

## THE GOVERNANCE OF EXCLUSIVE TERRITORIES WHEN DEALERS CAN BOOTLEG

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A transaction cost approach is used to investigate a manufacturer's policy towards exclusive territory dealers who bootleg (sell across their assigned territories). We show that optimal enforcement policies will generally tolerate some level of bootlegging. This tolerance is a natural consequence of the transaction cost principle that institutional arrangements are not fully enforceable, and that self-enforcing implicit agreements will require some degree of tolerance. The actual degree of tolerance is determined by (a) the importance of reseller services, (b) the reduction in margin realized from surreptitious sales, and (c) the resellers' beliefs about the manufacturer's long-run commitment to the channel. We also show that deploying exclusive territories is beneficial to the manufacturer because it safeguards reseller services and permits resellers to capitalize on their superior local information. However, the latter effect is contingent on being able to convince resellers of the manufacturer's long run commitment to the channel.

**(Channels of Distribution; Game Theory; Retailing and Wholesaling)**

### 1. Introduction

Exclusive territory distribution (ETD) consists of territories being assigned to resellers. For instance, beer distributors are assigned service areas by the brewers (Jordan and Jaffee 1987), and they are expressly forbidden from servicing accounts outside their area. In other instances, the assignment may cover a class of accounts, rather than a geographic area. ETD systems exhibit varying degrees of restrictiveness, ranging from very "strong" forms where resellers are expressly disallowed from soliciting or selling outside their own territory, to weaker forms where only solicitation may be forbidden.

ETD systems are almost always characterized by violations of the territorial restrictions by resellers. Terms like "gray marketing", "bootlegging", and "channel flow diversion" are all used to describe such practices.<sup>1</sup> The practices appear to be common even in channels characterized by large, powerful manufacturers. For instance, authorized resellers of computer firms like IBM and Lotus often sell to other unauthorized resellers such as mail-order dealers (Ramirez 1985). Likewise, in the beer industry, wholesalers make unauthorized sales to retailers outside their assigned territories (Jordan and Jaffee 1987).

Some indication of the pervasive nature of bootlegging is available in Banerji (1990) who concluded that IBM's PC channel was marked by pervasive bootlegging. He uses

<sup>1</sup> Such practices are not to be confused with the selling of counterfeit goods. The issue is not the legality of the goods, but only the means by which they are distributed.

internal IBM studies cited in court documents to suggest that there was “almost universal interest” (in bootlegging) on the part of authorized IBM resellers, including *the company’s own distribution division*. About 5% of IBM’s total PC sales volume actually came from bootlegged sales.

Other estimates are equally high. For instance, Lowe and McCrohan (1989) contend that gray markets are growing at 22% annually in the U.S. Similarly, a New York Times report cited by Cross et al. (1989) puts annual gray market volume at \$7 billion. Two interrelated issues concern marketers in this context. First, how can a manufacturer craft a sensible enforcement policy in an ETD system? Second, how does the bootlegging problem affect the decision to deploy ETD?

### 1.1. *Purpose of This Paper*

In this paper, we use transaction cost principles to assess the two issues indicated above. We address the issue of an enforcement policy towards bootlegging, and then assess ETD deployment itself.

Our most significant result is that firms deploying ETD will generally tolerate some level of bootlegging. Enforcement policies will be sensitive to the size of the violation, and this tolerance limit is governed by factors such as the importance of reseller services, the reduction in resellers’ realized margins for surreptitious sales, and the manufacturer’s commitment to the channel relationship. A noteworthy aspect of our work is that unlike previous work on self-enforcing agreements (Klein and Leffler 1981), we accommodate violations after a self-enforcing agreement has been struck. With respect to ETD deployment, we show that the decision is motivated by the need to safeguard resellers’ services and the superiority of information held by resellers, but that the decision is closely affected by the ability to convince resellers of the firm’s long run commitment to the channel.

### 1.2. *Past Research on Enforcement Policy*

The most common view is that bootlegging is intrinsically harmful to the manufacturer, and to the channel itself. Hence, vigorous efforts to combat the problem are indicated. For instance, Cavusgil and Sikora (1987) suggest that a firm should take whatever steps are feasible to maintain territorial integrity. Not only is bootlegging harmful, but any tolerance is going to unravel the channel. The focus is on the many ways in which firms can work to attack the problem. In this spirit, Lowe and McCrohan (1989) identify several methods for a manufacturer to “minimize the impact” of bootlegging.

On the other hand, some analysts have suggested the opposite course of action, viz. abandoning any pretense of assigned territories. Corey et al. (1989) note that the firm might as well abandon ETD and revert to permitting full intrabrand competition when it finds that it cannot prevent bootlegging.

Casual observation suggests that neither extreme (all or no enforcement) is employed very often by firms. Rather, enforcement occurs quite selectively, and actual tolerance of *documented* violators is quite common. For instance, Banerji (1990) reports a termination rate of only 3–4% of documented bootleggers in the IBM PC channel. Quite clearly, we need to sort out the desirability of these alternative courses of action. Unfortunately, the extant work in marketing and other research areas is of little help in formulating a policy which balances these competing interests.

A promising line of reasoning to address these issues is the work in transaction costs (TCA). In this approach, (e.g., Williamson 1985) it is argued that imperfect enforceability of contractual agreements is a natural consequence of the opportunistic tendencies of agents, and the bounded rationality of decision makers. Thus, the “legal centralism” assumption of costlessly enforceable institutional arrangements is merely a convenient fiction. A more realistic view is that of “private ordering”, where parties to an agreement

will strive to reach self-enforced agreements (Telser 1981). Legal redress is costly and particularly inefficient for ongoing relationships that need adjustments. At best, the law provides a backstop to self-enforcing agreements. Within the legal profession itself, this view is a growing perspective on the role of the law in maintaining business relationships. Most prominently, Macneil (1978) makes similar arguments about the realities of legal enforcement of contracts, and provides case data to support these notions.

Some work in TCA is beginning to address vertical restraints from the perspective of self-enforcing agreements (e.g., Klein and Murphy 1988, Rubin 1990), but on-going violations like bootlegging have not been addressed. While acknowledging partial enforceability, their focus is on self-enforced agreements that are never violated. This implies bootlegging should not be observed once a self-enforcing agreement is struck. This view is limiting in that it does not account for bootlegging as an on-going activity in channels.

Nevertheless, the TCA approach is an appealing one for our purposes since bootlegging involves the enforceability of contractual agreements in an obvious way. If agreements were perfectly (costlessly) enforceable, bootlegging would vanish as a problem in exclusive territory channels. In effect, we need to extend the extant TCA analysis to accommodate the possibility of bootlegging even after a self-enforcing agreement has been struck.

Notice that the existing TCA logic does not assume bootlegging serves any beneficial purpose for either the resellers or the manufacturer. As we shall see later, it is really a prisoner's dilemma that induces the behavior. In contrast, Banerji (1990) and Bucklin (1990) offer models wherein bootlegging increases primary demand (and the possibility for price discrimination). We deliberately take the position that bootlegging has no such demand enhancing properties, because demonstrating tolerance of bootlegging in our model's environment permits us to make stronger claims about bootlegging. Allowing for primary demand enhancement would only enhance tolerance of bootlegging.

