DISCUSSION PAPER SERIES

21056-1614177708

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INDUSTRIAL ORGANIZATION

ISSN 0265-8003

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Discussion Paper 21056-1614177708
Published N/A
Submitted 24 February 2021

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www.cepr.org

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- Industrial Organization

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JEL Classification: L1, L4, D4, D8

Keywords: Asymmetric information, Bargaining, Double marginalization, Optimal procurement mechanism, Vertical merger

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Acknowledgements
We are grateful to Giacomo Calzolari, Tobias Gamp, Fabian Herweg, Philippe Jehiel, Laurent Lamy, Raphael Levy, Simon Loertscher, David Martimort, Leslie Marx, Volker Nocke, Martin Peitz, Patrick Rey, Armin Schmutzler, Roland Strausz, Jean Tirole, Thomas Tröger, and Nicolas Vieille for constructive comments. This research is supported by a grant of the French National Research Agency (ANR), ``Investissements d'Avenir'' (LabEx Ecodec/ANR-11-LABX-0047).

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Philippe Choné† Laurent Linnemer† Thibaud Vergé†

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1 Introduction

The recent revision of the U.S. Vertical Merger Guidelines, and a series of high-profile cases, have revived policy discussions over the pros and cons of vertical integration.[1] Much of the discussion revolved around the antitrust assessment of efficiency claims – a topic not addressed in the previous version of the Guidelines.

The debate has fostered renewed interest in an old and supposedly well-known efficiency gain, the elimination of double marginalization, hereafter EDM.[2] Among other issues, antitrust scholars and practitioners have discussed whether consumers are likely to benefit from EDM, whether the efficiency gains are really merger-specific, and the relationship between EDM and foreclosure effects of vertical integration. FTC Commissioners Slaughter and Chopra challenged the notion that "vertical mergers often benefit consumers through the EDM", finding the Guidelines overly optimistic in this respect.[3] Slade and Kwoka Jr (2020) argued that vertical integration is not always necessary to achieve the benefits of EDM and that the alleged gains of EDM are merger-specific only if they cannot be achieved by other (less socially costly) means. The textbook presentation of EDM, that restricts attention to linear price schedules, acknowledges that a two-part schedule suffices to solve the problem, and thus does not allow for merger-specific EDM. Commissioner Wilson highlighted that the magnitudes of foreclosure effect and EDM often vary in concert, agreeing that "it is not appropriate to consider EDM as a factor in the calculation of a "net effect".[4]

This paper provides a setting in which EDM is not an artefact of contractual restrictions and can thus be merger-specific; EDM and foreclosure effects are closely intertwined; and final consumers may be harmed by the exclusion of an independent suppliers caused by vertical integration. Its main purpose is to examine under which circumstances market foreclosure, in combination with EDM, is pro- or anti-competitive.

[1]See the 2020 U.S. Vertical Merger Guidelines as well as the failed attempts by U.S. authorities to prohibit the acquisition of Time Warner by AT&T (*United States v. AT&T Inc., No. 1:17-cv-02511 (D.D.C. 2017)*), of Farelogix by Sabre (*United States v. Sabre Corp. et al. No 1:99-mc-0999 (D. Del. 2020)*; the merger was eventually prohibited by the UK CMA in April 2020) or the merger between Sprint and T-Mobile (*State of New York, et al., v. Deutsche Telekom AG, et al. No 1:19-cv-05434-VM-RWL (S.D.N.Y. 2020)*; this case raised both horizontal and vertical concerns).

[2]Section 6 of the Guidelines, "Procompetitive effects", is almost entirely devoted to EDM. The double marginalization phenomenon has first been identified by Cournot (1838) in the context of complementary goods (Chap IX, §57) and by Spengler (1950) within the context a vertical relation.

[3]The two commissioners voted against the publication of the Guidelines, see their dissenting statements, Chopra (2020) and Slaughter (2020).

[4]See Wilson (2020) and Global Antitrust Institute (2020).

We rely on three building blocks: a procurement setting in which a single buyer acquires a homogenous input from potential suppliers;[5] asymmetric information about the supplier's production costs; and a two-stage bargaining mechanism through which prices and quantities are determined. The environment extends that of Loertscher and Marx (2020a) to a setting with variable quantities. Where they assume that the buyer acquires a single unit from a selected supplier, we distinguish two decisions, namely the supplier(s)' selection process and the quantity choice(s). Accordingly, we introduce two sets of bargaining weights that reflect the players' abilities to influence each of the two decisions in their favor.

Our main findings are as follows. In equilibrium, the informational asymmetry creates a wedge between the supplier's cost and the upstream price perceived by the buyer.[6] The buyer chooses the purchased quantity based on the wholesale price, which exceeds the supplier's cost, hence the double marginalization phenomenon. The magnitude of the double margin is maximal when the buyer has all the bargaining power when choosing the quantity to buy from the selected supplier and vanishes when the buyer and suppliers' bargaining power are balanced.

All else being equal, the buyer prefers to supply from less aggressive suppliers, i.e., from suppliers with less bargaining power at the production stage. In particular, if the buyer has full control over the selection decision, she tends to avoid dealing with aggressive suppliers. On the other hand, when the suppliers have the same degree of influence over the selection and production decisions, the buyer ends up supplying more often from the most aggressive supplier.

The effect of vertical integration can be described as follows. When the buyer acquires a supplier, she is more likely to purchase from that supplier post-merger than pre-merger. In other words, independent suppliers are foreclosed from the market with positive probability. Moreover, when an independent supplier sells post-merger, it has to accept a lower payment even though the traded quantity remains unaffected; in that sense there is exploitation by the buyer.

Final consumers are unambiguously better off post-merger if the buyer was already purchasing from the acquired supplier prior to the merger. In this case, commonly referred to as EDM in the literature, they benefit directly from the efficiency gain.

When an independent supplier is foreclosed from the market, the traded quantity increases and the retail price decreases post-merger provided that the suppliers' bar-

[5]See Perry (1978) for a seminal model of vertical integration with a monopsonist.

[6]This is true under a very mild assumption about the procurement mechanism, namely the monotonicity of the selection decision. The mechanism can be implemented with a deferred-acceptance auction and a menu of two-part tariffs.

gaining power is not higher at the production stage than at the selection stage. Under this circumstance, the buyer's and final consumers' interests are aligned: EDM within the merged entity, together with the change of supplier, enhances consumer surplus. As a result, final consumers are better off with probability one, in line with the Chicago view of vertical integration.

On the other hand, if a supplier has more bargaining power at the production stage than at the selection stage, then the supplier's exclusion harms consumers with positive probability. With ex ante symmetric suppliers, consumer harm caused by foreclosure is magnified when the buyer fully controls the selection decision and the bargaining power are balanced at the production stage (and hence there is no double margin). In asymmetric configurations, however, vertical integration may correct preexisting distortions and foreclosure then increases consumer surplus. When the pre-merger procurement process discriminates against a supplier, its acquisition eliminates a productive misallocation and generates benefit for consumers even in the absence of double marginalization.

The paper is organized as follows. Before closing the introduction, we relate the paper to the existing literature. Section 2 presents the procurement framework and the bargaining environment under asymmetric information. Section 3 characterizes the optimal mechanism under vertical separation and explains how the bargaining weights affect the selection of suppliers and the traded quantity. Section 4 describes the effects of vertical integration and market foreclosure on firms and final consumers in symmetric and asymmetric environments. Section 5 discusses the policy implications of our findings.

Related literature The paper builds on and expands the Industrial Organization literature that emphasizes the role of incomplete information.

In the context of the regulation of public monopolies, the early principal-agent literature (Baron and Myerson (1982) and Laffont and Tirole (1986)) highlights the existence of a rent-efficiency trade-off. To reduce the agent's informational rent, the Principal is better off not implementing the complete information outcome. This insight, when applied to our procurement environment, is at the source of the double marginalization phenomenon. McAfee and McMillan (1986, 1987), Laffont and Tirole (1987), and Riordan and Sappington (1987) introduce competition between suppliers and connect the problem to auction theory.[7] Dasgupta and Spulber (1989) derive the optimal pro-

[7]See the pioneering work of Myerson (1981) and Riley and Samuelson (1981), as well as, Krishna (2002) for an advanced course on auction theory.

curement mechanism with variable quantities and supplier competition. The practical implementation of his mechanism is studied by the management literature, see, e.g., Chen (2007), Duenyas, Hu, and Beil (2013) and Tunca and Wu (2009). While these papers assume convex costs and focus on multiple sourcing, we maintain the constant returns to scale assumption. Moreover, they do not allow for balanced bargaining and do not consider the effect of vertical integration.

Loertscher and Marx (2019a) model buyer power as the ability to organize an optimal auction à la Myerson. In the spirit of Bulow and Klemperer (1996), they distinguish the ability to discriminate among suppliers ("bargaining power") and the ability to set binding reserve prices ("monopsony power"). They show that in the absence of cost synergies, a horizontal merger of two suppliers harms the buyer, regardless of buyer power. In a companion paper, Loertscher and Marx (2019b) introduce bargaining weights to model intermediate degrees of buyer power. More recently, Loertscher and Marx (2020a) develop a general bargaining model under incomplete information. They identify a new source of distortion created by vertical mergers. In the presence of bilateral asymmetric information, vertical integration may "render inefficient otherwise efficient bargaining", thereby reducing the probability of trade. Restricting attention to one-sided asymmetric information, we build on their setup to allow for variable quantities and price-elastic demand. We then concentrate on the effect of vertical integration at the intensive margin, namely on its impact on the traded quantity (given that trade occurs). We can thus examine how EDM and market foreclosure jointly affect final consumers, depending on the bargaining environment.

Assuming inelastic demand, Loertscher and Riordan (2019) study the profitability of vertical integration with an emphasis on suppliers' R&D investment taking place before the procurement stage. They oppose an "investment-discouragement effect" to a "markup-avoidance effect". Solving a parametric example they show that the negative effect dominates and the buyer is better off not integrating vertically.[8] Our approach is complementary to theirs. We are interested in the impact of vertical integration on final consumers rather than in profitability and for this reason we allow for elastic demand and endogenous quantities.

More broadly, the paper is related to the literature on backward integration. Within perfect information environments, this literature shows how capacity constraints and/or convex costs create incentives for a buyer to raise her rival's costs. Riordan (1998) shows that vertical integration by a dominant firm raises the competitive fringe's cost

[8]See also Allain, Chambolle, and Rey (2016) and Lin, Zhang, and Zhou (2020). In a context where investment is specific to the buyer, it would be natural to include it in the procurement mechanism itself. In this direction, see Tomoeda (2019).

and always harms consumers through higher prices.[9] Extending Riordan's analysis to Cournot competition, Loertscher and Reisinger (2014) find that vertical integration is more likely to benefit consumers the more concentrated is the industry. De Fontenay and Gans (2004) examine as we do backward integrations by monopsonists. Assuming suppliers have convex costs, they show that vertical mergers enable buyers to deal with fewer suppliers and thus to exert their monopsony power,[10] which always harms consumers. They assume efficient bilateral bargaining with individual suppliers, and hence no double marginalization. Here, we abstract away from raising rivals' costs considerations. Consumer harm (if any) comes *directly* from the impact on independent suppliers.

A growing empirical literature evaluates how vertical arrangements alleviate the double marginalization problem. In the supermarket industry, Sudhir (2001), Villas-Boas (2007), Bonnet and Dubois (2010), Cohen (2013) find evidence that under vertical separation manufacturers and retailers use nonlinear pricing contracts. For instance, the results of Villas-Boas (2007) rule out double marginalization in the yoghurt market. On the contrary, in the movie industry, Gil (2015) finds that vertically integrated theaters charge lower prices, putting forward EDM as an important explanation.[11] In the carbonated beverage industry, Luco and Marshall (2020) find that vertical integration causes price decreases in products with eliminated double margins but also price increases in the other products sold by the integrated firm. This is consistent with the mechanism identified by Salinger (1991), which assumes linear wholesale prices.

To examine vertical relationships in industries where intermediate prices are negotiated, a number of recent studies use the "Nash-in-Nash" bargaining solution, see Draganska, Klapper, and Villas-Boas (2010), Ho and Lee (2017), and Crawford, Lee, Whinston, and Yurukoglu (2018). Consistent with the theoretical model of Horn and Wolinsky (1988), they assume that buyers and suppliers bargain over linear fees.[12] Here, on the contrary, we allow for bargaining over nonlinear prices. Moreover, while these empirical studies assume that wholesale and retail prices are set simultaneously, we adopt here a sequential timing assumption.

