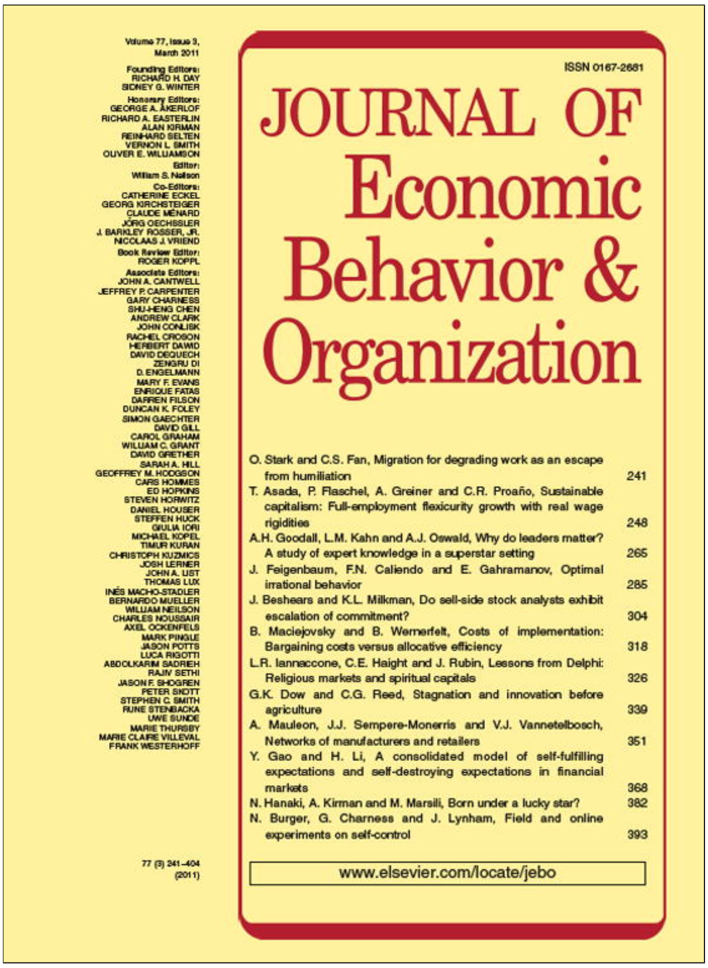
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Networks of manufacturers and retailers

Ana Mauleon[a,c], Jose J. Sempere-Monerris[b,c], Vincent J. Vannetelbosch[c,*]

[a] CEREC, Facultés universitaires Saint-Louis, Boulevard du Jardin Botanique 43, B-1000 Brussels, Belgium
[b] Department of Economic Analysis and ERI-CES, Universidad de Valencia, Campus dels Tarongers, Avda. dels Tarongers s/n, E-46022 Valencia, Spain
[c] CORE, Université catholique de Louvain, 34 voie du Roman Pays, B-1348 Louvain-la-Neuve, Belgium

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ABSTRACT

We study the endogenous formation of networks between manufacturers of differentiated goods and multi-product retailers. We find that, under both types of contracts (linear and two-part tariffs), only three distribution networks are stable for particular values of the degree of product differentiation and link costs: the non-exclusive distribution and non-exclusive dealing network, the exclusive distribution and exclusive dealing network, and a mixed distribution network in which both exclusive and non-exclusive relations are observed. Moreover, the stability of the first two networks is robust to the case of manufacturers with no bargaining power and the case of differentiated retailers who compete in prices. We show that, under both types of contracts, the distribution networks that maximize social welfare are not necessarily stable. Thus, a conflict between stability and social welfare is likely to occur, even more if the degree of product differentiation is low enough.

1. Introduction

Unquestionably, networks govern relations among firms in an important manner. In various industries, such as automobiles, clothing, electronics, pharmaceuticals and food, manufacturers develop networks of exchange both with input suppliers and retailers or wholesalers. Moreover, in the last few decades the importance of spot exchange in input or output procurement has decreased in favor of other methods such as manufacturer–supplier long-term contracting and manufacturer–retailer exchange networks. The relevance of interconnections in networks structures has grown notably (see e.g. Nishiguchi, 1994 for the automobile industry), and it seems that firms increasingly rely on a subset of suppliers with whom they maintain close business ties. This paper examines network formation between manufacturers of differentiated goods and retailers, who then sell them to consumers. We look into the tradeoff between building costly links and the nature of intrabrand, interbrand and in-store rivalry. Our analysis provides a rather general understanding of vertical distribution networks, and we further study whether the self-interest of the agents results in stable distribution networks that might maximize social welfare.

Our work is related to two different strands of the literature. Firstly, there is the literature on network formation, which has mainly focused on the upstream part of the vertical chain, thereby neglecting the analysis of the downstream part where

* Corresponding author. Tel.: +32 10474142; fax: +32 10474301.
E-mail addresses: mauleon@fusl.ac.be (A. Mauleon), Jose.J.Sempere@uv.es (J.J. Sempere-Monerris), vincent.vannetelbosch@uclouvain.be (V.J. Vannetelbosch).

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manufacturers and retailers enter into long-term relationships.[1] Kranton and Minehart (2001) have studied why buyers and sellers form bilateral links on which they mutually agree, and whether the individual incentives of agents are aligned with social welfare. Kranton and Minehart (2000b) have examined the competitive equilibrium prices in buyer–seller networks, whereas Wang and Watts (2006) have considered the case when sellers can produce goods of a different quality. Finally, Kranton and Minehart (2000a) have looked at the emergence of buyer–seller networks when sellers have an outsourcing motivation to see whether networks can perform better than vertically integrated markets or spot exchange markets. Manufacturers can decide to build a dedicated asset to produce their own inputs or, alternatively, they can invest in links to external sellers from which they will buy specialized inputs. We contribute to this literature by characterizing the networks that will emerge between asymmetric groups of agents whose architecture, in addition to the usual costs of link formation, depends on the type and intensity of competition involved in a particular network. We find a relation between the level of product differentiation and the link cost level as determinants of the "stable" distribution networks.[2]

Secondly, there exist a number of papers devoted to the analysis of distribution systems that arise when there is market power at both the manufacturing and retailing levels. Earlier literature has mainly addressed two questions: (i) whether manufacturers would prefer having a single common retailer rather than separate exclusive retailers and, (ii) whether a manufacturer's brand should be excluded from the market by use of exclusive contracts.[3] Recent contributions on the incentives of manufacturers and retailers to sign exclusivity arrangements[4] include Chang (1992), Dobson and Waterson (1996), and Moner-Colonques et al. (2004). Results are sensitive to how the arrangements are determined, to the degree of product differentiation, to brand asymmetry, and to the existence of retailer differentiation. Mycielski et al. (2000) have studied the manufacturers' choice of vertical arrangements considering territorial exclusivity. In contrast with the received literature, manufacturers are not given the leading role in shaping the distribution systems. The network approach that we undertake allows us to endogenize the creation of manufacturer–retailer bilateral links, and offers an economic intuition of the forces delineating distribution systems. The resulting networks of manufacturers and retailers neither follow from cooperative behavior nor reflect the interest of only one type of agent; rather, they are the result of the incentives of each of the two asymmetric types of agents that participate in the formation of a link. Then, the following questions arise:

(i) What are the incentives of manufacturers and retailers to link? What is the architecture of "stable" networks of distribution when both manufacturers and retailers decide the bilateral links they want to establish among them?
(ii) Are individual incentives to link adequate from a social welfare point of view?

In order to answer these questions we develop a benchmark model, which consists of a three-stage game played by manufacturers and retailers. Each manufacturer produces a differentiated product (brand) which is sold to one or several retailers at a constant per unit price and retailers can be multiproduct sellers. In the first stage, the manufacturers and the retailers decide about the bilateral relationships (or links) they want to establish among them. A link between a manufacturer and a retailer is necessary in order to sell the manufacturer's brand to consumers. The cost of a link is shared equally between the manufacturer and the retailer. The collection of pairwise links between manufacturers and retailers defines a distribution network. In the second stage, manufacturers choose simultaneously the transfer prices of their products to retailers. In the third stage, retailers compete simultaneously in quantities.

In order to solve the model we obtain the subgame perfect equilibrium for the two final stages and, for the initial stage, we obtain the set of "stable" distribution networks. A simple way to analyze the networks that are expected to emerge in the long run is to examine a sort of equilibrium requirement that agents not benefit from altering the structure of the network. A weak version of such condition is the pairwise stability notion defined by Jackson and Wolinsky (1996). A network is pairwise stable if no agent benefits from severing one of their links and no other two agents benefit from adding a link between them, with one benefiting strictly and the other at least weakly. We offer some general results for the case of n manufacturers and n retailers, and then characterize the set of stable networks for $n = 2$. The analysis of whether networks that involve exclusivities emerge is done for the case of linear contracts and two-part tariff contracts. The benchmark case

[1] The data in Betancourt (2004) suggests that there has been substantial forward vertical integration by manufacturers in the form of internalizing the wholesale function by selling directly to retailers. This process is most pronounced in the durable sectors: automobiles and other motor vehicles, 95.5 percent of sales; electronics, 70.9 percent of sales; toys and hobby goods, 95.6 percent of sales (US retail sector in 1987).

[2] There is a vast literature devoted to analyze the important role played by network structures in determining the outcome of many other economic situations. Belleflamme and Bloch (2004), Goyal and Moraga-González (2001), Goyal and Joshi (2003), Mauleon et al. (2008) have studied the formation of research and development networks and collusive alliances among corporations. Bramoullé and Kranton (2007) have developed the first model of network formation where links are used to share risk when formal insurance mechanisms are not available. Page and Wooders (2007) have analyzed the formation of clubs as a network formation game. Jackson (2003, 2005) provides surveys of models of network formation.

[3] In a setting with two manufacturers and only one retailer, O'Brien and Shaffer (1997) and Bernheim and Whinston (1998) have shown that vertical foreclosure is not an equilibrium.