### 1.3. *Past Research on ETD Deployment*

Vertical restraints including ETD were viewed quite simply as devices to restrain intrabrand competition. More recently, the emphasis has shifted, and the current view expressed in textbooks emphasizes efficiency effects (e.g., Stern and El-Ansary 1992).

The most commonly elaborated efficiency rationale for ETD (e.g., Mathewson and Winter 1984) is that resellers may be required to undertake services desired by customers. Such services are vulnerable in that any one reseller may not offer the services, and instead "steal" customers away from a competing full-service reseller. In effect, customers obtain the reseller service activities from *A*, but buy from *B*.

Neither *A* nor *B* will provide these services under such circumstances. This is dysfunctional since it reduces total demand. If each reseller were confident that other resellers would not be permitted to steal his customers, he is more likely to offer these services. Firms strive to accomplish this by assigning territories to individual resellers, thus preventing resellers from stealing away the customers of other resellers.

A newer, and less well recognized reason for deploying ETD is that individual resellers may possess superior information about demand or cost conditions in the end customer market. Rey and Tirole (1986a) show that assigning exclusive territories allows the resellers to use that information to their advantage in setting appropriate retail prices. This is a significant expansion of the efficiency rationale for ETD channels. It accounts for ETD deployment in situations where reseller services are relatively unimportant.

Unfortunately, these studies advancing the reseller services and/or the information argument for ETD deployment have not paid any attention to the issue of bootlegging, and are thus of little help in understanding enforcement policies. The analytic models have neglected bootlegging altogether (e.g., Mathewson and Winter 1984, Rey and Tirole 1986a,b). These studies assume ETD can be deployed and enforced in a costless fashion.

In contrast to these streams of work, we study the deployment of ETD in an environment in which resellers do not selflessly adhere to contracts assigning territories. They will bootleg if it is profitable to do so.

#### 1.4. Organization of the Paper

The remainder of the paper is organized as follows. Section 2 presents the formal models of an ETD channel and a channel with full intrabrand competition. We solve for the equilibrium prices, service levels, profits, and enforcement policies. We use these results to understand the influences on the enforcement policy and the deployment of ETD. Section 3 closes the paper with a discussion of the conclusions and limitations of the paper.

## 2. Model

### 2.1. Environment

2.1.1. *Manufacturers.* A profit-maximizing manufacturer produces a product at a constant marginal cost,  $c$ . She<sup>2</sup> sells through two dealers, and can elect to permit these dealers to compete freely with each other, or else to assign equal-sized territories to them. In the ETD case, each dealer is forbidden to solicit or sell outside the “territory”, which can be a geographic area, customer type, or any other clearly defined market. However, these assignments will not be honored by resellers unless there is an enforcement mechanism. Absent any enforcement, ETD channels become equivalent to channels with full intrabrand competition. At the beginning of each time period, the manufacturer offers the same wholesale price  $p$ , and a fixed fee  $F$  to each dealer.<sup>3</sup>

2.1.2. *Dealers.* Like the manufacturer, each dealer maximizes expected profits<sup>4</sup>. Each dealer chooses a retail price ( $q_i$ ) and a service level ( $s_i$ ) in response to local demand and cost conditions, as well as the other dealer’s anticipated behavior. These services are reseller activities such as customer education, product demonstrations, and the like. We assume that customers can obtain these services from dealer  $A$  but actually purchase the item from dealer  $B$ . The cost of these services depend on the level of services provided. We assume that the dealer’s cost of delivering a service level  $s_i$ , is  $bs_i^2$ . In addition to these service costs, the dealers also incur a cost per unit  $\gamma$  to undertake the routine business activities of a reseller.

End user demand in each territory is described as  $(1/2)(\delta - q_i + 2as_i)$ , where  $\delta$  is a demand parameter, and “ $a$ ” represents the demand enhancing effects of service activities.

To capture the superior information held by dealers about retail level conditions, we assume that  $\delta$  and  $\gamma$  are uncertain, and distributed on  $[\underline{\delta}, \bar{\delta}]$ , and  $[\underline{\gamma}, \bar{\gamma}]$  respectively.<sup>5</sup> The uncertainty in each period is assumed to be independent of the next period. The dealers make decisions about retail price and service level in each time period after observing the local cost and demand realization and after the manufacturer has set her

<sup>2</sup> For clarity, the manufacturer will be referred to as “she”, and the dealers as “he” throughout the rest of this paper.

<sup>3</sup> The fixed payment does not have to be a cash payment, but any other form of transfer which has value for the manufacturer, and a cost is incurred by the dealer. It allows us to deal with more complicated pricing arrangements than just wholesale prices. The fixed fee can be thought of as some type of sharing rule between manufacturers and dealers that shares gains made via channel efficiency with both the dealer and the manufacturer. One example of such a sharing rule could be a quantity discount. Jeuland and Shugan (1983) discuss these issues more fully.

<sup>4</sup> Risk neutrality leading to maximization of expected profits is the usual assumption in transaction cost analysis. It sharpens the focus on reasons other than “taste for risk” as an explanatory mechanism. Focusing on differential “taste for risk” obscures other important nonrisk related explanations (Williamson 1985).

<sup>5</sup> See footnote 11.

prices. However, the manufacturer makes her decisions prior to observing the realizations. Finally, it should be noted that the dealer decides how much bootlegging to do. The dealer's decision to bootleg is made before he observes the demand and cost realizations. In effect, we view the decision to bootleg as requiring some planning and organization.

2.1.3. *Bootlegging.* Bootlegging occurs when one dealer sells in the other dealer's territory. This is done surreptitiously, and we capture this by assuming that lower margins are realized for bootlegged sales compared to official sales in his own territory. The size of this reduction in the realized margin is represented by  $\epsilon$ .

Margins are eroded in two ways. First, the surreptitious behavior may add costs. For instance, the product is shipped from the factory to the bootlegging dealer, and then transshipped surreptitiously to the other territory. Absent assigned territories, a dealer could use a more cost effective method like drop-shipping directly to the other territory from the plant. The surreptitious behavior also renders the product less attractive to the customer and thus requires a price discount to generate sales. Bucklin (1990) documents these discounted prices for bootlegged items across a variety of product markets.

Notice that if the manufacturer chose not to enforce assigned territories at all, then any need to behave surreptitiously will disappear. We revert to de facto full intrabrand competition, which makes any notion of bootlegging moot. Thus,  $\epsilon$  would vanish.

2.1.4. *Enforcement.* As per transaction cost analysis, we assume that ETD agreements are not enforceable costlessly. We assume a time lag exists between the occurrence of the violation and any possible enforcement by the manufacturer. For analytic convenience, we assume this lag to be one period, but our results are robust for longer time lags.

The only sanction we consider is termination. Other sanctions such as monetary penalties or performance bonds are not considered. This follows from the TCA emphasis on the difficulty of using the legal system to enforce specific performance of contracts.

We model ETD enforcement policy with the parameter  $\theta$ . Any dealer that bootlegs beyond  $\theta$  is terminated as soon as feasible, viz. in the period following the breach. However, bootlegging up to  $\theta$  is tolerated indefinitely. "Complete" enforcement corresponds to  $\theta = 0$ . No enforcement at all is equivalent to abandoning ETD, and reverting to de facto full intrabrand competition. Here, any notion of an enforcement policy is moot.

