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Vertical Integration and Downstream Collusion*

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Abstract

We investigate the effect of a vertical merger on downstream firms' ability to collude in a repeated game framework. We show that a vertical merger has two main effects. On the one hand, it increases the total collusive profits, increasing the stakes of collusion. On the other hand, it creates an asymmetry between the integrated firm and the unintegrated competitors. The integrated firm, accessing the input at marginal cost, faces higher profits in the deviation phase and in the non cooperative equilibrium, which potentially harms collusion. As we show, the optimal collusive profit-sharing agreement takes care of the increased incentive to deviate of the integrated firm, while optimal punishment erases the difficulty related to the asymmetries in the non cooperative state. As a result, vertical integration generally favors collusion.

JEL Classification: D43, L13, L40, L42.
Keywords: Vertical Integration, Tacit Collusion.

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1 Introduction

The effects of vertical mergers on competition are an important issue in antitrust policy and have gained increasing attention in the last decades. Both the US and the EU merger policies embrace the idea that vertical mergers might give rise to anti-competitive effects due to coordinated effects. For instance, the US Non-Horizontal merger guidelines, adopted in 1984, state that "*A high level of vertical integration by upstream firms into the associated retail market may facilitate collusion.*". The more recent EU Non-Horizontal merger guidelines, adopted in 2008, also mention the risk that a vertical merger results in coordinated effects and state that "*A vertical merger may make it easier for the firms in the upstream or downstream market to reach a common understanding on the terms of coordination*".

However, the paucity of vertical mergers analyzed using coordinated effect theory by both EU and US antitrust authorities shows a certain degree of discomfort in bringing those cases. In the US the main cases are GrafTech/Seadrift, Merk/Medco and Premdor/Masonite. In the Merk/Medco and GrafTech/Seadrift cases, the Federal Trade Commission (FTC) appeared mainly concerned with the possibility of collusion among symmetric vertically integrated competitors and upstream coordination. In this context, the FTC evoked the risks associated with the fact that the merged entity will be able to monitor the commercial terms of upstream transactions thus "facilitating" tacit understanding. In the Premdor/Masonite case, the downstream collusion potential (neglected in the guideline) is explicitly evoked. The FTC explains that vertical integration is likely to conceal the incentives of an upstream firm to disrupt downstream collusion expanding the offer to non-colluding downstream competitor. In the EU, the most relevant cases come from the energy sector: Shell/DEA (Case COMP/M.2389) and BP/EO (Case COMP/M.2533). In the decisions, the Commission explicitly lists "retaliation possibilities" as an element to take into account to establish collective dominance. It also mentions that integrated undertakings can use the "tacit allocation of contracts" as a mean to increase collusion. The Commission also indicates the disappearance of an independent upstream supplier as a source of concern. More importantly, the Commission states that vertically integrated entities are likely to acquire through the merger "sufficient means of retaliation" to enforce collusion. Both the FTC and the EU Commission seem mainly concerned with the incentive to collude among vertically integrated firms. This is also the focus of most of the few theoretical contributions in the paper, as we explain below.

The present paper aims to shed light on possible channels through which a vertical merger can lead to coordinated effects in the downstream market. We present a framework in which increased retaliation possibilities can increase the collusion potential with downstream independent competitors. This aspect has been mainly neglected in the existent economic literature on the anticompetitive effects of vertical mergers.

Whereas the classic results of the Chicago school critique, starting from Stigler (1964), had created a prior of non harmfulness of vertical integration, the more recent literature has raised attention on its anticompetitive effects (see Riordan, 2008 for a review).[1] This first stream of literature took a static view of the interaction between firms. More recent contributions have explored the possibility that a vertical merger could facilitate the emergence of a collusive agreement when upstream and downstream firms interact repeatedly. The main theoretical contribution in this sense is Nocke and White (2007). They look at the possibility that vertical integration facilitates upstream collusion in a repeated games framework. In their model, vertical integration has both an "outlet effect" (foreclosing part of the downstream market) and a punishment effect (integrated firms typically make more profit in the punishment phase than unintegrated upstream firms). The main result of the paper, obtained under two-part tariffs, is that the outlet effect always outweighs the punishment effect and vertical integration unambiguously facilitates collusion. Normann (2009) independently derived similar results in a model with linear tariffs. When two-part tariffs are not available, in the absence of integration upstream collusion does not guarantee maximal profits, because of double marginalization. Thus, the overall welfare balance of vertical integration is not necessarily negative. The integrated firm serves its downstream unit at marginal cost, and the elimination of the double markup can imply a welfare gain. However, as in Nocke and White (2007) vertical integration can expand the values of the discount factor for which collusion is feasible, thus creating new opportunities to collude and potentially reduce welfare.

