilibrium). The merger benefits consumers in the green area but harms consumers in the red area (where v_A and the EDM effect are small relative to v_B and the stakeholder effect).[27] The dotted cutoff line is given by $v_A = D \times v_B = 0.5v_B$.[28]

Example 1 (*continued*). Comparing panels (a) and (b) shows that the regions where the merger is profitable overlap with regions where consumer welfare increases and decreases. Panel (b) shows that foreclosure is not necessary for the merger to be profitable and that profitability is nonmonotone in the sizes of the EDM and stakeholder effects (i.e., in v_A and v_B or, equivalently, c_A and c_B).[29] There are two regions where the merger is unprofitable.[30] In the leftmost of those two regions, consumer prices decrease, consumer welfare increases, and the merger is unprofitable because the strong EDM effect (relative to the stakeholder effect) commits the merged entity to price more aggressively and elicits the downstream competitor to price more aggressively too. In the other region, consumer prices increase, consumer welfare decreases, and the stakeholder effect decreases the

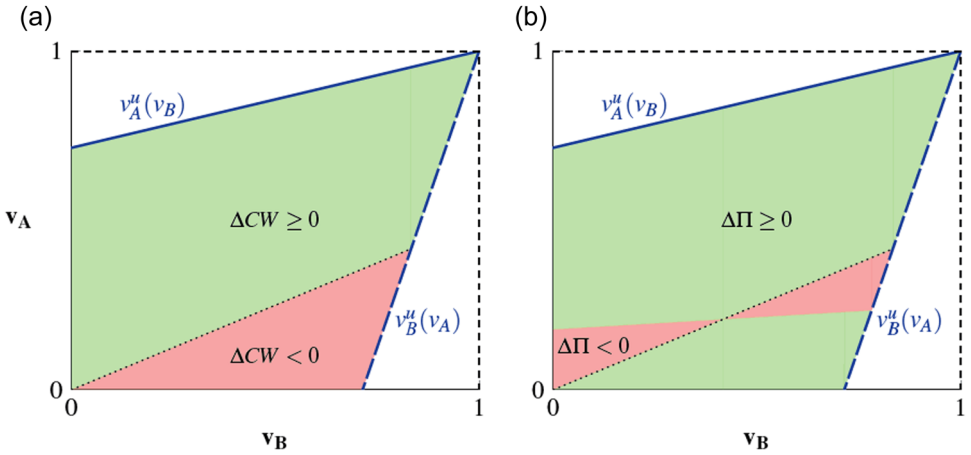

FIGURE 1 Merger effects without foreclosure in equilibrium (example). *Note*: Consumer welfare and profits of firms A and S increase in the green but decrease in the red areas postmerger. Demands are $Q_i = 1 - P_i + 0.5P_{-i}$ for $i \in \{A, B\}$. (a) Consumer welfare and (b) profit of the merging parties.

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aggressiveness and sales of the merged entity downstream sufficiently to make the merger unprofitable. Settings where vertical mergers are always weakly profitable are discussed in Section 5.1.

Remark 2. Profitable vertical mergers can lead the merged entity to lose quantity- and sales-based market share downstream and can profit the unintegrated firm more than the merging parties.[31] Intuitively, this occurs when the main effect is the stakeholder effect.

Remark 3. The constraints c_A and c_B can differ for several reasons. Suppose firms A and B source different inputs (e.g., smartphone chips and screens, respectively) or differentiated inputs (e.g., chips of higher and lower quality, respectively). Then, c_A and c_B reflect the costs of the second-most efficient supplier to produce these inputs. Alternatively, suppose c_A and c_B denote firms A's and B's unit costs to produce their input in-house. Then, cost differences reflect the two downstream firms' efficiencies.

3.4 | The results developed here complement existing antitrust tools

Propositions 1 and 2 complement existing antitrust tools. Below, I outline a proposed screening process to assess foreclosure concerns in vertical mergers that encompass existing results and those developed herein.

The merged entity may have the ability and incentive to (i) stop supplying rivals altogether or (ii) raise the price at which it sells to rivals.

(i) Antitrust authorities can use "vertical arithmetic," an existing antitrust tool, to assess a merged entity's incentive to stop supplying rivals (see Pittman, 2017). Intuitively, with this tool one assesses whether the loss of profit on sales to firm B is more than compensated by an increase in profit at the merged entity's own downstream unit. The test developed herein is relevant in determining the incentive to stop supplying because it clarifies whether obtaining a higher input price from firm B is possible in the alternative to halting supply. (Whether the merged entity is able to stop supplying is typically a legal rather than economic matter.)

(ii) Antitrust authorities can use existing tools to assess a proposed merged entity's incentive to raise the price at which it sells to rivals. See the vGUPPI developed by Moresi and Salop (2013)[32] and merger simulation tools, for example, those developed by DOJ and FTC economists Froeb et al. (2018) and Sheu and Taragin (2021).[33] Antitrust authorities can test whether a proposed merged entity has the ability to raise the price at which it sells to rivals using Proposition 1 (the test). Without such ability, the associated incentives are inconsequential. Authorities can identify whether vertical mergers that do not result in foreclosure benefit or harm consumers using Proposition 2. In this way, the results developed herein augment the toolbox of antitrust authorities by contributing new tools related to ability (to the existing tools on incentives).