Notice that all documented bootleggers do not have to be terminated. Only those violators beyond a policy limit will be terminated. In other words, the selective termination policy is sensitive to the size of the violation, and this policy limit itself will be shown to depend on certain factors.<sup>6</sup>

## 2.2. *Time Horizon*

We assume a long run relationship between the dealers and the manufacturer with an uncertain final period. This requires that we discount future returns by a parameter " $r$ " which captures the time value of money, as well as the uncertainty regarding the continuation of the relationship.

## 2.3. *Equilibrium*

Dealers are Nash competitors with each other on price and service. In other words, they do not collude. The manufacturer's decisions are made before the dealers' decisions,

<sup>6</sup> Since violations are assumed to be documented within one period of its occurrence, there is no gain to delaying termination beyond the next period. There is also no gain to enforcing only part of the time because the lower the enforcement rate for a given tolerance level, the more likely it is that dealers will bootleg (or the more costly it is to write a self-enforcing contract).

Less stringent sanctions than termination can also be analyzed, but these require even higher premiums to be offered to the dealers. Our results would be robust to these sanctions short of termination. In general, not being able to use termination will increase the costs to stopping bootlegging, thereby increasing the amount of tolerated bootlegging, and decreasing the value of exclusive territories relative to simply allowing competition.

albeit after taking into account the dealers' potential reactions to her actions. This captures the idea that manufacturers have more power than dealers in fashioning the terms of an ETD agreement.

#### 2.4. Analysis of ETD

Table 2 in Appendix 1 depicts the choices facing each dealer in an ETD setup. Recall that the firm has an implicit policy of terminating any dealer who bootlegs beyond  $\theta$ . However, the termination sanction can be applied only in the period following the violation. How will the dealers behave here?

In Appendix 1, we rule out all the possible dealer strategies except the case where each dealer's pricing and service strategy is based on his assumption that the other dealer will bootleg up to  $\theta$ . Likewise, each dealer's bootlegging strategy is to engage in bootlegging up to the level  $\theta$ . Is this a Nash equilibrium? We turn to examining this issue in detail below.

#### 2.5. Dealer Nash Equilibrium in ETD

To assess whether the cell denoted 6 in Table 2 is a dealer Nash equilibrium, we start in §2.5.1 by deriving each dealer's profits when each selflessly adheres to the policy limit on bootlegging. Then, in §2.5.2 we assess the expected gains to a reseller who bootlegs beyond the policy limit. In §2.5.3 we analyze a self-enforcing agreement which shows that an appropriately set price ( $p$  and  $F$ ) can ensure that a dealer will not want to bootleg beyond the policy limit. This makes the policy limit self-enforcing.

*2.5.1. Profits to dealers selflessly adhering to implicit policy limits.* Assume for the moment that neither dealer contemplates violating the policy limit. Instead, as per cell 6, they bootleg up to the policy limit.<sup>7</sup> This is tolerated indefinitely.

*Single period case:* Dealer 1 maximizes:

$$\text{Max } q_1, s_1: (1/2)[(\delta - q_1 - 2\theta + 2as_1)(q_1 - p - \gamma) + (\theta)(q_2 - p - \epsilon - \gamma) - bs_1^2 - F] \quad (1)$$

and Dealer 2 maximizes:

$$\text{Max } q_2, s_2: (1/2)[(\delta - q_2 - 2\theta + 2as_2)(q_2 - p - \gamma) + (\theta)(q_1 - p - \epsilon - \gamma) - bs_2^2 - F]. \quad (2)$$

Solving, we find the equilibrium retail price and service levels to be<sup>8</sup>:

$$q_1^* = q_2^* = [b(\delta - 2\theta) + (b - a^2)(p + \gamma)] / [(2b - a^2)], \quad (3)$$

$$s_1^* = s_2^* = [a(\delta - 2\theta - p - \gamma)] / [2(2b - a^2)]. \quad (4)$$

Substituting for  $q_1^*$  and  $q_2^*$  and  $s_1^*$  and  $s_2^*$  in each dealer's maximization, we get each dealer's expected profit in a single period as:

$$E\{[b(\delta - p - \gamma - 2\theta)(\delta - p - \gamma + 2\theta) / 4(2b - a^2)] - \theta\epsilon - F\}. \quad (5)$$

*Multiperiod case:* We can readily generalize the above analysis to the multiperiod case in the following manner. If the dealer stays within tolerated levels of bootlegging over each future period,<sup>9</sup> then his *total* expected profit is the infinite stream discounted

<sup>7</sup> Notice that Equations (1) and (2) include both the bootlegging done against them (the  $\theta$  in the first part of the equations), and the bootlegging that they undertake (the  $\theta$  in the second part of the equations). Since both dealers are bootlegging up to the tolerated limit, we use  $\theta$  in both parts of the equation.

<sup>8</sup> See footnote 11.

<sup>9</sup> It is reasonable to expect that if an arrangement can be written which guarantees that both resellers stay within tolerated levels of bootlegging in the first period, then the same arrangement can be used to guarantee

to the first period.<sup>10</sup> Thus, the expected profits to each dealer staying within tolerated bootlegging levels (assuming the other also complies) is:

$$E\{[b(\delta - p - \gamma - 2\theta)(\delta - p - \gamma + 2\theta)/4(2b - a^2)] - \theta\epsilon - F + (1/r)([b(\delta - p - \gamma - 2\theta)(\delta - p - \gamma + 2\theta)/4(2b - a^2)] - \theta\epsilon - F)\}. \quad (6)$$

2.5.2. *Profits to dealers who violate policy limit.* When Dealer 1 bootlegs beyond  $\theta$ , he expects to sell an additional amount  $E[(1/2)(\delta - 2\theta - q_2 + 2as_2)]$  at an expected price of  $E(q_2 - p - \gamma - \epsilon)$ . Why is this attractive? Notice that the ETD setup provides positive margins on additional sales outside his territory, albeit a lower margin than sales in his own territory. However, these added profits will be available for just one period, since he will be terminated in the following period. The same logic would apply to Dealer 2. Thus, for each dealer, the additional profits beyond those realized by bootlegging up to  $\theta$  is:

$$E\{[b(\delta - p - \gamma - 2\theta)/2(2b - a^2)][(b(\delta - p - \gamma - 2\theta)/(2b - a^2)) - \epsilon]\}. \quad (7)$$

The dealer's total expected profit is given by the sum of Equations (5) and (7):

$$E\{b(\delta - p - \gamma - 2\theta)(\delta - p - \gamma + 2\theta)/4(2b - a^2) - \theta\epsilon - F + [b(\delta - p - \gamma - 2\theta)/2(2b - a^2)][(b(\delta - p - \gamma - 2\theta)/(2b - a^2)) - \epsilon]\}. \quad (8)$$