[4] An exclusive dealing agreement is a restriction of the retailer's behavior under which the retailer agrees not to buy from any other manufacturer. Similarly, an exclusive distribution agreement is a manufacturer's behavior restriction under which the manufacturer agrees not to sell to any other retailer. Lin (1990) and O'Brien and Shaffer (1993) have shown that exclusive dealership rather than common dealership is chosen to dampen competition between the manufacturers.

concentrates on linear contracts which have several advantages and are present in a number of industries.[5] Two-part tariff contracts (retailers pay both a transfer price and an up-front fixed fee to a manufacturer) are used in several industries and deserve particular attention due to their strategic value for manufacturers. Further, in order to check for the robustness of our findings, we extend our analysis in two directions: no bargaining power upstream and differentiated retailers with price competition.

Depending on the particular distribution network, three kinds of rivalry may be eventually at play: interbrand rivalry, intrabrand rivalry and in-store rivalry. The first one corresponds to the rivalry among manufacturers' differentiated products and is more intense the lower the degree of product differentiation. The second is the rivalry in the same product sold by different retailers, and the third one is a special kind of interbrand rivalry since it appears when one retailer sells several products. Therefore, the distribution network that will emerge is the result of the interplay of these three rivalry types for each of the asymmetric agents. In particular, the addition of one link to the network has in general three effects on the agents' profits. One negative and common to both groups of agents, which is independent of the network considered, the link *cost effect* associated to the implementation of one link. There are two further effects, an *output expansion effect* and a *competition effect*, which depend on the rivalry types. These rivalry types affect each of the agents in a different way and enter differently depending on the initial network to which a new link is added. For example, consider the networks that can be formed between one manufacturer and the n retailers. We prove that, the manufacturer always has an incentive to form links with all the n retailers available provided the other manufacturers do not form any links (Result 1). In other words, the introduction of intrabrand rivalry is always profitable if it is the unique type of rivalry present in the market. The reason is that for the manufacturer, the positive output expansion effect from a new link offsets both the negative competition and the link cost effects. The output expansion effect is positive since a new strand of profits is associated with each additional link; while the competition effect is negative from the second link onwards, since a new link implies a reduction in the profits that come from existing links. For retailers there is no competition effect, since in this particular case they only sell one product and therefore they are always willing to form a link. In general, agents always have an incentive to form a link when it only comprises an output expansion effect and a cost effect. We also find that a retailer always has an incentive to form links with the n manufacturers, provided the other retailers do not. This means that the introduction of in-store rivalry, when it is the unique rivalry type in the market, is always profitable for the common retailer. The positive output expansion effect for the common retailer offsets both the competition and link cost effects. Finally, it is important to highlight that the size and sign of these effects might be affected by the type of contract linking manufacturers and retailers. In particular, Result 1 is no longer true for two-part tariff contracts since the output expansion and the competition effects for the manufacturer are both null. By use of the terms of the contract the manufacturer is able to replicate in the market the integrated monopolist outcome regardless of the number of retailers used. Since the link cost effect is negative, the network with one link is the only stable network.

For the case $n = 2$, there are fifteen possible network architectures, which, given the symmetry of products and retailers, reduce to six qualitatively different distribution networks (see Fig. 1). We find that, for either type of contract, three distribution networks are pairwise stable for particular values of the degree of product differentiation and link costs. These are network *C*, *non-exclusive distribution and non-exclusive dealing* where the three types of rivalry are present in the market in a symmetric way; network *ED*, *exclusive distribution and exclusive dealing*, where there is only interbrand rivalry in the market; and network *X*, the *mixed distribution system*.[6] However, the parameter regions for which these networks are stable are sensitive to the contract type. For example, network *C* is stable when brands are rather differentiated in the benchmark case, while it is stable when brands are weakly differentiated in the two-part tariff case. The opposite happens for network *ED*. The reason is that when products are rather similar, the firms are inclined to form a distribution network that relaxes competition upstream. By the effect of the terms of the contract, network *C* is the most competitive network (lowest transfer prices and largest output of all the networks) in the benchmark case while network *ED* entails the lowest transfer prices in the two part tariff case.

The use of two-part tariff contracts is a modification of the manufacturers' exercise of power, since they reinforce manufacturers' control on retailers with respect to the benchmark case. At the other extreme, consider the case where manufacturers do not have any bargaining power so that transfer prices are set equal to manufacturers' marginal cost under any possible distribution network. We find that, in addition to networks *C* and ED, network *H* is also pairwise stable. The reason for the stability of *H* rather than *X* is that now the introduction of interbrand rivalry (the move from *H* to *X*) is now less profitable (as it supposes a large negative competition effect) for a retailer because there is no improvement in the retailer's margin given the constant transfer price. Thus, network *H* might be stable now.

We finally complete the robustness of the benchmark case by analyzing the case of differentiated retailers who compete in prices. The fact that retailers' strategic variables are now strategic complements implies more output at equilibrium, but

[5] Linear contracts may turn appropriate if there are observability or renegotiation problems. Iyer and Villas-Boas (2003) have reported that in sectors such as grocery retailing or department stores retailers do not seem to pay lump-sum fees to manufacturers. Sass (2005) has described the U.S. beer industry as a three-tier system (brewers, distributors and retailers) where brewers set constant per-unit prices for beer and do not charge distributors explicit franchise fees. Distributors in turn independently set simple linear wholesale prices to retailers.

[6] We are also able to show that networks *C* and *ED* are pairwise stable for $n > 2$ in the benchmark case. The former is stable for small link costs regardless of the degree of product differentiation, the latter for large link costs and not too differentiated products.

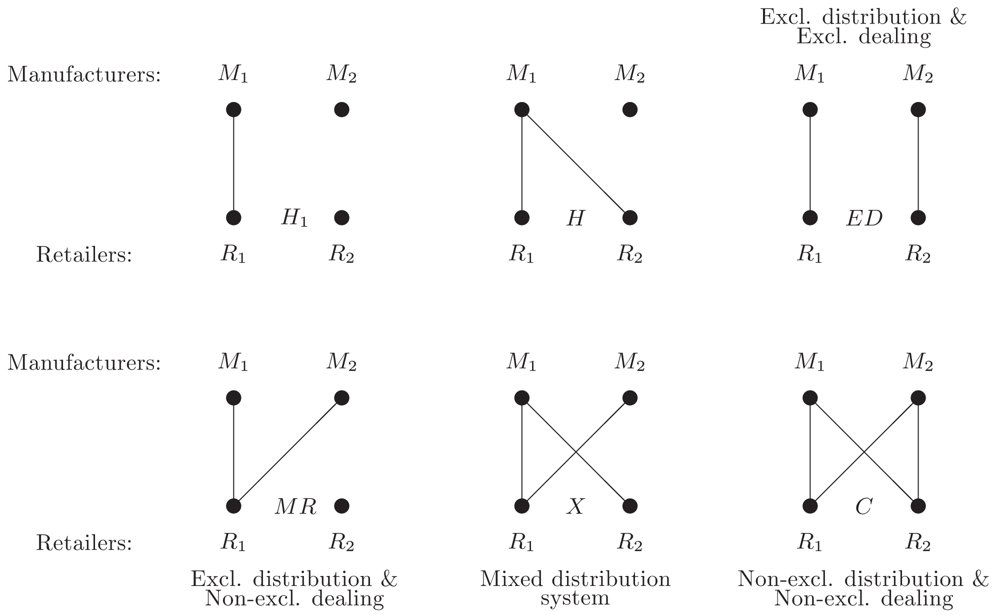

Fig. 1. The six qualitatively different distribution networks for $n = 2$.

it does not affect the set of pairwise stable networks already found in the benchmark case, *ED*, *X*, and *C*. The reason is that retailers benefit from lower transfer prices and equilibrium outputs increase when introducing intrabrand rivalry (moving from *ED* to *X* and then to *C*). However, for the manufacturers involved there appears a trade off since lower manufacturer margins are balanced by larger equilibrium outputs.

One wonders whether the set of stable distribution networks obtained by the strategic interaction of selfish agents coincides with the set of consumer and/or social welfare maximizing networks. We find that this is not the case and, consequently, a rationale for intervention arises. From the consumers view point, as they do not bear the link costs, they prefer the highest level of output in the market regardless of the number of links. Therefore, for the benchmark case, consumers preferred network is *C* where the three types of rivalry are present. However, for the two-part tariff case, consumers prefer network *ED*. From a social welfare perspective we find that, in the benchmark case, when link costs are small enough, two distribution networks may maximize social welfare: *C* and *X*. The former when the degree of product differentiation is high enough; the latter, otherwise. When link costs become large, network *ED* maximizes welfare for a high enough degree of product differentiation; the *exclusive distribution and non-exclusive dealing*, denoted by *MR*, otherwise. Thus, a conflict between stability and social welfare is likely to occur, regardless of the degree of product differentiation. Similarly, for the two-part tariff case, we find that there is no coincidence between the social interest and the stable networks. However, now the discrepancy is greater as compared with the benchmark case. There is one stable network, *C*, which is never welfare maximizing, and there is one, H_1, that maximizes social welfare which is never stable.

The paper is organized as follows. The benchmark model is presented in Section 2. In Section 3 we analyze the two-part tariff case. Section 4 deals with some robustness for the benchmark case. In Section 5 we analyze the networks that maximize consumer surplus and social welfare. Finally, Section 6 concludes.

2. The model

We develop a three-stage game to study the formation of networks among two asymmetric groups of agents (manufacturers and retailers) in a successive oligopoly. In order to sell the manufacturer's brand to consumers, manufacturers and retailers must form a product distribution network consisting of different bilateral relationships (or links) between them. In an initial stage, manufacturers and retailers decide on the links they want to establish. In the second stage, once the distribution network has been formed, manufacturers decide simultaneously the terms of the contracts offered to retailers. Finally, retailers decide simultaneously the quantity of each brand they are going to sell in the market.

