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## Abstract

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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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# Double marginalization and vertical integration*

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July 13, 2021

**Abstract**

Asymmetric information in procurement entails double marginalization. The phenomenon is most severe when the buyer has all the bargaining power at the production stage, while it vanishes when the buyer and suppliers' weights are balanced. Vertical integration eliminates double marginalization and reduces the likelihood that the buyer purchases from independent suppliers. Conditional on market foreclosure, the probability that final consumers are harmed is positive only if the buyer has more bargaining power when selecting suppliers than when negotiating over quantities and intermediate prices. The buyer's and consumers' interests are otherwise aligned.

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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 supplier 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 vertical framework with an intermediate buyer that acquires a homogenous input from potential suppliers and then addresses final consumers demand; asymmetric information about the supplier's production costs; and a two-stage bargaining mechanism through which prices and quantities are determined. Indeed, in many industries, procurement processes are sequential, with the buyer first selecting a number of suppliers and then bargaining over prices and quantities with those suppliers.[5] Accordingly, we distinguish two decisions –suppliers selection and quantity choice– and introduce two sets of bargaining weights that reflect the players' abilities to influence each of the two decisions in their favor.

The contribution of the paper is threefold. First, we provide theoretical foundations for the double marginalization (DM) phenomenon. Informational asymmetry about suppliers' costs creates a wedge between wholesale prices and production costs. Incentives to reduce the suppliers' rents are weaker and DM is less severe when selected suppliers have more bargaining power at the production stage. With balanced bargaining power, asymmetric information no longer matters and DM is no longer an issue. Second, we extend the Chicago view on vertical integration in an environment with nonlinear prices. When the buyer has full bargaining power, final consumers are always better off after the buyer has acquired a supplier. Third, vertical integration may harm consumers through a biased make-or-buy decision if the buyer has less bargaining power when negotiating wholesale prices and quantities than when selecting suppliers.

More precisely, vertical integration has the following effects on firms and consumers. First, final consumers are unambiguously better off post-merger if the buyer was already purchasing from the acquired supplier pre-merger. This case is commonly referred to as EDM in the literature. Second, 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. Third, the merger causes the buyer to purchase more often from the acquired supplier. Hence, with positive probability, independent suppliers are deprived of the access to final consumers, a phenomenon known as customer foreclosure.

The impact of customer foreclosure on final consumers is a priori ambiguous. Yet we find that when the suppliers' bargaining power is not higher at the production stage than at the selection stage, the eviction of an independent supplier causes the traded quantity

[5] To procure optical disc drives, OEMs select a limited set of suppliers through electronic requests for quotations before deciding quantities through auctions or bilateral negotiations. See European Commission, Decision AT.39639, 21/10/2015, para 33-38.

to rise and the retail price to fall post-merger. 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. By contrast, when suppliers' bargaining power increases after selection, customer foreclosure harms consumers with positive probability. With ex ante symmetric suppliers, consumer harm caused by foreclosure is magnified when the buyer fully controls selection whereas bargaining power is balanced at the production stage because there is no DM pre-merger in that case.

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. In Section 5, we emphasize that vertical integration may correct pre-merger distortions other than DM; we examine whether the buyer's choice of a merging partner is aligned with consumers' interests; and we show that our results are robust to multisourcing or bilateral asymmetric information. Section 6 concludes by discussing some policy implications of our findings.

**Related literature** The paper builds on and expands the Industrial Organization literature that emphasizes the role of incomplete information.[6] 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 DM phenomenon. Although our motivations are different from theirs, it is interesting to note that weights are used in the regulator's objective in both Baron and Myerson and Laffont and Tirole.

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] In particular, in Laffont and Tirole (1987), an auction selects a firm which is then regulated. They find that at the regulation stage, the power of incen-

[6]Recent papers in this trend include Calzolari and Denicolò (2013, 2015) and Dequiedt and Martimort (2015).

[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.

tives does not depend on the auction: Competition for the market is important but it only affects the fixed part of the cost reimbursement scheme. A similar dichotomy result is present in our model. Dasgupta and Spulber (1989) derive the optimal procurement mechanism with variable quantities and supplier competition. The practical implementation of their mechanism is studied by the management literature, see, e.g., Chen (2007), Duenyas, Hu, and Beil (2013) and Tunca and Wu (2009). They do not allow for balanced bargaining nor study vertical integration.

Building upon the major methodological contribution of Loertscher and Marx (2021), we introduce a downstream market with final consumers and thus allow the buyer's demand to respond to prices. Loertscher and Marx model markets as a mechanism that maximizes the expected weighted welfare of the agents.[8] Among other things, 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. We concentrate here on the effect of vertical integration at the intensive margin, namely on its impact on the traded quantity (given that trade occurs).[9] We are thus able to 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.[10] Our approach is complementary to theirs. We are interested in the impact of vertical integration on final consumers rather than on 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]Loertscher and Marx (2019a) model buyer power as the ability to organize an optimal auction à la Myerson. In a companion paper, Loertscher and Marx (2019b) introduce bargaining weights to model intermediate degrees of buyer power.

[9]We mostly restrict attention to one-sided asymmetric information, and discuss bilateral asymmetric information in an extension.

[10]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.[11] Extending Riordan's analysis to Cournot competition, Loertscher and Reisinger (2014) find that vertical integration is more likely to benefit consumers when the industry is more concentrated. De Fontenay and Gans (2004) examine as we do backward integrations by monopsonists. Assuming that suppliers have convex costs, they show that vertical mergers enable buyers to deal with fewer suppliers and thus to exert their monopsony power,[12] which always harms consumers. They assume efficient bilateral bargaining with individual suppliers hence no DM. 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 DM 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 DM 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.[13] In the carbonated beverage industry, Luco and Marshall (2020) find that vertical integration causes price decreases for products with eliminated double margins but also price increases for 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 adopted the "Nash-in-Nash" bargaining approach,[14] assuming bilateral bargaining over either fixed transfers or linear tariffs under perfect information.[15] By contrast, we allow for multilateral bargaining over nonlinear prices under asymmetric information.

EDM is not the only source of efficiency gains in a vertical integration.[16] In their study of the cement industry, Hortaçsu and Syverson (2007) link productivity gains to

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

[12] 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).

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

[14] E.g., Draganska, Klapper, and Villas-Boas (2010), Ho and Lee (2017), and Crawford, Lee, Whinston, and Yurukoglu (2018).

[15] 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 DM.

[16] Lafontaine and Slade (2007) review empirical findings on the motives and consequences of vertical integration.

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.[17]

# 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 positive densities $f_i$ over $[\underline{c}_i, \bar{c}_i]$. 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 $S(q) = \int_0^q [P(x) - P(q)] \, dx$, the buyer and selected supplier's joint-profit is $\Pi(q; c) = R(q) - cq$.

We assume that $\Pi$ 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 (2021). At each stage, a bargaining mechanism maximizes a weighted industry profit. Let $\Pi_B$ and $U_i$ be the buyer's and suppliers' profits. Let $\boldsymbol{\lambda} = (\lambda_0, \ldots, \lambda_n)$ and $\boldsymbol{\mu} = (\mu_0, \ldots, \mu_n)$ denote the suppliers's 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

[17] 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.

the production stage it maximizes $\Pi_B + \sum_{j\in\mathcal{S}} \mu_j U_j$. We assume throughout that the $\lambda$'s and $\mu$'s belong to $[0, 1)$.[18]

The weights $\mu_i$ reflect both the size and sharing of total profit. If $\boldsymbol{\mu} = \mathbf{1}$, the total profit of the buyer and the selected suppliers is maximized at the production stage. By contrast, if $\boldsymbol{\mu} = \mathbf{0}$, only the buyer's profit is maximized at this stage. The weights $\boldsymbol{\lambda}$ reflect how each supplier's profit is valued at the selection stage. However, because firms' profits depend on the payments and traded quantities, selection is governed by both sets of bargaining weights. If $\boldsymbol{\lambda} = \boldsymbol{\mu}$, the sequentiality of the procurement process is immaterial and the process can equivalently be represented by an integrated bargaining mechanism (over both selection and production) that maximizes $\Pi_B + \sum_{i\in\mathcal{N}} \lambda_i U_i$.

