B2B marketplaces: when it pays to be small*

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Abstract

In a successive vertical oligopoly, a set of "sellers" produce some input to be transformed into a final product by a set of "buyers". On this two-sided market, a firm's profit increases with the number of firms of the other type and decreases with the number of firms of its own type. We examine the entry of a new marketplace sponsored by a profit-maximizing intermediary who targets buyers and sellers in a sequential way by setting membership fees (or subsidies). We show that the intermediary might find it optimal to limit the size of the marketplace.

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1 Introduction

Business-to-business electronic marketplaces can be defined as *virtual marketplaces where several buyers meet several sellers in order to conduct transactions*. At the date of this writing (December 2004), *eMarket Services*[1] list about 900 international B2B marketplaces. The majority of them have a vertical industry focus and are owned by third-parties[2] (Popović, 2002). They are expected to improve productivity of participating firms. According to Lucking-Reiley and Spulber (2001), "[e]xpectations about productivity gains from B2B e-commerce can be usefully divided into four areas: possible efficiencies from automation of transactions, potential economic advantages of new market intermediaries, consolidation of demand and supply through organized exchanges, and changes in the extent of vertical integration of companies." When it comes to the specific case of B2B marketplaces, the third area appears to be dominant. Business analysts report indeed that the main motivation for firms to join a B2B marketplace is to enlarge their portfolio of potential trading partners.[3] In other words, it appears that the "liquidity benefits" (induced by bringing together a large number of buyers and sellers) prevail over the "efficiency benefits". As a result, the business literature stresses that "liquidity" is essential for the success of B2B marketplaces: "To succeed, [neutral] e-hubs must attract both buyers and sellers quickly, creating liquidity at both ends" (Kaplan and Sawhney, 2000); "the first pillar of e-marketplace success is building liquidity" (Brunn *et al.*, 2002).

By putting emphasis on (vertical, two-sided) network effects, this view neglects (horizontal) competition effects. It must indeed be stressed that the "liquidity" of the marketplace might have two contrasting effects on buyers

[1] *eMarket Services* is an international independent collaboration of trade promotion organisations (www.emarketservices.com).

[2] Kaplan and Sawhney (2000) and Yoo *et al.* (2003) call 'neutral' the marketplaces owned by independent third parties, and 'biased' the marketplaces owned by either suppliers or buyers. Marketplaces in the latter category are also sometimes called 'consortia marketplaces' or 'Industry Sponsored Exchanges (ISE)' (see Ordanini et al., 2004).

[3] See the interview of Ph. Nieuwbourg, CEO of AEPDM (Association européenne des places de marché) in Journal du Net (www.journaldunet.com/itws/it_nieuwbourg.shtml, last consulted 11/08/04).

and sellers: (i) the *positive indirect network effect* emphasized in the business literature (a firm's profit increases as the number of firms of the other type increases), *and* (ii) a *negative competition effect* (a firm's profit decreases as the number of firms of its own type increases). Accordingly, an intermediary, acting as a marketplace holder, may have to reduce membership fees (or to increase subsidies) to attract firms on a crowdy marketplace. Too much liquidity is then harmful and may prevent the viability of the marketplace.

We develop a model that explicitly deals with the network *and* the competition effects, and we analyze if, and how, an intermediary can launch a viable marketplace. We also address the following questions. Which fee structure should the intermediary put in place? Should he subsidize one or the other side of the market? How many firms of each type should he attract? Does it matter if he attracts one side before the other? Is the intermediation profitable for the industry?

Questions of this sort are at the center of a recent literature in economics, which examines *two-sided markets*[4]. Seminal contributions are Rochet and Tirole (2003), Evans (2003), Caillaud and Jullien (2003) and Armstrong (2004). Rochet and Tirole (2004) propose a useful introduction and road map to this flourishing literature. By contrast with most of the two-sided literature, we include the competition effect in our analysis.[5] Also, we develop a successive oligopoly model which allows us to derive, endogenously, the payoffs of both types of agents, and to give a precise structure to the various externalities (positive *and* negative) that exist between firms.

We consider the market for an intermediate good, which is produced by a set of upstream firms (the "sellers" who compete a la Cournot) and sold to a set of downstream firms (the "buyers" who also compete a la

[4] Jullien (2004) refers the concept of two-sided markets to "situations where one or several competing 'platforms' provide services that are used by two types of trading partners to interact and operate an exchange."

[5] Some papers consider competition between sellers but we have no knowledge of papers also considering competition between buyers. For instance, Rochet and Tirole (2002) and Schmalensee (2002) provide a formal analysis of the credit card payment industry, where merchants compete with one another but cardholders do not. Similarly, in Nocke, Peitz and Stahl (2004) sellers compete on the market for differentiated products, which are sold to independent consumers.

Cournot). The latter firms transform the input, on a one-for-one basis, into a (potentially differentiated) final product. When the game starts, all buyers and all sellers trade on an existing marketplace whose access is supposed to be free. Then, an intermediary starts a new B2B marketplace and takes decisions sequentially: he sets fees for one side of the market, then firms on that side decide to join the new marketplace or to stay with the old. The same sequence of decisions is taken afterwards with the other side of the market.

The intermediate good produced by sellers is homogenous *within* each marketplace. However, a seller cannot trade with buyers from the other marketplace: the intermediate goods produced on two different marketplaces are thus perfectly differentiated. Concerning the final product, we contrast two polar cases. In the first case, we assume that buyers produce perfectly differentiated varieties of the final product, meaning that there is no competition between them. In the second case, we take the same assumption as for the sellers: buyers produce a final product that is homogenous *within* each marketplace, but the product is perfectly differentiated *between* marketplaces.[6]

The number of firms that the intermediary attracts from the group of firms that he targets first is of primary importance to induce firms from the other group to join. We show that the intermediary attracts a sufficiently large number of firms from the first group, which convince firms from the other group that the new marketplace is attractive. Moreover, if the firms from the second group produce homogenous varieties, the new marketplace offers them the opportunity to reduce competition with firms that remain on the old marketplace. Therefore, the intermediary will make his marketplace even more attractive for the second group if he accepts only a limited number of these firms. We show that he accepts only one seller if sellers are targeted second, and he attracts only one buyer if buyers produce homogenous varieties and if they are targeted second. The intermediary then extracts a large rent from the single firm he has attracted. This result sharply contrasts with the business literature that emphasizes the role of creating liquidity at both ends to make a new marketplace viable.

[6] We discuss this hypothesis in Section 4.1.

Also, some firms remain on the old marketplace when buyers produce *homogenous products*: (i) all buyers but one remain if sellers are targeted first, (ii) all sellers but one remain otherwise. This makes the old marketplace very attractive for sellers in (i), and for buyers in (ii) because they find a large pool of trading partners. As a result, it is difficult for the intermediary to attract these firms. We show that his optimum is to attract less than one third of these firms, which also contrasts with the objective of creating the largest possible liquidity. We also show that the intermediary manages to launch a profitable new marketplace, whatever the group he targets first.

It is only when buyers produce *independent varieties* that the intermediary aims at the highest possible liquidity. If he enters, he attracts all buyers, which de facto destroys the old marketplace. Indeed, with independent varieties, the competition effect among buyers vanishes and only the network effect remains. Therefore, either all buyers switch to the new marketplace or none does. We show that the optimal strategy is to target sellers first, attract all of them and have all the buyers follow suit. Buyers all switch, and agree to pay a positive fee, if they can find at least half of the sellers on the new marketplace. The intermediary can easily make sure that it will be so, as sellers are keen to leave a marketplace that will be deserted by all buyers. As a result, all firms move to the new marketplace and the old one disappears. The industry profit is unchanged but the intermediary manages to extract all of it: firms are indeed willing to pay a membership fee up to the profits they achieve on the new marketplace as their fall back position is zero (if they individually move back to the old marketplace, they would face no firm to buy from or to sell to).

Because the competition effect is present among sellers, the intermediary cannot apply the same trick when he target buyers first. In that case, the intermediary cannot credibly threaten buyers that all sellers will join his marketplace: we show indeed that it is a dominant strategy to grant a monopoly to a single seller. As a result, the intermediary has to subsidize buyers to induce (all of) them to join his marketplace: all things equal, buyers prefer the existing marketplace which counts all but one sellers. Moreover, the more sellers there are in the industry, the larger is the pool of sellers on the old marketplace, and the larger is the total subsidy the intermediary has to pay to attract the buyers. Hence, the launch of the new marketplace is profitable only if the pool of sellers is small enough. Then, the old marketplace disappears by lack of buyers, and the total profit of the industry is reduced. For larger pools of sellers, however, the intermediary stays out.

