Colluding via Exclusive Territories*

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Abstract

This paper studies the rationale for exclusive territories in a model of repeated interaction between competing supply chains. We show that exclusive territories have two countervailing effects on the incentives for manufacturers to collude. On the one hand, exclusive territories dampen interbrand competition in the stage game. Hence, in a repeated game the punishment profit after deviation from the collusive agreement is larger, thereby rendering deviation more profitable. On the other hand, exclusive territories stifle deviation profits because retailers can adjust their pricing decisions to the wholesale contract offered by a deviant manufacturer, whilst intrabrand competition would prevent this 'instantaneous reaction' mechanism. We show that in a linear framework the latter effect dominates the former, whereby making exclusive territories a more suitable organizational mode to sustain cooperation between upstream manufacturers.

Keywords: Collusion, exclusive territories, public contracting, private contracting, supply chains, vertical restraints.

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1 Introduction

Exclusive territories are of widespread use in markets. For example, in industries such as the lodging business, computer service business or maintenance services business, manufacturers use franchise contracts that predominantly grant the franchisee an exclusive territorial area in which the franchisor commits not to add another outlet.[1] Also, car distribution in the U.S. and in Europe or distribution of beverages in the U.S. is often organized by way of exclusive territories where manufacturers select their dealers or retailers and prevent these dealers to sell into the territories of other dealers.[2] A well-known reason for this practice by manufacturers is to provide retailers with incentive to invest in services that would be eroded by competing retailers in the same district, see for example Mathewson and Winter (1984 and 1994). However, exclusive territories do not only have effects inside the supply chain, but they also induce strategic effects on competing manufacturers. As pointed out by Rey and Stiglitz (1995), softening intrabrand competition through exclusive territories also mitigates competition among substitute brands through a 'strategic effect': absent intrabrand competition, distributors of a given product increase their retail prices if competing brands sell at higher wholesale prices. This spurs downstream profits and, therefore, the surplus that manufacturers can extract via franchise fees. Although these effects are important to judge the effectivity of exclusive territories on manufacturers' profit, they are relatively unexplored so far. In particular, to the best of our knowledge, besides the study by Rey and Stiglitz (1995) there is no other paper having analyzed the consequences of exclusive territories in case of competing manufacturers.[3]

In addition, the existing literature has almost exclusively taken a static approach, and has thus neglected the effects that limits on intrabrand competition have on the repeated interactions between competing manufacturers. However, in the examples above, exclusive territories are especially prevalent in industries in which just a few big producers compete with each other for a long time. For example, Coca-Cola Company and PepsiCo, the two leading producers of non-alcoholic beverages control a very large market share in this segment.[4] Both of them grant exclusive territories to their bottlers. Another example is the hotel business in which only few big players like InterContinental Hotels Group, Wyndham Hotel Group and Marriott International — the three biggest companies — control a large share of the market in many cities or districts. All these companies give exclusive territories to their franchisees. Also, the big five car manufacturers that amount to a market share of 74.4% in 2008 in the U.S.[5] distribute their cars via dealership that are granted exclusive territories. Evidently, these companies do not compete on a pure static perspective but likely take dynamic considerations in their pricing behavior into account, namely that lowering their prices today may trigger a price reduction by its competitors in the future. Thus, the companies will engage in some form of implicit or tacit collusion to sustain high prices. For example, Fosfuri and Giarratana (2003) point out that Coca-Cola and Pepsi have often avoided direct price competition and that price adjustments by one company are usually followed immediately by the other company. These are telltale things that tacit collusion is important is this market.

[1] Azoulay and Shane (2001) document that more than 80% of franchisors among many different industries adopt exclusive territories.

[2] See, for example, Brenkers and Verboven (2006) for in-depth study of European car dealerships and Culbertson and Bradford (1991), Jordan and Jaffe (1987) and Sass and Saurman (1996) for detailed studies of the beer distribution.

[3] As we will mention in the literature review, Iyer (1998) considers a model of competition between manufacturers but he focussed on pure interbrand competition, i.e. each retailer has an exclusive territory. Thus, his model does not allow for a comparison of exclusive versus non-exclusive territories.

[4] As reported by Fosfuri and Giarratana (2003), between 1999 and 2003 the two firms controlled more than 75% of the carbonated soft drink market in the US.

[5] See http://online.wsj.com/mdc/public/page/2_3022-autosales.html.

The aim of this paper is to study the effects of such dynamic considerations on the pricing behavior, i.e. if they weaken or actually strengthen this earlier static insight. The objective is to identify the link between restrictions on intra- and interbrand competition and the incentives to achieve cooperative outcomes in a repeated game where manufacturers control the organizational strategies of the supply chain. We are interested in understanding what new trade-offs exclusive territories bring about in a dynamic game. What is the role that the strategic effect plays in a framework where tacit collusion can be enforced through repeated interactions? Do exclusive territories facilitate tacit collusion between upstream firms? What is the role of information sharing agreements among competing vertical chains in such a dynamic setting?

To address these issues we set-up a simple repeated game, where two manufacturers, each producing a single brand, compete by offering two-part tariffs and choose whether to grant exclusive territories or allow for intrabrand competition. Moreover, to unveil the role of public contracting on the extent of collusion, we consider two alternative regimes concerning the observability of wholesale contracts – one where these deals are observable (public contracts) and the other where they are unobservable (private contracts). To focus on the pure strategic effects of exclusive territories, we abstract from incentive problems that may arise inside the manufacturer-retailer relationship.

In the first part of the analysis we consider the case of public contracts. This is the praxis in business format franchising due to mandatory disclosure of franchising contracts required by the Federal Trade Commission since 1979. It extends the static framework of Rey and Stiglitz (1995) to a repeated game. We show that exclusive territories have two countervailing effects on collusion. On the one hand, the static analysis suggests that cooperative outcomes in the upstream market should be easier to sustain under arrangements allowing for intrabrand competition. As implied by the simple static insight, this is because exclusive territories increase profits along the punishment phase when manufacturers punish deviations with grim-trigger strategies. On the other hand, we demonstrate that a new countervailing effect kicks in with repeated interaction. When both manufacturers impose exclusive territories, retailers of a given brand can react on the deviation of a deviant manufacturer directly in the time period of deviation. They do so by optimally changing their retail price decisions, whereby reducing the spot gain from deviation. This instantaneous 'punishment' mechanism is no longer at work in the absence of exclusive territories: with intrabrand competition retailers are unable to tailor their pricing decisions to the wholesale contract offered by the competing manufacturer. Hence, as long as wholesale contracts are observable, exclusive territories reduce deviation profits relative to arrangements allowing for intrabrand competition.

Understanding which of these effects prevails is not an obvious question. One might argue that the effect of exclusive territories on the deviation profit has only a second-order effect relative to the impact that these arrangements produce on the punishment profit. While the strength of the former effect relies solely on the retailers' reaction to a deviation along the best-reply function, the latter also entails a reaction by the rival manufacturer. Our analysis suggests that this conjecture is incorrect and that the net effect is usually unclear. However, in the standard linear demand model, we show that the deviation effect is invariably stronger than the punishment effect, whereby making collusion easier to sustain with exclusive territories.

After having characterized collusion with observable contracts, we turn to examine the case of non-observable contracts. In this framework, we prove that the choice of the distribution channel has no impact on collusion: a *neutrality result*. With non-observable contracts there is no strategic effect: collusion, deviations and punishments profits are the same irrespective of manufacturers' distribution channels.

This result implies that the strategic value of exclusive territories emerges only if these arrangements are coupled with information sharing agreements among competing supply chains. To emphasize the key role of communication more vividly, we also study an extended model where the decision of whether disclosing information about wholesale contracts is endogenous and taken at each stage of the repeated game. It turns out that is in the manufacturers' best interest to exchange information about wholesale contracts: even in the deviation phase upstream firms prefer to make their contracts public in order not to give up the benefits of the strategic effect discussed before. This result shows quite clearly the potential benefits of communication systems among competing supply chains, a feature which seems widespread in many markets. Information sharing agreements between competing supply chains, often enforced through suppliers' trade associations, are common in several industries and have often triggered the interest of the Federal Trade Commission (e.g., see Briley et al., 1994, and Kulp et al., 2004).

The remainder of the paper is organized in the following way. Section 2 relates our contribution to the earlier literature. Section 3 sets up the baseline model. In Section 4 we analyze the public contracting regime, while the case of private contracting is studied in Section 5. Section 6 concludes. All proofs are in the Appendix.

2 Related Literature

The existing literature on exclusive territories, with the exception of Rey and Stiglitz (1995), focussed exclusively on the case of a monopolistic manufacturer and his incentive to grant exclusivity. Mathewson and Winter (1984 and 1994) were the first to show that exclusive territories can create an incentive for retailers to supply desired services, like product demonstrations are investments in quality. If retailers compete, each of them free rides on the services provided by the other retailers which erodes the incentive for each of them. Granting exclusive territories overcomes this problem by avoiding free riding. Drawing on these papers, Klein and Murphy (1988) and Alexander and Reiffen (1995) give precise conditions under which a retailer has the correct incentive to supply these services. Iyer (1998) explores under which conditions a manufacturer optimally offers heterogeneous contracts to retailer in order to provide them with the right incentives to (i) invest in services and (ii) target different consumer groups. In an extension, he considers competition between manufacturers and shows how this affects the coordination between price and nonprice competition of retailers. As mentioned, in the latter case he focusses on pure interbrand competition.[6]

There are several other interesting issues that have been explored in the framework of a monopolistic manufacturer. For example, Dutta et al. (1994) compare exclusive and non-exclusive territories but allow for bootlegging, i.e. even under exclusive territories a retailer can allowed to sell into a different geographical area to some extent. They show that the optimal degree of bootlegging is positive and is the larger, the more important are the services of the retailer and the longer the relationship.[7] Desiraju (2004) analyzes the case where retailers are subject to limited liability and demand is stochastic. Therefore, the manufacturers must adapt the fixed fee to extract surplus. Desiraju (2004) demonstrates that this may

[6]Rey and Tirole (1986) suggest a different rationale for exclusive territories, namely that distributors may learn information about local market conditions. If distributors compete, they have no market power and therefore any superior information is lost since the uninformed manufacturer sets the retail price. With exclusivity the informed distributor sets the price which allows for future segmentation of consumers.