The two sets $\boldsymbol{\lambda}$ and $\boldsymbol{\mu}$ reflect the notion that, depending on industry characteristics, the parties may gain or lose leverage after selection. For large and complex procurement projects, a contractor often obtains considerable leverage upon being awarded the contract. On the other hand, in procurement for rather standardized contracts (e.g., office supplies), the winner of the tender does not gain any advantage as the buyer could easily find an alternative supplier. In our asymmetric information framework, the weights measure the ability to extract rents (or to resist rent extraction) and changes in those weights are reminiscent of holdup considerations in the theory of the firm.[19]

We assume that the selection mechanism reveals only the minimal information about the suppliers' costs needed to prove that they should be winning, a property called "unconditional winner privacy" (UWP) by Milgrom and Segal (2020).[20] Furthermore, we restrict attention to selection rules that are monotonic in the sense that if $S_i$ with cost $c_i$ is selected then that supplier is also selected when his cost is lower than $c_i$. Formally, let $\mathbf{x} = (x_0, \ldots, x_n)$ denote the selection rule, i.e., $x_i(c_i, \mathbf{c}_{-i}) = 1$ if $S_i$ is selected, and $x_i = 0$ otherwise. The rule is monotonic if for all $i$ $x_i$ is a non-increasing function of $c_i$, i.e., if there exists a threshold value $c_i^{\text{Sel}}$ such that $S_i$ is selected if and only if $c_i \leqslant c_i^{\text{Sel}}$. UWP means that the threshold $c_i^{\text{Sel}}$ depends only on the costs of the *non-selected* suppliers, which we denote by $\mathbf{c}_{-\mathcal{S}}$.

At the production stage, when the buyer bargains with the selected suppliers, it is common knowledge that $c_j \leqslant c_j^{\text{Sel}}(\mathbf{c}_{-\mathcal{S}})$. Bargaining is described by a direct mechanism

[18] We consider powerful suppliers, $\mu_i \geqslant 1$, in Section 5.4.

[19] An alternative interpretation of the model is that the selection and quantity decisions are made by different entities within firms. The objectives of these entities need not be perfectly aligned. Within-firm misalignment can be related to past or future relationships with suppliers or to soft corruption.

[20] Among others, Ausubel (2004) discusses the importance of privacy in auctions. See also and Loertscher and Marx (2020).

$(\mathbf{Q}, \mathbf{M})$. The quantities $\mathbf{Q} = \left(Q_j\left(\widehat{\boldsymbol{c}}\right)\right)_{j \in \mathcal{S}}$ and payments $\mathbf{M} = \left(M_j\left(\widehat{\boldsymbol{c}}\right)\right)_{j \in \mathcal{S}}$ are functions of costs $\widehat{\boldsymbol{c}} = \left(\widehat{c}_j\right)_{j \in \mathcal{S}}$ reported by the selected suppliers. The buyer's and suppliers' profits are given by $\Pi_B(\mathbf{c}) = R\left(\sum_{j \in \mathcal{S}} Q_j(\mathbf{c})\right) - \sum_{j \in \mathcal{S}} M_j(\mathbf{c})$ and $U_j(\mathbf{c}) = M_j(\mathbf{c}) - c_j Q_j(\mathbf{c})$.

### 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, $\lambda_0'$ and $\mu_0'$, 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 $\Pi_B + U_0 + \sum_{i \geqslant 1} \lambda_i U_i$ and $\Pi_B + U_0 + \sum_{j \in \mathcal{S}^*} \mu_j U_j$, where $\mathcal{S}^*$ 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 $\lambda_0 \leqslant \lambda_0' \leqslant 1$ and $\mu_0 \leqslant \mu_0' \leqslant 1$.

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.

## 3 Vertical separation

In this section, we describe the outcome of the two-stage bargaining process under vertical separation. In section 3.1, we take as given the subset $\mathcal{S}$ of selected suppliers, determine quantities and intermediate prices, and explain how DM 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 selection phase only reveals that the cost of a selected supplier is below a threshold $c_j^{\mathrm{Sel}}$. The cost distributions at the production stage therefore obtain from right-truncations of the original distributions $F_j$. We define the weighted virtual costs as

$$\Psi_j(c_j;\mu_j) = c_j + (1-\mu_j)\frac{F_j(c_j)}{f_j(c_j)}\,, \tag{1}$$

and assume that they are nondecreasing functions of $c_j$ for all $\mu_j$ between 0 and 1. The ratios $F_j/f_j$ and hence the functions $\Psi_j(c_j;\mu_j)$ are unaffected by the truncation over $[\underline{c}_j, c_j^{\mathrm{Sel}}]$.

**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. □

When $\mu_j < 1$, the traded quantity is lower than the quantity that maximizes the joint profit of the buyer and the chosen supplier: $q^m(\Psi_j(c_j;\mu_j)) < q^m(c_j)$, and hence the retail price exceeds the monopoly price. Double marginalization results from the wedge $(1-\mu_j)F_j(c_j)/f_j(c_j)$ between the supplier's cost $c_j$ and his virtual cost $\Psi_j(c_j;\mu_j)$. Thus 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 $q^m(c_j) - q^m(\Psi_j(c_j;\mu_j))$, decreases with the supplier's weight $\mu_j$. The phenomenon is most severe when the mechanism maximizes the buyer's profit ($\boldsymbol{\mu} = 0$) and disappears when it maximizes total industry profit ($\boldsymbol{\mu} = 1$).

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

**Example** Assume that $S_0$ 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 reflects that the supplier' rent is less costly and hence is associated with a lower weighted virtual cost.

The magnitude of the DM also depends on 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 $\mu$. 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 supplier selection maximizes the weighted industry profit $\Pi_B + \sum_{i \in \mathcal{N}} \lambda_i U_i$. For each $i \in \mathcal{N}$, we introduce the following virtual profit which is assumed to be 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 both stages of the procurement process. In Appendix B, we provide a simple sufficient condition on the functions $q^m(c)$ and $F(c)$ guaranteeing that $\pi_i^v$ 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 $a \geqslant 3$.

**Proposition 2.** *Under two-stage bargaining, only the supplier with the highest virtual profit is selected. In equilibrium, $S_i$ earns*

$$U_i(\mathbf{c}) = \begin{cases} \int_{c_i}^{c_i^*(\mathbf{c_{-i}})} q^m\left(\Psi_i(c;\mu_i)\right) dc & \text{if } c_i \leqslant c_i^*(\mathbf{c_{-i}}) \\ 0 & \text{otherwise,} \end{cases} \tag{3}$$

*where the optimal selection threshold $c_i^{Sel}(\mathbf{c}_{-i}) = c_i^*(\mathbf{c}_{-i})$ is given by*

$$c_i^*(\mathbf{c}_{-i}) = \left(\pi_i^v\right)^{-1}\left(\max_{j \neq i} \pi_j^v\right). \tag{4}$$

*Proof.* See Appendix C. □

To understand the intuition of the result, assume that the bargaining weights differ at the two stages. If $S_i$ and $S_j$ are selected, the buyer actually purchases only from the one with the lowest virtual cost. This choice depends on $\mu_i$ and $\mu_j$ and ignores the weights $\lambda_i$ and $\lambda_j$ that are relevant at the selection stage. Hence, from the perspective of that 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.

**Dominant strategy implementation** We now check that the procurement mechanism of Proposition 2 can be implemented by auctioning off a menu of two-part tariffs and letting the buyer decide the quantity she wants to purchase given the tariff chosen by the winning supplier. The first part of the mechanism –the use of an auction for supplier selection– derives from the fact that a monotonic allocation rule preserving UWP can be computed by a deferred acceptance clock auction, a result established by Milgrom and Segal (2020).

Let $s$ denote a clock index. The auctioneer initiates the auction at a low level of $s$ and then raises it gradually. We define

$$c_i^*(s) = \max\left\{\underline{c}_i \leqslant c_i \leqslant \bar{c}_i \mid \pi_i^v(c_i) \geqslant s\right\}. \tag{5}$$

At the clock index $s$, $S_i$ has access to the menu of two-part tariffs, $\mathcal{T}_i(s)$, which consists of a family of tariffs indexed by $\tilde{c}_i$ in $[\underline{c}_i, c_i^*(s)]$, with wholesale price $w_i$ and fixed part

$M_i$ given by

$$\begin{cases} w_i(\tilde{c}_i) = \Psi_i(\tilde{c}_i; \mu_i) \\ M_i(\tilde{c}_i; s) = \int_{\tilde{c}_i}^{c_i^*(s)} q^m(\Psi_i(c; \mu_i))\, \mathrm{d}c - [w_i(\tilde{c}_i) - \tilde{c}_i] q^m(\Psi_i(\tilde{c}_i; \mu_i)). \end{cases} \tag{6}$$

As the index $s$ increases, the thresholds $c_i^*(s)$ decrease, the menus $\mathcal{T}_i(s)$ shrink, and the suppliers must decide whether to stay or exit. The winner is the last active supplier. If $S_i$ wins at index $s$, he is offered his current menu $\mathcal{T}_i(s)$, in which he then picks 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) facing that tariff, the buyer chooses a quantity.*

