Duopolistic Competition between Independent and Collaborative Business-to-Business Marketplaces*

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Abstract

This paper studies imperfect price competition between two intermediaries in an electronic business-to-business matching market with indirect network externalities. The intermediaries differ with regard to their ownership structure: an independent third party incumbent marketplace competes with a challenging collaborative buy-side consortium marketplace in terms of attracting buying and selling firms. When firms can register exclusively with at most one intermediary, the incumbent is only able to deter entry if the number of firms taking ownership in the consortium is sufficiently small. Otherwise, the consortium can successfully enter and monopolize the market. When firms can multi-home, i.e. they register simultaneously with both intermediaries, the consortium can always enter while both intermediaries stay in the market with positive profits.

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1 Introduction

After the slow-down of the first wave initial hype associated with commercial internet activities between companies and consumers (business-to-consumer or B2C electronic commerce), in recent years the focus of electronic commerce tended towards electronic transactions and relationships between companies (business-to-business or B2B e-commerce) which have consequently attracted considerable interest and investment capital. The transaction volume as well as the growth potential is indeed much higher in B2B than in B2C e-commerce, i.e. following the UNCTAD (2002) the former accounts for around 95 per cent of all e-commerce in most estimates. Several sources, as e.g. the Gartner Group and Forrester Research, coincide in predicting an intense growth potential of the worldwide B2B volume from around $433 billion in 2000 to already more than $1 trillion in 2004. Around 37% of this total volume will be done via B2B marketplaces acting as intermediaries in two-sided buyer-seller markets.[1]

However, despite this promising overall outlook of B2B e-commerce, especially the future of independent marketplaces is highly questionable. Over 400 B2B marketplaces that were predicted a glorious future some years ago had shut down by 2001 and only about 100 B2B marketplaces handled any genuine transactions in the same year.[2] Mainly independent third-party marketplaces have begun consolidating by shutting down or merging. Besides internal problems, as e.g. lack of liquidity, one of the main reasons for this decline lies in the increasing direct competition from upcoming collaborative (or biased) B2B marketplaces, which are jointly provided by industry competitors[3], as e.g. *Covisint* which is a joint buy-side platform of the car manufacturers DaimlerChrysler, Ford, GM and Renault-Nissan or the retailers' marketplace *GlobalNetXchange* by Sears, Roebuck, Carrefour and others. In fact, such consortia-led marketplaces dispose of a competitive advantage in the positioning to generate transactions since companies share the ownership while also being active participants in the market. Contrarily, the owners of third-party marketplaces are no trading partners.

[1] See UNCTAD (2002) and The Economist, May 15th (2004).

[2] See Harrington (2001) and The Economist, May 19th (2001).

[3] See Davenport, T.H., et al. (2001).

Accordingly, large or many owners of a consortium more easily attain critical mass of participants.[4] In turn this is crucial for an intermediary's prospects of success because of network effects, which are typical for such two-sided buyer-seller markets.

This paper contributes a theoretical framework for analysis of the ongoing process of de-intermediation and re-intermediation in the B2B landscape, reflecting the consolidated elimination of initially prevalent third-party intermediaries, together with market entry of collaborative intermediaries. We account for the fact that a crucial feature for a marketplace's prospects of success is its ownership structure. This happens by studying the impact on market structures and participation incentives of buying and selling firms when B2B marketplaces with non-identical ownership structures engage in price competition in a bilateral matching market. I.e. we consider a collaborative buy-side B2B marketplace, meaning that some buy-side firms form a coalition to build up their own marketplace,[5] as challenging competitor to an incumbent neutral intermediary in terms of attracting participants from each market side.

In particular, we show that even if an incumbent third party owned B2B marketplace has a reputation advantage, a challenging collaborative entrant is able to catch (at least) some market share. When intermediaries compete in access fees and registration is exclusively possible with only one marketplace, the entrant is able to overcome its reputation disadvantage by monopolizing the market, whenever the number of firms that provide the collaborative B2B marketplace is sufficiently large. When the B2B marketplaces are able to observe the occurrence of trade between two matched partners, they can apply transaction taxes as an additional pricing instrument. In such a situation the consortium can always enter the market. Furthermore, when firms can multi-home, i.e. they simultaneously register with both marketplaces, there also exists no pricing strategy that enables the independent incumbent to deter entry. However, in such a scenario both marketplaces remain in the market and sellers multi-home whereas buyers are segmented among both intermediaries.

[4] See The Economist, March 2nd (2000).

[5] Considering a sell-side instead of a buy-side platform would yield symmetrical results. However, buy-side consortium marketplaces are most common in practice.

These results are driven by indirect network effects. A buyer's value of participation in a B2B marketplace increases with the number of participating sellers and vice versa. Each participant is not only a consumer but also an input for an intermediary. Therefore an intermediary has to attract a large number of participants from one market side, say buyers, to ensure participation from firms on the respective other market side, while buyers are only willing to participate if they expect many sellers to register with the same intermediary.[6] Due to this particular market characteristic, intermediaries apply pricing strategies that subsidize participants from one market side and recover this loss on the other market side. In this regard, there is a crucial difference between an independent B2B marketplace and the collaborative buy-side B2B marketplace: besides providing intermediation services the latter already comprises some firms that participate in the matching process in terms of those buyers taking ownership in the joined marketplace. Hence, attracting sellers becomes easier for the collaborative marketplace because it can offer an additional input at the time of entrance.

Related literature:

Excellent overviews on descriptive categorizations of B2B markets and on the impact of the usage of B2B markets on transaction costs provide Lucking-Reiley and Spulber (2000) as well as Garicano and Kaplan (2001). Of particular relevance to this paper is the literature on intermediation and competition in matching markets. Bhargava et. al (2000) apply intermediation theory in an electronic market context. They focus on product differentiation and analyze the decision of an intermediary when aggregation benefits for buyers are present but do not consider a corresponding network externality on the sellers' side. Fasth and Savary (2002) analyze an electronic B2B exchange market and its dynamic evolution over time, showing that equilibrium prices within a marketplace may not always decrease with lower search costs. Yoo et al. (2002) concentrate on a neutral B2B intermediary's pricing decisions in the presence of network effects. In contrast to our approach they do not model competition between B2B marketplaces, also bilateral matching is omitted in their model.