The rest of the paper is organized as follows. In Section 2 we lay out the model. In Sections 3 and 4, we study in turn the cases where buyers produce independent varieties and where they produce homogenous varieties. We conclude and propose some directions for future research in Section 5.

2 The model

We consider a market with S sellers and B buyers. When the game starts, all B buyers and all S sellers trade on an existing marketplace whose access is supposed to be free. Then, we introduce one additional player in the game, namely an "intermediary", whose objective is to start a new B2B marketplace. We assume for simplicity that setting up this new marketplace does not involve any (fixed nor variable) cost, nor does it affect transaction costs for sellers and buyers. We also assume that the intermediary's strategy is restricted to setting (fixed) membership fees (or subsidies) for sellers and for buyers, which are respectively denoted by A_s and A_b.[7] Finally, we also assume that firms operate on one (and only one) marketplace; therefore, no trade takes place between buyers and sellers operating on different marketplaces.[8]

[7] We exclude (variable) usage fees for the following reasons. From an empirical point of view, it is observed that although usage (or transaction) fees are traditionally the most common sources of revenue, an increasing number of B2B marketplaces tend to reduce them while increasing membership (or subscription) fees. Popović (2002, p. 15) invokes the firms' "reluctance to be charged every time they decide to transact", while Rochet and Tirole (2004, p. 19) argue that the platform might be unable to tax the interaction properly: "Buyers and suppliers may find each other and trade once on a B2B exchange, and then bypass the exchange altogether for future trade". Moreover, we show in Belleflamme and Toulemonde (2004) that it might be impossible to solve the model when the intermediary is allowed to combine membership and usage fees.

[8] In the jargon of the two-sided markets literature, we say that agents are not allowed to "multi-home", i.e., to conduct transactions simultaneously on different marketplaces

The intermediary takes then the following sequence of decisions. First, he decides whether he enters or not the game. Second, he determines which type of firms to target before the other.[9] Say he decides to target buyers first. The next decision consists in setting the membership fee A_b. After buyers have decided whether or not to join the new marketplace, the intermediary observes the buyers' decisions and sets the membership fee A_s for sellers. The sellers, observing the whole sequence of decisions, choose then whether or not to join the new marketplace. (Obviously, if the intermediary decides to target sellers first, A_s will be set before A_b and sellers move before buyers do.) Finally, on each marketplace, production decisions are made in a successive Cournot oligopoly fashion: sellers choose first the quantity of the input and buyers, observing the input price, choose next the quantity of the final product.[10] The representative consumer demands the final product and all payoffs accrue. Figure 1 represents the timing of the game.

We will show how the relative size of the buyers' and sellers' pools determines the optimal sequence of moves for the intermediary. More importantly, we will stress the crucial role played by the degree of substitutability among final products (which determines the degree of competition between buyers). In this respect, we will contrast two polar cases. In the first case, we assume that buyers produce perfectly differentiated varieties of the final product,

(or platforms). The implications of multi-homing are examined in several recent papers (see, e.g., Gabszewicz and Wauthy, 2004).

[9]We assume that the intermediary targets the two sides of the market in a sequential way for the following reasons. First, in several categories of two-sided markets, most agents of one side of the market arrive before most agents of the other side. For example, Hagiu (2004) points that "in the software and videogame markets, most application developers join platforms (operating systems and game consoles) before most users do." Although no such natural order seems to prevail in the cases we consider, there is no more reason to think that the two sides arrive simultaneously. Second, as we argue in Belleflamme and Toulemonde (2004), the presence of indirect network effects makes impractical the simultaneous setting of the two membership fees (resulting in the simultaneous move of the two types of firms). As usual in this type of situations (see, e.g., Katz and Shapiro, 1985 or Gabszewicz and Wauthy, 2004), multiple equilibria might occur for a given pair of fees and there is no obvious way to select among them in order to solve the intermediary's problem.

[10]See, e.g., Abiru et al. (1998) for a similar successive oligopoly model.

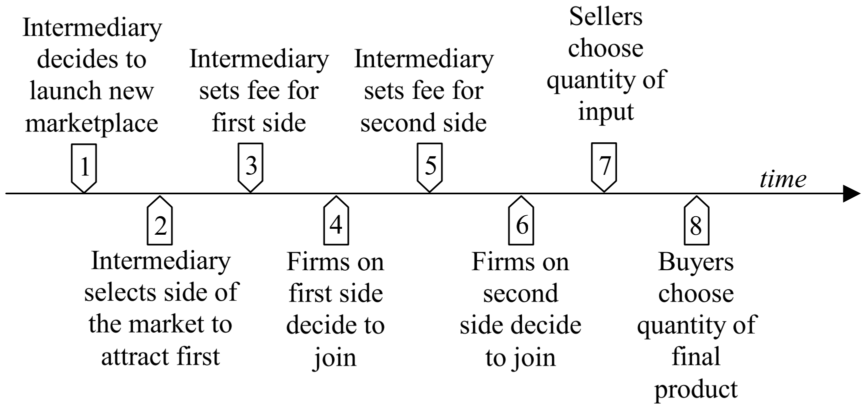

Figure 1: Timing of decisions

meaning that there is no competition between them. In the second case, we assume in contrast that buyers produce a homogeneous final product, which leads to the fiercest competition between them. We consider the case of *independent buyers* in Section 3 and the case of *rival buyers* in Section 4.

Before examining the two cases, we emphasize a result that is common to both. Which group of firms is targeted first is an important decision for the intermediary because the attractiveness of the marketplace for the second group of firms will depend positively on the number of joining firms from the first group. Thus, the first target chosen by the intermediary is a commitment vis-a-vis the firms in the second group that they will find a certain number of partners in the new marketplace. To commit vis-a-vis the second group, the intermediary must reduce the fee (or increase the subsidy) to the firms in the first group in order to induce them to join the marketplace. However, the commitment allows the intermediary to increase the revenue he can extract from the second group of firms (by attracting more of them and/or by setting higher membership fees). Therefore, the intermediary sacrifices part of his potential revenues extracted from firms in the first group in order to boost his revenues from firms in the second group. We will indeed observe that in both cases, the intermediary attracts more firms from the first group than from the second group.

3 Independent buyers

We suppose in this section that buyers produce completely differentiated varieties. *Leatherfashion and more* is an example of a B2B marketplace fitting these characteristics: sellers are leather producers while buyers produce transformed goods as differentiated as footwear products, garments, leathergoods, or upholstery.[11]

As we solve the game backwards, we analyze first the firms' production decisions and then the firms' marketplace choices and the intermediary's choice of a fee structure.

3.1 Production decisions

We start with the buyers. Suppose that the demand function for the variety produced by buyer i ($i = 1, 2..B$) is given by $p_i = 1 - q_i$: as varieties are perfectly differentiated, the price of variety i (p_i) only depends on the quantity produced by buyer i (q_i), who acts thus as a local monopolist. Supposing that the unit cost is just the price w paid for the input, buyer i's problem writes thus as $\max_{q_i} q_i (p_i - w)$ and the first-order condition for profit maximization yields

$$w = 1 - 2q_i.$$

Suppose that $(b - 1)$ other buyers operate on the same marketplace as buyer i. They all face the same demand and cost conditions. Hence, we can aggregate their first-order conditions:

$$w = 1 - \frac{2}{b}Q,$$

where Q is the total quantity produced by the buyers on this marketplace.

We consider now the problem of a typical seller. Because of the one-for-one transformation technology, the total quantity of the final product (Q) is equal to the total quantity of the input (X) produced by the sellers operating on that marketplace. The previous expression gives thus the inverse demand function for the sellers. So, seller j (with $j = 1, \ldots, s$), whose marginal cost of production is assumed to be equal to zero, faces the following problem:

[11] See www.leatherfashionandmore.com.