2.5.3. *Making the implicit policy limit self-enforcing.* In order to make the policy limit self-enforcing, we rely on a variation of the price premium or "quasi-rent" notion in TCA (Klein and Leffler 1981, Klein and Murphy 1988). Specifically, if the expected profit to the dealer from adhering to the policy limit in (6) is greater than the expected profit from bootlegging beyond  $\theta$  in this period and being terminated next period as per (8), they will find it in their own best interest to adhere to the policy limit. Subtracting (8) from (6) and solving for  $F$  gives us the maximum fixed payment ( $F$ ) that the manufacturer can get from each dealer in every period, and still keep dealers from cheating beyond  $\theta$ :

$$\begin{aligned} & E\{[b(\delta - p - \gamma - 2\theta)(\delta - p - \gamma + 2\theta)/4(2b - a^2)] - \theta\epsilon - F\} \\ & + (1/r)([b(\delta - p - \gamma - 2\theta)(\delta - p - \gamma + 2\theta)/4(2b - a^2)] - \theta\epsilon - F)\} \\ & - E\{b(\delta - p - \gamma - 2\theta)(\delta - p - \gamma + 2\theta)/4(2b - a^2) - \theta\epsilon - F \\ & + [b(\delta - p - \gamma - 2\theta)/2(2b - a^2)][(b(\delta - p - \gamma - 2\theta)/(2b - a^2)) - \epsilon]\} = 0. \end{aligned} \quad (9)$$

that both resellers will stay within tolerated levels of bootlegging in any period thereafter. Thus it is reasonable to forecast Equation (5) into the foreseeable future of the relationship. This is because the structure of the interaction does not change, and the manufacturer's optimal policy for any single period is the optimal policy in all future periods, despite changes in the demand and cost realizations in each period. Thus, in our analysis, we can focus on the solution for any single period (say the first period), find the optimal price and enforcement policy for that period, and repeat that solution for all of the remaining periods in the model. Intuitively, this is possible because the uncertainty across each period is independent of previous period actions. Further, each period's solutions have an infinite future stream of payments. Therefore, the problem in period 1 is the same as the problem in period 2, as well as in period 3, and so on.

<sup>10</sup> For any "r", the stream of profits for dealers staying within the policy limit is:

$$(1 + [1/(1+r)] + [1/(1+r)^2] + \dots + [1/(1+r)^n] + \dots) \times E\{b(\delta - p - \gamma - 2\theta)(\delta - p - \gamma + 2\theta)/4(2b - a^2) - \theta\epsilon - F\}.$$

Hence,

$$F = E\{[b(\delta - p - \gamma - 2\theta)(\delta - p - \gamma + 2\theta)/4(2b - a^2)] - \theta\epsilon - r[b(\delta - p - \gamma - 2\theta)/2(2b - a^2)][(b(\delta - p - \gamma - 2\theta)/(2b - a^2)) - \epsilon]\}. \quad (10)$$

In other words, if the manufacturer sets  $F$  according to (10), then each dealer will find it in his best interest to adhere to the policy limit. It should be noted that this goes beyond the Klein and Leffler or Klein and Murphy formulations. Here, the firm actually tolerates some violation (up to  $\theta$ ) of the territory agreement. In contrast, the extant work only deals with completely self-enforced agreements ( $\theta = 0$ ).

## 2.6. Outcomes in ETD

The manufacturer's expected profits for one period can be expressed as the fixed payment  $F$  from each dealer (i.e., twice Equation (10)) plus the profits she gets from selling to the two dealers. The manufacturer solves:

$$\begin{aligned} \Pi^*_{\text{ETD}} = \text{Max } p, \theta: E\{ & [[(p - c)(b(\delta - p - \gamma + 2\theta) - 2\theta a^2)]/(2b - a^2)] \\ & + 2[[b(\delta - p - \gamma - 2\theta)(\delta - p - \gamma + 2\theta)/4(2b - a^2)] \\ & - \theta\epsilon - r[b(\delta - p - \gamma - 2\theta)/2(2b - a^2)] \\ & \times [(b(\delta - p - \gamma - 2\theta)/(2b - a^2)) - \epsilon]\}. \quad (11) \end{aligned}$$

Taking the first-order necessary condition and solving simultaneously for  $p$  and  $\theta$  we get:<sup>11</sup>

$$\theta^*_{\text{ETD}} = [r(2b^2\delta^e - 2b^2c - 2b^2\gamma^e + (a^2b - 4b^2)\epsilon) + (a^2b - 2b^2)\epsilon]/[2(4b^2r + 2a^2b - a^4)], \quad (12)$$

$$\begin{aligned} p^*_{\text{ETD}} = [r(2b^2\delta^e + 2b^2c - 2b^2\gamma^e + a^2b\epsilon) \\ + (3a^2b - 2b^2 - a^4)\epsilon + (2a^2b - a^4)c]/(4b^2r + 2a^2b - a^4), \quad (13) \end{aligned}$$

where  $\delta^e$  and  $\gamma^e$  are the expected values of  $\delta$  and  $\gamma$  respectively. Equation (12) is one of the fundamental results of the paper. We shall examine its implications in the next section. We can also solve the expected retail price and service levels for these ETD setups. These are:

$$\begin{aligned} q^* = [1/(4b^2r + 2a^2b - a^4)][r(2b^2\gamma^e + (2b^2 + a^2)\epsilon + 2b^2\delta^e + 2b^2c) \\ + a^2b\delta^e + (a^2b - a^4)(\gamma^e + c) + (2a^2b - a^2)\epsilon], \quad (14) \end{aligned}$$

$$s^* = [1/(8b^2r + 4a^2b - 2a^4)][2aber + a^3\delta^e - a^3\gamma^e - a^3c + (2ab - a^3)\epsilon]. \quad (15)$$

Substituting the values of  $\theta^*$  and  $p^*$  from (12) and (13) in the manufacturer's profit Equation (11) we get the manufacturer's expected profit as:

$$\begin{aligned} [1/(4b^2r + 2a^2b - a^4)] \\ \times [8b^4(-\sigma_\delta^2 - \sigma_\gamma^2)r^2(1/2)(1/(2b - a^2)^2) + b^2r(\sigma_\delta^2 + \sigma_\gamma^2 + (\delta^e - \gamma^e - c)^2) \\ + a^2b(1/2)(\sigma_\delta^2 + \sigma_\gamma^2 + (\delta^e - \gamma^e - c)^2) + ber(2b - a^2)(-\delta^e + c + \gamma^e) \\ + (ber)^2 + b\epsilon^2r(3b - a^2) + (1/2)b\epsilon^2(2b - a^2)]. \quad (16) \end{aligned}$$

<sup>11</sup> We assume that demand is sufficiently large relative to the cost parameters ( $c$  and  $\gamma$ ), and the  $\epsilon$ -parameter. Specifically, we assume that

$$\underline{\delta} \geq \bar{\gamma} + c + [4b^2r^2\epsilon + (2b - a^2)(6b - a^2)rc + (2b - a^2)^2\epsilon]/[4br(b - a^2)]$$

and that  $b - a^2 > 0$ . This ensures that  $\theta^* > 0$  and less than total demand in a dealer territory. It also ensures that  $p^* - c > 0$ ,  $q^* - p > 0$ , and  $s^* > 0$ .



## 2.7. *Enforcement Policies in ETD*

The core of our analysis concerns the development of an enforcement policy. We can gain insight into this issue from our result for the optimal level of tolerance ( $\theta^*$ ) in equation (12). Our analysis emphasizes a particular trade-off which warrants some elaboration.

While there are affirmative reasons to deploy ETD, they also create the incentive to bootleg, and controlling bootlegging is expensive. Firms resolve this trade-off by tolerating some level of bootlegging. Tolerating some amount of bootlegging reduces the costs of limiting further amounts of bootlegging through a self-enforcing contract.