[6] This phenomenon is referred to as the "chicken and egg" problem. See e.g. Caillaud and Jullien (2001, 2003).

Matching in intermediated markets is a widely studied field in the literature. E.g. Rubinstein and Wolinsky (1987) examine a bilateral bargaining model under complete information to show that middlemen may exist to reduce search costs in a market with intermediation based on a time-consuming, stochastic matching-process. When buyers have diverse levels of willingness to pay, and suppliers differ with respect to their opportunity costs, intermediaries can eliminate the uncertainty arising from random matches in a decentralized fashion by posting bid and ask prices. Hence, they provide an advantage over a decentralized matching market (see Spulber, 1996b). Spulber (1996a) presents a model with several competing intermediaries, which act as price-setters. Gehrig (1993) deals with intermediation in search markets. In his model heterogenous buyers and sellers choose between direct trade on a search market and intermediated trade where a monopoly intermediary posts bid and ask prices.

Most related to this paper are the models by Caillaud and Jullien (2001, 2003) who analyze competition between two ex ante symmetric third-party intermediaries in a bilateral electronic matching market. Their main finding is that there always exist pricing strategies so that an incumbent intermediary can prevent entry of a competitor if buyers and sellers have so-called "bad expectations" against the potential entrant, i.e. they register with the incumbent, whenever it is not a dominated strategy. They claim that such a reputation advantage creates a powerful barrier to entry. We show that their findings do not generally apply when competing B2B marketplaces have non-identical ownership structures. Moreover, our results go into the opposite direction since in our model the challenging collaborative entrant is able to exert a competitive advantage despite bad expectations against it.

The remainder of the paper is structured as follows: the assumptions of the model are introduced in section 2. In section 3 we analyze intermediaries competing in access fees. In section 4 we introduce transaction taxes as an additional pricing instrument. Section 5 deals with competition when intermediation services are non-exclusive. Section 6 concludes the paper.

2 The Model

The framework we use is a simplified version of the models by Caillaud and Jullien (2001, 2003) where we introduce B2B marketplaces with non-identical ownership structures. There are 2 homogeneous populations consisting of a continuum of mass 1 of ex ante identical firms on each the sell- and the buy-side of the market, labelled $i = b, s$, respectively. For each agent i there exists a unique matching partner on the other market side j with whom trade is valuable. The total gain from trade equals 1 in case of a perfect match, otherwise the gain from trade is 0. Perfectly matched firms follow an efficient bargaining process yielding a linear sharing of the trade surplus, with u_i being the type-i agent's share, such that $u_b + u_s = 1$. Without loss of generality, we assume that the buyers' and sellers' shares from trade (u_s, u_b) are not too diverse so that for all j with $j \neq i$, it holds that $u_j < 2u_i$.[7] Firms cannot find their corresponding match without a matchmaking intermediary $k = I, E$ (I as *incumbent*, and E as *entrant*) who provides a matching technology that allows to process, select and use information on firms on both sides of the market. Hence, intermediaries compete in terms of attracting sellers and buyers. For simplicity, it is assumed that the intermediaries' registration and connection costs are negligible. Now if $n_i \leq 1$ firms of type i, drawn randomly within population i, register with matchmaker k, a j-agent finds its match through this intermediary with probability $n_i^k \in [0, 1]$. The resulting expected utility for agent j from registration with k then amounts to $n_i^k u_j(1 - t^k) - p_j^k$, with p_j^k being an upfront registration or access fee and t^k being a tax conditional on the realized transaction. Note that the registration fee p_j^k can be negative, which would represent a certain type of subsidizing joining firms.[8] On the other hand, we restrict the analysis to values t^k with $1 \geq t^k \geq 0$ because negative transaction fees would result in arbitrary pairs of firms pretending to match simply to collect the fee.[9]

[7] This assumption guarantees that no market side has an extremely dominant bargaining position.

[8] A negative registration fee might be interpreted as a price below marginal cost. In case that this is a large effect, the price can indeed be negative. This can be interpreted as the agent receiving free access to the marketplace and getting additional services as e.g. installing customer data in the database.

[9] The reader is referred to Caillaud and Jullien (2003) who proof that focusing on the total transaction fee instead of discriminatory fees for buyers and sellers, respectively, does not change results.

3 Marketplaces competing in access fees

The basic model is of competition in access fees, when intermediation services are exclusive, i.e. firms can only register with one marketplace I or E, but not with both. This may be because the data to build a firm specific profile in a data base are considered proprietary. Or, an intermediary might establish exclusivity[10] to impose a certain guarantee for its efforts in processing the users' demands ending up with a transaction. Intermediaries compete in access fees corresponding to a one-time joining fee which is indeed considered to be the most applied pricing scheme on B2B marketplaces.

The game is of simultaneous pricing, where the incumbent I chooses its access prices $P^I = (p_b^I, p_s^I)$ and E sets prices $P^E = (p_b^E, p_s^E)$. A resulting market allocation is then characterized by the allocation of firms $n_i^k(P^I, P^E)_{i,k}$, which is the result of a rational expectation market decision process by j-users, given any P^I, P^E and $n_i^k(P^I, P^E)_k, n_j^k(P^I, P^E)_k$ for $j \neq i$. An equilibrium comprises market allocations and pricing strategies for each possible price system, so that prices are a Nash equilibrium in the reduced-form pricing game induced by the system of market allocations.[11] The approach builds on the analysis of the entrants best response to the prices p_b^I and p_s^I set by the incumbent I, by fixing the incumbent's prices and considering various pricing strategies of the entrant E. Furthermore, it is assumed that users of both populations hold favorable beliefs for intermediary I so that j-users think that $n_i^I = 1$ whenever it is not irrational for i-users to do so (whenever it is not a dominated strategy for i-users to register with I). This can be interpreted as a certain reputation advantage of the incumbent. Now we consider that some share $n_b^{E\mathcal{O}} \in (0, 1]$ of buy-side firms build up an own collaborative B2B marketplace E for intermediation services,[12] competing with I. This is only profitable if the expected utility from the joint provision of E, which is supposed to be in equal shares, is higher for all firms $n_b^{E\mathcal{O}}$ than remaining at I, yielding:

$$n_b^{E\mathcal{O}} n_s^E u_b + n_s^E p_s^E + n_b^{E\mathcal{N}} p_b^E \quad > \quad n_b^{E\mathcal{O}}(u_b - p_b^I) \quad (\geq 0) \tag{1}$$

[10] See also The Economist, June 15th (2000).

