Double marginalization, market foreclosure, and vertical integration*

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Abstract

Double marginalization is a robust phenomenon in procurement under asymmetric information when sophisticated contracts can be implemented. In this context, vertical integration causes merger-specific elimination of double marginalization but biases the make-or-buy decision against independent suppliers. If the buyer has full bargaining power over prices and quantities, a vertical merger benefits final consumers even when it results in the exclusion of efficient suppliers. If on the contrary the buyer's bargaining power is reduced after she has committed to deal exclusively with a limited set of suppliers, exclusion of efficient suppliers may harm final consumers.

JEL codes: L1, L4, D4, D8

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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. Two FTC Commissioners 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. Another commissioner 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

[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. See Linnemer (2022) for an historical perspective.

[3]The two commissioners voted against the publication of the Guidelines, see their dissenting statements, Chopra (2020) and Slaughter (2020). In September 2021, a few weeks after Lina Khan became the new FTC Chairman, the FTC decided after a 3-2 vote to withdraw the 2020 Guidelines. The new majority argued that "*[t]he VMG's reliance on EDM is theoretically and factually misplaced".*

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

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.

We consider a procurement environment with competition and bargaining under asymmetric information. An intermediate buyer acquires a homogeneous input on an upstream market and addresses the demand from final consumers. The procurement process consists of a selection phase followed by a negotiation phase, as is common in many industries.[5] The buyer first selects a supplier, and then bargains with that supplier over prices and quantities. In line with recent empirical research (see the literature review below), the buyer maximizes her expected profit at the selection phase, anticipating the subsequent bargaining with the selected supplier. Following Ausubel, Cramton, and Deneckere (2002), we do not restrict attention to any particular extensive-form bargaining game. We adapt the mechanism design approach of Loertscher and Marx (2022) to model the negotiation of price and quantity under asymmetric information.

The contribution of the paper is twofold. 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 the selected supplier has more bargaining power. At the limit, with balanced bargaining power, asymmetric information no longer matters and DM vanishes. Second, we discuss 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 vertical integration. Otherwise, with positive probability, consumers suffer due to a biased make-or-buy decision.

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, he has to accept a lower payment even though the traded quantity remains unaffected; in that sense there is exploitation of the supplier. 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 "market foreclosure".

[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. We are grateful to Leslie Marx for bringing this case to our attention.

The impact of market foreclosure on final consumers is our most important research question. We find that when the suppliers have no bargaining power, the buyer's and final consumers' interests are aligned: EDM within the merged entity, together with the change of supplier, enhances consumer surplus. Indeed, the eviction of an independent supplier causes the traded quantity to increase and the retail price to fall post-merger. By contrast, when the suppliers do have bargaining power, customer foreclosure harms consumers with positive probability. In particular, with ex ante symmetric suppliers, consumer harm caused by foreclosure is magnified when bargaining power is balanced at the production stage because in that case there is no DM pre-merger. With asymmetric suppliers, however, market foreclosure can benefit consumers even in the absence of DM pre-merger because it allows to correct a pre-existing distortion.

Our main results, in particular the existence of anticompetitive market foreclosure, are robust to alternative bargaining environments. In a natural extension of our baseline setting, we assume that the suppliers have less bargaining power vis-à-vis the buyer when they are selected jointly than when they are selected separately. We find that when the suppliers have constant marginal costs, anticompetitive foreclosure occurs under similar conditions as in the baseline setting. When the costs are convex, the buyer has an incentive to purchase from many suppliers. Under vertical integration, she faces a tradeoff between excluding independent suppliers and multisourcing. Market foreclosure may still be anticompetitive in this context.[6]

Before closing the introduction, we relate the paper to the existing literature. Section 2 presents the procurement framework with bargaining under asymmetric information. Section 3 characterizes the optimal mechanism under vertical separation and explains how bargaining at the production stage affects 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 Section 5, we allow the bargaining environment to depend on the number of selected suppliers. We introduce convex costs and multisourcing. We examine whether the buyer's choice of a merger partner is aligned or not with consumers' interests. We check the robustness of our results to the presence of bilateral asymmetric information. Section 6 discusses the policy implications of our findings.

[6] Choné, Linnemer, and Vergé (2021) relax the assumption that the buyer has full bargaining power at the selection stage. They find that market foreclosure may be anticompetitive when the buyer has more bargaining power at that stage than when negotiating prices and quantities, which generalizes the results presented here.

Related literature The paper builds on and expands the Industrial Organization literature that emphasizes the role of incomplete information. In the context of the regulation of public monopolies, the early principal-agent literature (Baron and Myerson (1982) and Laffont and Tirole (1986)) highlights the existence of a rent-efficiency trade-off. To reduce the agent's informational rent, the Principal is better off not implementing the complete information outcome. This insight, when applied to our procurement environment, is at the source of the 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. 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 incentives 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).

None of the papers cited above allow for balanced bargaining nor study vertical integration. For that purpose, we combine these classical results with the recent contribution of Loertscher and Marx (2022). They offer a versatile framework to study incomplete information bargaining. In particular, they generalize the bilateral asymmetric information trade problem of Myerson and Satterthwaite (1983) to multiple buyers and multiple suppliers. Loertscher and Marx model markets as a mechanism that maximizes the expected weighted welfare of the agents.[7] 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.

A recent strand of the empirical bargaining literature studies environments with competition and bargaining. In an incomplete contract setting, An and Tang (2019) consider a buyer who chooses the initial design to maximize her ex ante expected profit, anticipating that the winner of the auction will have a positive weight in the subsequent

[7] 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.

negotiation.[8] In an asymmetric information setting, Larsen (2021) and Larsen and Zhang (2021) consider a seller who chooses the (secret) reserve price in the auction to maximize her ex ante expected profit, anticipating that the winner of the auction will have a positive weight in the subsequent negotiation.[9] As these authors, we assume that while the principal is able to maximize her expected profit at the selection stage, bargaining power is more balanced at the negotiation stage.

Building on these major methodological contributions, we introduce a downstream market with final consumers and thus allow the buyer's demand to respond to prices. 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). 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 (see Perry (1978) for a seminal contribution) 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 and always harms consumers through higher prices. 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

[8] Board (2011) studies a dynamic version of the holdup game under complete information. He considers a buyer who designs a contract to maximize her profit and must invest in at most one of the potential suppliers, with the chosen supplier having ex post all the bargaining power. Another interesting paper that separates selection from production is Calzolari and Spagnolo (2009, 2020). They show, under incomplete information, that a buyer optimally restricts the number of selected suppliers to maintain suppliers' incentives to provide quality.

[9] See also Elyakime, Laffont, Loisel, and Vuong (1997) for a model with an auction followed by bargaining.

[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).

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,[11] 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.

The competitive nonlinear pricing literature e.g. Martimort (1996), Calzolari and Denicolò (2013, 2015), has examined the polar case where the suppliers make take-it-or-leave-it offers to a common agent/retailer. In a related but different vein, Dequiedt and Martimort (2015), examine contractual arrangements by a manufacturer and a network of retailers. This strand of papers highlights quantity distortions caused by asymmetric information, but does not connect them to double marginalization or vertical integration.

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. Gayle (2013) regards codesharing in the airline industry as a form of vertical relationship and finds it does not fully eliminate DM. Luco and Marshall (2020) find that vertical integration in the carbonated beverage industry lowers prices for products with eliminated double margins but also increases prices for the other products sold by the integrated firm. A result 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 assuming bilateral bargaining over either fixed transfers or linear tariffs under perfect information, e.g. Draganska, Klapper, and Villas-Boas (2010), Ho and Lee (2017), and Crawford, Lee, Whinston, and Yurukoglu (2018).[12] By contrast, we allow for multilateral bargaining over nonlinear prices under asymmetric information.

[11] The bargaining externalities in their model mirror those studied by Hart and Tirole (1990) in the case of one seller dealing with many buyers. See also Reisinger and Tarantino (2015).

[12] In particular, Crawford, Lee, Whinston, and Yurukoglu find significant gains in consumer welfare from vertical integration in the multichannel television industry, partly through a reduction in DM.

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

2 Framework

A buyer B seeks to procure a homogeneous input from potential suppliers $S_0, \ldots, S_n$ who operate under constant returns to scale.[13] Their marginal costs c_i are independently drawn from distributions $F_i(.)$ that admit 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 exposition convenience, we assume a monopolistic downstream market.[14] Selling quantity q generates gross revenue $R(q) = P(q)q - C(q)$, where $P(.)$ is the inverse demand and $C(.)$ reflects the buyer's transformation and distribution costs. The revenue function $R(q)$ is assumed to be concave. If the buyer purchases from a single supplier with cost c, the industry profit is $\Pi(q; c) = R(q) - cq$. The monopoly quantity $q^m(c) = \arg\max_q \Pi(q; c)$ is uniquely defined and decreasing in c. The monopoly profit, denoted $\Pi^m(c) = \max_q \Pi(q; c)$, is decreasing and convex in c.

2.1 Procurement process

The procurement process is sequential. First the buyer selects a supplier; then she negotiates the price and the traded quantity with that selected supplier.

We do not attempt to characterize the outcome of the negotiation for particular extensive-form games. Instead, we follow the approach described in Ausubel, Cramton, and Deneckere (2002): "Rather than model bargaining as a sequence of offers and counteroffers, we employ mechanism design and analyze bargaining mechanisms as mappings

[13] Convex costs are introduced in Section 5.2.

[14] This is for instance the case if a competitive fringe offers a variant of the final good built from a different type of input.

from the parties' private information to bargaining outcomes. This allows us to identify properties shared by all Bayesian equilibria of any bargaining game."

Assuming that supplier S_j has been selected, we introduce a direct mechanism $(Q_j(\hat{c}_j), M_j(\hat{c}_j))$ where the quantity Q_j and the payment M_j are functions of the cost $\hat{c}_j$ reported by S_j. The buyer's and supplier' profits are given by $\Pi_B(\hat{c}_j) = R(Q_j(\hat{c}_j)) - M_j(\hat{c}_j)$ and $U_j(\hat{c}_j, c_j) = M_j(\hat{c}_j) - c_j Q_j(\hat{c}_j)$. Following Loertscher and Marx (2022), we assume that the negotiation between the buyer and the selected supplier is ex ante efficient, in the sense that the bargaining mechanism $(Q_j(\hat{c}_j), M_j(\hat{c}_j))$ maximizes a weighted sum of their expected profits. We denote by $\boldsymbol{\mu} = (\mu_0, \ldots, \mu_n)$ the vector of suppliers' weights. At the production stage, the mechanism maximizes the expectation of $\Pi_B + \mu_j U_j$ where j is the selected supplier. We assume that the suppliers' weights μ_j are lower than or equal to one.[15] When $\mu_j = 1$, the industry profit is maximized and the part of that profit in excess of the selected supplier's informational rent is shared in an arbitrary manner. In that case, following Loertscher and Marx (2022), we denote by $\eta_j \in [0, 1]$ the share that accrues to the supplier. A supplier with $\mu_j = \eta_j = 1$ is able to extract all the profit from the buyer.

At the selection stage, the buyer maximizes her expected profit anticipating the subsequent negotiation. Under constant returns to scale, only one supplier produces a positive quantity and hence there is no loss of generality in assuming that the buyer selects a single supplier as we implicitly did so far.[16] We assume that the selection mechanism reveals only the minimal information about the winner's costs needed to prove that he should be winning, a property called "unconditional winner privacy" (UWP) by Milgrom and Segal (2020).[17] 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^{Sel} such that S_i is selected if and only if $c_i \leqslant c_i^{\mathrm{Sel}}$. UWP means that the threshold c_i^{Sel} depends only on the costs of the *non-selected* suppliers. Hence at

[15]The weights μ_j affect *both* the size of the industry surplus and the sharing of that surplus between the buyer and the selected supplier, see Subsection 3.1. In the incomplete contract literature, e.g., An and Tang (2019), the weights reflect the possibility of holdup. Another 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.

[16]The constant returns to scale assumption is relaxed in Subsection 5.2.

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

the production stage, when the buyer bargains with the selected supplier, it is common knowledge that the cost of that supplier satisfies $c_j \leqslant c_j^{\mathrm{Sel}}$.

2.2 Vertical integration

When the buyer acquires a supplier, the buyer and that supplier form a single entity. Our baseline model assumes that the buyer perfectly internalizes the profit of the acquired supplier. Let S_0 denote the acquired supplier. After the merger, the buyer selects her supplier by maximizing the expectation of $\Pi_B + U_0$ and at the production stage price and quantity are determined by maximizing $\Pi_B + U_0$ if S_0 has been chosen or $\Pi_B + \mu_j U_j$, $j \neq 0$, if an independent supplier has been selected. In a couple of extensions, we allow for imperfect internalization of profits within the integrated firm, as in Crawford, Lee, Whinston, and Yurukoglu (2018) and we make the choice of the acquired supplier endogenous.

Our focus is on the impact of vertical integration on traded quantities and consumer surplus $S(q) = \int_0^q [P(x) - P(q)]\,\mathrm{d}x$. 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 identity of the selected supplier, and determine quantities and intermediate prices. The main takeaway is that DM emerges as a result of asymmetric information. In Section 3.2, we show how bargaining at the production stage affects the selection decision. In particular, we find that the buyer tends to avoid selecting suppliers with strong bargaining power.