Example 2. An antitrust authority reviews the proposed merger of firms A and S. It assesses that the proposed merged entity would have an incentive to raise the price at which it sells to firm B. The premerger unit dollar margin of firm S is \$5 and of firm B is \$10. Then, by Proposition 1, the proposed merged entity would be unable to raise the price at which it sells to its downstream rival. Premerger, firm S earns unit margins of \$3 and \$5 on firms A and B, respectively. The antitrust authority estimates that the diversion ratio from firms A and B exceeds 60%. Then, by Proposition 2, the merger increases consumer prices even without foreclosure. (If instead the diversion ratio lies below 60%, the EDM effect outweighs the stakeholder effect and consumers would benefit.)

Antitrust authorities may impose remedies or clear or block the vertical merger on foreclosure grounds depending on their assessment in (i) and (ii).[34]

Remark 4. Suppose an antitrust authority imposes a remedy whereby a merged entity cannot raise v_B beyond the premerger level. This remedy prevents foreclosure but not the stakeholder effect: the merger can harm consumers still. In contrast, blocking the merger would prevent the stakeholder effect.[35]

4 | ROBUSTNESS

Results of Sections 2 and 3 are robust to each of the extensions below.

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4.1 | General model and test, with unobservable contracts

Consider the following extensions to the baseline model. First, a downstream firm's demand can now be log-convex in its price P_i. Second, there can be any number of competing downstream firms. Third, each downstream firm may need several complementary inputs. The sets of inputs used by different downstream firms can differ. Fourth, every upstream producer can have a different cost to supply each downstream firm and hence, the efficiency ranking of producers may differ for every downstream firm.

I now formally describe the general model. There is a set $\mathcal{K}$ of inputs. There are one or more producers of each input. Let $\mathcal{D}$ denote the set of downstream firms, with $\frac{\partial Q_d}{\partial P_j} \geqslant 0$ for $d \neq j$ and $d, j \in \mathcal{D}$. Every downstream firm $d \in \mathcal{D}$ has a Leontief production technology and needs the set of inputs $\mathcal{K}_d \subseteq \mathcal{K}$. Let $\mathbf{P}$ denote the $|\mathcal{D}|$-dimensional vector of consumer prices. Producers have a constant unit marginal cost of production. The unit cost of producer s to supply downstream firm d is c_{sd}. Upstream producer s supplies the set of downstream firms $\mathcal{D}_s \subseteq \mathcal{D}$ in equilibrium.

In stage 1, producers simultaneously submit unit price offers to downstream firms. In stage 2, downstream firms simultaneously set consumer prices. Finally, consumers purchase and downstream firms order inputs. I assume (a) the profit Π_d of downstream firm $d, \forall\, d \in \mathcal{D}$, is twice differentiable and strictly quasiconcave in its consumer price P_d; (b) the pass-through rate ρ_d of any downstream firm d is nondecreasing in its unit cost; (c) the profit function of any supplier s is twice differentiable and strictly quasiconcave in the $|\mathcal{D}_s|$-dimensional vector of prices $\mathbf{v}_s$ it sets.

I depart from complete information. Let offers be secret (downstream firms do not observe the input prices of their competitors), let downstream firms form point beliefs about input prices of their competitors, and let these beliefs be correct in equilibrium. I use "passive beliefs," a term coined by McAfee and Schwartz (1994) and also used in, for example, Rey and Tirole (2007) and Moresi and Salop (2013). Beliefs are passive in that any downstream firm d does not update its beliefs about the input prices of its competitors based on any of its input prices $v_{kd}, k \in \mathcal{K}_d$.

Downstream firm $d \in \mathcal{D}$ pays unit price v_{kd} for input $k \in \mathcal{K}_d$. It has profit

$$\Pi_d = \left(P_d - \sum_{k \in \mathcal{K}_d} v_{kd}\right) Q_d(\mathbf{P})$$

and first-order condition (with respect to P_d)

$$Q_d(\mathbf{P}) + m_d^* Q_d'(\mathbf{P}) = 0, \tag{9}$$

where m_d is its unit margin. Supplier s has profit

$$\Pi_s = \sum_{d \in \mathcal{D}_s} (v_{sd} - c_{sd}) Q_d(\mathbf{P})$$

and first-order condition (with respect to v_{sd}), when it is unconstrained,

$$\begin{aligned} Q_d(\mathbf{P}) + \left(v_{sd}^u - c_{sd}\right)\frac{\partial Q_d(\mathbf{P})}{\partial v_{sd}} + \textstyle\sum_{j \neq d}(v_{sj} - c_{sj})\frac{\partial Q_j(\mathbf{P})}{\partial v_{sd}} = 0, \\ Q_d(\mathbf{P}) + m_{sd}^u \frac{\partial Q_d(\mathbf{P})}{\partial P_d}\frac{\partial P_d}{\partial v_{sd}} + \textstyle\sum_{j \neq d}(v_{sj} - c_{sj})\frac{\partial Q_j(\mathbf{P})}{\partial P_d}\frac{\partial P_d}{\partial v_{sd}} = 0, \\ Q_d(\mathbf{P}) + m_{sd}^u Q_d'(\mathbf{P})\rho_d + \rho_d \textstyle\sum_{j \neq d}(v_{sj} - c_{sj})\frac{\partial Q_j(\mathbf{P})}{\partial P_d} = 0. \end{aligned} \tag{10}$$