*Proof.* See Appendix D. □

The implementation result highlights 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 $\boldsymbol{\lambda}$ and $\boldsymbol{\mu}$ affect the supplier selection. Proposition 2 shows that the probability to select $S_i$ is an increasing function of the virtual profit $\pi_i^v$ given by (2). For a given weight $\lambda_i$, the virtual profit is a quasi-concave function of $\mu_i$ and reaches its maximum value, $\Pi^m(\Psi_i(c_i; \lambda_i))$, at $\mu_i = \lambda_i$. It increases with $\lambda_i$ 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, $\boldsymbol{\lambda} = \boldsymbol{\mu}$, as "one-stage bargaining" because in this case the distinction between selection and production is immaterial.[21]

**Proposition 4.** *Consider two suppliers $S_i$ and $S_j$ with the same cost distribution ($F_i = F_j$) and different bargaining weights at the production stage ($\mu_i > \mu_j$). When $\lambda_i$ and $\lambda_j$ are sufficiently close to $\mu_i$ and $\mu_j$ respectively, $S_i$ is preferred to $S_j$ 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 $\lambda_i$ and $\lambda_j$ are sufficiently small.*

*Proof.* See Appendix E. □

The parameters $\mu_i$ represent the degrees of suppliers' efficacy in bargaining over price and quantity at the production stage. Whether more powerful 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 power at the selection stage than at the production stage, i.e., when the environment is close to one-stage bargaining, she tends to select a powerful supplier, all else being equal. On the other hand, when she has full control at the early stage, she avoids selecting a powerful supplier.

Figure 1 illustrates the results of Proposition 4 in an economy with two potential suppliers, uniformly distributed costs, and linear demand. When bargaining weights are the same at both stages, $\boldsymbol{\lambda} = \boldsymbol{\mu}$, the buyer purchases more often from the supplier with the largest $\mu$ (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 ($\boldsymbol{\lambda} = 0$), then the less powerful supplier is selected more often (see the region below the maroon curve $OA'$).[22]

While the produced quantity is governed by the sole parameters $\boldsymbol{\mu}$, the selection rule depends on $\boldsymbol{\lambda}$ and $\boldsymbol{\mu}$. Because the virtual profit $\pi_i^v$ increases in $\lambda_i$ and decreases in $\mu_i$ (assuming $\mu_i$ greater than $\lambda_i$), a supplier with higher $\lambda_i$ and lower $\mu_i$ tends to be selected more often. The latter effect (dependence in $\mu_i$) becomes negligible when $\boldsymbol{\mu}$ tends to $\boldsymbol{\lambda}$, i.e., when the environment gets closer to one-stage bargaining.[23] In that case, the selection is essentially governed by $\boldsymbol{\lambda}$.

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

[22] The selection rule is given in Appendix I.1.

[23] 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 $\lambda_i$, see details in Appendix I.1.

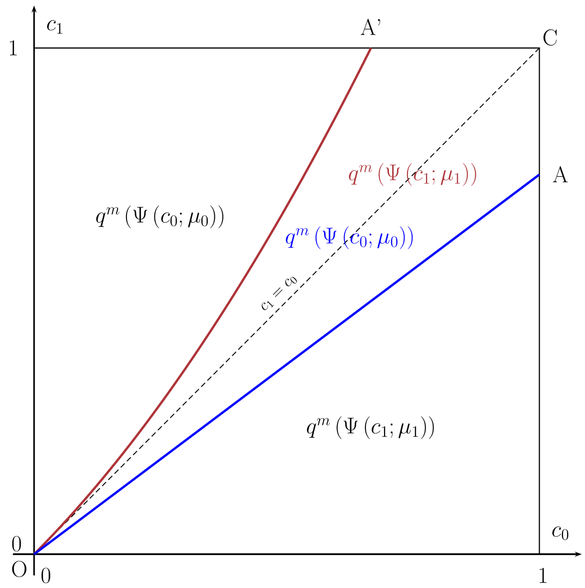



**Figure 1:** The most powerful supplier, $\mu_0 > \mu_1$, is selected above the blue line $OA$ under one-stage bargaining ($\lambda_0 = \mu_0$ and $\lambda_1 = \mu_1$), while he is selected above the red line $OA'$ under buyer-controlled selection ($\lambda_0 = \lambda_1 = 0$).
Suppliers' costs are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

# 4 Vertical integration

We now turn to the study of a vertical merger between the buyer and a supplier, which we denote $S_0$.[24] After the merger, $B$ and $S_0$ form a single entity, which causes $S_0$'s bargaining weights to increase to $\lambda'_0$ and $\mu'_0$. In our baseline model, we assume that these weights equal those of the buyer, i.e., $\lambda'_0 = \mu'_0 = 1$. Once this change of weights is accounted for, the analysis of Section 3 applies.

## 4.1 Effects on firms and consumers

We now present the main effects 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. It increases the acquired supplier's probability to produce. Conditional upon producing, independent suppliers sell the same quantity but earn a lower profit post-merger.*

*Proof.* Because $S_0$'s profit is fully taken into account at both stages ($\lambda'_0 = \mu'_0 = 1$), information about $S_0$'s cost is now irrelevant. The analysis of Section 3 thus carries

[24] In Section 5.2, we endogenize the choice of merging partner.

over, replacing the virtual profit $\pi_0^v$ with $\Pi^m(c_0) > \pi_0^v$. (Recall that the highest possible value of $\pi_0^v$ is $\Pi^m(c_0)$, that value being achieved only for $\lambda_0 = \mu_0 = 1$.) □

To describe in more detail the effects of vertical integration, we denote by $\pi_{(n)}^v$ the highest value of the virtual profit among the $n$ independent suppliers. Let $S_{(n)}$ and $c_{(n)}$ be the corresponding supplier and the cost of that supplier.[25] Finally, let $\pi_{(n-1)}^v$ be the second highest value of the virtual profits among the independent suppliers. We identify four possible regions:

1. *Pure EDM*: $\Pi^m(c_0) > \pi_0^v > \pi_{(n)}^v$. In this case, $S_0$ produces both pre- and post-merger. Vertical integration thus increases 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, $S_0$'s bargaining weights have increased and internal procurement is now preferred. As $\pi_0^v$ is replaced with $\Pi^m(c_0)$, the selection threshold $c_{(n)}^*$ given by (4) falls. The foreclosed supplier $S_{(n)}$ is deprived of the access to final consumers and is therefore harmed by the merger, while the merging parties are jointly better off. The impact of vertical integration on consumers is a priori ambiguous 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 $U_{(n)}$ of the independent supplier given by (3) is lower because the merger causes the threshold $c_{(n)}^*$ to fall, hence exploitation.[26] 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.

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

[25] With symmetric costs distributions and bargaining weights, we have $c_{(n)} = \min(c_1, \ldots, c_n)$.

[26] The condition that $\pi_{(n)}^v > \Pi^m(c_0)$ reflects a reserve price placed on independent suppliers. It implies that the profit earned by the buyer is higher than $\Pi^m(c_0)$ (proof left to the reader) and hence, as the intuition suggests, that the merged entity has no incentive to renege on its commitment to exclude $S_0$.

causes the buyer to switch from $S_{(n)}$ to $S_0$, and hence the quantity to move from $q^m\left(\Psi_{(n)}(c_{(n)};\mu_{(n)})\right)$ to $q^m\left(c_0\right)$. 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 $\Pi^m(c) > \pi^v_{(n)}(c)$ for any $c$, we have $c_{(n)} < c_0$ along the boundary of the foreclosure area where the equality $\Pi^m(c_0) = \pi^v_{(n)}$ holds. Therefore, in a neighborhood of that boundary, the production cost increases from $c_{(n)}$ to $c_0$. Proposition 6 underlines the role of the bargaining weights $\boldsymbol{\lambda}$ and $\boldsymbol{\mu}$ in this tradeoff.

**Proposition 6.** *The post-merger make-or-buy decision is aligned with the final consumers' interest if and only if $\boldsymbol{\lambda} \geqslant \boldsymbol{\mu}$. 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 $\boldsymbol{\lambda} \geqslant \boldsymbol{\mu}$. Because the virtual profit increases with $\lambda_i$, we have $\pi^v_i \geqslant \Pi^m\left(\Psi_i(c_i;\mu_i)\right)$. If $S_i$ is foreclosed due to the merger, we have $\Pi^m(c_0) \geqslant \pi^v_i$, hence $\Pi^m(c_0) \geqslant \Pi^m\left(\Psi_i(c_i;\mu_i)\right)$, or equivalently $q^m\left(\Psi_i(c_i;\mu_i)\right) \leqslant q^m(c_0)$. It follows that the merger causes the quantity to rise and improves consumer welfare.