Notice that all dealers will bootleg up to this policy limit. Bootlegging is not an aberrant, or rare condition. Rather, one should observe it quite commonly. This is consistent with industry observations reported by Banerji (1990), Lowe and McCrohan (1989), and Cross et al. (1989) about the pervasiveness of bootlegging.

The role of bootlegging in our analysis is rather different from observations made from more informal analysis (e.g., Cavusgil and Sikora 1987). These studies emphasize the disruptive effects of bootlegging, and express the need to enforce exclusive territory distribution to the fullest extent feasible. The dominant view expressed in these studies is that bootlegging should not be willingly tolerated, and that the manufacturer should try to get rid of bootlegging in the channel setting. Unless the firm attempts to sanction all documented violators, they argue that the channel would unravel. In contrast, our analysis shows that some ongoing tolerance of bootlegging is inherent in the management of ETD systems. Furthermore, ETD systems can tolerate bootlegging without collapsing.

Our results also depart sharply from traditional models of self-enforcing agreements (e.g., Klein and Leffler 1981) in that our setup is the first one to yield cheating in equilibrium. Conceptually, this is significant because it accommodates the TCA viewpoint that institutional design does not solve the incentive problem once and for all. Parties to agreements will shade on terms in an on-going fashion.

## 2.8. *Influences on the Policy Limit*

The factors which influence the policy limit can be understood by looking at the comparative statics from Equation (12). These comparative statics are shown in Appendix 2. Below, we explore the more interesting results in further detail.

**2.8.1. *Importance of reseller services.*** The effects of services operate through the “ $a$ ” and “ $b$ ” parameters. When services are more valuable (stronger customer demand effects via a larger “ $a$ ” parameter, or a greater ability to provide services due to a smaller cost parameter, “ $b$ ”), our prediction is that the firm will tolerate less bootlegging as per the signs of the comparative statics ( $\partial\theta^*/\partial a < 0$ ,  $\partial\theta^*/\partial b > 0$ ).

The intuition is that as ETD becomes more valuable as a device to overcome the bootlegging problem affecting service provision, safeguards against such behavior are needed to a greater degree. As we shall show later, if no enforcement at all existed, the resulting full intrabrand competition would drive services to a zero level. Hence, one would expect to see more stringent policy limits as these services are more valuable.

**2.8.2. *Margin erosion on bootlegged sales.*** Recall that the  $\epsilon$ -parameter represented the reduction in realized margin from bootlegged sales. Based on the sign of the comparative static for  $\epsilon$ , we predict that the firm will have a more stringent enforcement policy in such circumstances ( $\partial\theta^*/\partial\epsilon < 0$ ).

Consider the implications of this result. Recall that one source of the margin erosion is the additional costs borne by dealers involved in making surreptitious sales. Such costs ought to vary depending on the bulk of the product. For instance, industrial equipment should evoke higher costs in making surreptitious sales, compared to high value low bulk items like watches or cameras. Hence, markets for the latter types of products should

exhibit more relaxed enforcement policies as compared to heavy industrial equipment markets.

The other cause of eroded margins was the discounted price for bootlegged items. Surreptitious sales should be more difficult when customers feel more insecure about purchasing the product because its attributes are not readily inspected prior to purchase. A larger discount will be needed to generate these surreptitious sales. Thus, for product categories where experience and/or credence attributes dominate, we would expect manufacturers to be less tolerant of bootlegging.

*2.8.3. Long run commitments.* The parameter  $r$  accounts for the dealers' time value of money as well as the risk attached to the discontinuation of the relationship. A higher " $r$ " can be interpreted as indicating a less committed manufacturer. Previous studies have discussed long run commitments using similar notions; a larger "shadow of the future" (Axelrod 1984), and greater manufacturer "pledges" as perceived by the reseller (Anderson and Weitz 1992).

The sign of the comparative static ( $\partial\theta^*/\partial r > 0$ ) suggests the prediction that a higher " $r$ " (lower commitment) evokes a greater tolerance of bootlegging. The intuition is that the premium stream offered is less valued when " $r$ " is higher, thus enforcement is more expensive from the firm's point of view. The trade-off results in a higher policy limit.

One implication for managers is that newly established ETD systems should be enforced more tolerantly since the future course of the nascent relationships is more uncertain. This is somewhat counter-intuitive in that it might be thought that emerging channels are precisely those which should be enforced strictly in order to "set the tone". This latter argument is one-sided, however, and fails to account for the cost of creating self-enforced agreements.

Another implication is that efforts undertaken to lower resellers' perceptions of " $r$ " will be accompanied by stricter enforcement policies. Hence, attempts to bolster commitments via "pledges" and the like (Anderson and Weitz 1992) will be accompanied by stricter enforcement of assigned territories.

We have completed the analysis of the ETD system. We need to analyze the full intrabrand case before a comparative analysis of the two setups can be undertaken. We turn to this task below.

## 2.9. Analysis of Full Intrabrand Competition

Full intrabrand competition can arise in two ways. First, territorial restrictions may not be enforced at all which creates de facto intrabrand competition. Alternatively, territories may not have been assigned in the first place. In either case, the dealers will be faced with a prisoner's dilemma.

## 2.10. Dealer Nash Equilibrium

The focal dealer knows that the other dealer can sell in any territory with impunity. Given the lack of any sanction against such behavior, the only way a dealer can keep his customers from being stolen completely is to price so low that these sales are not attractive to the other dealer. Such competition leads to retail price equal to marginal cost:

$$q_c^* = p + \gamma. \quad (17)$$

Notice that the dealer's only option here is this price, as any price above cost will initiate unlimited bootlegging by their rivals. Applying the same logic to the other dealer, we find that both dealers will have the same price, and further, that price will be the wholesale price plus costs.

What happens to the provision of services? Notice that the dealer's margin on each additional sale is zero. Since dealers incur costs to provide services, they will offer no services at all. The intuition is that if either dealer were to offer some positive service

level, this would increase marketplace demand (because all customers can get that service level), but it would also increase his own costs. The focal dealer now requires additional profits to be able to cover this additional expense and still make normal returns. Unfortunately, since the other dealer can steal these customers via bootlegging, and avoid the costs of providing service himself, price will still be set according to (17). This drives the service level to zero in the intrabrand competition scenario. Collecting these results, we have:

$$s_c^* = 0. \quad (18)$$

### 2.11. Outcomes with Full Intrabrand Competition

From the previous section, we can see that each dealer is only covering his costs, i.e., zero economic profits are earned. Thus, there is no surplus to be shared between the manufacturer and the dealer. Hence, the fixed fee is driven to zero. The manufacturer solves:

$$\Pi_c = \text{Max } p: E\{[(1/2)(\delta - q_1^* - 2as_1^*) + (1/2)(\delta - q_2^* + 2as_2^*)](p - c)\}. \quad (19)$$

Substituting  $q^* = p + \gamma$ , and  $s^* = 0$  above, we get:

$$\Pi_c = \text{Max } p: E\{(\delta - p - \gamma)(p - c)\}. \quad (20)$$

Solving, and collecting results, we have the expected outcomes as follows:

$$p_c^* = (1/2)(\delta^e + c - \gamma^e), \quad (21)$$

$$F_c^* = 0, \quad (22)$$

$$\Pi_c^* = (1/4)(\delta^e - c - \gamma^e)^2, \quad (23)$$

$$q_c^* = (1/2)(\delta^e + c + \gamma^e), \quad (24)$$

$$s_c^* = 0, \quad (25)$$

where  $\delta^e$  and  $\gamma^e$  are the expected values of  $\delta$  and  $\gamma$  respectively. While interesting comparisons can be drawn between the wholesale and retail prices as well as service levels across the two-channel setups, our interest is focused on the relative profitability of the setups to the manufacturer. We turn to this task below.