There are n manufacturers, M_i ($i = 1,2,\ldots,n$), producing each its own branded product i under constant returns to scale and incurring a common unit cost c. There are n retailers, R_j ($j = 1,2,\ldots,n$), which might be supplied by manufacturers and sell the goods to consumers. The terms of payment for retailers will initially consist of a constant unit price per unit bought, the transfer price (usually named as linear contracts). If two-part tariff contracts are considered then the terms of payment include a transfer price and an up-front fixed fee. Let w_i and F_i denote the transfer price and the up-front fixed fee set by manufacturer i for supplying its brand. Retailers may be multi-product as they are allowed to carry several products and are assumed undifferentiated. However, we will later consider the case of a successive duopoly where retailers are differentiated and compete in prices. The retailing costs borned by the retailers are assumed to be zero. We define as the benchmark model the case of linear contracts, undifferentiated retailers and quantity competition among retailers.

A distribution network cannot be enforced. We assume that joint consent is needed to establish and/or maintain a link between a manufacturer and a retailer. The cost of a link for each agent is denoted by $k \geq 0$.[7] In a distribution network, manufacturers and retailers are the nodes in the graph and links indicate different bilateral relationships between the agents. Then, a distribution network g is simply a list of which pair of manufacturers and retailers are linked to each other. We denote by $N_n = \{M_1, M_2, \ldots, M_n, R_1, R_2, \ldots, R_n\}$ the set of agents which might be connected in a distribution network. Consider the pair formed by manufacturer i and retailer j, with M_i, $R_j \in N_n$. Then $(i, j) \in g$ indicates that i and j are linked under the network g. The network obtained by adding link (i, j) to an existing network g is denoted by $g_{+(i,j)}$ and the network obtained by deleting link (i, j) from an existing network g is denoted by $g_{-(i,j)}$.

Let G_n be the set of all possible distribution networks when n manufacturers and n retailers might be connected. It is then clear that each distribution network $g \in G_n$ determines a particular market configuration with the following features. For any given g, we denote by $m \leq n$ the number of manufacturers with at least one link in g and by n_{r_i} the number of retailers selling brand i. Similarly, we denote by $r \leq n$ the number of retailers with at least one link in g and by n_{b_j} the number of brands sold by retailer j. To sum up there are m brands competing through a retail oligopoly of r firms, some of the retailers possibly being multi-product sellers.

Let q_{ij} be the quantity of brand i that retailer j sells to consumers and let $Q_i = \sum_{j=1}^{n_{r_i}} q_{ij}$ denote the total amount of brand i produced by M_i and sold by the retailers linked with it. The system of inverse demand functions is defined by

$$p_i = a - Q_i - d\sum_{l \neq i} Q_l, \quad i, l = 1, 2, \ldots, m,$$

where $a > c > 0$ and $0 < d < 1$ (own effects on prices are greater than cross effects). So, any pair of brands i and l are imperfect substitutes and parameter d measures the degree of *interbrand rivalry*, that is, how similar the brands are perceived by consumers. When d approaches 1 brands become closer substitutes (interbrand rivalry increases). As the same brand can be sold by different retailers, there might be *intrabrand rivalry* in the market, that is how similar retailers' services are perceived by consumers to be when selling the same brand. If retailers are not differentiated, they are perfect substitutes and intrabrand rivalry is maximal. Finally, since retailers can be multi-product sellers there might be *in-store rivalry*, which is interbrand rivalry internalized by a retailer.

Retailer j's and manufacturer i's profits for the case of linear contracts are,

$$\Pi_{R_j}(\cdot) = \sum_{i=1}^{n_{b_j}} (p_i - w_i) q_{ij} - n_{b_j} k, \quad j = 1, 2, \ldots, r;$$

$$\Pi_{M_i}(\cdot) = (w_i - c) Q_i - n_{r_i} k, \quad i = 1, 2, \ldots, m.$$

For convenience we also denote by π_{R_j} and π_{M_i} the corresponding profits gross of any link costs. Each distribution network combines the above mentioned types of rivalry in a particular way. Therefore, finding the networks that will emerge in the long run amounts to finding how the different types of rivalry endogenously arise. There are several distribution networks that we specifically consider since they are fully symmetric, in the sense that each agent in its group (manufacturers or retailers) is symmetric in the network and imply interesting combinations of rivalry types. The first one is the *complete network*, C, where the n manufacturers have a link with each of the n retailers (for all i, j, $n_{b_j} = n_{r_i} = r = m = n$) and therefore, no further link is permitted. In such a network the three rivalry types are present symmetrically. The *exclusive distribution and dealing network*, ED, where each manufacturer has only one and exclusive retailer, each retailer sells exclusively one brand and there is neither intrabrand nor in-store rivalry (for all i, j, $n_{b_j} = n_{r_i} = 1$, and $r = m = n$). The *homogeneous oligopoly network*, H_r, where only one manufacturer is linked with $r \leq n$ retailers (we keep notation H when $r = n$), thus there is neither interbrand nor in-store rivalry. Finally, the *multiproduct monopolist retailer network*, MR_m, where only one retailer is linked with $m \leq n$ manufacturers (we keep notation MR when $m = n$) implying no intrabrand rivalry and the presence of interbrand and in-store rivalry.

A simple way to analyze the networks that one might expect to emerge in the long run is to examine a sort of equilibrium requirement that agents not benefit from altering the structure of the network. A weak version of such condition is the pairwise stability notion defined by Jackson and Wolinsky (1996). A network is pairwise stable if no agent benefits from severing one of their links and no other two agents benefit from adding a link between them, with one benefiting strictly and the other at least weakly. This definition of stability is quite weak and should be seen as a necessary condition for strategic stability.[8]

[7] We assume that the costs of links are constant and shared equally by both parties in the interest of tractability. Indeed, these costs capture the fact that there should be a permanent relationship among the manufacturer and the retailer and this is costly.

[8] Pairwise stability only considers deviations on a single link at a time. For instance, it could be that an agent would not benefit from severing any single link but would benefit from severing several links simultaneously, and yet the network would still be pairwise stable. Players cannot be farsighted in the sense that they do not forecast how others might react to their actions. Herings et al. (2004) have proposed a general concept, social rationalizability, that predicts which structures of cooperation are going to emerge among farsighted players. Moreover, Herings et al. (2009) have recently developed the notion of pairwise farsightedly stable set to predict which networks may be formed among farsighted players.

Definition 1. A network g is pairwise stable if

(i) for all $(i, j) \in g$, $\Pi_i(g) \geq \Pi_i(g_{-(i,j)})$ and $\Pi_j(g) \geq \Pi_j(g_{-(i,j)})$, and
(ii) for all $(i, j) \notin g$, if $\Pi_i(g) < \Pi_i(g_{+(i,j)})$ then $\Pi_j(g) > \Pi_j(g_{+(i,j)})$.

When one firm forms a new link three different effects might arise that affect firms's profits. First, there is an *output expansion effect* since either an additional brand is sold by a retailer or an additional distribution channel is open for a manufacturer. This effect is non negative and accounts for the profits directly generated by the new link. A second effect, the *competition effect*, shows up when the firm considered was already selling another brand or distributing through another distribution channel. This effect is thus the variation in profits coming from the existing links when a new link is introduced. It is usually negative since more competition is introduced, the magnitude of which depends on the initial and the new network architectures when one link is added. Finally, a third effect is a pure *cost effect*, the per firm link cost, and is negative. Therefore, the incentives to form a link are clearly defined. A new link will be added if both a manufacturer and a retailer realize an overall positive effect, that is, when the output expansion effect offsets the other two. It is important to note that the first two effects depend on the degree of product differentiation, on the initial distribution network to which the new link is added and on the resulting network and differ by the type of agent considered. The third effect is independent of the network and type of agent. If an existing link is severed then the above mentioned effects work in the opposite direction. In order to be profitable to cut a link, the firm's savings due to the cost effect must be greater than the combined effect of softer competition and one less stream of profits. To make comparisons possible we will define an upper bound on the link cost k, which depends on the number of possible manufacturers or retailers, n. The bound is $\bar{k}_n \equiv \min\{\pi_{R_j}/n_{b_j}, \pi_{M_i}/n_{r_i}\}$ for all possible i, j linked in all possible $g \in G_n$. This is so to guarantee that all agents get nonnegative equilibrium profits in each of the possible distribution network.

2.1. Some general results

To illustrate how the above effects work, take first the case where there is only intrabrand rivalry. Consider the $H_{(n-1)}$ distribution network where M_1 is linked will all the retailers except one. To add a new link between M_1 and the remaining retailer both firms must agree. The isolated retailer will always agree since there is no competition effect and the output expansion effect outweights the cost effect. This is a general result that can be stated as follows: *any isolated firm is always willing to form a link since the output expansion effect always offsets the cost effect.* However, for M_1, we need to compute and compare the three effects. The output expansion effect is the amount of profits that comes from the new distribution channel. The competition effect is computed as the variation (reduction) in profits that accrue from the $(n-1)$ distribution channels by the effect of the new link. Both the output and the competition effects are decreasing in n. The difference between the output and the competition effects is greater than $\pi_{R_j}(H)$ that, by assumption, is also greater than any link costs $k \leq \bar{k}_n$. Thus, the following result is proven.[9]

Result 1. If there are n retailers available, then all the distribution networks H_j for $j = 1, \ldots, (n-1)$ are not pairwise stable. There is always an incentive to form a link between the manufacturer and an isolated retailer.

Similarly, we can prove that the exclusive dealing and distribution configuration where all except one of the manufacturer–retailer pairs are linked is not pairwise stable since the remaining pair has always an incentive to link. Note that there is no competition effect and the output expansion effect is always greater than or equal to any link costs $k \leq \bar{k}_n$. In general, if the competition effect is null and there is a pair manufacturer–retailer which is not linked then a new link among them will be formed.