We also investigate the impact of vertical mergers in a dynamic game of repeated interaction between upstream and downstream firms, but, contrarily to Nocke and White (2007) and

[1] The post-Chicago scholar have raised several objections to the Chicago school view, showing first that vertical integration can produce foreclosure raising-rival's-costs (Ordover, Saloner, and Salop, 1990) and second that vertical integration can help restoring monopoly power when an upstream monopoly initially lacks the necessary commitment to extract full monopoly rents (Rey and Tirole, 2007). Starting from the raising-rival's-costs result, Chen (2001) shows that vertical integration can also induce independent downstream firms to be willing to contract with the integrated supplier at a supra-competitive price, softening downstream competition. As a result, vertical integration allows the realization of a collusive outcome. Chen and Riordan (2007) develop this line of research, showing that vertical integration can help an upstream firm to cartelize the downstream market via exclusive contracts with the other downstream providers.

Normann (2009), we focus on downstream collusion. The possibility of downstream collusion in vertical related industries has been studied in Piccolo and Miklós-Thal (2012). They consider vertical chains under exclusivity contracts and show that collusion on supply contracts, consisting in above marginal cost pricing plus a negative fee (slotting allowances) can increase collusion. In our paper, we do not assume vertical chains (downstream firms are not linked to a unique upstream supplier) and we introduce the possibility of a vertical merger. This possibility has been neglected by the existing literature, with the exception of Mendi (2009) who considers a competitive upstream industry and a downstream duopoly. Downstream firms have asymmetric costs. In this context, the author shows that vertical integration can help sustaining collusion under cost asymmetries, allowing for implicit side-transfers. We consider a similar problem, but we do not restrict the downstream market to be a duopoly and we do not assume asymmetric costs for downstream firms. In addition, we assume that the upstream market is also oligopolistic. We thus have two vertically related oligopolies. Downstream firms are ex-ante symmetric but backward integration creates a cost asymmetry: the integrated firm has access to the input at a lower cost. Moreover, we do not restrict our attention to Nash reversion, but, following a more recent literature, we consider optimal punishment strategies: when a firm deviates from the collusive agreement, all firms suffer maximal punishment (this is in line with the optimal punishments proposed in Abreu, 1986, 1988 and applied to an asymmetric oligopoly problem by Miklós-Thal, 2011).

Under our assumptions, we show that vertical integration generally favors collusion, decreasing the critical discount factor above which collusion is feasible. Vertical integration generates a trade-off. On the one hand, it allows downstream firms to have access to the input at a lower price, removing the upstream oligopolistic margin. On the other hand, vertical integration creates an asymmetry which is potentially harmful to collusion. The vertically integrated firm has a higher incentive to deviate both from the collusive agreement and from the defined behavior in the punishment phase (because it has unlimited access to the intermediate good at marginal cost). As we show, the optimal collusive agreement solves these two asymmetries. The asymmetry in the punishment phase is balanced by allocating asymmetric shares of the collusive profit to the integrated and non integrated firms, and the asymmetry in the punishment phase is solved by enforcing maximal punishment in case of deviation from the collusive agreement. For this reason, ex-post cost asymmetries are not an obstacle to collusion.

In principle, privileged access to an upstream producer can both increase the retaliation possibility of the integrated firm, as well as its incentive to disrupt collusion. Our model illustrates the theoretical arguments for which there are reasons to think that the pro-collusive effect of a vertical merger would generally prevail.

The paper proceed as follows. Sections 2 and 3 present the model and the main results. Section 4 concludes.

2 The model

We consider an industry with vertically related firms, $M \geq 2$ upstream firms denoted U_1, ...,U_M and $N \geq 2$ downstream firms denoted D_1, ..., D_N. Upstream firms sell an intermediate good which is necessary for the production of the final good by downstream firms. The intermediate good is uniquely used by these downstream firms (no alternative market).

There is no fixed production cost. Any upstream firm U_i has a constant marginal cost for producing the intermediate good, c_i. For the sake of simplicity, we order upstream firms so that for any $i < M$, $c_i \leq c_{i+1}$. We assume that $0 < c_1 < c_2$ and denote C the vector of marginal costs of size M.

In order to produce one unit of the final good, a downstream firm needs one unit of the intermediate good. We assume that the only cost that downstream firms face is the amount paid for the units of the intermediate good, normalizing other downstream costs to zero.

Neither upstream nor downstream firms have capacity constraints.

Units of the final good are sold to consumers who consider them as homogenous. Consumers are characterized by a demand function $Q(p)$. There is a maximal price $\overline{p} > c_2$ such that $Q(\overline{p}) = 0$ and for any $p < \overline{p}$, $Q(p) > 0$. Q is strictly decreasing on $[0, \overline{p})$, twice differentiable and for all $x \in [0, \overline{p}]$, $(p - x)Q(p)$ is strictly concave on $[x, \overline{p})$. This ensures that the monopoly price on the downstream market, p^m_c, is well defined and increasing in the constant unit cost c. We also assume that the differences between upstream firms are limited so that $p^m_{c_1} > c_2$ and $(x - c_1)Q(x)$ is strictly increasing on $[c_1, c_2]$.

In the markets for the intermediate and for the final good, firms compete in price with linear prices (Bertrand competition). We denote w_i the price offer of the upstream firm i, and p_j the price offer of downstream firm j to consumers.