$\max_{x_j} wx_j$. The first-order condition for profit maximization yields:

$$1 - (4/b)\, x_j - (2/b)\, X_{-j} = 0,$$

where X_{-j} is the quantity produced by all sellers but j. At the symmetric Cournot equilibrium, each seller produces a quantity

$$x = \frac{b}{2\,(s+1)}.$$

The total quantity exchanged on the marketplace is thus equal to

$$Q\,(s,b) = X\,(s,b) = \frac{bs}{2\,(s+1)}.$$

Using the latter expression, one computes the firms' profits at the equilibrium (with the superscript *ind* referring to independent buyers):

$$\text{for sellers, } \pi_s^{ind}\,(s,b) = \frac{b}{2\,(s+1)^2}, \quad (1)$$

$$\text{for buyers, } \pi_b^{ind}\,(s) = \frac{s^2}{4\,(s+1)^2}. \quad (2)$$

For the analysis that follows, it is important to understand how profits are affected by changes in the number of firms present on the marketplace. Analyzing the latter profit functions, we observe that the "liquidity" of the marketplace has two contrasting effects. First, for each type of firms, there is a *positive indirect network effect*: a firm's profit increases as the number of firms of the other type on the marketplace increases,

$$\pi_s^{ind}\,(s, b+1) > \pi_s^{ind}\,(s,b) \text{ and } \pi_b^{ind}\,(s+1) > \pi_b^{ind}\,(s)\,.$$

Second, for sellers, there is a *negative competition effect*: a seller's profit decreases as the number of other sellers on the marketplace increases,

$$\pi_s^{ind}\,(s+1, b) < \pi_s^{ind}\,(s,b)\,.$$

Note that because final varieties are perfectly differentiated, no such negative competition effect exists on the buyers' side.[12]

We now use expressions (1) and (2) to examine the firms' marketplace choices and to derive the intermediary's optimal structure of fees.

[12] This effect will be present in the next section.

3.2 Marketplace choices and fee structure

When the game starts, there is one, unsponsored, marketplace which is available. All S sellers and all B buyers interact through this marketplace, achieving profits respectively equal to $\pi_s^{ind}(S,B)$ and $\pi_b^{ind}(S)$. Then the intermediary I launches a new marketplace. Because firms can earn positive profits when they refrain from joining the new marketplace, we need to examine whether the creation of a new marketplace is a profitable venture. On the one hand, sellers on each marketplace face fewer competitors, but on the other hand, they can sell to fewer buyers and buyers can buy from fewer sellers. Thus, to induce firms to switch, the intermediary may have to subsidize one side of the market, and membership fees levied afterwards on the other side may not be sufficient to recoup the initial investment. We thus examine if the new intermediary is able to enter despite the competition of the existing marketplace. The profitability of entry and the fee structure vary with the strategy adopted by the intermediary. We thus examine what makes him prefer to attract buyers or sellers first.

The rest of this section is organized as follows. We successively study the strategies 'buyers first' and 'sellers first'. Under each strategy, we determine the number of buyers and sellers attracted by the new intermediary, we examine whether one side of the market is subsidized, and we check whether the new marketplace enhances the profits of the industry. Finally, we examine which strategy is preferred by the intermediary.

3.2.1 Strategy 'buyers first'

We solve the game backwards, starting with the sellers' decision to join the new marketplace in **stage 6**. Suppose that b buyers have joined the new marketplace in stage 4. Given the membership fee A_s set by the intermediary, it is a Nash equilibrium for $1 \leq s < S$ sellers to switch if the following two conditions are met: (i) the net profit of a seller on the new marketplace (with s sellers) is larger than (or equal to) the profit that he would get by going back to the existing marketplace (with $S - s + 1$ sellers); and (ii) the profit of a seller on the existing marketplace (with $S - s$ sellers) is larger than the profit that he would get by moving to the new marketplace (with

$s+1$ sellers). Algebraically, this gives the following two conditions:[13]

$$\begin{cases} \pi_s^{ind}(s,b) - A_s \geq \pi_s^{ind}(S-s+1, B-b), \\ \pi_s^{ind}(S-s, B-b) > \pi_s^{ind}(s+1,b) - A_s. \end{cases}$$

Defining

$$\hat{A}_s(s,b) \equiv \pi_s^{ind}(s,b) - \pi_s^{ind}(S-s+1, B-b),$$

one can rewrite the latter two conditions as the following interval:

$$\hat{A}_s(s+1,b) < A_s \leq \hat{A}_s(s,b).$$

Clearly, the properties of $\pi_s^{ind}(s,b)$ imply that $\hat{A}_s(s,b)$ decreases with s (and increases with b). Note that all S suppliers switch if $A_s \leq \hat{A}_s(S,b)$ and none of them switches if $A_s > \hat{A}_s(1,b)$. This set of conditions define a sequence of open and adjacent intervals, meaning that there exists a unique Nash equilibrium in stage 6 for all A_s and b.

Turning next to **stage 5**, we show that *for every positive number of buyers he has attracted beforehand, the intermediary always grant a monopoly to a single seller.* The argument goes as follows. The intermediary knows that by setting $A_s = \hat{A}_s(s,b)$, he induces s sellers to switch given that b buyers have done so before. His problem is thus to choose, for a given b, the value $s^*(b) = \arg\max_s s\hat{A}_s(s,b)$. Recalling that $s\hat{A}_s(s,b) = s\pi_s^{ind}(s,b) - s\pi_s^{ind}(S-s+1,B-b)$, we see that this problem is easy to solve. First, we know from Amir (2003) that in a Cournot market for a homogeneous product with linear costs, industry profits are maximized under monopoly: we check indeed that the function $s\pi_s^{ind}(s,b)$, which measures the total profits of sellers on a marketplace, decreases with s. Second, as more sellers move to the new marketplace, the fall back position of each seller (i.e., the profit a seller would achieve by unilaterally switching back to the old marketplace) improves; this means that the total compensation the intermediary has to pay, $s\pi_s^{ind}(S-s+1,B-b)$, increases with s. As these two results are independent of the distribution of buyers between the two marketplaces, it follows that for all $b \geq 1$, $s\hat{A}_s(s,b)$ decreases with s, meaning that $s^*(b) = 1$: the intermediary finds it optimal to attract a single seller. (Naturally, if the

[13] Without loss of generality, we assume that when firms are indifferent between the two marketplaces, they choose to trade on the new one.

intermediary attracts no buyer beforehand, he also chooses to attract no seller: $s^*(0) = 0$.)

Now, moving backward to **stage 4**, we observe that the previous result puts the intermediary in a difficult position: buyers perfectly anticipate that if they move to the new marketplace (in whatever number), they will face the worst possible situation as they will have to buy their input from a monopoly. More precisely, let us analyse the buyers' switching decision. Recalling that buyers' profits only depend on the number of sellers on the marketplace and that buyers are identical, we have that all buyers will move to the marketplace offering the best deal. That is, all B buyers switch if and only if $\pi_b^{ind}(s) - A_b \geq \pi_b^{ind}(S-s)$, or

$$A_b \leq \hat{A}_b(s) \equiv \pi_b^{ind}(s) - \pi_b^{ind}(S-s). \tag{3}$$

If condition (3) is not met, all B buyers stay with the old marketplace. From the expression of $\hat{A}_b(s)$, it is easy to see that $\hat{A}_b(s)$ is non-negative provided that $s \geq S/2$ and is negative otherwise. In other words, if the intermediary does not attract at least half of the sellers, he has to pay buyers a subsidy (a negative value of A_b) if he wants buyers to join his marketplace.

In the present case, as the intermediary attracts only one seller, the minimal subsidy he has to pay to any buyer in **stage 3** is equal to:

$$\hat{A}_b(1) \equiv \pi_b^{ind}(1) - \pi_b^{ind}(S-1) = -\frac{1}{16}(3S-2)\frac{S-2}{S^2},$$

which becomes more negative as S increases (intuitively, the larger S, the larger the disadvantage of the new marketplace with respect to the old one). The remaining issue for the intermediary is to figure out whether the total subsidy to be paid to the buyers, $B\hat{A}_b(1)$, can be recouped or not through the rent he can extract from the seller, $\hat{A}_s(1,B) = \pi_s^{ind}(1,B)$. Developing these expressions, we have:

$$B\hat{A}_b(1) + \hat{A}_s(1,B) = \frac{B}{16S^2}\left(8S - 4 - S^2\right),$$

which is positive for $S \in \{2,7\}$ and negative otherwise.

We summarize our results in the following lemma.