3.1 Production and double marginalization

Because the selection rule is monotonic, the selection phase only reveals that the cost of the selected supplier is below a threshold c_j^{Sel}. The cost distribution at the production stage therefore obtains from a right-truncation of the original distribution 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 μ_j between 0 and 1. The ratio F_j/f_j and hence the function $\Psi_j(c_j;\mu_j)$ are unaffected by the truncation over $[\underline{c}_j, c_j^{\mathrm{Sel}}]$.

Proposition 1 (Production)**.** *The selected supplier produces the quantity $q^m\left(\Psi_j(c_j;\mu_j)\right)$. As the supplier's weight μ_j increases from zero to one, the double marginalization phenomenon becomes less severe, both the supplier's and the industry expected profits increase, whereas the buyer's expected profit decreases.*

Proof. See Appendix A.1. □

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 mechanism allows for efficient quantities to be traded, but the optimal quantity is lowered to reduce the supplier's informational rent. The degree of DM, measured by the difference $q^m(c_j) - q^m\left(\Psi_j(c_j;\mu_j)\right)$, decreases with the supplier's weight μ_j.

The magnitude of DM also depends on market concentration and on the shape of the cost distributions. A higher number of potential suppliers makes it more likely that the selected supplier has a low marginal cost, which reduces the observed distortion. To understand the role of the cost distributions, consider a symmetric environment where all suppliers' weights are equal to μ. Suppose now that the common distribution of the suppliers' costs changes from $F(.)$ to $G(.)$, 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.

The bargaining mechanism maximizes the weighted sum $\mathbb{E}\,\Pi_B + \mu_j \mathbb{E}\,S_j$ of the buyer's and selected supplier's expected profits. Thus, provided that we ignore final consumers and consider only the two negotiating parties, the outcome of the bargaining can be

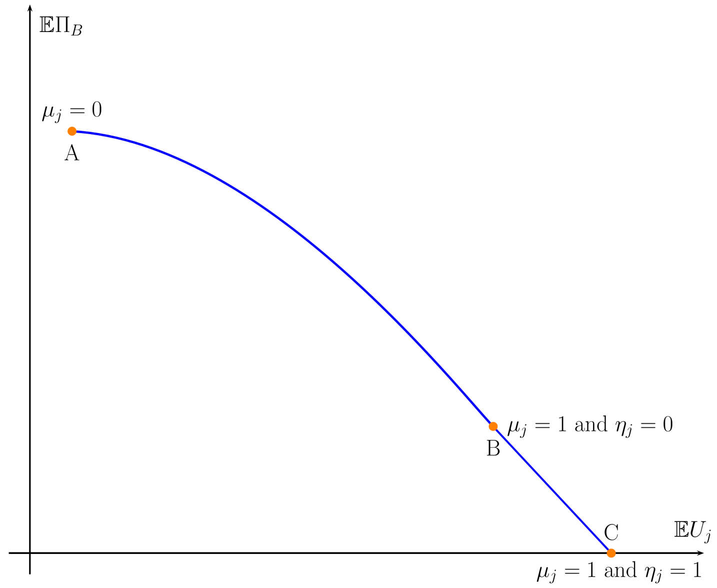


Figure 1: Bargaining over price and quantity: Williams curve

said to be ex ante efficient. Figure 1 shows the set of ex ante efficient allocations $(\mathbb{E}\,\Pi_B, \mathbb{E}\,S_j)$ as the supplier's weight μ_j varies, which Loertscher and Marx (2022) call the "Williams curve". Williams (1987) has indeed been the first author to derive the ex ante efficient frontier. The buyer's share and the supplier's share of the expected industry profit respectively decreases and increases with the supplier's weight μ_j, see Appendix A.1. The expected profits are located on the Williams curve at ex ante efficient equilibria of any extensive game describing the details of the bargaining under asymmetric information (e.g., a sequence of offers and counteroffers).

The quantity that maximizes the industry profit, $q^m(c_j)$, is said to be ex post efficient. (The ex ante and ex post notions of efficiency do not take final consumers into account.) Under asymmetric information, ex post efficiency obtains only for $\mu_j = 1$. For $\mu_j < 1$, the double marginalization phenomenon creates ex post inefficiency. As the selected supplier's weight increases from zero to one, the buyer has less monopsony power, the traded quantity increases, and the industry surplus to be shared between the two parties increases as well. This phenomenon creates the curvature of the Williams line between the points A and B on Figure 1. As emphasized by Larsen and Zhang (2021) and Loertscher and Marx (2022), the relationship between bargaining power and the size of the pie is a key point ignored by the complete information literature (e.g. Nash or Nash-in-Nash bargaining). When $\mu_j = 1$, the industry profit is maximized and the sharing of that profit net of the supplier's informational rent is arbitrary. Let η_j denote the share of this surplus received by the supplier. The Williams curve between the points B and C is a straight line parameterized by η_j. At point B, the selected supplier earns $\int_{\underline{c}_j}^{\bar{c}_j} q^m(c)F_j(c)\,\mathrm{d}c$, which is the expectation of his informational rent, $\int_{c_j}^{\bar{c}_j} q^m(c)\,\mathrm{d}c$, when $\mu_j = 1$. At point C, the supplier appropriates all of the industry profit. Section 5.4 clarifies the subtle link between the complete information setting and the case where the suppliers weights μ_j are equal to one.

3.2 Supplier selection

Anticipating the quantity decision described in Proposition 1, the buyer selects a supplier to maximize her expected profit. In this section, we characterize the optimal selection rule and explain how it depends on the suppliers' weights. We show that our mechanism can be implemented in dominant strategies.

For each supplier S_i, we define the virtual profit π_i^v by

$$\pi_i^v = (1-\nu_j)\,\Pi\left(q^m\left(\Psi_i(c_i;\mu_i)\right);\Psi_i(c_i;0)\right), \tag{2}$$

with $\nu_j = 0$ if $\mu_j < 1$ and $\nu_j = \eta_j$ if $\mu_j = 1$. The virtual profit involves two different virtual costs $\Psi_i(c_i;0)$ and $\Psi_i(c_i;\mu_i)$, which reflect the discrepancy in the objectives maximized at both stages of the procurement process. The virtual profit decreases with μ_i and reaches its maximum value, $\Pi^m(\Psi_i(c_i;0))$, at $\mu_i = 0$. We assume hereafter that for all suppliers the virtual profit is positive and decreasing in c_i. In Appendix A.2, we provide a simple sufficient condition on the functions $q^m(c)$ and $F_i(c)$ guaranteeing that π_i^v decreases with c_i.

Example There are two potential suppliers S_0 and S_1 with cost uniformly distributed over $[0,1]$. The downstream revenue function is $R(q) = q(a-q)$, hence the monopoly quantity is $q^m(c) = (a-c)/2$. The weighted virtual cost (1) is $\Psi(c_i;\mu_i) = (2-\mu_i)c_i$. The virtual profit (2) is $\pi_i^v = \left[(a-2c_i)^2 - \mu_i^2 c_i^2\right]/4$. It is positive and decreasing in c_i provided that $a \geqslant 3$.

Proposition 2 (Selection)**.** *Assume that the virtual profit of each supplier decreases with his cost. Then the buyer selects the supplier with the highest virtual profit.*

Proof. See Appendix A.2. □

Because the virtual profit is decreasing, a supplier is selected when his cost is below the threshold given by

$$c_i^{\text{Sel}}(\mathbf{c}_{-i}) = (\pi_i^v)^{-1}\,(\max_{j\neq i}\pi_j^v). \tag{3}$$

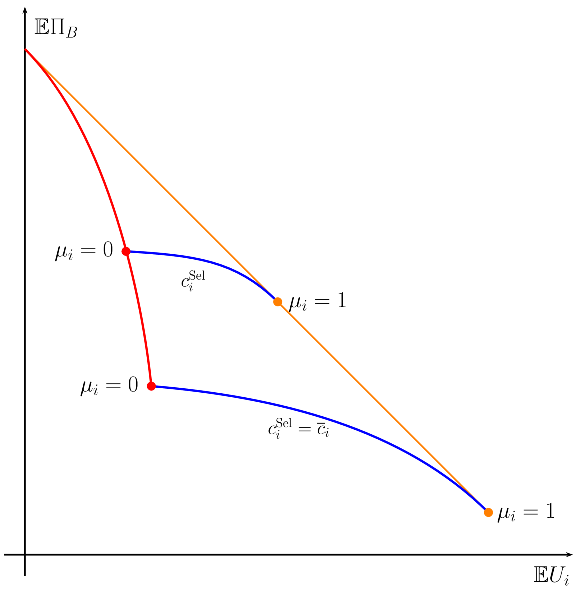


Figure 2: Williams curves (parameterized by μ_i) for two values of the selection threshold c_i^{Sel}

This threshold reflects the competitive pressure exerted on S_i by the other suppliers at the selection stage. It determines the distribution of the selected supplier's cost by right-truncation. The selected supplier's cost is known to belong to the interval $[\underline{c}, c^{\mathrm{Sel}}]$. The profit of the selected supplier is:

$$U_i(\mathbf{c}) = \begin{cases} \int_{c_i}^{c_i^{\mathrm{Sel}}(\mathbf{c_{-i}})} q^m\left(\Psi_i(c;\mu_i)\right) dc & \text{if } c_i \leqslant c_i^{\mathrm{Sel}}(\mathbf{c_{-i}}) \\ 0 & \text{otherwise.} \end{cases} \tag{4}$$

Figure 2 shows two Williams curves for (arbitrarily chosen) values of c^{Sel}. When c_i^{Sel} is high, little information about the selected supplier's cost c_i is gained from the selection phase. On the contrary, when it is low, it is common knowledge at the production phase that the selected supplier is very efficient and hence that supplier is less protected by private information and earns lower profits. More competitive pressure on the selected supplier, i.e., a low c_i^{Sel}, is good news for the buyer.

The buyer's expected profit decreases with the supplier's weight, see again Figures 1. The buyer therefore has an incentive to select suppliers with low bargaining power. This is illustrated on Figure 3 in an economy with two potential suppliers, uniformly distributed costs, and linear demand. The suppliers S_0 and S_1 have different weights: $\mu_0 > \mu_1$. The less powerful supplier is selected more often, namely in the region below the red curve OA. The buyer's preference for less powerful suppliers is reflected in the optimal selection thresholds c_i^{Sel} given by (3), which depend on the suppliers' weights.[18]

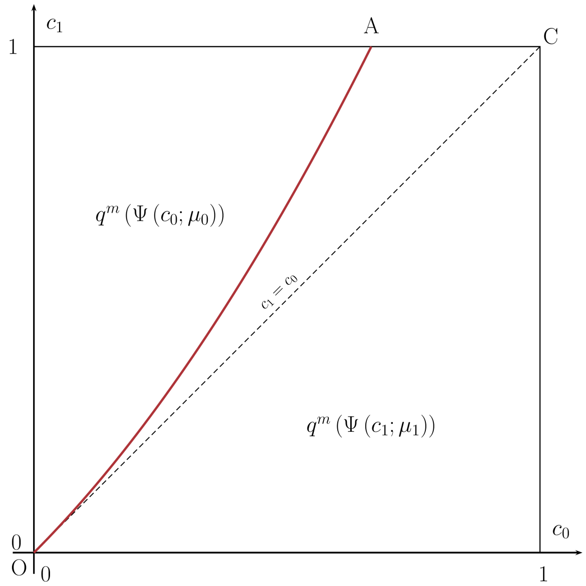


Figure 3: The most powerful supplier, $\mu_0 > \mu_1$, is selected above the red line OA. Suppliers' costs are uniform on $[0, 1]$, demand is linear.

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

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

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 lump-sum

[18]See the linear example presented in Appendix B.2.

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 (Implementation)**.** *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 A.4. □

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.

4 Vertical integration

We now turn to the study of a vertical merger between the buyer and a supplier, which we denote S_0 (we study the choice of a merger partner in Section 5.3). After the merger, B and S_0 form a single entity, which causes the acquired supplier's weight μ_0 to increase to one. We present the effect of vertical integration on firms in Subsection 4.1 and on consumers and total welfare in Section 4.2, where we also allow for imperfect internalization of profits within the integrated firm. Finally, in Section 4.3, we show that in asymmetric configurations vertical mergers may benefit consumers by correcting preexisting distortions other than DM.

4.1 Effect on firms: Market foreclosure

We now present the main effects of vertical integration. When B and S_0 have merged, the buyer selects her supplier by maximizing the expectation of $\Pi_B + U_0$ and, at the production stage, price and quantity are determined by maximizing $\Pi_B + U_0$ if S_0 has been selected or $\Pi_B + \mu_j U_j$, $j \neq 0$ if an independent supplier has been selected. Because S_0's profit is fully taken into account at both stages, the informational asymmetry about S_0's cost is now irrelevant. The analysis of Section 3 applies, replacing the virtual profit π_0^v with $\Pi^m(c_0) > \pi_0^v$, see Appendix B.

Proposition 4. *Vertical integration eliminates double marginalization whenever the buyer supplies internally. It increases the probability to select the acquired supplier. Conditional upon being selected, independent suppliers sell the same quantity but earn a lower profit post-merger.*

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. Finally, let $\pi_{(n-1)}^v$ be the second highest value of the virtual profits among the independent suppliers. We identify four possible regions:

- *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 $q^m(c_0)$. The efficiency gain arising from EDM is passed on to final consumers, hence the textbook Pareto-improvement due to vertical integration.