[7]Nault and Tyagi (2001) consider the problem when customers in one geographical area may buy in another area but firms' investments only affect the demand of their local consumers. They show under which conditions the optimal agreement between fims involves transfers or shared ownership.

lead to non-exclusive territories being optimal although the free riding problem appears. Chiang et al. (2003) demonstrate under which conditions it is beneficial for a manufacturer open an own retail store in competition to the existing retailer although this may involve self-cannibalization. They show that this can even benefit the retailer if wholesale prices decrease.[8]

On the empirical side, several studies measured the reasons for firms to grant exclusive territories. For example, Dutta et al. (1999), using data from manufacturers of industrial machinery and electronic equipment in the U.S., demonstrate that both effects are important for manufacturers to deploy exclusive territories. In particular, they found that the free-riding problem and competition between manufacturers are highly significant explanatory variables of why manufacturers grant territorial exclusivity in these industries. These variables dominate, for example, the explanation that exclusive territories are given due to a higher enforcement ability of manufacturers.[9] Kalnins (2004) used data from the hotel industry in Texas from 1990 to 1999 to quantify the effects of exclusive territories. In this industry franchising is the common practice and franchisors often grant exclusive territories that ensure the franchisee that the franchisor will not to add another hotel in the same geographical area, a practice that is called no encroachment. Kalnins (2004) finds that for hotel chains that do not grant exclusive territories, if the franchisor adds a new hotel within the 10 closest hotels, this is associated with a $66 loss per room and has highly negative effects on the franchisee's profit. Culbertson and Bradford (1991), Jordan and Jaffe (1987) and Sass and Saurman (1996) examine the effects of exclusive territories on beer prices in the U.S. They find that this use leads to an increase in the wholesale and retail price of beer. In addition, they show that if manufacturers can choose between exclusive or non-exclusive territories, they predominantly use exclusive territories. Finally, Brenkers and Verboven (2006) evaluate the effects of enhanced competition between car dealers due to the removal of exclusive territories and exclusive distribution agreements in the European car market and find that car prices fall. However, they also demonstrate that after the removal almost all car manufacturers chose a distribution system that limits the number of dealers in order to retain some market power with each of them in the respective geographical area. In sum, the empirical studies overwhelmingly demonstrate that exclusive territories have a large impact on retail prices and that competing manufacturers are more likely to choose this distribution system than an upstream monopolistic.

Our analysis also adds to the recent and growing literature on repeated interaction between competing supply chains. Nocke and White (2007) and Normann (2009) analyze whether vertical integration facilitates collusion by comparing an industry with no integration to one in which some firms are vertically integrated. Both these papers consider perfect Bertrand competition upstream with public contracts. Nocke and White (2007) show that vertical integration facilitates collusion when upstream firms compete by setting two-part tariffs. Normann (2009), instead, considers linear prices in the upstream market. He shows that, in this case, similar results obtain even if collusion and deviation profits are different due to double marginalization. Differently from these papers we are concerned with exclusive territories instead of vertical integration and show that this practice facilitates collusion only if *both* manufacturers distribute via exclusive territories and not just one. In addition, we also analyze the case of private contracts and show that manufacturers endogenously make their contracts public if they have the possibility to do so.

Jullien and Rey (2007) study the effects of resale price maintenance (RPM) on collusion in a model

[8]For a model that analyzes exclusive territories without the free riding problem and compares price versus quantity competition between retailers, see Matsumura (2003).

[9]Frazier and Lassar (1996) also find for products used in business-to-business markets that distributing via exclusive territories is positive correlated to the degree of competition at the producer levels.

with stochastic demand. They find that due to demand uncertainty manufacturers never opt for RPM in a static context but that they do so to facilitate collusion. The reason is that RPM reduces the punishment profit and, in addition, it also allows for an easier detection of deviations. Hence, the main difference between our paper and Jullien and Rey (2007) is that while the anticompetitive role of exclusive territories works through deviation profits, in their framework RPM renders collusion easier to sustain mainly because it makes detection and punishments more effective.

Finally, Piccolo (2009) also analyzes the role of public contracts in a dynamic setting by focusing, however, on the case of buyer power — i.e., perfect competition among manufacturers. There are two main differences between this paper and ours. First, we focus on cases where the initiative is in the manufacturers' hand which the prevalent observation in the industries where exclsuive territories are prevalent. Second while we are interested in the interplay between organizational and contractual strategies to sustain cooperative outcome, Piccolo (2009) focuses mainly on the latter.

3 The Baseline Model

Players and environment: Consider a game where two manufacturers, each denoted by M_i, $i = 1, 2$, compete by selling imperfect substitute goods (brands) through independent retailers. The downstream technology is one-to-one, and brand i's final demand is $D^i(p_i, p_j)$, which depends on the retail price p_i charged for good i as well as on the retail price of the competing brand p_j. Manufacturers and retailers have linear cost functions with marginal costs normalized to zero. As in Rey and Stiglitz (1995), each manufacturer can organize his distribution network in two alternative manners. He can impose exclusive territories — i.e., grant his retailers exclusivity in th geographical area in which potential consumers reside. Alternatively, the manufacturer can allow for intrabrand competition by letting his retailers compete in a territory. Since dealers of one manufacturer distribute the same brand in a territory, they are in perfect Bertrand competition to each other in this regime.

Contracts and observability: Manufacturers make take-it-or-leave-it-offers to their retailers and compete by offering two-part tariffs. A contract $C_i = (w_i, T_i)$ specifies a wholesale price w_i charged to all retailers distributing brand i, while T_i is the franchise fee that these must pay to M_i. We assume that contracts are uniform within the same brand, that is, all retailers dealing with M_i get the same contract. This *symmetry* hypothesis is without loss of generality and is imposed for arbitrage reasons as in Rey and Stiglitz (1995). It reflects the implicit assumption that resale on the downstream market prevents manufacturers from offering different wholesale trade rules to identical retailers. It also rules out non-constant per-unit wholesale prices, whereby justifying our focus on two-part tariffs.

We consider two alternative regimes concerning contracts observability:

- *Public contracts:* contracts are observed by all retailers before the retail (competition) stage.
- *Private contracts*: the contract issued by a manufacturer cannot be observed by the retailers distributing the competing brand before they set final prices.

In the first part of the paper we suppose that wholesale contracts are observable, e.g. due to mandatory disclosure rules, as is the case for business-format franchising contracts.[10] However, this mandatory rules

[10] This is also in line with the existing literature e.g. Jullien and Rey (2007), Nocke and White (2007), and Rey and Stiglitz (1995) who focus on the case of contract observability.

do not exist for other industries like automobile distribution. In this case manufacturers have the choice to make their contracts public, for example via information sharing agreements and strategic alliances. Such syndicates and suppliers' trade associations are widespread and often allow to disseminate information among competing supply chains see e.g. Stern et al. (1996).[11] We therefore then extend our framework by endogenizing this choice and consider a model where information sharing among competing supply chains is voluntary and taken at every stage of the game.

Timing: Consider an infinitely repeated game with discrete time, $\tau = 0, .., +\infty$. Following Nocke and White (2007) and Rey and Jullien (2007), assume that manufacturers are infinitely lived and discount future at the same rate $\delta \in (0, 1)$, whereas retailers are short-lived and thus maximize their spot profits. Our analysis extends to the arguably more realistic situation where manufacturers are not able to make long-term commitments and retailers are too short-sighted to collude at their level.

Given the observability regime, the sequence of events within the stage game unfolds as follows:

T=1 (**Contracting):** Manufacturers offer wholesale contracts.

T=2 (Acceptance): Retailers (simultaneously) decide whether to accept the received offers. In case of rejection they enjoy an outside option, which we normalized to zero for simplicity. Wholesale contracts become common knowledge in the public contracts regime. With private contracts, wholesale contracts of the competing manufacturer remain secret.

T=3 (Competition): Retailers set prices and the market clears — i.e., final demands materialize and input orders are placed. Contract obligations are executed.

Collusion: We look for stationary equilibria such that manufacturers maximize their discounted joint profits. For simplicity, we assume that manufacturers sustain collusion through infinite Nash reversion — i.e., a deviation by a manufacturer is followed by an infinitely-repeated play of the equilibrium of the stage game. In contrast, deviation by retailers do not trigger punishments. Since a manufacturer observes the input order of his retailers in each period, he can infer if the rival manufacturer has deviated from collusion, independent of the contract observability regime. Such a deviation would then trigger infinite Nash reversion.

Assumptions and equilibrium concept: The analysis will be developed under the following simplifying assumptions:

A1 The inverse demand function for good i is $P^i(q_i, q_j) = \alpha - \beta q_i - \gamma q_j$ for $i = 1, 2$, where q_i is good i's total output.[12] We assume that $\alpha > 0$, $\beta > \gamma \geq 0$, so that inverting the system of inverse demand functions yields well behaved (symmetric) direct demand functions

$$D^i(p_i, p_j) = \frac{\alpha(\beta - \gamma) - \beta p_i + \gamma p_j}{\beta^2 - \gamma^2} \quad \text{for } i = 1, 2. \tag{1}$$

[11] An important trend in distribution is the growth of information-intensive channels. These are usually characterized by channel partners who invest in bundles of sophisticated information technology like telecommunication and satellite linkages, bar coding and electronic scanning systems, database management systems etc.