At any period of the game, firms play the following stage game.

- Stage 1: Upstream firms simultaneously make a public offer: a unit price w_i from upstream firm i to any downstream firm for units which can only be bought and used during this period of the game.[2]

- Stage 2: Each downstream firm chooses one or several proposals of the upstream firms without specifying the precise quantity it will buy. The quantity will be determined later by the Bertrand game on the downstream market.

- Stage 3: Downstream firms simultaneously make price offers to consumers for the final goods.

- Stage 4: A quantity $Q(\underline{p})$ of the final good is sold to consumers at a price $\underline{p} = \min_j p_j$. If only one firm proposes price $\underline{p}$, it sells the whole quantity $Q(\underline{p})$. In case of tie, if there is no specific agreement among firms having proposed the lowest price, the demand is split between the firms having proposed price $\underline{p}$ in any way consistent with the equilibrium (no firm has an incentive to deviate to a different price). The firms having proposed a price equal to $\underline{p}$ may also jointly decide of an allocation of the total quantity (market sharing agreement). Any agreement can be sustained as long as the total quantity is equal to $Q(\underline{p})$ and all quantities are weakly positive.

- Stage 5: Downstream firms who sold units to consumers pay the units of the intermediate good they bought to their suppliers, choosing freely how to share the total quantity among their suppliers.

In the model, the upstream firms make their offers to downstream first so that downstream firms are aware of their costs before proposing prices to final consumers. However, the quantity of intermediate goods bought is fixed only once the downstream market is organized.

The game consists in an infinite repetition of the stage game. Firms maximize the discounted sum of stage game payoffs with a common discount factor $\delta \in (0, 1)$. At the end of a period of the game, all the decisions of the players are perfectly observed by all the players (perfect monitoring). If a firm is vertically integrated, it maximizes the joint profit of its upstream and downstream branches. This implies that in stage 1, the upstream branch of the integrated firm makes an offer to the downstream branch at a price equal to its marginal cost.

[2] We don't allow for storage capacities to avoid additional interdependence across periods which would make the game much more complex. For instance, firms' actions would depend on the anticipation of all future prices of the intermediate good, making the game hardly tractable.

Since we focus on the effect of vertical integration on downstream collusion, we assume that a vertical merger does not affect the cost functions of the firms.[3]

We focus on the effects of vertical integration on the feasibility of collusion, investigating whether a vertical merger increases the capability of firms to sustain a tacit collusion agreement. For this reason, our object of interest is the *critical threshold of the discount factor*, $\underline{\delta}$, such that collusion is sustainable if and only if firms' discount factor is larger than this threshold.

We denote V_i^{col} the present value of collusive profits and V_i^{pun} the present value of punishment profits, while π_i^d is the period payoff from a deviation. Collusion is sustainable if the following incentive compatibility constraint is satisfied:

$$V_i^{col}(\delta) \geq \pi_i^d + \delta V_i^{pun}(\delta) \tag{1}$$

The critical discount factor $\underline{\delta}$ is determined by the incentive compatibility constraints of each firms, given by (1). There exists a collusive equilibrium (in which downstream firms sell at the collusive price)[4] if and only if $\delta > \underline{\delta}$. If $\underline{\delta}$ is lower (resp: higher) with vertical integration than without it, we will say that vertical integration raises (resp: reduces) collusion opportunities. We will denote, $\underline{\delta}^{NI}$ and $\underline{\delta}^{I}$, the critical collusive discount factor without integration and with integration respectively.

3 The Analysis

3.1 No vertical integration

To analyze the benchmark case of no vertical integration, we rely on a standard representation of a collusive agreement in a repeated game framework. If downstream firms form a cartel, they jointly fix a collusive price. A firm starts charging this price and does it at each period if all the other firms do the same. If one firm deviates, this triggers a punishment phase in which downstream firms play the Bertrand static equilibrium in all subsequent periods. The repeated game has an infinity of collusive equilibria but we focus on collusive equilibria in which downstream firms obtain the highest total profit. We can show that the vertical structure of the market does not affect much the conditions for the existence of collusion in the downstream

[3]However, assuming that vertical integration reduces the marginal cost for producing the intermediate good would not affect the results as long as the upstream branch of the integrated firm has the lowest marginal cost for producing the intermediate good. Indeed, the lower marginal cost of the integrated firm could alternatively be interpreted as the efficiency effect of the merger.

[4]Considering the best offers of upstream firms as their joint cost function.

market. The critical collusive discount factor coincides with what we observe in vertically unrelated markets where firms have an identical constant marginal costs.

Result 1 *Without vertical integration,* $\underline{\delta}^{NI} = \frac{N-1}{N}$.