Comparing (9) and (10),[36]

$$\begin{aligned} & m_d^* = m_{sd}^u \times \rho_d + \tfrac{1}{Q_d'(\mathbf{P})}\rho_d \textstyle\sum_{j \neq d}(v_{sj} - c_{sj})\frac{\partial Q_j(\mathbf{P})}{\partial P_d} \\ \Rightarrow\ & m_d^* \leqslant m_{sd}^u \times \rho_d. \end{aligned} \tag{11}$$

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Theorem 2 (General test). *With passive beliefs, if* $m^*_{sd} \times \rho_d < m^*_d$, *then supplier* s *is constrained in the price at which it sells to downstream firm* d *premerger and cannot sell to the unintegrated downstream firm* d *at a higher price postmerger.*

The intuition for Theorem 2 is simpler than for Theorem 1 because, with unobservable contracts and passive beliefs, downstream firms do not react to a change in a competitor's input price. Intuitively, with log-concave (log-convex) demand, the monopoly margin of supplier s on sales to downstream firm d is higher (lower) than the margin of the downstream firm because the pass-through rate is below (above) one and therefore, the elasticity of demand upstream is lower (higher) than downstream.

Remark 5. Suppose upstream producers do not know the unit cost of their competitors. If each downstream firm uses a second-price auction for every input $k \in \mathcal{K}_d$ and producers bid the offered unit price down to the lower of (i) the unit cost of the second-most efficient producer of input k or (ii) the monopoly price of the most efficient producer of input k, the outcome is the same as the complete information outcome of Section 2.

Remark 6. Suppose supplier s is a multiproduct supplier: it supplies not one but multiple complementary inputs to downstream firm d. The test still applies. When applying it, one simply needs to compare supplier s's total unit margin (across all the inputs it supplies) to downstream firm d's margin.

Briefly: Proposition 2 generalizes simply. Consider a merger between downstream firm $d = 1$ and upstream supplier s. Suppose supplier s is constrained in the price it charges to any downstream firm $d \in \mathcal{D}_s \setminus \{1\}$. If, in addition, $m^*_{s1} < \sum_{d \in \mathcal{D}_s \setminus \{1\}} m^*_{sd} D_{1d}$, then the merger harms consumers; otherwise, the merger benefits consumers. The intuition of Proposition 2 still applies: the condition verifies whether it is worth losing profits from the EDM effect to gain profits on units diverted to unintegrated firms.

4.2 | Production technology and differentiated inputs

The unconstrained (or monopoly) price is unaffected by the nature of the constraint by definition. The test (Proposition 1) therefore applies when an input is nonessential, in the sense that above a certain price, a downstream firm chooses to do without that input. It also applies when competing producers of an input produce differentiated rather than homogeneous versions of that input.

4.3 | Multiproduct downstream firms

As is well known, a vertical merger of single-product successive monopolies eliminates double marginalization and necessarily decreases the consumer price. Salinger (1991) and Luco and Marshall (2020, 2021) build on Edgeworth's taxation paradox (Edgeworth, 1925) and develop a counterintuitive result. They find that vertical integration by a multiproduct downstream firm can lead all consumer prices to increase if some products benefit from EDM ("integrated products") whereas others do not ("unintegrated products"). Surprisingly, costs decrease but prices increase. Intuitively, thanks to EDM, it becomes more profitable to sell integrated products and therefore, the merged entity raises the price of unintegrated products to divert sales to integrated products. The latter effect can be sufficiently large for all downstream prices to rise. This theory of harm does not feature a downstream competitor and thus, it does not feature foreclosure.

In the present paper, all downstream prices can increase after a vertical merger due to the stakeholder effect. If the merged entity sells multiple substitute consumer products, where some benefit from EDM whereas others do not, the merged entity has additional tools (prices of unintegrated products) to raise not only demand for integrated products but also demand for the competitor's product. The insights of Sections 2 and 3 continue to apply.

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5 | DISCUSSION OF DIFFERENT SETTINGS

In this section, I discuss settings that differ from the standard model of vertical mergers analyzed in the baseline model (Section 2) and explain whether the test is applicable to these different settings. The test is built on two ideas. First, margins reveal information on market power. Therefore, the test does not apply to settings where unit margins do not reflect market power, for example, when suppliers set two-part tariffs.[37] Second, premerger margins reveal information on postmerger ability to increase price. Therefore, the test does not apply if the ability to raise price is endogenous to the merger. Sections 5.2 and 5.3 deal with two such settings. However, the test still holds when the merged entity can use a delegate downstream or becomes a Stackelberg leader in consumer prices. I begin by discussing this in Section 5.1 and explain briefly why delegation is profitable.