[9] Yet, total welfare can increase because production is shifted towards the most efficient firm.

[10] De Fontenay and Gans (2004)' bargaining externalities mirror those studied by Hart and Tirole (1990) in the case of one seller dealing with many buyers. See also Reisinger and Tarantino (2015).

[11] In the airline industry, Gayle (2013) regards codesharing as a form of vertical relationship and finds it does not fully eliminate DM.

[12] In the multichannel television industry, Crawford, Lee, Whinston, and Yurukoglu (2018) find significant gains in consumer welfare from vertical integration, in part through the reduction of double marginalization.

EDM is not the only source of efficiency gains in a vertical integration. Lafontaine and Slade (2007) organize the empirical literature on the motives and consequences of vertical integration. In their study of the cement industry, Hortaçsu and Syverson (2007) link productivity gains to improved logistics coordination afforded by large local concrete operations. In a broader study of the U.S. manufacturing industry Atalay, Hortaçsu, and Syverson (2014) show that vertical integration promotes efficient intrafirm transfers of intangible inputs. Using the same dataset, Atalay, Hortaçsu, Li, and Syverson (2019) nevertheless estimate a substantial shadow value of ownership in physical shipments.[13]

2 Framework

A buyer B seeks to procure a homogeneous input from potential suppliers $S_0, \ldots, S_n$. The suppliers operate under constant returns to scale and their marginal costs c_i, for $i \in \mathcal{N} = \{0, \ldots, n\}$, are independently drawn from distributions F_i with supports $[\underline{c}_i, \bar{c}_i]$. The buyer transforms one unit of input into one unit of output, which she sells to final consumers. For expositional convenience, we assume a monopolistic downstream market. This is for instance the case if a competitive fringe offers a variant of the final good built from a different type of input. Selling quantity q generates gross revenue $R(q) = P(q)q - C(q)$, where $P(.)$ is the inverse demand and $C(.)$ is the buyer's production (i.e., transformation and distribution) cost. For a given supplier's cost c, consumers' surplus is $S(q) = \int_0^q [P(x) - P(q)] \, \mathrm{d}x$, the buyer and selected supplier's joint-profit is $\Pi(q; c) = R(q) - cq$.

We assume that Π is a single-peaked function of q, hence the monopoly quantity $q^m(c) = \arg\max_q \Pi(q; c)$ is uniquely defined and is a decreasing function of c. The monopoly profit, denoted $\Pi^m(c) = \max_q \Pi(q; c)$, is thus a decreasing and convex function of c.

2.1 Procurement process

The procurement process has two stages. First, a subset of suppliers $\mathcal{S} \subset \mathcal{N}$ is selected; second the selected firms produce and sell quantities to the buyer. Each stage involves bargaining under incomplete information, which we model by using the flexible price-formation mechanism of Loertscher and Marx (2020a). At each stage, a bargaining mechanism maximizes a weighted industry profit. Let Π_B and U_i be the buyer's and

[13] They find that having an additional vertically integrated establishment in a given destination ZIP code has the same effect on shipment volumes as a 40% reduction in distance.

suppliers' profits. Let λ_i and μ_i denote supplier'i bargaining power relative to the buyer at the selection and production stage respectively. The bargaining mechanism at the selection stage maximizes $\Pi_B + \sum_{i\in\mathcal{N}} \lambda_i U_i$, while at the production stage it maximizes $\Pi_B + \sum_{j\in\mathcal{S}} \mu_j U_j$. We define the weighted virtual costs as

$$\Psi_i(c_i; \mu_i) = c_i + (1 - \mu_i) F_i(c_i)/f_i(c_i), \tag{1}$$

and assume that they are nondecreasing functions of c_i for all μ_i between 0 and 1.

The selection mechanism reveals information about the suppliers' costs. To avoid uninteresting complications, we restrict attention to selection rules that are monotonic in the sense that if supplier i with cost c_i is selected then that supplier is also selected when his cost is lower than c_i, see Definition 4 in Milgrom and Segal (2020). Formally, let $x = (x_0, \ldots, x_n)$ denote the allocation rule, i.e., $x_i(c_0, \ldots, c_n) = 1$ if and only if supplier i is selected. The selection rule is monotonic if for all i, c_{-i} and $c_i < c_i'$ we have

$$x_i(c_i; c_{-i}) \geq x_i(c_i'; c_{-i}).$$

The production stage is described with a direct mechanism $(\mathbf{Q}, \mathbf{M})$ whereby the quantities $\mathbf{Q} = (Q_j(\widehat{\mathbf{c}}))_{j\in\mathcal{S}}$ and payments $\mathbf{M} = (M_j(\widehat{\mathbf{c}}))_{j\in\mathcal{S}}$ are functions of costs $\widehat{\mathbf{c}} = (\widehat{c}_j)_{j\in\mathcal{S}}$ reported by the suppliers. The buyer profit is $\Pi_B(\mathbf{c}) = R(\sum Q_j(\mathbf{c})) - \sum M_j(\mathbf{c})$ while the suppliers' profits are given by $U_j(\mathbf{c}) = M_j(\mathbf{c}) - c_j Q_j(\mathbf{c})$.

2.2 Vertical integration

When the buyer acquires a supplier (say S_0), B and S_0 form a single entity. Our baseline model assumes that the buyer perfectly internalizes the profit of the acquired supplier and hence that S_0's post-merger bargaining weights at the selection and production stages, λ_0' and μ_0', equal the buyer's weights, i.e., $\lambda_0' = \mu_0' = 1$. Under this circumstance, the weighted industry profits that govern bargaining at the selection and production stages are changed into $\Pi_B + U_0 + \sum_{i\geq 1} \lambda_i U_i$ and $\Pi_B + U_0 + \sum_{i\in\mathcal{S}^*} \mu_i U_i$, where S^* is the set of selected independent suppliers. In a couple of extensions, however, we allow for imperfect internalization of profits within the integrated firm, as in Crawford, Lee, Whinston, and Yurukoglu (2018), and assume only $\lambda_0 \leq \lambda_0' \leq 1$ and $\mu_0 \leq \mu_0' \leq 1$.

Our focus is on the impact of vertical integration on traded quantities and consumer surplus. In other words, we analyze the impact of integration at the intensive margin. We therefore assume throughout the paper that bargaining never involves positive reserve prices, i.e., a positive quantity is traded with probability one. This occurs when consumers' willingness to pay (at least for the first units) is sufficiently high.

2.3 Interpretation of two-stage bargaining

The weights μ_i reflect both the size of total profit and how it is shared. If all μ_i equal one, then total profit is maximized. Despite the loss in total profit, B prefers all μ_i to be zero. The λ_i's reflect how each supplier is valued at the selection stage. However, selection is conditional on the production stage, hence is governed by both the λ_i's and the μ_i's. If the bargaining weights are the same at both stages, i.e., $\lambda_i = \mu_i$, we shall see that the sequentiality of the procurement process is immaterial. The procurement process can equivalently be represented by an integrated bargaining mechanism (over both selection and production) that maximizes $\Pi_B + \sum_{i \in \mathcal{N}} \lambda_i U_i$. When the suppliers' weights are zero at both stages, $\lambda_i = \mu_i = 0$, the buyer has full buyer power. When the weights are one at both stages, $\lambda_i = \mu_i = 1$, the weighted profit is the total profit of the industry.

Although one-stage bargaining (invariant weights $\lambda_i = \mu_i$) is a salient special case, weights can vary between selection and production for several reasons. On the one hand, suppliers could be empowered from belonging to a selected few. In that case, a supplier would not lose bargaining power vis-à-vis the buyer once he has been selected, i.e., $\mu_i \geq \lambda_i$. On the other hand, a selected supplier could have lost a valuable outside option (by committing to produce for B) meaning B can extract more rents from him, i.e. $\mu_i \leq \lambda_i$. The former environment is exemplified by $\lambda_i = 0$ and $\mu_i > 0$, where the buyer has full control over the selection decision but has to bargain at the production stage. The latter by a configuration $\lambda_i > 0$ and $\mu_i = 0$, where the buyer is ruthless at the production stage but selection is more consensual.

Although our perspective is on industrial organization and competition policy, our framework can also be viewed through the lens of the theory of the firm. Regarding selection as an ex ante investment stage,[14] one could ask how investment is distorted by firms' ex post behavior at the production stage. Our two-stage setting can represent hold-up configurations à la Williamson when the production stage is marred by inefficient haggling (i.e. $\mu_i < 1$ and asymmetric information),. It is also consistent with a Hart and Moore hold-up model when the production stage is efficient (i.e., $\mu_i = 1$).[15]

An alternative interpretation of the model is that the mechanism is operated by the procurement division of the buyer, which is in charge of negotiating with potential

[14]Selecting (resp. not selecting) S_i corresponds to investing 1 (resp. 0) in project i.

[15]See Gibbons (2005) and Segal and Whinston (2013)

suppliers. In this interpretation, the positive weights placed on suppliers may reflect the behavioral assumption that the division has a different objective from that of the buyer as a whole. Reasons for that can be related to past or future relationships with suppliers or to soft corruption.[16]

3 Vertical separation

In this section, we describe the outcome of the two-stage bargaining process under vertical separation. The selection of suppliers maximizes the weighted industry profit $\Pi_B + \sum_{i \in \mathcal{N}} \lambda_i U_i$, where Π_B and U_i are the buyer's and suppliers' profits that result from the second-stage bargaining over prices and quantities. In section 3.1, we take as given the subset $\mathcal{S}$ of selected suppliers, determine prices and quantities, and explain how double marginalization emerges as a result of asymmetric information. In section 3.2, we show that a single supplier is selected and explain how the selection probabilities depend on the suppliers' bargaining weights at both stages.

3.1 Production and double marginalization

Let $\mathcal{S}$ denote the subset of selected suppliers. Because the selection rule is monotonic, the distributions of the costs of the selected suppliers $j \in \mathcal{S}$ obtain from right-truncations of the original distributions F_j. In other words, the selection phase only reveals that the cost of an active supplier is below a threshold c_j^*. The weighted virtual cost functions $\Psi_j(c_j; \mu_j)$ are truncated accordingly.[17]

Proposition 1. *Under the optimal mechanism, only the selected supplier $j \in \mathcal{S}$ with the lowest virtual cost $\Psi_j(c_j; \mu_j)$ produces. Except for $\mu_j = 1$, the traded quantity, $q^m(\Psi_j(c_j; \mu_j))$, is bilaterally inefficient.*

Proof. See Appendix A. □

The traded quantity is lower than the quantity that maximizes the joint profit of the buyer and the chosen supplier: $q^m(\Psi_i(c_i; \mu_i)) \leq q^m(c_i)$, and hence the retail price exceeds the monopoly price. Double marginalization results from the wedge $(1 - \mu_i)F_i(c_i)/f_i(c_i)$ between the supplier's cost c_i and the virtual cost $\Psi_i(c_i; \mu_i)$. Thus

[16]The weighted industry profit is reminiscent of the regulator's objective in Baron and Myerson (1982). Following Laffont and Tirole (1986), one could also assume costly transfers on top of or instead of the bargaining weights.

[17]A result reminiscent of Laffont and Tirole (1987). In their model, an auction selects a firm which is then regulated. Competition in the auction affects at the regulation stage the fixed part of the cost reimbursement scheme (a lump-sum transfer) but not the power of incentives.

in contrast to most of the industrial organization/vertical relationship literature, the phenomenon is not caused by contractual limitations (e.g., restriction to linear contracts). The general mechanism allows for efficient quantities to be traded, but the optimal quantity is lowered to reduce the seller's informational rent. The degree of DM, measured by the difference $q^m\left(\Psi_i(c_i;\mu_i)\right) - q^m(c_i)$, decreases with the supplier's weight μ_i. The phenomenon is most severe when the objective of the mechanism is the buyer's profit ($\mu_i = 0$) and disappears when the objective is the total industry profit ($\mu_i = 1$).

In addition to the bilateral inefficiency, the supplier with the lowest marginal cost does not necessarily produce. Indeed, in an asymmetric environment, having the lowest marginal cost does not imply having the lowest virtual marginal cost. Only when selected suppliers are symmetric, i.e., $\Psi_j(.;\mu_j) = \Psi_{j'}(.;\mu_{j'})$, does the most efficient one produce.