### 2.12. Comparative Analysis of Channels

We can write the difference in the manufacturer's expected profits across the two-channel options as Equations (16)–(23):

$$\begin{aligned} \Pi_{ET}^* - \Pi_c^* = & [8b^4(-\sigma_\delta^2 - \sigma_\gamma^2)r^2(1/2(2b - a^2)^2) + b^2r(\sigma_\delta^2 + \sigma_\gamma^2) \\ & + (a^2b/2)(\sigma_\delta^2 + \sigma_\gamma^2) + (a^4/4)(\delta^e - \gamma^e - c)^2 + b\epsilon r(2b - a^2) \\ & \times (-\delta^e + c + \gamma^e) + (b\epsilon r)^2 + b\epsilon^2 r(3b - a^2) + (1/2)b\epsilon^2(2b - a^2)] / \\ & [(4b^2r + 2a^2b - a^4)]. \quad (26) \end{aligned}$$

The comparative statics of this equation can be used to determine the influences on the firm's decision to deploy ETD versus permitting full intrabrand competition.

### 2.13. Influences on the ETD Deployment Decision

The fundamental insight from Equation (26) is that neither ETD nor full intrabrand competition among dealers dominate one another from the manufacturer's perspective. Depending upon the situation, ETD may or may not be preferable to full intrabrand competition. As before, we examine the relevant comparative statics to obtain greater insight into this decision. The comparative statics from equation (26) are reported in Appendix 3.

2.13.1. *Importance of reseller services.* Recall service effects operate through the “*a*” and “*b*” parameters. A larger “*a*” or smaller “*b*” denotes stronger service effects. We see that as services becomes more valuable, the firm is increasingly better off deploying ETD ( $\partial(\Pi_{ETD}^* - \Pi_c^*)/\partial a > 0$ ;  $\partial(\Pi_{ETD}^* - \Pi_c^*)/\partial b < 0$ ).

This prediction is consistent with the conventional wisdom about the desirability of ETD as a mechanism to induce resellers to provide services (e.g., Stern and El-Ansary 1992). Absent any assignment of territories, and some enforcement, the prisoner’s dilemma facing the dealers would drive the services to a zero level.

Note that our analysis expands the scope of the traditional argument. The extant work (e.g., Mathewson and Winter 1986) holds that customers obtain services from one reseller, but then purchase from another reseller who offers no services. Klein and Murphy (1988) contend that such an argument holds only for those circumstances where the customer can tell prior to purchase that the relevant services have indeed been provided. Suppose we consider some service attribute that is not readily ascertained prior to purchase by the customer.

For instance, in the distribution of beer, a major issue is the freshness of the stock. Absent open-dating, this product attribute is not readily verifiable by the customer prior to purchase. Even though an ETD setup protects the beer wholesaler from other wholesalers stealing his business by offering lower prices sans services, it does not offer any improved incentive to rotate stock to the desired extent. He can continue to shade on his obligation. This was a major issue in the Coors case involving transshipping (Jordan and Jaffee 1987) by beer wholesalers.

In contrast, our implicit agreement provides a safeguard against shading for these types of reseller services as well. Since manufacturers can tell (albeit with a lag) when shading has occurred; our enforcement policy provides an appropriate safeguard. The presence of the premium stream (or quasi-rent) creates an incentive for the reseller to stay within the policy limit.

2.13.2. *Margin erosion on bootlegged sales.* Recall that  $\epsilon$  was interpreted as the increased costs due to surreptitious behavior, and/or the price discounts on bootlegged sales. According to the comparative static, larger values of  $\epsilon$  lead to lower profits for ETD systems as compared to full intrabrand competition ( $\partial(\Pi_{ETD}^* - \Pi_c^*)/\partial \epsilon < 0$ ).

In other words, as resellers find it increasingly difficult to make these surreptitious sales, the desirability of ETD *decreases* relative to intrabrand competition. This is somewhat counter-intuitive, and the reasoning behind it involves the influence of reseller services. Our ETD results indicated that the equilibrium level of services offered ( $s^*$ ) increases with  $\epsilon$ . This makes it more attractive for the dealer to bootleg. In the first place, there is a higher per unit margin. Furthermore, additional demand is stimulated by the higher service level. Thus, the manufacturer has to pay out more in the form of the premium to control bootlegging. The net effect is to diminish the relative profitability of ETD.

2.13.3. *Long run commitments.* The comparative static for  $r$  suggests the prediction that greater commitment to the channel leads to relatively greater profits with ETD ( $\partial(\Pi_{ETD}^* - \Pi_c^*)/\partial r < 0$ ). When a manufacturer can convince their dealers that she is in for the long haul, she is better able to deploy ETD because smaller premiums suffice to control bootlegging.

This is particularly significant in deploying ETD channels in a new market. Since the firm has not yet established a reputation in the market, she would face a high “ $r$ ” value unless she works hard to convince the resellers of her long run expectations of continuity and commitment to the dyad. As Anderson and Weitz (1992) have demonstrated, the means of accomplishing this includes “pledges” and other forms of bonding activities. The desirability of lowering “ $r$ ” is a significant result in that we are able to link “soft”

contracting variables like “pledging” and relationship building to profitability. Studies in the behavioral and empirical literature have demonstrated that firms spend considerable attention and effort to these activities. Yet, their causal links to profits have not been clearly delineated.

2.13.4. *Resellers’ information superiority.* The superiority of the dealers’ information about local conditions is captured by the variance of  $\delta$  and  $\gamma$ . Examining the comparative statics with respect to  $\sigma_\delta^2$  and  $\sigma_\gamma^2$ , we find that the effects of these downstream demand and cost uncertainties on ETD deployment are somewhat complex.

Rey and Tirole (1986a) found that as these uncertainties became larger, ETD was increasingly more profitable than intrabrand competition. Their intuition was that when these uncertainties are relatively larger, ETD resellers can capitalize on unexpected changes in demand and/or retail cost by changing their prices, without being constrained by intrabrand competition from other dealers.

Our predictions modify the Rey and Tirole results. Our comparative statics ( $\partial(\Pi_{ETD}^* - \Pi_c^*)/\partial\sigma_\delta^2$  and  $\partial(\Pi_{ETD}^* - \Pi_c^*)/\partial\sigma_\gamma^2$ ) are positive only when  $r < 0.5$ . If  $r > 0.5$ , these could be either negative or positive. In other words, greater downstream uncertainties favor ETD over intrabrand competition *only when the long run commitment is strong enough* (i.e., low  $r$ ).

The intuition is that greater downstream uncertainty makes it even more valuable to allow the ETD dealer to capitalize on changing circumstances. However, this prospective benefit could be readily eroded by bootlegging. Unfortunately, the premium stream needed to control bootlegging becomes larger when the potential profit from bootlegging is larger. Dealers must perceive a long run commitment to the ETD system by the firm so as to reduce the premium sufficiently.