5.1 | Delegation or Stackelberg leadership

The merged entity can face an issue: the EDM effect makes its downstream competitor more aggressive. Previous research has found a managerial solution to limiting pricing aggressiveness postmerger. In seminal work, Schelling (1960) shows firms can use delegation to elicit less aggressive behavior from rivals. Relatedly, see Schwartz and Thompson (1986) and Fershtman and Judd (1987) on delegation. The latter analyzes how owners can affect strategic incentives in oligopoly when they delegate decisions to managers. Indeed, a vertical merger is always profitable if the merged entity (a) delegates setting its consumer price, that is, if it sets v_A and v_B in stage 1 to maximize its profit Π_M and a delegate sets P_A in stage 2 to maximize its downstream profit $(P_A - v_A)Q_A(P_A, P_B)$ or if the merged entity (b) becomes a Stackelberg leader in consumer prices, that is, if it sets v_B and P_A in stage 1.[38] Delegation and Stackelberg leadership lead to identical profits and consumer prices; on this link, see Vickers (1985) and Moresi and Schwartz (2017).

Intuitively, the test still applies when the game changes postmerger to allow the merged entity to delegate or move first because these changes do not affect competitive constraints upstream and because the test only uses premerger data to identify constraints.

5.2 | Timing, commitment, and switching costs

Constraints are exogenous in the present paper but endogenous in Chen (2001). Downstream firms order after setting consumer prices in the present paper but, in Chen (2001), downstream firms select their supplier (and commit to their choice) before setting consumers prices. In both papers, downstream firms source from the cheapest supplier premerger but postmerger, in Chen (2001), the unintegrated downstream firm strictly prefers to source the input from the merged entity at cost v_B rather than from another producer (or in-house) at cost v_B to weaken the merged entity's aggressiveness downstream (the stakeholder effect). Consequently, the merged entity can raise the input price above c_B: the ability to foreclose is endogenous in Chen (2001).

This effect, identified by Chen (2001), harms consumers but is not foreclosure in the traditional sense: the unintegrated firm pays a higher input price to the merged entity due to a self-interested and anticompetitive motivation rather than due to the lack of cheaper alternatives. Nevertheless, vertical mergers always harm the unintegrated downstream firm in Chen (2001)—sourcing from the merged entity merely reduces the harm.

Chen (2001) shows that the merged entity can engage in foreclosure if, instead of being fully committed to its chosen supplier, the unintegrated downstream firm can switch at some fixed cost after consumer prices are set. Similar results materialize if the unintegrated downstream firm has fixed costs to switch to in-house production; such fixed costs are considered in Katz (1987) and Inderst and Valletti (2009).[39] The lower the switching costs, the less the merged entity can raise rivals' costs. The results of Sections 2–4 can be interpreted as holding when switching costs are negligible.

5.3 | Bargaining

The test does not apply when upstream and downstream firms bargain over prices because, whilst margins do reflect bargaining power, input prices can increase postmerger even if a supplier has little bargaining power. The 2020 U.S.

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DOJ and FTC vertical merger guidelines explain how, with bargaining, disagreement payoffs change postmerger. The change allows the merged entity's upstream unit to demand a higher input price from unintegrated downstream firms, such that the merger results in RRC and can harm consumers (U.S. Department of Justice & The Federal Trade Commission, 2020, p. 7).

Rogerson (2020) develops a tool to estimate the size of such effects, which he calls "bargaining leverage effect," but in a partial rather than full equilibrium model (he leaves out EDM effects).[40] In contrast, Das Varma and De Stefano (2020) show that the merged entity can have the incentive to lower the input price of its downstream rival (and customer) such that the average equilibrium downstream consumer price decreases. Constraints, a focus of the present paper, are less relevant to bargaining but not superfluous. When suppliers are not monopolists, the EDM effect might be small and the merged entity is less likely to lower its rivals' costs (see Das Varma & De Stefano, 2020; Zenger, 2020). Hence, with competition upstream, bargaining models might indeed only yield RRC.

There is a growing literature on vertical mergers with bargaining and incomplete information. In such settings, merger effects can go either way (as with linear pricing and complete information). For example, Choné et al. (2023) find vertical mergers can be anticompetitive even if they eliminate double marginalization. Similarly, Loertscher and Marx (2022) find there is no basis for assuming vertical mergers increase social surplus. With bargaining and incomplete information, another reason the test should not be applied is that margins reflect, in part, uncertainties about costs.

6 | CONCLUSION

A primary focus in vertical merger theory and of antitrust agencies is foreclosure. Much has been written on the *incentive* of vertically integrated entities to raise rivals' costs. An underlying premise of numerous theoretical models and their use in practice is that integrated entities have pricing power (or "market power") and can raise input prices. However, the presence of upstream competitors may constrain the *ability* of a merged entity in the price it sets to unintegrated downstream rivals. Even if the merged parties have high margins (or "market power"), the merged entity may be unable to foreclose rivals.