Result 2. Any $g \in G_n$ which includes at least one isolated manufacturer and one isolated retailer is not pairwise stable.

Finally, we discuss how the three effects work when there is both interbrand and in-store rivalries but not intrabrand, that is we analyze MR_{n-1}. Recall that in this situation the not linked manufacturer, say M_i, has an incentive to link with the multiproduct retailer since the competition effect is null and $\pi_{M_i}(MR) \geq \bar{k}_n$. However, the new link must also be profitable to the multiproduct monopolist retailer, say R_1. The output expansion effect is equal to the profits that R_1 obtains from selling the brand of the previously not linked manufacturer when n brands are sold in *MR*. The competition effect is computed as the variation in R_1's profits that accrue from the $(n-1)$ brands by the effect of the new link. We have proved that for $n = 2$ the competition effect is positive since the multiproduct retailer is able to internalize the competition by the new brand sold due to the lower transfer price from the previously linked manufacturer. For $n = 3$, the new brand added imposes tougher competition to the existing two and the better terms of payment can compensate for it only when the interbrand rivalry is not too intense. For $n \geq 4$, the new brand imposes still tougher competition that cannot be compensated by better terms of payment from manufacturers and therefore the competition effect is negative. We prove that the positive output expansion effect offsets both the competition and the cost effects for all n. Therefore, the next result holds.

[9] All the equilibrium expressions for the general networks and all the proofs are available from the authors upon request.

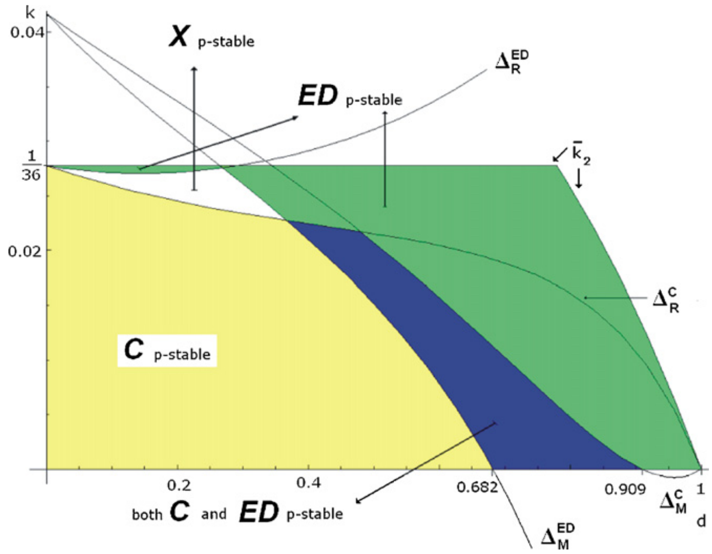

Fig. 2. Pairwise stable distribution networks: the benchmark case.

Result 3. If there are n manufacturers available, then all the distribution networks MR_i for $i = 1,\ldots,(n-1)$ are not pairwise stable. There is always an incentive to form a link between the retailer and an isolated manufacturer.

2.2. The case 2 × 2

To completely characterize the set of pairwise stable networks we next turn to the case of two manufacturers and two retailers. In such a case there are only six qualitatively different distribution networks. Five already defined: H_1, H, MR, ED and C. The remaining one is an asymmetric distribution network, which will be denoted by X standing for mixed distribution networks, formed from severing a link in the complete network or adding a link to either ED or MR or H (see Fig. 1). For the asymmetric network, X, take the equilibrium expressions in $C_{-(1,1)}$. Further to check for pairwise stability we specify the upper bound for the cost effect in the following result. The upper bound $\bar{k}_2$, is equal to the $\min\{\pi_{R_j}(H), \pi_{M_i}(C)/2\}$. The former expression is the minimum for $0 < d < 0.7790$, the latter expression is the minimum for d superior to 0.7790. It is important to say that since $\bar{k}_2$ is a function of d and d is also bounded, the relevant parameter region in the space (k, d) is bounded.[10]

It follows from Results 1–3 that H_1 is not pairwise stable. It can also be shown that neither H nor MR is pairwise stable. None of the firms with only one link in H or MR want to severe a link since the output expansion effect is greater than the cost effect. Therefore the source of instability comes from the incentives to form a new link. It is clear that the isolated manufacturer in H and the isolated retailer in MR are always willing to form a link. The point is that there is always a retailer in H willing to link with the isolated manufacturer and introduce interbrand rivalry in the market because by accepting a new brand becomes its exclusive retailer and at the same time a multiproduct seller. The internalization of in-store rivalry results in not only lower output from the former brand but also a lower transfer price and this is to be added to the new stream of profits from the additional brand. The result is that the output expansion effect is large enough to compensate for the negative but relatively small competition effect and for the cost effect. Similarly, there always exists a manufacturer willing to link with the isolated retailer in MR, since by introducing intrabrand rivalry its transfer price is reduced at equilibrium to increase its aggregate equilibrium output at the expense of a reduction in the rival's equilibrium output that more than compensates the lower margin and the extra link cost.

The following proposition summarizes (and Fig. 2 depicts the regions) the networks of manufacturers and retailers that are pairwise stable for $n = 2$.

Proposition 1. *Consider $n = 2$. Then only three distribution networks may be pairwise stable: C, X and ED. The parameter space (k, d) is partitioned into four regions.*

(i) *Low values of d and k imply that C is the only pairwise stable network.*
(ii) *Low values of d and intermediate values of k, imply that X is the only pairwise stable network.*

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[10] Further note that the term $(a-c)^2$ is present in all of the π_{R_j} and π_{M_i} expressions since it is the usual scale parameter. Thus, we can normalize it to one without loss of generality or alternatively we can define $k/(a-c)^2$ as the relative fixed cost of a link and work in the space $(k/(a-c)^2, d)$. For the ease of the exposition we choose the first option in all the figures.

(iii) *Either low values of d and values of k close to the upper bound and large values of d and k, imply that ED is the only pairwise stable network.*
(iv) *Intermediate values of d, imply that there are two pairwise stable networks C and ED.*

In general, for $n \geq 2$, the only pairwise deviation from network C consists in deleting one link moving to $C_{-(i,j)}$. Therefore, C is pairwise stable as long as the link cost is small enough. Consider the link between R_1 and M_1, then R_1 does not sever the link if and only if $k < \Delta_R^C = \pi_{R_1}(C) - \pi_{R_1}(C_{-(1,1)})$, and M_1 does not sever the link if and only if $k < \Delta_M^C = \pi_{M_1}(C) - \pi_{M_1}(C_{-(1,1)})$. Note that the expressions Δ contain the combined effect of the output expansion and the competition effect. Then, network C is pairwise stable if and only if $k < \min\{\Delta_R^C, \Delta_M^C\}$. Note that both the manufacturer and the retailer might not increase their gross payoffs by cutting a link for different reasons which basically rely on the fact that the competition effect for M_1 depends on what happens with brand one, while that of R_1 depends on what happens with the reactions of the other brands. First, when the manufacturer deletes one of its distribution channels, a negative output expansion effect is produced (which is smaller the higher d is) and M_1's derived demand function changes from $Q_1(C)$ to $Q_1(C_{-(1,1)})$. The latter is less sensitive to changes in M_1's transfer price which implies a less elastic derived demand. Then, M_1's equilibrium transfer price increases, which amounts to a positive competition effect, whose size is decreasing with d. In fact, in the move from C to $C_{-(1,1)}$ all transfer prices increase and the one that increases the most is that of M_1. Finally, the trade off between a lower demand but a higher transfer price results in a decrease in M_1 gross payoffs. This decrease is lower the lower the degree of product differentiation. In the case of $n=2$, see Fig. 2, we find that when brands are slightly differentiated the deletion of a link increases gross profits since the competition effect outweights the output expansion effect, $\Delta_M^C < 0$, making C not stable for $k=0$. Note that when $n=2$, if one manufacturer deletes a link this means that intrabrand rivalry in its brand is eliminated. However, for $n>2$ this never occurs. For R_1 the intuition is simpler since it reduces the number of streams of revenue by not selling product one (negative output expansion effect), sells more output and obtains a lower margin for all the other products it sells since the move from C to $C_{-(1,1)}$ results in softer competition upstream. Overall, the stability of the complete network depends on the amount saved with one link less (cost effect) with respect to the decrease in gross payoffs for M_1 and R_1 (output plus competition effect). We find that for $n>2$, *network C is stable for small k for all possible d. The required level of k to ensure the stability of network C is decreasing in d. Thus,* Proposition 1's *result on the stability of network C is basically robust for* $n>2$.[11]