The intuition for this result is as follows. When downstream firms collude, they all buy the intermediate good at the lowest upstream price,[5] c_2, and set a price equal to $p^m_{c_2}$. They equally share the total profit, $\pi^m_{c_2}$, so that at each period a downstream firm obtains $\frac{\pi^m_{c_2}}{N}$. If a downstream firm deviates, it can propose a price arbitrarily close to $p^m_{c_2}$ and obtain a revenue arbitrarily close to $\pi^m_{c_2}$. However, in all the following periods, at least two downstream firms will choose a price equal to c_2 so that no downstream firm will make any profit. The continuation payoff after any deviation is equal to zero. Hence the minimum value of the discount factor, $\underline{\delta}^{NI}$, above which collusion is sustainable must be such that the cooperation profit $V^{col} = \frac{\pi^m_{c_2}}{N(1-\underline{\delta})}$ is equal to the deviation profit: $\pi^d_i = \pi^m_{c_2}$ (the punishment profit is $V^{pun}_i = 0$). The incentive compatibility constraint (1) determines the threshold discount factor: $\frac{\pi^m_{c_2}}{N(1-\underline{\delta}^{NI})} = \pi^m_{c_2}$ so that $\underline{\delta}^{NI} = \frac{N-1}{N}$.

Let us also note that, even if we consider downstream collusion on a different price and a different collusive profit π^{col}, the lowest δ allowing for collusion remains equal to $\frac{N-1}{N}$ since we can apply exactly the same reasoning. The collusion profit for any downstream firm is $\frac{\pi^{col}}{N(1-\delta)}$, the deviation profit is arbitrarily close to π^{col} (or strictly higher than π^{col} if the collusive price is strictly higher than $p^m_{c_2}$) and firms make zero profits in the periods following a deviation.

3.2 Vertical integration

We assume that U_1 and D_1 merge to create I_1.[6] Before analyzing this situation, we need to specify our representation of competition and collusion in this case.

First, the integrated firm, I_1. Its profit is equal to the sum of the profits of U_1 and D_1. Besides, we assume that D_1 always has the possibility to buy an unlimited quantity of intermediate goods to U_1 at a price equal to c_1.

Second, the other competitors. As long as there is no collusion, their situation is not modified. In case of collusion between downstream firms, we assume that in period 1 of the stage game, the integrated firm can make an extra offer to downstream firm j at a price w^c_j per

[5]Since there is a Bertrand competition on the upstream market, the price for the intermediate good is equal to the second lowest cost for the intermediate good: c_2.

[6]If another upstream firm rather than U_1 merges with a downstream firm, this will not affect the competition outcome.

unit for a specified quantity $\underline{q}_j$ of intermediate goods.[7] In period 2, in addition to other offers, downstream firms may accept or refuse the offer made by the integrated firm.

Now, we see that the vertical merger has two effects. First, it creates an asymmetry among downstream firms. D_1 has a direct access to intermediate goods at a lower price than other firms. As any asymmetry, this does not favor cooperation among downstream firms. Second, under vertical integration, unlike no integration, when downstream firms cooperate, double marginalization is avoided and productive efficiency increases which favor collusion. Furthermore, D_1 that is vertically integrated can share its access to cheaper intermediate goods with the other members of the cartel and still replicate the monopoly profit with a marginal cost c_1.

Proposition 1 *The critical collusive discount factor is strictly lower with vertical integration than without integration, $\underline{\delta}^I < \underline{\delta}^{NI}$. Vertical integration facilitates downstream collusion.*

Proof: see in the appendix

The result stated in Proposition 1 can be illustrated with the following collusive agreement. In stage 1, I_1 makes a proposal to other downstream firms, selling to each of them a quantity $\frac{1-\varepsilon}{N} q^m_{c_1}$ (with $\varepsilon > 0$ and small) at a price c_1 and an unlimited quantity at price c_2. In stage 2, each downstream firm i with $i \neq 1$ accepts the offer of the integrated firm U_1. In stage 3, all the firms propose a price equal to $p^m_{c_1}$. In stage 4, the division of the market is as follows. Firm U_1 sells a quantity $\frac{1+(N-1)\varepsilon}{N} q^m_{c_1}$ and all the other downstream firms sell a quantity equal to $\frac{1-\varepsilon}{N} q^m_{c_1}$. The terms of collusion (market shares) are distorted in favor of the integrated firm to relax its incentive compatibility constraint. This allows to increase the scope of collusion. The intuition for this result is the following. As already mentioned, a merger increases total industry profits under collusion. In addition, the merger makes firms asymmetric. Despite this asymmetry, after a deviation, firms can be made symmetric by a maximal punishment scheme which set all the continuation payoff to zero. This is straightforward for non integrated firms D_j with $j \neq 1$. For instance, maximal punishment can be obtained if, after a deviation, firms play the static Bertrand game with price equal to c_2 (and firm I_1 serves all the market). But we

[7] We add this element in order to take into account the possibility for the integrated firm to sell a limited quantity of intermediate good at a lower price to members of the cartel. It would be less natural to assume that the integrated firm gives an unlimited access to the intermediate good at a low price even though it wants the other members of the cartel to sell a limited quantity of the final good. Let us also mention that we could also obtain the same results without these price-quantity offers and a different organization of the cartel. For instance, the integrated firm may leave the downstream market to the other firms but it would sell the intermediate good at a price w strictly higher than c_1 (without any quantity limit), while the downstream firm set a collusive price $p^m_{c_1}$ and share the market symmetrically. In this case, the integrated firm would extract it collusive profits from upstream sells. However, we chose to consider the current setting because we consider it as a more natural way to coordinate among cartel members.