I develop a general relation between upstream and downstream margins for settings where firms set unit prices. Using this relation, I develop a test for vertical mergers. One can use this test to determine whether the merged entity cannot foreclose its rival. One can also use the test to identify models in the existing literature that are consistent with data on industries they seek to portray.

Finally, this paper highlights that vertical mergers can benefit all firms—including the unintegrated downstream firms—by reducing competition, increasing prices, and harming consumers. This has significant implications for empirical studies. As is recognized in the literature, a downstream firm that integrates with a rival's supplier gains a stake in that rival and thus behaves less aggressively. Therefore, ownership of competitors' suppliers can also contribute to rising margins. It would be interesting for further empirical work to augment the generalized HHI index to account for such ownership structures (on the generalized HHI index, see Azar et al., 2022).

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ENDNOTES

[1] See Federal Trade Commission (2021).

[2] Beyond the plethora of comments to the FTC and academic debates at conferences, particular industry associations have also voiced views. For example, the farmer association Farm Action welcomes the new guidelines and tighter enforcement (Farm, 2023), whereas the tech association Computer & Communications Industry Association does not (CCIA, 2023).

[3] I focus on input foreclosure, which can take different forms. The merged entity can either sell to downstream rivals at a higher price or stop supplying them (consequently, downstream rivals incur higher costs or exit the market). No terms are used uniformly across the academic and legal antitrust literature to distinguish between these two forms. See Salop (2018) on customer foreclosure.

[4] In other theories of harm, vertical mergers facilitate downstream collusion (Biancini & Ettinger, 2017), upstream collusion (Nocke & White, 2007, 2010), or price discrimination across industries (see Perry, 1978, 1980, on the classic ALCOA case).

[5] Salop (2022) argues, "Pass on of EDM [is not...] automatic" and that EDM is not necessarily merger-specific. On this, see also Kwoka and Slade (2020). With a large EDM effect, a merged entity lowers rivals' costs (Das Varma & De Stefano, 2020; Domnenko & Sibley, 2019; Lu et al., 2007).

[6] The post-Chicago literature formalized this argument. Partial vertical integration can also cause foreclosure (Levy et al., 2018).

[7] This effect has no agreed-upon name in the literature. Chen (2001) calls it the "collusive effect." Moresi and Schwartz (2017) call it the "input supply effect." Moresi and Schwartz (2021) call it the "Chen effect."

[8] For example, Riordan (1998) shows that harmful effects can dominate, whereas Loertscher and Reisinger (2014) show that the EDM effect can exceed foreclosure effects.

[9] The pass-through rate exceeds 100% for log-convex demand.

[10] Adachi and Ebina (2014b) obtain this result for the case of successive monopolies in a Cournot setting.

[11] See Zenger (2020) and the DOJ and FTC 2020 Vertical Merger Guidelines, pp. 9–10, on diagonal mergers.

[12] Adachi and Ebina (2014a) analyze symmetric Cournot competition upstream and downstream. There, the ratio of margins depends on the number of upstream and downstream firms.

[13] His model also allows for countermergers, though they do not occur in equilibrium.

[14] See Theorem 1, Proposition 2, and Proposition 3 in Chen (2001), p. 676 on (i), (ii), and (iii), respectively.

[15] In a tie between upstream producers, firm S wins.

[16] Assumption 2 is sufficient for a constrained supplier to price at the constraint rather than below.

[17] Assumption 3 can be replaced by a weaker though less transparent assumption. It removes a second-order effect. It is satisfied for any demand function where the price of a competing downstream firm enters as an additively separable term, for example, in linear demand systems, but it allows for $\frac{\partial^2 Q_i}{\partial P_i^2} \neq 0$.

[18] Using the weak log-concavity of demand and that prices are strategic complements confirms that the second-order condition is satisfied.

[19] The monopoly price v_i^u is a function of the price charged to the other downstream firm, v_j. This can be seen algebraically in (4) and graphically in the example depicted in Figure 1.

[20] The results relate margins: they still apply if producers have strictly positive production costs.

[21] The merged entity's profits on firm B are directly proportional to firm B's quantity rather than profit.

[22] Any incentive to lower rivals' costs results from the EDM effect.

[23] Even if the supplier is unconstrained premerger, a constraint could lie just above its premerger price, such that its ability to engage in RRC may be limited.

[24] Moresi and Salop (2013) also compare pre- and postmerger first-order conditions and obtain a very similar condition to (8) when they gauge the incentive (in percent) of the merged entity to increase its downstream price. Here, I focus on the direction of the consumer welfare change.

[25] See also Conlon and Mortimer (2021) on estimating diversion ratios.

[26] On this demand system, see Shubik and Levitan (1980) and, for a review, Choné and Linnemer (2020).

[27] The merged entity's profit-maximizing unconstrained price $v_B^{uM} = 0.985$. Therefore, the merged entity lowers its rival's cost if $v_B > 0.985$ premerger.

[28] The region of consumer harm increases with a higher diversion ratio D.

[29] Indeed, mergers can be profitable without foreclosure and without EDM (see Figure A1 in the appendix). In other words, neither an efficiency gain nor harming a rival is necessary for the merger to be profitable.