Concerning ED, it is clear by Result 2 that none of the manufacturer–retailer pairs will severe a link. Thus, regardless the number of agents of each type, network ED is pairwise stable when at least one firm is not better off with one more link (the move from ED to $ED_{+(i,j)}$). Consider R_2 and M_1, then R_2 will not form a link with M_1 if and only if $k > \Delta_R^{ED} = \pi_{R_2}(ED_{+(1,2)}) - \pi_{R_2}(ED)$, whereas M_1 will not if and only if $k > \Delta_M^{ED} = \pi_{M_1}(ED_{+(1,2)}) - \pi_{M_1}(ED)$. Thus, network ED is pairwise stable if and only if $k > \min\{\Delta_R^{ED}, \Delta_M^{ED}\}$. See Fig. 2 for the regions where network ED is pairwise stable for $n=2$. The analysis of network ED stability requires some more elaboration. First notice that intrabrand rivalry is introduced in only one of the products and that one of the retailers becomes a multiproduct seller while the others remain as exclusive retailers. Second, the addition of a link affects the derived demand functions for manufacturers in an asymmetric way. Thus, when manufacturers compete in setting transfer prices there will be three different equilibrium transfer prices in network $ED_{+(1,2)}$. Indeed, the introduction of one link implies that the three different derived demands are now more elastic. Consequently, M_1 reduces its equilibrium transfer price (with respect to that in ED), M_2 reacts to face the introduction of intrabrand competition in its former exclusive retailer by reducing its transfer price in a larger amount than M_1. The remaining manufacturers also react by reducing their transfer prices but in a less important way. As a result, R_2 is getting a positive output expansion effect and a small negative competition effect since it gets a greater margin than in ED for product two due to the introduction of intrabrand competition in product one. We find that R_2 is always willing to form a new link with manufacturer one ($\Delta_R^{ED} > \bar{k}_n$) for $n>2$ and $d \in (0,1)$. The source of instability might come from M_1. From M_1's point of view the competition effect is greater than the output expansion effect since the reduction in transfer prices adds to less output from its former exclusive dealer. The result is that the competition effect can outweigh the output expansion effect for large enough d. The introduction of intrabrand competition by one of the manufacturers when rivals do not, is not profitable unless brands are sufficiently differentiated. For example, Δ_M^{ED} is negative for $d>0.6820$ when $n=2$. For M_1 the new link is not profitable if d and k are sufficiently large. In general, for $n>2$ we identify two thresholds for d: $d_1(n)$ and $d_2(n)$. If $d<d_1$ the ED network is never stable. If $d_1<d<d_2$ the network is stable for k large enough and the required k for stability decreasing in d. Finally, for $d>d_2$ the network is stable for all k. We conclude that *network ED is stable for large d regardless of k or for large k. Thus,* Proposition 1's *result on the stability of network ED regarding large enough d is basically robust for* $n>2$.

Finally, note that when $n=2$, distribution networks $C_{-(1,1)}$, $ED_{+(1,2)}$ and X are qualitatively the same. Therefore and since MR is never pairwise stable, X is pairwise stable when both C and ED are not stable. That is, for intermediate levels of the link cost: $\min\{\Delta_R^C, \Delta_M^C\} < k < \min\{\Delta_R^{ED}, \Delta_M^{ED}\}$, as depicted in Fig. 2.

Assume now that there are three retailers and two manufacturers and consider the ED-like network with each of the manufacturers linked with only one retailer and one isolated retailer. It is interesting to ask whether the manufacturers prefer to introduce intrabrand rivalry through the isolated retailer or through an already linked retailer. Transfer prices

[11] We know that both Δ_M^C and Δ_R^C are decreasing in d, being $\Delta_R^C = \pi_{R_1}(H) < \Delta_M^C$ if $d=0$ and both $\Delta_R^C = \Delta_M^C = 0$ if $d=1$. In any case $\min\{\Delta_M^C, \Delta_R^C\}$ is smaller than $\bar{k}_n$ for all $d<1$.

fall but the fall is smaller when using the isolated retailer. It can be shown that by linking with the isolated retailer, the output expansion effect always offsets the competition effect for the manufacturers, thus implying that the *ED*-like network is unstable if there are no link costs. Therefore, the manufacturers are always willing to increase the number of exclusive retailers to which they are linked.

3. Two-part tariff analysis

This section examines the case of two-part tariff contracts between manufacturers and retailers. The terms of payment for the retailer are defined by the pair $\{w, F\}$ where w is the transfer price and F is the up-front fixed fee. Firm's profits for a generic network g with $r \leq n$ retailers active and $m \leq n$ brands in the market are

$$\Pi^t_{R_j}(\cdot) = \sum_{i=1}^{n_{b_j}} (p_i - w_i)q_{ij} - n_{b_j}k - \sum_{i=1}^{n_{b_j}} F_{ij} \quad \text{for all } j = 1, \ldots, r,$$

and

$$\Pi^t_{M_i}(\cdot) = (w_i - c)Q_i - n_{r_i}k + \sum_{j=1}^{n_{r_i}} F_{ij} \quad \text{for all } i = 1, 2, \ldots m,$$

where the superscript t denotes the two part tariff case. A contract with two instruments strengthens manufacturers power upon retailers. It is well known that, in a successive monopoly (i.e. H_1), the use of two part tariffs allows the manufacturer to dictate the integrated monopoly output, then obtaining the integrated monopoly profits and leaving the retailer with zero profits. This drives the market to a more efficient outcome as compared to the linear contracts case. However, the ability of these two instruments to extract profits and to reach a more efficient outcome is limited under other market situations. For example, if the retailer is a multiproduct seller it is no longer true that the manufacturer is able to extract all the retailers' profits with a two-part tariff contract. The effects governing the incentives to form a link are affected by this new power balance in the manufacturer–retailer relationship.

In the last stage of the game, links, transfer prices and fixed fees are given. The unique Nash equilibrium of this stage game coincides with the corresponding one in the benchmark model. In other words, the derived demands for manufacturers do not differ in both cases. In the second stage, manufacturers decide simultaneously the transfer prices and the fixed fees such that retailers accept. Manufacturers' profits are increasing in the fees whereas retailers' profits are decreasing, therefore the fee charged to a retailer is set to the point that the retailer accepts. Two situations are distinguished. First, if a retailer is a single-product seller then the up-front fixed fee is set by the manufacturer such that the retailer gets zero profits: a fully extracting fee. Second, if a retailer is a multiproduct seller the most that manufacturer i will extract from retailer j is an up-front fixed fee set equal to product i's marginal contribution to the retailer's j profits (see Shaffer, 1991; O'Brien and Shaffer, 1993).[12] Multiproduct retailers can threat manufacturer i with selling zero of product i since the retailer can compensate for by selling more of the other substitute products. Retailers' ability to threat manufacturers vanishes when products are independent. Once fixed fees are defined, their expressions are substituted back in the manufacturers' profits and the first derivative with respect to the transfer price is obtained to compute the first order condition. In contrast with the linear contract case, a third term appears accounting for the marginal effect of the transfer price on the corresponding fee. Let us consider the $n = 2$ case. In particular, for network C we have:

$$\frac{\partial \Pi^t_{M_i}(\cdot)}{\partial w_i} = Q_i + (w_i - c)\frac{\partial Q_i}{\partial w_i} + \sum_{j=1}^{2} \frac{\partial F_{ij}}{\partial w_i} = 0; \quad i = 1, 2.$$

The third term differs across networks and determines whether the equilibrium transfer price is above or below marginal cost. It is easy to prove that for network C, where the fixed fee is not fully extracting, thus implying that the manufacturer trades off a higher transfer price for a lower fee. Finally, the FOC can be simplified to $\partial \Pi^t_{M_i}(\cdot)/\partial w_i = Q_i/3 + (w_i - c)\partial Q_i(\cdot)/\partial w_i = 0$ concluding that the equilibrium transfer price is above manufacturer's marginal cost, that is the double marginalization inefficiency arises as in the linear contract case. Next take network *MR*. The fee is not fully extracting, and the FOC for each manufacturer simplifies to $\partial \Pi^t_{M_i}(\cdot)/\partial w_i = (w_i - c)\partial Q_i(\cdot)/\partial w_i = 0$ and, therefore, the equilibrium transfer prices are set equal to marginal costs. Finally, for network *ED*, where the fixed fee is fully extracting, we have: $\partial \Pi^t_{M_i}(\cdot)/\partial w_i = -d^2 Q_i/(4 - d^2) + (w_i - c)\partial Q_i(\cdot)/\partial w_i = 0$, $i = 1, 2$. It then follows that equilibrium transfer prices are now set below marginal costs. Note that when the fixed fee is fully extracting, the manufacturer pays for the whole cost of the link, $2k$. In other words, since

[12] In order to illustrate how fees are computed, consider for example network C and the case of fixed fee F_{ij}. The contract set by M_i is accepted by R_j if: $\sum_{i=1}^{2}((p_i - w_i)q_{ij}(C) - F_{ij}) - 2k$ is greater than or equal to the profits R_j can obtain by threatening M_i with dropping product i. That is, $\max_{q_{lj}}(p_l - w_l)q_{lj} - F_{lj} - 2k$; $l \neq i$ subject to $q_{ij} = 0$.

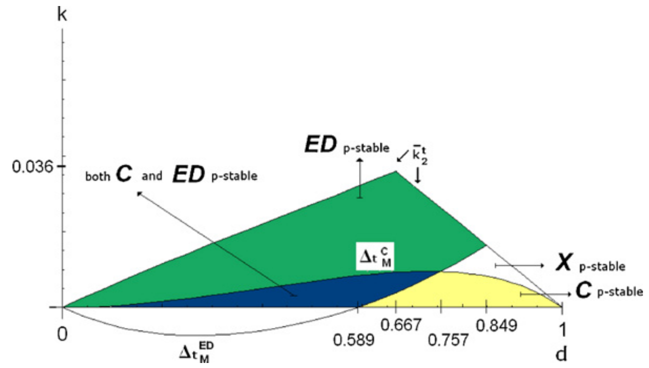

Fig. 3. Pairwise stable distribution networks: the two-part tariff contracts case.

$\Pi^t_{R_j}(ED) = (p_i(ED) - w_i(ED))Q_i(ED) - F_i(ED) - k = 0$, $i = j = 1, 2$; then $F_i(ED) = (p_i(ED) - w_i(ED))Q_i(ED) - k$. As before define by convenience $\pi^t_{R_j}(ED)$ as R_j's profits gross of link costs given network ED and under the two-part tariff contract.

As previously done in the benchmark case we first obtain the upper bound for the link cost, $\bar{k}^t_2$, i.e. the set of link costs ensuring that agents' profits in all possible distribution networks are positive.[13] The upper bound $\bar{k}^t_2$ is set equal to $\min\{\pi^t_{R_j}(C)/2, \pi^t_{M_j}(C)/2\}$. The following proposition summarizes pairwise stability among distribution networks and Fig. 3 displays the regions in the (k, d) space where each distribution network is pairwise stable.