[11] See Caillaud and Jullien (2001).

[12] Note that we consider $n_b^{E\mathcal{O}}$ to be exogenous since we are interested in the prospect of success of such a consortium given the number of participating providers.

The left hand side is the expected total profit of the collaborative B2B marketplace,[13] which is decomposed into the expected benefits from trade by ownership taking firms $n_b^{E\mathcal{O}} n_s^E u_b$ as well as expected payments $n_i^E p_i^E$ from participating sellers and buyers, respectively. The right hand side of (1) is the sum of the expected utilities of those buy-side firms $n_b^{E\mathcal{O}}$ when staying at I. Note that $n_b^{E\mathcal{N}}$ denotes buy-side firms that register with E but do not participate in its ownership. Hence, the total number of buy-side firms that participate in E is $n_b^E = n_b^{E\mathcal{O}} + n_b^{E\mathcal{N}}$. Suppose inequality (1) holds, then sellers cannot rationally believe that $n_b^I = 1$. They hold (rational) beliefs that $n_b^E > 0$ and consider registering to E by comparing the expected utility at E with the utility when staying at I and 0 when not registering with any intermediary. Hence, intermediary E must charge prices so that

$$n_b^{E\mathcal{O}} u_s - p_s^E \quad > \quad (1 - n_b^{E\mathcal{O}}) u_s - p_s^I \quad (\geq 0) \tag{2}$$

in order to convince sellers to register with E. The left hand side is a sellers expected utility from registration with the new marketplace E, the right hand side shows the utility when staying at intermediary I. Now, provided E adopts a pricing strategy so that (2) holds, it is a dominant strategy for sellers to register with E and the remaining buyers at I, namely n_b^I, cannot rationally believe that $n_s^I = 1$. They hold (rational) beliefs that $n_s^E = 1$ and must then consider registering with E as well by comparing $u_b - p_b^E$ with $-p_b^I$ and 0 (if they do not register at all). So, with beliefs favorable to I, maximal profits for intermediary E are given by

$$n_b^{E\mathcal{O}} u_b + \underbrace{u_s(2n_b^{E\mathcal{O}} - 1) + p_s^I}_{\gtrapprox p_s^E} + (1 - n_b^{E\mathcal{O}}) \underbrace{(u_b + \min\{p_b^I, 0\})}_{\gtrapprox p_b^E} \tag{3}$$

with $\gtrapprox$ meaning 'slightly bigger than'. Hence, for $P^I = (p_s^I, p_b^I)$ to be supported as a dominant firm equilibrium, it must necessarily hold that those $n_b^{E\mathcal{O}}$ buyers cannot profitably leave I and build up their own marketplace E, so that it follows from (3) together with (1) that an entry deterring pricing scheme would have to be such that

$$u_s(2n_b^{E\mathcal{O}} - 1) + p_s^I + (1 - n_b^{E\mathcal{O}})(u_b + \min\{p_b^I, 0\}) + n_b^{E\mathcal{O}} u_b < n_b^{E\mathcal{O}}(u_b - p_b^I). \tag{4}$$

[13] We assume that $p_b^{E\mathcal{O}} = 0$, since a positive price would just be redistributed among those firms taking ownership in E.

From that, it can be shown, that there only exist pricing strategies $P^I = (p_b^I, p_b^I)$ that enable I to corner the market in a dominant firm equilibrium, if $n_b^{E\mathcal{O}}$ is sufficiently small.

Proposition 1 *In a scenario with exclusive registration and competition in access fees, the independent incumbent is able to apply an entry deterring pricing strategy, only if the share of buyers taking ownership in the collaborative marketplace is sufficiently small, i.e.* $n_b^{E\mathcal{O}} \leq \frac{1}{2}$. *Otherwise, if the share of ownership taking buyers is large, i.e.* $n_b^{E\mathcal{O}} > \frac{1}{2}$, *the consortium can enter and monopolize the market.*

Proof. The proof is relegated to the appendix.

This result is driven by indirect network effects. The higher the number $n_b^{E\mathcal{O}}$ of buy-side firms taking ownership in E, the higher is the incentive for firms on the other market side (sellers) to switch to E. In the presence of bad-expectations against E, the entrant would have to apply a so-called "divide-and-conquer" strategy[14] to get a positive market share. That means, E would have to "bribe" sellers (divide) while recovering this loss on the other market side (conquer). Contrarily to the benchmark case of Caillaud and Jullien (2001), where a challenging independent intermediary has to subsidize one market side through negative access prices, in our framework the collaborative marketplace E has an additional tool for attracting sellers since besides the mere provision of a matching platform, the collaborative B2B marketplace already offers a certain amount $n_b^{E\mathcal{O}}$ of buy-side matching partners. This constitutes an additional input for subscribing sellers who can expect to profit from participation in E in two ways: first, their expected probability of trade and second a potentially negative registration fee (bribe). Accordingly, the higher the share $n_b^{E\mathcal{O}}$ of providing firms at E, the higher is a participating seller's expected matching probability and the lower is the bribe which is necessary to convince a seller to switch to E.

[14] See e.g. Caillaud and Jullien (2003).

Proposition 2 *I can only sustain dominant firm equilibria if $n_b^{E\mathcal{O}} \leq \frac{1}{2}$. In case that $n_b^{E\mathcal{O}} \in [0, \frac{u_b - u_s}{u_b - 2u_s}]$ this happens by subsidizing buyers with prices $p_s^I = u_s$; $p_b^I = (n_b^{E\mathcal{O}} - 1)u_b - 2n_b^{E\mathcal{O}}u_s$. If $n_b^{E\mathcal{O}} \in (\frac{u_b - u_s}{u_b - 2u_s}, \frac{1}{2}]$ the incumbent subsidizes sellers with prices $p_s^I = -u_b + (1 - 2n_b^{E\mathcal{O}})u_s$; $p_b^I = u_b$. E's best response prices are given by $p_s^E \lessapprox u_s(2n_b^{E\mathcal{O}} - 1) + p_s^I$ and $p_b^E \lessapprox u_b + min\{p_b^I, 0\}$. In equilibrium only one intermediary is active with (weakly) positive profits implying prices as specified above.*

Proof. The proof is in the appendix.