[12] This demand function can be derived from a representative consumer (or a unit mass of identical consumers) with utility function

$$U(q_1, q_2) = \sum_{i=1}^{2} \left(\alpha q_i - \frac{1}{2}\beta q_i^2\right) - \gamma q_1 q_2 - \sum_{i=1}^{2} p_i q_i + M,$$

where M is the utility from income. Differentiating this utility function with respect to q_i, $i = 1, 2$ yields the inverse demand function.

Linearity is often imposed in models that study repeated interaction between upstream and downstream firms. It helps us to make our point in the simplest possible way.

A2 Whenever indifferent between accepting a wholesale contract and opting out, retailers accept the contract and secure input supply.

This hypothesis allows to focus on equilibria with positive sales. The equilibrium concept that we use in solving the repeated game is subgame-perfect Nash Equilibrium (SPNE) in the regime with public contracts. In the private contracting regime the game is one of imperfect information. Hence we shall use perfect Bayesian Equilibrium (PBE) with the added passive beliefs refinement

A3 A retailer does not revise his beliefs about the contract offered to the competing retailer, even if his own contract is an unexpected one.[13]

4 Public Contracts

We start with the case of public contracts where wholesale prices are observable. There are three cases to analyze: (*i*) both manufacturers impose exclusive territories; (*ii*) both allow for intrabrand competition, and (*iii*) a manufacturer imposes exclusive territories while the other does not. Below we analyze each in turn.

Exclusive Territories

When both manufacturers impose exclusive territories only interbrand competition matters. Hence, the profit of a retailer distributing brand i is

$$\pi^i(p_i, p_j) = D^i(p_i, p_j)(p_i - w_i) - T_i.$$

Maximizing this objective function with respect to p_i yields the system of first-order conditions[14]

$$\frac{\partial D^i(p_i, p_j)}{\partial p_i}(p_i - w_i) + D^i(p_i, p_j) = 0, \quad \forall\ i = 1, 2. \tag{2}$$

The solution of these equations yields the equilibrium of the retail game — i.e., the price functions $p_i(w_i, w_j)$ $(i = 1, 2)$, which allows to solve the upstream game. Indeed, using a backward induction logic, M_i maximizes the profit

$$\Pi^i(w_i, w_j) = D^i(p_i(w_i, w_j), p_j(w_j, w_i))\, w_i + T_i, \tag{3}$$

subject to retailers' participation constraint

$$D^i(p_i(w_i, w_j), p_j(w_j, w_i))(p_i(w_i, w_j) - w_i) - T_i \geq 0. \tag{4}$$

[13]Passive beliefs are standard in models with private contracts — see e.g. Hart and Tirole (1990), McAfee and Schwartz (1994) or White (2007).

[14]It is straightforward to verify that this condition is also sufficient for an optimum with linear demands.

Clearly, (4) is satisfied as equality at equilibrium. Hence, M_i's optimization program is

$$\max_{w_i} D^i\left(p_i\left(w_i,w_j\right),p_j\left(w_i,w_j\right)\right)p_i\left(w_j,w_i\right).$$

The symmetric Nash equilibrium of the upstream game w_{ET}^N is then defined by the following system of first-order conditions

$$\left(\frac{\partial D^i(.)}{\partial p_i}p_i(.)+D^i(.)\right)\frac{\partial p_i(.)}{\partial w_i}+\underbrace{\frac{\partial D^i(.)}{\partial p_j}\frac{\partial p_j(.)}{\partial w_i}}_{\text{strategic effect}}p_i(.)=0,\quad i=1,2. \tag{5}$$

The first term in equation (5) is the standard marginal revenue expression — i.e., each manufacturer internalizes the effect that a change in his wholesale price has on the final demand through the retail price, and thus on the sales profit. The second term reflects a *strategic effect*: when choosing the wholesale price, each manufacturer anticipates the competing retailers' reaction in the retail market, and the resulting effect on his own product's demand (see, e.g., Rey and Stiglitz, 1995). Since prices are strategic complements, the strategic effect of an increase in w_i on M_i's profits is positive.

With linear demand, the equilibrium wholesale price with exclusive territories is

$$w_{ET}^N=\frac{\alpha\gamma^2(\beta-\gamma)}{\beta(4\beta^2-\gamma^2-2\beta\gamma)},$$

which yields the manufacturer's profit

$$\Pi_{ET}^N=\frac{2\alpha^2\beta(\beta-\gamma)(2\beta^2-\gamma^2)}{(\beta+\gamma)(4\beta^2-\gamma^2-2\beta\gamma)^2}. \tag{6}$$

When the degree of differentiation between the two brands is minimal — i.e., $\gamma=\beta$ — both manufacturers price at marginal costs ($w_{ET}^N=0$) and make zero profits.

Consider now collusion. Recall that retailers always set prices according to (2) for given wholesale prices w_i and w_j. Hence, colluding manufacturers maximize joint profits — namely,

$$\max_{(w_1,w_2)}\sum_{i=1,2,j\neq i}D^i\left(p_i\left(w_i,w_j\right),p_j\left(w_j,w_i\right)\right)p_i\left(w_i,w_j\right).$$

The wholesale prices solving this program are determined by the following system of first-order conditions

$$\sum_{i=1,2,j\neq i}\frac{\partial D^i(.)}{\partial p_i}\frac{\partial p_i(.)}{\partial w_i}p_i(.)+\sum_{i=1,2,j\neq i}\frac{\partial D^i(.)}{\partial p_j}\frac{\partial p_j(.)}{\partial w_i}p_i(.)+\sum_{i=1,2,j\neq i}D^i(.)\frac{\partial p_i(.)}{\partial w_i}=0,\quad i=1,2.$$

With linear demands, this yields the collusive

$$w_{ET}^C=\frac{\alpha\gamma}{2\beta}.$$

When the degree of differentiation between the two brands is maximal — i.e., $\gamma=0$ — the collusive wholesale price is equal to zero: each manufacturer behaves as a monopolist in all (sub)markets and extracts the whole downstream surplus by way of the fixed fee. Since manufacturers are symmetric, in collusion each receives an equal share of the aggregate profit. Hence,

$$\Pi_{ET}^{C} = \frac{\alpha^2}{4(\beta+\gamma)}. \tag{7}$$

Finally, consider deviation. Suppose that M_i is the deviant manufacturer — i.e., he offer a wholesale price different than w_{ET}^{C} — while M_j sticks to w_{ET}^{C}. The deviant's maximization program is then

$$\max_{w_i} D^i\left(p_i\left(w_i, w_{ET}^C\right), p_j\left(w_{ET}^C, w_i\right)\right) \; p_i\left(w_i, w_{ET}^C\right) \; ,$$

which immediately yields the first-order condition

$$\left(\frac{\partial D^i\left(.\right)}{\partial p_i} p_i\left(.\right) + D^i\left(.\right)\right)\frac{\partial p_i\left(.\right)}{\partial w_i} + \frac{\partial D^i\left(.\right)}{\partial p_j}\frac{\partial p_j\left(.\right)}{\partial w_i} p_i\left(.\right) = 0$$

Because contracts are observable, M_i anticipates that the retailers distributing the competing brand will react immediately to his deviation — i.e., when observing an unexpected wholesale price $w_i < w_{ET}^{C}$, they charge a retail price $p_j\left(w_j, w_i\right)$ which, by definition, is lower than $p_j\left(w_j, w_{ET}^{C}\right)$. With linear demands, this leads to the deviation wholesale price

$$w_{ET}^{D} = \frac{\alpha\gamma^2(4\beta^2 - 2\beta\gamma - \gamma^2)}{8\beta^2(2\beta^2 - \gamma^2)}.$$

It is straightforward to show that w_{ET}^{D} falls short of the collusive wholesale price — i.e., $w_{ET}^{D} < w_{ET}^{C}$. This is because the deviant manufacturer gains from undercutting his competitor to maximize his sales profit. Differently, the deviant's wholesale price exceeds the Nash level — i.e., $w_{ET}^{D} > w_{ET}^{N}$. This is because the wholesale price in collusion is larger than in Nash and wholesale prices are strategic complements. The deviant manufacturer gets the profit

$$\Pi_{ET}^{D} = \frac{\alpha^2(4\beta^2 - 2\beta\gamma - \gamma^2)^2}{32\beta(\beta+\gamma)(\beta-\gamma)(2\beta^2-\gamma^2)}. \tag{8}$$

Equipped with this characterization, we can now determine the critical discount factor $\underline{\delta}_{ET}$ above which manufacturers can sustain collusion with exclusive territories. The condition that identifies this discount factor is standard: it implies that the stream of profits earned by a manufacturer in collusion must exceed the sum of profits in the deviation and punishment phase. Formally,

$$\frac{\Pi_{ET}^{C}}{1-\delta} \geq \Pi_{ET}^{D} + \frac{\delta}{1-\delta}\Pi_{ET}^{N}. \tag{9}$$

The value of δ which solves this self-enforceability constraint as an equality identifies the lowest critical discount factor above which manufacturers can collude with exclusive territories. Using (6), (7) and (8) we then get

$$\underline{\delta}_{ET} = \frac{(4\beta^2 - 2\beta\gamma - \gamma^2)^2}{(32\beta^3 - 12\gamma^2\beta)(\beta-\gamma) + \gamma^4}.$$

It is easy to show that this discount factor is increasing in γ — i.e., collusion becomes more difficult to sustain when competition gets more intense (products are closer substitutes). Moreover, $\underline{\delta}_{ET}$ is also decreasing in β — i.e., demands that are less sensible to own price variations facilitate cooperation.