Lemma 1 *In the case of independent buyers and under the strategy 'buyers first', the intermediary's optimal conduct is as follows. For a small pool of sellers ($S \leq 7$), the intermediary sets membership fees so as to attract all B buyers and a single seller. For a larger pool of sellers ($S \geq 8$), the intermediary does not launch the new marketplace.*

We thus see that when the pool of sellers is relatively large ($S \geq 8$), the launch of the new marketplace is not a profitable venture because buyers anticipate correctly that a large pool of sellers will remain on the existing marketplace, which makes the option of staying on that marketplace more profitable for them. It is then too expensive for the intermediary to attract buyers. It is only when the pool of sellers is relatively small ($S \leq 7$) that the intermediary will enter when he targets buyers first. The intermediary collects then his rent from the unique seller he attracts and increases this rent by subsidizing all buyers to join.

From a policy point of view, we want to investigate the extent to which the activity of the intermediary promotes or undermines the profitability of the industry. We focus thus on the case where $S \leq 7$. In that case, it is clear that the entry of the new marketplace is detrimental for the industry. First, the intermediary attracts all buyers and prevents thereby the existing marketplace to survive. Second, the intermediary attracts only one seller. As a result, the intermediary promotes his new marketplace at the expenses of the existing marketplace and of the industry. We confirm our intuition by checking that total profits are lower after than before entry of the new marketplace: $B\pi_b^{ind}(1) + \pi_s^{ind}(1, B) < B\pi_b^{ind}(S) + S\pi_s^{ind}(S, B) \iff$

$$\frac{3B}{16} < \frac{SB(S+2)}{4(S+1)^2} \iff \frac{B(S+3)}{16(S+1)^2}(1-S) < 0,$$

which is clearly true.

We now consider the other strategy where the intermediary determines first the membership fee for sellers and next, the membership fee for buyers.

3.2.2 Strategy 'sellers first'

We again solve the game backwards. Let us first look at the buyers' switching decision in **stage 6**. We have shown above that either all buyers switch to the new marketplace or they all stick to the existing one. We have also shown that the intermediary will have to pay subsidies if he has not attracted at least half of the sellers beforehand. In **stage 5**, the intermediary maximizes the rent he can extract from buyers. In the subgames with $s \geq S/2$, the intermediary clearly attracts all buyers by setting a membership fee equal to $\hat{A}_b(s) = \pi_b^{ind}(s) - \pi_b^{ind}(S-s) \geq 0$. In the subgames where $s < S/2$, the intermediary is better off attracting no buyer at all. In short, $b^*(s) = B$ for $s \geq S/2$, and $b^*(s) = 0$ for $s < S/2$.

Let us now consider sellers' switching decisions in **stage 4**. We compute the maximal fee (or minimal subsidy) that would induce the sth seller to switch (i.e., any seller who anticipates that $(s-1)$ other sellers would switch along). That is, we compute

$$\hat{A}_s(s) = \pi_s^{ind}(s, b^*(s)) - \pi_s^{ind}(S-s+1, B-b^*(s-1)).$$

Note that the maximal fee is now a function of s only: sellers do indeed realize that their switching decision affects the intermediary's optimal conduct, meaning that the number of buyers who join in stage 6 depends on the number of sellers who join in stage 4. Because of the discontinuity in the function $b^*(s)$, there are three cases to distinguish: (i) if $s < S/2$, then $b^*(s-1) = b^*(s) = 0$ and $\hat{A}_s(s) = -\pi_s^{ind}(S-s+1, B) < 0$; (ii) if $s = S/2$, then $b^*(s-1) = 0$, $b^*(s) = B$ and $\hat{A}_s\left(\frac{S}{2}\right) = \pi_s^{ind}\left(\frac{S}{2}, B\right) - \pi_s^{ind}\left(\frac{S}{2}+1, B\right) > 0$; (iii) if $s > S/2$, then $b^*(s-1) = b^*(s) = B$ and $\hat{A}_s(s) = \pi_s^{ind}(s, B) > 0$.

Finally, we can derive the intermediary's optimal conduct with respect to sellers in **stage 3**. Obviously, it cannot be optimal for the intermediary to attract less than half of the sellers as he would have to subsidize sellers as well as buyers. If the intermediary decides to attract strictly more than half of the sellers, he chooses $s^* = \arg\max_s \Pi_I(s) \equiv s\hat{A}_s(s) + B\hat{A}_b(s)$, with $b^* = B$ for all s. Some lines of computations establish that $\Pi_I(S) - \Pi_I(s) > 0$ for all $S/2 < s < S$. We can therefore conclude that if he decides to attract more than half of the sellers, the intermediary attracts all S sellers (followed by all B buyers). This gives him a profit

$$\Pi_I(S) = \frac{BS}{4}\frac{S+2}{(S+1)^2}.$$

The remaining option is to attract exactly half of the sellers. As the rent extracted from buyers is equal to zero in this case, the corresponding profit for the intermediary is easily computed as

$$\Pi_I\left(\frac{S}{2}\right)=\frac{S}{2}\left(\pi_s^{ind}\left(\frac{S}{2},B\right)-\pi_s^{ind}\left(\frac{S}{2}+1,B\right)\right)=4BS\frac{S+3}{(S+2)^2\,(S+4)^2}.$$

As

$$\Pi_I\,(S)-\Pi_I\left(\frac{S}{2}\right)=\frac{1}{4}BS\frac{S^5+14S^4+60S^3+120S^2+144S+80}{(S+1)^2\,(S+2)^2\,(S+4)^2}>0,$$

the former option is preferred to the latter and we can state the following lemma.

Lemma 2 *In the case of independent buyers and under the strategy 'sellers first', the intermediary sets membership fees so as to attract all S sellers and all B buyers.*

Because buyers are independent, they all take the same decision: either they all move to the new marketplace, or they stay with the existing one. Hence, to find buyers, all sellers must take the same decision: either they all move towards the new marketplace, or they all stay with the old. Each seller knows that if he stays on the existing marketplace whereas all other sellers and buyers move towards the new marketplace, the intermediary will make profits. Thus, the new marketplace is viable even in the absence of one seller. Therefore all sellers anticipate that the intermediary will indeed attract the remaining sellers and buyers. All firms move to the new marketplace.

Buyers and sellers pay positive fees to the intermediary because they all migrate to the new marketplace. As there is no firm left on the existing marketplace, buyers and sellers on the new marketplace do not have any positive fall back and the intermediary can thus extract their entire profits. Also, total profits of the industry are left unchanged because all firms remain active on a single marketplace. Thus, a new marketplace emerges despite the existence of a marketplace which does not charge any membership fee. Due to the sequential strategy adopted by the intermediary, the best reaction of all firms is to move to the new marketplace even though their whole profits are diverted towards the intermediary. In this game the intermediary not only solves the chicken and egg problem, but he also destroys the free marketplace.

3.2.3 Buyers or sellers first?

In **stage 2** of the game, the intermediary chooses the strategy that gives him the largest profits. Proposition 3 describes the optimal strategy.

Proposition 3 *In the case of independent buyers, the intermediary's optimal strategy is to target sellers first: he attracts first all S sellers and then all B buyers.*

Proof. When buyers are independent and the pool of sellers is large ($S \geq 8$), the 'sellers first' strategy clearly dominates as it allows the intermediary to make positive profits. When the pool of sellers is smaller ($S \leq 7$), the optimal strategy is guided by the profits

$$\begin{aligned} \Pi_I^{bf}(1, B) &= B\left(8S - 4 - S^2\right) / \left(16S^2\right), \\ \Pi_I^{sf}(S, B) &= BS(S+2) / \left(4(S+1)^2\right). \end{aligned}$$

It is readily checked that $\Pi_I^{sf}(S, B) - \Pi_I^{bf}(1, B) > 0$.[14] ■

In the buyers first strategy ($b^* = B$ and $s^* = 1$), a buyer who would not move to the new marketplace knows that he would find at least one seller who would stay on the existing marketplace. Thus, this buyer keeps a positive fall back option which prevents the intermediary to capture his whole profits. By contrast, in the sellers first strategy ($b^* = B$ and $s^* = S$), a seller who does not move to the new marketplace does not find any trading partner on the existing marketplace, his fall back option is nil. The same holds for buyers who would not find any partner on the existing marketplace. By choosing the sellers first strategy, the intermediary reduces the firms fall back option to zero which allows him to capture the whole profits.

An immediate corollary to Proposition 3 is that, in **stage 1** of the game, the intermediary decides to launch the new marketplace as this turns out to be a profitable venture.