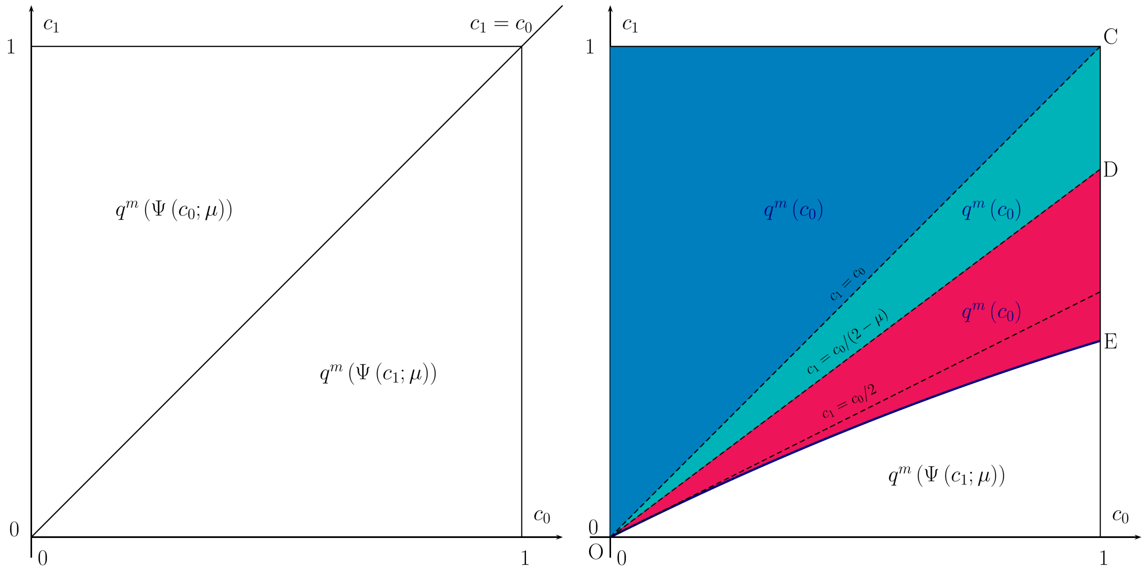
Next, suppose $\lambda_j < \mu_j$ for some $j$. By monotonicity of the virtual profit, this implies $\pi^v_j < \Pi^m\left(\Psi_j(c_j;\mu_j)\right)$. The foreclosure region can thus be divided into two subregions, see Figure 2. If $\pi^v_0 < \pi^v_j < \Pi^m(c_0) < \Pi^m\left(\Psi_j(c_j;\mu_j)\right)$, 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 $\pi^v_0 < \pi^v_j < \Pi^m\left(\Psi_j(c_j;\mu_j)\right) < \Pi^m(c_0)$, final consumers benefit from a larger quantity. $\square$

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, $\boldsymbol{\lambda} = \boldsymbol{\mu} = 0$. 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 procompetitive. 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, $\boldsymbol{\mu} > \boldsymbol{\lambda}$, customer foreclosure is anticompetitive with positive probability. 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 ($F_i = F$ for all $i$), the buyer fully controls the selection decision ($\boldsymbol{\lambda} = 0$), and there is no DM pre-merger ($\boldsymbol{\mu} = 1$). Then final consumers are always harmed by the foreclosure of independent suppliers.*

*Proof.* With symmetric suppliers and no DM ($\boldsymbol{\mu} = 1$), consumer surplus is maximized pre-merger as the buyer always purchases the monopoly quantity from the most efficient supplier ($q = q^m(\min c_i)$). After the merger, in the customer foreclosure region, the buyer purchases from $S_0$ while it is less efficient than an independent supplier, hence a fall in the traded quantity and a loss in consumer surplus.[27] □




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

**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: $ODC$

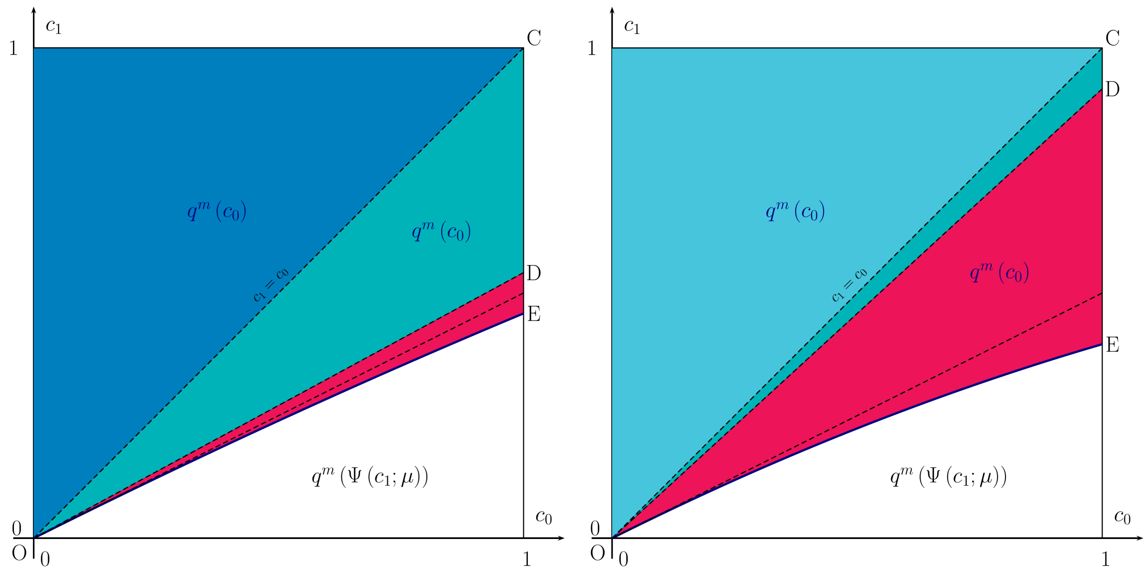
Figures 2 and 3 show the effect of the merger on consumer surplus in the case of two symmetric suppliers. Under vertical separation, the most efficient firm is selected but the quantity is distorted downwards, as shown on Figure 2(a). The post-merger equilibrium is represented on Figure 2(b).[28] The pure EDM region is located above the 45 degree line, $OC$, whereas the exploitative region is the area below the line

[27]We show in Section 5.1 how this result is modified in asymmetric environments.
[28]Details can be found in Appendix I.2.

$OE$. The customer foreclosure region, $OCE$, is separated in two parts by the line $OD$ along which the actual cost of the integrated supplier 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 $ODC$ region) and from the independent supplier below the line (i.e., in the $ODE$ area). In region $ODC$, the selection phase is actually irrelevant. If both suppliers had been selected, then bargaining at the production stage would lead the buyer to purchase exclusively from $S_0$, which benefits final consumers. Only foreclosure that is directly caused by the selection stage, i.e., that would not occur at the production stage if the supplier were allowed to participate in that stage, harms consumers, as is the case in the $ODE$ region.

Figures 3(a) and 3(b) further stress the role of bargaining over wholesale prices and quantities. For $\mu = 0$, the lines $OD$ and $OE$ coincide. As $\mu$ increases, they shift respectively upwards and downwards. For $\mu = 1$, the lines $OD$ and $OC$ coincide. Therefore, when DM is severe pre-merger (low $\mu$), backward integration mostly benefits consumers. On the contrary, when the DM phenomenon is mild (high $\mu$), customer foreclosure mostly harms final consumers.

More generally, with symmetric cost distributions and bargaining weights, anticompetitive foreclosure arises whenever the suppliers' bargaining power increases between the selection and production stages ($\lambda < \mu$), and is magnified when $\lambda = 0$ and $\mu = 1$.




(a) DM is severe (low $\mu$)

(b) DM is mild (high $\mu$)

**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 assumption and assume that vertical integration yields increased, but not necessarily perfect, internalization of profits within the merged entity: $\lambda_0 < \lambda_0' \leqslant 1$ and $\mu_0 < \mu_0' \leqslant 1$. In particular, when $\mu_0 < \mu_0' < 1$, the DM 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 $\boldsymbol{\lambda} = \boldsymbol{\mu}$. This remains true even if DM is not fully eliminated within the merged entity.

