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Collusion and downstream entry in a vertically integrated industry

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Collusion and downstream entry in a vertically integrated industry

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Abstract

We analyse the impact of an entry threat at the downstream level on the ability of a pair of vertically integrated incumbents to collude. We present an original model of horizontal product differentiation on the final market and characterize the structures of this market for which an entry threat facilitates collusion between incumbents. While the entry threat leaves collusion and deviation profits unchanged, it lowers profits in punishment periods. Consequently, an entry threat discourages deviations and facilitates collusion, thus benefiting incumbents.

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1 Introduction

The characterization of the impact of an entry threat on the ability of incumbents to collude can be deduced from a standard result of comparative statics in collusion models. Consider an infinitely repeated game of homogeneous Bertrand competition between n firms. These firms maximize joint-profits and thus charge the monopoly price and share monopoly profits. A deviating firm captures the entire monopoly profits for one period. Then, firms play the static Bertrand equilibrium, with zero profits, for ever. For collusion to be an equilibrium of the game, the discount factor must be at least equal to a threshold called the critical discount factor. The comparative statics result is that this critical discount factor increases with n .¹ As the number of firms in the industry increases, the deviation and punishment profits remain unchanged, but

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¹This threshold is given by the following inequality:

$$\frac{1}{1-\delta}\pi^K \geq \pi^D + \frac{1}{1-\delta}\pi^P$$

the individual collusive profit decreases. The monopoly profit is shared between a larger number of firms. Collusion becomes more difficult as n increases in the sense that the collusive price is the same but the critical discount factor is larger. Now consider a Bertrand oligopoly with m incumbents and l potential competitors. All firms are equally efficient and there is no entry cost. If the incumbents collude, potential competitors enter the market. A collusive equilibrium in the post-entry Bertrand game can emerge but only if the discount factor is larger than the new, higher critical factor induced by the increase in the number of firms. Entry may thus lead to the breakdown of the collusive scheme with monopoly pricing. In this case, collusion is still possible but for a lower collusive price that does not allow firms to maximize joint-profits. Entry thus either has no impact on the ability to collude (large discount factor) or makes collusion more difficult.

The previous analysis ignores the possibility that the colluding incumbents may be vertically integrated. This raises the question of whether the conclusions of this analysis still hold for industries in which colluding firms are vertically integrated and may sell to other downstream firms, which are strategic buyers with interdependent demands. The stakes are significant since such various sectors as telecommunication services, gasoline or luxury goods retailing and mobile phones production are in this situation. The non-horizontal merger guidelines published by the European Commission (European Commission (2008)) point at a specificity of this industrial structure: integrated incumbents may raise barriers to entry in order to reduce the competitive pressure exerted on the cartel by entrants.² They may protect their market and maintain collusion, so that the negative impact of potential competition on collusion is weaker than in non-integrated industries. In this paper, we show that there is more than this to say: when incumbents are vertically integrated, potential competition may actually facilitate collusion in the sense that the collusive price is not reduced and the critical discount factor is lower. In our model, the entry threat leaves incumbents' collusive profits unchanged. It also does not create new opportunities for deviation from the collusive scheme. However, the punishment profits are lower and this is why collusion is easier to sustain. In fact, the entrants are used by incumbents as a way to make punishment tougher in case of a deviation.

In 2005, the French antitrust authority fined the three Mobile Network Operators (MNOs) present on the French market for mobile phone services (Orange

in which collusive profit, deviating profit and punishment profit are respectively $\pi^K = \frac{\pi^M}{n}$, $\pi^D = \pi^M$ and $\pi^P = 0$. By replacing profits by these values, we get:

$$\delta \geq 1 - \frac{1}{n}.$$

² "Vertical mergers may reduce the scope for outsiders to destabilise the coordination by increasing barriers to enter the market or otherwise limiting the ability to compete on the part of outsiders to the coordination." (European Commission (2008), §89) Riordan (2008) suggests a similar interpretation of section 4.21 of the US guidelines (US Department of Justice (1984)) by discussing it in a section devoted to the impact of vertical integration on collusion. However, section 4.21 is not devoted to this point, which is discussed in section 4.22 of the guidelines.

France, Bouygues Télécom and SFR) for an anticompetitive agreement (Conseil de la concurrence (2005)). Three years later, the authority issued a report in which it noted the very limited development of Mobile Virtual Network Operators (MVNOs) on the French market as compared to other countries such as Germany and related it to the very restrictive conditions offered to them by the three Mobile Network Operators for access to their networks (Conseil de la concurrence (2008)). MVNOs are typically in the situation of downstream firms willing to enter the market for mobile phone services, but that do not have their own network - they are not vertically integrated - and thus need access to the network of at least one incumbent. The 2008 report does not discuss collusion between the MNOs, but since the market conditions were not substantially different from the conditions in 2005, it seems reasonable to assume that they were favorable to collusion. Based on the European Commission guidelines, it is tempting to wonder if the very restrictive conditions offered by MNOs to MVNOs were not part of a broader scheme aiming at protecting a collusive market from entry. The fact that entry was not entirely prevented may result from a desire not to attract the attention of the authority or the telecommunications regulator on collusion or from the pressure exerted by the regulator on MNOs. Our analysis suggests another story. The MVNOs may be used by the MNOs to reinforce their collusive agreement by worsening the punishment in case of deviation by one of the MNOs. The MNOs are on the market and, although their market shares are very low, they may expand very fast once they are offered favorable conditions by MNOs. This is what would happen if collusion breaks down after a deviation. Then, rather than entering in an infinite repetition of the non-collusive one-shot game with three firms, the MNOs would have to share the market with the MVNOs, leading to much lower profits for them.³

The structure of the paper is as follows: in the next section, we discuss the related literature and several relevant cases. Then, in section 3, we present the general model. Section 4 presents the benchmark case in which incumbents face no entry threat. Section 5 presents the resolution of the general model and the main results. Section 6 concludes.

2 Literature and relevant cases

We could not find any academic literature on collusion, vertical integration and (downstream) entry considered simultaneously. The related literature considers either entry and vertical integration or collusion and vertical integration. We successively discuss these two strands of literature jointly with examples.

³The 2005 case is still pending by the Cour de Cassation, the highest court in the French legal system, and is thus not definitive. Our discussion here is just illustrative. We are not accusing the firms of any violation of antitrust laws. Rather, we want to stress the benefits that could be reached by considering together cases that the authority must deal with in separate ways for legal reasons or because of the chronology.

2.1 Vertical integration and downstream entry: the foreclosure issue

The analysis of the relation between vertical integration and downstream entry has been focused on the foreclosure issue for more than twenty years. The foreclosure story is very simple to tell. Consider a vertically integrated firm that is a monopolist on the intermediate market and faces a potential competitor on the final market. The entrant needs the intermediate good to produce the final good and can purchase it only from the integrated incumbent. Unless downstream firms are sufficiently differentiated or the incumbent faces a narrow capacity constraint on the final market, the incumbent has no incentive to supply the entrant. The entrant is thus unable to enter and the incumbent remains in a monopoly position. While foreclosure may result from a refusal to deal with the entrant, the same result may be achieved by charging the entrant a very high price. There is no real difference between foreclosure and vertical price squeeze. As simplistic as this story may seem, there are real world examples of such practices. One is an Australian case decided in 1988 by the High Court of Australia in which Queensland Wire Industries (QWI) was opposed to The Broken Hill Proprietary Company (BHP) (High Court of Australia (1988)). BHP was a quasi-monopolist on the Australian market for steel products. In particular, it was producing "Y bars" that it used to elaborate a type of fencing that was highly appreciated by farmers. QWI wanted to enter this market and asked BHP for the prices of "Y bars". The answer was that BHP was not selling "Y bars". Later on, they presented QWI with an offer, but it was based on unreasonably high prices. QWI sued BHP for violation of the Australian antitrust laws and the High Court of Australia ultimately decided that BHP had to sell Y bars to QWI at a reasonable price.⁴ The Clear-Telecom dispute is another, well-known case of foreclosure. When liberalizing its telecommunication markets, New Zealand considered that there was no need to create a specific regulator for the sector and that antitrust laws were sufficient to allow entrants to overcome any barrier to entry that the historic operator, Telecom, may erect. Clear tried to enter the market for phone services for firms and needed to reach an agreement with Telecom for the termination of phone calls originating from its clients willing to connect with clients of Telecom. Telecom's offer to Clear turned out to be everything but reasonable and this started a legal battle that was very long and consumed lots of resources, so that finally New Zealand decided that a regulator was needed for the telecommunications sector. Actually, the existence of a regulator is not a guarantee that antitrust problems will vanish and there are lots of antitrust cases in regulated sectors. The Deutsche Telekom and Wanadoo Interactive cases (European Commission (2003a,b)) are typical for such cases and reading the decisions shows how his-