Proposition 2. *Consider $n = 2$. Then, only three distribution networks may be pairwise stable: C, X and ED. The stability of each one is associated with a particular combination of the two parameters (k, d) as follows.*

(i) *Low values of k and large values of d guarantee that C is the only pairwise stable network.*
(ii) *Large values of k and d small enough imply that ED is the only pairwise stable network.*
(iii) *Intermediate or large k together with large enough values of d imply that X is the the only pairwise stable network.*
(iv) *Finally, if both k and d are sufficiently low then both C and ED are pairwise stable.*

To understand how the agents incentives to form a new link change when two-part tariff contracts are considered, we first analyze the robustness of the general Results 1–3 obtained in the linear contracts case. The most important changes come from the fact that manufacturers are able to extract all the profits from single-product retailers but not from multiproduct retailers; thus, retailers always want to become multiproduct. Another consequence of two-part tariff contracts is that the output expansion effect for manufacturers could be nil and the same may happen for the competition effect. With this in mind, note that Result 1 is no longer true since now there is no incentive for the linked manufacturer in H_{n-1} to form a link with a not linked retailer. Then, H is not pairwise stable because the linked manufacturer gets the same gross profits in both networks H and H_{n-1} whereas it pays $2k$ more (the total cost of the new link). In any network H_r, $r \neq 1$, the manufacturer is able to set a transfer price that induces the monopoly output in the retail market (since there is no interbrand rivalry) and through the fixed fees getting the same gross profits as in H_1. There is no increase in the manufacturer's profits by adding a new distribution channel, a null output expansion effect. Retailers are always indifferent since they always get zero. Thus no network H_r, $r \neq 1$, is pairwise stable. Moreover, H_1 is not pairwise stable because Result 2 applies and ED will be formed. In network H_1 there is a manufacturer and a retailer not linked and, although the retailer is indifferent, the manufacturer always obtains positive profits in ED. Finally, Result 3 also holds here since from MR_1 to MR when $n = 2$, the linked retailer becomes multiproduct and then obtains positive profits.[14]

The only pairwise deviation from network C consists in deleting one link. Note that neither retailer has an interest to do it, since this implies that it becomes a single-product seller and then the corresponding manufacturer is able to set a fully extracting fee thus achieving zero payoffs. Regarding manufacturers, no manufacturer wants to sever a link if and only if $k < \Delta t^C_M \equiv \pi^t_{M_i}(C) - \pi^t_{M_i}(X)$, where i is the manufacturer that deletes a link and Δt^C_M is the increment in gross profits for M_i when C is formed from X. Pairwise stability requires that the combination of the output and competition effect offsets the cost effect. By severing a link, M_i only sells its product throughout a multiproduct retailer and sets a transfer price that equals its marginal cost. As already noted, the increase in w_i has three effects: increases the revenue from the output sold, reduces the output sold and reduces the fixed fee. By moving from C to X the second effect is weak and the third one strong. Therefore the manufacturer is better off reducing its transfer price to the point that all its income is obtained from the fixed fee. By strategic complementarity the other manufacturer also reduces its equilibrium transfer price, resulting in more output for

[13] We have $\bar{k}^t_2 = \pi^t_{R_j}(C)/2 = d(a-c)^2/(1+d)(4-d)^2$ if $0 < d \leq \frac{2}{3}$ and $\bar{k}^t_2 = \pi^t_{M_j}(C)/2 = 2(1-d)(a-c)^2/(1+d)(4-d)^2$ if $(2/3) < d < 1$.

[14] For $n = 3$, the move from MR_2 to MR is also made by the linked retailer since the increase in gross profits by forming a new link with an isolated manufacturer is greater than the link cost.

both products and a more competitive situation in the market. It is profitable for M_i to sever a link if the saving in link costs offsets the decrease in gross profits explained by the combined output expansion and competition effect. It is important to remark that, in this case, the effect of severing a link is a negative output expansion effect and a positive competition effect.

Consider the stability of network *ED*. It happens that *ED* is pairwise stable if and only if no agent wants to form a link since, by Result 2 above, no one will sever an existing link. A retailer always wants to form a new link since it gets positive payoffs by becoming a multi-product seller. However, a manufacturer prefers not to form a link if the link cost is sufficiently large, $k > \Delta t_M^{ED} \equiv \pi_{M_i}^t(X) - \pi_{M_i}^t(ED)$. By forming a link the manufacturer distributes its product both through a single-product and a multiproduct retailer. Then its link cost only increases in k, its derived demand becomes more sensitive to changes in w_i and the sum of the fees is less sensitive to changes in w_i. The result is that now manufacturer i's transfer price increases (it is above marginal cost) and the rival's increases too (now it equals marginal costs). The combined effect on product's i total output of a less competitive situation in terms of transfer prices together with the introduction of both intrabrand and in-store rivalry is not uniform and depends on the degree of product differentiation. Product i's equilibrium output is greater in network *ED* than in network *X* (when M_i has two links) if and only if $d < 0.8320$. Therefore, the output expansion effect to form a new link is positive if and only if $d > 0.8320$, otherwise is negative. The competition effect for manufacturers is always positive in this case. In fact the relative size of the two effects depends also on d, implying a negative Δt_M^{ED} when products are sufficiently differentiated since the output expansion effect dominates the competition effect. Consequently, network *ED* is pairwise stable if products are sufficiently differentiated regardless the size of the link cost (see Fig. 3). As d increases, Δt_M^{ED} increases too. This is basically because $\pi_{M_i}^t(ED)$ decreases quickly when products become close substitutes. The reason is that in network *ED*, manufacturers compete strongly on transfer prices, they bear negative profits from the linear part of their gross profits by setting transfer prices below marginal costs that are compensated for by positive profits in the fixed fee part of their profits. When d increases the difference between the positive and the negative parts shrinks quadratically. Thus, if products are rather close substitutes then *ED* is never pairwise stable. The required level of fixed cost to convince a manufacturer not to form a link is larger than the upper bound, $\overline{k^t}$ (see Fig. 3).

Finally note that network *X* is pairwise stable so long as the manufacturer selling to both retailers prefers not to break the link with the multi-product retailer, (which happens for $k < \Delta t_M^{ED}$) and also when the manufacturer selling to one retailer prefers not to form a new link with the single product retailer, which happens for $k > \Delta t_M^C$. The remaining option, the manufacturer selling to both retailers severing the link with the single product retailer is never profitable for the manufacturer since the required saving in link cost would be so large that it would exceed $\overline{k^t}$. This is the reason why *MR* is not pairwise stable either. By severing a link with a single-product retailer it eliminates intrabrand rivalry but, given the type of contract, both equilibrium transfer prices decrease down to marginal costs and, at the same time, output decreases. This together with the fact that the manufacturer that deletes the link loses all the single-product retailer's profits that are fully extracted via the fee explains the instability of network *MR*.

4. Robustness analysis

We wish to extend the main intuitions of the benchmark model by providing alternative model specifications in two directions. The first one is related with the exogenous advantage given to the upstream firms in setting first the transfer price. We consider the simplest situation where upstream firm has no bargaining power that is equivalent to the case where both differentiated products are produced by competitive industries. In this case, the transfer price is just the marginal cost of production and the double marginalization inefficiency is eliminated. Secondly, both retailer differentiation and price competition in the retail industry are considered.

4.1. No bargaining power upstream

We assume that in this situation both products have the same transfer price which equals marginal cost of production and that retailers pay the full cost of a new link. The third stage of the benchmark model is replicated for each possible distribution network and equilibrium quantities are easily obtained by setting $w_1 = w_2 = c$. Manufacturers obtain zero profits. We denote by $\Pi_{R_j}^r(g)$ and by $\pi_{R_j}^r(g)$ the R_j's equilibrium profits and equilibrium gross profits, respectively, for network g. We then obtain the relevant set for the link costs, that is, $0 \leq k \leq \bar{k}_2^r \equiv \frac{(a-c)^2}{18(1+d)}$ and then find the stable distribution networks. The following proposition summarizes pairwise stability among distribution networks and Fig. 4 displays the corresponding areas in the relevant parameter space.[15]

Proposition 3. *Only three distribution networks might be pairwise stable: C, H and ED. The stability of each one is associated with a particular combination of the two parameters (k, d) as follows.*

[15] In Fig. 4, the expressions Δr_R^C, Δr_R^{ED}, and Δr_R^H, are, respectively, $(\pi_{R_j}^r(C) - \pi_{R_j}^r(X))/2$, $(\pi_{R_j}^r(X) - \pi_{R_j}^r(ED)/2)$, and $(\pi_{R_j}^r(X) - \pi_{R_j}^r(H))/2$.

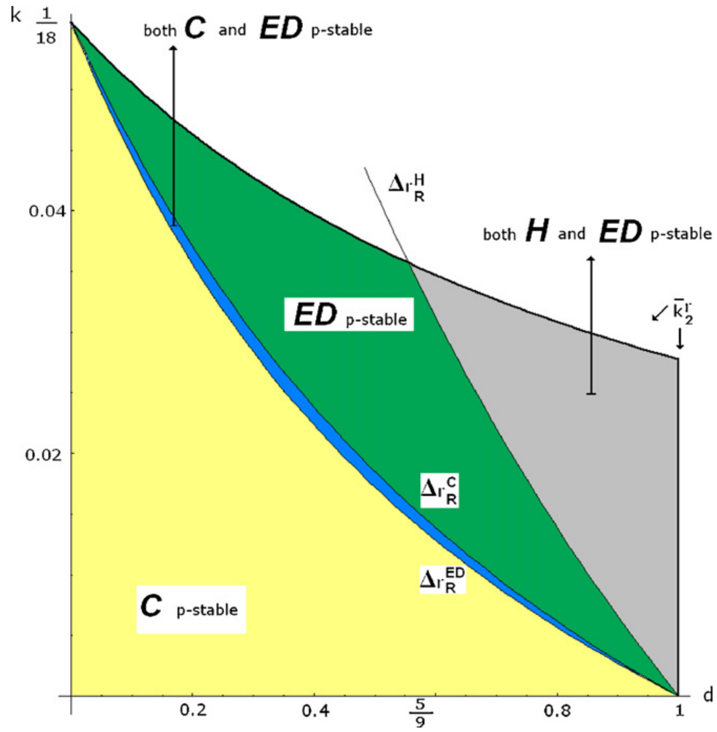

Fig. 4. Pairwise stable distribution networks: no bargaining power upstream.