**Corollary 2.** *If $\boldsymbol{\lambda} = \boldsymbol{\mu}$ and $\lambda_0 = \mu_0 < \lambda_0' = \mu_0' < 1$, then independent suppliers are foreclosed with positive probability, but vertical integration always increases consumer surplus.*

*Proof.* The merger increases the integrated supplier' virtual profit from $\Pi^m(\Psi_0(c_0; \lambda_0))$ to $\Pi^m(\Psi_0(c_0; \lambda_0'))$. It follows that independent suppliers lose access to the market with positive probability. The quantity rises from $\max(q^m(\Psi_0(c_0; \mu_0)), q^m(\Psi_{(n)}(c_{(n)}; \mu_{(n)})))$ to $\max(q^m(\Psi_0(c_0; \mu_0')), q^m(\Psi_{(n)}(c_{(n)}; \mu_{(n)})))$, where $S_{(n)}$ is the independent supplier with the highest virtual profit. $\square$

Similarly, the anticompetitive effect of customer foreclosure when the suppliers gain bargaining power at the production stage (second part of Proposition 6) holds true when DM subsists to some extent 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 that $\lambda_j < \mu_j$ for some independent supplier and that $\mu_0' = \lambda_0' >$ $\max(\lambda_0, \mu_0)$. Then with positive probability $S_j$'s eviction 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 $q^m(\Psi_0(c_0; \mu_0'))$. $\square$

**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 is 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 eliminates DM but locally increases production costs.[29]

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

*Proof.* Suppose that $S_i$ 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 $OED'$ while consumer surplus falls in the narrower region $OED$.[30]

# 5 Extensions

In this section, we explore several paths based on our model. In section 5.1, we show that vertical mergers may benefit consumers by correcting preexisting distortions other than DM. In section 5.2, we let the buyer choose her merging partner and examine whether her choice is aligned with consumers' interests. In section 5.3, we model multisourcing by assuming that suppliers have convex costs. In section 5.4, we check that our results are robust to the presence of private information on the buyer's side.

## 5.1 Correcting pre-merger misallocation

In this and the next subsection, we consider more closely environments where potential suppliers differ in cost distributions or bargaining power. If under vertical separation

[29] Recall that close to the boundary of the foreclosure region, $\Pi^m(c_0) = \pi_i^v(c_i)$, we have $c_0 > c_i$.
[30] The equation of $OD'$ in the example is given in Appendix I.2.

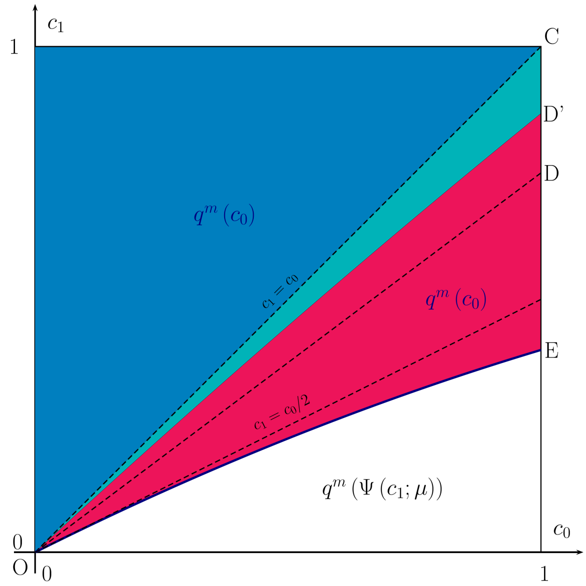



**Figure 4:** Effect of the merger on total welfare (symmetric suppliers). Suppliers' costs are uniform on $[0, 1]$, demand is linear $\lambda_0 = \lambda_1 = 0$, and $0 < \mu_0 = \mu_1 = \mu < 1$.
Foreclosure area: $OCE$. Consumer harm: $ODE$. Fall in total welfare: $OD'E$

the procurement process inefficiently discriminates against a supplier, the acquisition of that supplier eliminates the pre-merger productive misallocation while leading to the foreclosure of independent suppliers.[31]

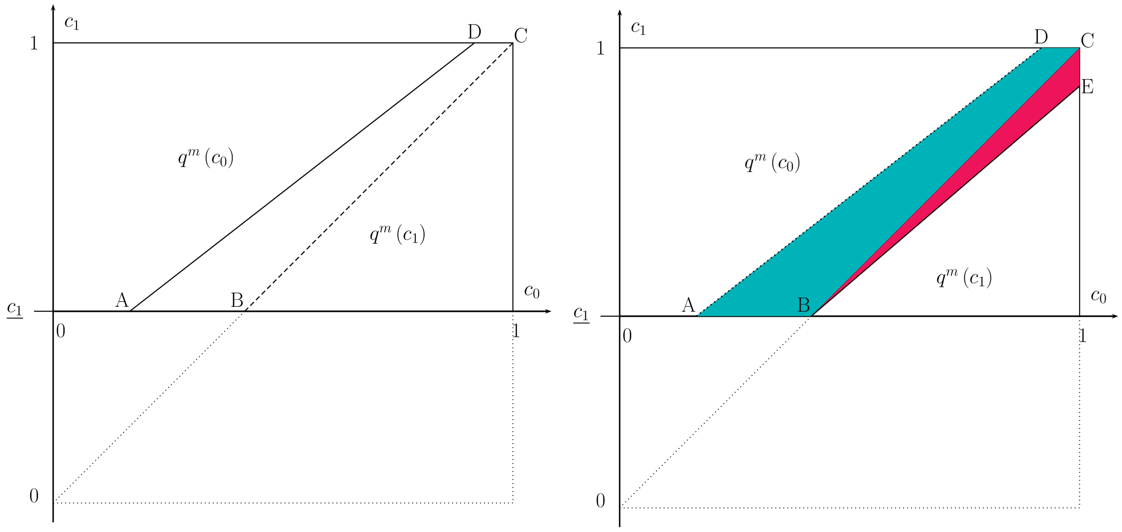
**Proposition 8.** *Suppose that prior to the merger supplier selection is biased against $S_0$, i.e., the buyer supplies from $S_1$ in a region of the cost parameters where $c_1 > c_0$. Then vertical integration causes the buyer to switch from $S_1$ to $S_0$ in this region, which benefits final consumers.*

*Proof.* See Appendix F. □

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*

[31] 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: $ACE$

*order ($F_0/f_0 > F_1/f_1$). Then final consumers benefit from the foreclosure of $S_1$ with positive probability.*

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 (in the sense of the likelihood ratio order) 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.[32]

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 $q^m(c_1)$

[32]Under the assumptions of Corollary 4, the buyer indeed prefers to merge with $S_0$ rather than with $S_1$, see Appendix J.

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.

### 5.2 Choice of merging partner

When potential suppliers are ex ante asymmetric, the question arises of which supplier the buyer prefers to merge with. To address this question, we now allow the choice of the acquired supplier to be endogenous. To convey intuitions more transparently, we restrict attention to the case of two potential suppliers.[33]

We assume that the buyer can approach sequentially the two suppliers and make take-it-or-leave-it buyout offers to acquire one supplier. More precisely, we consider the following sequential game. The buyer chooses which supplier it wishes to acquire and publicly offers a buyout payment which the supplier decides to accept or not. The game ends if the merger takes place, otherwise, the buyer makes a final offer to the remaining supplier. At the last stage, the buyer offers a payment slightly above the suppliers' expected profit under vertical separation and the offer is accepted. The supplier that receives an offer at the first stage, say $S_i$, anticipates that should he reject it, the buyer would acquire $S_j$, $j \neq i$. Thus $S_i$ accepts any offer larger than her expected profit following the acquisition of $S_j$, which we denote by $\Pi^j_{S_i}$. Let $\Pi^i_{BS_i}$ denote the joint-profit of the merging parties $B$ and $S_i$. The buyer thus prefers to acquire $S_0$ if and if $\Pi^0_{BS0} - \Pi^1_{S_0} \geqslant \Pi^1_{BS_1} - \Pi^0_{S_1}$, that is, whenever total industry profit is larger when $B$ acquires $S_0$ rather than $S_1$.

We examine how the acquisition decision is affected by the suppliers' bargaining weights. We show that when bargaining weights are the same at both stages ($\boldsymbol{\lambda} = \boldsymbol{\mu}$), the buyer's choice of her merging partner is aligned with consumers' interests.

**Proposition 9.** *When the two suppliers' costs are drawn from the same distribution $F$ and bargaining weights are $\lambda_0 = \mu_0 > \lambda_1 = \mu_1$, the buyer prefers to acquire the least powerful supplier, $S_1$. This choice benefits final consumers.*

*Proof.* See Appendix G □

This result that the buyer prefers to acquire the least powerful supplier may seem counterintuitive. It involves two effects that play in the same direction. First, when the

[33] We ignore here the possible strategic interactions between the merging partners and the antitrust authorities. For thorough merger analyses along this line, see Nocke and Whinston (2010, 2013).