can also build equilibrium strategies such that I_1's continuation payoff is equal to zero after a deviation, thus ensuring maximal punishment to the integrated firm. After a deviation by I_1, in all the posterior periods, the non integrated competitors choose an upstream firm different from I_1, so that the upstream price chosen firm I_1 is irrelevant for its payoff. Then, the integrated firm and a competitor, say firm D_2, set $p_1 = p_2 = c_1$ and all other downstream competitors set a higher price, while the allocation rule is such that firm I_1 serves all the market so that all firms get zero profits.

Under this scheme, if profit shares were allocated symmetrically in the collusion phase, the situation would be exactly the same for D_1 as in the case without vertical integration (except that the cost of the intermediate good decreased from c_2 to c_1). I_1 would obtain a fraction $\frac{1}{N}$ of the collusive profit in all the periods of cooperation, the whole profit in deviation and nothing after the first period of deviation. Therefore, with symmetric profit shares, the critical collusive discount factor would be exactly the same as without vertical integration for D_1.

However, upon a merger, firms become asymmetric also in the deviation phase. When deviating, other firms face a marginal cost c_2 for the extra units. Thus, if firms insist in symmetric profit shares, the critical discount rate for the non integrated firms would now be strictly lower than the one without vertical integration because the deviation profit would be strictly lower than N times the collusion profit. Thus, the cartel can decrease the critical discount factor for the integrated firm and increase it for the non integrated competitor, by sharing profits asymmetrically in the collusive case, i.e. allocating a higher share of the profits to the integrated firm. Because the cost of a deviation is now strictly higher for the non-integrated competitors, starting from a symmetric profit allocation, it is always possible to increase the market share of D_1 and decrease the market share of the competitors in a way that allows to find a common critical discount factor which is lower than $\underline{\delta}^{NI}$.

We note here that the chosen punishment strategies maximize the scope of collusion because they allow firms to inflict maximal punishments in case of any deviation. For each firm, the minmax payoff is zero, so that a punishment path with a continuation value of zero is a security level punishment. During the punishment phase, no firm can make a short term gain by deviating from the punishment path, but a deviation starts again a security level punishment for the deviator. One may argue that the punishment strategy following a deviation by firm I_1 is implausible because it requires that at least one firm plays a weakly dominated strategy in the one-shot game. Nonetheless, following Miklós-Thal (2011) who considers the role of minmax punishments applied to the case of collusion under cost asymmetries, the idea that firms can coordinate on punishments that are harsher than usual grim-trigger strategies is now standard in the literature. Maximal punishment of the most efficient firm can also be obtained using a stick and carrot strategy which involves below cost pricing for this firm for a finite number of periods (a finite "price war"). It seems reasonable to think that firms are able to enforce harsh punishment schemes if they constitute an equilibrium.

Let us also mention that, because of this first step in which the terms of the contracts for providing the intermediate good are fixed, the game is a repeated extensive-form game rather than a repeated normal form game. In this environment, Nocke and White (2007), Piccolo and Miklós-Thal (2012) and Mailath et al. (2015) show that it may be possible to exploit the sequentiality in order to build more subtle punishments. It turns out that, in our framework, these extra possibilities are not needed to establish the main result that vertical integration increases the collusion possibilities.

Imperfect collusion.

As shown in Section 3.1, in the absence of vertical integration, the critical threshold $\underline{\delta}^{NI}$ does not depend on the chosen collusive price. We now consider the creation of a collusive cartel among downstream firms choosing a price lower than $p^m_{c_1}$ under vertical integration. We define here a constant collusive equilibrium as an equilibrium in which firms behave the same way during all collusive periods. The constant collusive price is the price at which the final good is sold during all the periods.

Proposition 2 *With vertical integration, for any value of $\delta > 0$, there exists a constant collusive equilibrium with a collusive price, $p^{col} \in (c_2, p^m_{c_1})$.*

Proposition 3 *With vertical integration, as δ becomes smaller, the maximum constant collusive price that can be sustained get closer to c_2 (the non collusive price).*

Proof: see in the appendix.

The intuition for Propositions 2 and 3 is the following. From Proposition 1 we know that upon vertical integration, it is possible to decrease the critical discount factor of collusion by allocating a smaller market share to the non integrated firms, because their gains from deviations are smaller than the one obtained by firm D_1. This asymmetry in deviation incentives is larger when the price is closer to c_2. Thus, when the collusive price p^{col} becomes closer to c_2, it is possible to raise α, the fraction of the collusive profit allocated to I_1, closer to 1 so that all firms stick to the collusive equilibrium. However, to enforce collusion when δ becomes smaller, the collusive price must get closer to c_2 (the non collusive price), so that the market power distortion related to collective dominance vanishes when δ goes to zero.

Welfare Analysis.