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[30] Loertscher and Riordan (2019) show that vertical mergers can be unprofitable when they reduce innovation incentives of unintegrated upstream producers.

[31] See Kadner-Graziano (2023b), p. 76 for a simple example with $c_A = 0$, $c_B = 0.1$, and $Q_i = 1 - P_i + 0.5P_{-i}$. Ordover et al. (1990) and Hart and Tirole (1990) pioneered work on endogenous mergers. On endogenous mergers, see also Buehler and Schmutzler (2008). In practice, downstream firms A and B may be active on many markets rather than only one, such that there may be incentives to merge related to activities not captured within the present model.

[32] The vGUPPI applies to settings with and without input substitution.

[33] See the Antitrust R package authored by Taragin and Sandfort as well as the web interface on competitiontoolbox.com authored by Taragin, Rios, and Wolak.

[34] See footnote 1 for examples of further theories of harm.

[35] See Loertscher and Marx (2024) on divestitures and mergers that should be blocked.

[36] Equation (11) holds with equality if s supplies only one downstream firm or if $v_{sj} = c_{sj}$ for $j \neq d$.

[37] With two-part tariffs, unit prices do not reflect market power fully but may still be positive, for example, with contractual frictions (see Calzolari et al., 2020; Herweg & Müller, 2014) or when a supplier supplies competing downstream firms (see Herweg & Müller, 2016; Inderst & Valletti, 2009). See Reisinger and Tarantino (2015) on vertical integration with two-part tariffs and incomplete information.

[38] Intuitively, the merged entity can at least replicate the premerger profit (a) with delegation, by charging the premerger price v_A^* internally, and (b) with Stackelberg leadership, by setting v_A and P_A to their premerger levels. Moresi and Schwartz (2017) explain that the result with delegation requires commitment by the merged entity not to alter v_A internally and interim observability of v_A by the unintegrated firm.

[39] In Chen (2001), a downstream firm incurs the switching cost only if it chooses one supplier at the end of stage 1 but orders from another after stage 2. Hence, if downstream firm B decides to source from the second-most efficient firm after the merger and does not change its choice at the end of stage 2 of the postmerger game, downstream firm B incurs no switching cost. This differs from downstream firm B incurring a fixed cost whenever it switches to in-house production.

[40] He simplifies the exercise by assuming downstream prices are fixed during input price negotiations. He motivates this assumption by arguing that upstream and downstream prices may be set simultaneously.

[41] As a specific example on the equilibrium pass-through rate: if downstream firms each face the same demand function $Q_i = \alpha - P_i + \frac{1}{2}P_j$, with $\Pi_i = (P_i - v_i)Q_i$, then $\frac{dP_i^*}{dv_i} = \frac{2}{2 \times 2 - \frac{1}{2} \times \frac{1}{2}} = \frac{2}{4 - \frac{1}{4}} = \frac{8}{15} < 1$.

[42] We have $|\frac{dP_i^*}{dv_i}| > |\frac{dP_j^*}{dv_i}|$ because the nominator of the former (weakly) exceeds 1 (due to log concavity of demand) whereas the nominator of the latter lies in $(0, 1)$ (as the consumer products are gross substitutes, Assumption 1).

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APPENDIX A

In the appendix, I use $Q_i' = \frac{\partial Q_i}{\partial P_i}$, $Q_i'' = \frac{\partial^2 Q_i}{\partial P_i^2}$, and, where convenient, $r_i = 2 - \frac{Q_i Q_i''}{Q_i'^2}$ for conciseness. The log-concavity of quantity Q_i in price P_i implies that $r_i \geqslant 1$.

Proof of Theorem 1. The theorem states that m_{Si}^u, given in (5), weakly exceeds m_i^*, given in (6). In a first step, I show that

$$-v_j \frac{\frac{\partial Q_j}{\partial P_j}\frac{dP_j^*}{dv_i} + \frac{\partial Q_j}{\partial P_i}\frac{dP_i^*}{dv_i}}{Q_i'\frac{dP_i^*}{dv_i} + \frac{\partial Q_i}{\partial P_j}\frac{dP_j^*}{dv_i}} \geqslant 0.$$

In a second step, I show that

$$-\frac{Q_i}{Q_i'\frac{dP_i^*}{dv_i} + \frac{\partial Q_i}{\partial P_j}\frac{dP_j^*}{dv_i}} \geqslant -\frac{Q_i}{Q_i'}.$$