- *Customer Foreclosure*: $\Pi^m(c_0) > \pi_{(n)}^v > \pi_0^v$. Post-merger, internal procurement is now preferred, as π_0^v is replaced with $\Pi^m(c_0)$. Supplier $S_{(n)}$ is selected pre-merger but foreclosed from the market after the merger. The impact of vertical integration on consumers is a priori ambiguous and is discussed in Proposition 5 below.

- *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 is given by the same formula as (4), where the upper bound of the integral, $c_i^{\mathrm{Sel}}(\mathbf{c}_{-i})$, is replaced by a lower threshold because $S_{(n)}$ is selected less often post-merger. It follows that the merger causes the profit of the independent supplier $S_{(n)}$ to fall.[19] Consumers are unaffected by the merger.

[19] The inequality $\pi_{(n)}^v > \Pi^m(c_0)$ reflects a reserve price placed on independent suppliers. It implies that in this region the profit earned by the buyer is higher than $\Pi^m(c_0)$ (proof left to the reader) and

- *Indifference*: $\pi^v_{(n-1)} > \Pi^m(c_0)$. 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.

4.2 Effect on consumers and total welfare

Final consumers benefit from the merger in the pure EDM region and are unaffected in the exploitation and indifference regions. In the foreclosure area, the merger causes the buyer to switch from $S_{(n)}$ to S_0, and hence the quantity to move from $q^m\left(\Psi_{(n)}(c_{(n)};\mu_{(n)})\right)$ to $q^m(c_0)$. The resulting quantity variation is driven by two opposite forces. 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 5, our main result, underlines the role of bargaining power in this tradeoff.

Proposition 5. *The post-merger make-or-buy decision is aligned with the final consumers' interests if and only if all the independent suppliers have zero bargaining power. If an independent supplier $j \neq 0$ has a positive weight, $\mu_j > 0$, then the eviction of that supplier after the merger harms consumers with positive probability.*

Proof. Suppose first that the suppliers have no bargaining power, $\boldsymbol{\mu} = \mathbf{0}$. The virtual profit of an independent supplier is $\pi^v_j = \Pi^m(\Psi_j(c_j;0))$. If S_j is foreclosed due to the merger, we have $\Pi^m(c_0) \geqslant \pi^v_j = \Pi^m(\Psi_j(c_j;0)) > \pi^v_0$, and hence $q^m(c_0) \geqslant q^m(\Psi_j(c_j;0))$. It follows that the merger causes the quantity to increase and enhances consumer welfare.

Next, suppose $\mu_j > 0$ for some independent supplier j. By monotonicity of the virtual profit, this implies $\pi^v_j < \Pi^m(\Psi_j(c_j;\mu_j))$. The region where S_j is foreclosed from the market can thus be divided into two sub-regions, see Figure 4. If $\pi^v_0 < \pi^v_j < \Pi^m(c_0) < \Pi^m(\Psi_j(c_j;\mu_j))$, the switch from S_j to S_0 harms final consumers due to a lower quantity: $q^m(c_0) < q^m(\Psi_j(c_j;\mu_j))$. On the contrary, if $\pi^v_0 < \pi^v_j < \Pi^m(\Psi_j(c_j;\mu_j)) < \Pi^m(c_0)$, final consumers benefit from a larger quantity. □

The first part of Proposition 5 supports the optimistic view that vertical integration benefits consumers. The full buyer power condition $\boldsymbol{\mu} = 0$, however, is a strong as-

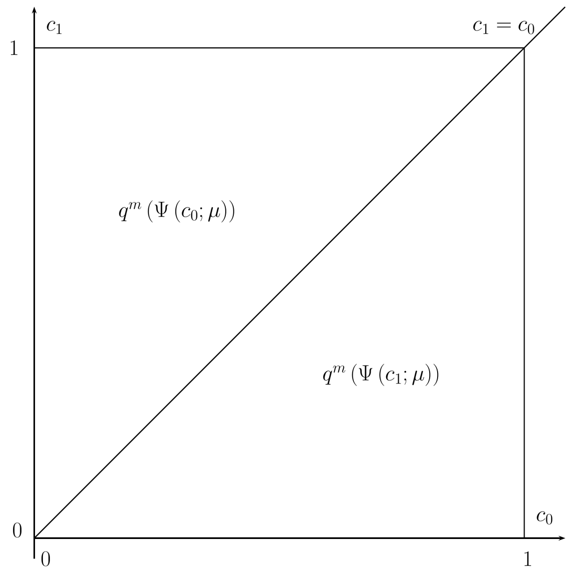
hence that the merged entity has no incentive to renege on its commitment to exclude the acquired supplier S_0.

sumption. This corresponds to the standard Myersonian setup where the buyer has full bargaining power. Customer foreclosure is associated with an increase in quantity and thus is procompetitive. Final consumers unambiguously benefit from a vertical merger.

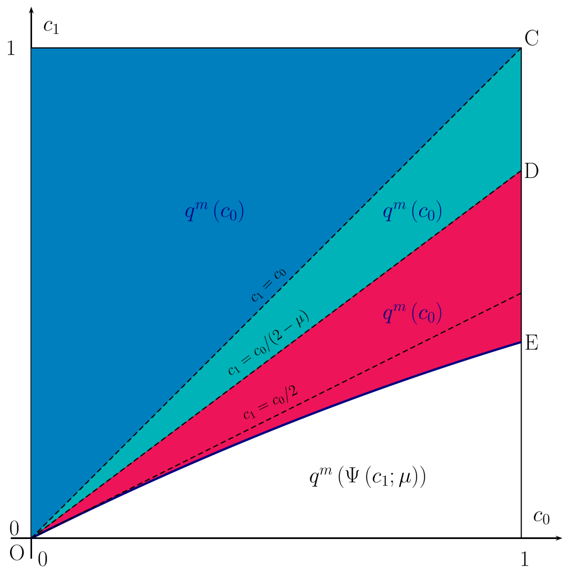
The second part of Proposition 5 calls for a tougher stance on the treatment of EDM in vertical mergers. In the arguably more realistic case where suppliers have some bargaining power over production, customer foreclosure is anticompetitive with positive probability. Corollary 1 below highlights that in the absence of DM pre-merger customer foreclosure unambiguously harms final consumers.

Corollary 1. *Suppose that the potential suppliers have identical cost distributions ($F_i = F$ for all i), and there is no DM pre-merger ($\boldsymbol{\mu} = \mathbf{1}$). Then final consumers are always harmed by the foreclosure of independent suppliers.*

Proof. With symmetric suppliers and no DM ($\boldsymbol{\mu} = \mathbf{1}$), 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.[20] □



(a) Vertical separation



(b) Effect of the merger

Figure 4: Effect of the merger on consumers' surplus. Suppliers' costs are uniform on $[0, 1]$, demand is linear, $0 < \mu_0 = \mu_1 < 1$.
Foreclosure area: OCE. Consumer harm: ODE. Consumer benefit: ODC

[20] We show in Section 4.3 how this result is modified in asymmetric environments.

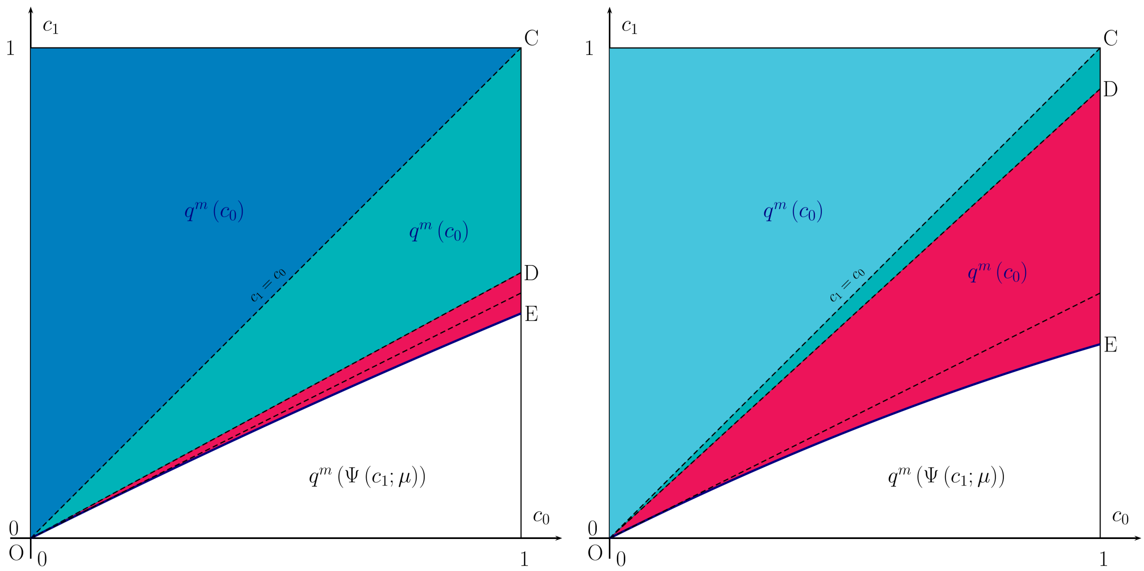
Figures 4 and 5 show the effect of the merger on consumer surplus in the case of two symmetric suppliers. Under vertical separation, the most efficient firm is selected but the quantity is distorted downwards, as shown on Figure 4(a). The post-merger equilibrium is represented on Figure 4(b).[21] The pure EDM region is located above the 45 degree line, OC, whereas the exploitative region is the area below the line 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 5(a) and 5(b) further stress the role of bargaining over wholesale prices and quantities. For $\mu = 0$, the lines OD and OE coincide. As μ increases, they shift respectively upwards and downwards. For $\mu = 1$, the lines OD and OC coincide. Therefore, when DM is severe pre-merger (low μ), backward integration mostly benefits consumers. On the contrary, when the DM phenomenon is mild (high μ), customer foreclosure mostly harms final consumers.

More generally, with symmetric cost distributions and suppliers' weights, anticompetitive foreclosure arises whenever $\mu > 0$, it increases with μ and is magnified when $\mu = 1$.

Imperfect internalization within the integrated firm We have assumed so far that under vertical integration the profit of the acquired supplier is perfectly internalized within the merged entity, i.e., Π_B is replaced by $\Pi_B + U_0$ post-merger. In this subsection, we show that our main result (Proposition 5) continues to hold when internalization is imperfect and DM subsists to some extent within the integrated structure, as in Crawford, Lee, Whinston, and Yurukoglu (2018). To reflect imperfect internalization, we introduce a post-merger weight μ_0', with $\mu_0 < \mu_0' < 1$, and assume that Π_B is replaced by $\Pi_B + \mu_0' U_0$ after the merger.

[21] Details can be found in Appendix B.2.



(a) DM is severe (low μ)

(b) DM is mild (high μ)

Figure 5: Role of bargaining over price and quantity. Suppliers' costs are uniform on $[0, 1]$, demand is linear, and $0 < \mu_0 = \mu_1 = \mu < 1$. Foreclosure area: OCE. Consumer harm: ODE

Corollary 2. *Suppose that the objective of the merged entity is $\Pi_B + \mu_0' U_0$, with $\mu_0 < \mu_0' < 1$. If all the independent suppliers have zero bargaining power, then vertical integration always increases consumer surplus. On the contrary, if an independent supplier $j \neq 0$ has positive weight $\mu_j > 0$, then the exclusion of that supplier harms final consumers with positive probability.*

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.[22]

Proposition 6. *Whenever vertical integration harms final consumers, it lowers total welfare.*

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

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). □

Proposition 6 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 6, this occurs in the ODD' area. Total welfare falls in OED' while consumer surplus falls in the narrower region OED.[23]

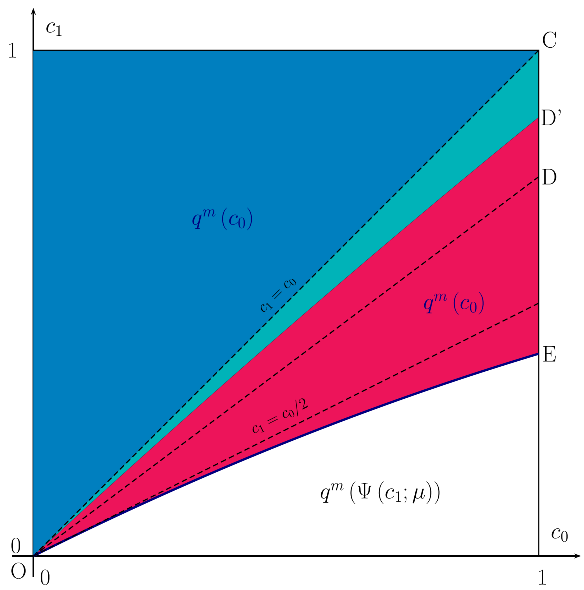


Figure 6: Effect of the merger on total welfare (symmetric suppliers). Suppliers' costs are uniform on $[0,1]$, demand is linear, and $0 < \mu_0 = \mu_1 = \mu < 1$.
Foreclosure area: OCE. Consumer harm: ODE. Fall in total welfare: $OD'E$