Non-exclusive Territories

Suppose now that both manufacturers distribute by way of non-exclusive territories — i.e., they both allow for intrabrand competition. In this case, retailers distributing the same brand are in Bertrand competition. Retail prices are equal to marginal costs — i.e., $p_i = w_i$ for $i = 1, 2$ — and retailers make zero profits irrespective of the contract offered by the rival manufacturer. As a consequence, franchise fees must be zero at equilibrium and manufacturers can make profits only by increasing wholesale prices above their marginal costs (zero in our model).

As before, we first look at the stage game, which determines manufacturers' profits along the punishment phase. M_i's objective function is

$$\Pi^i (w_i, w_j) = D^i (w_i, w_j) w_i, \quad i = 1, 2. \tag{10}$$

Optimizing with respect to w_i we get

$$\frac{\partial D^i (w_i, w_j)}{\partial w_i} w_i + D^i (w_i, w_j) = 0, \quad i = 1, 2. \tag{11}$$

Note that, in contrast to the case where both manufacturers impose exclusive territories, with intrabrand competition there is no strategic effect. Essentially, allowing for intrabrand competition precludes retailers from adjusting their final prices to the competitors' marginal costs. Looking for a symmetric equilibrium in wholesale prices we get

$$w_{NE}^N = \frac{\alpha(\beta - \gamma)}{2\beta - \gamma}.$$

As before, when brands' differentiation is minimal ($\gamma = \beta$) manufacturers price at marginal costs (zero in our model). Inserting the equilibrium wholesale price w_{NE}^N into the profit function (10) yields the punishment profit

$$\Pi_{NE}^N = \frac{\alpha^2 \beta(\beta - \gamma)}{(\beta + \gamma)(2\beta - \gamma)^2}, \tag{12}$$

with, of course, $\Pi_{NE}^N = 0$ for $\gamma = \beta$.

Consider now collusion. It is straightforward to show that the collusive wholesale price is now $w_{NE}^C = \alpha/2$. Manufacturers' collusive profit is then

$$\Pi_{NE}^C = \frac{\alpha^2}{4(\beta + \gamma)}.$$

Notice that collusive profits are the same with exclusive and non-exclusive territories, although wholesale prices change in these two regimes. This is because when both manufacturers allow for intrabrand competition, they choose the retail price directly. Differently, when both impose exclusive territories, the wholesale prices is set in such a way to induce retailers to charge the same equilibrium retail price as with non-exclusive territories. Hence, the total 'pie' they split does not change.

Turning to the deviation profits, the same logic developed above allows us to calculate the deviation wholesale price and profit. Suppose that M_i is the deviant manufacturer, his optimization program writes as

$$\max_{w_i} D^i \left(w_i, w_{NE}^C\right) w_i,$$

whose first-order condition is

$$\frac{\partial D^i\left(w_i, w_{NE}^C\right)}{\partial w_i} w_i + D^i\left(w_i, w_{NE}^C\right) = 0 \tag{13}$$

With linear demands, we then get

$$w_{NE}^D = \frac{\alpha(2\beta - \gamma)}{4\beta},$$

and

$$\Pi_{NE}^D = \frac{\alpha^2(2\beta - \gamma)^2}{16\beta(\beta - \gamma)(\beta + \gamma)}. \tag{14}$$

Summing up, the lowest discount factor above which manufacturers collude $\underline{\delta}_{NE}$ is identified by the following indifference condition

$$\frac{\Pi_{NE}^C}{1 - \delta} = \Pi_{NE}^D + \frac{\delta}{1 - \delta}\Pi_{NE}^N,$$

whose solution is

$$\underline{\delta}_{NE} = \frac{(2\beta - \gamma)^2}{8\beta(\beta - \gamma) + \gamma^2}.$$

As before, also this critical value increases when competition becomes more intense, as reflected by a larger γ, and decreases when demand becomes less sensible to own prices, as implied by a larger β.

Asymmetric Distribution Channels

Suppose now that manufacturers have different distribution modes — e.g., M_i imposes exclusive territories while M_j allows for intrabrand competition. In this case, the retailers dealing with M_j set retail prices equal to marginal costs as they face intrabrand competition — i.e., $p_j = w_j$. Differently, those distributing brand i only face interbrand competition and adjust their final prices to the rivals' marginal cost. With linear demands, it is immediate to check that this yields the following best reply function

$$p_i\left(w_i, w_j\right) = \frac{\alpha(\beta - \gamma) + \beta w_i + \gamma w_j}{2\beta}.$$

A simple backward induction argument allows to show that the manufacturer imposing exclusive territories sets a wholesale price equal to his marginal costs ($w_i = 0$), so as to maximize his retailers' profit, and then fully extract this surplus through the fixed fee T_i. Differently, the manufacturer distributing via non-exclusive territories must charge a wholesale price above his marginal costs to make profits, which yields

$$w_j = \frac{\alpha(2\beta^2 - \beta\gamma - \gamma^2)}{2(2\beta^2 - \gamma^2)}.$$

Hence,

$$\Pi_i = \Pi_{ET,NE}^N = \frac{\alpha^2(2\beta + \gamma)^2(\beta - \gamma)}{8\beta(\beta + \gamma)(2\beta^2 + \gamma^2)}, \tag{15}$$

and

$$\Pi_j = \Pi_{NE,ET}^N = \frac{\alpha^2(\beta - \gamma)(4\beta^2 - 2\beta\gamma - \gamma^2)^2}{16\beta(\beta + \gamma)(2\beta^2 + \gamma^2)}. \tag{16}$$

With $\Pi_{ET,NE}^N = \Pi_{NE,ET}^N = 0$ for $\gamma = \beta$.

Consider now collusion. Since the distribution networks are asymmetric, we assume that manufacturers share the 'collusive pie' so as to minimize the incentive to deviate. Let x be M_i's share of the manufacturers' joint profits. It is straightforward to verify that the collusive wholesale prices are $w_i^C = \alpha\gamma/(2\beta)$ and $w_j^C = \alpha/2$. Hence, manufacturers' profits in collusion are

$$\Pi_i^C = \Pi_{ET,NE}^C(x) = \frac{x\alpha^2}{2(\beta+\gamma)} \quad \text{and} \quad \Pi_j^C = \Pi_{NE,ET}^C(x) = \frac{(1-x)\alpha^2}{2(\beta+\gamma)}.$$

Finally, consider deviation. Following the logic developed above, the deviation wholesale prices are given by

$$w_i = w_{ET,NE}^D = 0 \quad \text{and} \quad w_j = w_{NE,ET}^D = \frac{\alpha(4\beta^2 - 2\beta\gamma - \gamma^2)}{4(2\beta^2 - \gamma^2)}.$$

Hence, manufacturers' profits in deviation are

$$\Pi_{ET,NE}^D = \max_{w_i} D^i\left(p_i\left(w_i, w_j^C\right), w_j^C\right) p_i\left(w_i, w_j^C\right) = \frac{\alpha^2(2\beta - \gamma^2)^2}{16\beta(\beta-\gamma)(\beta+\gamma)},$$

and

$$\Pi_{NE,ET}^D = \max_{w_j} D^j\left(w_j, p_i\left(w_i^C, w_j\right)\right) w_j = \frac{\alpha^2(4\beta^2 - 2\beta\gamma - \gamma^2)^2}{32\beta(\beta-\gamma)(\beta+\gamma)(2\beta^2-\gamma^2)}.$$

In the asymmetric case under consideration there are two different self-enforceability constraints, one for each manufacturer. This asymmetry leads to two critical discount factors, that can be determined with the standard procedure developed above — i.e.,

$$\delta \geq \underline{\delta}_i(x) \equiv \frac{\Pi_{ET,NE}^D - \Pi_{ET,NE}^C(x)}{\Pi_{ET,NE}^D - \Pi_{ET,NE}^N},$$

and

$$\delta \geq \underline{\delta}_j(x) \equiv \frac{\Pi_{NE,ET}^D - \Pi_{NE,ET}^C(x)}{\Pi_{NE,ET}^D - \Pi_{NE,ET}^N}.$$

Then, x is chosen so as to minimize the maximum between these discount factors — i.e.,

$$x \in \arg\min_{x' \in [0,1]} \left\{\max\left\{\underline{\delta}_i(x'), \underline{\delta}_j(x')\right\}\right\}. \tag{17}$$

The unique solution of this program is obtained by equalizing $\underline{\delta}_i(x)$ and $\underline{\delta}_j(x)$, so we have

$$\underline{\delta}_{AS} = \frac{(2\beta^2-\gamma^2)(8\beta^2 - 4\beta\gamma - \gamma^2)}{32\beta^4 - 16\beta^3\gamma - 24\beta^2\gamma^2 + 8\gamma^3\beta + 3\gamma^4}.$$

For every discount factor above this threshold, collusion is viable with asymmetric distribution networks.

4.1 The Collusive Effect of Exclusive Territories

We can now provide the first result of the paper by ranking the critical discount factors obtained above.

Proposition 1 *With public contracts, collusion is easier to sustain when both manufacturers impose exclusive territories — i.e.,* $\underline{\delta}_{ET} < \underline{\delta}_{NE} < \underline{\delta}_{AS}$.