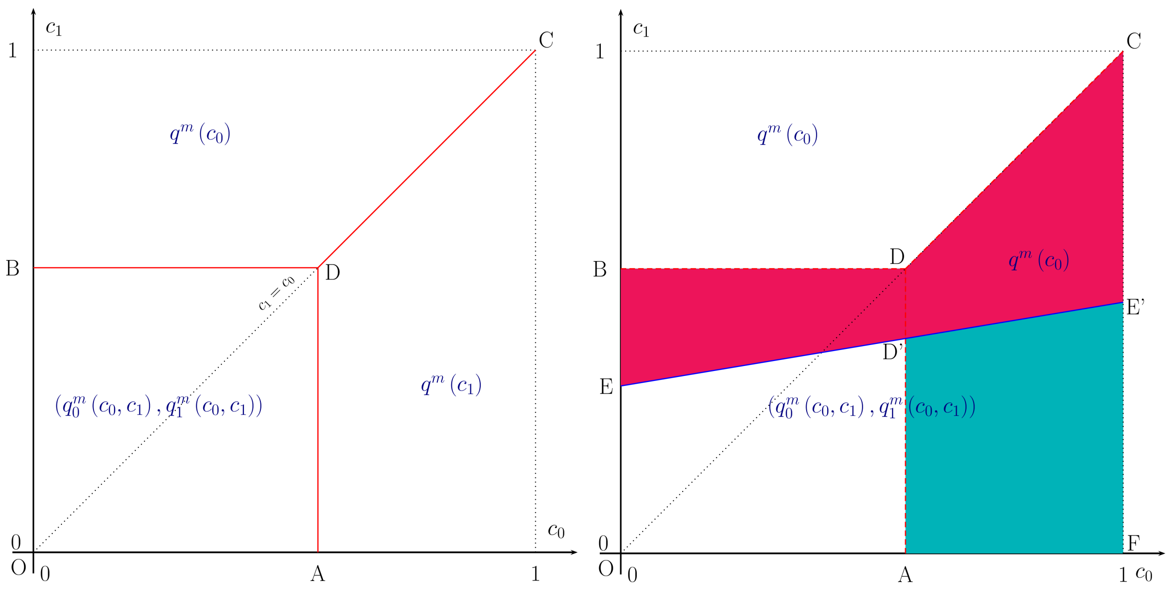
buyer purchases from the independent supplier post-merger, the quantity and industry profit increase with that supplier's bargaining power at the production stage. This thus induces the buyer to merge with the least powerful supplier, $S_1$. Second, foreclosure is more likely if she acquires $S_0$, which reduces quantity and total industry profit, further inducing the buyer to acquire $S_1$. In Appendix H, we present a counterexample where the buyer has more control over selection than over production ($\boldsymbol{\lambda} < \boldsymbol{\mu}$). In this example, she prefers to acquire the most powerful supplier, $S_0$, and this choice harms final consumers.

### 5.3 Multisourcing

We have assumed so far that suppliers produce a homogenous input under constant returns to scale. In this context, there is no incentive to purchase from more than one supplier. Multisourcing may emerge when the buyer's revenue depend on the quantity of each of input (rather than simply on the total quantity) and/or when the supplier's costs are convex. Although multisourcing deserves a comprehensive treatment in a separate paper, it is worthwhile to check that our main qualitative insights carry over to these cases. To this aim, we consider in Appendix K two symmetric suppliers that have a cost function of the form $C(q_i; c_i) = c_i q_i + \tilde{C}(q_i)$, where $\tilde{C}(q_i)$ is convex in $q_i$.

On the one hand, multisourcing reduces total production cost but on the other it entails leaving an informational rent to both suppliers. When the rents are valued equally at the production and selection stages ($\lambda = \mu$), both suppliers are selected and there is in effect a single bargaining stage. By contrast, when the rents left at the production stage are perceived as excessive from the selection stage ($\lambda < \mu$), bargaining may lead to select only one supplier in spite of the associated productive inefficiency. This tends to occur when one of the suppliers' cost is high because the cost associated with leaving a rent to this supplier exceeds the efficiency gains from multisourcing. Multisourcing thus occurs when both suppliers' costs are sufficiently low, see region $OADB$ on Figure 6(a).

A merger between $B$ and $S_0$ affects final consumers through three channels. First, as under constant returns to scale, the merger gives rise to pure EDM in a subregion of the cost parameters. As soon as the same set $\mathcal{S}$ of suppliers is selected pre- and post-merger, with that set containing $S_0$, then the merger causes the marginal virtual cost to decrease and hence the total quantity to increase, which benefits final consumers. Formally, given a set $\mathcal{S}$ of selected suppliers containing $S_0$, the total virtual cost of producing total quantity $q$ is $C^{\mathrm{v}}(q; \mathcal{S}) = \min \sum_j C(q_j; \Psi(c_j; \mu_j))$, where the minimum




(a) Vertical separation

(b) Effect of the merger

**Figure 6:** Multisourcing occurs in $OADB$ pre-merger and in $OFE'E$ post-merger

Buyer's revenue $R(q) = q(a - q)$, with $a = 2.5$. Suppliers' cost functions $C(q; c_i) = c_i q + \alpha q^2/2$, with $c_0$ and $c_1$ uniformly distributed over $[0, 1]$, $\alpha$=2. Bargaining weights: $\lambda = 0$, $\mu = 1$

runs over the quantities $q_j$, $j \in \mathcal{S}$, such that $\sum_j q_j = q$. At the production stage, the total quantity is given by $R'(q) = (C^{\mathrm{v}})'(q; \mathcal{S})$. The marginal virtual cost $(C^{\mathrm{v}})'(q; \mathcal{S})$ weakly decreases with $\mu$, hence as $\mu_0$ rises to one following the merger, total quantity weakly increases.[34] It follows in particular that if $\lambda = \mu$, final consumers are always better off post-merger.

The second channel, also present under constant returns to scale, occurs when independent suppliers are foreclosed from the market *at the selection stage* while they would have produced a positive quantity had they been allowed to participate in the production stage. In this situation, final consumers are harmed.[35] This effect is particularly strong in the absence of DM pre-merger ($\mu = 1$), a situation represented on Figure 6. In region $EE'CDB$, $S_1$ produces and is not selected post-merger, which is inefficient and harms consumers.

The third channel through which the merger affects consumers is new. It occurs when $S_0$ is inefficiently foreclosed from the market pre-merger while there is multisourcing post-merger, see the area $AFE'D'$ on Figure 6(b). This is another instance

[34] It increases strongly in the cost region where $q_0 > 0$.

[35] By contrast, as we have seen above, eviction due to bargaining at the production stage benefits consumers.

where the merger corrects a pre-existing distortion, and thereby improves consumer welfare.

### 5.4 Bilateral asymmetric information

We have assumed so far that the buyer's revenue function is common knowledge. In the spirit of Loertscher and Marx (2021), we now introduce private information on the buyer's side, and assume that her revenue $R(q;\theta)$ depends on a privately known cost or demand parameter $\theta \in [\underline{\theta}, \overline{\theta}]$.[36] This change turns out to be innocuous when the buyer has more bargaining power than the suppliers and therefore earns the industry profit minus the suppliers' informational rents. In this environment, the above analysis still holds for any value of $\theta$, with prices and quantities simply affected by $\theta$ through the change in the marginal revenue $R'(q;\theta)$.

By contrast, the outcome dramatically changes when the buyer is *not* the party endowed with the strongest bargaining power. Suppose for instance that a dominant supplier, say $S_0$ (and only that supplier) now has a stronger bargaining power than the buyer. The dominant supplier is thus now the residual claimant, earning the industry profit net of all informational rents. In this configuration, the buyer's private information about $\theta$ becomes critical to protect her from having all of her profit appropriated by $S_0$ under vertical separation. Because the buyer's rent is now costly, the traded quantity is subject to a second source of distortion pre-merger. As a result, when $S_0$ is not producing, there are *two* sources of DM, coming from the incentives to reduce the buyer's and the active supplier's rent. The additional source of inefficiency is corrected by vertical integration when the dominant supplier acquires the buyer.

The dominant supplier case generates interesting additional insights, but seems at odds with our focus on the case of a monopsonistic buyer that serves as a bottleneck to access final consumers. A thorough analysis of mergers with powerful suppliers would require to model downstream competition which is beyond the scope of this paper.

## 6 Antitrust perspective

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

[36] We maintain the assumption that demand is sufficiently high so that trade always occurs.

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 simultaneously increasing aggregate profits and consumer surplus. The canonical model has led to the entrenched view among antitrust practitioners that vertical mergers help solve the DM problem. For instance, the FTC Bureau of Competition Director argued 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."*[37]

This 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.[38] 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 implicitly assume that the alleged cost savings require vertical integration for their realization, i.e., that the cost savings should be merger-specific.