Example Assume S_0 and S_1 have been selected and their costs are uniformly distributed over $[0,1]$. The downstream revenue function is $R(q) = q(a-q)$, hence the monopoly quantity is $q^m(c) = (a-c)/2$. As $F(c) = c$, the weighted virtual cost of S_i is $\Psi(c;\mu_i) = (2-\mu_i)c$. The buyer purchases from S_0 whenever $c_1 > c_0(2-\mu_0)/(2-\mu_1)$.

More generally, if cost distributions are symmetric and bargaining weights differ, then the buyer is more likely to purchase from the supplier with the strongest bargaining power. This is because given any identical value for suppliers' costs, a higher bargaining weight is associated with a lower weighted virtual cost.

The magnitude of the DM also depends on the market concentration and on the shape of the cost distributions. First, a higher number of potential suppliers makes it more likely that the selected supplier has a low marginal cost, which reduces the observed distortion. Second, consider a symmetric environment where the costs are distributed according to the distribution F with density f and the suppliers' weights are equal to μ. Suppose now that the common distribution of the suppliers' costs changes to G with density g, and assume that costs are lower under F than under G in the likelihood ratio order, i.e., the likelihood ratio $g(c)/f(c)$ increases with c. Then the DM phenomenon is more severe under F than under G because F/f is larger than G/g and hence the wedge due to asymmetric information is higher under F than under G. Third, consider an asymmetric environment where the bargaining weights are identical but the cost distributions differ. If the cost distribution of S_0 is lower than that of S_1 in the likelihood ratio order, then the buyer is more likely to purchase from S_1. The mechanism is biased in favor of less efficient suppliers as is standard in Myersonian settings.

3.2 Supplier selection

Given the quantity decision described in Proposition 1, the selection of suppliers maximizes the weighted industry profit $\Pi_B + \sum_{i\in\mathcal{N}} \lambda_i U_i$. We introduce the following virtual profits which are assumed positive and decreasing in c_i.

$$\pi_i^v = \Pi\left(q^m\left(\Psi_i(c_i;\mu_i)\right);\Psi_i(c_i;\lambda_i)\right). \tag{2}$$

This virtual profit involves two different virtual costs $\Psi_i(c_i;\lambda_i)$ and $\Psi_i(c_i;\mu_i)$, reflecting the discrepancy in the objectives maximized at each two stages of the procurement process. In the appendix, we provide a simple sufficient condition on the functions $q^m(c)$ and $F(c)$, inequality (B.2), guaranteeing that π_i^v decreases with c_i.

Example (continued) When F_i is uniform on $[0,1]$ and the demand is linear, the virtual profit (2) can be written

$$\pi_i^v = \left[(a-(2-\lambda_i)c_i)^2 - (\mu_i-\lambda_i)^2 c_i^2\right]/4.$$

It is positive and decreasing in c_i provided that $a \geq 3$.

Proposition 2. *Under two-stage bargaining, only the supplier with the highest virtual profit (2) is selected.*

Proof. See Appendix C. □

To understand the intuition of the result, assume that the bargaining weights differ at the two stages. If two suppliers i and j are selected, the buyer purchases from only one of them. This chosen supplier is determined on the basis of the weights μ_i that govern bargaining at the production stage, irrespective of the weights λ_i that are relevant at the selection stage. Hence, from the perspective of the selection stage, keeping more than one supplier cannot enhance the implicit objective of the bargaining when $\lambda_i \neq \mu_i$. As a result, competition between suppliers is exhausted at the selection stage.

Implementation The optimal procurement mechanism can be implemented by auctioning off a menu of two-part tariffs and letting the buyer (facing the tariff chosen by the winner) decide the quantity she wants to purchase. Consider the following deferred-acceptance auction. Let s denote a clock index. The auctioneer initiates the auction at a low level of s and then raises it gradually. We define

$$c_i^*(s) = \max\{\underline{c}_i \le c_i \le \bar{c}_i \mid \pi_i^v(c_i) \ge s\}. \tag{3}$$

At the clock index s, supplier i has access to the following menu of two-part tariffs, which we call $\mathcal{T}_i(s)$. The menu consists of a family of tariffs indexed by $\tilde{c}_i$ in $[\underline{c}_i, c_i^*(s)]$, with fixed part

$$M_i(\tilde{c}_i; s) = \int_{\tilde{c}_i}^{c_i^*(s)} q^m(\Psi_i(c;\mu_i))\,\mathrm{d}c - [w_i(\tilde{c}_i) - \tilde{c}_i]q^m(\Psi_i(\tilde{c}_i;\mu_i)),$$

and wholesale price $w_i(\tilde{c}_i) = \Psi_i(\tilde{c}_i;\mu_i)$. As the index decreases, the suppliers decide whether to stay or exit. The winner is the last active supplier. If supplier i wins, he is offered his current menu $\mathcal{T}_i(s)$, in which he then chooses a particular option $\tilde{c}_i$. Finally facing the wholesale price $w_i(\tilde{c}_i)$, the buyer decides the quantity she wants to purchase. To summarize

Proposition 3. *The procurement mechanism of Proposition 2 can be described as a three-stage process: (i) a unique supplier is selected through a deferred-acceptance clock auction; (ii) the winning supplier picks a two-part tariff in a menu; (iii) the buyer facing that tariff chooses a quantity.*

Proof. See Appendix D. □

The dynamic implementation highlights the absence of commitment issue, see Loertscher and Marx (2020b) and Milgrom and Segal (2020). During the selection phase, the mechanism reveals only that the cost of active suppliers is below a threshold $c_i^*(s)$ when the clock index is s. It is reminiscent of the dichotomy principle presented in Laffont and Tirole (1987), whereby the supplier's selection and the second-stage incentive problem (here the determination of the traded quantity) are two separate issues. In practice, the auction affects the fixed part of the tariff (a lump-sum transfer) but not the power of incentives. Specifically, the wholesale price chosen by the supplier with cost c_i, which determines the variable part of the two-part tariff, is $w_i(c_i) = \Psi_i(c_i;\mu_i)$. The buyer's perceived cost is therefore larger than the supplier's cost, which leads to double marginalization.

Bargaining weights and supplier selection We now investigate how the weights λ_i and μ_i affect the selection of suppliers. According to Proposition 2, the probability that supplier i is selected is an increasing function of the virtual profit π_i^v given by (2). For a given weight λ_i, the virtual profit is quasi-concave with respect to μ_i and achieves its maximum value, $\Pi^m(\Psi_i(c_i;\lambda_i))$, at $\mu_i = \lambda_i$. It increases with λ_i and its overall maximum, $\Pi^m(c_i)$, is achieved when the two bargaining weights are equal to one.

Hereafter, we refer to the special case where the bargaining weights remain constant at the production and selection stages ($\lambda_i = \mu_i$ for all suppliers) as "one-stage bargaining" because in this case the distinction between selection and production is immaterial.[18]

Proposition 4. *Consider two suppliers i and j with the same cost distributions $F_i = F_j$ and different bargaining weights at the production stage, $\mu_i > \mu_j$. When λ_i and λ_j are sufficiently close to μ_i and μ_j respectively, supplier i is preferred to supplier j at the selection stage, $\pi_i^v(c) > \pi_j^v(c)$. The reverse is true when the buyer has enough control over the selection decision, i.e., when λ_i and λ_j are sufficiently small.*

Proof. See Appendix E. □

The parameters μ_i represent the degrees of suppliers' efficacy or aggressiveness in bargaining over price and quantity at the production stage. Whether more aggressive suppliers tend to be selected (and hence to be admitted into the final bargaining game) depends on how much control the buyer has over the selection process. When she does not have superior bargaining at the selection stage than at the production stage, i.e., when the environment is close to one-stage bargaining, she tends to select aggressive suppliers, all else being equal. On the other hand, when she has full control at the early stage, she avoids selecting aggressive suppliers.

Figure 1 illustrates the results of Proposition 4 in an economy with two potential suppliers, uniformly distributed costs, and linear demand. When bargaining weights remain the same between selection and production, $\lambda_0 = \mu_0$ and $\lambda_1 = \mu_1$, the buyer purchases more often from the supplier with the largest μ (see the region above the blue line OA). On the contrary, when the objective at the selection stage is aligned with the buyer's own profit ($\lambda_0 = \lambda_1 = 0$), then the less aggressive supplier is selected more often (see the region below the maroon curve OA').[19]

While the produced quantity is governed by the sole parameters μ_i, the selection rule depends on both the λ_i's and μ_i's. Because the virtual profits increase in λ_i and decreases in μ_i (assuming μ_i greater than λ_i), suppliers with higher λ_i and lower μ_i

[18] If two suppliers $i \neq j$ are selected, the buyer purchases from i if and only if $\Psi_i(c_i;\mu_i) \leq \Psi_j(c_j;\mu_j)$. The choice coincides with the implicit objective of the bargaining at the selection stage if and only if $\lambda_i = \mu_i$ and $\lambda_j = \mu_j$.

[19] The selection rule is given in Appendix F.1.

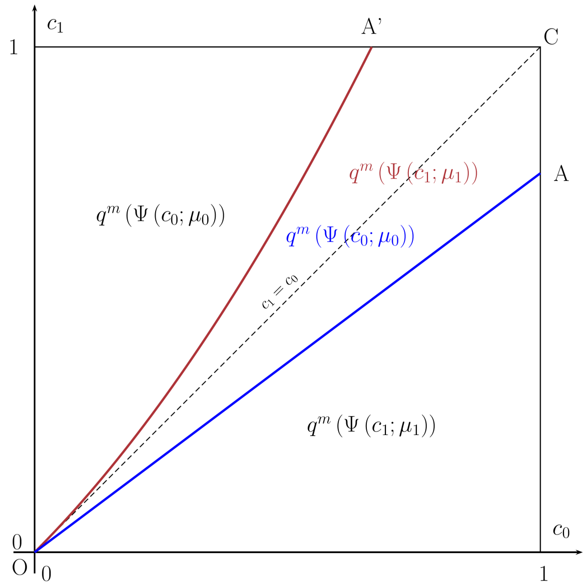


Figure 1: The most aggressive supplier, $\mu_0 > \mu_1$, is selected above the blue line OA under one-stage bargaining ($\lambda_0 = \mu_0$ and $\lambda_1 = \mu_1$), while he is selected above the red line OA' under buyer-controlled selection ($\lambda_0 = \lambda_1 = 0$).
Suppliers' costs are uniform on $[0, 1]$, demand is linear.

tend to be selected more often. The latter effect (dependence in μ_i) becomes negligible when μ_i tends to λ_i, i.e., when the environment gets closer to one-stage bargaining.[20] In that case, the selection is essentially governed by the λ_i's.

4 Vertical integration

We now turn to the study of a vertical merger between the buyer and a supplier, which we denote S_0.[21] As explained in Section 2, after a merger, B and S_0 form one entity, thus the weight given to S_0 becomes the same as the weight given to B, namely one. Once this change of weights is accounted for, the analysis of section 3 applies.

4.1 Effects on firms and consumers

Proposition 5 highlights the pros and cons of vertical integration. In particular, independent suppliers are more likely to be denied access to the market, a phenomenon often referred to as "customer foreclosure".

Proposition 5. *Vertical integration eliminates double marginalization whenever the buyer supplies internally. Compared to vertical separation, the internal supplier is more*

[20] This is because $\partial \pi_i^v / \partial \mu_i = 0$ at $\mu_i = \lambda_i$, hence the virtual profit is locally a function of λ_i, see details in Appendix F.1.

[21] In Section 4, we make the identity of the acquired supplier endogenous.

likely to produce. Conditional upon producing, independent suppliers sell the same quantity but earn a lower profit post-merger.

Proof. The virtual profit prevailing in the absence of vertical integration, π_0^v, is replaced post-merger with $\Pi^m(c_0) > \pi_0^v$. (Recall that the highest possible value of π_0^v is $\Pi^m(c_0)$, that value being achieved only for $\lambda_0 = \mu_0 = 1$.) The other virtual profits are unchanged and are given by (2). The analysis requires no assumption of symmetric information within the merged entity. $\square$

To describe in more details the effects of vertical integration, let $\pi_{(n)}^v$ and $\pi_{(n-1)}^v$ denote the highest and second highest value of the virtual profits among the n outside suppliers. We identify four possible regions:

1. *Pure EDM*: $\Pi^m(c_0) > \pi_0^v > \pi_{(n)}^v$. In this case, supplier S_0 produces both pre- and post-merger. Vertical integration thus modifies the traded quantity from $q^m(\Psi_0(c_0;\mu_0))$ to $q^m(c_0)$. In this region, the merging parties benefit from the merger whereas the outside suppliers are unaffected. The efficiency gain arising from EDM is passed on to final consumers, hence the textbook Pareto-improvement due to vertical integration.