(i) *Low values of k and all values of d guarantee that C is the only pairwise stable network.*
(ii) *Intermediate values of k and all values of d imply that both C and ED are pairwise stable network.*
(iii) *Either large values of k and d smaller than 5/9 or intermediate values of k and d greater than 5/9 imply that ED is the only pairwise stable network.*
(iv) *Finally, large values of k and d greater than 5/9 imply that both H and ED are pairwise stable.*

Note that since manufacturers now play a passive role, only the retailers' incentives to form links need consideration. Regarding the results stated in the benchmark case, it easily follows that Results 1 and 2 remain valid. However, Result 3 is not always true, either of the two networks MR_1 or MR might be preferred by the multi-product retailer depending on the particular values of link cost and product differentiation. This is explained because now the move from MR_1 to MR does not benefit the multiproduct retailer with a reduction in the transfer price of the formerly linked manufacturer since transfer prices are not strategic. However, MR_1 is not pairwise stable once we apply Result 2. Also MR is not pairwise stable because the isolated retailer has always incentives to form a link with one manufacturer. The stability of network C requires $k < \Delta r_R^C$, being R_j the retailer that deletes a link. As in the benchmark case, by severing a link the retailer enjoys a positive cost effect, it gets a negative output expansion effect and a positive competition effect. The main difference is that it saves 2 k instead and that the competition effect is greater since transfer prices are not strategic. The fact that transfer prices are not strategic is thus the main force underlying the results in this case and can be applied to justify why network H is now stable under particular conditions. If the transfer prices were strategic as in the benchmark case, then there would always be a retailer in H willing to link with the isolated manufacturer and introduce interbrand rivalry in the market. Now the introduction of interbrand rivalry does not have the effect of lowering transfer prices and therefore, the competition effect is stronger thus making the stability of network H possible. The same argument applies to sustain that the stability of network ED is reinforced against the possibility of forming a new link and moving to network X. Therefore, the general claim in this case is that the effect of allocating all bargaining power on the retailers side implies that the introduction of interbrand rivalry (moving from H to X) or the introduction of intrabrand rivalry (moving from ED to X) is less likely to happen since the associated competition effects are stronger than in the benchmark case. Finally note that if the link cost effect is zero, then network C will be the unique pairwise stable network since the output expansion effect always dominates the competition effect.

4.2. Differentiated retailers

In the benchmark model, retailers were not differentiated and the same product sold by different retailers was perceived as identical by consumers implying maximal intrabrand rivalry. In that case, and assuming that retailers compete in prices, intrabrand rivalry yields zero profits in this brand to retailers by standard Bertrand competition type of arguments. In this section we are going to provide some results about pairwise stability when retailers are differentiated at the eyes of consumers and there is price competition. We will assume that intrabrand rivalry increases as parameter s increases for $s \in (0,1)$. Also, to simplify the analysis, we will assume zero link costs and $n = 2$. To be as close as possible to the benchmark model, we will start with the inverse demand system already employed that incorporates the new feature of retailers differentiation as follows:[16]

$$p_{ii} = a - q_{ii} - sq_{ij} - dq_{ji} - sdq_{jj} \quad \text{for } i, j = 1, 2.$$

The first subscript denotes the product and the second subscript the retailer. Since there are two differentiated products and two differentiated retailers, the four different products affect the price of product i sold by retailer i in four ways. The own effect is as in the benchmark case. Next, s is the parameter that incorporates the degree of intrabrand rivalry in the market since it is the effect of product i sold by retailer j. Also, d is the parameter that incorporates the degree of interbrand rivalry in the market, the effect of the other product sold by the same retailer. Finally, we assume that the effect of the other product sold by the other retailer is the product of the two already mentioned parameters, sd. Notice that the inverse demand given above depends on the specific distribution network considered. For instance, the system of demand functions obtained by inverting the system of inverse demands in network C is: $q_{ii} = ((1-s)(1-d)a - p_{ii} + sp_{ij} + dp_{ji} - sdp_{jj})/((1-d^2)(1-s^2))$, $i, j = 1, 2$. However, for network ED, the demand system is $q_{ii} = ((1-sd)a - p_{ii} + sdp_{jj})/((1-s^2d^2))$, $i, j = 1, 2$ and $i \neq j$.

Note that price competition in the third stage implies in this context that retailers' decisions are strategic complements. In general this will lead to greater output at equilibrium when compared to a situation with quantity competition. For example if there is only intrabrand rivalry in one of the products, network H, the manufacturer monopolist is setting the monopoly transfer price no matter the nature of competition at the retail level. Also, the equilibrium level of product 1 is greater when retailers compete in prices. The manufacturer is better off with price competition while retailers are better off with quantity competition. The same conclusions apply for the case of network C: greater output and the same transfer prices in case of price competition. Thus, manufacturers prefer price competition whereas retailers prefer quantity competition. Regarding pairwise stability we prove the next two results.

Result 4. Networks MR, H and H_1 are not pairwise stable when retailers are differentiated and compete in prices.

The reason is simple for network H_1 since the not linked manufacturer–retailer pair are always better off forming a link. In case of network H, the relevant agent is a retailer, since either of the two has an incentive to link with the not linked manufacturer. This retailer is better off with the new link since by introducing interbrand rivalry in the market the equilibrium transfer prices are lower ($w_1(H) > w_1(X) > w_2(X)$ for M_1 being the one with two links in X) and the multiproduct retailer sells more of both products at equilibrium. In case of network MR, the relevant agent is a manufacturer. There is always a manufacturer with incentives to form a link with the not linked retailer to reach network X. By doing so, both equilibrium transfer prices increase ($w_1(X) > w_2(X) > w_1(MR)$) and M_1 equilibrium output also increase $q_{11}(MR) < q_{11}(X) + q_{12}(X)$.

Proposition 4. *Network C is the unique pairwise stable network for d sufficiently low, while network ED is the unique pairwise stable network for d sufficiently large. Then, network X is stable for intermediate values of d and s sufficiently large.*

First note that the retailers involved in the stability of ED, X and C are always better off forming a link. The move from ED to X and then to C, allows retailers to benefit from lower transfer prices ($w_1(ED) > w_1(X) > w_2(X) > w_1(C)$) and larger equilibrium outputs. However, for the manufacturers involved there is a trade off between lower manufacturer margins and larger equilibrium outputs when moving from ED to X and then to C. It can be shown that network ED is stable when the increase in the equilibrium output by forming a link is not high enough (this happens when products are rather similar), while network C is stable when products are rather differentiated because severing a link leads to an important decrease in the equilibrium outputs.

5. Welfare analysis

Some of the very central questions about network formation concern the conditions under which the networks which are formed by the players turn out to be efficient from an overall societal perspective. We will distinguish two points of view. One concerns consumers as measured by consumer surplus and another concerns all agents together, total welfare. In this section we will concentrate on the case of $n = 2$. Consumer surplus in network g is denoted by $CS(g)$ and is given by the following expression

$$CS(g) = \frac{1}{2}[(Q_1(g))^2 + (Q_2(g))^2].$$

The social welfare associated to network g is denoted by $W(g)$ and is defined as the sum of the equilibrium profits of the four firms in network g plus the consumer surplus associated to g.

[16] We borrow the inverse demand system from Dobson and Waterson (1996).

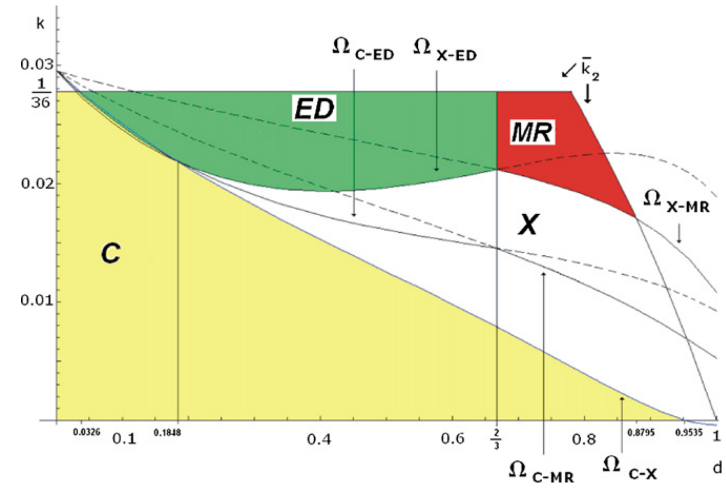

Fig. 5. Social welfare maximizing distribution networks: the benchmark case.

5.1. Consumer surplus and social welfare in the benchmark case

Depending on the particular distribution network, one or two products are present in the market. Different combinations of intrabrand, interbrand and in-store rivalry can be present. Which distribution network yields the highest consumer surplus? It is clear that consumers are better off the higher the rivalry in the market since this implies the highest amount of output. Thus they prefer the three types of rivalry to be present in both products and retailers: that is network *C*. If this is not possible, the next preferred network is *X*, where there is in-store rivalry at one retailer and with the presence of both inter and intrabrand competition. Either network *MR* comes next for low enough product differentiation or network *H* for intermediate levels of product differentiation or network *ED* for sufficiently large product differentiation levels. Note that only one retailer selling both products can be preferred to a homogeneous duopoly. The reason is that when *MR* is at play, the rivalry among manufacturers results in a lower equilibrium transfer price than in network *H*, despite the fact that in the latter the rivalry among retailers is stronger than in the former. The combination of both effects explains why *MR* generates a higher consumer surplus than *H* when *d* is large enough, since transfer prices in *MR* are lower for large *d*.[17] Finally, the worst distribution network for consumer is the one with only one product in one retailer, H_1. Then, consumer surplus is increasing with the introduction of different products by retailers.