In order to deter E's entrance, I has to create a strong bound to (at least) one market side through the application of negative access fees. This creates an incentive for firms on the subsidized market side to stay with I and attracts firms from the other market side through the associated network effect. Note, that $\frac{u_b - u_s}{u_b - 2u_s}$ can only take values $\in [0, 1]$ if $u_b \leq u_s$.[15] Then I can successfully deter entry by E through subsidizing buyers if $n_b^{E\mathcal{O}} \leq \frac{u_b - u_s}{u_b - 2u_s}$ and through subsidizing sellers if $n_b^{E\mathcal{O}} > \frac{u_b - u_s}{u_b - 2u_s}$. The figure below gives a graphical representation of the results obtained above:

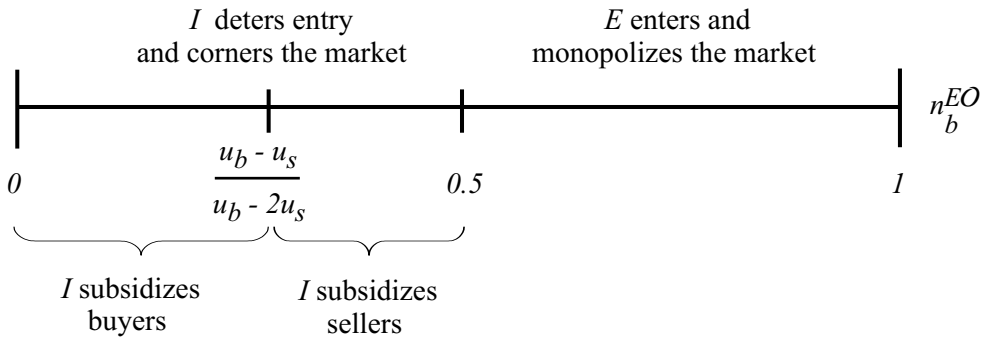

Figure 1: emerging market structures dependent on $n_b^{E\mathcal{O}}$

If $n_b^{E\mathcal{O}}$ is sufficiently small, i.e. less (or equal) than $\frac{u_b - u_s}{u_b - 2u_s}$, the subsidy received at I is a sufficient incentive for those firms $n_b^{E\mathcal{O}}$ to stay with I. In other words, there are too few firms that would take ownership in E so that the comparative advantage in terms of having already some buy-side firms at E is outbalanced by the buy-side

[15] This is due to the assumption that $u_j < 2u_i, \forall j \neq i$. Moreover, $n_b^{E\mathcal{O}}$ can only take values $\in [0, \frac{1}{2}]$ in such a situation. See the appendix.

subsidy at I so that building up an own marketplace E cannot be profitable. On the other hand, if $n_b^{E\mathcal{O}} > \frac{u_b - u_s}{u_b - 2u_s}$, then I cannot deter entry by subsidizing buyers. This is because subsidizing buyers reduces E's cost of attracting sellers. Even if those buy-side firms $n_b^{E\mathcal{O}}$ would forgo the subsidy at I when building up E, this is not enough to compensate the potential gains from the build-up of E. Since sellers would have to pay positive access fees at I, they could be attracted at a relatively cheap price by E, whenever $n_b^{E\mathcal{O}}$ is large enough. This is because the higher $n_b^{E\mathcal{O}}$ the higher is the probability for a seller to meet its match at E.

If in turn $u_b > u_s$,[16] then I can only deter entry by subsidizing sellers (as long as $n_b^{E\mathcal{O}} \leq \frac{1}{2}$). This is because in such a case, the sellers share from trade u_s is too small so that I could recover a buy-side subsidy through positive access fees p_s^I. This means p_s^I would have to be higher than u_s, but then no sell-side firm would register with I. Accordingly, subsidizing sellers is a good strategy for I because with only few firms $n_b^{E\mathcal{O}}$ at E, sellers' incentive from having already some potential matching partners at E cannot compensate for the subsidy which sellers would forgo when leaving I.

4 Competition with access fees and transaction taxes

Let us extent the analysis by introducing transaction fees t^k as a further pricing instrument. It is assumed that intermediaries can observe and verify whether trade takes place but not the exact transaction price, so that the transaction fee depends on the occurrence of trade only. Such a fee is supposed to be paid by firms ex post after a transaction between two matched partners takes place. Hence, the net surplus to be shared among matched partners is $(1 - t^k) \geq 0$. We impose transaction fees to be (weakly) positive, so that $1 \geq t^k \geq 0$, because negative transaction fees would result in arbitrary pairs of firms pretending to match simply to collect the fee.

Indeed, the application of transaction dependent fees is widespread among B2B marketplaces especially when the fulfillment of transactions is observable. Caillaud and Jullien (2001, 2003) find that in such a set-up the incumbent intermediary is able to

[16] In this case, $\frac{u_b - u_s}{u_b - 2u_s} < 0$, so that the critical value would lie to the left of 0 in figure 1.

sustain dominant firm equilibria implying zero profits. We show, that this findings do not hold in case of competing intermediaries with different ownership structures.