[14]More precisely, this expression is equal to $B(S-1)\ [S^2(S+3) + 4(S-1)(S+1)^2]$ / $16(S+1)^2 S^2$.

4 Rival buyers

When buyers produce substitutable varieties (we consider here the extreme case where the final product is homogeneous), an additional force drives marketplace choices: other things being equal, buyers tend to prefer the marketplace with the lowest number of buyers as it reduces the competition between them. We expect thus to find, on the buyers' side, a similar negative competition effect as on the sellers' side. However, the exact realization of this effect depends on the way we model the consumption side. When two marketplaces coexist, the crucial issue is to know whether each marketplace is visited by a different representative consumer, or whether a unique representative consumer has access to both marketplaces. In other words, what matters is the degree of substitutability between goods produced on different marketplaces. Note that in the previous section, this issue did not matter as final varieties were completely differentiated, meaning that buyers were isolated from competition irrespective of their marketplace choice.

In what follows, we make the assumption that final products sold on different marketplaces are perfectly differentiated. Another way to formulate this assumption is to say that *different marketplaces are visited by different representative consumers*.[15] Not only does this assumption greatly simplify the analysis of marketplace choices, but it also clears the production game of some unwanted results.

To see the latter point, consider the alternative assumption according to which a unique representative consumer visits both marketplaces and sees products sold anywhere as perfect substitutes. We show in the appendix that firms' equilibrium profits under this assumption depend on the *distribution of firms* between the two marketplaces (i.e., on the number of firms on each marketplace). It follows that movements of firms from one marketplace to another involve a complex web of externalities, which can lead to some counter-intuitive results. Let us look, for instance, at the sellers' side.

[15] This assumption could be justified as follows: either marketplaces are geographically separated, or using e-commerce instead of 'traditional' (paper-based) commerce in the upstream stage confers a distinguishing feature to final varieties (for example by having them sold only through a distinct set of distributors with e-commerce capabilities).

Suppose that an additional seller leaves marketplace 2 to join marketplace 1. On marketplace 1, this movement exerts a downward pressure on sellers' profits as competition increases. On the other hand, buyers on marketplace 1 have two reasons to welcome the arrival of an additional seller: first, their input becomes cheaper and second, the input of their competitors on marketplace 2 is now more expensive (as there is now one seller less there). There is thus a twofold improvement in the buyers' competitive position. This induces buyers to produce more and, hence, to demand more input, which exerts an upward pressure on sellers' profits. We provide an example in Appendix **??** where the latter effect outweighs the former, so that sellers' profits *increase* as an additional seller joins their marketplace. In other words, the competition effect we were observing in the previous section has its sign reversed! We also provide another example where buyers are better off with the arrival of another buyer on their marketplace, meaning that a similar reversion of the competition effect can happen on the buyers' side.

We think that effects of this sort complicate the analysis of the previous stages of the game in a needless way; moreover, they undermine the comparison with the results of Section 3. We proceed therefore under the assumption that marketplaces are differentiated in terms of final products.

4.1 Production decisions

Our assumption of different representative consumers implies that the buyers on one marketplace do not compete with the buyers on the other marketplace; they just compete among themselves (which contrast with the previous section where buyers were facing no competition at all). Therefore, we can analyze production decisions on each marketplace separately.

Consider a typical marketplace with s sellers and b buyers. The inverse demand function for the homogeneous final product is given by $p = 1 - Q$, where Q is the total quantity produced by the b buyers. As in Section 3, we start with analyzing the buyers' Cournot game. As each buyer is facing the same marginal cost w, we have that the Cournot equilibrium quantity is equal to $q = (1 - w) / (b + 1)$. Rearranging this expression, we have

$$w = 1 - \frac{b+1}{b} Q = 1 - \frac{b+1}{b} X,$$

which gives the inverse demand function for the sellers. Recalling that the sellers' marginal cost is equal to zero, one finds that at the symmetric Cournot equilibrium, each seller produces a quantity

$$x = \frac{b}{(b+1)(s+1)}.$$

The total quantity exchanged on the marketplace is thus equal to

$$Q(s,b) = X(s,b) = \frac{bs}{(b+1)(s+1)}.$$

We are now in a position to compute the firms' profits at the equilibrium (with the superscript riv referring to rival buyers):

$$\text{for sellers, } \pi_s^{riv}(s,b) = \frac{b}{(s+1)^2(b+1)}, \quad (4)$$

$$\text{for buyers, } \pi_b^{riv}(s,b) = \frac{s^2}{(s+1)^2(b+1)^2}. \quad (5)$$

Examining functions (4) and (5), one observes that the "liquidity" of the marketplace has one additional effect with respect to the ones observed in Section 3: on top of the positive indirect network effect for sellers ($\pi_s^{riv}(s,b+1) > \pi_s^{riv}(s,b)$) and for buyers ($\pi_b^{riv}(s+1,b) > \pi_b^{riv}(s,b)$), and of the negative competition effect for sellers ($\pi_s^{riv}(s+1,b) < \pi_s^{riv}(s,b)$), there is now also a *negative competition effect for buyers*: $\pi_b^{riv}(s,b+1) < \pi_b^{riv}(s,b)$.

As we will now see, the addition of this competition effect between buyers affects buyers' decisions with respect to marketplace choices and, thereby, the intermediary's optimal fee structure. Indeed, when buyers are direct competitors, they can alleviate the fierce competitive pressure by moving to a new marketplace counting a smaller number of buyers; this "differentiation incentive" was not present in the previous case where buyers were independent. We can thus anticipate that in the present case, the intermediary will find it easier to attract buyers, and thereby to make profit and to create value for the whole industry.

4.2 Marketplace choices and fee structure

We first consider the 'buyers first' strategy, then we move to the analysis of the 'sellers first' strategy. Afterwards, we examine whether the intermediary prefers one strategy or the other.

4.2.1 Strategy 'buyers first'

We solve the game backwards. As for **stages 5 and 6**, we can apply the argument we used in the 'buyers first' game with independent buyers, and conclude that *the intermediary never finds it optimal to attract more than a single seller*. In stage 5, the intermediary's objective is indeed to maximize $s\hat{A}_s^{riv}(s,b) = s\pi_s^{riv}(s,b) - s\pi_s^{riv}(S-s+1, B-b)$. Because sellers produce a homogeneous input at a constant marginal cost, the first term ($s\pi_s^{riv}(s,b)$) decreases with s (industry profits reach a maximum under monopoly). On the other hand, the second term ($s\pi_s^{riv}(S-s+1, B-b)$) increases with s (as π_s^{riv} decreases in its first argument and as $S-s+1$ decreases with s). It follows that $s\hat{A}_s^{riv}(s,b)$ decreases with s. The optimum for the intermediary is therefore to set a fee that attracts a single seller, unless this particular fee turns out to be a subsidy. That is, we still need to check whether $\hat{A}_s^{riv}(1,b)$ is non-negative. Note first that $\hat{A}_s^{riv}(1,0) < 0$: obviously, if the intermediary has not attracted any buyer beforehand ($b=0$), he will have to subsidize sellers to join. Next, for $b \geq 1$, it is clear that because of the competitive effect among buyers, $\hat{A}_s^{riv}(1,b)$ decreases with b. Therefore, a sufficient condition for $\hat{A}_s^{riv}(1,b) \geq 0$ is

$$\begin{aligned}\hat{A}_s^{riv}(1,1) &= \pi_s^{riv}(1,1) - \pi_s^{riv}(S, B-1) \\ &= \frac{\left(S^2+2S-7\right)(B-1)+(S+1)^2}{8B(S+1)^2} \geq 0,\end{aligned}$$

which is clearly satisfied for all $S \geq 2$. So, to summarize stage 5, we write

$$\begin{cases} s^*(b) = 1, & \forall b \geq 1 \\ s^*(b) = 0 & \text{if } b = 0. \end{cases}$$

Regarding **stage 4**, buyers' switching decision differs markedly according to whether buyers are rival or independent. In the previous section, independent buyers were all ending up on the marketplace offering the best deal (in terms of sellers' presence and of membership fee). Now, because of the competitive effect, rival buyers also care about the number of other buyers operating on their marketplace. As a result, the intermediary is able (as he does for sellers) to attract any number of buyers by setting the appropriate fee. More precisely, buyers base their decision to switch on the membership fee, A_b, set by the intermediary and on the anticipated $s^*(b)$. It is a Nash equilibrium for $1 \leq b < B$ buyers to switch if the following two conditions are met:

$$\begin{cases} \pi_b^{riv}(s^*(b), b) - A_b \geq \pi_b^{riv}(S - s^*(b-1), B - b + 1), \\ \pi_b^{riv}(S - s^*(b), B - b) > \pi_b^{riv}(s^*(b+1), b+1) - A_b. \end{cases}$$

Defining

$$\hat{A}_b^{riv}(b) \equiv \pi_b^{riv}(s^*(b), b) - \pi_b^{riv}(S - s^*(b-1), B - b + 1),$$

we can rewrite the latter two conditions as the following interval

$$\hat{A}_b^{riv}(b+1) < A_b \leq \hat{A}_b^{riv}(b). \tag{6}$$

Moreover, it is a Nash equilibrium for all firms to stay on the existing marketplace if $A_b > \hat{A}_b^{riv}(1)$, and for all firms to switch to the new marketplace if $A_b \leq \hat{A}_b^{riv}(B)$. Given the value of $s^*(b)$ and the fact that π_b^{riv} is a decreasing function of b, expression (6) and the latter two conditions define a sequence of non-empty and adjacent intervals, meaning that stage 4 admits a unique equilibrium for any value of A_b chosen by the intermediary.