2. *Customer Foreclosure*: $\Pi^m(c_0) > \pi_{(n)}^v > \pi_0^v$. Post-merger, the weight of S_0 has increased and internal procurement is now preferred. The foreclosed supplier is deprived of the access to the final consumers and is therefore harmed by the merger, while the merging parties are jointly better off. The impact of vertical integration on the consumers is a priori non trivial in this area and is discussed in Proposition 6 below.

3. *Exploitation*: $\pi_{(n)}^v > \Pi^m(c_0) > \pi_{(n-1)}^v$. The same supplier $S_{(n)}$ produces pre- and post-merger, with the same quantities being traded in both cases. The profit of the independent supplier, $\int_{\underline{c}_i}^{c_i^*} q^m(\Psi_i(c;\mu_i))\,\mathrm{d}c$, is lower because the merger causes the threshold c_i^* to fall, hence exploitation.[22] Consumers are unaffected by the merger.

4. *Indifference*: $\pi_{(n-1)}^v > \Pi^m(c_0)$. In this case, the merger does not have any effect. Supplier $S_{(n)}$ produces and effectively competes with $S_{(n-1)}$ pre- and post-merger.[23]

[22] The threshold falls because $\Psi_0(c_0;\mu_0)$ is replaced with c_0.

[23] In a symmetric environment, the probability of indifference tends to one and the profitability of the merger diminishes to zero as the number of potential suppliers grows large.

Final consumers benefit from the merger in the pure EDM region and are unaffected in the exploitation and indifference regions. In the foreclosure area, the merger causes the buyer to switch from an independent supplier S_i to the acquired supplier S_0, and hence the quantity to move from $q^m(\Psi_i(c_i;\mu_i))$ to $q^m(c_0)$. The resulting quantity variation depends on two opposite effects. On the one hand, the merger eliminates DM for the internal supplier, which pushes the post-merger quantity upwards. On the other hand, it locally creates a cost inefficiency, which pushes the post-merger quantity downwards. Specifically, because $\Pi^m(c) > \pi_i^v(c)$ for any c, we have $c_i < c_0$ along the boundary of the foreclosure area where the equality $\Pi^m(c_0) = \pi_i^v(c_i)$ holds. Therefore, in a neighborhood of that boundary, the production cost increases from c_i to c_0. Proposition 6 underlines the role of the bargaining weights λ_i and μ_i in this tradeoff.

Proposition 6. *The post-merger make-or-buy decision is aligned with the final consumers' interest if and only if $\lambda_i \geq \mu_i$ for all i. In this case, a merger between the buyer and any supplier enhances consumer welfare for all values of the suppliers' costs. Otherwise, if $\lambda_j < \mu_j$ for some independent supplier, the eviction of that supplier harms consumers with positive probability.*

Proof. Suppose first that $\lambda_i \geq \mu_i$ for all i. Because the virtual profit increases with λ_i, we have $\pi_i^v \geq \Pi^m(\Psi_i(c_i;\mu_i))$. If supplier i is foreclosed due to the merger, we have $\Pi^m(c_0) \geq \pi_i^v$, hence $\Pi^m(c_0) \geq \Pi^m(\Psi_i(c_i;\mu_i))$, or equivalently $q^m(\Psi_i(c_i;\mu_i)) \leq q^m(c_0)$. It follows that the merger causes the quantity to rise and improves consumer welfare.

Next, suppose $\lambda_j < \mu_j$ for some j. By monotonicity of the virtual profit, this implies $\pi_j^v < \Pi^m(\Psi_j(c_j;\mu_j))$. The foreclosure region can thus be broken down in two subregions, see Figure 2. If $\pi_0^v < \pi_j^v < \Pi^m(c_0) < \Pi^m(\Psi_j(c_j;\mu_j))$, the switch from S_j to S_0 harms final consumers due to a lower quantity: $q^m(c_0) < q^m(\Psi_j(c_j;\mu_j))$. On the contrary, if $\pi_0^v < \pi_j^v < \Pi^m(\Psi_j(c_j;\mu_j)) < \Pi^m(c_0)$, final consumers benefit from a larger quantity. □

The first part of Proposition 6 supports the optimistic view that vertical integration benefit consumers. A special case is the standard Myersonian setup where the buyer has full bargaining power ($\lambda_i = \mu_i = 0$ for all i). More generally, when the suppliers' bargaining weights do not increase between the selection and the production stages, in particular under one-stage bargaining, customer foreclosure is associated with a rise in quantity and thus is not anticompetitive. Final consumers unambiguously benefit from a vertical merger. In fact, in this bargaining environment, they would like more foreclosure.

The second part calls for a tougher stance on the treatment of EDM in vertical mergers. In the arguably realistic case where suppliers gain bargaining power after selection ($\mu_i > \lambda_i$), there is anticompetitive customer foreclosure. Corollary 1 highlights that in the absence of DM prior to the merger customer foreclosure unambiguously harms final consumers.

Corollary 1. *Suppose that the potential suppliers have identical cost distributions ($F_i = F$), the buyer fully controls the selection decision ($\lambda_i = 0$ for all i), and there is no DM pre-merger ($\mu_i = 1$). Then final consumers are surely harmed by the foreclosure of independent suppliers.*

With symmetric suppliers and no double marginalization ($\mu = 1$), consumer surplus is maximal for any values of the suppliers' costs prior to the merger. The buyer purchases from the most efficient supplier and the equilibrium quantity is $q^m(\min c_i)$. After the merger, in the customer foreclosure region, the buyer purchases from the acquired supplier while it is less efficient than an independent supplier, hence a fall in the traded quantity and a loss in consumer surplus.[24]

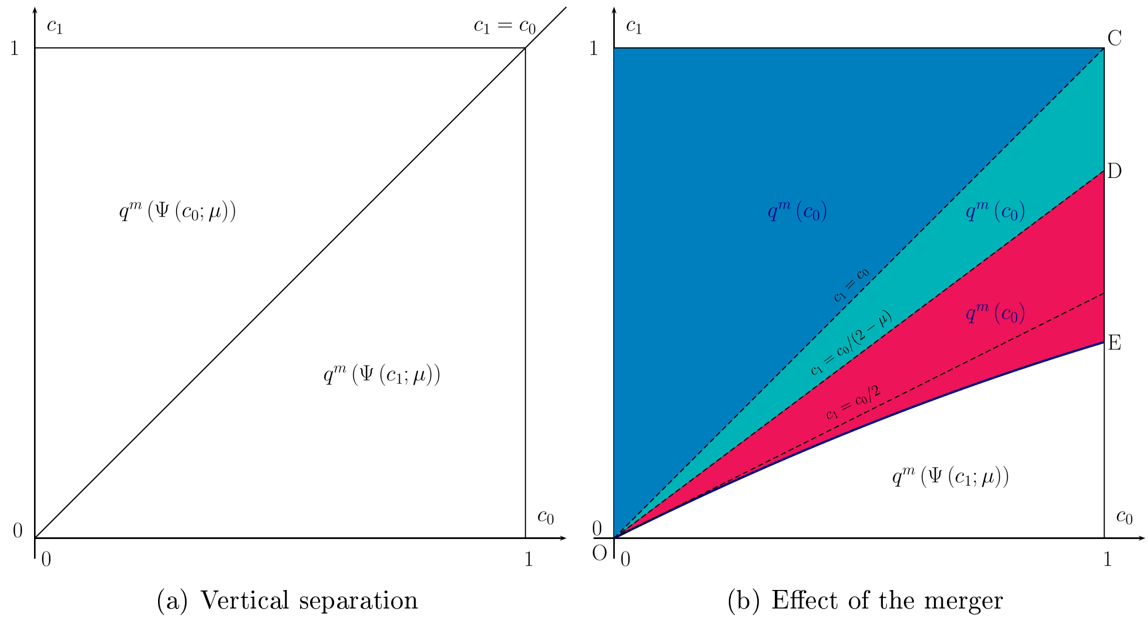


Figure 2: Effect of the merger on consumers' surplus. Suppliers' costs are uniform on $[0, 1]$, demand is linear, $\lambda_0 = \lambda_1 = 0$, and $0 < \mu_0 = \mu_1 < 1$.
Foreclosure area: OCE. Consumer harm: ODE. Consumer benefit: ODC

Example (continued) Assume there are two symmetric potential suppliers, $\lambda_0 = \lambda_1$, $\mu_0 = \mu_1 = \mu$. Under vertical separation, the most efficient firm is selected but the

[24]We show in Section 4.2 how this result is modified in asymmetric environments.

quantity is downwards distorted, as shown on Figure 2(a). The post-merger equilibrium is represented on Figure 2(b).[25] The pure EDM region is located above the 45 degree line. The exploitative region is the area below OE and is left uncolored. The customer foreclosure region, OCE, is cut in two parts by the OD line along which the actual cost of the upstream entity equals the virtual cost of the independent supplier, $c_0 = \Psi(c_1; \mu)$. Consumers prefer the buyer to supply internally above the line (i.e., in the blue-green ODC region) and to supply from the independent supplier below the line (i.e., in the red ODE area).

Figures 3(a) and 3(b) further stress the role of bargaining over prices and quantity. When DM is severe pre-merger (μ small), backward integration mostly benefits consumers. On the contrary, when the DM phenomenon is mild (μ is large), customer foreclosure mostly harms final consumers. In the symmetric environment, anticompetitive foreclosure arises whenever the suppliers' bargaining power increases between the selection and production stages ($\lambda < \mu$), and is magnified when $\lambda = 0$ and $\mu = 1$.

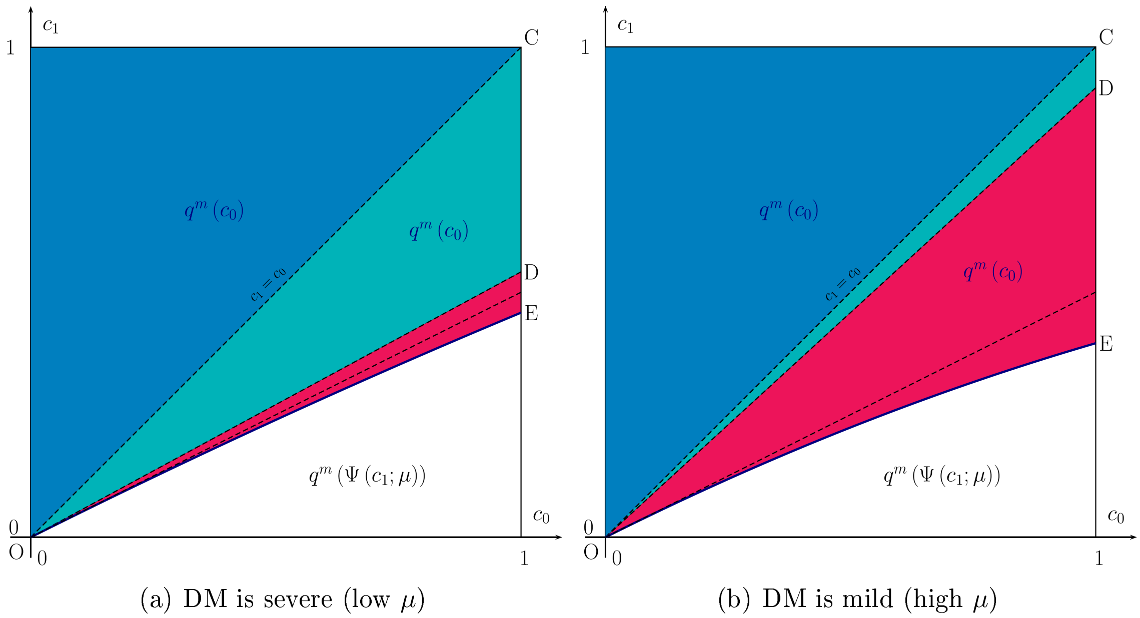


Figure 3: Role of bargaining over price and quantity. Suppliers' costs are uniform on $[0, 1]$, demand is linear, $\lambda_0 = \lambda_1 = 0$, and $0 < \mu_0 = \mu_1 = \mu < 1$. Foreclosure area: OCE. Consumer harm: ODE

Imperfect internalization within the integrated firm So far, we have assumed that the post-merger bargaining weights of the acquired supplier are $\lambda_0' = \mu_0' = 1$. Following Crawford, Lee, Whinston, and Yurukoglu (2018), we now relax this assump-

[25] Details can be found in Appendix F.2.

tion. We assume that vertical integration yields increased, but not necessarily perfect, internalization of profits within the merged entity: $\lambda_0 < \lambda_0' \leq 1$ and $\mu_0 < \mu_0' \leq 1$. In particular, when $\mu_0 < \mu_0' < 1$, the double marginalization phenomenon is alleviated but is not fully eliminated when the buyer supplies internally post-merger.