Again, we look at E's best response to the prices p_i^I, t^I set by I, when beliefs favor the incumbent. E's entrance will only be profitable if the expected utility from the collaborative B2B marketplace is higher for each firm $n_b^{E\mathcal{O}}$ than remaining at I, yielding

$$n_b^{E\mathcal{O}} n_s^E u_b + n_s^E (p_s^E + n_b^E u_s t^E) + n_b^{E\mathcal{N}} (p_b^E + n_s^E u_b t^E) \quad > \quad n_b^{E\mathcal{O}} \left(u_b(1-t^I) - p_b^I\right). \quad (5)$$

As in (1), the left hand side shows the maximum profit the collaborative B2B marketplace could make. This profit is decomposed into $n_b^{E\mathcal{O}} n_s^E u_b$ as expected benefits from trade by ownership taking firms as well as expected payments $n_s^E(p_s^E + n_b^E u_s t^E)$ and $(n_b^E - n_b^{E\mathcal{O}})(p_b^E + n_s^E u_b t^E)$ from participating sellers and buyers, respectively. The right hand side is the sum of expected utilities of those buy-side firms $n_b^{E\mathcal{O}}$ when staying at I.[17] To attract sellers, E would have to apply a pricing strategy such that there is an incentive for sellers to leave I. Note that (given that (5) holds) there is already a positive share $n_b^{E\mathcal{O}}$ of buyers at E so that joining sellers can expect a positive matching probability. Sellers join E, if the associated benefit is higher than staying at I, given that $n_b^{E\mathcal{O}}$ buyers left I to build their own marketplace E. This yields

$$n_b^{E\mathcal{O}} u_s(1-t^E) - p_s^E \quad > \quad \max\{\underbrace{(1-n_b^{E\mathcal{O}})}_{=n_b^I} u_s(1-t^I) - p_s^I, 0\}. \quad (6)$$

The left hand side is a seller's benefit from switching to E, while the right hand side is the maximum of the corresponding benefit from staying with I, and 0 as expected utility from not registering with any intermediary. If (6) holds, it is a dominant strategy for all sellers to switch to E so that non-ownership taking buyers have to believe that $n_s^E = 1$. Those buyers then have to compare $u_b(1-t^E) - p_b^E$ as expected utility from also registering with E, with $-p_b^I$ as expected utility from staying with I, and 0 as utility when not registering with any intermediary. Hence, those buyers will decide to register with E provided

$$p_b^E - u_b(1-t^E) < \min\{p_b^I, 0\}. \quad (7)$$

[17] It is implied that ownership taking buyers do not incur any transaction nor registration fees, that is $p_b^{E\mathcal{O}} = t^{E\mathcal{O}} = 0$, due to the same argumentation as in the scenario with competition in access fees.

E's maximal potential profits then read as:

$$n_b^{E\mathcal{O}}u_b + \overbrace{p_s^I + n_b^{E\mathcal{O}}u_s(1-t^E) - (1-n_b^{E\mathcal{O}})u_s(1-t^I)}^{\gtrapprox p_s^E} + u_s t^E$$
$$+(1-n_b^{E\mathcal{O}})(\underbrace{u_b(1-t^E) + \min\{p_b^I, 0\}}_{\gtrapprox p_b^E} + u_b t^E) \tag{8}$$

Note, that the achievement of the highest possible profit for E always implies for E to set the maximum transaction fee $t^E = 1$, which can be applied without jeopardizing the sellers' possible shift from I to E. Hence, (8) can be simplified, yielding

$$n_b^{E\mathcal{O}}u_s + u_b + p_s^I + (1-n_b^{E\mathcal{O}})(\min\{p_b^I, 0\} + u_s t^I) \tag{9}$$

A dominant firm structure where I can successfully deter entrance of the challenging consortium requires a pricing strategy so that E's maximal potential profits are less than $n_b^{E\mathcal{O}}[u_b(1-t^I) - p_b^I]$ together with firms registering with I (i.e. $u_i(1-t^I) - p_i^I \geq 0$) and I's profits being non-negative: $p_s^I + p_b^I + t^I \geq 0$. It turns out that there is no pricing strategy that enables I to deter market entry of the buy-side consortium. Hence, the challenging entrant corners the market with positive profits.[18]

Proposition 3 *With exclusive intermediation and competition in registration and transaction fees, there always exists a best response strategy enabling the collaborative buy-side marketplace E to enter and monopolize the market.*
The entrant's maximal profits are bounded from below by $\pi^E \geq n_b^{E\mathcal{O}}u_s$, involving the price system: $p_b^I = u_b, p_s^I = -u_b, t^I = 0$ and $p_b^E \lessapprox 0, p_s^E \lessapprox -u_b - (1-n_b^{E\mathcal{O}})u_s$, $t^E = 1$.

Proof. See the appendix.

Again, this result is due to the feature that besides providing intermediation services, the owners of the collaborative consortium also participate in the matching process. Compared to the benchmark case of an independent challenging intermediary competing with an independent incumbent,[19] attracting firms from one market side,

[18] Since in such a framework there exist multiple equilibria we are particularly interested in the maximum profits the entrant could make given that the incumbent wants to minimize the entrant's profits.

[19] See Caillaud and Jullien (2001, 2003) who show that in such a case the incumbent can sustain a dominant firm equilibrium only by making zero profits.

i.e. in our case conquering sellers, is easier for the consortium E since sellers expect a strictly positive matching probability. The possibility of applying transaction taxes as a second pricing instrument benefits the entrant. This is due to the following: given that beliefs favor I, so that firms register with I whenever it is not a dominant strategy to do so, both pricing instruments are perfect substitutes in terms of extracting profits from non-ownership taking buyers. For the potential entrant, charging a high transaction tax $t^E = 1$ allows E to extract an additional benefit from sellers since non-ownership taking buyers pay this fee only by the share u_b. Therefore, a high transaction tax reduces E's cost of attracting sellers dramatically. When transaction taxes can be applied, it is not possible for the incumbent to prevent that E attracts any trade because the share of profit needed to be forgone by I in order to protect a potential monopoly position is too big, so that I could not stay in the market at (weakly) positive profits.

5 Competition with non-exclusive intermediation services

Now we relax the assumption that registration is exclusively possible with only one intermediary. Firms might register with both B2B marketplaces simultaneously ("multi-homing") in order to benefit from their different user bases so to increase their matching probability. The matching processes the two marketplaces perform are supposed to be independent. We explicitly exclude firms $n_b^{E\mathcal{O}}$ that take ownership in E from the possibility of also registering with I since this would hold obvious results: the benefit which firms $n_b^{E\mathcal{O}}$ initially obtain at I could be used to pay a (incrementally) small subsidy to firms at E, so that all other firms would subscribe with E as well. Therefore, such a situation cannot yield a dominant firm equilibrium where I can apply an entry deterring strategy. But also when we exclude firms $n_b^{E\mathcal{O}}$ from the possibility to register with I, this result holds, which is in contrast to Caillaud and Jullien (2001), where the incumbent can apply an entry deterring pricing scheme.