In **stage 3**, the intermediary's problem is to choose:[16]

$$b^* = \max\left\{\arg\max_{b \geq 1} \Pi_I(1, b) = b\hat{A}_b^{riv}(b) + \hat{A}_s^{riv}(1, b); 0\right\}.$$

We show easily that the zero option is not exerted. For instance, one can establish that the intermediary can make positive profits by attracting one buyer and one seller. The optimal number of buyers to attract is, however, more tedious to compute. In the technical appendix we prove that the intermediary finds it optimal to attract a small number of buyers (that is, a number between one and roughly one third of the pool of buyers). Our results are summarized in the following lemma (and illustrated in the table of Figure 2 for $S, B \leq 20$).

[16] The zero option expresses the fact that the intermediary always has the possibility of staying out and ensuring a zero profit; he can indeed charge an excessive fee to buyers so that none of them (and none of the sellers) join: $b^* = s^*(b^*) = 0$.

Lemma 4 *In the case of rival buyers and under the strategy 'buyers first', the intermediary sets membership fees so as to attract a single seller and an intermediate number of buyers (b^* with $1 \leq b^* < (B+4)/3$). This number is non decreasing in the size of the pool of buyers (B) and non increasing in the size of the pool of sellers (S).*

Proof. (Sketch) We first show that when the intermediary selects only one seller, his profit $\Pi_I(1,b)$ is single-peaked in the number of buyers. Hence, there is only one value of the number of buyers that maximizes the intermediary's profit. This value is approximated by the value of b such that $d\Pi_I(1,b)/db = 0$ (it is the integer that is the closest to this value). To prove that this number is non decreasing in the size of the pool of buyers (B) and non increasing in the size of the pool of sellers (S), we compute $d^2\Pi_I(1,b)/dbdB > 0$ and $d^2\Pi_I(1,b)/dbdS < 0$. Finally we show that $\Pi_I(1,(B+4)/3) < \Pi_I(1,(B+1)/3)$. Combined with the single-peakedness of $\Pi_I(1,b)$, this implies that $b^* < (B+4)/3$. ■

4.2.2 Strategy 'sellers first'

As usual, we solve the game backwards. Regarding the final stages, we can, once again, appeal to the fact that firms produce a homogeneous product with constant marginal cost and state that the intermediary's objective in stage 5 decreases with the number of buyers he attracts (see the full argument above). So, the intermediary will charge a fee so as to attract one or zero buyer. The maximum fee the intermediary can set while attracting a single buyer is computed as follows. Given that s sellers have switched to the new marketplace, a single buyer agrees to switch too as long as $\pi_b^{riv}(s,1) - A_b \geq \pi_b^{riv}(S-s,B)$, or $A_b \leq \pi_b^{riv}(s,1) - \pi_b^{riv}(S-s,B) \equiv \hat{A}_b^{riv}(s,1)$. The intermediary sets the latter fee as long as it is non-negative (otherwise, he is better off setting an excessive fee and attracting no buyer). A few lines of computations show that $\hat{A}_b^{riv}(s,1) \geq 0$ unless $B = 2$, $S \geq 5$ and $s = 1$. Noting that there is no incentive for the intermediary to attract any buyer if he has not attracted any seller beforehand, we conclude that the equilibrium at **stage 5** is such that

$$\begin{cases} b^*(0) = 0, \\ b^*(1) = \begin{cases} 0 & \text{if } B = 2 \text{ and } S \geq 5, \\ 1 & \text{otherwise,} \end{cases} \\ b^*(s) = 1 \ \forall s > 1. \end{cases}$$

In **stage 4**, sellers base their decision to switch on the membership fee, A_s, set by the intermediary and on the anticipated $b^*(s)$. As explained above, it is a Nash equilibrium for $1 \leq s < S$ sellers to switch if

$$\hat{A}_s^{riv}(s+1) < A_s \leq \hat{A}_s^{riv}(s)$$

where $\hat{A}_s^{riv}(s) \equiv \pi_s^{riv}(s, b^*(s)) - \pi_s^{riv}(S - s + 1, B - b^*(s-1))$. Also, it is a Nash equilibrium for none of the sellers to switch if $A_s > \hat{A}_s^{riv}(1)$ and for all sellers to switch if $A_s \leq \hat{A}_s^{riv}(S)$. Again, these conditions guarantee that the fee charged by the intermediary induces a unique Nash equilibrium in stage 4.

Two cases must be studied in **stage 3**. First, suppose that the intermediary faces two buyers and at least five sellers. The intermediary has three options. He may either decide to attract no seller (and no buyer); in this case he makes no profit. Alternatively, he may attract only one seller (and thus no buyer). To attract a seller who will not find a partner, he must grant a subsidy which will not be recouped by a fee paid by buyers. Hence, the intermediary makes losses. Finally, he may decide to attract more than one seller (and thus one buyer). In that case, it is readily checked that he can make positive profits.[17] Hence, for $B = 2$ and $S \geq 5$, the intermediary earns larger profits if he attracts more than one seller than if he attracts exactly one seller or no seller.

Second, suppose that the economy comprises more than two buyers (or just two but less than 5 sellers). If the intermediary attracts no seller (and no buyer), he makes zero profits. By contrast, if he attracts at least one seller (and thus one buyer), we show that he makes positive profits. Hence,

[17] For instance, if he attracts 3 sellers (and thus one buyer), his profits are $\left(71S^4 - 298S^3 - 517S^2 + 3372S - 3492\right) / \left[576\,(S-1)^2\,(S-2)^2\right]$, which is strictly positive for any $S \geq 4$.

the intermediary prefers to attract at least one seller. The exact number of sellers that he attracts is more tedious to compute. We are able to prove, however, that the optimal number is relatively small insofar as it does not exceed by more than one unit the third of the available pool of sellers. We summarize our results in the following lemma (which is proved in the technical appendix). The table of Figure 2 illustrates the results for $S, B \leq 20$.

Lemma 5 *In the case of rival buyers and under the strategy 'sellers first', the intermediary sets membership fees so as to attract a single buyer and an intermediate number of sellers (s^* with $1 \leq s^* < (S+3)/3$). This number is non decreasing in the size of the pool of sellers (S) and non increasing in the size of the pool of buyers (B).*

Proof. (Sketch) In the technical appendix, we first show that when the intermediary selects only one buyer, his profit $\Pi_I(s,1)$ is single-peaked in the number of sellers. Hence, there is only one value of the number of sellers that maximizes the intermediary's profit. This value is approximated by the value of s such that $d\Pi_I(s,1)/ds = 0$ (it is the integer that is the closest to this value). To prove that this number is non decreasing in the size of the pool of sellers (S) and non increasing in the size of the pool of buyers (B), we compute $d^2\Pi_I(1,b)/dsdS > 0$ and $d^2\Pi_I(s,1)/dsdB < 0$. Finally we show that $\Pi_I((S+3)/3,1) < \Pi_I(S/3,1)$. From the single-peakedness of $\Pi_I(s,1)$, this implies that $s^* < (S+3)/3$. ■

4.2.3 Buyers or sellers first?

When buyers are rival, the intermediary offers a marketplace on which buyers differentiate themselves from their competitors who remain on the existing marketplace. The launch of the new marketplace adds then more value to the industry than when buyers are independent from the start. Indeed, we show in the technical appendix that the industry's profits are enhanced by the new marketplace. It is therefore not surprising to observe that, under both strategies, the intermediary is able to launch a profitable new marketplace. Moreover, the new marketplace is so attractive that in most cases, buyers and sellers pay positive fees.[18]

Both strategies are profitable for the intermediary (which guarantees the launch of the new marketplace in stage 1) but one may be more profitable than the other. The intermediary attracts an intermediate number of firms from the group targeted first, and a single firm from the other group. It is not possible to compute the exact value of the number of firms that the intermediate attracts but it is possible to compare the profits under the two strategies. The comparison is done in the technical appendix. Proposition 6 states our main result, which is illustrated in Figure 2.