We know from the first part of Proposition 6 that the merger is pro-competitive when the bargaining weights are the same at the selection and production stages. This remains true even if there remains some double marginalization within the merged entity.

Corollary 2. *Suppose there is one-stage bargaining ($\lambda_i = \mu_i$ for any supplier i) and imperfect internalization ($\lambda_0 = \mu_0 < \lambda_0' = \mu_0' < 1$). Then independent suppliers are foreclosed from the market with positive probability, but final consumers are better off post-merger for all values of the suppliers' costs.*

Proof. S_0's virtual profit increases from $\Pi^m(\Psi_0(c_0;\lambda_0))$ pre-merger to $\Pi^m(\Psi_0(c_0;\lambda_0'))$ post-merger. It follows that independent suppliers lose access to the market with positive probability. When supplier i is foreclosed, $\Pi^m(\Psi_0(c_0;\lambda_0)) \leq \pi_i^v = \Pi^m(\Psi_i(c_i;\lambda_i)) \leq \Pi^m(\Psi_0(c_0;\lambda_0'))$, the quantity raises from $q^m(\Psi_i(c_i;\lambda_i))$ to $q^m(\Psi_0(c_0;\lambda_0'))$, which benefits consumers.

On the other hand, when the buyer still supplies from S_0 post-merger, consumers are better off as well thanks to the reduction in the double margin: the quantity increases from $q^m(\Psi_0(c_0;\lambda_0))$ to $q^m(\Psi_0(c_0;\lambda_0'))$. □

Similarly, the anti-competitive effect of customer foreclosure when the suppliers gain bargaining power at the production stage (second part of Proposition 6) holds true when some double marginalization subsists within the integrated structure. In other words, we can relax the assumption $\lambda_0' = \mu_0' = 1$ as the next result shows.

Corollary 3. *Suppose $\lambda_j < \mu_j$ for some independent supplier. Suppose also that $\mu_0' = \lambda_0' > \max(\lambda_0, \mu_0)$. Then with positive probability the eviction of supplier j harms final consumers.*

Proof. Because $\mu_0' = \lambda_0' > \max(\lambda_0, \mu_0)$, S_0's virtual surplus is higher post-merger than pre-merger, hence foreclosure. By monotonicity of the virtual profit, we have $\pi_j^v < \Pi^m(\Psi_j(c_j;\mu_j))$. Along the boundary of the foreclosure region, $\pi_j^v = \Pi^m(\Psi_0(c_0;\mu_0'))$, which implies $\Psi_0(c_0;\mu_0') > \Psi_j(c_j;\mu_j)$. Hence, locally the merger causes S_j to be replaced with S_0 and the quantity to fall from $q^m(\Psi_j(c_j;\mu_j))$ to $q^m(\Psi_0(c_0;\mu_0'))$. □

Total welfare Total welfare $W(q; c) = \int_0^q P(x)dx - C(q) - cq$ is highest when the buyer deals with the most efficient supplier (i.e., with the lowest marginal cost). In the absence of vertical integration, efficiency would be achieved when the buyer selects a supplier through an inverse second-price auction without reserve price.

The effect of vertical integration on total welfare is as follows. In the pure EDM region, total welfare increases unambiguously. In the exploitation and indifference regions, total welfare is unaffected. Hereafter, we focus on the foreclosure region, where total welfare moves from $W(q^m(\Psi_i(c_i; \mu_i)); c_i)$ to $W(q^m(c_0); c_0)$ as the independent supplier S_i is replaced with S_0. As explained above, the merger reduces the double margin inefficiency (if any) but locally increases production costs.[26]

Proposition 7. *Whenever vertical integration harms final consumers, it lowers total welfare.*

Proof. Suppose that Supplier i is foreclosed from the market. Final consumers are harmed if and only if the quantity falls post-merger, i.e., $q^m(c_0) < q^m(\Psi_i(c_i; \mu_i))$ or equivalently $c_0 > \Psi_i(c_i; \mu_i)$. The latter condition implies $c_0 > c_i$, hence a fall in total welfare (lower quantity, higher unit cost). $\square$

Proposition 7 states that the region associated with total welfare losses is broader than the region associated with consumer surplus losses. Antitrust authorities should keep in mind that even if a vertical merger benefits final consumers, it can be welfare-detrimental due to productive misallocation. On Figure 4, this occurs in the ODD' area. Total welfare falls in $OD'E$, while consumer surplus falls in the narrower region OED.[27]

4.2 Asymmetric environments

In this section, we consider environments where potential suppliers differ in cost distributions or bargaining power. We first highlight pro-competitive aspects of customer foreclosure in such environments. Next, as the potential suppliers are ex ante different, the question arises of which supplier the buyer prefers to merge with. To convey intuitions more transparently, we restrict attention to the case with two potential suppliers.

Pro-competitive aspect of customer foreclosure We now show that vertical mergers may benefit consumers by correcting preexisting distortions. If under vertical separation the procurement process discriminates a supplier, its acquisition eliminates

[26] Recall that close to the boundary of the foreclosure region, $\Pi^m(c_0) = \pi_i^v(c_i)$, we have $c_0 > c_i$.

[27] The equation of OD' in the example is given in Appendix F.2.

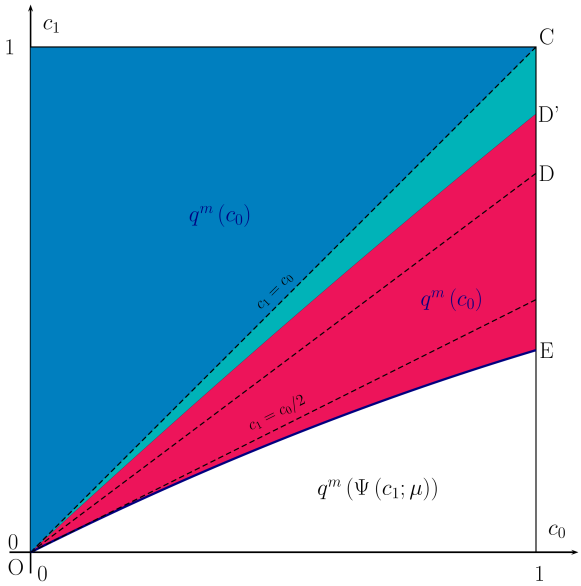


Figure 4: Effect of the merger on total welfare (symmetric suppliers). Suppliers' costs are uniform on $[0,1]$, demand is linear $\lambda_0 = \lambda_1 = 0$, and $0 < \mu_0 = \mu_1 = \mu < 1$.
Foreclosure area: OCE. Consumer harm: ODE. Fall in total welfare: $OD'E$

the pre-merger productive misallocation while leading to the foreclosure of independent suppliers.[28]

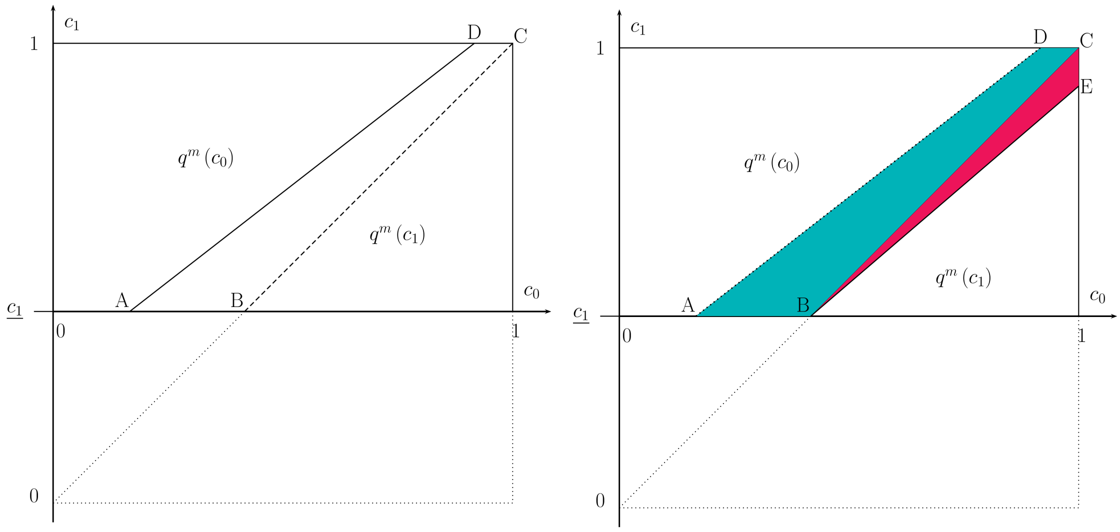
Proposition 8. *Suppose that prior to the merger supplier selection is biased against S_0, i.e., the buyer supplies from S_1 in a region of the cost parameters where $c_1 > c_0$. Then vertical integration causes the buyer to switch from S_1 to S_0 in this region, which benefits final consumers.*

Proof. See Appendix G. □

Proposition 8 applies when the pre-merger selection boundary $\pi_1^v(c_1) = \pi_0^v(c_0)$ lies above the 45 degree line, i.e., when $\pi_1^v(c) > \pi_0^v(c)$ for all c. From the monotonicity properties of the virtual profit, this condition holds in particular when $F_0 = F_1$ and either $\lambda_0 = \lambda_1 < \mu_1 < \mu_0$ or $\lambda_0 < \lambda_1$, $\mu_0 = \mu_1$. It also holds in the configuration considered below.

Corollary 4. *Suppose that the buyer fully controls the selection decision ($\lambda_0 = \lambda_1 = 0$), there is no DM pre-merger ($\mu_0 = \mu_1 = 1$), and c_0 is lower than c_1 in the likelihood ratio order ($F_0/f_0 > F_1/f_1$). Then final consumers benefit from the foreclosure of S_1 with positive probability.*

[28]The merger between Turner and Time Warner illustrates the forces at play. Suzuki (2009) finds that Time Warner was foreclosing many Turner channels prior to the merger and was on the contrary favoring these channels post-merger (to the detriment of independent channels).



(a) Vertical separation (b) Effect of the merger

Figure 5: Acquired supplier more efficient than independent supplier ($F_0/f_0 > F_1/f_1$). $\mu_0 = \mu_1 = 1$. Foreclosure area: $ABECD$. Consumer benefit: $ABCD$. Consumer harm: ACE

In section 4.1, we established that in symmetric environments with no DM pre-merger foreclosure of independent suppliers harms final consumers with probability one (recall Corollary 1). Corollary 4 highlights the role of the symmetry assumption in this result. When S_0 is more likely to have lower costs than his rival, the pre-merger mechanism discriminates against S_0. The asymmetry of the cost distributions implies a distortion in favor of the weakest supplier, as is standard in the Myerson framework. Vertical integration corrects this distortion and the foreclosure of S_1 is partly pro-competitive.

Figure 5(a) illustrates Corollary 4 when the costs of the acquired supplier and of the independent supplier are uniformly distributed on $[0, 1]$ and $[\underline{c}_1, 1]$, $\underline{c}_1 > 0$, respectively. Under separation, the buyer selects supplier S_1 when (c_0, c_1) lies at the right of (AD), although in the $ABCD$ area S_1 is less efficient than S_0. Post-merger, the buyer on the contrary favors her internal supplier, which is selected when (c_0, c_1) lies at the left of (BE), see Figure 5(b). This creates a productive misallocation in BEC where S_0 is selected and is less efficient than S_1. In sum, the customer foreclosure region –the area $ABECD$– can be divided in two subregions. In $ABCD$, the quantity rises from $q^m(c_1)$ to $q^m(c_0)$, which benefits consumers. This is because the merger restores productive efficiency in this region. In BEC, the quantity falls from $q^m(c_1)$ to $q^m(c_0)$, which harms the consumers.