Finally, we analyze the effects of the different distribution networks on social welfare. The distribution networks that attain the maximum social welfare are either *ED* or *MR* or *X* or *C*, depending on the degree of product differentiation and the size of the link costs. Thus, only distribution networks that market both products can achieve the highest social welfare. That is, interbrand competition is always socially desirable in the market. However, intrabrand competition and in-store competition are not necessarily socially desirable.

Fig. 5 displays[18] the distribution networks that maximize social welfare. We find that network *C* attains the highest level of social welfare for high enough degrees of product differentiation and low enough link costs. Network *X* for low enough degrees of product differentiation and intermediate sizes of link costs. Network *MR* for intermediate degrees of product differentiation and high sizes of link costs. Network *ED* attains the highest level of social welfare when products are more differentiated than those that imply the highest welfare with network *MR* and high enough link costs. Comparing Fig. 2 with Fig. 5 we observe that the distribution networks that firms will endogenously form following their own interest enter, in general, in contradiction with those that maximize welfare. Thus a sort of market failure is identified that should call the attention of antitrust authorities.

For the particular case $k = 0$, we find that: (i) when *C* is stable it is the one that maximizes social welfare, but the reverse is not true; (ii) and that *X* maximizes social welfare when products are almost homogeneous but it is not stable. Once the formation of links is costly, networks *ED* and *MR* also maximize social welfare for some parameter values. While *ED* could be stable when it maximizes social welfare, network *MR* is never stable when it maximizes welfare. Moreover, costly links increase the conflict between social welfare and stability with respect to network *C*.

In general, there are distribution networks like *C*, *MR* and *X* that are less likely to arise when leaving the market forces on their own, as compared with the socially desirable outcome. By contrast, the distribution network *ED* appears to be stable under more situations than what would be socially desirable. We find that restricting exclusive distribution and exclusive

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[17] The equilibrium transfer price ranking is: $w(C) = w(MR) < w_2(X) < w_1(X) < w(ED) < w(H) = w(H_1)$.

[18] Expressions Ω_{C-X}, Ω_{C-ED}, Ω_{C-MR}, Ω_{X-ED} and Ω_{X-MR} are defined as follows: for any two networks g_1, $g_1 \in G_2$, $\Omega_{g_1-g_2}$ is the level of k that solves $\Omega_{g_1-g_2} = W(g_1) - W(g_2) = 0$.

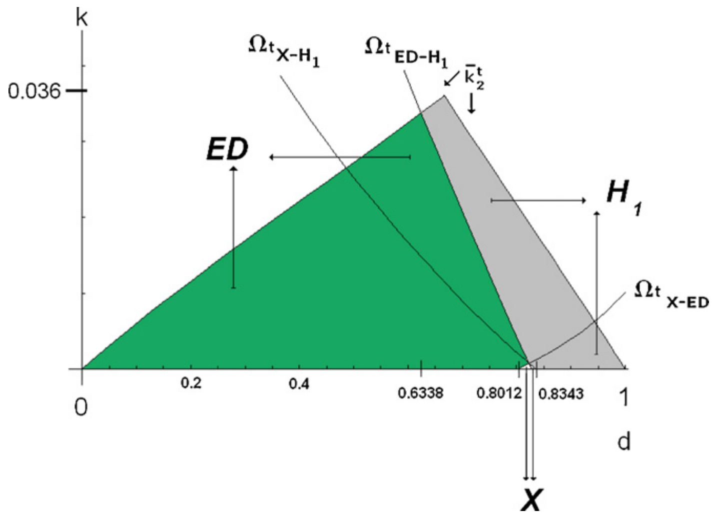

Fig. 6. Social welfare maximizing distribution networks: two-part tariff contracts case.

dealing arrangements might have a positive impact on social welfare when the degree of product differentiation is low enough.

5.2. Consumer surplus and social welfare in the two-part tariff case

As already established consumers prefer the network that will induce the highest level of output in both products. This of course depends crucially on the equilibrium transfer prices. With the use of two part tariff contracts, three types of situations are found at equilibrium regarding the sign of the manufacturers' margin. This margin is positive for all manufacturers in the distribution networks *C* and *H*, and for the manufacturer that employs two retailers, M_1, in *X*. It is zero in H_1, *MR* and for the manufacturer that employs one retailer, M_2, in *X*. Finally, in the distribution network *ED* both manufacturers have negative margins. This fact is crucial to understand which network maximizes consumer surplus and which attains the highest welfare.[19]

Consumers are better off in the distribution network in which competition at the manufacturers' level appears to be the toughest, that is, network *ED*. Network *ED* is the one where: (a) both products are sold and then there is interbrand rivalry, (b) the two retailers are active and are single-product and (c) by the use of two-part tariffs, there is a negative manufacturers' margin that induces a large amount of output at the retail level. It is important to underline that network *ED* yields more consumer surplus than *C* because, despite the existence of intrabrand rivalry in the latter, retailers' multiproduct nature implies that a smaller fixed fee in the two-part tariff contract is compensated by a higher transfer price thus reducing equilibrium output.

Finally and concerning welfare, the result is obtained as a combination of the consumer interest that advocates for *ED* and the maximization of the sum of the profits of the four firms which favors monopoly market configurations. It is easy to see that the distribution networks that end up in zero manufacturers' margin and that consist of a monopoly at the retailer level (networks H_1 and *MR*) are efficient for the members of the network.

In Fig. 6,[20] we see that social welfare is maximized either at *ED*, at H_1 or at *X*. Thus, at most three links appear in the socially optimal networks: three links (network *X*) only in case of very low link costs and intermediate levels of product differentiation, two links (network *ED*) when products are sufficiently differentiated, and only one link (network H_1) when products are close substitutes. If we consider the extreme cases e.g. for $k = 0$, the three networks mentioned above can be social maximizing. In particular, either *ED* if $d < 0.8012$; or *X* if *d* belongs to (0.801, 0.8343); or H_1 otherwise. If $d = 0$ and for any level of *k*, *ED* is the social maximizing network while for $d = 1$, it is H_1 It is important to underline that there is no coincidence between the social interest and the stable distribution networks. This is a result that already appeared in the benchmark case thus suggesting that the use of two-part tariff contracts does not solve the conflict. Comparing with the benchmark case notice that the trade off between the number of links and the degree of product differentiation is also present but involving networks that include fewer links. The reason is that the market is more competitive and more efficient than in the benchmark model with less links. To compensate for the pro-efficiency effect of the two-part tariff contracts, in the benchmark case more links are required by the social maximizing networks. In particular, we have that the distribution network *C* is stable but never maximizing social welfare. The distribution network *X* is not maximizing social welfare when it

[19] The equilibrium transfer price ranking is: $w^t(ED) < w^t(MR) = w^t(H_1) = w_2^t(X) < w_1^t(X) < w^t(C) < w^t(H)$.

[20] Expressions Ωt_{X-H_1}, Ωt_{ED-H_1}, and Ωt_{X-ED} are defined as follows: for any two networks $g_1, g_2 \in G_2$, $\Omega t_{g_1-g_2}$ is the level of k that solves $\Omega t_{g_1-g_2} = W^t(g_1) - W^t(g_2) = 0$.

Table 1
Stable distribution networks.

	Link cost	Product differentiation		
		High	Medium	Low
Linear contracts stability	Small	Network *C*	Network *C*	Both networks *C* and *ED*
	Medium	Network *C*	Both networks *C* and *ED*	Network *ED*
	High	Both networks *ED* and *X*	Network *ED*	Network *ED*
Two-part tariff contracts stability	Small	Both networks *C* and *ED*	Network *C*	Network *C*
	Medium	Network *ED*	Both networks *C* and *ED*	Network *C*
	High	Network *ED*	Network *ED*	Network *X*

is stable and, viceversa, is never stable when it maximizes welfare. Only the distribution network *ED* is sometimes both, the one that maximizes social welfare and the stable one. We find that restricting non-exclusive distribution and non-exclusive dealing networks might have a positive impact on social welfare when the degree of product differentiation is low enough.

6. Conclusion

We have analyzed the endogenous formation of distribution systems adopting a network theory perspective, where the stability of a distribution link requires the joint consent of asymmetric groups of agents, i.e. a manufacturer and a retailer. Both the *non-exclusive distribution and non-exclusive dealing* network (network *C*) and the *exclusive distribution and exclusive dealing* network (network *ED*) are found to be stable in the $(n \times n)$ linear contract case and results are characterized by the interplay of rivalry types, which depend on the degree of product differentiation, and link costs. We completely characterize the set of stable networks in the (2×2) case, which also includes the *mixed distribution* network (network *X*). However, the parameter region for which these particular networks are stable is sensitive to the contract type, as presented in Table 1. Our robustness analysis examines the case of the manufacturers with no bargaining power and the case of differentiated retailers who compete in prices. It has been shown that networks *C* and *ED* remain stable in both cases, and that network *X* is only stable under retailer differentiation. In case that manufacturers have no bargaining power, the distribution network in which a unique manufacturer is linked with both retailers could also be pairwise stable.

Interestingly, there is a conflict between stability and social welfare that arises under both types of contracts. Stable networks do not necessarily maximize consumer and/or social welfare, a fact that suggests a number of competition policy implications. Thus, we find that in industries where linear contracts are used, restricting exclusive distribution and exclusive dealing arrangements might have a positive impact on social welfare for a low degree of product differentiation. However, in industries where two-part tariff contracts are used, restricting non-exclusive distribution and non-exclusive dealing arrangements might have a positive impact on social welfare when product differentiation is weak.

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