Distributing via exclusive territories has two opposing effects on collusion. On the one hand, the stage game profit is larger when both manufacturers impose exclusive territories. This effect hinges on the genuine incentive of manufacturers to raise wholesale prices above marginal costs in the stage game with exclusive territories— recall that with non-exclusive territories retail prices equal marginal costs because of intrabrand competition. As shown in (5), this incentive is 'measured' by the strategic effect — i.e.,

$$-\frac{\partial D^i\left(p_i\left(w_{ET}^N,w_{ET}^N\right),p_j\left(w_{ET}^N,w_{ET}^N\right)\right)}{\partial p_i}\frac{\partial p_i\left(w_{ET}^N,w_{ET}^N\right)}{\partial w_i}w_{ET}^N. \tag{18}$$

The larger is this term, the less harsh is the punishment with exclusive territories.[15]

On the other hand — since contracts are observable — when both manufacturers distribute via exclusive territories, retailers can spot and react to a deviation in the very same time period where such a unexpected offer is made. When a manufacturer undercuts his rival by charging a wholesale price lower than what expected, the retailers dealing with the latter reduce their final prices, thereby stifling the deviation gain of the former manufacturer. The extent of this reaction on the deviant's profits also rests on the strategic effect — i.e.,

$$-\frac{\partial D^i\left(p_i\left(w_{ET}^D,w_{ET}^C\right),p_j\left(w_{ET}^C,w_{ET}^D\right)\right)}{\partial p_i}\frac{\partial p_i\left(w_{ET}^D,w_{ET}^C\right)}{\partial w_i}w_{ET}^D. \tag{19}$$

The larger is this term, the smaller is the profit that a manufacturer can earn by undercutting his rival when both impose exclusive territories and the latter charges the collusive wholesale price w_{ET}^C.

Which of these two countervailing forces prevails? In general, it is not clear whether (19) is larger than (18). However, with linear demands — and more generally when the second order derivatives of the demand function are small — it turns out that the latter effect is invariably stronger than the former. This is because, due to strategic complementarity, the deviation wholesale price exceeds the Nash level — i.e., $w_{ET}^D > w_{ET}^N$. And, with linear demand the slope of the demand function is constant.

It is important to note that exclusive territories facilitate collusion only if *both* manufacturers distribute in this manner. As long as only one manufacturer, say M_i, imposes exclusive territories, collusion is harder to sustain — i.e., $\underline{\delta}_{AS} > \underline{\delta}_{NE}$. This is because intrabrand competition prevents the retailers dealing with M_j to react on M_i's deviation. Hence, only the effect of reduced punishment survives in this case, M_i's incentive to undercut his competitor is thus stronger than in the case where both manufacturers allow for intrabrand competition. This result is not present in the earlier literature — e.g., Nocke and White (2007) and Normann (2009), where the punishment and the reaction effects are both independent from the manufacturers' actions.

4.2 Endogenous Distribution Modes

So far we have treated each manufacturer's distribution mode as an exogenous feature of the environment. In this section we extend the analysis by allowing each manufacturer to make this choice. Suppose that, at the outset of the game, manufacturers simultaneously and independently choose distribution channels. And, for the sake of crispiness, assume for the moment that these decisions are made once and for all.[16]

Denote by $\mathcal{G}$ the extended game with the added commitment stage. The next proposition shows that exclusive territories are anticompetitive and that the equilibrium distribution channels sustain collusion

[15] This expression is obtained by combining (5) with (2).

[16] This modelling feature reflects the idea that distribution systems are not easy to change in practice. For example, Azoulay and Shane (2001) note that in the franchising industry transaction costs of changing the contracts are very large due to mandatory registration and material change laws.

whenever possible.

Proposition 2 *With public contracts, game $\mathcal{G}$ has the following properties:*

- *For $\delta < \underline{\delta}_{ET}$, there exists a unique equilibrium where both manufacturers impose exclusive territories but do not collude.*
- *For $\underline{\delta}_{ET} \leq \delta < \underline{\delta}_{NE}$, there exists a unique equilibrium where both manufacturers impose exclusive territories and collude.*
- *For $\underline{\delta}_{NE} \leq \delta < \underline{\delta}_{AS}$, there are two payoff-equivalent symmetric equilibria, one where both manufacturers impose exclusive territories, and another where they both allow for intrabrand competition. In each equilibrium collusion is sustained.*
- *For $\delta \geq \underline{\delta}_{AS}$, there exists a unique equilibrium where both manufacturers impose exclusive territories and collude.*

Interestingly, for $\delta \geq \underline{\delta}_{AS}$ there is a unique equilibrium where both manufacturers impose exclusive territories and collude even if, in this region of parameters, cooperation would be viable with one or both manufacturers allowing for intrabrand competition. This is because when one manufacturer imposes exclusive territories but the other does not, the former receives a larger fraction of the collusive profit since he has a larger incentive to deviate. Hence, for each manufacturer it is strictly dominant to impose exclusive territories.[17]

Clearly, this result rests on the way we have derived the critical discount factor $\underline{\delta}_{AS}$ — i.e., manufacturers split the collusive profit so as to minimize the discount factor when they end up with asymmetric distribution networks, see program (17). Let us now suppose that manufacturers, instead, share the collusive profit evenly in each regime. The critical discount factor for the asymmetric case is larger then. Indeed, it is straightforward to verify that in this case we have

$$\hat{\underline{\delta}}_{AS} = \frac{(2\beta^2 - \gamma^2)^2}{\beta(8\beta^3 - 4\beta^2\gamma - 5\beta\gamma^2 + 2\gamma^3)} > \underline{\delta}_{AS}.$$

Let $\widehat{\mathcal{G}}$ be the game where manufacturers always split evenly the stakes of collusion irrespective of their distribution modes. We have,

Lemma 1 *With public contracts, game $\widehat{\mathcal{G}}$ has the following properties as long as manufacturers split evenly the stakes from collusion:*

- *For $\delta < \underline{\delta}_{ET}$, there exists a unique equilibrium where both manufacturers impose exclusive territories but do not collude.*
- *For $\underline{\delta}_{ET} \leq \delta < \underline{\delta}_{NE}$, there exists a unique equilibrium where both manufacturers impose exclusive territories and collude.*
- *For $\underline{\delta}_{NE} \leq \delta < \hat{\underline{\delta}}_{AS}$, there are two payoff-equivalent symmetric equilibria, one where both manufacturers impose exclusive territories, and the other where they both allow for intrabrand competition. In each equilibrium collusion is sustained.*

[17] This result is in line with Nocke and White (2007) who note, that the distribution of the collusive profit is often asymmetric if upstream firms are asymmetric as well.

- *For $\delta \geq \hat{\underline{\delta}}_{AS}$, every configuration of distribution modes is an equilibrium. Manufacturers always collude and obtain the same equilibrium profit irrespective of the chosen distribution modes.*

The proof of this result as well as its intuition are exactly the same as those of Proposition (2).

5 Private Contracts

We now study the case of private contracts. Hence, each manufacturer's offer cannot be observed by the retailers distributing the competing brand. This assumption captures the idea that in some instances manufacturers lack commitment power, because they can recontract and/or offer secret discounts. In line with the earlier literature — e.g., Katz (1991) — we assume passive beliefs: when a retailer is offered a contract different the one he expects in a candidate equilibrium, he does not revise its beliefs about the contract offered to the rival retailers.

The next proposition shows that in this case a *neutrality result* obtains:

Proposition 3 *With private contracts, the critical discount factor above which collusion can be sustained is independent of the distribution modes chosen by manufacturers and is equal to $\underline{\delta}_{NE}$.*

The intuition is as follows. Since retailers' choice of downstream prices are unaffected by unobserved changes in input prices to rivals, each manufacturer acts as if integrated with his retailers and facing a given residual downstream demand. Profit maximization then involves setting input price equal to the manufacturers' marginal cost.[18] Hence, the lack of commitment due to private contracting intensifies upstream competition relative to the case of public contracting. Essentially, although the distribution choice is public, with secret contracts, manufacturers cannot credibly influence the behavior of their rivals. Interestingly, this neutrality result holds for general demand functions — see the Appendix.

6 Extensions

So far we concentrated ourselves on the cases in which the observability regime is given and manufacturers are committed to the distribution mode. However, as we noted above, if contracts are not publicly available by law, manufacturers have the choice via participating in information sharing agreements to make these contracts public. In addition, they also can change the distributional mode over time.[19] Therefore in this section we augment our model to allow for these possibilities. We will show that the main insights of the previous analysis do not change when: (*i*) manufacturers voluntarily decide whether to share information about wholesale contracts, and (*ii*) manufacturers can change the distribution mode every period.

6.1 Endogenous Communication

So far, we assumed that manufacturers' contracts are either private or public. However, the management of a supply chain can usually decide whether to make wholesale contracts observable to third parties, e.g., by joining a trade association — see Briley et al. (1994). To account for this possibility, we extend the

[18]As observed by McAfee and Schwartz (1994), this result is quite general: it does not hinge on the nature of downstream production (fixed versus variable proportions) or of downstream competition (strategic substitutes or strategic complements).

[19]An prominent example is McDonald's who changed their distributional system from exclusive to non-exclusive territories in 1969.

baseline model presented in the previous section by allowing manufacturers to choose at each stage of the game between making contracts observable to third parties or to keeping them secret.

The following result obtains:

Proposition 4 *With endogenous communication, manufacturers always make their contracts observable to third parties in equilibrium and the critical discount factors are the same as those characterized in Proposition 1. Hence, exclusive territories facilitate collusion.*

An interesting feature of this result is that a manufacturer that imposes exclusive territories always gains by making his contract public. This is because with exclusive territories disclosing the wholesale price generates the strategic effect which is always beneficial to manufacturers. Differently, when a manufacturer allows for intrabrand competition, he is indifferent between making his offer public or keeping it secret. This is because when intrabrand competition forces retailers of the same brand to price at marginal costs. Summing up, if manufacturers have the choice between information sharing or not, they decide to make the contract public under exclusive territories to be able to sustain collusion for a larger range of parameters.