Choice of merging partner We now allow the choice of the acquired supplier to be endogenous. We assume that the buyer can approach each of the two suppliers and make take-it-or-leave-it offer with a payment in exchange of vertical integration. As the merger is jointly profitable it will take place, with the supplier that rejects the offer become the independent supplier. The buyer must leave the corresponding profit to convince a supplier to accept her offer. Let $\Pi^i_{BS_i}$ and $\Pi^i_{S_j}$ denote the joint profit of the merging parties B and S_i and the profit of the outsider S_j in the case where B and S_i have merged, $i \neq j$. The buyer prefers to approach S_0 if and only if

$$\Pi^0_{BS0} - \Pi^1_{S_0} \geq \Pi^1_{BS_1} - \Pi^0_{S_1},$$

which occurs if and only if the total industry profit is higher under the BS_0-merger than under the BS_1-merger.

We first emphasize the role of cost distributions. We focus on the bargaining environment of Corollary 4.

Proposition 9. *Suppose that the buyer fully controls the selection decision ($\lambda_0 = \lambda_1 = 0$), there is no DM pre-merger ($\mu_0 = \mu_1 = 1$), and c_0 is lower than c_1 in the likelihood ratio order ($F_0/f_0 > F_1/f_1$) Then the buyer prefers to integrate with supplier S_0.*

From Corollary 4 and Proposition 9, we conclude that the presence of asymmetric suppliers ex ante tends to make the vertical merger less harmful to consumers. The reason is as follows. Under separation, the allocation is distorted towards the weaker buyers, resulting in suboptimal quantities and a loss in consumer welfare. The buyer is likely to integrate with the most efficient supplier, which causes the less efficient one to be excluded from the market in a large region. In the subregion of the foreclosure zone where productive efficiency is restored, the switch to the internal supplier is beneficial to consumers.

Next, we examine how the choice of the acquired supplier depends on the suppliers' bargaining weights. We first show that under one-stage bargaining (i.e., when the bargaining weights remain constant between selection and production), the buyer prefers to merge with the less powerful supplier.

Proposition 10. *Suppose there are two potential suppliers with the same cost distribution F and bargaining weights $\lambda_0 = \mu_0 > \lambda_1 = \mu_1$. The post-merger industry profit is higher when the buyer integrates with S_1 than when she integrates with S_0. As a result, she prefers to integrate with S_1 than with S_0.*

Proof. See Appendix I □

The result of Proposition 10 involves two effects that play in the same direction. First, when post-merger the buyer purchases from the independent supplier, the quantity and industry profit increase with the bargaining power of that supplier at the production stage, so a larger weight of the outsider is associated with a higher industry profit. This pushes the buyer to merge with the aggressive supplier, S_1. Second, there is more foreclosure if she acquires S_0 than if she acquires S_1, and as a result a higher industry profit in the latter case. This, again, pushes the buyer to acquire S_1 rather than S_0.

Example: Acquiring the less aggressive supplier Suppose $a = 3$, $F_0 = F_1$ uniform on $[0, 1]$, $\lambda_0 = \mu_0 = .8$, $\lambda_1 = \mu_1 = .2$. Then the industry profit is higher when B merges with S_1 (1.786) than when she merges with S_0 (1.751). Then the buyer prefers to merge with the less aggressive supplier S_1.

Finally, we check that the above results, which may seem counterintuitive, are potentially reversed when the buyer fully controls the selection decision. The reason is that in this case there is *less* foreclosure if she acquires S_0 than if she acquires S_1, which pushes the buyer to acquire S_0.

Example: Acquiring the most aggressive supplier Suppose $a = 3$, $F_0 = F_1$ is uniform on $[0, 1]$, $\lambda_0 = \lambda_1 = 0$, $\mu_0 = 1 > \mu_1 = 0$. Then the industry profit is higher when B merges with S_0 (1.740) than when she merges with S_1 (1.738). Hence the buyer prefers to merge with the most aggressive supplier S_0. This example show that when the buyer fully controls the selection decision, she may want to acquire the most aggressive supplier and leave the less aggressive one as the independent supplier. See Appendix J for details.

5 Discussion

As explained by Spengler (1950), suppliers endowed with market power charge prices to intermediate buyers that exceed their marginal cost, which combined with downstream mark-ups may result in inefficiently low quantities and high retail prices. In the textbook successive monopolies model, the final price exceeds the price that would be charged by a vertically integrated firm. In that sense, vertical mergers eliminate the double marginalization problem and allow the new entity to set a lower price thereby increasing aggregate profits and consumer surplus simultaneously. The entrenched view that vertical mergers help solving the double marginalization problem even led the FTC

Bureau of Competition Director to argue in 2018 that *"due to the elimination of double-marginalization and the resulting downward pressure on prices, vertical mergers come with a more built-in likelihood of improving competition than horizontal mergers."*[29]

On the other hand, the perception of EDM claims as "intrinsic" efficiency justifications has been heavily criticized. For instance, Salop (2018) argues that such claims do not deserve to be silver bullets in vertical merger cases and advocates for more stringent policy intervention.[30] Slade and Kwoka Jr (2020) regret that "*policy analysis has continued to treat the claimed benefits from EDM relatively uncritically, too often automatically crediting vertical mergers with the cost saving benefits predicted by the classic economic model.*" In particular, they stress that EDM claims assume that the alleged cost savings require vertical integration for their realization, i.e., that the cost savings should be merger-specific.

The paper sets out the theoretical foundations that underly merger-specific EDM. Our analysis shows that under vertical separation nonlinear pricing does not suffice to eliminate DM when production costs are privately known. Hence, under such circumstances, EDM can be merger-specific. Our results also highlight the role of bargaining in the severity of the DM phenomenon. In the *Comcast - NBCU* merger, the DoJ concluded that *"much, if not all, of any potential double marginalization is reduced, if not completely eliminated, through the course of contract negotiations."*[31] We find that more balanced bargaining when deciding price and quantities (our "production stage") is associated with less severe DM, all else equal.

Regarding the welfare analysis of vertical integration, it is remarkable that the section of the 2020 U.S. Vertical Merger Guidelines devoted on pro-competitive effects is only concerned with estimating *"the likely cost saving to the merged firm from self-supplying inputs that would have been purchased from independent suppliers absent the merger"*, but never mentions quantifying the benefits to direct and/or final customers. By contrast, European enforcers explicitly insist that, as they do for any efficiency claim in horizontal merger cases, they will consider EDM claims only if they meet three conditions: they are verifiable, merger-specific, and they benefit consumers.[32] Although we have examined the effect on total surplus, the main focus of the paper is on final

[29]Speech given in January 2018 at the Crédit Suisse 2018 Washington Perspectives Conference, https://www.ftc.gov/system/files/documents/public_statements/1304213/hoffman_vertical_merger_speech_final.pdf.

[30]See also Salop and Culley (2016).

[31]Competitive Impact Statement at 30, United States v. Comcast Corp., 808 F. Supp. 2d. 145 (D.D.C. 2011) (No. 1:11-cv-00106), http://www.justice.gov/atr/case-document/file/492251/download or http://perma.cc/LE6C-U37X.

[32]See EU Non-Horizontal Merger Guidelines, European Commission (2008), paragraphs 53 and 55.

consumers. As put forward by FTC Commissioner Slaughter *achieving EDM is not guaranteed. Nor are the benefits of EDM always passed along to consumers."*[33]

EDM and foreclosure effects are closely intertwined and should be considered jointly.[34] The welfare effects of vertical integration critically depend on the bargaining environment. We find that foreclosure of independent suppliers does not necessarily harms final consumers. In fact, when the buyer has equal bargaining power at the production stage than at the selection stage, she acts as a perfect agent for final consumers. Post-merger make-or-buy decision harm consumers only if the buyer has less bargaining power when negotiating prices and quantities than when selecting suppliers. These findings call for a thorough examination of pre-merger negotiations. Antitrust enforcers should investigate how suppliers are selected and how quantities are determined. They should document the buyer's ability to exclude suppliers from negotiations and impose quantity and prices. Does a formal selection process prevent losers from participating in subsequent negotiations? Do we observe contractual amendments that change quantity and price?

The theory of harm put forward in the paper is simple and direct. By contrast, the EU guidelines on non-horizontal mergers suggest an indirect mechanism whereby the reduced access to a large customer for upstream rivals harms downstream rivals and in turn final consumers.[35] As to Example 5 of the 2020 U.S. Vertical Merger Guidelines, it considers the same market structure as we do, with a dominant buyer and multiple suppliers, but does not elaborate a theory of harm for customer foreclosure.[36] In this study, we have demonstrated that when the buyer is able to exclude independent suppliers and DM is not severe pre-merger, then customer foreclosure will cause production costs to rise and the traded quantity to fall. Hence, consumer harm comes *directly* from the impact on upstream rivals. We have checked, however, that foreclosure is a two-edged

[33]In the AT&T - Time Warner merger, the DoJ's expert witness conceded efficiency benefits from EDM of the order of $350 million: *"According to the Government's expert, Professor Shapiro, EDM would result in AT&T lowering the price for DirecTV by a significant amount: $1.20 per-subscriber, per month."*, see Judge Leon Memorandum Opinion (page 67), U.S. v. AT&T Inc., *et al.*, June 12, 2018, Civil Case No.17-2511, US District Court of Columbia. However, it appears that AT&T raised the prices of its video streaming service three times during the 18 months that followed the transaction closing. See the contribution to the debate on the Draft Vertical Merger Guidelines by Public Knowledge and Open Technology Institute.

[34]See FTC Commissioner Wilson's reflections on the 2020 Draft Vertical Merger Guidelines, Wilson (2020). See also Das Varma and De Stefano (2020).

[35]See Section IV.A.2, "Customer foreclosure", in European Commission (2008). This theory of customer foreclosure, which is reminiscent of Ordover, Saloner, and Salop (1990), requires to demonstrate successively the effect on upstream suppliers, its transmission to downstream rivals, and the impact on final consumers.

[36]Moreover, this example assumes "supply at a constant unit wholesale price", leaving the issue of merger-specificity unresolved.

sword, as put by Slade (2020). Foreclosure may benefit consumers when the pre-merger procurement mechanism is distorted and vertical integration eliminates the preexisting distortion.

The empirical literature on vertical relationships and vertical integration relies on the complete information paradigm, and hence tends to equate double marginalization with linear pricing.[37] By contrast, the empirical literature on procurement, auction and nonlinear pricing emphasizes asymmetric information and develops methods to identify distributions of suppliers' costs, while generally assuming strong bargaining power on the buyer side.[38] It remains to be seen whether methods from these two strands of empirical literature can be combined to shed light on incomplete information and bargaining in Industrial Organization.

[37] See Section 1.

[38] See the recent survey by Perrigne and Vuong (2019).

APPENDIX

A Proof of Proposition 1

Supplier S_j's utility if he report a cost $\widehat{c}_j$ while his true cost is c_j and the other suppliers report truthfully is then

$$U_j(\widehat{c}_j;\mathbf{c}) = (M_j - c_j Q_j)\,, \tag{A.1}$$

where Q_j and M_j are evaluated at $(\widehat{c}_j, \mathbf{c}_{-j})$. Supplier S_j's expected utility is defined as

$$u_j(c_j) = \max_{\widehat{c}_j}\ \mathbb{E}_{\mathbf{c}_{-j}} U_j(\widehat{c}_j, \mathbf{c}_{-j}). \tag{A.2}$$

By the envelope theorem, the derivative of the rent is

$$u_j'(c_j) = -\mathbb{E}_{\mathbf{c}_{-j}}\ \left[Q_j(c_j, \mathbf{c}_{-j})\right]. \tag{A.3}$$

Setting the payment M_j eliminates any rent for the least efficient types, $u_j(\bar{c}_j) = 0$. Computing the expected value of $u_j(c_j)$ and integrating by parts yields:

$$\begin{aligned}
\mathbb{E}_{\mathbf{c}} U_j(\mathbf{c}) &= \int_{\underline{c_j}}^{\overline{c_j}} u_j(c_j)\,\mathrm{d}F_j(c_j) = \int_{\underline{c_j}}^{\overline{c_j}} \mathbb{E}_{\mathbf{c}_{-j}}\left[Q_j(c_j, \mathbf{c}_{-j})\right] F_j(c_j) dc_j \\
&= \mathbb{E}_{\mathbf{c}}\left[Q_j(c_j, \mathbf{c}_{-j}) \frac{F_j(c_j)}{f_j(c_j)}\right].
\end{aligned}$$

Conditional on $\mathbf{c}$, the weighted industry profit is

$$R\left(\sum_{j\in\mathcal{S}} Q_j\right) - \sum_{j\in\mathcal{S}} M_j + \sum_{j\in\mathcal{S}} \mu_j U_j = R\left(\sum_{j\in\mathcal{S}} Q_j\right) - \sum_{j\in\mathcal{S}} \left(c_j Q_j + (1-\mu_j) U_j\right).$$

Taking the expectation over $\mathbf{c}$ and substituting for the value of $\mathbb{E}_{\mathbf{c}} U_j$, the expected weighted industry profit can be rearranged into

$$\mathbb{E}_{\mathbf{c}}\left[R\left(\sum_{j\in\mathcal{S}} Q_j\right) - \sum_{j\in\mathcal{S}} \Psi_j(c_j;\mu_j) Q_j\right].$$

The above expression is maximum when the supplier with the lowest weighted virtual cost, $\Psi_j(c_j;\mu_j)$, produces $Q_j = q^m(\Psi_j(c_j;\mu_j))$ and the other suppliers do not produce.