This result is quite significant in that it challenges the conventional wisdom about vertical restraints leading to more centralization. Notice that ETD is beneficial because it permits the firm to *decentralize* the retail price and service decisions in response to changing local circumstances. Except for Rey and Tirole (1986a), the extant work has tended to focus on the centralization advantages accruing from vertical restraints such as assigned territories.

### 3. Conclusions and Limitations

While the specific results of the analysis have been discussed in the previous section, we need to place them in a broader context. In Table 1, we have collected the substantive results from our model. The utility of a formal model is readily evident from the multiple implications that flow from the analysis. Some of the results like the contingent effects of downstream uncertainties are clearly not realizable without such a model.

Taken together, considerable insight has been obtained from our analysis which goes well beyond the extant work. We turn now to a discussion of the broader implications of the work.

#### 3.1. Theoretical Issues

From a theory-building perspective, the principal conclusion is that it is possible to model imperfectly enforceable agreements. While imperfect agreements are a core aspect of all TCA work, very few studies have offered formal models. Formalization affords the ability to sharpen the argument, and to distinguish it from related arguments. For instance, we saw that reseller services were implicated in previous ETD studies, but the current model differs from these studies in that the services in question need not be verifiable by the customer prior to purchase.

Most significantly, our work extends TCA in that this is the first formal analysis to accommodate violations of implicit self-enforced agreements in equilibrium. Breaches up to the policy limit were expected to happen routinely, and were tolerated indefinitely.

TABLE 1

Exogenous Parameter	Effect on Enforcement of ETD	Effect on Relative Profitability of ETD
Importance of reseller services	Stricter	More profitable
Margin erosion on bootlegged sales	Stricter	Less profitable
Long run commitment to ETD (smaller "r")	Stricter	More profitable
Resellers' superior information	No Effect	More profitable with greater long run commitment ( $r < 0.5$ )

The current work also offers a very different conceptualization for the existence of cheating. The need to limit the costs of self-enforced agreements are the issue, rather than the difficulty of detection of violations or the costs of legal action. Recall that termination could only occur with a lag, and third party enforcement of specific performance was ruled out. Our analysis focuses on the opportunity costs of enforcement rather than positing cost functions for detection and legal action.

Of course, the question arises whether our perspective on bootlegging is a robust one. Recall that our firm does not reach hitherto untapped customers by allowing the dealers to bootleg. In fact, the lower service levels induced by bootlegging would diminish demand. This contrasts with Banerji (1990), and Bucklin (1990) who offer models wherein bootlegging increases primary demand (and hence the possibility for price discrimination).

We can show that our basic conclusions would remain unchanged in such a revised formulation.<sup>12</sup> Bootlegging continues to be tolerated in equilibrium, and the policy limit will be affected in the same fashion by the factors identified previously. The intuition is that allowing for demand enhancement would only enhance tolerance of bootlegging. In this paper we deliberately took the most conservative position to draw attention to the pervasive nature of bootlegging. It changes our perception of the nature of bootlegging. It is a natural consequence of ETD, and should not be viewed as an aberrant or rare condition.

### 3.2. Managerial Issues

From a managerial perspective, we can summarize our insights into the following set of heuristics for deploying and managing ETD channels. ETD deployment serves to protect reseller services, and enables resellers to capitalize on their superior local information. These two factors are the principal drivers of the benefits of an ETD setup. However, ETD, like all other institutions, is imperfect. It brings along its own set of problems. In particular, bootlegging is intrinsic to ETD. In order to deploy ETD, the firm must craft a policy of *selective enforcement*. Neither complete enforcement nor reverting to full intrabrand competition is the answer when there is a need for reseller services, and/or the resellers possess superior information about local market conditions. The policy limit on tolerated bootlegging must take into account the importance of services, the level of difficulty involved in bootlegging surreptitiously, and resellers' perceptions of the manufacturer's long-run commitment.

### 3.3. Future Directions

It appears that the most pressing need for future work concerns the role of competition at the manufacturer level in addition to competition at the reseller level. Although text-

<sup>12</sup> We have worked out a model with primary demand enhancement effects. The details are available from the authors.

books dutifully note that channel arrangements must reflect customer, company, and competitor influences, our knowledge of competitive influences is very limited. Studies of interbrand competition effects on any type of vertical restraints are virtually nonexistent (see McGuire and Staelin 1983 for a notable exception). Yet, it is evident that interbrand competition is a powerful influence on channel arrangements in addition to the intrabrand effects studied here. Hopefully, future work will deal with this issue.<sup>13</sup>

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**Appendix 1**

*Strategy Table Analysis*

There are only three plausible levels of bootlegging a dealer can choose: (a) don't bootleg at all ( $b_0$ ), (b) bootleg up to the policy limit ( $b_\theta$ ), or (c) bootleg completely ( $b_c$ ). The first option only makes sense if the bootlegged price is lower than the dealer's cost. Otherwise, it makes sense to bootleg at least up to the policy limit. Furthermore, if a dealer was going to bootleg beyond the policy limit, then he should not stop at any intermediate level below the full extent ( $b_c$ ) since he is going to be terminated in the next period for exceeding the policy limit in the slightest.

Similarly, there are only three price/service strategies for dealers to consider: (a) choose price and service assuming the other dealer will not bootleg at all ( $d_0$ ), (b) choose price and service assuming the other dealer will bootleg up to the policy limit ( $d_\theta$ ), or (c) choose price and service assuming the other dealer will bootleg completely ( $d_c$ ).

The 81 resulting combinations of strategy choices facing the dealers are depicted in Table 2. Below, we rule out all but one cell as candidates for a Nash equilibrium.

*Argument 1.* The optimal response of any dealer to another dealer's strategy of bootlegging totally in their territory is for the focal dealer to price low enough to render bootlegged sales unprofitable. Any prospective

TABLE 2

Dealer 1	$d_0:b_0$	$d_\theta:b_0$	$d_c:b_0$	$d_0:b_\theta$	$d_\theta:b_\theta$	$d_c:b_\theta$	$d_0:b_c$	$d_\theta:b_c$	$d_c:b_c$
Dealer 2									
$d_0:b_0$	3	3	2	3	3	3	1	1	1
$d_\theta:b_0$	3	3	2	3	3	3	1	1	1
$d_c:b_0$	2	2	2	2	2	2	5	5	5
$d_0:b_\theta$	3	3	2	4	4	2	1	1	1
$d_\theta:b_\theta$	3	3	2	4	6	2	1	1	1
$d_c:b_\theta$	3	3	2	2	2	2	5	5	5
$d_0:b_c$	1	1	5	1	1	5	1	1	1
$d_\theta:b_c$	1	1	5	1	1	5	1	1	1
$d_c:b_c$	1	1	5	1	1	5	1	1	5

bootlegger facing a dealer pricing this way will not bootleg at all because he will lose money on all bootlegged sales. This rules out all cells denoted as 1 in Table 2 as plausible Nash equilibria. In all these cells, one or the other dealer is bootlegging completely. This leaves the cells with bootlegging less than or equal to the policy limit.

*Argument 2.* If the other dealer is going to bootleg into the focal dealer's territory up to or below the policy limit ( $b_\theta$  or  $b_0$ ), it is always more profitable for the focal dealer to price at  $d_\theta$  or  $d_0$  rather than  $d_c$ . This rules out all cells denoted 2 as possible Nash equilibria.