⁴There were actually two suits before the case reached the High Court of Australia and in these first two suits BHP prevailed, the court considering that there was no abuse on the market for Y bars because this market did not exist. The High Court of Australia rightly observed that the fact that the market did not exist was a consequence of a particularly severe violation of antitrust laws.

torical operators in Germany and France used administrative strategies to resist the regulator's demand for reasonable interconnection charges and, ultimately, to delay entry on their downstream markets.

The liberalization of key sectors of the economy in many countries generally created such structures in which a vertically integrated incumbent faces entry on downstream markets. The foreclosure issue is however not limited to these structures. It may also apply to situations in which there is imperfect competition both upstream and downstream. It must be noted however that the theory of foreclosure is then far from straightforward. Since Ordover et al. (1990), the debate focuses on the ability of an integrated firm to commit to foreclosure when upstream rivals may supply the downstream entrant. Contributions to this debate include Avenel and Barlet (2000), Choi and Yi (2000), Chen (2001) and Avenel (2008).⁵ The evidence is mixed. Supermarkets used to be entrants in the retail market for gasoline. They managed to enter and are now well-established on the market, while still non-integrated and competing with integrated majors. On the contrary, they failed, at least in France, in their attempt to enter the market for luxury goods, like high quality perfumes, as well as the market for cars. The recently announced merger between Google and Motorola raises worries about the possibility that some producers of mobile phone may be driven out of the market as a consequence of the merger (Catan (2011)). Google makes one of the mobile operating systems (Android) that makers of smartphones, such as Motorola, use as an input. There is a risk that smartphone making competitors of Motorola that used to rely on Android may loose access to the latest versions of Android and may not be able to switch to another operating system, in particular because several are also produced by vertically integrated firms such as Apple. This type of anticompetitive effects of a vertical merger are clearly identified both by the 1984 Non-horizontal merger guidelines of the US Department of Justice (US Department of Justice (1984), section 4.21) and by the 2008 Non-horizontal merger guidelines of the European Commission (European Commission (2008), section IV.A).

2.2 Vertical integration and collusion

In several instances, collusion between vertically integrated firms was either proved or strongly suspected. French mobile network operators are a typical example. As discussed above, the three firms were found guilty of illegal collusion in 2005 (Conseil de la concurrence (2005)). This led to the government's decision to issue a fourth licence. The licence was purchased by a maverick, Free Mobile, which launched its service in January 2012 with prices about half the incumbents' prices. Another sector in which vertical integration is important and collusion was regularly alleged is gasoline retailing. Allegations of collusion in this sector are triggered by the fact that prices experience regular simultaneous upward jumps and then go down only very slowly until the next upward jump. The simultaneity of competing firms' price movements is often perceived as an

⁵See Rey and Tirole (2007) for a primer on these issues.

indication of collusion. The issue here is that of parallelism of behavior and its legal treatment.⁶ In a recent report, the German antitrust authority concluded that the German retail gasoline market is collusive (Bundeskartellamt (2009, 2011a, 2011b)). The possibility that there may actually be a causal relation between the degree of vertical integration in a sector and the emergence of collusion in this sector is explicitly acknowledged in the US Department of Justice Non-horizontal merger guidelines (US Department of Justice (1984), section 4.22) and in the European Commission Non-horizontal merger guidelines (European Commission (2008), section IV.C). As regards the academic literature, this possibility has recently been examined in two papers.

Nocke and White (2007) analyze the impact of vertical integration on collusion between upstream firms. The focus on collusion between upstream firms may seem to be an essential difference with our contribution, but it is not. Indeed, in their paper, downstream divisions of vertically integrated firms participate in the collusive scheme and, in particular, do not play best replies to their non-integrated rivals' strategies on the final market. In the specific case in which every upstream firm is integrated, vertically integrated firms collude on both markets, while non-integrated downstream firms play non-collusive prices (or quantities). This is similar to our contribution. It is worth noting, however, that this is not the structure the authors consider with the most attention. Rather, they focus on the comparison between the case in which no upstream firm is integrated and the case in which one upstream firm is integrated. Then, they discuss further vertical integration, but do not pay much attention to the full vertical integration case that we consider here. The most important difference is however in the structure of the downstream industry. Nocke and White assume that the demand system is symmetric, so that monopoly profits can be obtained with downstream firms charging the same price and selling the same quantity. In this symmetric downstream industry, all the firms are incumbents and, actually, there would be no benefit for upstream firms, even integrated ones, to exclude any downstream firm from the market. In our model, the downstream industry is asymmetric, with two different types of markets served by two different types of firms. Incumbents operate on highly profitable markets in which consumers are willing to pay high prices for the good. Furthermore, the incumbents are vertically integrated, so that their presence on the market cannot be challenged by vertical foreclosure. Entrants operate on less profitable markets in which they cannot charge such high prices as the incumbents can do it on their markets. Furthermore, they are not vertically integrated and depend on the vertically integrated incumbents for access to the essential input and thus to be able to enter the market. Since entrants would charge low prices upon entry, they would attract part or all of the incumbents' consumers, especially if the incumbents charge high prices. Due to this, joint-profits maximization

⁶Price dynamics in this sector fit quite well the definition of Edgeworth cycles. While Edgeworth cycles are discussed from a theoretical point of view in Maskin and Tirole (1988), Noel (2007) provides an empirical analysis of Edgeworth cycles in Toronto retail gasoline market and a very interesting and quite critical discussion of the allegations of collusion in the retail gasoline market.

by the incumbents requires that the entrants stay out of the market. While in Nocke and White (2007) intermediate prices are used by incumbents to limit the intensity of competition between downstream firms, in our model they are used to prevent entry on the less profitable markets and preserve monopoly profits on the more profitable markets for the incumbents. To sum up, also there are similarities in the modelling of collusion between vertically integrated firms, Nocke and White (2007) focus on collusion between upstream firms and make simplifying assumptions on downstream market competition, while we focus on collusion on the final market and pay much attention to the characterization of competition between incumbents and entrants on this market. While differing from Nocke and White (2007), in particular because of the assumption of linear prices on the intermediate market, Normann (2009) shares the characteristics of Nocke and White's paper that make it different from our contribution. In particular, the issue of downstream entry is absent from the analysis. Rather, the downstream industry is composed of incumbents and the demand system is symmetric.

3 The model

The industry is composed of two vertically integrated incumbents, I_A and I_B , and two non-integrated downstream potential competitors, E_a and E_b . The incumbents are equally efficient in the production of the intermediate good, with upstream production costs normalized to zero. Both incumbents thus procure the good internally. Then, they transform it into the final good on a one-to-one basis. We also normalize transformation costs to zero. Each incumbent offers a different variety of the final good: variety A for I_A and variety B for I_B . Consumers' preferences on these two varieties are heterogeneous. We consider two groups of consumers, group A and group B . A consumer in group A values variety A at V and variety B at $V - t$, where t is uniformly distributed on $[0; T]$. Similarly, consumers in group B value variety B at V and variety A at $V - t$. Groups A and B each have a mass equal to one. Consumers' preferences are heterogeneous both because consumers are split into two groups and because inside each group consumers differ in their disutility t of purchasing the alternative variety.