B Monotonicity of the virtual profit

The virtual profit given by (2) decreases with c if and only if

$$(\mu-\lambda)\frac{\Psi(c;\mu)\,(q^m)'}{q^m} < \frac{cf(c)}{F(c)}\;\frac{\Psi(c;\mu)}{c}\;\frac{1+(1-\lambda)(F/f)'}{1+(1-\mu)(F/f)'}, \tag{B.1}$$

where q^m and $(q^m)'$ are evaluated at $\Psi(c;\mu)$. If $\mu \le \lambda$, the inequality is automatically satisfied. If $\mu > \lambda$, the last two factors at the right-hand side are larger than one, implying that (B.1) is satisfied if

$$(\mu-\lambda)\varepsilon_q(\Psi(c;\mu)) < \varepsilon_F(c), \tag{B.2}$$

where $\varepsilon_q(c) = -c(q^m)'/q^m$ and $\varepsilon_F = cf/F$ are the elasticities of q^m and F with respect to c. In our baseline example, the suppliers' costs are uniformly distributed on $[0,1]$, hence $\varepsilon_F = 1$. The elasticity of the monopoly demand $q^m = (a-c)/2$ is $\varepsilon_q = c/(a-c)$, which tends to zero as a grows large. It follows that (B.1) and (B.2) hold when a is large enough.

C Proof of Proposition 2

Assume that the suppliers belonging to a subset $\mathcal{S}$ of $\{0,1,\ldots,n\}$ have been selected and consider the price-quantity bargaining at the second stage of the procurement process. Because the selection rule is monotonic, the distributions of the costs of the selected suppliers $j \in \mathcal{S}$ obtain from right-truncations of the original distributions F_j. Supplier j is selected, $x_j(c_j, c_{-j}) = 1$, is equivalent to $c_j \le c_j^{\mathrm{Sel}}$ for a certain threshold $c_j^{\mathrm{Sel}}(c_{-j})$. The right-truncations leave the virtual costs $\Psi_j(c_j;\mu_j)$ unchanged. From Proposition 1, we know that under the optimal mechanism only the supplier with the lowest virtual cost among the selected suppliers sells a positive quantity, namely $q^m(\Psi_j(c_j;\mu_j))$. The cost of the active supplier is below $c_j^{\mathrm{Prod}}(c_{-j})$ with

$$c_j^{\mathrm{Prod}}(c_{-j}) = \max\left\{\, c_j \le \bar{c}_j \mid \Psi_j(c_j;\mu_j) \le \min_{k\in\mathcal{S}\setminus j} \Psi_k(c_k;\mu_k) \,\right\}.$$

Let $\tilde{x}_j$ denote the indicator that the supplier j is selected and active at the production stage. The function $\tilde{x}_j(c_j, c_{-j}) = 1$ is given by $c_j \le \tilde{c}_j$ with

$$\tilde{c}_j = \min\left(c_j^{\mathrm{Sel}},\, c_j^{\mathrm{Prod}}\right),$$

and is therefore non-increasing in c_j. Conditionally on c_{-j}, supplier j expected rent is given by

$$\mathbb{E}\left(x_j U_j \; | c_{-j}\right) = \int_{\underline{c}_j}^{\tilde{c}_j(c_{-j})} q^m(\Psi_j(c_j;\mu_j))F_j(c)\,\mathrm{d}c.$$

At the selection stage, the bargaining mechanism maximizes

$$\begin{aligned}
\mathbb{E}\;\sum_j \tilde{x}_j\;\{R(q^m(\Psi_j(c_j;\mu_j))) - c_j q^m(\Psi_j(c_j;\mu_j)) - U_j(c_j,c_{-j})\;+\lambda_j U_j(c_j,c_{-j})\} &= \\
\mathbb{E}\;\sum_j \tilde{x}_j\;\left\{R(q^m(\Psi_j(c_j;\mu_j))) - c_j q^m(\Psi_j(c_j;\mu_j)) - (1-\lambda_j)\frac{F_j(c_j)}{f_j(c_j)}q^m(\Psi_j(c_j;\mu_j))\right\} &= \\
\mathbb{E}\;\sum_j \tilde{x}_j\;\{R(q^m(\Psi_j(c_j;\mu_j))) - \Psi_j(c_j;\lambda_j)q^m(\Psi_j(c_j;\mu_j))\;\} &= \\
\mathbb{E}\;\sum_j \tilde{x}_j\;\Pi(q^m(\Psi_j(c_j;\mu_j));\Psi_j(c_j;\lambda_j)).&
\end{aligned}$$

The above quantity is maximal if and only if $\tilde{x}_j = 1$ is equivalent to $\pi_j^v = \max_{k\in\mathcal{N}}\pi_k^v$ where the virtual profit is defined by (2). This selection rule is monotonic provided that the virtual profit decreases with c. It defines the optimal selection threshold $c_j^*(c_{-j})$ and the corresponding quantities

$$Q_i(\mathbf{c}) = \begin{cases} q^m\left(\Psi_i(c_i;\mu_i)\right) & \text{if } c_i \le c_i^*(\mathbf{c_{-i}}) \\ 0 & \text{otherwise} \end{cases}$$

and payment

$$M_i(\mathbf{c}) = \begin{cases} c_i q^m\left(\Psi_i(c_i;\mu_i)\right) + \int_{c_i}^{c_i^*(\mathbf{c_{-i}})} q^m\left(\Psi_i(c;\mu_i)\right)dc & \text{if } c_i \le c_i^*(\mathbf{c_{-i}}) \\ 0 & \text{otherwise.} \end{cases}$$

D Proof of Proposition 3

Given the wholesale price $w_i(\tilde{c}_i) = \Psi_i(\tilde{c}_i;\mu_i)$ chosen by the winning supplier i, the buyer maximizes $R(q) - w_i(\tilde{c}_i)q$ and thus purchases $q^m(\Psi_i(\tilde{c}_i))$. Anticipating this, supplier i chooses $\tilde{c}_i$ to maximize

$$[w(\tilde{c}_i) - c_i]q^m(\Psi_i(\tilde{c}_i;\mu_i)) + M_i(\tilde{c}_i) = [\tilde{c}_i - c_i]q^m(\Psi_i(\tilde{c}_i;\mu_i)) + \int_{\tilde{c}_i}^{c_i^*(s)} q^m(\Psi_i(c;\mu_i))\,\mathrm{d}c$$

which is maximal for $\tilde{c}_i = c_i$. It follows that supplier i chooses the two-part tariff designed for him in the menu. When the clock index is s, supplier i anticipates that winning the contract would yield utility

$$\int_{c_i}^{c_i^*(s)} q^m(\Psi_i(c;\mu_i))\,\mathrm{d}c.$$

As this is positive if and only if $c_i < c_i^*$, remaining in the auction as long as $\pi_i^v(c_i)$ is higher than s is a dominant strategy. It follows that the supplier with the highest virtual profit wins the auction.

E Proof of Proposition 4

Assume first that $\lambda_i = \mu_i > \lambda_j = \mu_j$, which holds in particular under one-stage bargaining. We have: $\pi_i^v(c) = \Pi^m(\Psi(c;\mu_i)) > \Pi^m(\Psi(c;\mu_j)) = \pi_j^v(c)$ for any cost value c. This implies that $c_i > c_j$ along the boundary $\pi^v(c_i) = \pi^v(c_j)$, see Figure 1.

Next, assume that $\lambda_i = \lambda_j = 0$. We have $\pi_i^v(c) < \pi_j^v(c)$ because π_k^v decreases in μ_k when $\lambda_k = 0$, for $k = i, j$. This implies that $c_i < c_j$ along the boundary $\pi^v(c_i) = \pi^v(c_j)$.

The results extend locally by continuity.

F Example (details)

We provide details about the example with two potential suppliers, uniformly distributed costs, and linear demand.

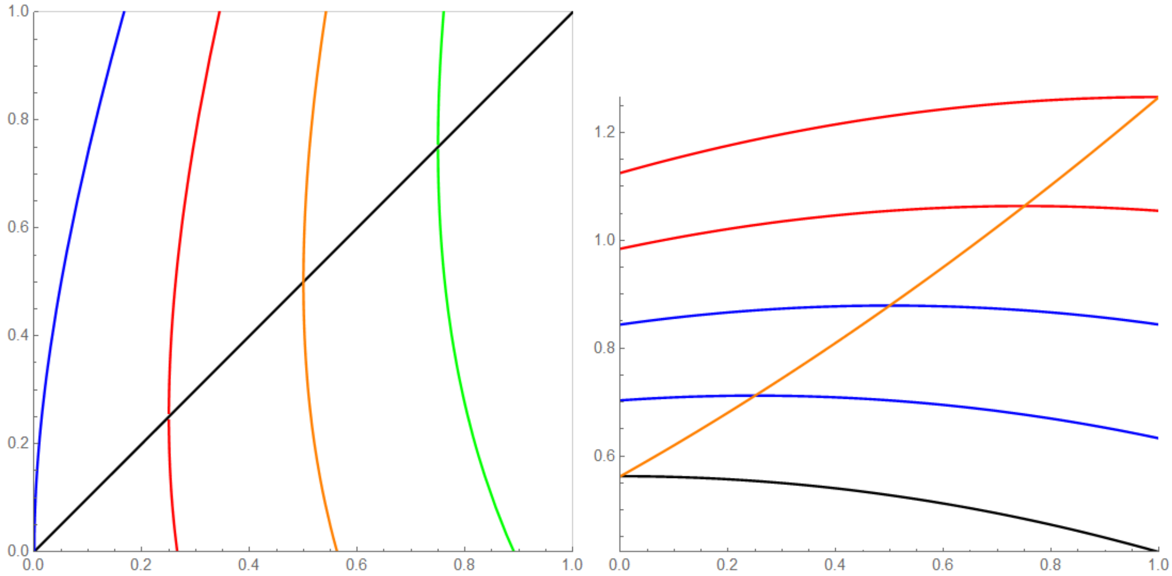
F.1 Vertical separation

Supplier S_0 is selected if and only if $c_1 \geq c_1^{\mathrm{vs}}(c_0)$ with the selection threshold $c_1^{\mathrm{vs}}(c_0)$ given by

$$\begin{aligned} c_1^{\mathrm{vs}}(c_0) &= \frac{a(2-\lambda_1)}{(2-\lambda_1)^2-(\mu_1-\lambda_1)^2}\times \\ &\left[1-\sqrt{1+\frac{(2-\lambda_1)^2-(\mu_1-\lambda_1)^2}{a(2-\lambda_1)}\left[-2\frac{2-\lambda_0}{2-\lambda_1}c_0+\frac{(2-\lambda_0)^2-(\mu_0-\lambda_0)^2}{a(2-\lambda_1)}c_0^2\right]}\,\right] \end{aligned}$$

Under one-stage bargaining, i.e., $\lambda_i = \mu_i$ for $i = 0, 1$, the threshold simplifies into $c_1^{\mathrm{vs}}(c_0) = (2-\mu_0)c_0/(2-\mu_1)$, which is lower than c_0 when $\mu_0 \geq \mu_1$. When B fully controls selection, i.e., $\lambda_0 = \lambda_1 = 0$, the threshold becomes $c_1^{\mathrm{vs}}(c_0) = c_0 + (\mu_0^2 - \mu_1^2)c_0^2/(4a) + O(c_0^3)$.

Figure 6(a) shows level curves of the virtual profit in the (λ, μ) space. Figure 6(b) plots π_i^v as a function of μ for various value of λ. The black curve (at the bottom of the graph) is for $\lambda = 0$, while the red curve (at the top of the graph) is for $\lambda = 1$. The increasing orange curve is π_i^v when $\lambda = \mu$, it passes through the maximum of the other curves.