*Argument 3.* Consider any cell in which pricing is  $d_\theta$  or  $d_0$ . In these cases there is a positive margin on each unit bootlegged by a dealer who chooses to bootleg up to  $\theta$ . If the opposing dealer is pricing  $d_\theta$  or  $d_0$ , and not bootlegging above tolerated limits, a dealer should bootleg up to  $\theta$ . This rules out cells denoted 3 as possible Nash equilibria.

*Argument 4.* When dealers choose to bootleg up to  $\theta$ , the optimal price/service strategies for the other dealer are, by definition,  $d_\theta$ . This rules out cells denoted 4 as possible Nash equilibria.

*Argument 5.* Any dealer facing a dealer pricing low enough to render bootlegged sales unprofitable will not bootleg at all. This rules out cells denoted 5 as possible Nash equilibria.

We are left with just one possibility. This is the cell denoted 6. Here, both dealers price under the assumption that the other dealer will bootleg up to  $\theta$ . They also intend to bootleg themselves up to  $\theta$ . Is this a Nash equilibrium? We turn to this matter in §2.5.

## Appendix 2

### Comparative Statistics for ETD Enforcement Policy

Equation (12) describes the optimal policy limit size for self-enforced ETD systems. To understand the influences on the size of this policy limit, we take the comparative statics with respect to the parameters of interest, and sign it.

$$\begin{aligned}\partial\theta^*/\partial c &= -2b^2r/(2(4b^2r + a^2(2b - a^2))) < 0, \\ \partial\theta^*/\partial\gamma^e &= -2b^2r/(2(4b^2r + a^2(2b - a^2))) < 0, \\ \partial\theta^*/\partial\delta^e &= 2b^2r/(2(4b^2r + a^2(2b - a^2))) > 0, \\ \partial\theta^*/\partial\epsilon &= (-b(2b - a^2) - br(4b - a^2))/(2(4b^2r + a^2(2b - a^2))) < 0, \\ \partial\theta^*/\partial r &= [b(2b - a^2)2ba^2(\delta^e - c - \gamma^e) + (2b - a^2)^3b\epsilon]/[2(4b^2r + 2a^2b - a^4)^2] < 0, \\ \partial\theta^*/\partial a &= ab[(4b^2 - 4a^2b)r(-\delta + \gamma + c) + 4b^2r^2\epsilon + (2b - a^2)(6b - a^2)r\epsilon \\ &\quad + (2b - a^2)^2\epsilon]/(4b^2r + 2a^2b - a^4)^2 < 0, \\ \partial\theta^*/\partial b &= (-a^2/2)[(4b^2 - 4a^2b)r(-\delta + \gamma + c) + 4b^2r^2\epsilon + (2b - a^2)(6b - a^2)r\epsilon \\ &\quad + (2b - a^2)^2\epsilon]/(4b^2r + 2a^2b - a^4)^2 > 0.\end{aligned}$$

## Appendix 3

### Comparative Statics for ETD Profitability Relative to Intra-brand Competition

Equation (26) describes the profitability of ETD relative to intra-brand competition. To understand the various influences on the size of the profit difference, we take the comparative statics of this equation with respect to the various parameters of interest and sign them.

$$\begin{aligned}\partial(\Pi_{\text{ETD}}^* - \Pi_c^*)/\partial\sigma_\delta^2 &= [b(2b - 2br - a^2)]/[2(2b - a^2)^2] > 0 \quad \text{for } r < 0.5, \\ \partial(\Pi_{\text{ETD}}^* - \Pi_c^*)/\partial\sigma_\gamma^2 &= [b(2b - 2br - a^2)]/[2(2b - a^2)^2] > 0 \quad \text{for } r < 0.5, \\ \partial(\Pi_{\text{ETD}}^* - \Pi_c^*)/\partial\epsilon &= [2b^2\epsilon^2 + br(2b - a^2)(-\delta^e + \gamma^e + c) + 2ber(3b - a^2) \\ &\quad + b(2b - a^2)\epsilon]/(4b^2r + 2a^2b - a^4) < 0, \\ \partial(\Pi_{\text{ETD}}^* - \Pi_c^*)/\partial r &= \{(-16b^6r^2 - 8a^2b^4(2b - a^2)r)(\sigma_\delta^2 + \sigma_\gamma^2) - a^4b^2(2b - a^2)^2(\delta - \gamma - c)^2 \\ &\quad - a^2b(2b - a^2)^4(\delta^e - \gamma^e - c)\epsilon + 4b^4(2b - a^2)^2r^2\epsilon^2 + 2a^2b^2(2b - a^2)^3\epsilon^2r \\ &\quad - b(b - a^2)(2b - a^2)^4\epsilon^2\}/(4b^2r + 2a^2b - a^4)^2 < 0, \\ \partial(\Pi_{\text{ETD}}^* - \Pi_c^*)/\partial a &= \{r^3[-64ab^6(\sigma_\delta^2 + \sigma_\gamma^2)] + r^2[16ab^4(b - 2a^2)(2b - a^2)(\sigma_\delta^2 + \sigma_\gamma^2) \\ &\quad - 4ab^2(2b - a^2)^3(3b - a^2)\epsilon^2 + 8ab^3(2b - a^2)^3\epsilon(\delta^e - c - \gamma^e)]\end{aligned}$$



$$\begin{aligned}
& + r[4a^3b^2(2b - a^2)^3(\sigma_6^2 + \sigma_7^2) + 4a^3b^2(2b - a^2)^3(\delta^e - \gamma^e - c)^2 \\
& + 2ab(2b - a^2)^5(\delta^e - \gamma^e - c)\epsilon - 2ab(2b - a^2)^4(4b - a^2)\epsilon^2] \\
& + a^5b(2b - a^2)^3(\sigma_6^2 + \sigma_7^2) + a^5b(2b - a^2)(\delta^e - \gamma^e - c)^2 - ab(2b - a^2)^5\epsilon^2 \} / \\
& (4b^2r + 2a^2b - a^4)^2 > 0,
\end{aligned}$$

$$\begin{aligned}
\partial(\Pi_{\text{ETD}}^* - \Pi^*)/\partial b = \{ & r^3[64a^2b^5(\sigma_6^2 + \sigma_7^2)] + r^2[-16a^2b^3(b - 2a^2)(2b - a^2)(\sigma_6^2 + \sigma_7^2) \\
& - 8a^2b^2(2b - a^2)^3(\delta^e - \gamma^e - c)\epsilon + 4a^2b(2b - a^2)^3(3b - a^2)\epsilon^2] \\
& + r[-4a^4b(2b - a^2)^3(\sigma_6^2 + \sigma_7^2) - 4a^4b(2b - a^2)^3(\delta^e - \gamma^e - c)^2 \\
& + 2a^2(2b - a^2)^4(4b - a^2)\epsilon^2 - 2a^2(2b - a^2)^5(\delta^e - \gamma^e - c)\epsilon] + a^2(2b - a^2)^5\epsilon^2 \\
& - a^6(2b - a^2)^3(\sigma_6 + \sigma_7) - a^6(2b - a^2)^3(\delta^e - \gamma^e - c)^2 \} / (4b^2r + 2a^2b - a^4)^2 < 0.
\end{aligned}$$

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