The entrants are as efficient as the incumbents in transforming the intermediate good into the final good, but they are not vertically integrated. Consequently, they need to purchase their inputs on the intermediate market. This means purchasing from I_A and/or I_B . On the final market, E_a and E_b act as competitive fringes and thus offer the product at marginal purchasing cost. E_a and E_b each have a captive demand. Consumers in group a (which is of mass one) value E_a 's product (variety a) at v and the product at any other location at zero. E_a may also sell to consumers in group A . Indeed, these consumers value a at $V - t - \sigma$, with $\sigma \geq 0$. It is more costly for a consumer in group A to purchase from E_a than to purchase from I_B . Moreover, if a consumer in group A is indifferent between purchasing from E_a and from I_B , we assume

that he purchases from I_B . Similarly, if a consumer in group B is indifferent between purchasing from E_b and I_A , he purchases from I_A . While consumers in groups a and b are not mobile, in the sense that they get a positive utility from consuming only one variety, consumers in group A may get a positive utility either from consuming variety A or variety B or variety a . Similarly, consumers in group B choose from B , A and b .⁷

This model can be interpreted as a model of geographic differentiation. A and B are two cities, each with a population normalized to one. In each city, there is an incumbent firm. A consumer in A purchasing from the local firm, I_A , gets a utility of V minus the price paid to the firm. If this consumers want to purchase from the firm located in B , it will support a transportation cost t . Then, his gross utility from variety B is identical to his gross utility from variety A . Since consumers differ in their transportation cost, they are more or less likely to travel to the other city to purchase the good. If I_A charges a lower price than I_B , all the consumers in A prefer purchasing from A to purchasing from B , while some consumers in B may prefer to purchase from A rather than from B . There are two other cities, a and b . The size of the population in each of these cities is the same as in A and B , but the preferences of consumers located in these cities differ from those of consumers located in A or B . The difference is twofold. First, their utility from consuming the good is lower. Second, they are not mobile. Either they purchase in their city or they do not purchase at all. This may be a consequence of a lower revenue in these cities, leading to a lower willingness to pay for the good as well as a lower mobility. Conversely, consumers in A are mobile and they consider the possibility to purchase in a . To do this, they face a larger transportation cost than to purchase in B . Our assumptions are compatible with a situation in which consumers travel by car and the driving distance between A and a is equal to the driving distance between A and B , but the road between A and a is a toll road. Here, σ is the toll that consumers have to pay to use the road. If a is closer to A than b , then consumers in A do not consider the opportunity to purchase in b , because they would get the same product for the same price, but they would face a larger transportation cost. Our assumptions are compatible with a situation in which consumers driving from A to b have to drive through a , while symmetrically consumers driving from B to a have to drive through b .

Since entrants may attract consumers from A and B , they are a real threat for incumbents. If entry occurs, the incumbents may have to reduce their prices in order to limit the number of consumers switching to the entrants. However, entry is not only a problem for incumbents. It is also a potential source of profits since the entrants are the incumbents' clients. While incumbents do not serve consumers in a and b , the entrants, to the contrary, do serve these consumers and thus extract from them a value that would be lost in their absence.⁸ Then, part

⁷ Assuming that consumers in group A may also purchase from E_b (and consumers in group B from E_a) would not change the analysis. In fact, it would make no difference to assume that there is only one entrant and that consumers in groups A and B may purchase from this unique entrant.

⁸ We ignore the possibility that incumbents may settle in markets a and b . Suppose that

of (in fact, with our assumptions, all of) this value is transferred to incumbents. Incumbents thus have incentives both to supply entrants and to foreclose them. Furthermore, incumbents are competing on the intermediate market, so that what they actually do is determined by the strategic interaction between them.

We assume that firms engage in an infinitely repeated game, in which, in each period, they play the following multistage game:

Stage 1 (wholesale market): I_A and I_B simultaneously offer a wholesale price to the entrants. These offers are non-discriminatory and publicly observed.⁹ We denote by w_A and w_B respectively the wholesale price offered by I_A and I_B .

Stage 2 (final market): I_A and I_B set the prices p_A and p_B for their varieties on the final market. Consumers make their decisions, given that E_a and E_b offer $w = \min(w_A, w_B)$. E_a and E_b purchase the product from the incumbent offering the lowest wholesale price. If both incumbents offer the same price, the demand of E_a and E_b is shared equally between I_A and I_B .

We analyze collusive schemes in which I_A and I_B collude on both wholesale and final prices. In the collusive scheme, I_A and I_B choose wholesale and final prices so as to maximize their joint profits in each period.¹⁰ In punishment periods, I_A and I_B play the non-cooperative equilibrium of the one-shot game. Deviations can take different forms. First, one of the firms may deviate in the second stage of the one-shot game (final market). Then, the punishment will start at the following period. Alternatively, a firm may deviate in the first stage of the one-shot game (wholesale market). For example, the collusive scheme may be based on foreclosure of entrants and firm A offers a wholesale price that allows entrants to compete on the final market. Such a deviation is observed by the other firm after the first stage and this latter will consequently adapt its final price in the second stage of the one-shot game within the same period: In stage 2, firms thus play the non-cooperative equilibrium of the final market price competition subgame. From the following period on, firms play the non-cooperative equilibrium of the one-shot game. When calculating the present value of profits, both firms use the same discount factor δ .

We restrict the set of parameters by assuming that $0 < T - \sigma \leq v \leq T \leq V/3$. These four assumptions can be interpreted as follows: $T - \sigma > 0$ (assumption 1) means that for at least some consumers in group A (resp. B) the cost of purchasing from E_a (resp. E_b) is less than twice the cost of purchasing from I_B (resp. I_A). $T - \sigma \leq v$ (assumption 2) guarantees that the price consumers in groups a and b are willing to pay for the good, and thus the profits that can be

downstream firms are supermarkets. The incumbents are backward integrated in the product of a specific food product. It would not make sense to settle a supermarket in a or b just because an incumbent wants to sell this specific product in these cities. The question is rather whether the incumbent should supply the supermarket already existing in a or b with this product. Here, the supermarket in a is operating in any case, selling many products, but it can sell the specific food product we consider only if it can purchase it from one of the incumbents.

⁹This amounts to assuming that entrants can resell the input to each other.

¹⁰We focus here on the issue of the sustainability of profit maximizing collusion. When this cannot be achieved, firms may reduce their profits in each period in order to sustain a collusive scheme with lower profits (collusion). We do not consider this here.

obtained by supplying them, are not too low. Assumption 3 ($v \leq T$) conversely imposes that it is not too large either. What is important in fact is the relative profitability of supplying groups a and b , on the one hand, and groups A and B , on the other hand. The combination of assumption 3 and assumption 4 ($T \leq V/3$) implies that it is much more profitable to supply groups A and B than groups a and b .¹¹ a and b are small, peripheral markets, but they are not negligible. What we show in the following sections is that assumptions 1 to 4 are sufficient conditions for the entry threat to facilitate collusion between the incumbents.

4 Benchmark: No entry threat

In order to determine the impact of an entry threat on collusion, we need to analyze the benchmark situation in which there is no entry threat. In the absence of an entry threat, we essentially have two vertically integrated firms procuring internally and colluding on final prices. The following proposition characterizes the equilibrium of the infinitely repeated game.