4.3 Correcting pre-merger misallocations

In this subsection, we consider more closely environments where potential suppliers differ in cost distributions or bargaining power. If under vertical separation 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.[24]

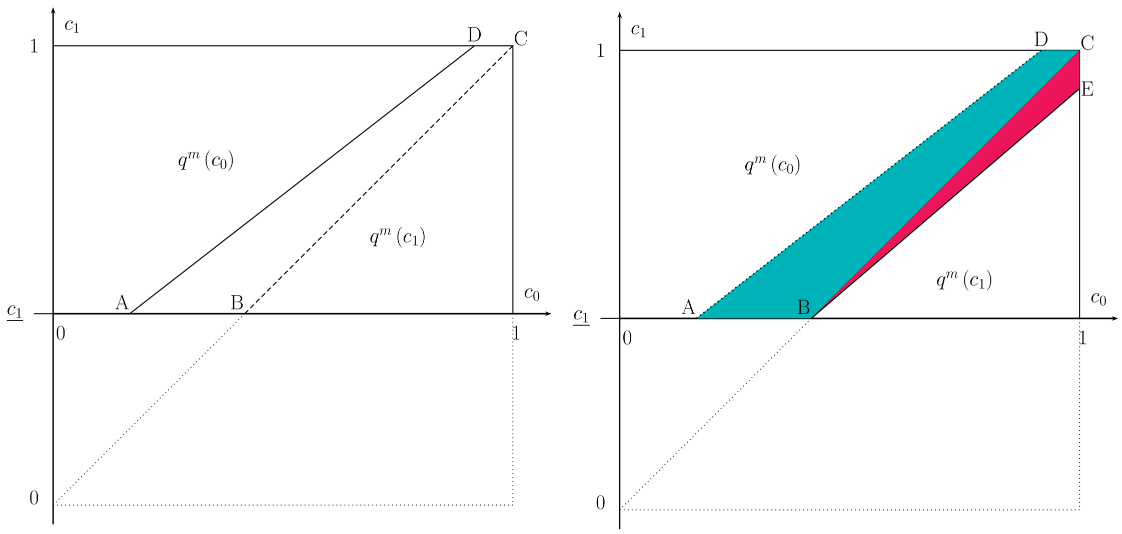
[23]The equation of OD' in the example is given in Appendix B.2.

[24]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).

Proposition 7. *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 B.1. □

Proposition 7 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. This is the case in two interesting situations. First, when the cost distributions are identical $F_0 = F_1$ and S_0 has more bargaining power than S_1, $\mu_1 < \mu_0$, the buyer selects S_0 less often, recall Figure 3. A second environment where the pre-merger selection is biased against S_0 is described in Corollary 3 and represented on Figure 7.



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

Figure 7: 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

Corollary 3. *Suppose that there is no DM pre-merger ($\mu_0 = \mu_1 = 1$) and that S_0 is ex ante more efficient than S_1 in the sense that c_0 is lower than c_1 for the likelihood ratio order ($F_0/f_0 > F_1/f_1$).*

Then the pre-merger selection rule is biased against S_0, and the corresponding misallocation is corrected by the merger with this supplier.

In Section 4.2, 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 3 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.[25]

Figure 7 illustrates Corollary 3 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, figure 7(a) 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 7(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 increases from $q^m(c_1)$ to $q^m(c_0)$, which benefits consumers. This is because the merger restores productive efficiency in this region. In BEC, the quantity falls from $q^m(c_1)$ to $q^m(c_0)$, which harms final consumers.

5 Extensions

In this section, we extend our baseline model in a number of directions. First, we consider the possibility that the suppliers have less bargaining power when selected jointly than when selected separately. In Subsections 5.1 and 5.2, we examine the buyer's decision to select one or many suppliers respectively when the suppliers have constant marginal costs and when they have convex costs. Although the underlying trade-offs are different in the two environments, the qualitative effects of a vertical merger tend to be similar. In particular, the possibility of anticompetitive foreclosure persists. Next, in Subsection 5.3, we let the buyer choose her merger partner and examine whether her choice is aligned with consumers' interests. Finally, in Subsection 5.4, we check that our results are robust to the presence of private information on the buyer's side.

[25]Proposition E.1 in the appendix states that under the assumptions of Corollary 3 the buyer indeed prefers to merge with S_0 rather than with S_1.

5.1 Foregoing selection to increase bargaining power

In our baseline setting, we have implicitly assumed that a supplier's weight would remain unchanged should the buyer select many competing suppliers. Since under constant returns to scale only one supplier is eventually active (i.e. produces a positive quantity of input), selecting a single supplier is optimal for the buyer in this context. We now allow the suppliers' weights to depend on the number of selected suppliers.[26] To convey intuitions more transparently, we assume in this and the next subsections that the buyer faces two potential suppliers with the same cost distributions, $F_0 = F_1$.

We still denote by μ_0 and μ_1 the weights of the two suppliers when they are selected in isolation. We introduce the corresponding weights μ_0' and μ_1' when they are both invited to bargain over prices and quantities. To reflect the intuition that the buyer gains bargaining power when negotiating with many suppliers, we assume that $\mu_0' \leqslant \mu_0$ and $\mu_1' \leqslant \mu_1$.[27]

The decision to forego selection, i.e., to allow both suppliers to negotiate prices and quantities, is driven by the following trade-off. On the one hand, the suppliers have less bargaining power when negotiating together with the buyer. On the other hand, in that case, the buyer does not perfectly control the identity of the active supplier, as the following lemma shows.

Lemma 1. *If the buyer allows the two suppliers to bargain over prices and quantities, the supplier with the lowest virtual cost,* $\min(\Psi(c_0;\mu_0'), \Psi(c_1;\mu_1'))$*, produces a positive number of units, and the other supplier is inactive.*

Proof. See Appendix C. □

When the buyer uses her ability to select a single supplier, she maximizes her expected profit anticipating the bargaining with the selected supplier. She can thus avoid leaving large informational rents to powerful suppliers. By contrast, when the buyer admits both buyers at the negotiation table, the price and the quantity are chosen to maximize the expectation of a weighted sum of the buyer's and suppliers' profits $\Pi_B + \mu_0' U_0 + \mu_1' U_1$.[28] When μ_0' and μ_1' are different, negotiating with the two suppliers together leads the buyer to supply too often from the most powerful supplier,

[26] We thank the Editor, Vasiliki Skreta, and an anonymous Referee for urging us to envisage this scenario.

[27] All else equal, more buyer power implies lower quantities and reduced consumer surplus.

[28] When the buyer bargains with the two suppliers, we assume that the determination of quantities is unconditionally ex ante efficient, as in Loertscher and Marx (2022). By contrast, when the buyer bargains with a single supplier as in the two-stage mechanism of Sections 3 and 4, the quantity negotiated with the selected supplier is ex ante efficient *only conditional on the selection decision.*

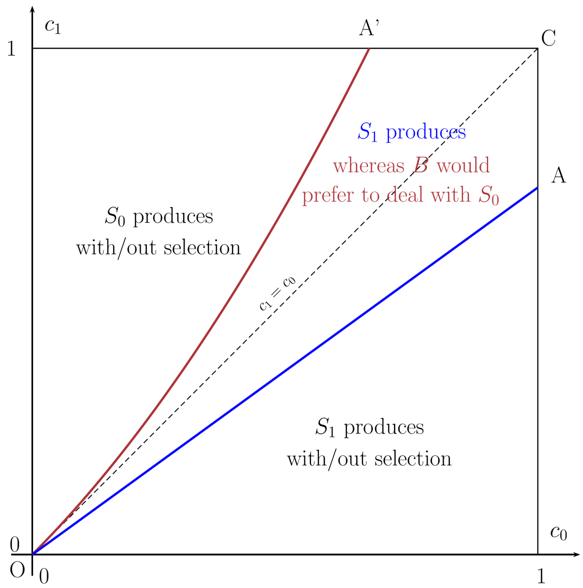


Figure 8: If $\mu'_0 > \mu'_1$, negotiating with both S_0 and S_1 leads the buyer to supply from S_0 in the region above OA while supplying from S_0 in the narrower region above OA' would maximize her expected profit. Suppliers' costs are uniform on $[0, 1]$, demand is linear.

see Figure 8. Hence a trade-off between enjoying more buyer power and picking the desired partner. A comprehensive analysis of this trade-off is not central for the study of vertical integration and EDM.[29]

To check the robustness of the results presented in Section 4, we prefer to concentrate on the new case where under vertical separation the buyer negotiates quantities with the two suppliers. A simple sufficient condition for this to happen is that $\mu'_0 = \mu'_1 \leqslant \min(\mu_0, \mu_1)$. If the multilateral weights μ'_0 and μ'_1 are equal, it is unambiguously profitable for the buyer to negotiate quantities with the two suppliers as doing so entails no loss due to the determination of the active supplier.

After the buyer has merged with S_0, she either excludes the independent supplier S_1 or negotiates quantities with both S_0 and S_1. She chooses the second option when

$$\Pi(q^m(\Psi(c_1; \mu')); \Psi(c_1; 0)) \geqslant \Pi^m(c_0). \tag{7}$$

Notice that it is never profitable for the buyer to exclude S_0. If the buyer considers dealing with S_1, keeping S_0 in the loop lowers S_1's weight from μ_1 to μ' without inducing S_0 to produce. (This is because when (7) holds it is a fortiori true that $c_0 \geqslant \Psi(c_1; \mu')$.) It follows that the effect of vertical integration and the role of market foreclosure are the

[29] In appendix C, we show in a simplified framework the existence of a non-trivial set of suppliers' weights $\mu'_0 \leqslant \mu_0$ and $\mu'_1 \leqslant \mu_1$ for which the buyer prefers to select a single supplier and thus to give up the benefit of lower suppliers' weights.

same as in Proposition 5, with the weight μ_1 being replaced with μ'. If $\mu' > 0$, consumers may be harmed by the merger, recall Figure 4. The next proposition summarizes the above analysis.

Proposition 8. *If the suppliers have symmetric cost distributions, $F_0 = F_1$, and symmetric bargaining power when jointly selected, i.e., $\mu'_0 = \mu'_1 = \mu' \leqslant \min(\mu_0, \mu_1)$, then the buyer selects the two suppliers with probability one.*

If $\mu' > 0$, the exclusion of the independent supplier after the buyer and S_0 harms final consumers with positive probability.

Under constant returns to scale, only one supplier is eventually active, i.e., produces a positive quantity of input, even when many suppliers are invited at the negotiation table. We now relax the constant returns assumption to allow for multisourcing.

5.2 Multisourcing

In this subsection, we show that multisourcing may emerge when the suppliers' production costs are convex. We find that the buyer's decision to select one or many suppliers is governed by a new tradeoff: multisourcing improves production efficiency but it forces the buyer to leave informational rents to several suppliers.

Importantly, under multisourcing, the buyer negotiates prices and quantities with many suppliers, with all of them producing a positive quantity of input. In this context, it is natural to assume that her bargaining power might increase with the number of selected suppliers. For the sake of simplicity, we examine multisourcing in a symmetric framework with two suppliers, S_0 and S_1. Their weight is μ when a single supplier is selected and μ' when both of them are selected. Whenever $\mu' < \mu$, the buyer has an extra incentive (compared to $\mu' = \mu$) to select the two suppliers.

The suppliers S_0 and S_1 have private types c_0 and c_1, which are independently drawn from a common distribution F. Their cost functions are $c_i q_i + \alpha q_i^2/2$, with $\alpha > 0$. The revenue function is $R(q) = q(a - q)$, where $q = q_0 + q_1$ is the total quantity. We denote by $\Pi(q_0, q_1\,;\, c_0, c_1)$ the industry profit when the buyer purchases q_i from S_i:

$$\Pi(q_0, q_1; c_0, c_1) = R(q_0 + q_1) - c_0 q_0 - c_1 q_1 - \alpha q_0^2/2 - \alpha q_1^2/2.$$

We denote by $\Pi^m(c_0, c_1)$ the monopoly industry profit and by $q_i^m(c_0, c_1)$, for $i = 0, 1$, the monopoly quantities

$$q_0^m(c_0, c_1) = \frac{\alpha a - (2+\alpha)c_0 + 2c_1}{\alpha(4+\alpha)} \quad \text{and} \quad q_1^m(c_0, c_1) = \frac{\alpha a + 2c_0 - (2+\alpha)c_1}{\alpha(4+\alpha)}.$$

The total quantity $q^m(c_0, c_1) = q_0^m(c_0, c_1) + q_1^m(c_0, c_1) = (2a - c_0 - c_1)/(4+\alpha)$ decreases with c_0 and c_1. In what follows, we assume that the intercept parameter a is large enough so that the monopoly quantities evaluated at the relevant values of the suppliers' (virtual) costs are always positive. In other words, demand is sufficiently high so that if the two suppliers are selected the buyer purchases positive quantities from each of them. If on the contrary a single supplier (say S_0) is selected, we denote by $\Pi^m(c_0, \infty)$ and $q_0^m(c_0, \infty)$ the corresponding outcomes. We have

$$q_0^m(c_0, \infty) = \frac{a - c_0}{2+\alpha} \quad \text{and} \quad q_1^m(\infty, c_1) = \frac{a - c_1}{2+\alpha}.$$

The individual (total) quantity is lower (greater) under multisourcing than under single sourcing: $q_0^m(c, \infty)/2 < q_0^m(c, c) = (a-c)/(4+\alpha) < q_0^m(c, \infty)$.