Because $c_1 < c_2$, vertical integration can avoid double marginalization, which increases productive efficiency. Nonetheless, we have also shown that vertical integration creates new collusion opportunities, expanding the range of the discount factor for which collusion is sustainable. When collusion is created by vertical integration, the price increases from the competitive Bertrand price c_2 to the monopoly price, which is strictly larger, thus decreasing welfare.

Corollary 1 *If downstream firms always collude in a way which maximizes their joint profit whenever it is possible, for all $\delta \leq \frac{N-1}{N}$ vertical integration decreases welfare and for all $\delta > \frac{N-1}{N}$ vertical integration increases welfare.*

If $0 < \delta < \frac{N-1}{N}$, without vertical integration, there is no collusive equilibrium and the price is equal to c_2. With vertical integration, there always exists a collusive equilibrium in which the final price is strictly higher than c_2 (c_2 being the price in the absence of collusion). If $\delta > \frac{N-1}{N}$, with or without vertical integration, a collusive equilibrium exists and the price is lower with vertical integration, because it is equal to the monopoly price with a marginal cost of c_1 rather than the monopoly price with a marginal of cost c_2. Integration allows to avoid double marginalization in this case.

The welfare effect of a vertical merger is thus ambiguous. It increases efficiency by lowering the price of the intermediate good, but it possibly increases market power through collective dominance, lowering the critical discount factor. It is important to note that Corollary 1 depends on our assumption that firms sustain the collusive outcome which gives them the highest possible profit (when there exists a collusive equilibrium). Vertical integration is welfare decreasing for $0 < \delta < \frac{N-1}{N}$ because it creates new collusion opportunities and we do not allow the efficiency effect to be large enough to lead to lower prices (i.e. we restrict our attention to the case $c_2 \leq p^m_{c_1}$).

Nonlinear upstream tariffs.

We have assumed so far that upstream firms charge linear tariffs for the intermediate good. We now consider the possibility of nonlinear tariff. For the sake of simplicity, we assume that the tariff is a classic two-part tariff (a unit price w plus a fixed fee T).

In the case of vertical integration, the possibility to use nonlinear upstream tariffs cannot increase the critical discount factor above which collusion is feasible. First, in the collusion phase, the additional possibility of using nonlinear tariffs cannot reduce payoffs. In addition, the fact that upstream firms can use nonlinear tariffs does not increase the deviation profits, because the transfer to upstream firms must at least cover their costs (i.e. at least a unit cost of c_2 for firms different from I_1). Finally, in the punishment phase, nonlinear tariffs cannot make the punishment harsher (in the case of linear tariffs, the continuation value of firm is already set at the security level of zero). Thus nonlinear tariffs cannot increase the critical discount factor in case of vertical integration.

Now, without vertical integration, we can show (see the following paragraph) that the possibility to use upstream two-part tariffs cannot decrease the critical discount threshold, δ^{NI}. Hence, the main result that vertical integration generally helps to sustain collusion is preserved.

The intuition for the non decreasing effect of nonlinear tariffs on δ^{NI} is as follows. When there is no vertical merger and no collusion, a two-part tariff cannot increase the upstream profits, because of downstream Bertrand competition. On the other hand, when downstream firms collude, the most efficient upstream firm U_1 could increase its profits proposing a non-linear tariff. In this case, the best contract that U_1 can propose is a linear fee $w = c_1$ and $T = \frac{1}{N}(\pi^m_{c_1} - \pi^m_{c_2})$. Such a T is the maximum fixed fee that the upstream U_1 can extract without inducing downstream firms to choose an alternative upstream provider. In this case the collusive profits left to the downstream firms are the same as with linear tariffs ($\frac{1}{N}\pi^m_{c_2}$) with a collusive price $p^m_{c_1}$, but the deviation profits are higher (because the marginal unit can be bought at c_1). As a result, the critical discount factor above which collusion is feasible is larger than δ^{NI}. Then, two-part tariffs make collusion under the benchmark case of no merger even more difficult, reinforcing our result.[8]

4 Conclusion

The paper shows that in a simple double oligopoly context vertical integration generally increases the feasibility of downstream collusion. Using maximal punishments firms can enforce

[8]More complicated nonlinear tariffs could possible decrease the critical discount factor. For instance, we can imagine that the upstream firm might propose a tariff with two kinks of the type $w = c_1$ and $T = \frac{1}{N}(\pi^m_{c_1} - \pi^m_{c_2})$ for quantities $q_i \leq \frac{1}{N}Q^M(c_1)$, and a linear tariff $w = c_2$ otherwise. However, these more complicate schemes cannot push the critical discount factor as low as the one obtained under vertical integration, because the presence of a fixed tariff makes a deviation from the collusive scheme less attractive to downstream firms.

a collusive outcome more easily when vertical integration takes place. As such, our results contribute to the debate on coordinated effects of mergers. In this context, the analysis of factors which facilitate collusion is meant to inform merger policy decisions: a vertical merger could help firms to facilitate collusion in contexts in which previous attempts revealed ineffective. For instance, the European merger guidelines recognize that evidence of past coordination is an important element when evaluating the coordinated effect of merger. Similarly, the US guidelines indicate past price wars as a possible indicators of failed attempts to collude. Our analysis shows that a vertical merger can indeed be a way for firms to increase the feasibility of collusion and make it successful in these kind of markets. As a consequence, the potential collusive impact of vertical integration on the downstream market should be taken into account when attempting to establish if a merger is likely to create or strengthen collusion.