The paper contributes to the debate by spelling out a theoretical rationale for merger-specific EDM. In our setting with asymmetric information about suppliers' costs, nonlinear pricing does not suffice to eliminate DM under vertical separation. 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."*[39] We find that, ceteribus paribus, more balanced bargaining at the production stage (i.e., when deciding price and quantities) is associated with less severe DM. With vertical integration, only the joint profit of the buyer and the integrated supplier matter, hence the merger eliminates DM: in that sense, EDM is merger specific.

[37]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.

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

[39]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.

Regarding the welfare effects of vertical integration, it is remarkable that the section of the 2020 U.S. Vertical Merger Guidelines devoted to 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 state that, as for efficiency claims in horizontal mergers, EDM claims must satisfy three conditions: any efficiency gain must be verifiable, be merger-specific, and benefit consumers.[40] Similarly, Makan Delrahim, then in charge of DOJ Antitrust Division, argued that "*EDM is not specific to every vertical merger, so courts should not assume consumers will benefit from EDM [...] until defendants come forward with evidence demonstrating the existence and size of such benefit.*"[41] Although we do consider the effect of vertical integration on total surplus, the main focus of the paper is on consumer surplus. As put forward by FTC Commissioner Slaughter, *"achieving EDM is not guaranteed. Nor are the benefits of EDM always passed along to consumers."*[42]

EDM and foreclosure effects are closely intertwined and should always be considered jointly.[43] The welfare effects of vertical integration critically depend on the bargaining environment. We find that foreclosure of independent suppliers does not necessarily harm final consumers. In fact, when the buyer has the same bargaining power at the production and selection stages, her interests are perfectly aligned with those of final consumers. Vertical integration may harm consumers through a biased make-or-buy decision only if the buyer has less bargaining power when negotiating wholesale 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.

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

[41]See Assistant Attorney General Makan Delharim's remarks delivered at the George Mason Law Review 22nd Annual Antitrust Symposium, February 15, 2019.

[42]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.

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

They could for instance document whether the buyer uses a formal selection process that prevents some non-selected suppliers ("losers") from participating in subsequent negotiations. Another useful indication of changes in bargaining power would be to observe contractual amendments modifying the agreed tariffs and/or quantities.

The customer foreclosure theory of harm developed in this 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.[44] The 2020 U.S. Vertical Merger Guidelines propose one example of a vertical merger that is based on the same market structure as ours, with a dominant buyer and multiple suppliers, but they do not go as far as elaborating a theory of customer foreclosure.[45] In this article, we have demonstrated that when the buyer is able to exclude independent suppliers and double marginalization is limited pre-merger, customer foreclosure causes 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 sword, as put by Slade (2021). Foreclosure may benefit consumers when the pre-merger procurement mechanism is distorted and vertical integration eliminates this preexisting distortion.

The empirical literature on vertical relationships and vertical integration relies on the complete information paradigm, and hence tends to equate DM with linear pricing.[46] By contrast, the empirical literature on procurement, auctions and nonlinear pricing emphasizes asymmetric information and develops methods to identify the distributions of suppliers' costs, while generally assuming strong bargaining power on the buyer side.[47] 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.

# APPENDIX

[44] 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. The latter aspect generally involves dynamic considerations such as reduced incentives to invest.

[45] Moreover, this example (Example 5) assumes "supply at a constant unit wholesale price", leaving the issue of merger-specificity unresolved.

[46] See Section 1.

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

# 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

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

where the expectation is with respect to the updated distribution of the selected suppliers' costs. Setting the payment $M_j$ eliminates any rent for the least efficient types, $u_j(c_j^{\mathrm{Sel}}) = 0$. Computing the expected value of $u_j(c_j)$ and integrating by parts yields:

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

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

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

Taking the expectation over $\mathbf{c}$ for the updated distributions 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 $\mu \leqslant \lambda$, 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 $c_j \leqslant c_j^{\text{Sel}}$ for a certain threshold $c_j^{\text{Sel}}(\mathbf{c}_{-\mathcal{S}})$. 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 $c_j^{\text{Prod}}(c_{-j})$ with

$$c_j^{\text{Prod}}(\mathbf{c}_{-j|\mathcal{S}}) = \max\left\{\; c_j \leqslant \bar{c}_j \;\middle|\; \Psi_j(c_j;\mu_j) \leqslant \min_{k\in\mathcal{S}\setminus j} \Psi_k(c_k;\mu_k) \;\right\}.$$

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 $c_j \leqslant \tilde{c}_j$ with

$$\tilde{c}_j(\mathbf{c}_{-j}) = \min\left(c_j^{\text{Sel}}(\mathbf{c}_{-\mathcal{S}})\,,\; c_j^{\text{Prod}}(\mathbf{c}_{-j|\mathcal{S}})\,\right),$$

and is therefore non-increasing in $c_j$. Conditionally on $\mathbf{c}_{-j}$, supplier $j$ expected rent is given by

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

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 $c$, which defines the optimal selection threshold $c_i^*(c_{-i})$ given by (4). The optimal quantities and payments are given by

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

and

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

# 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 $S_i$, the buyer maximizes $R(q) - w_i(\tilde{c}_i)q$ and thus purchases $q^m(\Psi_i(\tilde{c}_i))$. Anticipating this, $S_i$ chooses $\tilde{c}_i$ to maximize

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

where the transfer $M_i$ is given by (6). As the above expression is maximal for $\tilde{c}_i = c_i$, $S_i$ chooses the two-part tariff designed for him in the menu. When the clock index is

$s$, $S_i$ 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 $c_i < c_i^*(s)$, 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 $\pi_k^v$ decreases in $\mu_k$ 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 Proof of Proposition 8 and Corollary 4

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.

When $F_0 = F_1$ and $\lambda_0 = \lambda_1 < \mu_1 < \mu_0$, the monotonicity of the virtual profit in $\mu$ guarantees that: $\pi_1^v(c) > \pi_0^v(c)$ 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 when $\lambda_0 < \lambda_1$, $\mu_0 = \mu_1$, using this time the monotonicity of $\pi^v$ in $\lambda$.

To prove Corollary 4, 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.[48] It follows that $\pi_1^v(c) > \pi_0^v(c)$ for any $c$, which gives the desired result.

# G Proof of Proposition 9

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

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

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

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

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

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

Because $\mu_0$ is larger than $\mu_1$, the buyer is more likely to supply internally when she integrates with $S_0$ than when she integrates with $S_1$:

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

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

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

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

The first term above is positive because $\Pi(q^m(\Psi(c_1;\mu_0));c_1) \geqslant \Pi(q^m(c_0);c_1) \geqslant \Pi^m(c_0)$. The second term above is positive as well because $q^m(\Psi(c_1;\mu_1)) \leqslant q^m(\Psi(c_1;\mu_0)) \leqslant q^m(c_1)$. 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.

# H Merging with the most powerful 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 $S_1$.[49] 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 $S_1$.

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

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

[49] 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 first term is positive as $\Pi^m(c_0) < \Pi_1^v(c_1) < \Pi(q^m(\Psi(c_1;\mu_1);c_1)$ in the corresponding region. The second term is negative as it just the opposite of the corresponding term in the proof of Proposition 9.

**Example** 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 powerful supplier $S_0$. The expected consumer surplus post-merger is .84 in this case, while it would be .87 in case of a merger with $S_1$. This example shows that when the buyer fully controls the selection decision, she may want to acquire the most powerful supplier and leave the less powerful one as the independent supplier. The buyer's choice to acquire $S_0$ rather than $S_1$ harms final consumers.

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# I Example (details)

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

## I.1 Vertical separation

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

$$c_1^{\text{vs}}(c_0) = \frac{a(2-\lambda_1)}{(2-\lambda_1)^2-(\mu_1-\lambda_1)^2} \times \left[1-\sqrt{1+\frac{(2-\lambda_1)^2-(\mu_1-\lambda_1)^2}{a(2-\lambda_1)}\left[-2\frac{2-\lambda_0}{2-\lambda_1}c_0+\frac{(2-\lambda_0)^2-(\mu_0-\lambda_0)^2}{a(2-\lambda_1)}c_0^2\right]}\right]$$

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

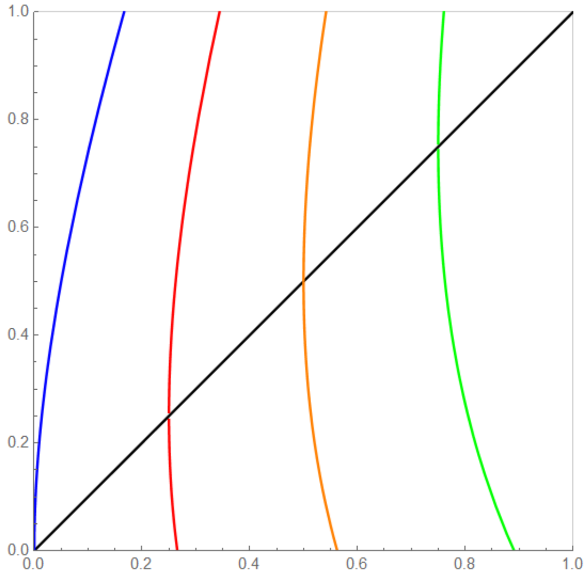
Figure 7(a) shows level curves of the virtual profit in the $(\lambda, \mu)$ space. Figure 7(b) plots $\pi_i^v$ as a function of $\mu$ for various value of $\lambda$. The black curve (at the bottom of the graph) is for $\lambda = 0$, while the red curve (at the top of the graph) is for $\lambda = 1$. The increasing orange curve is $\pi_i^v$ when $\lambda = \mu$, it passes through the maximum of the other curves.