Pre-merger choice between single- and multi-sourcing We restrict attention to selection rules implementable with a deferred-acceptance clock auction as described in Section 3.2. We allow the buyer to select the two suppliers if the clock index reaches a certain value s^*, i.e., if suppliers are efficient enough, $c_0 \leqslant c^*$ and $c_1 \leqslant c^*$. The intuition is that when suppliers' costs are low, quantities are high, and convexity makes it profitable to employ both suppliers even though this implies leaving rents to both of them.

In the multisourcing region, quantities are determined by the virtual costs $\Psi(c_0; \mu')$ and $\Psi(c_1; \mu')$.[30] The buyer's profit equals the industry profit net of informational rents:

$$\begin{aligned}\Pi_B(c_0, c_1) &= \Pi(q_0^m(\Psi(c_0; \mu'), \Psi(c_1; \mu')), q_1^m(\Psi(c_0; \mu'), \Psi(c_1; \mu')); c_0, c_1) \\ &\quad - \int_{c_0}^{c^*} q_0^m(\Psi(c_0; \mu'), \Psi(c_1; \mu'))\, \mathrm{d}c_0 \\ &\quad - \int_{c_1}^{c^*} q_1^m(\Psi(c_0; \mu'), \Psi(c_1; \mu'))\, \mathrm{d}c_1. \qquad (8)\end{aligned}$$

[30]This result is the intensive version of Lemma 1. See Appendix D for details.

When a single supplier is selected, the weight of that supplier is μ. For instance, if supplier S_1 exits at a clock index $s > s^*$, only S_0 is selected and the buyer's profit is

$$\Pi_B(c_0, \infty) = \Pi(q_0^m(\Psi(c_0, \mu), \infty), 0; c_0, \infty) - \int_{c_0}^{c_0^*(s)} q_0^m(\Psi(c, \mu), \infty)\, \mathrm{d}c. \tag{9}$$

Comparing (8) and (9), we clearly see the tradeoff between generating higher industry profit and leaving rent to a single supplier rather than to both of them. This tradeoff exists even when the weights do not depend on the number of selected suppliers, i.e., when $\mu' = \mu$. If $\mu' < \mu$, the buyer is more likely to prefer multisourcing over single-sourcing.

In the appendix, we characterize the critical cost threshold c^* under which the buyer prefers to multi-source.[31] It may happen that the buyer prefers to multi-source for all values of c_0 and c_1, as represented on Figure 9(a). In particular, when $\mu' = 0$ –full bargaining power– she always purchases positive quantities from both S_0 and S_1. More generally, multisourcing occurs with probability one when the suppliers' rents are not too costly for the buyer (μ' is low) and when the cost functions are sufficiently convex (α is high). In Figure 10(a), multisourcing occurs only when the suppliers are very efficient.

Post-merger choice between multisourcing and exclusion We now suppose that B and S_0 form a single entity. If the acquired supplier S_0 is selected, his weight is one. If S_1 is selected as the single supplier, his weight is μ and if he is selected together with S_0, his weight is $\mu' \leqslant \mu$. As in the constant returns to scale setting, selecting S_1 alone is dominated by selecting S_0 and S_1 because the industry profit is lower with S_1 alone and S_1 produces more input and earns a larger informational rent than under multisourcing. Accordingly, only two regimes can prevail post-merger: exclusion of S_1 or multisourcing.

The profit of the new entity is $\Pi^m(c_0)$ when only S_0 is selected and equals the industry profit minus S_1's informational rent under multisourcing:

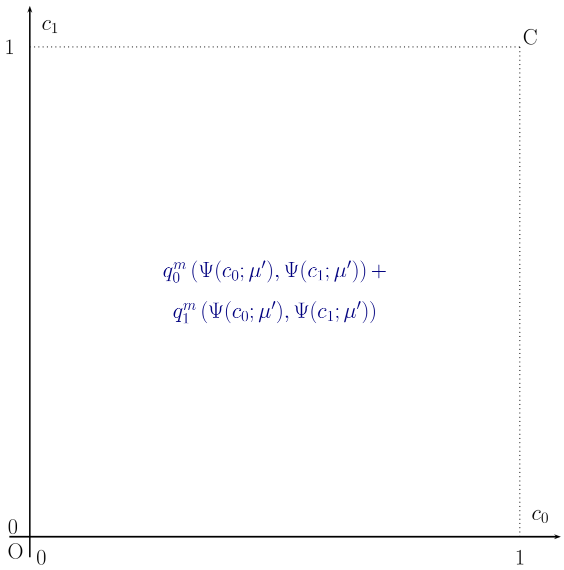
$$\begin{aligned} \Pi_B + U_0 \quad = \quad & \Pi(q_0^m(c_0, \Psi(c_1; \mu')), q_1^m(c_0, \Psi(c_1; \mu')); c_0, c_1) \\ & - \int_{c_1}^{c^*} q_1^m(c_0, \Psi(c; \mu'))\, \mathrm{d}c\,. \end{aligned} \tag{10}$$

[31] See Lemma D.1. See also the virtual profits corresponding to the single and multisourcing environments, respectively (D.1) and (D.2), and the buyer's expected profit (D.3).

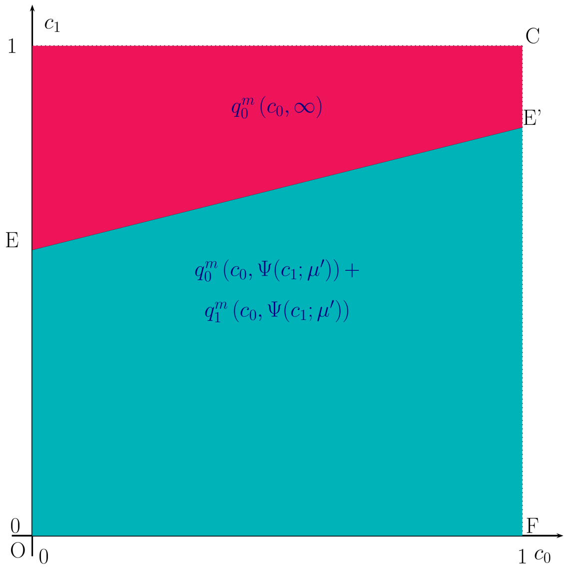
Integrating by parts the rent term in (10), we find the virtual profit under multisourcing post-merger:

$$\pi_{01}^v = \Pi^m(c_0, \Psi(c_1; \mu')) - \mu' \frac{F(c_1)}{f(c_1)} q_1^m(c_0, \Psi(c_1; \mu')). \tag{11}$$

The buyer chooses multisourcing if and only if $\pi_{01}^v \geqslant \Pi^m(c_0)$. As in the pre-merger situation, we observe that if $\mu' = 0$, the virtual profit π_{01}^v is greater than $\Pi^m(c_0)$ and multisourcing occurs with probability one. In contrast, if $\mu' > 0$, S_1 is selected only if he is sufficiently efficient, see Figures 9(b) and 10(b).



(a) Vertical separation



(b) Effect of the merger

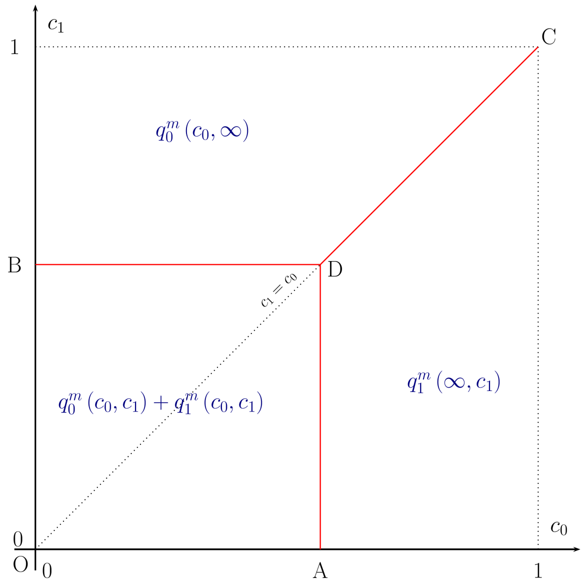
Figure 9: Multisourcing is prevalent pre-merger and occurs in $OFE'E$ post-merger

Buyer's revenue $R(q) = q(a - q)$, with $a = 3$. Suppliers' cost functions $C(q; c_i) = c_i q + \alpha q^2/2$, with c_0 and c_1 uniformly distributed over $[0, 1]$, $\alpha = 2$. Suppliers' weights: $\mu = 1$, $\mu' = 0.5$

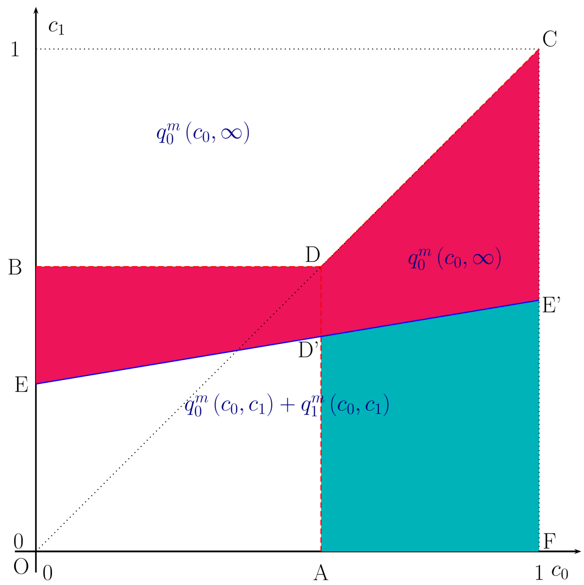
Effect of the merger Suppose first that both suppliers are selected both before and after the merger. Then the total quantity increases from $q^m(\Psi(c_0; \mu'), \Psi(c_1; \mu'))$ pre-merger to $q^m(c_0, \Psi(c_1; \mu'))$ post-merger, hence the final consumers benefit from the merger through the EDM.[32] As mentioned earlier, this situation occurs in particular if the buyer has full bargaining power under multisourcing ($\mu' = 0$).

When $\mu' > 0$, we show in Appendix D that if the buyer is indifferent between excluding S_1 and multisourcing then the total quantity under multisourcing exceeds

[32]Total quantity increases even though the quantity produced by the independent supplier S_1 falls.



(a) Vertical separation



(b) Effect of the merger

Figure 10: 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 $[0, 1]$, α=2. Suppliers' weights: $\mu = \mu' = 1$

the total quantity under exclusion:

$$q^m(c_0, \Psi(c_1; \mu')) > q_0^m(c_0; \infty). \tag{12}$$

In other words, the buyer's and final consumers' interests are not aligned after the merger. The buyer prefers to exclude S_1 while final consumers would prefer multisourcing. Under constant returns to scale, we have seen in Section 4 that the misalignment of interests mechanically translates into consumer harm. This is less obvious here. Assuming multisourcing pre-merger, consumers are worse off when the independent supplier is excluded post-merger if

$$q^m(\Psi(c_0; \mu'), \Psi(c_1; \mu')) > q_0^m(c_0; \infty). \tag{13}$$

Equations (12) and (13) coincide only in the absence of DM, i.e., if $\mu' = 1$. In this case, the exclusion of S_1 necessarily harms consumers post-merger, see for instance the example shown on Figure 10(b). The result is more general, however, as shown by the example of Figure 9(b) where $\mu' = .5$. Here EDM is present but not strong enough to compensate the anticompetitive effect of the exclusion of the independent supplier.

We gather the above remarks in the following proposition, and leave a comprehensive treatment of multisourcing for further research.

Proposition 9. *Suppose there are two potential suppliers with cost functions* $c_i q_i + \alpha q_i^2/2$ *and* c_0 *and* c_1 *are independent and uniformly distributed on* $[0, 1]$*, and the revenue function is* $R(q) = q(a - q)$ *with large intercept* a*. Then the following properties hold:*

(i) When the buyer has full bargaining under multisourcing ($\mu' = 0$)*, she purchases positive quantities from the two suppliers, both pre- and post-merger;*

(ii) Prior to the vertical merger, multisourcing is more likely when the suppliers' weights are low if the two of them are selected (i.e., μ' *is small), when the degree* α *of cost convexity is high, and when the suppliers' cost parameters* c_0 *and* c_1 *are low;*

(iii) After the merger, the buyer purchases either from both suppliers or exclusively from the acquired supplier. When deciding whether to select or exclude the independent supplier, her interests are not aligned with those of final consumers.

(iv) When both suppliers are selected before and after merger, final consumers are better off post-merger;

(v) If the independent supplier is excluded (i.e., not selected) after the merger, his exclusion may harm final consumers.

Proof. See Appendix D □

An important insight from the above analysis is that when both suppliers are selected EDM harms the independent supplier but benefits final consumers. Consumer harm can only result from customer foreclosure, i.e., from the outright exclusion of the independent supplier from the market. This occurs when the independent supplier is excluded *at the selection stage* while he would have produced a positive quantity if he had been allowed to bargain over prices and quantities. In other words, for consumer to be harmed, the extensive margin plays a fundamental role. This effect is particularly strong in the absence of DM pre-merger, a situation represented on Figure 10. In region $EE'CDB$, S_1 produces a positive quantity pre-merger and is not selected post-merger, which is inefficient and harms consumers.[33]

[33]On the other hand, for cost parameters (c_0, c_1) in $AFE'D'$, S_0 is inefficiently foreclosed from the market pre-merger while there is multisourcing post-merger. This is another instance where the merger corrects a pre-existing distortion, and thereby improves consumer welfare.