Proposition 4 *In a scenario with multi-homing and competition in access fees, there exists no entry deterring pricing strategy the incumbent could apply. In equilibrium both marketplaces are active and make positive profits* $\pi^I = (1 - n_b^{E\mathcal{O}})$ *and* $\pi^E \lessapprox n_b^{E\mathcal{O}}$. *Sellers multi-home, while non-ownership taking buyers register only with the incumbent* I. *Equilibrium prices imply* $p_s^I = (1 - n_b^{E\mathcal{O}})u_s, p_b^I = u_b, p_s^E \lessapprox n_b^{E\mathcal{O}} u_s$ *and* $p_b^E \in [0, u_b]$.

Proof. The overall profit of E is still as on the left hand side in (1). Sellers will now register with E, as long as the associated expected benefit is greater than zero, yielding

$$n_b^{E\mathcal{O}} u_s - p_s^E \quad > \quad 0. \tag{10}$$

The difference with the case of exclusivity is that here, firms do not necessarily have to leave I when registering at E. Hence, firms might register with E as "second-home". Accordingly, sellers simultaneously stay with I, only if they expect (weakly) positive profits given the share $(1 - n_b^{E\mathcal{O}})$ of remaining buyers at I, so that

$$(1 - n_b^{E\mathcal{O}})u_s - p_s^I \geq 0. \tag{11}$$

If (10) holds, the $(1 - n_b^{E\mathcal{O}})$ buy-side firms have to believe, that $n_s^E = 1$, so that they will register with E, provided that

$$(1 - n_s^I)u_b - p_b^E > 0. \tag{12}$$

Note that n_s^I can only take values $\in \{0, 1\}$: if $n_s^I = 1$, I's pricing strategy is such that all sellers stay at the same time with I, so that E tries to attract remaining buyers as a second source. Hence, the only chance for E to attract those buyers $(1 - n_b^{E\mathcal{O}})$ is by paying negative access prices p_b^E, because those buyers get their match at I with certainty. The case that $n_s^I = 0$ means that all sellers leave I. Then E could attract those buyers with prices $p_b^E < u_b$. Since we are interested in questioning if I is able to deter entry and to stay in the market at the same time, so that the relevant case is I's pricing strategy such that $n_s^I = 1$. The non-ownership taking buyers $(1 - n_b^{E\mathcal{O}})$ will simultaneously stay with I, only if $n_s^I u_b - p_b^I \geq 0$. The maximum possible profit for E is then given by (almost) $n_b^{E\mathcal{O}}(u_b + u_s) = n_b^{E\mathcal{O}}$. An entry deterring pricing strategy by

I would require this maximum profit to be less than the utility the $n_b^{E\mathcal{O}}$ buyers expect when not opening E and staying with I, yielding

$$p_b^I \quad < \quad -u_s. \tag{13}$$

In a dominant firm equilibrium with I being the only active intermediary, it must hold that I makes (weakly) positive profits so that $p_b^I + p_s^I \geq 0$. Since I can only stay in the market when firms from both market sides register, p_s^I has to meet condition (11). This is obviously a contradiction to (13) and I's zero profit condition. Since E cannot profit from attracting non-ownership taking buyers, it is obvious that I stays in the market. Equilibrium prices and profits then follow from the conditions above. Accordingly, in a scenario where multi-homing is possible and intermediaries compete in access fees, there is no entry deterring pricing strategy that enables I to remain the only active intermediary. •

Caillaud and Jullien (2001) show for the case of competition between two neutral intermediaries, that there exist dominant firm equilibria where the incumbent can prevent the challenger from catching any market share. These equilibria imply zero profits for I. In our model, such equilibria cannot be sustainable. When $n_b^{E\mathcal{O}}$ buyers decide to build their own marketplace, they can always charge sellers a positive access price p_s^E because the collaborative marketplace comprises already some potential matching partners from one market side. At the same time the number of buyers at I is reduced by $n_b^{E\mathcal{O}}$ inducing a reduction of sellers' incentive to stay with I. Contrarily to the scenario with exclusive registration, I can stay in the market. This is because E cannot benefit from attracting non ownership taking buyers $(1 - n_b^{E\mathcal{O}})$ since this would require to apply negative access prices. Buyers staying with I expect to get their match at I with certainty since all sellers stay with I as well (given that I applies a pricing scheme such that (11) holds). Accordingly, those buyers taking ownership in E are the only buy-side users of their marketplace.

6 Discussion

The paper at hand deals with the analysis of imperfect price competition between two intermediaries in an electronic B2B matching market. The essential contribution is the analysis of competing intermediaries that differ with respect to their ownership structure in terms of the impact on market structures and firms' participation incentives. We consider a collaborative B2B marketplace which is owned by some firms from one market side competing with an independent "classic type" intermediary. This is to account for recent developments in B2B e-commerce, namely the formation of industry consortiums for establishing business-to-business electronic marketplaces together with the decline of independent B2B marketplaces. Many of the latter type were highly valued during the initial technology-stock race at the advent of B2B e-commerce some years ago, but recently they are often facing problems. One of the main reasons for this development grounds in the increasing direct competition from upcoming collaborative B2B marketplaces.

A key aspect of such intermediated markets is the "chicken & egg" nature, meaning that buyers (sellers) are interested in registering with a B2B marketplace only if they expect sellers (buyers) to subscribe with the same marketplace as well, in order to meet the appropriate matching partner. The extant literature, e.g. Caillaud and Jullien (2001, 2003), claims that in such markets intermediaries have to subsidize firms on one side of the market together with recovering the associated loss with the other market side in order to attract firms for subscription. We show that subsidizing one side of the market is easier for a consortia-led intermediating B2B marketplace than for an independent third-party marketplace. This is due to the feature that biased marketplaces already comprise matching partners from one market side, whereas independent marketplaces merely offer intermediation and matching services. The availability of differentiated ownership structures of intermediating marketplaces as proposed in this paper deeply affects the market structure. I.e. the benchmark result of Caillaud and Jullien (2001, 2003) where an incumbent intermediary is able to exert market power does not generally hold in such a scenario. In particular, we show that even if the incum-

bent has a reputation advantage, the challenging collaborative entrant is able to catch at least some market share. When registration is exclusively possible with only one marketplace and intermediaries compete in access fees, the entrant is able to overcome its reputation disadvantage and monopolizes the market, whenever the number of firms that provide the collaborative B2B marketplace is sufficiently large. The possibility of applying transaction taxes as an additional pricing instrument benefits the challenging consortium. While being a perfect substitute to the application of access fees in terms of extracting profits from non-ownership taking buyers, a high transaction fee reduces the cost of attracting sellers substantially.