As a preliminary to both steps, I solve for $\frac{dP_i^*}{dv_i}$ and $\frac{dP_j^*}{dv_i}$. To do so, I rewrite (1) as

$$Q_i\Big(P_i^*(v_i, v_j), P_j^*(v_j, v_i)\Big) + \Big[P_i^*(v_i, v_j) - v_i\Big]Q_i'\Big(P_i^*(v_i, v_j), P_j^*(v_j, v_i)\Big) = 0, \tag{A1}$$

totally differentiate (A1) with respect to v_i, and obtain

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$$Q_i' \frac{dP_i^*}{dv_i} + \frac{\partial Q_i}{\partial P_j}\frac{dP_j^*}{dv_i} + \left[P_i^* - v_i\right]Q_i'' \frac{dP_i^*}{dv_i} + \left[\frac{dP_i^*}{dv_i} - 1\right]Q_i' = 0$$

$$\Leftrightarrow \frac{dP_i^*}{dv_i} = \frac{1 - \frac{1}{Q_i'}\frac{\partial Q_i}{\partial P_j}\frac{dP_j^*}{dv_i}}{2 - \frac{Q_i Q_i''}{Q_i'^2}}.$$

Similarly, one can calculate the total derivative

$$\frac{dP_j^*}{dv_i} = \frac{-\frac{1}{Q_j'}\frac{\partial Q_j}{\partial P_i}\frac{dP_i^*}{dv_i}}{2 - \frac{Q_j Q_j''}{Q_j'^2}}.$$

Solving simultaneously yields[41]

$$\frac{dP_i^*}{dv_i} = \frac{2 - \frac{Q_j Q_j''}{Q_j'^2}}{\left(2 - \frac{Q_j Q_j''}{Q_j'^2}\right)\left(2 - \frac{Q_i Q_i''}{Q_i'^2}\right) - \frac{1}{Q_i'}\frac{\partial Q_i}{\partial P_j}\frac{1}{Q_j'}\frac{\partial Q_j}{\partial P_i}} > 0,$$

$$\frac{dP_j^*}{dv_i} = \frac{-\frac{1}{Q_j'}\frac{\partial Q_j}{\partial P_i}}{\left(2 - \frac{Q_j Q_j''}{Q_j'^2}\right)\left(2 - \frac{Q_i Q_i''}{Q_i'^2}\right) - \frac{1}{Q_i'}\frac{\partial Q_i}{\partial P_j}\frac{1}{Q_j'}\frac{\partial Q_j}{\partial P_i}} > 0.$$

Both denominators are positive, because $Q_i'^2 > Q_i Q_i''$ (due to log-concavity) and because $|Q_i'| > \frac{\partial Q_i}{\partial P_j}$ (by Assumption 1).[42]

As a further preliminary, I show that $\frac{dQ_i}{dv_i} < 0$ and $\frac{dQ_j}{dv_i} \geqslant 0$. Plugging in $\frac{dP_i^*}{dv_i}$ and $\frac{dP_j^*}{dv_i}$ into $\frac{dQ_i}{dv_i} = Q_i'\frac{dP_i^*}{dv_i} + \frac{\partial Q_i}{\partial P_j}\frac{dP_j^*}{dv_i}$ yields

$$\frac{Q_i' r_j - \frac{\partial Q_i}{\partial P_j}\frac{1}{Q_j'}\frac{\partial Q_j}{\partial P_i}}{\left(2 - \frac{Q_j Q_j''}{Q_j'^2}\right)\left(2 - \frac{Q_i Q_i''}{Q_i'^2}\right) - \frac{1}{Q_i'}\frac{\partial Q_i}{\partial P_j}\frac{1}{Q_j'}\frac{\partial Q_j}{\partial P_i}}.$$

The fraction above has a positive denominator, because $r_j \geqslant 1$, $r_i \geqslant 1$ and, by Assumption 1, $\frac{1}{Q_i'}\frac{\partial Q_i}{\partial P_j}\frac{1}{Q_j'}\frac{\partial Q_j}{\partial P_i} < 1$. Therefore, the sign of the fraction above is equal to the sign of the nominator. Evaluating the sign of the nominator yields

$$\text{sign}\{\text{nominator}\} = -\text{sign}\left\{r_j - \frac{1}{Q_i'}\frac{\partial Q_i}{\partial P_j}\frac{1}{Q_j'}\frac{\partial Q_j}{\partial P_i}\right\} < 0.$$

Therefore $\frac{dQ_i}{dv_i} < 0$.

Plugging in $\frac{dP_i^*}{dv_i}$ and $\frac{dP_j^*}{dv_i}$ into $\frac{dQ_j}{dv_i} = Q_j'\frac{dP_j^*}{dv_i} + \frac{\partial Q_j}{\partial P_i}\frac{dP_i^*}{dv_i}$ yields

$$\frac{-\frac{\partial Q_j}{\partial P_i} + \frac{\partial Q_j}{\partial P_i} r_j}{\left(2 - \frac{Q_j Q_j''}{Q_j'^2}\right)\left(2 - \frac{Q_i Q_i''}{Q_i'^2}\right) - \frac{1}{Q_i'}\frac{\partial Q_i}{\partial P_j}\frac{1}{Q_j'}\frac{\partial Q_j}{\partial P_i}}.$$

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The sign of the above expression is equal to the sign of the nominator.

$$\text{sign}\{\text{nominator}\} = \text{sign}\{(r_j - 1)\frac{\partial Q_j}{\partial P_i}\} \geqslant 0.$$

Therefore $\frac{dQ_j}{dv_i} \geqslant 0$.