Proposition 1 *In the benchmark case, the equilibrium of the infinitely repeated game has the following properties: (i) in collusion periods, incumbents charge prices equal to V and get profits $\pi_A^K = \pi_B^K = V$, (ii) the most profitable deviation is to charge $p = V - T$ so that a deviating firm's profit is $\pi_A^D = \pi_B^D = 2(V - T)$ and (iii) in punishment periods, incumbents charge prices equal to T and get profits $\pi_A^P = \pi_B^P = T$.*

Proof. Since the collusive case is trivial, we consider here only the deviation and punishment cases, starting with deviation. Assume that I_A deviates from the collusive price and offers $p_A^D = V - d < V$. (Offering $p_A^D > V$ ($p_A^D \geq V$) would obviously not be a profitable deviation). Consumers located in A will purchase from I_A , while consumers located in B purchase from I_A if and only if $t < d$. The demand for I_A from consumers located in B is thus $\frac{d}{T}$. For $d = T$, I_A captures all the consumers from group B . Increasing d above T can only lower I_A 's profit. For $d \leq T$, $\pi_A^D = (1 + \frac{d}{T})(V - d)$. The deviation profit π_A^D is a concave function of d , which derivative at $d = T$ is strictly positive under assumption 4. So, I_A 's most profitable deviation is $d = T$, which allows I_A to capture all the group B consumers and leads to the deviation profit $\pi_A^D = 2(V - T)$.

Punishment profits correspond to the equilibrium of the one-shot game. Let us first calculate the demand addressed to I_A . If $p_A > p_B + T$, then $D_A = 0$ and $D_B = 2$. Consumers located both in B and in A purchase from I_B . If $p_B + T \geq p_A \geq p_B$, then $D_A = 1 - \frac{p_A - p_B}{T}$ and $D_B = 1 + \frac{p_A - p_B}{T}$. Consumers in B purchase from I_B . For a consumer in A , the utility of purchasing from I_A is $V - p_A$. The utility of purchasing from I_B is $V - p_B - t$. So, a consumer in A purchases from I_A iff $V - p_A \geq V - p_B - t$, which is equivalent to $t \geq p_A - p_B$.

¹¹In its analysis of the French market for mobile phone services (Conseil de la concurrence (2008)), the Conseil de la concurrence observed that MVNOs' market shares calculated on turnover were lower than their market shares calculated in terms of number of consumers.

The mass of consumers for which this condition holds is $1 - \frac{p_A - p_B}{T}$. If $p_B > p_A \geq p_B - T$, the demand for I_A is $D_A = 1 + \frac{p_B - p_A}{T}$ and $D_B = 1 - \frac{p_B - p_A}{T}$. Consumers in A purchase from I_A and consumers in B purchase from I_A iff $V - p_A - t > V - p_B$ iff $t < p_B - p_A$. If $p_A < p_B - T$, then $D_A = 2$ and $D_B = 0$. Consumers in A and B purchase from I_A . To sum up,

$$\begin{array}{lll} p_A < p_B - T & D_A = 2 & D_B = 0 \\ p_B + T \geq p_A \geq p_B - T & D_A = 1 + \frac{p_B - p_A}{T} & D_B = 1 - \frac{p_B - p_A}{T} \\ p_A > p_B + T & D_A = 0 & D_B = 2 \end{array}$$

Let us now determine I_A 's best reply to p_B . If $p_B \leq T$, then p_A cannot be strictly lower than $p_B - T$. I_A makes positive profits for $p_A \in [0; p_B + T]$. These profits are given by $\pi_A = p_A \cdot D_A = p_A \left(1 + \frac{p_B - p_A}{T}\right)$. This is maximal for $p_A = \frac{p_B + T}{2}$ which is interior to the interval of admissible values. Thus, I_A 's best reply to p_B is $BR_A(p_B) = \frac{p_B + T}{2}$. If $T < p_B \leq 3T$, then I_A will charge $p_A = \frac{p_B + T}{2}$ (which maximizes $p_A \left(1 + \frac{p_B - p_A}{T}\right)$) unless $\frac{p_B + T}{2} < p_B - T$. However, $p_B \leq 3T$ implies that $\frac{p_B + T}{2} \geq p_B - T$, so that $BR_A(p_B) = \frac{p_B + T}{2}$. If $3T < p_B \leq V$, then $\frac{p_B + T}{2} < p_B - T$. It is optimal for I_A to capture all the consumers located in B : $BR_A(p_B) = p_B - T$. If $p_B > V$, I_A is in a monopoly position on both locations. It is optimal for I_A to cover both markets. $BR_A(p_B) = V - T$. To sum up,

$$\begin{array}{ll} p_B \leq 3T & BR_A(p_B) = \frac{p_B + T}{2} \\ 3T < p_B \leq V & BR_A(p_B) = p_B - T \\ V < p_B & BR_A(p_B) = V - T \end{array}$$

I_B 's best reply is similarly defined. Best reply functions cross each other for $p_A = p_B = T$. Profits are $\pi_A = \pi_B = T$. ■

Given consumers' preferences, in collusion periods I_A and I_B maximize their joint profits by setting $p_A = p_B = V$. All the consumers in group A purchase the good from firm I_A (similarly for B), so that $\pi_A = \pi_B = V$. Incumbents extract all the value from the consumers. A deviation for a firm, say I_A , is to offer a price $p < V$. Observing a price $p_A^D < V$, consumers located in A will purchase from I_A . There is a negative price effect since they would also purchase at $p_A = V$. The positive quantity effect results from consumers in B switching to I_A . Under assumption 4, the optimal deviation is for I_A to charge a price low enough to capture all the group B consumers. Punishment profits correspond to the non-cooperative one-shot game. Competition on the final market drives prices and profits down to T . As in more standard models of price competition with horizontal differentiation, prices are strategic complements. I_A 's best reply is weakly increasing in p_B . As long as p_B is smaller than or equal to $3T$, the two firms share the total demand. For p_B smaller than T , I_A 's best reply is larger than p_B and consequently some consumers located in A purchase variety B . For p_B larger than T , I_A 's best reply is smaller than p_B and consumers move the other way. When I_B charges a price above $3T$, while below V , I_A charges $p_A = p_B - T$ and captures all the consumers located in B . Finally, if I_B charges

a price above V , I_A charges $p_A = V - T$ and also captures all the consumers. These situations however do not emerge in equilibrium. Crossing the best reply functions leads to $p_A = p_B = T$. The two firms share the market and, thanks to product differentiation, enjoy positive mark-ups, although these mark-ups are lower than in the collusive case.

We can now clarify the implications of assumption 1. If this assumption does not hold, entry has no impact on the equilibrium of the non-cooperative one-shot game. Suppose indeed that $\sigma \geq T$. Then, entry on the downstream market, even by a firm offering the product for free, would not lead any consumer located in A or B to purchase from the entrant. Assumption 1 thus implies that entry impacts the non-cooperative one-shot game equilibrium.

5 Collusion with an entry threat

Entry happens only if at least one of the incumbents offers to the entrants a wholesale price that allows them to compete. The level of wholesale prices is actually the central issue here. Essentially, this is the vertical foreclosure issue that we have to deal with in this section. If the wholesale price is below v , the entrants can supply consumers in a and b and this will generate profits for the incumbent from which they purchase. The negative side of this low wholesale price is that both incumbents will have to charge a lower final price. This means they will have to renounce to the monopoly price V . Alternatively, foreclosure protects markets A and B from competition by the entrants and allows incumbents to stick to the monopoly price. Incumbents deal with this issue very differently when they collude and when they compete. Colluding incumbents behave like a monopolist and maximize industry profits. Competing incumbents in general fail to maximize industry profits because they find it profitable to deviate from any strategy profile leading to joint-profits maximization. The following proposition characterizes the equilibrium of the game.

Proposition 2 (Equilibrium properties) *The equilibrium of the infinitely repeated game with an entry threat has the following properties: (i) in collusion periods, incumbents do not supply downstream entrants with input which results in complete vertical foreclosure, (ii) it is more profitable for an incumbent to deviate on the final market (lowering the price to consumers) than on the intermediate market (supplying downstream entrants) and (iii) in punishment periods, downstream entrants are supplied by incumbents at marginal cost.*

Proof. 1. Collusive one-shot game

I_A and I_B should not charge $w < v$. This would reduce their profits from the fringe markets and constrain their pricing strategies on markets A and B . So, $w \geq v$.