(a) Level curves of π_i^v in the (λ, μ) space. (b) π_i^v as function of μ for various λ.

Figure 6: Effect of μ and λ on π_i^v, for a given c_i.

F.2 Vertical integration

There are two potential suppliers ($n = 1$). Their costs are uniformly distributed on $[0, 1]$. Demand is linear. The bargaining weights satisfy: $\lambda_0 = \lambda_1 = 0$, and $\mu_0 = \mu_1 = \mu$.

The customer foreclosure area, OCE, is defined by $c_1^{\text{vi}}(c_0) < c_1 < c_0$, with

$$c_1^{\text{vi}}(c_0) = \frac{(2-\lambda_1)a}{(2-\lambda_1)^2 - (\mu_1-\lambda_1)^2}\left(1 - \sqrt{1 - \frac{(2-\lambda_1)^2 - (\mu_1-\lambda_1)^2}{(2-\lambda_1)^2 a^2}\left(2ac_0 - c_0^2\right)}\right).$$

where the right-hand side is the value of c_1 such that π_1^v and $\Pi^m(c_0)$.[39] The *Exploitation* region is defined by c_1 below that threshold. Consumers benefit from VI in the foreclosure region if $c_0 < \Psi(c_1; \mu_1) = (2 - \mu_1)c_1$ and they are hurt, otherwise.

Within the foreclosure area, total welfare increases in the region OCD' defined by

$$c_1 \geq \frac{(4-\mu)a}{4-\mu^2}\left(1 - \sqrt{1 - \frac{12(4-\mu^2)}{(4-\mu)^2}\left(c_0/2a - c_0^2/4a^2\right)}\right),$$

[39] A Taylor series expansion of which about $c_0 = 0$ is $c_0/(2-\lambda_1) - (\mu_1-\lambda_1)^2 c_0^2/(2a(2-\lambda_1)^3) + O(c_0^3)$.

with the equality holding along the line OD'.

G Proof of Proposition 8

Because $\Pi^m(c) > \pi_1^v(c)$ for any c, it is a fortiori true that $\Pi^m(c_0) > \pi_1^v(c_1)$ when $c_0 < c_1$. Hence the buyer purchases post-merger from S_0 whenever S_0 is more efficient than S_1. If pre-merger the buyer purchased from S_1 while $c_1 > c_0$, the merger causes the quantity to move from $q^m(\Psi_1(c_1;\mu_1))$, which is lower than $q^m(c_1)$, to $q^m(c_0)$, hence an increase in quantity that benefits consumers.

In case (a), by monotonicity of the virtual profit in μ, we have $\pi_1^v(c) > \pi_0^v(c)$ for any c, hence $c_1 > c_0$ along the pre-merger selection boundary $\pi_1^v(c_1) = \pi_0^v(c_0)$, represented by the line OA' on Figure 1. In other words, the pre-merger selection is biased against S_0. The same holds in case (b) using this time the monotonicity of π^v in λ.

To study case (c), we first show that the virtual profit $\pi^v(c) = \Pi(q^m(c+(1-\mu)z); c+(1-\lambda)z)$, with $z = F(c)/f(c)$, is decreasing in z. We have

$$\frac{\partial}{\partial z}\Pi(q^m(c+(1-\mu)z); c+(1-\lambda)z) = -(1-\mu)(\mu-\lambda)z(q^m)'(y) - (1-\lambda)q^m(y),$$

with $y = c + (1-\mu)z$. The right-hand side of the above equation is negative as soon as the choke price $P(0)$ is high enough.[40] It follows that in case (c) we have $\pi_1^v(c) > \pi_0^v(c)$ for any c, which gives the desired result as above.

H Proof of Proposition 9

To compare the industry profit under each possible vertical integration, we first compute the expected profit loss relative to the maximum industry profit achieved when the most efficient supplier is active, i.e., we subtract $\iint \Pi^m(\min(c_0, c_1))\,\mathrm{d}F_0\,\mathrm{d}F_1$. The difference involves only the foreclosure region. When B integrates with S_0, this loss is:

$$L^0 = \iint_{c_1 \le c_0 \le (\Pi^m)^{-1}(\Pi_1^v(c_1))} [\Pi^m(c_0) - \Pi^m(c_1)]\, f_0(c_0) f_1(c_1)\,\mathrm{d}c_0\,\mathrm{d}c_1$$

Similarly, when B integrates with S_1

$$L^1 = \iint_{c_0 \le c_1 \le (\Pi^m)^{-1}(\Pi_0^v(c_0))} [\Pi^m(c_1) - \Pi^m(c_0)]\, f_0(c_0) f_1(c_1)\,\mathrm{d}c_0\,\mathrm{d}c_1.$$

[40]Replacing $P(q)$ with $P(q)+a$, $a>0$, increases the quantity $q^m(c)$ without changing its derivative.

The latter can be rewritten, exchanging labels of the cost variables:

$$L^1 = \iint_{c_1 \le c_0 \le (\Pi^m)^{-1}(\Pi_0^v(c_1))} [\Pi^m(c_0) - \Pi^m(c_1)]\, f_0(c_1) f_1(c_0)\, \mathrm{d}c_0\, \mathrm{d}c_1$$

Because c_0 is lower than c_1 in the likelihood ratio order, the same is true in the sense of the hazard rate, which implies $\Psi_0 > \Psi_1$ and the ordering of the virtual profits:

$$\Pi_1^v(c_1) = R(q^m(c_1)) - \Psi_1(c_1) q^m(c_1) > R(q^m(c_1)) - \Psi_0(c_1) q^m(c_1) = \Pi_0^v(c_1).$$

As the function Π^m is decreasing, the foreclosure region is larger when the buyer merges with S_1 than when she merges with S_0:

$$(\Pi^m)^{-1}(\Pi_1^v(c_1)) < (\Pi^m)^{-1}(\Pi_0^v(c_1)).$$

It follows that

$$\begin{aligned} L^0 - L^1 &= \iint_{c_1 \le c_0 \le (\Pi^m)^{-1}(\Pi_1^v(c_1))} [\Pi^m(c_0) - \Pi^m(c_1)]\, [f_0(c_0) f_1(c_1) - f_0(c_1) f_1(c_0)]\, \mathrm{d}c_0\, \mathrm{d}c_1 \\ &+ \iint_{(\Pi^m)^{-1}(\Pi_1^v(c_1)) \le c_0 \le (\Pi^m)^{-1}(\Pi_0^v(c_1))} [\Pi^m(c_0) - \Pi^m(c_1)]\, f_0(c_0) f_1(c_1)\, \mathrm{d}c_0\, \mathrm{d}c_1. \end{aligned}$$

As $c_0 \ge c_1$, we have $f_0(c_0) f_1(c_1) \le f_0(c_1) f_1(c_0)$ and $\Pi^m(c_0) \le \Pi^m(c_1)$ in both integrals, implying that the first and second terms are nonnegative. It follows that L^0 is larger than L_1, the desired result.

I Proof of Proposition 10

When B integrates with S_0, the non-weighted industry profit is given by

$$\begin{aligned} \Pi_{BS_0}^0 + \Pi_{S_1}^0 &= \iint_{c_0 \le \Psi(c_1;\mu_1)} \Pi^m(c_0)\, \mathrm{d}F(c_0)\, \mathrm{d}F(c_1) \\ &+ \iint_{c_0 \ge \Psi(c_1;\mu_1)} \Pi(q^m(\Psi(c_1;\mu_1)); c_1)\, \mathrm{d}F(c_0)\, \mathrm{d}F(c_1). \end{aligned}$$

Similarly, when B integrates with S_1, the non-weighted industry profit is given by

$$\begin{aligned} \Pi_{BS_1}^1 + \Pi_{S_0}^1 &= \iint_{c_1 \le \Psi(c_0;\mu_0)} \Pi^m(c_1)\, \mathrm{d}F(c_0)\, \mathrm{d}F(c_1) \\ &+ \iint_{c_1 \ge \Psi(c_0;\mu_0)} \Pi(q^m(\Psi(c_0;\mu_0)); c_0)\, \mathrm{d}F(c_0)\, \mathrm{d}F(c_1). \end{aligned}$$

By symmetry of the cost distributions, we can exchange the labels of the cost variables and rewrite the above expression as

$$\begin{aligned}\Pi^1_{BS_1} + \Pi^1_{S_0} &= \iint_{c_0 \leq \Psi(c_1;\mu_0)} \Pi^m(c_0)\,\mathrm{d}F(c_0)\,\mathrm{d}F(c_1) \\ &\quad + \iint_{c_0 \geq \Psi(c_1;\mu_0)} \Pi(q^m(\Psi(c_1;\mu_0));c_1)\,\mathrm{d}F(c_0)\,\mathrm{d}F(c_1).\end{aligned}$$

Because μ_0 is larger than μ_1, the buyer is more likely to supply internally when she integrates with S_0 than when she integrates with S_1:

$$\Psi(c_1;\mu_0) \leq \Psi(c_1;\mu_1).$$

In other words, there is more foreclosure if she acquires S_0 than if she acquires S_1. The differences in industry profits in the two configurations is therefore given by

$$\begin{aligned}\Pi^1_{BS_1} + \Pi^1_{S_0} &- \Pi^0_{BS_0} - \Pi^0_{S_1} \\ &= \iint_{\Psi(c_1;\mu_0)\leq c_0 \leq \Psi(c_1;\mu_1)} \left[\Pi(q^m(\Psi(c_1;\mu_0));c_1) - \Pi^m(c_0)\right]\,\mathrm{d}F(c_0)\,\mathrm{d}F(c_1) \\ &+ \iint_{c_0 \leq \Psi(c_1;\mu_1)} \left[\Pi(q^m(\Psi(c_1;\mu_0));c_1) - \Pi(q^m(\Psi(c_1;\mu_1));c_1)\right] dF(c_0)\,\mathrm{d}F(c_1).\end{aligned}$$

The first term above is positive because $\Pi(q^m(\Psi(c_1;\mu_0));c_1) \geq \Pi(q^m(c_0);c_1) \geq \Pi^m(c_0)$. The second term above is positive as well because $q^m(\Psi(c_1;\mu_1)) \leq q^m(\Psi(c_1;\mu_0)) \leq q^m(c_1)$. It follows that the (non-weighted) industry profit is larger when the buyer merges with S_1, and hence she prefers to merge with that supplier.

J Merging with the most aggressive supplier

Suppose that the buyer fully controls the selection decision: $\lambda_0 = \lambda_1 = 0$, the two potential suppliers have the same cost distribution F, and the bargaining weights at the production stage satisfy $\mu_0 > \mu_1$.

On the one hand, there is now *less* foreclosure if the buyer integrates with S_0 than if she integrates with S_1.[41] On the other, the quantity distortion when she purchases from the independent supplier is lower if she integrates with S_1. The former effect pushes the buyer to merge with S_0, the latter to integrate with S_1.

[41]This is because $(\Pi^m)^{-1}(\Pi^v_1(c_1)) < (\Pi^m)^{-1}(\Pi^v_0(c_1))$. This inequality comes from $\Pi(q^m(c_1);c_1 + F/f(c_1)) = \Pi^v_0(c_1) < \Pi^v_1(c_1) = \Pi^m(c_1 + F/f(c_1))$.

The sign of the difference in total industry profit is ambiguous:

$$\begin{aligned}\Pi^0_{BS_0} + \Pi^0_{S_1} \quad &- \quad \Pi^1_{BS_1} - \Pi^1_{S_0} \\ &= \iint_{(\Pi^m)^{-1}(\Pi^v_1(c_1)) \leq c_0 \leq (\Pi^m)^{-1}(\Pi^v_0(c_1))} [\Pi(q^m(\Psi(c_1;\mu_1)); c_1) - \Pi^m(c_0)] \, \mathrm{d}F(c_0) \, \mathrm{d}F(c_1) \\ &+ \iint_{c_0 \geq (\Pi^m)^{-1}(\Pi^v_0(c_1))} [\Pi(q^m(\Psi(c_1;\mu_1)); c_1) - \Pi(q^m(\Psi(c_1;\mu_0)); c_1)] \, dF(c_0) \, \mathrm{d}F(c_1).\end{aligned}$$

The first term is positive as $\Pi^m(c_0) < \Pi^v_1(c_1) < \Pi(q^m(\Psi(c_1;\mu_1); c_1)$ in the corresponding region. The second term is negative as it just the opposite of the corresponding term in the proof of Proposition 10.

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