## I.2 Vertical integration

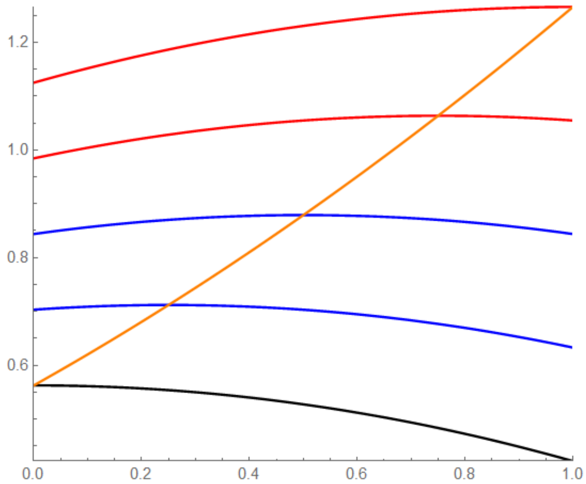
There are two potential suppliers ($n = 1$). Their costs are uniformly distributed on $[0, 1]$. Demand is linear. The customer foreclosure area, $OCE$, is defined by $c_1^{\text{vi}}(c_0) < c_1 < c_0$, with

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

The $OE$ line, along which $\Pi^m(c_0) = \pi_1^v$, lies below the straight line $c_1 = c_0/(2-\lambda)$ and is tangent to that line at $c_0 = 0$. The *Exploitation* region is defined by $c_1$ below




(a) Level curves of $\pi_i^v$ in the $(\lambda, \mu)$ space.




(b) $\pi_i^v$ as function of $\mu$ for various $\lambda$.

**Figure 7:** Effect of $\mu$ and $\lambda$ on $\pi_i^v$, for a given $c_i$.

that threshold. Consumers benefit from vertical integration in the foreclosure region if $c_0 < \Psi(c_1; \mu) = (2 - \mu)c_1$ and they are harmed, otherwise.

In the case where $\lambda_1 = 0$, total welfare increases in the region $OCD'$ defined by

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

with equality holding along the line $OD'$.

# J Merger choice with asymmetric cost distributions

**Proposition 10.** *When the buyer controls the selection decision ($\boldsymbol{\lambda} = \mathbf{0}$), there is no DM pre-merger ($\boldsymbol{\mu} = \mathbf{1}$), and $S_0$ is more likely to be the efficient supplier ($F_0/f_0 > F_1/f_1$), the buyer prefers to acquire supplier $S_0$.*

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:

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

Similarly, when $B$ integrates with $S_1$

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

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

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

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 $\Pi^m$ 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

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

As $c_0 \geqslant c_1$, we have $f_0(c_0) f_1(c_1) \leqslant f_0(c_1) f_1(c_0)$ and $\Pi^m(c_0) \leqslant \Pi^m(c_1)$ 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.

# K Multisourcing

We consider two symmetric suppliers $S_0$ and $S_1$ and a common cost function $C(q; c) = cq + \tilde{C}(q)$ that is increasing in $c$ and $q$ and convex in $q$. The parameters $c_0$ and $c_1$, which are each supplier's private information, are independently drawn from a common distribution $F$. The bargaining weights are $\lambda$ at the selection stage and $\mu$ at the production stage.

We denote by $\Pi^m(c_0, c_1)$ and $q_j^m(c_0, c_1)$ the monopoly profit and quantities under complete information, i.e., the maximum and maximand of $R(q_0+q_1) - C(q_0; c_0) - C(q_1; c_1)$. Slightly abusing notations, we denote $\Pi^m(c) = \max_q R(q) - C(q; c)$ and $q^m(c)$ the monopoly profit and quantity when only one supplier is selected.

If the buyer has selected $S_0$ and $S_1$, the quantities maximize

$$R(q_0+q_1) - \sum_{j=0,1} \left[ \Psi(c_j; \mu) q_j + \tilde{C}(q_j) \right],$$

and are thus equal to $q_j^m(\Psi(c_0; \mu), \Psi(c_1; \mu))$. At the selection stage, the virtual profit associated with selecting $S_0$ and $S_1$

$$\pi_{01}^v = R(q_0^m(\Psi(c_0; \mu) + q_1^m(\Psi(c_1; \mu)) - \sum_{j=0,1} C(q_j^m(\Psi(c_j; \mu); \Psi(c_j; \lambda)).$$

Similarly, if the buyer has selected only $S_j$, he produces quantity $q^m\left(\Psi(c_j; \mu)\right)$. At the selection stage, the virtual surplus associated to selecting only $S_j$ is

$$\pi_j^v = R\left(q^m\left(\Psi(c_j; \mu)\right)\right) - C\left(q^m\left(\Psi(c_j; \mu)\right); \Psi(c_j; \lambda)\right).$$

It is then optimal to select supplier(s) so as to maximize the virtual surplus (i.e., to "choose" between $\pi_{01}^v$, $\pi_0^v$ and $\pi_1^v$). Under decreasing returns, keeping the two suppliers reduces the total production cost but implies leaving an informational rent to both suppliers. In this tradeoff, the former effect tends to dominate when the suppliers' costs are low and the quantities are large.

**Lemma 1.** *If $\lambda = \mu$, the two suppliers are selected with probability one both pre- and post-merger.*

*Proof.* For $\lambda = \mu$, the virtual profits are given by $\pi_{01}^v = \Pi^m(\Psi(c_0; \mu), \Psi(c_1; \mu))$ and $\pi_i^v = \Pi^m(\Psi(c_i; \mu))$. The claims before and after the merger follow respectively from the inequalities

$$\Pi^m(\Psi(c_0; \mu), \Psi(c_1; \mu)) \geqslant \max\left(\Pi^m(\Psi(c_0; \mu)), \Pi^m(\Psi(c_1; \mu))\right)$$

and

$$\Pi^m(c_0, \Psi(c_1; \mu)) \geqslant \max\left(\Pi^m(c_0), \Pi^m(\Psi(c_1; \mu))\right).$$

$\square$

By contrast, when the rents left at the production stage are perceived as excessive at he selection perspective ($\lambda < \mu$, ), there is an incentive to select only one supplier (in spite of the associated productive inefficiency). To describe the phenomenon, we restrict attention to selection rules that implementable with a deferred-acceptance clock auction.

**Lemma 2.** *When $\lambda < \mu$, the buyer supplies from both suppliers if and only if their costs are below the threshold $x$ given by*

$$\int_0^x \left[\pi_{01}^v(x, c_1) - \pi_1^v(c_1)\right] f(c_1)\,\mathrm{d}c_1 = 0. \tag{K.1}$$

*Proof.* As the clock index rises, the marginal costs of the active participants decrease, the quantities increase, and the former effect (convexity of the cost function) is more likely to dominate the latter (two informational rents instead of one). If one supplier exits for a low clock index (i.e., for a high cost parameter $c_i$), the other supplier is selected. On Figure 6(a), $S_0$ is selected above $BDC$ and $S_1$ is selected below $ADC$. Otherwise, when a critical index is attained with both suppliers being active, the auction stops, the two suppliers are selected; accordingly at the production stage it is known that their types are below a critical threshold $x$, see the square $OADB$. The threshold $x$ is obtained by maximizing the expected virtual profit, which is now the sum of three terms

$$\mathbb{E}\left(\pi_{01}^v \mathbb{1}_{c_0 \leqslant x, c_1 \leqslant x} + \pi_0^v \mathbb{1}_{c_0 \leqslant c_1, c_1 \geqslant x} + \pi_1^v \mathbb{1}_{c_0 \geqslant x, c_1 \leqslant c_0}\right).$$

Differentiating with respect to $x$ yields (K.1). $\square$