If $w > v$, then consumers in a and b are not served by the entrants. It is then optimal for I_A and I_B to neutralize the entrants by charging w sufficiently large for consumers in groups A and B not to purchase from entrants, that is,

$w \geq V$. Then, the incumbents can stick to the monopoly price V and enjoy profits $\pi_A = \pi_B = V$.

If $w = v$, then consumers in a and b are served, but p_A and p_B cannot be set at V . Indeed, consumers in A and B would all switch to the fringe: The utility for a consumer of type T in A from purchasing in A at V is 0, while his utility from purchasing from E_a at v is $V - v - T - \sigma > 0$. So, I_A and I_B should charge $p < V$. The optimal p belongs to the interval $[v + \sigma; v + \sigma + T]$. Indeed, for $p \leq v + \sigma$, no consumer in groups A and B purchases from entrants. There is no point pricing less than this threshold value. For $p > v + \sigma + T$, all the consumers in groups A and B purchase from the fringe. The incumbents thus make zero profit. Prices above this threshold value are irrelevant. For $p \in [v + \sigma; v + \sigma + T]$, $\pi_A = v + p \left(1 - \frac{p-v-\sigma}{T}\right) + v \left(\frac{p-v-\sigma}{T}\right)$. This is maximal for $p = v + \frac{\sigma+T}{2}$, which belongs to $[v + \sigma; v + \sigma + T]$ since $\sigma < T$ (Assumption 1). This leads to $\pi_A = 2v + \frac{(\sigma+T)^2}{4T}$. For $\sigma < T$ (Assumption 1), $2v + \frac{(\sigma+T)^2}{4T} < 2v + T$, which is smaller than or equal to V because $v \leq T$ (Assumption 3) and $3T \leq V$ (Assumption 4). Consequently, in the collusive equilibrium of the one-shot game, the entrants are foreclosed. Incumbents maintain the collusive price they should adopt in the absence of an entry threat and block entry by refusing to supply entrants with the intermediate good.

2. Non-cooperative one-shot game

The non-cooperative one-shot game is a two-stage sequential game that we solve backwards. The equilibrium of stage 2 subgames is presented in the following lemma.

Lemma 1 *Equilibrium prices on markets A and B in the stage 2 subgames depend on w as follows:*

For $w \geq T - \sigma$, $p_A = p_B = T$.

For $w < T - \sigma$ and $w_A < w_B$, $p_A = \frac{\sigma+T}{2} + w$ and $p_B = \frac{\sigma+T}{2} + \frac{1}{2}w$ (and symmetrically for $w_B < w_A$).

For $w < 2(T - \sigma)$ and $w_A = w_B$, $p_A = p_B = \frac{\sigma+T}{2} + \frac{3}{4}w$.

Proof. First consider the case where $p_A \leq \sigma + w$. Then, no consumer from groups A and B purchases from entrants. I_B is competing only with I_A and thus plays $p_B = BR_B(p_A)$. Similarly, I_A competes only with I_B and thus plays $p_A = BR_A(p_B)$. Consequently, it must be the case that $p_A = p_B = T$. If $w \geq T - \sigma$, it is an equilibrium. Conversely, for $w < T - \sigma$, there is no equilibrium such that $p_A \leq \sigma + w$ or $p_B \leq \sigma + w$.

When $p_A > \sigma + w$ and $p_B > \sigma + w$, each incumbent competes with an entrant and thus plays its best reply to $\sigma + w$. As a consequence, prices are as follows:

$$\begin{aligned} \text{If } w_A = w_B, p_A = p_B &= \frac{T+\sigma}{2} + \frac{3}{4}w, \\ \text{If } w_A < w_B, p_A &= \frac{T+\sigma}{2} + w \text{ and } p_B = \frac{T+\sigma}{2} + \frac{1}{2}w, \\ \text{If } w_A > w_B, p_A &= \frac{T+\sigma}{2} + \frac{1}{2}w \text{ and } p_B = \frac{T+\sigma}{2} + w. \end{aligned}$$

For the conditions $p_A > \sigma + w$ and $p_B > \sigma + w$, to be satisfied, it must be that $w < T - \sigma$ or $w_A = w_B < 2(T - \sigma)$. Note that, for $T - \sigma \leq w < 2(T - \sigma)$, there are two equilibria in stage 2 when $w_A = w_B$. ■

The equilibrium of the game is presented in the following lemma.

Lemma 2 *The non-cooperative one-shot game has a unique subgame perfect Nash equilibrium in which:*

$$w_A = w_B = 0, \quad p_A = p_B = \frac{T + \sigma}{2} \quad \text{and} \quad \pi_A = \pi_B = \frac{(T + \sigma)^2}{4T}.$$

Proof. We proceed by eliminating any other candidate equilibrium and then show that $w_A = w_B = 0$ and $p_A = p_B = \frac{T + \sigma}{2}$ is an equilibrium. Let us first consider $w \geq 2(T - \sigma)$. Then, $p_A = p_B = T$. Profits depend on whether w is above or below v . If $w > v$, then consumers in a and b do not purchase the good. If one of the incumbents, say I_A , deviates and offers $w_A = v \geq T - \sigma$, final prices will not change and I_A will get profits $2v$ from supplying the entrants. If $w \leq v$, then at least one of the incumbent finds it profitable to undercut its rival on the intermediate market. If $w = w_A < w_B$, then I_B can offer $w - \varepsilon$, which does not impact on final prices in stage 2 and allows I_B to get profits from the entrants. If $w = w_A = w_B$, then I_B can offer $w - \varepsilon$, which does not impact on final prices in stage 2 and allows I_B to get all the profits from the entrants rather than sharing these profits with I_A .

Let us now examine $w \in (T - \sigma; 2(T - \sigma))$. If one of the incumbents offers a wholesale price strictly lower than the other, the proof is similar to the previous case. However, if $w = w_A = w_B$, we have to consider the two possible equilibria in stage 2. When incumbents play $p_A = p_B = T$ in stage 2, the proof is again similar to the previous case. Let us thus focus on the case when in stage 2 incumbents play $p_A = p_B = p = \frac{T + \sigma}{2} + \frac{3}{4}w$. If $w \leq v$, $\pi_A = p(1 - \frac{p - w - \sigma}{T}) + w(\frac{p - w - \sigma}{T}) + w$, or equivalently, $\pi_A = \frac{T}{4} + 2w - \frac{w^2}{16T} + \frac{\sigma}{2} + \frac{\sigma^2}{4T}$. Slightly undercutting I_B on the intermediate market and offering $w - \varepsilon$ leads to $p_A = p_B = T$ in stage 2 and $\pi_A^D = T + 2w - 2\varepsilon$. The deviation is profitable iff $\frac{T}{4} + 2w - \frac{w^2}{16T} + \frac{\sigma}{2} + \frac{\sigma^2}{4T} < T + 2w$ or equivalently $\frac{3T}{4} + \frac{w^2}{16T} - \frac{\sigma}{2} - \frac{\sigma^2}{4T} > 0$. Since $w < 2(T - \sigma)$ means $\sigma < T - \frac{w}{2}$, we have $\frac{3T}{4} + \frac{w^2}{16T} - \frac{\sigma}{2} - \frac{\sigma^2}{4T} > \frac{1}{2}w > 0$. The deviation is thus profitable. If $w > v$, consumers from groups a and b do not purchase the good. $\pi_A = p(1 - \frac{p - w - \sigma}{T}) + w(\frac{p - w - \sigma}{T}) = \frac{T}{4} + w - \frac{w^2}{16T} + \frac{\sigma}{2} + \frac{\sigma^2}{4T}$. A possible deviation for A is to offer $w_A = v$. This leads to $p_A = p_B = T$ in stage 2 and $\pi_A^D = T + 2v$. This deviation is profitable iff $\frac{T}{4} + w - \frac{w^2}{16T} + \frac{\sigma}{2} + \frac{\sigma^2}{4T} < T + 2v$ or equivalently $\frac{3T}{4} + 2v - w + \frac{w^2}{16T} - \frac{\sigma}{2} - \frac{\sigma^2}{4T} > 0$. Since $\sigma < T - \frac{w}{2}$, $\frac{3T}{4} + 2v - w + \frac{w^2}{16T} - \frac{\sigma}{2} - \frac{\sigma^2}{4T} > 2v - \frac{w}{2}$. Given that $\sigma \geq T - v$, $2v - \frac{w}{2} > 0$ and the deviation is profitable. There is no equilibrium such that $w \in (T - \sigma; 2(T - \sigma))$.