Proposition 6 *In the case of rival buyers, the intermediary's optimal strategy is generally to target the largest group of firms first: if $B \geq S$, he chooses the 'buyers first' strategy, whereas if $S > B$, he chooses the 'sellers first' strategy. This rule admits a few exceptions in very small industries (i.e., when $S \leq 6$ and $B \leq 4$).*

In the rival buyers scenario, competition exists on both sides of the market, but the willingness to move to a marketplace with a fewer number of firms is stronger on the side which counts the largest number of firms. It is thus easier for the intermediary to attract a large number of firms of this side. Because the intermediary must attract a relatively large number of buyers in the buyers first strategy, and a relatively large number of sellers in the sellers first strategy, he chooses the strategy for which it is easier to attract firms: buyers first if $B \geq S$, sellers first otherwise. With many firms easily attracted on board, the intermediary is able to extract a larger rent from the single firm that he will attract from the other side afterwards. [19]

[18] For the proof, see the technical appendix. It is only in the 'buyers first' scenario with two buyers that buyers are subsidized: competition among buyers is limited to a duopoly so that the new marketplace offers less value added, and the input is cheaper on the existing marketplace which counts many sellers than on the new marketplace which attracts only one seller.

[19] Because of integer constraints and of the discontinuity of the intermediary's profits at $(s, b) = (1, 1)$, this result might be reversed for small values of S and B.

S \ B	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	1,2	1,2	1,2	1,2	1,3	1,3	1,3	1,3	1,4	1,4	1,4	1,5	1,5	1,5	1,5	1,6	1,6	1,6	1,6
3	1,1	1,1	1,2	1,2	1,2	1,2	1,3	1,3	1,3	1,3	1,3	1,4	1,4	1,4	1,4	1,4	1,5	1,5	1,5
4	2,1	1,1	1,1	1,2	1,2	1,2	1,2	1,3	1,3	1,3	1,3	1,3	1,4	1,4	1,4	1,4	1,4	1,5	1,5
5	2,1	2,1	2,1	1,2	1,2	1,2	1,2	1,2	1,3	1,3	1,3	1,3	1,3	1,4	1,4	1,4	1,4	1,4	1,4
6	2,1	2,1	2,1	2,2	2,2	2,2	2,2	2,2	2,3	2,3	2,3	2,3	2,3	2,3	2,4	2,4	2,4	2,4	2,4
7	3,1	2,1	2,1	2,1	2,2	2,2	2,2	2,2	2,2	2,3	2,3	2,3	2,3	2,3	2,4	2,4	2,4	2,4	2,4
8	3,1	2,1	2,1	2,1	2,2	2,2	2,2	2,2	2,2	2,3	2,3	2,3	2,3	2,3	2,4	2,4	2,4	2,4	2,4
9	3,1	2,1	2,1	2,1	2,2	2,2	2,2	2,2	2,2	2,3	2,3	2,3	2,3	2,3	2,4	2,4	2,4	2,4	2,4
10	3,1	3,1	3,1	2,1	2,2	2,2	2,2	2,2	2,2	2,3	2,3	2,3	2,3	2,3	2,3	2,4	2,4	2,4	2,4
11	3,1	3,1	3,1	3,1	3,2	3,2	3,2	3,2	3,2	3,3	2,3	2,3	2,3	2,3	2,3	2,4	2,4	2,4	2,4
12	4,1	3,1	3,1	3,1	3,2	3,2	3,2	3,2	3,2	3,3	3,3	3,3	3,3	3,3	3,3	3,4	3,4	3,4	3,4
13	4,1	3,1	3,1	3,1	3,2	3,2	3,2	3,2	3,2	3,3	3,3	3,3	3,3	3,3	3,3	3,4	3,4	3,4	3,4
14	4,1	3,1	3,1	3,1	3,2	3,2	3,2	3,2	3,2	3,3	3,3	3,3	3,3	3,3	3,3	3,4	3,4	3,4	3,4
15	4,1	4,1	3,1	3,1	3,2	3,2	3,2	3,2	3,2	3,3	3,3	3,3	3,3	3,3	3,3	3,4	3,4	3,4	3,4
16	4,1	4,1	4,1	4,1	3,2	3,2	3,2	3,2	3,2	3,3	3,3	3,3	3,3	3,3	3,3	3,4	3,4	3,4	3,4
17	5,1	4,1	4,1	4,1	4,2	4,2	4,2	4,2	4,2	4,3	4,3	4,3	4,3	4,3	3,3	3,4	3,4	3,4	3,4
18	5,1	4,1	4,1	4,1	4,2	4,2	4,2	4,2	4,2	4,3	4,3	4,3	4,3	4,3	4,3	4,4	4,4	4,4	4,4
19	5,1	4,1	4,1	4,1	4,2	4,2	4,2	4,2	4,2	4,3	4,3	4,3	4,3	4,3	4,3	4,4	4,4	4,4	4,4
20	5,1	5,1	4,1	4,1	4,2	4,2	4,2	4,2	4,2	4,3	4,3	4,3	4,3	4,3	4,3	4,4	4,4	4,4	4,4

The first digit is the optimal number of sellers under the sellers first strategy (s*). The second digit is the optimal number of buyers under the buyers first strategy (b*). Shaded cells indicate situations where the intermediary prefers the sellers first strategy (roughly, when S> B, with a few exceptions for small values of B and S).

Figure 2: Optimal strategy with rival buyers

5 Conclusion

In this paper, we examine the incentives for a third-party intermediary to launch a new vertical B2B marketplace within a specific industry. We focus on the two-sided nature of B2B intermediation: the marketplace benefits accruing to sellers (resp. buyers) increase as the pool of buyers (resp. sellers) enlarges. Alongside these positive indirect network effects, our framework also exhibits negative direct competition effects: other things being equal, sellers and buyers are better off the fewer firms of their own type are present on their marketplace. In this complex web of externalities, we investigate the following issues: the scope for profitable intermediation, the optimal strategy for the intermediary (which side of the market to attract first? which fee structure to put in place?), and the effect of intermediation on firms' profits.

We contrast two scenarios according to whether there is competition among buyers or not. Our main results are the following. First, we show that competition among firms induces the intermediary to limit the access to his marketplace, even though liquidity continues to play an important role. Second, we show that the intermediary can always find a profitable way to launch the new marketplace. The optimal way, however, depends on the scenario we consider. When buyers are independent, the intermediary prefers to target sellers first. Doing so, the best strategy is to divert all sellers and all buyers from the existing marketplace. When buyers are rival, the intermediary chooses to target first the largest group of firms. The best strategy is to attract about one third of firms in this group, followed by a single firm of the other group.

Our analysis focuses on third-party (or 'neutral') marketplaces. There exists, however, another category of marketplaces, namely consortia (or 'biased') marketplaces which takes an increasing importance on the B2B scene (see Ordanini *et al.*, 2004). These marketplaces (like *Covisint* in the automotive industry) come directly from the decisions of leaders on one side of the market. In future research, we shall endeavour to analyse the formation of such consortia marketplaces within the framework developed in this paper. Our objective is to address unanswered questions such as: What is the equilibrium size of the consortium running the marketplace? Do sellers or buyers have a higher incentive to launch such a marketplace? How do consortium members trade off their own profits with the fees (or subsidies) they collect from (or pay to) firms on the other side of the market? What are the antitrust implications of consortia marketplaces? This analysis could combine insights from recent papers analysing consortia marketplaces (but with exogenous marketplace sizes) such as Milliou and Petrakis (2004) and Yoo *et al.* (2003)[20] and from the literature on endogenous coalition formation (e.g., Soubeyran and Weber, 2002).