5.3 Choice of merger 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.[34] 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.

Lemma 2. *The merger partner is chosen so as to maximize the industry profit.*

Proof. See Appendix E □

The suppliers may be asymmetric in production costs and in bargaining power. We focus here on asymmetric suppliers' weights.[35] The next result highlights the trade-off that governs the choice of the merger partner. The DM phenomenon is most severe when the supplier with the lowest bargaining power produces, and merging with that supplier allows to eliminate this strong inefficiency. But doing so leaves the supplier with the highest bargaining power as independent, which creates a strong incentive to inefficiently foreclose that supplier from the market (and hence to reduce the industry profit) after the merger.

Proposition 10. *When $F_0 = F_1$ and $\mu_1 < \mu_0$, the choice of the merger partner is driven by opposite incentives. On the one hand, merging with S_1 allows to magnify the EDM effect. On the other, merging with S_0 minimizes the foreclosure effect.*

The endogenous choice of the merger partner may not be aligned with the consumers' interests. In the example below, the buyer prefers to acquire the most powerful supplier, while final consumers would prefer her to merge with the other supplier.

Example Suppose $a = 3$, $F_0 = F_1$ is uniform on $[0, 1]$, $\mu_0 = 1 > \mu_1 = .75$. Prior to the merger, the expected industry and consumer surplus are respectively 1.790 and .868. The industry profit is higher when B merges with S_0 (1.740) than when she merges with

[34] We ignore here the possible strategic interactions between the merger partners and the antitrust authorities, see Nocke and Whinston (2010, 2013).

[35] In the case of asymmetric cost distributions, Proposition E.1 in the appendix suggests that the buyer tends to acquire the more efficient supplier.

S_1 (1.738). Hence the buyer prefers to merge with the most powerful supplier S_0. The expected consumer surplus post-merger is .863 in this case, while it would be .869 after a merger with S_1.

To conclude this section, we stress that the opposite incentives seen in Proposition 10 arise in the two-stage game with supplier selection followed by bargaining over price and quantity. By contrast, Choné, Linnemer, and Vergé (2021) show that in the one-stage game where the buyer negotiates price and quantities with all the suppliers,[36] the two effects play in the same direction. Merging with S_1 magnifies the EDM effect (as in Proposition 10) and at the same time minimizes the incentive to inefficiently foreclose the independent supplier (contrary to Proposition 10).[37] As a result, in the one-stage game, the buyer would always prefers to acquire the least powerful supplier. The situation where she acquires the most powerful suppliers to avoid facing strong independent suppliers post-merger seems more natural.

5.4 The role of asymmetric information

Complete information Under complete information, there is no double marginalization. The selected supplier S_j produces the monopoly quantity associated with his known cost, $q^m(c_j)$, which we called above the "ex post efficient" quantity. The joint profit is maximized. Let α_j denote the share of the monopoly profit that goes to S_j. Figure 11 is drawn from the "ex ante perspective" where the supplier's cost is not known. The segment $A'C$ represents the expected Pareto frontier $\mathbb{E}_{c_j}\Pi_B + \mathbb{E}_{c_j}U_j = \mathbb{E}_{c_j}\Pi^m(c_j)$, which is parameterized by α_j. The sub-segment BC is part of the ex ante efficient frontier under incomplete information, the so-called "Williams curve" represented on Figure 1.

In the absence of DM, the effect of a merger is entirely driven by customer foreclosure. Under vertical separation, the buyer observes c_0 and c_1 and selects the supplier that yields the highest anticipated profit. In practice, she compares $(1-\alpha_0)\Pi^m(c_0)$ with $(1-\alpha_1)\Pi^m(c_1)$. By contrast, the merged entity compares its profit when supplying internally, $\Pi^m(c_0)$, with the negotiated profit when purchasing from the independent supplier, $(1-\alpha_1)\Pi^m(c_1)$.

The negative effect of vertical integration is seen in pure form when the suppliers have the same complete information weights: $\alpha_0 = \alpha_1$. The above analysis shows that

[36] In the one-stage game, quantities maximize the expectation of $\Pi_B + \mu_0 U_0 + \mu_1 U_1$ and are thus unconditionally ex ante efficient, recall Footnote 28.

[37] This is because the buyer purchases more often from the independent supplier if his weight is high.

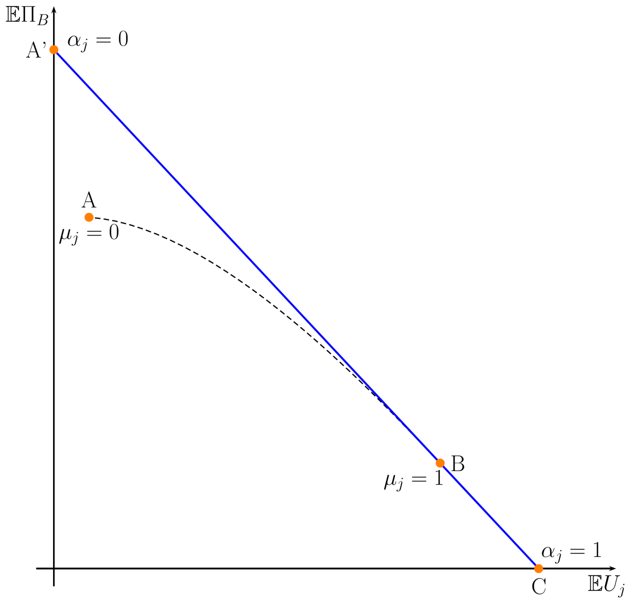


Figure 11: Bargaining over price and quantity: Williams curves under complete Information (solid straight line $A'C$) and under incomplete information (dashed line AC)

under vertical separation the buyer selects the most efficient supplier, which is best for final consumers. Under vertical integration, selection is based on the comparison between $\Pi^m(c_0)$ and $\alpha_1\Pi^m(c_1)$, implying that S_0 may be selected even when $c_0 > c_1$. Vertical integration thus leads to inefficient customer foreclosure, which harms final consumers. In the extreme case where $\alpha_0 = \alpha_1 = 1$, vertical integration harms consumers the most because S_1 is never selected post-merger.[38]

When the complete information weights are asymmetric ($\alpha_0 \neq \alpha_1$), there exists pre-merger customer foreclosure, which VI can sometimes correct. For instance, when $\alpha_0 > \alpha_1 = 0$, B inefficiency selects S_1 pre-merger, i.e. for some values of $c_1 > c_0$, which harms consumers. Post-merger, B selects the most efficient supplier, thus, here, vertical integration benefits final consumers by correcting the pre-merger inefficiency.

Bilateral asymmetric information We now explore the role of asymmetric information on the buyer's side with and without powerful suppliers. As in Loertscher and Marx (2022), we assume the buyer holds private information. More precisely, we assume that the buyer's revenue $R(q;\theta)$ depends on a privately known cost or demand parameter $\theta \in \left[\underline{\theta}, \overline{\theta}\right]$ and we maintain the assumption that trade always occurs. This change turns out to be innocuous when the buyer has more bargaining power than the suppliers, $\boldsymbol{\mu} < \mathbf{1}$, and therefore still earns the industry profit minus the selected

[38]This case is reminiscent of the incomplete information set-up with $\mu_0 = \mu_1 = 1$, see Corollary 1.

supplier's informational rents. In this environment, the above analysis still holds for any value of θ, with prices and quantities simply affected by θ through the change in the marginal revenue $R'(q;\theta)$.

By contrast, the outcome dramatically changes in the presence of powerful suppliers, $\mu_j > 1$. When selected, such a dominant supplier becomes the residual claimant, earning the industry profit net of the buyer's informational rents. In this configuration, the buyer's private information about θ becomes critical to protect her from having all of her profit appropriated by S_j. Because the buyer's rent is now costly, the traded quantity is still distorted pre-merger, i.e. DM is present. 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 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."*[39]

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.[40] Slade and Kwoka Jr (2020) regret that "*policy analysis has continued to treat*

[39] 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`.

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

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. Two-part tariffs are observed in equilibrium but the unit price is higher than the selected supplier's marginal cost. 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."*[41] We find that, ceteris 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.

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.[42] 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.*"[43] 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 Com-

[41]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`.

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

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

missioner Slaughter, *"achieving EDM is not guaranteed. Nor are the benefits of EDM always passed along to consumers."*[44]

EDM and foreclosure effects are closely intertwined and should always be considered jointly.[45] EDM is a robust feature in our setting – i.e., DM is always eliminated (or reduced) when the buyer procures from its integrated supplier – the magnitude of the effect depends on the supplier's (pre-merger) bargaining power. Moreover, the anti-competitive effects of vertical integration (i.e., the extent to which the buyers biases its make-or-buy decision and does not buy from the most efficient supplier), depends again on the suppliers' relative bargaining power at the selection and production stages. The welfare effects of vertical integration thus critically depend on the bargaining environment. We find that foreclosure of efficient 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. 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.[46] The 2020 U.S. Vertical Merger Guidelines propose

[44]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.

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

[46]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

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. 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 increase 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. By contrast, the empirical literature on procurement, auctions and nonlinear pricing (see the recent survey by Perrigne and Vuong (2019)) emphasizes asymmetric information and develops methods to identify the distributions of suppliers' costs, while generally assuming strong bargaining power on the buyer side. Recent advances in the empirical bargaining literature (see e.g., Larsen (2021) and Larsen and Zhang (2021)) make us confident that these two strands of literature can be combined to shed light on procurement environments with asymmetric information. Identifying suppliers' production costs and bargaining weights and estimating the magnitude of the DM phenomenon are challenging, but not unrealistic, tasks for future work.

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.

APPENDIX

A Vertical separation (Proofs)

A.1 Proof of Proposition 1

Supplier S_j's utility if he reports cost $\widehat{c}_j$ while his true cost is c_j is $U_j(\widehat{c}_j; c_j) = M_j(\widehat{c}_j) - c_j Q_j(\widehat{c}_j)$. His indirect utility is $u_j(c_j) = \max_{\widehat{c}_j} U_j(\widehat{c}_j; c_j)$. By the envelope theorem, the derivative of the rent is $u_j'(c_j) = -Q_j(\widehat{c}_j)$.

When $\mu_j < 1$, the mechanism sets the payment M_j to eliminate the rent of the least efficient type, $u_j(c_j^{\text{Sel}}) = 0$. Computing the expected value of $u_j(c_j)$ and integrating by parts yields:

$$\frac{1}{F_j(c_j^{\text{Sel}})} \int_{\underline{c}_j}^{c_j^{\text{Sel}}} u_j(c_j) \, \mathrm{d}F_j(c_j) = \frac{1}{F_j(c_j^{\text{Sel}})} \int_{\underline{c}_j}^{c_j^{\text{Sel}}} Q_j(c_j) F_j(c_j) dc_j.$$

The weighted industry profit is $R(Q_j) - M_j + \mu_j U_j = R(Q_j) - [c_j Q_j + (1-\mu_j) U_j]$. Taking the expectation over c_j and substituting for the value of the expected utility, we rearrange the expected weighted industry profit as

$$\mathbb{E}\left(\Pi_B + \mu U_0 \,|\, c_j \leqslant c_j^{\text{Sel}}\right) = \frac{1}{F_j(c_j^{\text{Sel}})} \int_{\underline{c}_j}^{c_j^{\text{Sel}}} \Pi\left(Q_j(c_j); \Psi_j(c_j; \mu_j\right) f_j(c_j) \, \mathrm{d}c_j, \tag{A.1}$$

which is maximal when the supplier produces the quantity $Q_j(c_j) = q^m(\Psi_j(c_j; \mu_j))$. The supplier's indirect utility is $u_j(c_j) = \int_{c_j}^{c_j^{\text{Sel}}} q^m(\Psi_j(c; \mu_j)) dc$. The buyer's profit is $\Pi_B(c_j) = \Pi(q^m(\Psi_j(c_j; \mu_j)); c_j) - \int_{c_j}^{c_j^{\text{Sel}}} q^m(\Psi_j(c; \mu_j)) dc$.

When $\mu_j = 1$, the industry profit is maximized, hence $Q_j(c_j) = q^m(\Psi_j(c_j; 1)) = q^m(c_j)$. The supplier earns his informational rent plus the fraction η_j of the industry profit net of that rent. His indirect utility is therefore $u_j(c_j) = \eta_j \Pi^m(c_j) + (1 - \eta_j) \int_{c_j}^{c_j^{\text{Sel}}} q^m(c) dc$. The buyer's profit is $\Pi_B(c_j) = (1-\eta_j) \left[\Pi^m(c_j) - \int_{c_j}^{c_j^{\text{Sel}}} q^m(c) dc\right]$.