If firms can simultaneously subscribe with both marketplaces, the buy-side consortium can always enter the market. However, in such a situation both intermediaries stay in the market with positive profits. Sellers then register with both intermediaries and buyers that do not participate in the provision of the challenging marketplace stay with the incumbent. Indeed, we can widely observe such market structures in the B2B landscape where collaborative marketplaces comprise their owners as only users from the respective market side. Because of coordination costs it is sometimes difficult to form a large pool of companies to provide a joint marketplace in practice. The benefit of the collaborative marketplace, comes in particular from a large number of owners. Accordingly, in industries where it is not easy to attract sufficient firms to jointly provide a platform, there will be greater opportunities for independent intermediaries.

The present model could be extended in various directions. In this paper we took the number of firms providing the collaborative B2B marketplace as exogenously given since we were interested in how many owners would be necessary to enable such a consortium to enter the market. An interesting extension would be to define the number of firms that engage in the provision of such a joined B2B marketplace endogenously. A further topic would be to study collaborative marketplaces that are provided by firms from both market sides. This will be taken up in future research.

Appendix

Proof of Proposition 1

Note that (4) can be simplified, yielding

$$p_s^I + n_b^{E\mathcal{O}}(u_s + p_b^I) + (1 - n_b^{E\mathcal{O}})(u_b - u_s + \min\{p_b^I, 0\}) \quad < \quad 0. \tag{14}$$

The left hand side of (14) increases in $n_b^{E\mathcal{O}}$ as long as $\max\{p_b^I, 0\} - u_b + 2u_s > 0$, which is always the case given our initial assumption that for all j with $j \neq i$, it holds that $u_j < 2u_i$. In order to sustain a dominant firm equilibrium, I's pricing decision has to be such that I's profit is (weakly) positive:

$$p_s^I + p_b^I \geq 0. \tag{15}$$

Consider the benchmark cases where $n_b^{E\mathcal{O}} \in \{0, 1\}$. The case of $n_b^{E\mathcal{O}} = 0$ is identical to Caillaud and Jullien (2001) representing competition between two independent marketplaces. They show that in such a scenario there always exists a price pair $P^I = (p_s^I, p_b^I)$ that enables I to be the only active intermediary in a dominant market equilibrium.

In case that $n_b^{E\mathcal{O}} = 1$, meaning that all buy-side firms provide the collaborative buy-side B2B platform, (14) reads as

$$u_s + p_s^I + p_b^I < 0, \tag{16}$$

which must be fulfilled together with (15) under a pricing strategy for intermediary I that guarantees that E cannot capture any share of either market. It can be easily seen that there is no pricing strategy $P^I = (p_s^I, p_b^I)$ that fulfills both conditions simultaneously.

Accordingly, there must be a critical value $n_b^{E\mathcal{O}*}$ with regard to the existence of a price pair $P^I = (p_s^I, p_b^I)$ so that there exists a dominant market equilibrium where I can prevent E from attracting any trade. This critical value $n_b^{E\mathcal{O}*}$ is obtained as follows: assume condition (15) to be binding, i.e. we consider the minimal possible profit that keeps I in the market. This requires one price p_i^I to be (weakly) negative, in other words, one type of firms must be subsidized.

1. Suppose first, that this happens with buyers, so that $p_b^I < 0$. Then (4) yields the following critical value

$$n_b^{E\mathcal{O}*} = \frac{u_b - u_s}{u_b - 2u_s}. \tag{17}$$

Note, that $n_b^{E\mathcal{O}*} \in [0,1]$ only if $u_b \leq u_s$. In such a case $n_b^{E\mathcal{O}*} \in [0, \frac{1}{2}]$, so that it is a necessary condition for an entry deterring pricing scheme that $n_b^{E\mathcal{O}} \leq \frac{1}{2}$. If $u_b > u_s$, there is no possibility for I to deter entrance by subsidizing buyers since then $n_b^{E\mathcal{O}*}$ would be negative in (17), enabling E to enter with any $n_b^{E\mathcal{O}} \in (0,1]$. This is due to our assumption that $2u_s > u_b > u_s$.[20]

2. Now consider subsidizing the sellers' side by I's pricing strategy, so that $p_s^I < 0$. From (15) and (4) we then get the following prices, I could apply to deter entry by E:

$$p_b^{I*} = u_b + \frac{(1 - 2n_b^{E\mathcal{O}})u_s}{n_b^{E\mathcal{O}} - 1} \tag{18}$$

$$p_s^{I*} = -u_b - \frac{(1 - 2n_b^{E\mathcal{O}})u_s}{n_b^{E\mathcal{O}} - 1} \tag{19}$$

Since a price $p_i^I > u_i$ would hinder firms i from participation at I, $\frac{(1-2n_b^{E\mathcal{O}})u_s}{n_b^{E\mathcal{O}}-1}$ can maximally be equal to zero so the maximal value for $n_b^{E\mathcal{O}}$ that enables I to apply an entry deterring pricing strategy is $\frac{1}{2}$. On the other hand, subsidizing sellers requires that $p_s^I < 0$, this is only possible, if $n_b^{E\mathcal{O}} > \frac{u_b - u_s}{u_b - 2u_s}$.