From the preliminaries, it directly follows that

$$-v_j \frac{\frac{dQ_j}{dv_i}}{\frac{dQ_i}{dv_i}} \geqslant 0,$$

because the denominator $\frac{dQ_i}{dv_i} < 0$ and the nominator $\frac{dQ_j}{dv_i} \geqslant 0$.

Finally, I show

$$-\frac{Q_i}{Q_i'\frac{dP_i^*}{dv_i} + \frac{\partial Q_i}{\partial P_j}\frac{dP_j^*}{dv_i}} \geqslant -\frac{Q_i}{Q_i'}.$$

Rearranging,

$$Q_i' \leqslant Q_i'\frac{dP_i^*}{dv_i} + \frac{\partial Q_i}{\partial P_j}\frac{dP_j^*}{dv_i}.$$

Plugging in $\frac{dP_i^*}{dv_i}$ and $\frac{dP_j^*}{dv_i}$, and simplifying,

$$\begin{aligned} &\Leftrightarrow r_i r_j Q_i' - \tfrac{\partial Q_i}{\partial P_j}\tfrac{1}{Q_j'}\tfrac{\partial Q_j}{\partial P_i} \leqslant r_j Q_i' - \tfrac{\partial Q_i}{\partial P_j}\tfrac{1}{Q_j'}\tfrac{\partial Q_j}{\partial P_i} \\ &\Leftrightarrow r_j Q_i'(r_i - 1) \leqslant 0, \end{aligned}$$

because $r_j \geqslant 1$, $Q_i' < 0$ and $r_i - 1 \geqslant 0$. Therefore $m_{Si}^u \geqslant m_i^*$. □

Proof of Corollary 1. By Theorem 1, if $v_i^* = v_i^u$ then $m_{Si}^u \geqslant m_i^*$. Therefore $m_{Si}^u < m_i^* \Rightarrow v_i^* \neq v_i^u$. □

Proof of Proposition 1. If $m_{SB}^* < m_B^*$, then by Corollary 1 the supplier is constrained premerger. If the supplier is constrained it sets $v_B^* = c_B$ (rather than $v_B^* = v_B^u$). Therefore, it cannot raise the price beyond c_B. □

Proof of Proposition 2. The input price v_B does not change postmerger if the merged entity is constrained. At the premerger prices v_B and P_A, (8) is negative if and only if

$$v_A \frac{\partial Q_A(P_A, P_B)}{\partial P_A} < -v_B \frac{\partial Q_B(P_B, P_A)}{\partial P_A} \;\Leftrightarrow\; v_A > -\frac{\frac{\partial Q_B(P_B, P_A)}{\partial P_A}}{\frac{\partial Q_A(P_A, P_B)}{\partial P_A}} \times v_B \;\Leftrightarrow\; m_{SA}^* > D_{AB} \times m_{SB}^*.$$ □

Proof of Theorem 2. This follows from (9), (10), and the comparison in (11). □

Finally, I include a three-dimensional version of Figure 1b to illustrate that vertical mergers can be profitable not only without foreclosure (i.e., when the merged entity is constrained in v_B) but also without an efficiency gain (i.e., when $v_A = 0$ premerger). The green surface depicts the percentage change in the merging parties' profit $(\Pi_M - \Pi_S - \Pi_A)/(\Pi_S + \Pi_A)$, whereas the red surface is the zero-plane.

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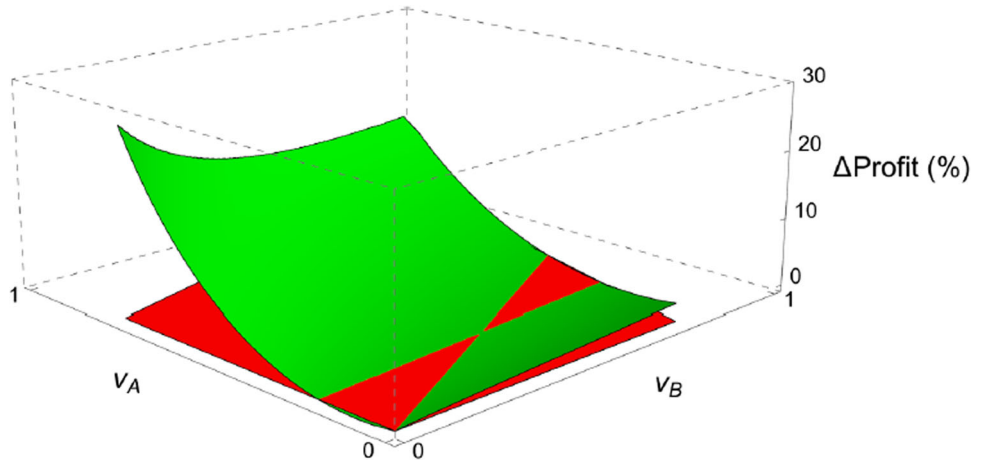

FIGURE A1 Change in the merging parties' profit—3D-version of Figure 1b. *Note*: Consumer demand functions are $Q_i = 1 - P_i + 0.5P_{-i}$ for $i \in \{A, B\}$.

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