Shape of Williams curves (Figure 1) For simplicity, we drop the index j. The expected supplier's profit is

$$A(\mu) \stackrel{d}{\equiv} \mathbb{E}\left(U | c \leqslant c^{\text{Sel}}\right) = \frac{1}{F(c^{\text{Sel}})} \int_{\underline{c}}^{c^{\text{Sel}}} q^m(\Psi(c; \mu)) F(c) \, \mathrm{d}c.$$

Its derivative with respect to μ is $A'(\mu) = -(1/F(c^{\text{Sel}})) \int_{\underline{c}}^{c^{\text{Sel}}} (q^m)' \frac{F^2(c)}{f(c)} dc > 0$, where $(q^m)'$ is evaluated at $\Psi(c;\mu)$. The expected industry profit is

$$B(\mu) \overset{d}{\equiv} \mathbb{E}\left(\Pi_{BS} | c \leqslant c^{\text{Sel}}\right) = \frac{1}{F(c^{\text{Sel}})} \int_{\underline{c}}^{c^{\text{Sel}}} \Pi(q^m(\Psi(c;\mu)); c) f(c) dc$$

Observing that $\partial \Pi / \partial q(q^m(\Psi(c;\mu)); c) = R'(q^m(\Psi(c;\mu))) - c = (1-\mu)F(c)/f(c)$, we find that the derivative of the industry profit with respect to μ is

$$B'(\mu) = -\frac{1}{F(c^{\text{Sel}})} \int_{\underline{c}}^{c^{\text{Sel}}} (1-\mu) \frac{F(c)}{f(c)} (q^m)' \frac{F(c)}{f(c)} f(c) dc = (1-\mu) A'(\mu),$$

which is positive except at $\mu = 1$. It follows that the buyer's expected profit $B - A$ decreases with μ ($(B-A)' = -\mu A' < 0$). As a result, the buyer's share and the supplier's share of the industry profit respectively decreases and increases with the supplier's weight.

A.2 Proof of Proposition 2

Because the selection rule is monotonic, supplier S_j is selected, $x_j(c_j, c_{-j}) = 1$, is equivalent to $c_j \leqslant c_j^{\text{Sel}}$ for a certain threshold $c_j^{\text{Sel}}(\mathbf{c}_{-j})$. The right-truncations leave the virtual costs $\Psi_j(c_j;\mu_j)$ unchanged.

The buyer selects the supplier to maximize her expected profit. From the proof of Proposition 1, the buyer's profit if she selects S_j is

$$\Pi_B(c_j) = (1-\nu_j)\left[\Pi(q^m(\Psi_j(c_j;\mu_j)); c_j) - \int_{c_j}^{c_j^{\text{Sel}}} q^m(\Psi_j(c_j;\mu_j)) dc_j\right], \tag{A.2}$$

where $\nu_j = 0$ if $\mu_j < 1$ and $\nu_j = \eta_j$ if $\mu_j = 1$. Integrating by parts, we get

$$\begin{aligned}
&\mathbb{E}\ \sum_j x_j(1-\nu_j)\left[\Pi(q^m(\Psi_j(c_j;\mu_j)); c_j) - \int_{c_j}^{c_j^{\text{Sel}}} q^m(\Psi_j(c_j;\mu_j)) dc_j\right] = \\
&\mathbb{E}\ \sum_j x_j(1-\nu_j)\left[\Pi(q^m(\Psi_j(c_j;\mu_j)); c_j) - \frac{F_j(c_j)}{f_j(c_j)} q^m(\Psi_j(c_j;\mu_j))\right] = \\
&\qquad \mathbb{E}\ \sum_j x_j(1-\nu_j)\ \Pi(q^m(\Psi_j(c_j;\mu_j)); \Psi_j(c_j;0)).
\end{aligned}$$

The above quantity is maximal if and only if $x_j = 1$ is equivalent to $\pi_j^v = \max_k \pi_k^v$, 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 (3). The optimal quantities and payments are given by

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

and

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

A.3 Monotonicity of the virtual profit

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

$$\mu \frac{\Psi(c;\mu)\,(q^m)'}{q^m} < \frac{cf(c)}{F(c)}\ \frac{\Psi(c;\mu)}{c}\ \frac{1+(F/f)'}{1+(1-\mu)(F/f)'}, \tag{A.3}$$

where q^m and $(q^m)'$ are evaluated at $\Psi(c;\mu)$. The last two factors at the right-hand side are larger than one, implying that (A.3) is satisfied if

$$\mu\varepsilon_q(\Psi(c;\mu)) < \varepsilon_F(c), \tag{A.4}$$

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 (A.3) and (A.4) hold when a is large enough.

A.4 Proof of Proposition 3 (implementation)

We assume first that $\mu_i < 1$. Given the wholesale price $w_i(\tilde{c}_i) = \Psi_i(\tilde{c}_i;\mu_i)$ chosen by the winning supplier, S_i, the buyer maximizes $R(q) - w_i(\tilde{c}_i)q$ and thus purchases $q^m(\Psi_i(\tilde{c}_i;\mu_i))$. Anticipating this quantity, S_i chooses $\tilde{c}_i$ to maximize

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

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 the above integral 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.

Assume now that $\mu_i = 1$ and the share η_i of the industry profit net of the supplier's informational rent that goes to the selected supplier (on top of his informational rent). Then the mechanism is implementable in the same way, with the only changes that the wholesale price is $w(\tilde{c}_i) = \tilde{c}_i$ and the payment is given by

$$M_i(\tilde{c}_i; s) = \eta_i \Pi^m(\tilde{c}_i) + (1-\eta_i)\int_{\tilde{c}_i}^{c_i^*(s)} q^m(c)dc.$$

The proof proceeds the same way, noticing that the derivative of M_i with respect to $\tilde{c}_i$ is $-q^m(\tilde{c}_i)$.

B Vertical integration (Proofs)

Proof of Proposition 4 Consider the post-merger situation where the buyer and supplier S_0 form a single entity. If the buyer selects S_0, the quantity is determined by maximizing the industry profit $\Pi_B + U_0$, hence $q_0 = q^m(c_0)$, and $\Pi_B + U_0 = \Pi^m(c_0)$. If the buyer selects an independent supplier S_j, the profit of the merged entity is thus given by (A.2). Its expected profit is thus

$$\mathbb{E}\left(\Pi_B + U_0\right) = \mathbb{E}\left\{x_0\Pi^m(c_0) + \sum_{j\neq 0} x_j(1-\nu_j)\ \Pi(q^m(\Psi_j(c_j;\mu_j));\Psi_j(c_j;0))\right\}.$$

We see that the only change compared to the pre-merger buyer's expected profit is that the virtual profit π_0^v has been replaced with $\Pi^m(c_0)$.

Proof of Corollary 2 The merger increases the integrated supplier' virtual profit from $\Pi^m(\Psi_0(c_0;0))$ to $\Pi^m(\Psi_0(c_0;\mu_0'))$. The virtual profit of an independent supplier $j \neq$

0 is $\pi_j^v = \Pi^m(\Psi_j(c_j;0))$. If S_j is foreclosed due to the merger, we have $\Pi^m(\Psi_0(c_0;\mu_0')) \geqslant \pi_j^v = \Pi^m(\Psi_j(c_j;0)) > \pi_0^v$, and hence $q^m(\Psi_0(c_0;\mu_0')) \geqslant q^m(\Psi_j(c_j;0))$. It follows that the merger causes the quantity to increase from $q^m(\Psi_j(c_j;\mu_j))$ to $q^m(\Psi_0(c_0;\mu_0'))$, which benefits final consumers.

Next, suppose $\mu_j > 0$ for some independent supplier j. By monotonicity of the virtual profit, this implies $\pi_j^v < \Pi^m(\Psi_j(c_j;\mu_j))$. Because $\mu_0' > \mu_0$, S_0's virtual profit is higher post-merger than pre-merger, hence foreclosure. Along the boundary of the foreclosure region, we have $\pi_j^v = \Pi^m(\Psi_0(c_0;\mu_0')) < \Pi^m(\Psi_j(c_j;\mu_j))$, which implies $\Psi_0(c_0;\mu_0') > \Psi_j(c_j;\mu_j)$. Hence, in the neighborhood of that boundary, 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 $q^m(\Psi_0(c_0;\mu_0'))$.

B.1 Pre-merger misallocations

Proof of Proposition 7 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 $\mu_1 < \mu_0$, the monotonicity of the virtual profit in μ 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 3. In other words, the pre-merger selection is biased against S_0.

Proof of Corollary 3 We first show that the virtual profit $\pi^v(c) = \Pi(q^m(c + (1-\mu)z); c+z)$ decreases with $z = F(c)/f(c)$. We have

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

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.[47] Given that $F_0/f_0 > F_1/f_1$, it follows that $\pi_1^v(c) > \pi_0^v(c)$ for any c, which shows that the selection is biased against S_0 prior to the merger. □

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

B.2 Example

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

Under vertical separation, S_1 is selected if and only if $c_1 \leqslant c_1^{\mathrm{Sel}}(c_0)$, where the selection threshold $c_1^{\mathrm{Sel}}(c_0)$ is given by

$$c_1^{\mathrm{Sel}}(c_0) = \frac{2a}{4-\mu_1^2}\left[1-\sqrt{1+\frac{4-\mu_1^2}{2a}\left[-2c_0+\frac{4-\mu_0^2}{2a}c_0^2\right]}\right].$$

Under vertical integration, S_1 is selected if and only if $c_1 \leqslant c_1^{\mathrm{vi}}(c_0)$, where the selection threshold $c_1^{\mathrm{vi}}(c_0)$ is given by

$$c_1^{\mathrm{vi}}(c_0) = \frac{2a}{4-\mu_1^2}\left[1-\sqrt{1-\frac{4-\mu_1^2}{4a^2}\left(2ac_0-c_0^2\right)}\right].$$

When the suppliers have, pre merger, the same bargaining power, $\mu_0 = \mu_1$, then $c_1^{\mathrm{Sel}}(c_0) = c_0$, as shown on Figure 4(a). The customer foreclosure area OCE on Figure 4(b) is defined by $c_1^{\mathrm{vi}}(c_0) < c_1 < c_0$. The OE line, i.e. $c_1^{\mathrm{vi}}(c_0)$, lies below the straight line $c_1 = c_0/2$ and is tangent to that line at $c_0 = 0$. The *Exploitation* region is defined by c_1 below that threshold. In the foreclosure region, consumers benefit from vertical integration if $c_0 < \Psi(c_1;\mu_1) = (2-\mu_1)c_1$ and are harmed otherwise. When $\mu_1 = 0$, we have $c_1^{\mathrm{vi}}(c_0) = c_0/2$, and consumers are better off in the entire foreclosure region, $c_0/2 \leqslant c_1 \leqslant c_0$.

On Figure 6, total welfare increases – despite inefficient foreclosure and thanks to EDM – in the region OCD' where

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

C Selection versus negotiation

Proof of Lemma 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

$$U_j(\widehat{c}_j;\mathbf{c}) = (M_j - c_jQ_j)\,, \tag{C.1}$$

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

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

By the envelope theorem, the derivative of the rent is

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

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:

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

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

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

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.

Selection versus Negotiation in a simple set-up Assume the buyer has to commit before learning anything about the marginal costs c_0 and c_1 to either run the selection stage of Section 3.2 or skip it and directly negotiate with both suppliers about price and quantity. We maintain the assumption that the suppliers have symmetric cost distributions, $F_0 = F_1$.

Before making her decision, the buyer knows the values of the suppliers' weights in both scenarios. That is, μ_0 and μ_1 when selection is chosen (and only one supplier is selected) and μ'_0 and μ'_1 when they are both invited to bargain over prices and quantities. Intuitively, the buyer should gain bargaining power when negotiating with many suppliers and in that case $\mu'_0 \leqslant \mu_0$ and $\mu'_1 \leqslant \mu_1$, but we do not have to assume that here.

Let $\Pi_B^{\text{one}}(\mu_0, \mu_1)$ denote the buyer's expected profits when she commits to the selection procedure, and let $\Pi_B^{\text{both}}(\mu'_0, \mu'_1)$ be her expected profits when she commits to no selection. The buyer prefers to commit to selection or not depending on the comparison of these two expected profits. From Proposition 8, we know that if $\mu'_0 = \mu'_1 = \mu' \leqslant \min(\mu_0, \mu_1)$, then $\Pi_B^{\text{one}}(\mu_0, \mu_1) < \Pi_B^{\text{both}}(\mu', \mu')$. It is also intuitive that if $\mu'_0 = \mu_0 - \varepsilon$ and $\mu'_1 = \mu_1 - \varepsilon$ then for ε close enough to zero, $\Pi_B^{\text{one}}(\mu_0, \mu_1) > \Pi_B^{\text{both}}(\mu', \mu')$.