Two other areas of further research are likely to require some modifications of the present setting. First, the model proves ill-suited to analyze head-to-head competition between two new intermediaries. Intuitively, as

[20] Milliou and Petrakis (2004) analyse a firm's incentives to create a *private* B2B marketplace (i.e., in their analysis, a procurement network owned by a single buyer and used exclusively for doing business with its established suppliers). Like in our framework, firms' payoffs are derived explicitely from a production model and competition exists among buyers and among sellers. Yoo *et al.* (2003) study the impact of the ownership structure–third-party vs. consortia marketplaces, but take an ad hoc formulation for firms' payoffs and allow competition only among sellers.

soon as each intermediary finds it optimal to attract more than half of the available sellers and/or buyers, there always exists a profitable way to undercut the rival and no equilibrium in pure strategies exists in this Bertrand competition (based on membership fees). Indeed, when a firm switches marketplaces, it modifies the profit to be made on each marketplace and thereby, creates an endogenous source of horizontal differentiation between marketplaces. Because horizontal differentiation softens price competition, intermediaries manage to avoid the Bertrand Paradox but, as buyers and sellers face switching costs, intermediaries always have some leeway to profitably lure away a firm from the rival marketplace. Some form of heterogeneity among firms on each side of the market (for instance in terms of costs of adopting e-commerce) should solve this problem.

Second, we would also need to extend our model to consider multi-homing. It is indeed common for firms to conduct transactions on several marketplaces. However, it is not obvious how to introduce this possibility in our successive oligopoly model.

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Appendix. Unique representative consumer

Consumer. Suppose that b_1 buyers are active on marketplace 1 and b_2 buyers are active on marketplace 2, with $b_1 + b_2 = B$. Let $\mathcal{B}_m$ denote the set of buyers operating on marketplace m ($m = 1, 2$). Let $\gamma_m \in [0, 1]$ measure the degree of substitutability between the goods produced by buyers in $\mathcal{B}_m$, and $\beta \in [0, 1]$ measure the degree of substitutability between goods produced in different marketplaces. The unique representative consumer visiting the two marketplaces has the following quadratic surplus function:

$$U(q_1,q_2,\ldots,q_B) = \sum_{m=1}^{2}\left(\sum_{i\in\mathcal{B}_m} q_i - \frac{1}{2}\left(\sum_{i\in\mathcal{B}_m} q_i^2 + \gamma_m \sum_{i\in\mathcal{B}_m}\sum_{k\in\mathcal{B}_m,k\neq i} q_i q_k\right)\right)$$
$$-\beta\sum_{i\in\mathcal{B}_1}\sum_{j\in\mathcal{B}_2} q_i q_j - \sum_{m=1}^{2}\sum_{i\in\mathcal{B}_m} p_i q_i.$$

The consumer chooses the quantities $q_1, q_2, \ldots, q_B$ to maximize her surplus. The first-order conditions yield the linear inverse demand schedules in the region of prices where quantities are positive:

$$\begin{cases} \text{for good } i \text{ produced on marketplace 1,} & p_i = 1 - q_i - \gamma_1 Q_1^{-i} - \beta Q_2, \\ \text{for good } j \text{ produced on marketplace 2,} & p_j = 1 - q_j - \gamma_2 Q_2^{-j} - \beta Q_1, \end{cases}$$

where $Q_m = \sum_{k\in\mathcal{B}_m} q_k$ and $Q_m^{-x} = \sum_{k\in\mathcal{B}_m,k\neq x} q_k$.

Buyers' game. Supposing that the unit cost is just the price w_1 paid for the input, the problem for a typical buyer i on marketplace 1 writes as $\max_{q_i} q_i\,(p_i - w_1)$ and the first-order condition for profit maximization yields

$$w_1 = 1 - 2q_i - \gamma_1 Q_1^{-i} - \beta Q_2.$$

Similarly, the first-order condition for profit maximization for a typical buyer j on marketplace 2 is given by

$$w_2 = 1 - 2q_j - \gamma_2 Q_2^{-j} - \beta Q_1.$$

At the symmetric Cournot equilibrium, all buyers on marketplace m produce the same quantity q_m $(m = 1, 2)$. We can thus rewrite the previous two expressions as

$$\begin{aligned} w_1 &= 1 - (2 + \gamma_1(b_1 - 1))\,q_1 - \beta b_2 q_2, \\ w_2 &= 1 - (2 + \gamma_2(b_2 - 1))\,q_2 - \beta b_1 q_1. \end{aligned}$$

Sellers' game. Because of the one-for-one transformation technology, the total quantity of the final good produced on marketplace m (Q_m) is equal to the total quantity of the input produced on the same marketplace (X_m). The latter two expressions gives thus the inverse demand functions for the sellers on each marketplace. So, seller i on marketplace 1 (with $i =$

$1, \ldots, s_1$), whose marginal cost of production is assumed to be equal to zero, faces the following problem: $\max_{x_i} w_1 x_i$. The first-order condition for profit maximization yields:

$$1 - (2/b_1)(2 - \gamma_1 + \gamma_1 b_1) x_i - (1/b_1)(2 - \gamma_1 + \gamma_1 b_1) X_1^{-i} - \beta X_2 = 0,$$

(where the notation follows the same conventions as above). Similarly for a seller j on marketplace 2:

$$1 - (2/b_2)(2 - \gamma_2 + \gamma_2 b_2) x_j - (1/b_2)(2 - \gamma_2 + \gamma_2 b_2) X_2^{-j} - \beta X_1 = 0.$$

At the symmetric Cournot equilibrium, each seller on marketplace 1 produces a quantity x_1 and each seller on marketplace 2 a quantity x_2, with x_1 and x_2 solving the following system (obtained from the two previous equations):

$$\begin{cases} (2 - \gamma_1 + \gamma_1 b_1)(s_1 + 1) x_1 + \beta b_1 s_2 x_2 = b_1, \\ \beta b_2 s_1 x_1 + (2 - \gamma_2 + \gamma_2 b_2)(s_2 + 1) x_2 = b_2. \end{cases}$$

It follows that

$$x_1 = \frac{b_1 (2 - \gamma_2 + \gamma_2 b_2)(s_2 + 1) - \beta b_1 b_2 s_2}{(2 - \gamma_1 + \gamma_1 b_1)(2 - \gamma_2 + \gamma_2 b_2)(s_1 + 1)(s_2 + 1) - \beta^2 b_1 b_2 s_1 s_2},$$

and x_2 has the same expression with the indices 1 and 2 reversed.

After some manipulations, one can establish the following relationships (with $m = 1, 2$):

$$w_m = \frac{b_m}{b_m + 1} x_m, \; q_m = \frac{s_m}{b_m} x_m \text{ and } p_m - w_m = q_m.$$

We can now express equilibrium profits on marketplace m:

$$\begin{aligned} &\text{for a buyer,} \quad \pi_b^m(s_1, s_2, b_1, b_2) = q_m^2 = \left(\tfrac{s_m}{b_m} x_m\right)^2, \\ &\text{for a seller,} \quad \pi_s^m(s_1, s_2, b_1, b_2) = w_m x_m = \tfrac{b_m}{b_m + 1} x_m^2. \end{aligned}$$

Let us now show that the competition effect may be positive. We construct the following examples. Suppose that the goods produced anywhere are seen as perfect substitutes by the representative consumer (i.e., $\gamma_1 = \gamma_2 = \beta = 1$).

- *Example 1*: let $b_1 = 5, s_1 = 19, b_2 = 15$ and $s_2 = 1$. In that case, a buyer on marketplace 2 achieves a profit equal to $25/233\,289$. Suppose now that one buyer moves from marketplace 1 to marketplace 2 (so that $b'_1 = 4$ and $b'_2 = 16$); each buyer on marketplace 2 achieves now a profit equal to $1/8281 > 25/233\,289$. Therefore, buyers on marketplace 2 are better off after the arrival of one additional buyer.

- *Example 2*: let $b_1 = 19, s_1 = 5, b_2 = 1$ and $s_2 = 15$. In that case, a seller on marketplace 2 achieves a profit equal to $50/233\,289$. Suppose now that one seller moves from marketplace 1 to marketplace 2 (so that $s'_1 = 4$ and $s'_2 = 16$); each seller on marketplace 2 achieves now a profit equal to $2/8281 > 50/233\,289$. Therefore, sellers on marketplace 2 are better off after the arrival of one additional buyer.