From that it follows, that I can only apply an entry deterring pricing strategy, if $n_b^{E\mathcal{O}} \in [0, \frac{1}{2}]$. If $n_b^{E\mathcal{O}} \in [0, \frac{u_b - u_s}{u_b - 2u_s}]$ this happens by subsidizing buyers. Otherwise, if $n_b^{E\mathcal{O}} \in (\frac{u_b - u_s}{u_b - 2u_s}, \frac{1}{2}]$ this happens by subsidizing sellers. •

Proof of Proposition 2

It follows from the proof of proposition 1, that depending on $n_b^{E\mathcal{O}}$ the incumbent either has to subsidize sellers or buyers in order to deter entry. We determine the according price system as follows:

[20] Note that there is no loss of generality through assuming that $u_j < 2u_i, \forall j \neq i$. If in turn it would be possible that $u_b > 2u_s$, then $n_b^{E\mathcal{O}*}$ would be bigger than 1 in (17), but then the left hand side in (14) would be decreasing in $n_b^{E\mathcal{O}}$, meaning that also any $n_b^{E\mathcal{O}} \in (0,1]$ enables E to enter.

1. In the case of $n_b^{E\mathcal{O}} \in [0, \frac{u_b - u_s}{u_b - 2u_s}]$ the incumbent subsidizes buyers by applying those prices that yield the maximal profits, given that E cannot enter. These prices are obtained by taking $p_s^I = u_s$ and setting (4) equal to zero, hence solving for $p_b^I = (n_b^{E\mathcal{O}} - 1)u_b - 2n_b^{E\mathcal{O}}u_s$. This yields (weakly) positive profits for the incumbent, given that $n_b^{E\mathcal{O}} \leq n_b^{E\mathcal{O}*}$.

2. If $n_b^{E\mathcal{O}} \in (\frac{u_b - u_s}{u_b - 2u_s}, \frac{1}{2}]$ the incumbent subsidizes sellers. Again, I applies those prices that deter entry and yield the maximal profits. Taking the maximal value $p_b^I = u_b$ and setting (4) equal to zero then yields $p_s^I = -u_b + (1 - 2n_b^{E\mathcal{O}})u_s$.

3. If $n_b^{E\mathcal{O}} \in (\frac{1}{2}, 1]$ the challenger enters and monopolizes the market (no firms stay at I). The prices $p_s^E \lessapprox u_s(2n_b^{E\mathcal{O}} - 1) + p_s^I$ and $p_b^E \lessapprox u_b + \min\{p_b^I, 0\}$ then yield (weakly) positive profits for E.

Accordingly, in the first two cases the incumbent can apply and entry deterring pricing strategy yielding at least zero profits, in the third case this is not possible. •

Proof of Proposition 3

In order to sustain an equilibrium with I as dominant firm, I's profit has to be (weakly) positive, yielding

$$p_s^I + p_b^I + t^I \geq 0. \tag{20}$$

Additionally an entry deterring pricing strategy by I requires E's maximal potential profits to be (weakly) lower than $n_b^{E\mathcal{O}}[u_b(1 - t^I) - p_b^I]$, so that

$$u_b + p_s^I + n_b^{E\mathcal{O}}p_b^I + (1 - n_b^{E\mathcal{O}})\min(p_b^I, 0) + n_b^{E\mathcal{O}}(1 - t^I)(u_s - u_b) + u_s t^I \quad \leq \quad 0. \tag{21}$$

Minimizing the left hand side, implies for I to choose $t^I = 0$. So that (21) reduces to

$$u_b + p_s^I + n_b^{E\mathcal{O}}p_b^I + (1 - n_b^{E\mathcal{O}})\min(p_b^I, 0) + n_b^{E\mathcal{O}}(u_s - u_b) \quad \leq \quad 0. \tag{22}$$

We have to distinguish to cases with respect to p_b^I:

1. For the case $p_b^I < 0$, I's pricing strategy has to be such that

$$u_b + p_s^I + p_b^I + n_b^{E\mathcal{O}}(u_s - u_b) \quad \leq \quad 0. \tag{23}$$

It is obvious that there are no prices p_i^I that fulfill condition (23) together with (20) for any value $n_b^{E\mathcal{O}} \in [0,1]$.

2. If $p_b^I \geq 0$, I's pricing strategy has to be such that

$$u_b + p_s^I + n_b^{E\mathcal{O}}(u_s - u_b + p_b^I) \quad \leq \quad 0. \tag{24}$$

Only for $n_b^{E\mathcal{O}} = 0$, there exists a pricing strategy that enables I to deter entry. Furthermore such a pricing strategy can only be applied, if $u_b \leq u_s$. Then the prices $p_s^I = -u_b$, $p_b^I = u_b$ and $t^I = 0$ enable I to deter E's entry but this involves zero profits for I.

Since we analyze competition between an independent and a collaborative marketplace, we are interested in strictly positive values of $n_b^{E\mathcal{O}}$,[21] so that it follows that there is no pricing strategy that enables I to deter entry for any value $n_b^{E\mathcal{O}} \in (0,1]$, when intermediaries can apply transaction taxes as an additional pricing instrument. Accordingly, any positive value $n_b^{E\mathcal{O}} > 0$ enables E to enter the market.

We are aware of the multiplicity of potential equilibria. In particular we are therefore interested in the maximum possible profit the entrant could achieve, given that the incumbent wants to minimize this profit. To determine this lower bound, we consider the incumbents pricing strategy such that (20) is binding. Minimizing the entrant's profit then requires the pricing strategy $p_i^I = -p_j^I = u_i$, $t^I = 0$. There are two cases:

1. If $p_b^I = -p_s^I = u_b$, E's maximal potential profits determined in (8) yield $n_b^{E\mathcal{O}} u_s$, implying prices $p_b^E \lessapprox 0$, $p_s^E \lessapprox -u_b - (1 - n_b^{E\mathcal{O}})u_s$ and $t^E = 1$.

2. If $p_s^I = -p_b^I = u_s$, E's maximal potential profits determined in (8) yield $2n_b^{E\mathcal{O}} u_s + n_b$, implying prices $p_b^E \lessapprox -u_s$, $p_s^E \lessapprox n_b^{E\mathcal{O}} u_s$ and $t^E = 1$.

Since $2n_b^{E\mathcal{O}} u_s + n_b > n_b^{E\mathcal{O}} u_s$, the first case determines the lower bound. •

[21] The case of $n_b^{E\mathcal{O}} = 0$ corresponds to E being and independent marketplace. See Caillaud and Jullien (2001).

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