Figure 12 shows, more generally, the trade-off in the (μ'_0, μ'_1) space where μ'_0 (resp. μ'_1) is S_0's weight (resp. S_1's weight). The reference point is A, where $\mu'_0 = \mu_0$ and

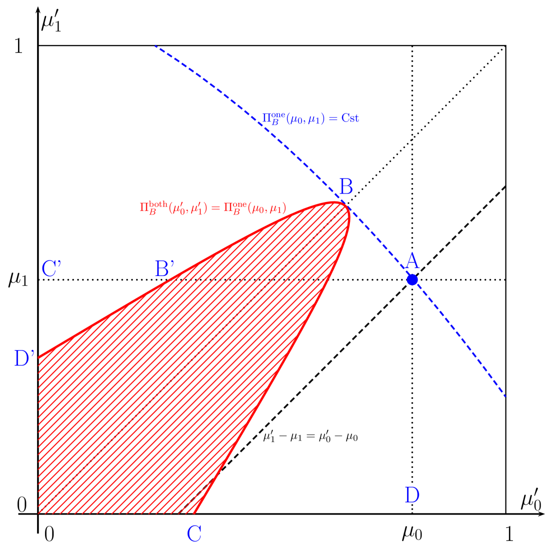


Figure 12: Suppliers' weights under separate selection: μ_0 and μ_1. The buyer prefers to select both suppliers when their weights under joint selection, μ'_0 and μ'_1, lie in the red area. Both c_0 and c_1 are uniformly distributed over $[0, 1]$

$\mu'_1 = \mu_1$. From there, the dashed blue curve separates the space in two parts. Above this curve the expected profit under selection is lower than $\Pi^{\text{one}}(\mu_0, \mu_1)$ while below the curve the profit is larger. The solid red curve is the set of suppliers' weights (μ'_0, μ'_1) such that the change in weights is favorable enough to compensate loosing the ability to select, i.e. $\Pi_B^{\text{both}}(\mu'_0, \mu'_1) = \Pi^{\text{one}}(\mu_0, \mu_1)$.

From Proposition 8, the two curves are tangent at point B where $\mu'_1 = \mu'_0$. When the weights (μ'_0, μ'_1) lie in the red hatched area, the gain in terms of bargaining power is large enough to compensate the lack of selection. Otherwise the buyer is better off selecting only one supplier. This is the case in the ABCD area, and in particular along the $\mu_1' - \mu_1 = \mu_0' - \mu_0$ line (for $\mu_1' < \mu_1$ and $\mu_0' < \mu_0$) where the asymmetry is maintained (unless μ_1' is close enough to zero).

When (μ_0', μ_1') are in the B'C'D' area, both weights are reduced compared to the reference point A, and μ_0', which can even be zero, is significantly lower than μ_0. However, the asymmetry between μ_0' and μ_1' is too large which makes the loss of the selection ability too costly.

On the contrary, in a neighborhood of B included in the red hatched area, μ_0' is lower than μ_0 but μ_1' is larger than μ_1. Yet, μ_0' and μ_1' are close enough to make it worth it giving up selection.

D Multisourcing (Proof of Proposition 9)

We consider here the pre-merger situation. When only one supplier is selected, the buyer bargains with that supplier over price and quantity. We have seen in the proof of Proposition 1 that the bargaining mechanism maximizes the expected weighted industry profit given by (A.1) and we have derived the buyer's profit just below that equation. Then, as in the proof of Proposition 2, we integrate by parts the rent term in (9) and derive the expression of the virtual profit if a single supplier (say S_0) is selected:

$$\pi_0^v = \Pi(q^m(\Psi_0(c_0;\mu),\infty), 0; \Psi_0(c_0;0), \Psi_1(c_1;0)),$$

which can be rewritten as

$$\pi_0^v = \Pi^m(\Psi_0(c_0;\mu),\infty) - \mu\frac{F(c_0)}{f(c_0)}q^m(\Psi_0(c_0;\mu),\infty). \tag{D.1}$$

We show in the same way that if the two suppliers are selected, the bargaining over prices and quantities maximizes

$$\mathbb{E}\left(\Pi_B + \mu' U_0 + \mu' U_1 \mid c_0, c_1 \leqslant c^{\mathrm{Sel}}\right) = \frac{1}{F(c^{\mathrm{Sel}})^2} \iint_{c_0,c_1\leqslant c^{\mathrm{Sel}}} \Pi(Q_0, Q_1; \Psi(c_0;\mu'), \Psi(c_1;\mu'))f(c_0)f(c_1)\,\mathrm{d}c_0\,\mathrm{d}c_1,$$

with $c^{\mathrm{Sel}} = c^*$. The optimal quantities are thus determined by the virtual costs: $Q_i = q_i^m(\Psi(c_0;\mu_0), \Psi(c_1;\mu_1))$ for $i = 1, 2$. Integrating by parts the two rent terms in (8), we find the corresponding virtual profit

$$\pi^v_{01} = \Pi(q^m_0(\Psi(c_0;\mu'),\Psi(c_1;\mu')), q^m_1(\Psi(c_0;\mu'),\Psi(c_1;\mu')); \Psi(c_0;0), \Psi(c_1;0)),$$

which can be rewritten as

$$\begin{aligned}\pi^v_{01} \quad &= \quad \Pi^m(\Psi(c_0;\mu'),\Psi(c_1;\mu')) - \mu'\frac{F(c_0)}{f(c_0)}q^m_0(\Psi(c_0;\mu'),\Psi(c_1;\mu')) \\ &\quad -\mu'\frac{F(c_1)}{f(c_1)}q^m_1(\Psi(c_0;\mu'),\Psi(c_1;\mu')). \end{aligned} \tag{D.2}$$

The buyer's expected profit is

$$\mathbb{E}\,\Pi_B = \mathbb{E}\left(\pi^v_{01}\mathbb{1}_{c_0\leqslant c^*, c_1\leqslant c^*} + \pi^v_0\mathbb{1}_{c_0\leqslant c_1, c_1\geqslant c^*} + \pi^v_1\mathbb{1}_{c_0\geqslant c^*, c_1\leqslant c_0}\right). \tag{D.3}$$

Lemma D.1 (Pre-merger situation)**.** *If $\mu' = 0$, the two suppliers are selected with probability one. If $\mu' > 0$, the buyer supplies from both suppliers if and only if their costs are below the threshold c^* given by*

$$\int_0^{c^*} \left[\pi^v_{01}(x,c_1) - \pi^v_1(c_1)\right] f(c_1)\,\mathrm{d}c_1 = 0. \tag{D.4}$$

Proof. For $\mu' = 0$, the virtual profits are given by $\pi^v_{01} = \Pi^m(\Psi(c_0;0),\Psi(c_1;0))$ and $\pi^v_i = \Pi^m(\Psi(c_i;0))$. The first claim before follow from the inequality

$$\Pi^m(\Psi(c_0;0),\Psi(c_1;0)) \geqslant \max\left(\Pi^m(\Psi(c_0;0)), \Pi^m(\Psi(c_1;0))\right),$$

for any c_0 and c_1. The threshold c^* is obtained by maximizing the expected virtual profit, which is now the sum of three terms

$$\mathbb{E}\left(\pi^v_{01}\mathbb{1}_{c_0\leqslant c^*, c_1\leqslant c^*} + \pi^v_0\mathbb{1}_{c_0\leqslant c_1, c_1\geqslant c^*} + \pi^v_1\mathbb{1}_{c_0\geqslant c^*, c_1\leqslant c_0}\right).$$

Differentiating with respect to c^* yields (D.4). □

Implementation in dominant strategy As the clock index increases, the marginal costs of the active participants decrease, the quantities increase, and the convexity of the cost functions is more likely to the informational costs (two 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 10(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 c^*, see the square $OADB$.

If the clock index has reached s^*, S_0 is offered a menu of tariffs of the form $T(q_0; \tilde{c}_0, \tilde{c}_1) = \alpha q_0^2/2 + w_0 q_0 + M_0$, where

$$w_0(\tilde{c}_0) = \Psi(\tilde{c}_0; \mu')$$

and

$$M_0(\tilde{c}_0, \tilde{c}_1) = \int_{\tilde{c}_i}^{c^*} q^m(\Psi(c; \mu'), \Psi(\tilde{c}_1; \mu'))\,\mathrm{d}c - [w_0(\tilde{c}_0) - \tilde{c}_0] q^m(\Psi(\tilde{c}_0; \mu'), \Psi(\tilde{c}_1; \mu')).$$

The other supplier, S_1, is offered the symmetric menu (obtained by changing the indices 0 and 1).

Once the suppliers have chosen $\tilde{c}_0$ and $\tilde{c}_1$, the buyer's profit is $\Pi(q_0, q_1; w_0, w_1)$ and hence the buyer purchases quantities $q_0^m(w_0, w_1)$ and $q_1^m(w_0, w_1)$ from each supplier. Anticipating these quantities, S_0 chooses $\tilde{c}_0$ to maximize

$$\begin{aligned}[w(\tilde{c}_0) - c_0] q_0^m(\Psi(\tilde{c}_0; \mu'), \Psi(\tilde{c}_1; \mu')) + M_0(\tilde{c}_0, \tilde{c}_1) = \\ [\tilde{c}_0 - c_0] q_0^m(\Psi(\tilde{c}_0; \mu'), \Psi(\tilde{c}_1; \mu')) + \int_{\tilde{c}_0}^{c^*} q_0^m(\Psi(c; \mu'), \Psi(\tilde{c}_1; \mu'))\,\mathrm{d}c\end{aligned}$$

Whatever the value of $\tilde{c}_1$, the above quantity is quasi-concave and maximum at $\tilde{c}_0 = c_0$, so S_0 chooses the contract intended for him irrespective of S_1's decision. For s slightly below and slightly above s^*, i.e., when c_1 is slightly above and slightly below c^*, S_0's profit is respectively given by

$$\int_{c_0}^{c^*} q^m(\Psi(c; \mu), \infty)\,\mathrm{d}c$$

and

$$\int_{c_0}^{c^*} q_0^m(\Psi(c; \mu'), \Psi(c^*; \mu'))\,\mathrm{d}c$$

The quantity produced by S_0 and his profit jump downward as we move from single-sourcing to multisourcing.

Post-merger situation: Proof of Equation (12) The buyer prefers multisourcing over excluding S_1 if and only if

$$\Pi^m(c_0, \Psi(c_1;\mu')) - \mu' \frac{F(c_1)}{f(c_1)} q_1^m(c_0, \Psi(c_1;\mu')) \geqslant \Pi^m(c_0, \infty).$$

Hence, if the buyer is indifferent post-merger between selecting or excluding S_1 (i.e., if there is equality above), then

$$\Pi^m(c_0, \Psi(c_1;\mu')) > \Pi^m(c_0, \infty), \tag{D.5}$$

which is equivalent to $q_1^m(c_0, \Psi(c_1;\mu')) > 0$. The total quantity under multisourcing $q^m(c_0, \Psi_1) = q_0^m(c_0, \Psi_1) + q_1^m(c_0, \Psi_1)$ decreases with Ψ_1 and is equal to $q_0^m(c_0;\infty)$ when Ψ_1 is so large that $q_1^m(c_0, \Psi_1) = 0$. Equation (12) thus follows from (D.5).

E Choice of merger partner

Proof of Lemma 2 At the last stage of the game, 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. $\square$

Proof of Proposition 10 Suppose that the suppliers' weights at the production stage satisfy $\mu_1 < \mu_0 \leqslant 1$.[48] For clarity of exposition, we now regard the virtual profit defined in (2) as a function of the supplier's cost and weight: $\pi_i^v = \Pi^v(c_i;\mu_i)$, where the function Π^v does not depend on the supplier's identity because the distributions F_0 and F_1 are the same. If B and S_0 merge, the industry profit if

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

[48] If $\mu_0 = 1$, we restrict attention to the case where $\eta_0 = 0$.

If B and S_1 merge, the industry profit if

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

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

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

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

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

The first term is positive because

$$\Pi^m(c_0) < \Pi^v(c_1;\mu_1) = \Pi(q^m(\Psi(c_1;\mu_1));\Psi(c_1;0)) < \Pi(q^m(\Psi(c_1;\mu_1));c_1)$$

in the corresponding region. This reflects the force that pushes B to merge with S_0 to limit foreclosure (there is less foreclosure when the independent supplier has less bargaining power, recall $\mu_1 < \mu_0$). The second term is negative because $\Psi(c_1;\mu_1) > \Psi(c_1;\mu_0)$. It reflects the force that pushes B to merge with S_1 to magnify the EDM effect (the double markup is larger when the supplier has less bargaining power). □

Proposition E.1. *Suppose, as in Corollary 3, that there is no DM pre-merger ($\mu_0 = \mu_1 = 1$) and that S_0 is ex ante more efficient than S_1 in the sense that c_0 is lower than c_1 for the likelihood ratio order ($F_0/f_0 > F_1/f_1$).*

Then the buyer prefers to acquire supplier S_0, the ex ante more efficient supplier.

Proof. Lemma 2 states that the acquired supplier is chosen to maximize the industry profit. To compare the industry profit under each possible vertical integration, it is convenient to subtract the maximum industry profit, $\iint \Pi^m(\min(c_0, c_1))\, \mathrm{d}F_0\, \mathrm{d}F_1$, which is achieved when the most efficient supplier is active. The difference indeed involves only the foreclosure region in each scenario. When B integrates with S_0, the difference is:

$$D^0 = \iint\limits_{c_1 \leqslant c_0 \leqslant (\Pi^m)^{-1}(\Pi_1^v(c_1))} [\Pi^m(c_0) - \Pi^m(c_1)]\, f_0(c_0) f_1(c_1)\, \mathrm{d}c_0\, \mathrm{d}c_1$$

Similarly, when B integrates with S_1

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

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

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

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:

$$\Pi_1^v(c_1) = R(q^m(c_1)) - \Psi_1(c_1; 0) q^m(c_1) > R(q^m(c_1)) - \Psi_0(c_1; 0) q^m(c_1) = \Pi_0^v(c_1).$$

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

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

It follows that

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

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 D^0 is larger than D^1, the desired result. □

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