The welfare effect of vertical integration is generally ambiguous. However, our framework allows to identify instances in which a vertical merger, creating new collusion opportunities, has a welfare reducing effect.

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Appendix A1: Proof of Proposition 1

Let us consider the following collusive agreement which makes more precise elements already introduced in section 3.2.

In stage 1, I_1 makes a proposal to other downstream firms, selling to each of them a quantity $\frac{1-\varepsilon}{N} q_{c_1}^m$ (with $\varepsilon > 0$ and arbitrarily small) at a price c_1 and an unlimited quantity at price c_2.

In stage 2, each downstream firm i with $i \neq 1$ accepts the offer of the integrated firm U_1.

In stage 3, all the firms propose a price equal to $p_{c_1}^m$.

In stage 4, the division of the market is as follows. Firm U_1 sells a quantity $\frac{1+(N-1)\varepsilon}{N} q_{c_1}^m$ and all the other downstream firms sell a quantity equal to $\frac{1-\varepsilon}{N} q_{c_1}^m$.

For the time being, assume that after a deviation from this collusive agreement, there is an optimal punishment such that the deviator gets zero profit in all the remaining periods of the game (we will prove this later on).

But let us focus on the deviation profit. If a firm deviates from the collusive agreement, it can propose a price arbitrarily close to $p_{c_1}^m$ and sell a quantity arbitrarily close to $q_{c_1}^m$. If U_1 makes such a deviation, it will obtain a profit arbitrarily close to $\pi_{c_1}^m$. If another downstream firm makes such a deviation, it will buy the first $\frac{1-\varepsilon}{N} q_{c_1}^m$ units of the intermediate good at price c_1 and the other units at a price c_2 so that its deviation profit is strictly smaller than $\pi_{c_1}^m - \frac{N-1+\varepsilon}{N} q_{c_1}^m (c_2 - c_1)$ and the firm prefers not to deviate if

$$\frac{\frac{1-\varepsilon}{N} \pi_{c_1}^m}{1-\delta} \geq \pi_{c_1}^m - \frac{N-1+\varepsilon}{N} q_{c_1}^m (c_2 - c_1) \tag{2}$$

If we denote $K = \frac{N-1+\varepsilon}{N} q_{c_1}^m (c_2 - c_1) > 0$, this condition can be rewritten:

$$\delta \geq 1 - \frac{1}{N} \frac{1-\varepsilon}{1 - \frac{K}{\pi_{c_1}^m}} \tag{3}$$

Since $K > 0$, there exists an ε sufficiently small such that $\frac{1-\varepsilon}{1-\frac{K}{\pi_{c_1}^m}} > 1$ so that:

$$1 - \frac{1}{N} \frac{1-\varepsilon}{1 - \frac{K}{\pi_{c_1}^m}} < 1 - \frac{1}{N} = \underline{\delta}^{NI} \tag{4}$$

Now, if firm 1 deviates, it can obtain a profit arbitrarily close to $\pi_{c_1}^m$ so that it prefers not to deviate if

$$\frac{\frac{1+(N-1)\varepsilon}{N} \pi_{c_1}^m}{1-\delta} \geq \pi_{c_1}^m \tag{5}$$

equivalent to

$$\delta \geq 1 - \frac{1}{N} - \frac{N-1}{N}\varepsilon \qquad (6)$$

With $1 - \frac{1}{N} - \frac{N-1}{N}\varepsilon < \underline{\delta}^{NI}$.

Eventually, we need to build an equilibrium such that after a deviation by any firm, the continuation payoff of the deviating firm will be equal to zero.

We can easily build equilibrium strategies such that if D_j with $j \neq 1$ deviates from the collusive behavior, its profit in all the following periods is equal to zero. For instance, this is the case if, after such a deviation, U_1 and U_2 and all the downstream firms propose a price equal to c_2 in all the posterior periods (assuming, for instance, that U_1 sells all the units).

We can also propose equilibrium strategies such that I_1's continuation payoff is equal to zero after a deviation, thus ensuring maximal punishment also to the integrated firm. Suppose that, after a deviation by I_1, in all the posterior periods, the non integrated firms choose an upstream offer different than the one of firm I_1. Then, on the downstream market, $p_1 = p_2 = c_1$ and $\forall j > 2$, $p_j > c_1$ for any value of the vector $(w_1, ..., w_M)$ and the equilibrium allocation rule is such that D_1 sells a quantity $Q(c_1)$ of the final good and D_2 sells zero unit of the final good. Without even specifying the value of $(w_1, ..., w_M)$, in this equilibrium, all the players obtain a continuation payoff equal to zero. I_1 cannot profitably deviate since if it chooses a price $p_1 < c_1$, it will lose money and if it chooses $p_1 > c_1$, it will not sell anything neither to final consumers nor to any downstream firm.