Let us now consider $w = T - \sigma$. If $w_A < w_B$, then $\pi_B = T$. Offering $w_B^D = w_A$ leads to $\pi_B^D = T + w > \pi_B$. If $w_A = w_B$ and $p_A = p_B = \frac{T + \sigma}{2} + \frac{3}{4}w$, then the proof is as in the previous case. If $w_A = w_B$ and $p_A = p_B = T$, then $\pi_B = T + w$. If I_B undercuts I_A and offers $w_B^D = w - \varepsilon$, it gets a profit π_B^D such that $T\pi_B^D \sim (\frac{T + \sigma}{2})^2 + (\frac{T + \sigma}{2} + 3T - \sigma)w - \frac{1}{2}w^2 > T^2 + wT$. The deviation is profitable.

Finally assume that $w < T - \sigma$. Since $T - \sigma \leq v$, consumers from groups a and b purchase the good. First assume that $w_A = w_B = w$. $\pi_A = p_A \left(\frac{T + \sigma + w - p_A}{T} \right) +$

$\frac{1}{2}w \left(\frac{p_A - \sigma - w}{T} \right) + \frac{1}{2}w \left(\frac{p_B - \sigma - w}{T} \right) + w$. Equivalently, $T\pi_A = \left(\frac{T+\sigma}{2} \right)^2 + \left(\frac{3T+\sigma}{2} + \frac{T-\sigma}{2} \right) w - \frac{1}{16}w^2$. If I_A deviates and offers $w - \varepsilon$ in stage 1, it gets $\pi_A^D = p_A^D \left(\frac{T+\sigma+w-\varepsilon-p_A^D}{t} \right) + (w - \varepsilon) \left(\frac{p_A^D - \sigma - w + \varepsilon}{T} \right) + (w - \varepsilon) \left(\frac{p_B^D - \sigma - w + \varepsilon}{T} \right) + 2(w - \varepsilon)$, where p_A^D and p_B^D are the prices set by I_A and I_B in stage 2 for $w - \varepsilon$. Neglecting terms in ε and ε^2 , $T\pi_A^D \sim \left(\frac{T+\sigma}{2} \right)^2 + \left(\frac{T+\sigma}{2} + 3T - \sigma \right) w - \frac{1}{2}w^2$. Consequently, $T(\pi_A^D - \pi_A) \sim w \left(\frac{3T-\sigma}{2} - \frac{7}{16}w \right)$. For $w < T - \sigma$, $\left(\frac{3T-\sigma}{2} - \frac{7}{16}w \right) > 0$. The deviation is profitable. Let us now assume that $w_A < w_B$. Then $\pi_B = p_B \left(\frac{T+\sigma+w-p_B}{T} \right) = \frac{1}{T} \left(\frac{T+\sigma}{2} + \frac{1}{2}w \right)^2$. Equivalently, $T\pi_B = \left(\frac{T+\sigma}{2} \right)^2 + \left(\frac{T+\sigma}{2} \right) w + \frac{1}{4}w^2$. If I_B deviates and offers $w - \varepsilon$, it gets $\pi_B^D = p_B^D \left(\frac{T+\sigma+w-\varepsilon-p_B^D}{t} \right) + (w - \varepsilon) \left(1 + \frac{p_A^D - \sigma - w + \varepsilon}{T} \right) + (w - \varepsilon) \left(1 + \frac{p_B^D - \sigma - w + \varepsilon}{T} \right)$ and $T\pi_B^D \sim \left(\frac{T+\sigma}{2} \right)^2 + \left(\frac{T+\sigma}{2} + 3T - \sigma \right) w - \frac{1}{2}w^2$. Consequently, $T(\pi_B^D - \pi_B) \sim (3T - \sigma)w - \frac{3}{4}w^2 = w \left(3T - \sigma - \frac{3}{4}w \right) > 0$. There is no equilibrium such that $w < T - \sigma$ and $0 < w_A = w < w_B$ and, for similar reasons, no equilibrium such that $w < T - \sigma$ and $0 < w_B = w < w_A$. For $w_A = w = 0 < w_B$, $\pi_A = \left(\frac{T+\sigma}{2} \right) \left(\frac{T+\sigma-\frac{T+\sigma}{2}}{T} \right) = \frac{1}{T} \left(\frac{T+\sigma}{2} \right)^2$. If I_A deviates and offers $w_A^D = \varepsilon < w_B$, it gets $\pi_A^D = p_A^D \left(\frac{T+\sigma+\varepsilon-p_A^D}{T} \right) + \varepsilon \left(1 + \frac{p_A^D - \sigma - \varepsilon}{T} \right) + \varepsilon \left(1 + \frac{p_B^D - \sigma - \varepsilon}{T} \right)$ and $T\pi_A^D = \left(\frac{T+\sigma}{2} \right)^2 + \left(\frac{T+\sigma}{2} + 3T - \sigma \right) \varepsilon - \frac{1}{2}\varepsilon^2$. Consequently, $T(\pi_A^D - \pi_A) = \varepsilon \left(\frac{T+\sigma}{2} + 3T - \sigma - \frac{1}{2}\varepsilon \right) > 0$ for ε strictly positive and sufficiently small. There is no equilibrium such that $w_A = w = 0 < w_B$. There is only one candidate equilibrium left, namely $w_A = w_B = w = 0$ (followed in stage 2 by $p_A = p_B = \frac{T+\sigma}{2}$). There is obviously no profitable deviation in stage one. It is thus an equilibrium. ■

3. Deviations

A deviation in stage 2 leads for the deviating firm to a profit equal to $2(V - T)$. Now consider a deviation in stage 1. Assume that I_A offers $w < T - \sigma$. $\pi_A^D = p_A^D \left(\frac{T+\sigma+w-p_A^D}{T} \right) + w \left(1 + \frac{p_A^D - \sigma - w}{T} \right) + w \left(1 + \frac{p_B^D - \sigma - w}{T} \right)$. Equivalently, $T\pi_A^D = \left(\frac{T+\sigma}{2} \right)^2 + \frac{7T-\sigma}{2}w - \frac{1}{2}w^2$. This expression reaches a unique unconstrained maximum for $w = \frac{7T-\sigma}{2}$. However, $\frac{7T-\sigma}{2} > T - \sigma$, so the optimal deviation is to offer w as close as possible to $T - \sigma$, leading to profits close to $\pi_A^D = \frac{13}{4}T - \frac{10}{4}\sigma + \frac{\sigma^2}{4T}$. Assume now that I_A offers $w \in [T - \sigma; v]$. $\pi_A^D = T + 2w$. This is maximal for $w = v$, with profits equal to $T + 2v$. Offering $w = v$ is more profitable than offering $w = T - \sigma - \varepsilon$ iff $\frac{13}{4}T - \frac{10}{4}\sigma + \frac{\sigma^2}{4T} < T + 2v$ which holds for $\sigma \leq T$ (Assumption 1) and $v \geq T - \sigma$ (Assumption 2). Finally, offering $w > v$ is not profitable. Indeed, no consumer from groups a and b would purchase the good and deviations to capture only I_B 's clients are more profitable when they take place in stage 2 because I_B cannot adjust its final price. Comparing $T + 2v$ with $2(V - T)$ shows that the most profitable deviation is the deviation in stage 2. ■

In the collusive one-shot game, the relevant options for incumbents are either to foreclose entrants and maintain the unconstrained monopoly price on the final

market or to supply entrants at a wholesale price exactly equal to v . Offering a wholesale price below v would reduce prices and profits on all the markets. Offering a wholesale price above v would not allow firms to extract any value from consumers located in a and b , in which case it is better to foreclose entrants. Offering $w = v$ forces incumbents to lower their price on markets A and B . Under our assumptions, this price reduction is too costly to be compensated by profits from markets a and b . Consequently, in the collusive equilibrium of the one-shot game, the entrants are foreclosed. Incumbents maintain the collusive price they would adopt in the absence of an entry threat and block entry by refusing to supply entrants with the intermediate good.