6.2 Lack of Commitment

In the previous analysis we assumed that the distribution mode of each supply chain is chosen once and for all at the outset of the game. This is clearly a strong assumption but it is justified e.g. in cases of business format franchising where transaction costs of contractual changes are very large. However, such costs are not present in the automotive or beer distributing industry. To account for the possibility of changes in the distributional mode we now allow manufacturers to decide about this mode period after period. Hence, consider a game where each manufacturer's action has three components at each stage — i.e., (*i*) a distribution mode (exclusive *vs* non-exclusive territories), (*ii*) a disclosure decision (public *vs* private contracting), and (*iii*) a wholesale contract. We obtain the following result:

Proposition 5 *If manufacturers can change their mode of distribution in every period, manufacturers collude via exclusive territories and the range of discount factors where collusion is viable is larger than in case of commitment to the distribution mode.*

The intuition is as follows. By imposing exclusive territories a manufacturer enables his retailers to react to an unexpected offer by the rival manufacturer in the period where such an offer is observed. Hence, with exclusive territories, the deviation profit is the lowest among all distribution modes, and the critical discount factor is the lowest as well.

Moreover, with lack of commitment, the stage game has two symmetric equilibria. The first type of equilibrium is such that both manufacturers choose exclusive territories and make their contracts observable to third parties. The second type of equilibrium is such that both manufacturers choose non-exclusive territories and do not disclose their contracts. Clearly, in the latter type of equilibrium manufacturers obtain lower profits than in the former. However, if M_j chooses non-exclusive territories and private contracting, the profit of M_i is the same independent of his regime choice. This is because, due to intrabrand competition, retailers dealing with M_j have no discretion in setting prices, and, due to private contracting, those dealing with M_i cannot observe the wholesale price of M_j. Thus, it is optimal for M_i to choose non-exclusive territories and private contracting as well. The implication for the infinitely repeated game is then that the critical discount factor is minimized if this equilibrium is played as a punishment in the periods after a deviation.

As a consequence, we obtain that exclusive territories facilitate collusion in the extreme cases when manufacturers are committed to the organizational mode and when they can change it at no costs. But this implies that even in less extreme cases, i.e. when changing the organizational mode involves some finite costs or can only be changed every $t > 1$ periods, the result applies.

7 Conclusion

The anticompetitive role of exclusive territories has been analyzed in a model of repeated interaction between competing supply chains. Our results show that there is a genuine tension between static and dynamic incentives that shapes manufacturers' scope for limiting intrabrand competition. While in the static analysis manufacturers unambiguously benefit from exclusive territories, because this allows retailers to price above marginal costs, in a repeated framework this effect makes collusion more difficult to sustain as it increases profits in the punishment phase. Nevertheless, with repeated interaction, a countervailing effect tends to make collusion easier to sustain with exclusive territories through deviation profits. When both manufacturers impose exclusive territories, retailers adapt their pricing decisions to the wholesale contract offered by the competing manufacturer. This 'instantaneous reaction' mechanism makes collusion easier to sustain with exclusive territories because it stifles manufacturers' (spot) gains from deviation. With linear demands, it turns out that the latter effect completely offsets the former, whereby making exclusive territories anticompetitive. This result is robust to a number of extensions concerning the timing and commitment rules of the game.

We analyzed the case in which manufacturers sustain collusion through infinite Nash reversion. An interesting direction for future research could be to consider optimal punishments — i.e., cases in which manufacturers punish a deviation as strong as possible for some periods, and then return to the collusive phase as long as both adhered to the punishment. Such an analysis is likely to be more complicated since it involves the calculation of the optimal punishment length. Our intuition is that the result that exclusive territories facilitate collusion should be enforced via optimal punishment. The reason is that the instantaneous reaction effect under exclusive territories remains while the punishment profit with exclusive and non exclusive territories is likely to be more similar now. This is because optimal punishment involves returning to collusion after some time, and we know that the collusion profit is the same under both regimes. Thus, the instantaneous reaction effect should be even stronger, whereby reinforcing our conclusions.

8 Appendix

Proof of Proposition 1: Using the expressions for the discount factors found in Section 3 we have

$$\underline{\delta}_{ET}-\underline{\delta}_{NE}=-\frac{4\beta^3\gamma^4(\beta-\gamma)(4\beta-3\gamma)}{(8\beta(\beta-\gamma)+\gamma^2)((32\beta-12\beta\gamma^2)(\beta-\gamma)+\gamma^4)},$$

and

$$\underline{\delta}_{NE}-\underline{\delta}_{AS}=-\frac{2\gamma^3(\beta-\gamma)(4\beta^2-\beta\gamma-\gamma^2)}{(8\beta(\beta-\gamma)+\gamma^2)(32\beta^4-16\beta^3\gamma-24\beta^2\gamma^2+8\beta\gamma^3+3\gamma^4)}.$$

It is immediate to verify that $\underline{\delta}_{ET}<\underline{\delta}_{NE}<\underline{\delta}_{AS}$. Hence, there is a range of δ in which collusion can be sustained if both manufacturers impose exclusive territories but not if they for intrabrand competition. ■

Proof of Proposition 2: For $\delta<\underline{\delta}_{ET}$ collusion can never be sustained. Hence, each manufacturer chooses the distribution mode that yields the largest stage game profit, given the rival's distribution mode. Since $\Pi^N_{ET}>\Pi^N_{NE,ET}$ and $\Pi^N_{ET,NE}>\Pi^N_{NE}$, it is a dominant action for each manufacturer to impose exclusive territories.

Suppose that $\delta\in[\underline{\delta}_{ET},\underline{\delta}_{NE})$. In this case collusion can be sustained only when both manufacturers impose exclusive territories, in which case each manufacturer earns Π^C_{ET}. No manufacturer wants to deviate from this strategy because $\Pi^C_{ET}>\Pi^N_{NE,ET}$. Since $\Pi^N_{ET,NE}>\Pi^N_{NE}$, imposing exclusive territories is again a dominant action for each manufacturer.

Suppose now that $\delta\in(\underline{\delta}_{NE},\underline{\delta}_{AS})$. We know that $\Pi^C_{ET}>\Pi^N_{NE,ET}$, hence there exists an equilibrium where both manufacturers impose exclusive territories. But, since in this range of parameters collusion can also be sustained if both manufacturers allow for intrabrand competition, and $\Pi^C_{NE}>\Pi^N_{ET,NE}$ there exists also an equilibrium where both manufacturers do not impose exclusive territories.

Finally, suppose that $\delta\geq\underline{\delta}_{AS}$, collusion can be sustained under either combination. We know that if both manufacturers choose the same distribution network, each of them gets half of the collusive profit, while if M_i chooses exclusive territories and M_j chooses non-exclusive territories, M_i receives a share x of the collusive profit. Calculating x so as to minimize the discount factor in the asymmetric case yields

$$x=\frac{256\beta^7-128\beta^6\gamma-320\beta^5\gamma^2+160\beta^4\gamma^3+104\beta^3\gamma^4-56\beta^2\gamma^5-3\beta\gamma^6+3\gamma^7}{8\beta(2\beta^2-\gamma^2)(32\beta^4-16\beta^3\gamma-24\beta^2\gamma^2+8\gamma^3\beta+3\gamma^4)}.$$

It is easy to check that

$$x-\frac{1}{2}=\frac{\gamma^3(32\beta^4-16\beta^3\gamma-24\beta^2\gamma^2+9\gamma^3\beta+3\gamma^4)}{8\beta(2\beta^2-\gamma^2)(32\beta^4-16\beta^3\gamma-24\beta^2\gamma^2+8\gamma^3\beta+3\gamma^4)}>0.$$

Therefore, M_i receives a larger fraction of the collusive profit than M_j, and we have that $\Pi^C_{ET,NE}>\Pi^C_{NE}$ and $\Pi^C_{ET}>\Pi^C_{NE,ET}$. As a consequence, it is again a dominant strategy for each manufacturer to distribute by way of exclusive territories. ■

Proof of Proposition 3: We start with the Nash-equilibrium of the stage game. In case both manufacturers have non-exclusive territories, we have $p_i=w_i$. Therefore, the optimization problem of a manufacturer is the same independent if contracts are private or public, and the optimal wholesale prices are implicitly given by

$$\frac{\partial D^i\left(w_i,w_j\right)}{\partial w_i}w_i+D^i\left(w_i,w_j\right)=0,\quad\forall\ i=1,2. \tag{20}$$

In case both manufacturers distribute their products via exclusive territories, we know that the retail prices are chosen according to

$$\frac{\partial D^i\left(p_i,p_j\right)}{\partial p_i}(p_i-w_i)+D^i\left(p_i,p_j\right)=0\quad\forall\ i=1,2. \tag{21}$$

In case of private contracting, a manufacturer i cannot influence the retail price of the rival's retailers because they cannot observe the wholesale price of manufacturer i. Thus, we get that M_i's profit is given by

$$\Pi^i(w_i, w_j) = D^i(p_i(w_i), p_j(w_j))p_i(w_i),$$

which gives a system of first-order conditions of

$$\left(\frac{\partial D^i(p_i(w_i), p_j(w_j))}{\partial p_i} p_i(w_i) + D^i(p_i(w_i), p_j(w_j))\right) \frac{\partial p_i}{\partial w_i} = 0, \quad \forall\, i = 1, 2.$$

So, optimal wholesale prices satisfy

$$\frac{\partial D^i(p_i(w_i), p_j(w_j))}{\partial p_i} p_i(w_i) + D^i(p_i(w_i), p_j(w_j)) = 0, \quad \forall\, i = 1, 2. \tag{22}$$

It is easy to see that the retail prices in (22) must be the same as the wholesale prices in (20). But since manufacturers can induce any retail price by setting their wholesale prices, we have that manufacturers choose wholesale prices under exclusive territories so that they yield the same retail prices as in case of non-exclusive territories.[20] As manufacturers can extract all retail profits via the fixed fee, profits of manufacturers must also the same in both regimes.