Q.E.D.

Appendix A2: Proof of Proposition 2

Let us consider the following collusive agreement.

In stage 1, I_1 makes a proposal to other downstream firms, selling to each of them a quantity $\frac{1-\alpha}{N-1}Q(p^{col})$, with $\alpha \in (0,1)$ at a price c_1 and an unlimited quantity at price c_2.

In stage 2, each downstream firm i with $i \neq 1$ accepts the offer of U_1.

In stage 3, all the firms propose a price equal to $p^{col} \in (c_2, p^m_{c_1})$.

In stage 4, the division of the market is as follows. Firm U_1 sells a quantity $\alpha Q(p^{col})$ an all the other downstream firms sell a quantity equal to $\frac{1-\alpha}{N-1}Q(p^{col})$.

Again, let us assume that after a deviation by any firm, its continuation profit in the following periods is equal to zero (we will go back to this issue later on).

I_1's collusive profit is $\frac{\alpha Q(p^{col})(p^{col}-c_1)}{1-\delta}$ and its maximum deviation profit is arbitrarily close to $Q(p^{col})(p^{col} - c_1)$ so that a deviation is not profitable for I_1 as long as $\delta > 1 - \alpha$.

The collusive profit of firm j with $j \neq 1$ is

$$\frac{(1-\alpha)Q(p^{col})(p^{col} - c_1)}{(N-1)(1-\delta)} \tag{7}$$

And its deviation profit is arbitrarily close to:

$$\frac{(1-\alpha)Q(p^{col})(p^{col} - c_1)}{N-1} + (1 - \frac{1-\alpha}{N-1})Q(p^{col})(p^{col} - c_2) \tag{8}$$

So that a deviation is not profitable for D_i as long as

$$\delta > (\frac{(N-2+\alpha)(p^{col} - c_2)}{(1-\alpha)(p^{col} - c_1) + (N-2+\alpha)(p^{col} - c_2)} \tag{9}$$

This value tends towards zero when p^{col} tends towards c_2, for any strictly positive value of α. Then, as p^{col} becomes closer to c_2, it is possible to raise α closer to 1 so that both I_1 and the other downstream firms prefer cooperating than deviating in a collusive equilibrium with a collusive price p^{col} for any strictly positive value of δ.

Now, regarding continuation payoffs after a deviation, we can use exactly the same arguments as in the proof of Proposition 1 in order to prove that it is possible to define an equilibrium such that after a deviation by any firm, its continuation payoff is equal to zero.

Q.E.D.

Appendix A3: Proof of Proposition 3

To prove Proposition 3 we have to show that the maximum collusive price is decreasing in δ. Let us consider a $\hat{\delta} < \underline{\delta}^I$ and $\hat{p}$ the maximum collusive price that can be sustained with $\delta = \hat{\delta}$. We intend to prove that for a $\delta > \hat{\delta}$, it is possible to sustain a collusive equilibrium with a price strictly higher than $\hat{p}$.

First, by definition of $\underline{\delta}^I$, we know that $\hat{p} < p^m_{c_1}$.

Second, following the same continuation strategies as the one we mentioned in the proof of Proposition 1, we know that it is possible to build equilibrium continuation payoffs such that the deviating firm obtains zero profit after the deviation so that for any firm i:

$$\frac{\alpha_i(\hat{p} - c_1)Q(\hat{p})}{1-\hat{\delta}} \geq \pi_i^d(\hat{\delta}, \hat{p}) \tag{10}$$

with α_i the share of the collusive profit obtained by firm i and $\pi_i^d(\hat{\delta}, \hat{p})$, the maximum profit that firm i can obtain by deviating from the collusive behavior.

Now, let us consider the situation with a discount factor $\tilde{\delta} > \hat{\delta}$. Suppose that firms follow the same behavior as in a collusive equilibrium with discount factor $\hat{\delta}$ and a collusive price $\hat{p}$. From the previous inequality, we derive that for any firm i:

$$\frac{\alpha_i(\hat{p} - c_1)Q(\hat{p})}{1 - \tilde{\delta}} > \pi_i^d(\hat{\delta}, \hat{p}) \tag{11}$$

Then, by a continuity argument, we know that there exists a $\tilde{p} \in (\hat{p}, p_{c1}^m)$ such that, for any firm i:

$$\frac{\alpha_i(\tilde{p} - c_1)Q(\tilde{p})}{1 - \tilde{\delta}} > \pi_i^d(\tilde{\delta}, \tilde{p}) \tag{12}$$

Again,we know that, for any collusive agreement, it is possible to build equilibrium continuation payoffs such that the deviating firm obtains zero profit after the deviation. Therefore, this inequality ensures that when the discount factor is equal to $\tilde{\delta}$, there exists a collusive equilibrium with a price $\tilde{p}$ strictly higher than $\hat{p}$.

Q.E.D.

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