The non-cooperative one-shot game is a sequential game. Firms choose intermediate prices in stage 1 and final prices in stage 2. Backward induction imposes that we first consider final prices conditional on wholesale prices (see lemma 1 in the proof of the proposition). If the wholesale price, i.e. $\min(w_A, w_B)$, is larger than or equal to $T - \sigma$, then no consumer from groups A and B would purchase from the entrants for $p_A = p_B = T$. The incumbents can ignore entry and indeed charge the same prices as in the game without entry. Conversely, if the wholesale price is below $T - \sigma$, then incumbents cannot ignore the entrants. If they do so, they will lose some of their customers to the entrants. It does not necessarily mean that they will charge a different price in equilibrium, but it turns out that they do. If one of the incumbents, say I_A , charges a strictly lower wholesale price than the other, then they have different pricing incentives in stage 2 and the equilibrium will be asymmetric. Indeed, for I_B , clients lost to the entrants generate no profit. Consequently, I_B has an incentive to keep its clients by reducing p_B and p_B is strictly lower than T for any w below $T - \sigma$. For I_A , losing a customer to an entrant is less of a problem because the entrant will purchase from I_A to supply the customer. The supplementary revenue on the intermediate market partially compensates the loss of revenue on the final market. Due to that, I_A charges a higher price than I_B and p_A is larger than T when w is comprised between $(T - \sigma)/2$ and $T - \sigma$. When w is below $(T - \sigma)/2$, for example for w equal to zero, p_A is lower than T . If both incumbents charge the same wholesale price, they share equally the revenues from supplying the entrants. This reduces their aggressiveness on the final market and for some values of the wholesale price, they charge final prices above T . When both firms charge the same wholesale price comprised between $T - \sigma$ and $2(T - \sigma)$, there are two equilibria in stage 2, one in which firms charge T and one in which they charge prices above T . In the first case, the incumbents make profits only on the final market (i.e. $w > v$), while in the second, they extract profits from both the final and the intermediate market (i.e., $w = v$). Supplying the entrants makes incumbents less aggressive on final market.¹²

The equilibrium of stage 2 determines incumbents' incentives in stage 1. It turns out that competition in stage 1 is fierce and incumbents actually offer to the entrants wholesale prices equal to the marginal production cost, which we assumed to be zero. The mechanism leading to this result is essentially the same

¹²Vertical integration thus has a collusive impact in a static framework as in Chen (2001).

as in a standard Bertrand duopoly game with a homogeneous good. Of course, it is a bit more sophisticated because deviations on the intermediate market lead to different equilibria on the final market and thus impact incumbents' sales and profits in markets A and B . However, it is still the case that for any profile of prices leading to a wholesale price above marginal cost, a profitable deviation exists, which typically consists in undercutting the rival by offering a slightly lower wholesale price.

In the collusive one-shot game, an entry threat does not make a difference because firms can and actually do prevent entry by making the intermediate good prohibitively costly. This is in fact a typical instance of a vertical price squeeze. In the non-collusive one-shot game, an entry threat has a dramatic impact. The incumbent do not coordinate on the price squeeze situation but rather compete to supply the entrants. As a consequence, entry occurs and the incumbents's final price fall from T to $(T + \sigma)/2$. Each incumbent's profit falls from V to $(T + \sigma)^2/4T$ which is strictly lower than $V/3$.¹³ If collusion breaks down and firms return to the endless repetition of the non-cooperative one-shot game, their profit per period is divided by more than three. This is a very strong punishment.

To complete the characterization of the repeated game, we have to consider deviations. The extra profit an incumbent can get from a deviation in stage 2 is exactly the deviation profit in the repeated game without entry. What is different from the game without entry is the possibility that an incumbent deviates in stage 1. In the collusive scheme, entrants are foreclosed. Consequently, a deviation consists in offering entrants an acceptable wholesale price. Offering a price strictly above v would not allow the entrants to supply consumers in groups a and b . They could only attract clients from the incumbents. In some way, this allows the deviating incumbents to indirectly capture clients from the competing incumbent. However, it is more profitable to directly capture clients from the competing incumbent by deviating in the second stage on the game. While the competing incumbent would reduce its final price in reaction to a deviation on the wholesale price, it cannot adjust to a deviation at the stage 2. The most profitable deviation on the intermediate market for wholesale prices below or equal to v is to offer exactly v . Offering a wholesale price strictly lower than v reduces the profits from consumers in groups a and b and increases the competitive pressure on incumbents' final prices. Comparing the optimal deviation on the final prices and the optimal deviation on the intermediate prices shows that the most profitable deviation is the former. The presence of entrants opens new deviation opportunities for the incumbents, but the opportunities are less profitable than the optimal deviation already accessible in the absence of an entry threat. A deviating incumbent, say I_A , faces a choice between two alternatives. I_A can either renounce to the profits that could be extracted from consumers in groups a and b and capture consumers from group B (deviation in stage 2) or extract profits from groups a and b (through the entrants) but renounce to the profits that could be extracted from consumers in group B (de-

¹³This inequality results from Assumptions 1 and 4.

viation in stage 1). Given our assumptions, in particular the assumption that v is relatively low, it is more profitable for I_A to capture group B . Of course, I_A would find even better to cheat on the collusive agreement on both markets, but this is not possible. When I_B observes that I_A deviates on the intermediate market, it no longer plays the collusive price on the final market, but rather switches to its equilibrium price in the subgame corresponding to the deviation wholesale price. In this sense, the punishment of a deviation in stage 1 of the one-shot game begins in the current period and goes on in the following periods in which the non-cooperative one-shot game is played.¹⁴

Putting together the above elements of comparison between the equilibrium of the repeated game with and without an entry threat leaves no ambiguity about the impact of an entry threat on entry in our model. This is summarized in the proposition below.

Proposition 3 (Impact of an entry threat on collusion) *An entry threat at the downstream level leaves the collusive final price, as well as the collusion and the deviation profits unchanged, but lowers the punishment profit. Consequently, it is easier for the incumbents to sustain collusion (lower δ) when they face an entry threat on the downstream market than when entry is impossible on this market.*

Proof. Although the result is a straightforward consequence of propositions 1 and 2, it can be established through the usual comparison between the critical discount factors. We thus determine these critical values in the benchmark case and the general case.