In the asymmetric case in which M_i distributes via exclusive territories while M_j does not, the optimality condition for M_i is still given by (22) while the one of M_j is still given by (20). Therefore, the result in the asymmetric case is the same as in the two cases above, and profits are also the same.

Now we turn to the collusive profit. In case of non-exclusive territories of both manufacturers, we have, since $p_i = w_i$, that w_i is chosen to maximize

$$\sum_{i=1,2} \Pi^i(w_i, w_j) = D^i(w_i, w_j)w_i + D^j(w_j, w_i)w_j,$$

which yields first-order conditions of

$$D^i(w_i, w_j) + \frac{\partial D^i(w_i, w_j)}{\partial w_i} w_i + \frac{\partial D^j(w_j, w_i)}{\partial w_i} w_j = 0, \quad \forall\, i = 1, 2. \tag{23}$$

In case both manufacturers have exclusive territories, we have

$$\sum_{i=1,2} \Pi^i(w_i, w_j) = D^i(p_i(w_i), p_j(w_j))p_i(w_i) + D^j(p_j(w_j), p_i(w_i))p_j(w_j),$$

where the relation between p_i and w_i is given by (21). For each $i = 1, 2$ the optimality condition for w_i is then

$$D^i(p_i(w_i), p_j(w_j)) + \frac{\partial D^i(p_i(w_i), p_j(w_j))}{\partial p_i} p_i(w_i) + \frac{\partial D^j(p_j(w_j), p_i(w_i))}{\partial p_i} p_j(w_j) = 0, \tag{24}$$

But by the same argument as above, condition (24) implies the same retail prices as in (23). This also holds for the case in which manufacturers collude via asymmetric distribution networks.

Now we have to determine the optimal deviation of a manufacturer under the three regimes. In case where both manufacturers have non-exclusive territories, we know from (20), that the optimal deviation price is given by

$$\frac{\partial D^i\left(w_i, w_{NE}^C\right)}{\partial w_i} w_i + D^i\left(w_i, w_{NE}^C\right) = 0, \quad \forall\, i = 1, 2, \tag{25}$$

where w_{NE}^C is the solution to the system of equations (23). In case manufacturers distribute via exclusive

[20]Since in our case wholesale costs are equal to zero, manufacturers set $w_i = 0$ to avoid double marginalization.

territories, we have from (22) that the optimal deviation wholesale price of M_i is

$$\frac{\partial D^i\left(p_i(w_i), p_j(w_{ET}^C)\right)}{\partial p_i} p_i(w_i) + D^i\left(p_j(w_{ET}^C), p_i(w_i)\right) = 0, \quad \forall\, i = 1, 2, \tag{26}$$

where w_{ET}^C is the solution to the system of equations (24). But we know from above that the collusive retail prices are the same in case where both manufacturers distribute via exclusive territories and where they do not, that is $p_j(w_{ET}^C) = w_{NE}^C$. But this implies that the optimal deviation is the same in both cases and so the deviation profit is the same as well. Again, by the same arguments this also holds for the asymmetric case.

As a consequence, collusion, deviation and punishment profit are the same in all three regimes. This implies that the critical discount factor is also the same. Finally, we know that in case both manufacturers distribute via non-exclusive territories the observability of contracts does not change profits since retailers always set $p_i = w_i$, for $i = 1, 2$, and so the critical discount factor in this case is unchanged. Since the critical discount factor under private contracting is the same for all regimes, it is therefore given by $\underline{\delta}_{NE}$. ■

Proof of Proposition 4:

We start with the case in which both manufacturers distribute via non-exclusive territories. We know already that in this case it is not important if the contract is observable to rival competitors or not because retailers set $p_i = w_i$ due to Bertrand competition. Thus, manufacturers are indifferent between making their contracts observable or not. The critical discount factor is the same as the one calculated in Subsection 3.1 and is given by

$$\delta_{NE}^{crit} = \frac{(2\beta - \gamma)^2}{8\beta(\beta - \gamma) + \gamma^2}.$$

Now we turn to the case in which both manufacturers distribute via exclusive territories. We first look at the stage game. The profit function of a retailer of manufacturer i is given by

$$(p_i - w_i)\left(\frac{\alpha(\beta - \gamma) - \beta p_i + \gamma E[p_j]}{\beta^2 - \gamma^2}\right).$$

Here we write $E[p_j]$ because in case manufacturer j decides to make his contract non-observable, a retailer of i does not observe w_j and must form expectations about w_j.

Maximizing the profit function yields that the equilibrium in the game of retailers is given by

$$p_i = \frac{\alpha(2\beta^2 - \gamma^2 - \beta\gamma) + \beta(2\beta w_i + E[\gamma w_j])}{4\beta^2 - \gamma^2}, \quad i = 1, 2 \tag{27}$$

Now we turn to the first stage, the contract choice of manufacturers. Here potentially three outcomes can occur dependent on the manufacturer's decision to make a contract public or private, that it either both manufacturers offer secret contracts, both manufacturers offer public contracts and one offers a secret, the other one a public contract. We start with the case in which both choose to make the contract non-observable. Inserting the prices in (27) into the quantities yields

$$q_i = \frac{\beta\left(\alpha(2\beta^2 - \gamma^2 - \beta\gamma) + \beta\gamma(2w_j - E[w_j]) - 2\beta^2 w_i + \gamma^2 E[w_i]\right)}{(2\beta - \gamma)(2\beta + \gamma)(\beta + \gamma)(\beta - \gamma)}, \quad i = 1, 2. \tag{28}$$

As a consequence, the profit of a retailer of manufacturer i is $\Pi_i^r = q_i(p_i - w_i)$, where p_i and q_i are defined in (27) and (28). Since manufacturer i can extract everything via the fixed fee he maximizes $\Pi_i = p_i q_i$ with respect to w_i. Calculating equilibrium prices yields $w_i = 0$ which gives a profit of

$$\Pi_N^{nob} = \frac{\alpha^2\beta(\beta - \gamma)}{(2\beta - \gamma)^2(\beta + \gamma)}. \tag{29}$$

We now have to check if a firm has an incentive to deviate from this by making the contract observable. Calculating the optimal w_i for this case yields

$$w_i = \frac{\alpha\gamma^2(2\beta^2 - \gamma^2 - \beta\gamma)}{4\beta^2(2\beta^2 - \gamma^2)}$$

and a profit of

$$\Pi_N^{ob,nob} = \frac{\alpha^2(\beta - \gamma)(2\beta + \gamma)}{8\beta(\beta + \gamma)(2\beta^2 - \gamma^2)}.$$

It is readily checked that $\Pi_N^{ob,nob} > \Pi_N^{nob}$. Thus, it cannot be an equilibrium that both producers choose non-observability in the stage game.

In the same one can check that it can never be an equilibrium if producer i chooses non-observability while producer j chooses observability because producer i has an incentive deviate then.

Now let us look at the case in which both manufacturers make the contract observable to the rival. From Subsection 3.1 we know that profits in this case are

$$\Pi_N^{ob} = \frac{2\alpha^2\beta(\beta - \gamma)(2\beta^2 - \gamma^2)}{(\beta + \gamma)(4\beta^2 - \gamma^2 - 2\beta\gamma)^2}.$$

Deviation to secret contracting by producer i yields $w_i = 0$ and a profit of

$$\Pi_N^{nob,ob} = \frac{16\alpha^2\beta^3(\beta - \gamma)(2\beta^2 - \gamma^2)}{(\beta + \gamma)(2\beta + \gamma)^2(2\beta - \gamma)^2(4\beta^2 - \gamma^2 - 2\beta\gamma)^2}$$

to producer i which is smaller than Π_N^{ob}. Thus, the stage game profit is given by Π_N^{ob}.

Now we turn to the collusion phase. Maximizing joint profits of the manufacturers yields, independent of contracts being observable or not, that $w = \gamma\alpha/2\beta$ and each manufacturer earns a profit of

$$\Pi_C = \frac{\alpha^2}{2(\beta + \gamma)}.$$

It is nevertheless important, how manufacturer achieve the collusion profit, i.e. by public or private contracts, because this determines the deviation profit. Producers will in equilibrium collude in such a way that deviation profits are minimized in order to achieve collusion for as many discount factors as possible.

We know already that if both manufacturers collude via observable contracts, and one of them deviates by keeping his contract public but changes the wholesale tariff, the deviation profit is given by

$$\Pi_D^{ob} = \frac{\alpha^2(4\beta^2 - \gamma^2 - 2\beta\gamma)^2}{32\beta(\beta + \gamma)(\beta - \gamma)(2\beta^2 - \gamma^2)}.$$

On the other hand, if firm i deviates by making the contract secret, the retailers of manufacturers j also know that a deviation has occurred since they can no longer observe manufacturer i's contract. As a consequence of that, i optimally deviates by setting $w_i = 0$ and receives

$$\Pi_D^{nob,ob} = \frac{\alpha^2\beta(4\beta^2 - \gamma^2 - 2\beta\gamma)^2}{4\beta(\beta + \gamma)(\beta - \gamma)(2\beta - \gamma)^2(2\beta + \gamma)^2},$$

which is smaller than Π_D^{ob}. In the same way one can easily check that if firms collude in a way where at least one firm offers a private contract, the deviation profit is always larger than Π_D^{ob}. Thus, the deviation profit is given by Π_D^{ob}.

As a result, both firms optimally choose public contracting and so the critical discount factor is again given by

$$\delta^{crit}_{ET,ET} = \frac{(4\beta^2 - \gamma^2 - 2\beta\gamma)^2}{32\beta^3(\beta-\gamma) - 12\beta\gamma^2(\beta-\gamma) + \gamma^4}.$$

Finally, suppose that firm i distributes via exclusive territories, while firm j does not. We can then perform the same analysis as in the case on which both distribute via exclusive territories. It is readily shown that the firm distributing via exclusive territories chooses to make his contract public in the stage game, in the collusive phase and also when deviating, while the firm distributing via non-exclusive contracts is indifferent in any phase. As a result we get that thew critical discount factor is the same as the one determined in Subsection 3.1 and is given by

$$\delta^{crit}_{ET,NET} = \frac{(2\beta^2 - \gamma^2)(8\beta^2 - 4\beta\gamma - \gamma^2)}{32\beta^4 - 16\beta^3\gamma - 24\beta^2\gamma^2 + 8\beta\gamma^3 + 3\gamma^4}.$$

The statement of the proposition then follows directly from the proof of Proposition 1. ■

Proof of Proposition 5:

We start with the stage game. Now both manufacturers have four different choice variables, namely the mode of distribution, i.e. exclusive or non-exclusive territories, to make to contract observable or not and the contract fees T_i and w_i. Suppose first that both distribute by way of exclusive territories and make the contract observable. . The profit of a manufacturer in this case is given by (6). From the proof of Proposition 4 we know that deviating to secret contracting is not profitable.

However, a manufacturer can now also deviate by choosing non-exclusive territories. Suppose that manufacturer i does so and chooses to make his contract observable. We know from the analysis of the asymmetric case in Section 4 that retailers in this case set prices of

$$p_i = w_i \quad \text{and} \quad p_j = \frac{\alpha(\beta-\gamma) + \beta w_i + \gamma w_j}{2\beta}.$$

Manufacturer j sets a per-unit wholesale price of

$$w_j = \frac{\alpha\gamma^2(\beta-\gamma)}{\beta(4\beta^2 - \gamma^2 - 2\beta\gamma)}.$$

After calculating the retail quantities we can write the profit function of manufacturer i as

$$\Pi_i = \frac{w_i(2\beta^2 - \gamma^2\left(4\alpha\beta(\beta-\gamma) - w_i(4\beta^2 - \gamma^2 - 2\beta\gamma)\right))}{2\beta(4\beta^2 - \gamma^2 - 2\beta\gamma)(\beta+\gamma)(\beta-\gamma)}. \tag{30}$$

Maximizing this with respect to w_i yields

$$w_i = \frac{2\alpha\beta(\beta-\gamma)}{4\beta^2 - \gamma^2 - 2\beta\gamma}.$$

Inserting this back into (30) yields a profit that is the same as the one (6). Thus, via deviating to non-exclusive territories and observable contracts, a manufacturer does as well as with sticking to exclusive territories and observable contracts and so he has no incentive to deviate.

In the same way we can calculate if a manufacturer has an incentive to deviate to non-exclusivity and non-observable contracts. Doing so yields that he gets a profit of

$$\frac{16\alpha^2\beta^3(2\beta^2 - \gamma^2)^2(\beta-\gamma)}{(4\beta^2 - \gamma^2 - 2\beta\gamma)^2(\beta+\gamma)(2\beta-\gamma)^2(2\beta+\gamma)^2}$$

in this case. But this is strictly lower than (6) and so deviating is not optimal. Therefore, it is stage game equilibrium that both manufacturers distribute via exclusive territories and observable contracts. As mentioned in the proof of Proposition 4 it can never be a stage game equilibrium that both or one manufacturers chooses exclusive territories and non-observability because opting for public contracts yields larger profits.

Now we turn to the case in which both manufacturers distribute via non-exclusive territories and make their contracts observable. The profit in this case is given by (12). We know that deviating to private contracts yields the same profit in this case. Therefore, suppose now that manufacturer i deviates and chooses to distribute via exclusive territories. Here is does not matter if he makes the wholesale contract observable or not because the retailers of manufacturer j set $p_j = w_j$. We know that manufacturer j sets $w_j = \alpha(\beta-\gamma)/(2\beta+\gamma)$. Calculating the optimal deviation wholesale price yields $w_i = 0$ giving a profit of

$$\Pi = \frac{\alpha^2\beta(\beta-\gamma)}{(2\beta-\gamma)^2(\beta+\gamma)}$$

to manufacturer i which is the same as the profit in (12). Thus, no manufacturer has an incentive to deviate and distributing via non-exclusive territories and observable contracts is also an equilibrium of the stage game. By the same logic we get that both manufacturers distributing via non-exclusive territories and both or just one of them makes the contract not observable is also a Nash equilibrium of the stage game yielding the same profit as in (12).

Finally, one can show that it can never be a Nash equilibrium that the manufacturers distribute via asymmetric distribution channels because in that case the manufacturer who chooses non-exclusivity has an incentive to deviate to exclusive territories.

Thus, there are two Nash equilibrium outcomes, one in which both manufacturers choose exclusive territories and observable contracts and one where both choose non-exclusive territories and either make contracts public or private. The profit in the first Nash equilibrium is given by (6) while the profit in the second is (12). Comparing the two we get that the difference between (6) and (12) is given by

$$\frac{\alpha^2\beta(\beta-\gamma)(32\beta^3(\beta-\gamma)+12\beta\gamma^3-8\beta^2\gamma^2-\gamma^4)}{(4\beta^2-\gamma^2-2\beta\gamma)^2(\beta+\gamma)(2\beta-\gamma)^2(\beta+\gamma)}$$

which is positive since $\beta > \gamma$. Thus, the harshest subgame perfect punishment is the one in which firms play non-exclusive territories in the stage game.

Now we turn to the collusion. In the proof of Proposition 1 we have seen that if manufacturers collude via exclusive territories and observable contracts, they set a per-unit price of $w_i = \alpha\gamma/(2\beta)$. From the proof of Proposition 4 we know that if a manufacturer sticks to exclusive territories, he optimally deviates by making he contract observable. He gets a deviation profit of

$$\frac{\alpha^2(4\beta^2-\gamma^2-2\beta\gamma)^2}{32\beta(\beta+\gamma)(\beta-\gamma)(2\beta^2-\gamma^2)}. \tag{31}$$

in this case. Now suppose instead that the manufacturer deviates via non-exclusive territories and public contracts. His optimal deviation price in this case is given by

$$w_i = \frac{\alpha(4\beta^2-\gamma^2-2\beta\gamma)}{4(2\beta-\gamma^2)}$$

leading also to a deviation profit of (31). One can easily check that the deviation profit when distributing via non-exclusive territories and private contracts is strictly smaller. Thus, in this case the largest deviation profit is given by (31).

Now suppose that both manufacturers distribute via non-exclusive territories. From Proposition 3 we know that in this case it does not matter if contracts are public or private. Therefore, the profit that the deviating manufacturer earns when continues to choose non-exclusive territories in the period of deviation is given by (14), that is

$$\frac{\alpha^2(2\beta-\gamma)^2}{16\beta(\beta-\gamma)(\beta+\gamma)}.$$

Now subtracting (31) from (14) yields

$$\frac{\alpha^2\gamma^3(4\beta-3\gamma)}{32\beta(\beta+\gamma)(\beta-\gamma)(2\beta^2-\gamma^2)} > 0.$$

Thus, the deviation profit if both manufacturers distribute via non-exclusive territories is larger and so it cannot be optimal that both manufacturers choose this mode of distribution.

Finally, in case manufacturers choose asymmetric distribution networks, one can show by the same method that the deviation profit of the manufacturers that distributes by way of exclusive territories is larger than (31). As a consequence, manufacturers optimally collude by way of exclusive territories and public contracts.

We can now calculate the critical discount factor $\underline{\delta}$ above which collusion can be sustained if manufacturers are not committed to their distribution mode. This discount factor is given by

$$\frac{\underline{\delta}}{1-\underline{\delta}}\left(\frac{\alpha^2\beta(\beta-\gamma)}{(2\beta-\gamma)^2(\beta+\gamma)}\right) = \frac{\alpha^2(4\beta^2-\gamma^2-2\beta\gamma)^2}{32\beta(\beta+\gamma)(\beta-\gamma)(2\beta^2-\gamma^2)} + \frac{\underline{\delta}}{1-\underline{\delta}}\left(\frac{\alpha^2}{4(\beta+\gamma)}\right)$$

or

$$\underline{\delta} = \frac{(2\beta-\gamma)^4}{16\beta^2(2\beta-\gamma)(\beta-\gamma)+\gamma^4}.$$

Comparing this discount factor with $\underline{\delta}_{ET}$ yields

$$\underline{\delta}_{ET} - \underline{\delta} = \frac{(32\beta^2\gamma(4\beta-3\gamma)(2\beta^2-\gamma^2)(\beta-\gamma)^2}{(4\beta(\beta-\gamma)(8\beta^2-3\gamma^2)(\beta-\gamma)+\gamma^4)(16\beta^2(2\beta-\gamma)(\beta-\gamma)+\gamma^4)} > 0.$$

Therefore, collusion is easier sustain than in case of commitment to the distribution mode. ■

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