Lemma 3 *In the benchmark case, the cartel is stable iff $\delta \geq \frac{V-2T}{2V-3T}$*

Proof. Given the collusion, deviation and punishment profits, the stability condition is $\pi_A^K \left(\frac{1}{1-\delta} \right) \geq \pi_A^D + \delta \left(\frac{1}{1-\delta} \right) \pi_A^P$, that is, $V \left(\frac{1}{1-\delta} \right) \geq 2(V-T) + \delta \left(\frac{1}{1-\delta} \right) T$. ■

Lemma 4 *In the general case, the cartel is stable iff $\delta \geq \frac{V-2T}{2(V-T) - \frac{(T+\sigma)^2}{4T}}$.*

Proof. Given the collusion, deviation and punishment profits, the stability condition is $V \left(\frac{1}{1-\delta} \right) \geq 2(V-T) + \delta \left(\frac{1}{1-\delta} \right) \frac{(T+\sigma)^2}{4T}$. ■

Comparing the two discount factors completes the proof. ■

The ability of the colluding incumbents to prevent entry at the downstream level is an essential element in our analysis of the relation between vertical integration, collusion and entry. It results from the absence of an alternative source of input from which entrants could purchase. We briefly discuss here the consequences of the existence of an alternative source of input assuming that it is a competitive fringe with a constant marginal cost of production c . As long as c is larger than or equal to $V - \sigma$, the existence of the fringe does not make

¹⁴This is the *reaction effect* identified by Nocke and White (2007).

any difference. The entrants could attract neither consumers from groups a and b , nor consumers from groups A and B . If the fringe is able to produce at a cost below $V - \sigma$, then the entrants will be able to attract some consumers from A and B if the incumbents stick to monopoly prices. The entrants would then have to choose between maintaining high prices and losing part of their consumers or lowering their prices to keep them. Under the first alternative (maintaining high prices), the entrants actually sell the product and thus purchase positive quantities of input. The incumbents should not leave the intermediate market to the competitive fringe, but rather undercut the fringe and supply the entrants. The existence of an alternative supply would then break down the collusive equilibrium based on the foreclosure of entrants. Under the second alternative (reducing prices), the incumbents may retain their monopoly position on their markets, but at the cost of lower prices. In both cases, the market outcome and the profits in the collusive scheme differ from what they are in the absence of entry. Consequently, it is difficult to appreciate the impact of an entry threat on collusion. The entry threat may modify the critical discount factor, but it also modifies the collusive strategies and profits. While there are ways out of this technical problem (see Normann (2009)), the existence of an alternative supply of input also makes the analysis of deviations much more intricate, with deviations on the intermediate market possibly more profitable than deviations on the final market, and it would not provide substantial new insights on the relations between vertical integration, collusion and entry.

6 Conclusion

We consider the infinitely repeated interaction between two incumbents and two entrants on a final market composed of asymmetric groups of heterogeneous consumers. Incumbents enjoy a competitive advantage on entrants that relies on the fact that their products better match the tastes of the most profitable consumer groups and that they are vertically integrated in the production of an essential input. Entrants depend on input supplies from the incumbents to be able to operate on the market. In the situations corresponding to our assumptions on parameters, the incumbents foreclose the entrants in the collusive scheme. Consequently, the existence of the entrants does not change the market outcome observed in the collusive equilibrium. However, it makes collusion easier to sustain. This is not due to a modification of deviation profits, since the most profitable deviation is to stick to foreclosure and deviate only on the final market. The impact of an entry threat on the sustainability of collusion is entirely due to an impact on punishment profits. If a firm deviates, collusion breaks down and firms play the non-cooperative equilibrium of the one-shot game. In this equilibrium, entrants are not foreclosed and entry intensifies competition on the final market, leading to lower profits. Because the incumbents know that they will not foreclose the entrants in punishment periods, they have a stronger incentive to stick to collusion when facing an entry threat on the final market.

The legal treatment by antitrust authorities and courts of the type of practices that incumbents adopt in our collusive equilibrium deserves a brief discussion. Obviously, what we have here is a typical case of collusion. However, the legal treatment of collusion depends on the distinction between tacit collusion and explicit collusion. Explicit collusion will be proved in particular if evidence of bilateral communication between the colluding firms can be found. The ban on explicit collusion and the sanctions against firms entering in explicit collusion are probably the most important aspect of antitrust laws around the world. In the absence of such evidence, however, one cannot exclude the possibility that collusion is tacit. Tacit collusion is not illegal and firms cannot be sanctioned. However, in the European Union, tacit collusion is treated as a case of collective dominant position. This becomes a problem for the firms if the authorities consider that they abuse this collective dominant position. Here, the vertical foreclosure of entrants could be considered as such an abuse. This is why taking a broader view on cases such as the French mobile phone services cartel discussed in the introduction may be of interest both for academics interested in the functioning of these markets and for antitrust authorities looking for legal instruments to fight against what they perceive as anticompetitive behavior.

7 References

- Avenel, E., 2008, Strategic vertical integration without foreclosure, *Journal of Industrial Economics*, Volume LVI, No. 2, 247-262.
- Avenel, E. and C. Barlet, 2000, Vertical foreclosure, technological choice, and entry in intermediate markets, *Journal of Economics & Management Strategy*, Volume 9, Issue 2, 211-230.
- Bundeskartellamt, 2009, Fuel sector inquiry, Interim report, June 2009. Available at: http://www.bundeskartellamt.de/wEnglisch/download/pdf/09-242_Zwischenbericht_Kraftstoffe-E.pdf
- Bundeskartellamt, 2011a, Sektoruntersuchung Kraftstoffe, Abschlussbericht Mai 2011 (in german). Available at: http://www.bundeskartellamt.de/wDeutsch/download/pdf/Stellungnahmen/2011-05-26_Abschlussbericht_final2.pdf
- Bundeskartellamt, 2011b, Fuel sector inquiry, Final Report, May 2011 – Summary. Available at: http://www.bundeskartellamt.de/wEnglisch/download/pdf/11-085_Abschlussbericht_SU_Kraftstoffe_Zusammenfassung-E.pdf
- Catan, T., 2011, The Google-Motorola Deal: Bid comes amid tougher scrutiny, *The Wall Street Journal*, August 16, 2011.
- Chen, Y., 2001, On vertical mergers and their competitive effects, *Rand Journal of Economics*, Vol. 32 Issue 4, 667-685.
- Choi, J. P. and S.-S. Yi, 2000, Vertical foreclosure with the choice of input specifications, *RAND Journal of Economics*, Vol. 31 Issue 4, 717-743.
- Conseil de la concurrence, 2005, Décision n° 05-D-65 du 30 novembre 2005 relative à des pratiques constatées dans le secteur de la téléphonie mobile.
- Conseil de la concurrence, 2008, Avis n° 08-A-16 du 30 juillet 2008 relatif à la situation des opérateurs de réseaux mobiles virtuels (MVNO) sur le marché

français de la téléphonie mobile.

European Commission, 2003a, Commission Decision of 21 May 2003 relating to a proceeding under Article 82 of the EC Treaty (Case COMP/C-1/37.451, 37.578, 37.579 — Deutsche Telekom AG), *Official Journal of the European Union* L 263 of 14/10/2003.

European Commission, 2003b, Commission Decision of 16 July 2003 relating to a proceeding under Article 82 of the EC Treaty (COMP/38.233 - Wanadoo Interactive).

European Commission, 2008, Guidelines on the assessment of non-horizontal mergers under the Council Regulation on the control of concentrations between undertakings, *Official Journal of the European Union* C 265 of 18/10/2008.

High Court of Australia, 1988, QUEENSLAND WIRE INDUSTRIES V THE BROKEN HILL PROP CO (1988) 167 CLR 77.

Maskin, E. and J. Tirole, 1988, A theory of dynamic oligopoly II: Price competition, kinked demand curves and Edgeworth cycles, *Econometrica*, 56, 571-599.

Nocke, V. and L. White, 2007, Do vertical mergers facilitate upstream collusion, *American Economic Review*, Vol. 97 Issue 4, 1321-1339.

Noel, M. D., 2007, Edgeworth price cycles: evidence from the Toronto retail gasoline market, *Journal of Industrial Economics*, Volume LV, No. 1, 69-92.

Normann, H.-T., 2009, Vertical integration, raising rivals' costs and upstream collusion, *European Economic Review*, Vol. 53, 461-480.

Ordover, J. A., G. Saloner and S. C. Salop, 1990, Equilibrium vertical foreclosure, *American Economic Review*, Vol. 80 Issue 1, 127-142.

Rey, P. and J. Tirole, 2007, Chapter 33: A primer on foreclosure, in *Handbook of Industrial Organization*, Vol. 3, 2145-2220.

Riordan, M.H., 2008, Competitive effects of vertical integration, in: Buc-cirossi, P. (Ed.), *Handbook of Antitrust Economics*, MIT Press, Cambridge, MA, 145-182.

US Department of Justice, 1984, Non-horizontal merger guidelines. Available at: <http://www.justice.gov/atr/public/guidelines/2614.htm>.