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Garcia, Daniel

University of Vienna

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# Branding and Collusion in Vertically Differentiated Industries

Daniel Garcia*
University of Vienna

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**Abstract**

This paper presents a model of collusion in vertically differentiated industries where firms have the option to make their products distinguishable to consumers by attaching a brand. We show that if consumers' preferences are linear in the quality dimension and their beliefs satisfy a standard refinement, collusion is facilitated in the absence of brands. More precisely, we show that if collusion is feasible with brands it is also feasible without them.

Keywords: Collusion, Vertical Differentiation, Brands
JEL Clasification Codes:

## 1 Introduction

Brands allow consumers to relate current products with previous purchasing experiences. Consumers recognize different brands and attach different values to the consumption of otherwise identical products. It is well-known that in so doing, brands ensure firms to have the incentives to provide high quality products (see e.g. Tadelis (1999), Bar-Isaac (2003)) and allow them to profit

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from economies of scope when introducing new products (Hakenes and Peitz (2008), Andersson (2002)). In this paper we argue that brands may also foster competition in markets with vertically differentiated products that are subject to collusion.

In particular we show that if different firms offer products that are undistinguishable to consumers ex-ante but that differ in their quality ex-post, the threshold discount factor such that a collusive agreement is implementable in any (Perfect-Bayesian) Equilibrium satisfying a standard refinement criterion is lower than under distinguishable products. This result rests on two basic observations. First, if consumers can distinguish different products, every firm trades at a different price and so increasing the quantity produced by the lowest-quality firm reduces total profits at a constant rate equal to the ratio of willingness-to-pay for each product. If products are undistinguishable, however, all firms trade at the same price and, therefore, the marginal rate of substitution between profits is lower so that the Pareto Frontier expands. Intuitively, high-quality producers cross-subsidize low-quality sellers by allowing them to charge higher prices.

Second, price deviations if products are undistinguishable require consumers to form beliefs about the identity of the deviator. We restrict such beliefs to satisfy a standard refinement called *Intuitive Criterion*. Roughly speaking, a belief system satisfies the Intuitive Criterion if it puts zero probability on all types for which an off-the-equilibrium action is dominated by their equilibrium payoff. Thus, by appropriately crafting the agreement, firms may ensure that the deviator is believed to be a low-quality producer, reducing the profitability of such deviation. These two forces reduce the gain from deviating for all firms and, therefore, reduce the threshold discount factor that makes the agreement implementable.

This result provides a theoretical link between branding and collusion in vertically differentiated industries. This link has been found to exist in a number of Antitrust Cases. For instance, in the Spanish northern region of Asturias virtually all cider producers were part of a cartel until the late 90s[1]. Prices were publicly announced through local newspapers and fixed throughout the year and across sale points. The industry comprised many small producers offering their (heterogenous) products without any branding:

[1]Cider is one of the most popular beverages in this region, with an estimated per-person consumption of over 50 liters per year. For more details see the resolution by the Spanish Competition Authority 376/96, available at www.cncompetencia.es.

bottles had no labels in them and only the cork had an identification number with a code for the producer[2]. After the Spanish Antitrust Authority fined the producers for anticompetitive practices, the industry introduced labels in their bottles and different quality products sold at different prices.

This example is by no means unique. In many agricultural markets, producers use a *Collective Brand* based on their location or type of product. Collective Brands are equivalent to no Brands since consumers are unable to distinguish the behavior of different producers. In Loureiro and McCluskey (2000) they argue that Collective Brands are usually related to high prices and high-quality perceptions by consumers. Fishman et al. (2010) provides a model of reputation with intermediaries where firms may optimally choose to brand their product together as a way to induce high effort and higher prices. Our results provide another interpretation to these phenomena in terms of collusion rather than reputation vis-a-vis consumers, which may radically change its welfare effects[3]

The contribution of this paper is threefold. First, it is the first paper that studies the relation between collusion and vertical differentiation with imperfectly informed consumers. The literature on collusion with differentiated products starting with Jehiel (1992) and Friedman and Thisse (1993) has focused on games of perfect information where consumers know the location of each firm's product. Since consumers are unable to distinguish firms, they must form beliefs about the quality offered by suppliers. Second, it contributes to the policy debate on the effects of brands on competition by studying the relation between brands and collusion. It provides a rationale for Competition Authorities to promote the introduction of individual brands and to restrict the behavior of trade organizations producing under a *Collective Brand* in markets with vertically differentiated products. Finally, on a theoretical level, this model provides one of the few examples where the so-called unraveling results of disclosure of a vertical dimension by producers fails to hold[4]. In addition, it is the first signalling game where the off-the-equilibrium path beliefs that some agents hold depend naturally on an equilibrium object. In particular, consumers' beliefs about the identity

[2]Wholesale markets used 12-bottle boxes as their unit. These boxes had a label but were not easily recognized by consumers

[3]The use of Collective Brands in agricultural products has been subject ot debate in the recent rounds of the WTO negotiations.

[4]To the best of my knowledge the only paper where unraveling does not happen in the context of vertically differentiated producers and free disclosure is Janssen and Roy (2010)

of a deviator depends on the collusive agreement that is in place. This is natural since off-the-equilibrium beliefs that put positive weights on deviators' types whose equilibrium payoff is higher than their deviation payoff for any possible belief are ruled out. This condition depends on the equilibrium agreement and, therefore, firms may adjust the agreement in order to induce different beliefs about such deviators' identities.

The remaining of the paper is organized as follows. We first describe the baseline model with unit demand and homogenous consumers and sketch the analysis when consumers are certain of the quality supplied by each producer. Then we study the role of imperfect information and provide the main results. Finally, we discuss the robustness of these results to more general utility functions.

## 2 Model

We consider an industry populated by a number $n$ of long-lived players (firms) and a continuum of short-lived players (consumers). Firm $i$ supplies a good of certain quality $x_i$ at a constant unit cost $c_i$. We order firms so that $x_j > x_{j+1}$. In order to ease the exposition we shall assume that[5]

$$x_n \geq \max\{\frac{1}{2}x_1, \max\{c_j\}\}. \tag{1}$$

Each firm's quality is common knowledge among firms but is ex-ante unknown to consumers. Consumers derive utility $x_i - p_i$ if they buy from firm $i$ at a price $p_i$. Firms live forever and discount the future by $\delta < 1$. The stage-game is as follows. At the beginning of each period, firms observe the whole history of events and the realization of a random variable uniformly distributed in a (finite) interval. Firms simultaneously send a public message $b_{i,t} \in \{M_i, \emptyset\}$. If a firm has sent a message $b_{i,t'} = M_i$ in any period $t' < t$, then $b_{i,t} = i$. That is, the message is irreversible. We call this message a Brand. Once messages are observed, each firm decides whether to stay active in the period or not, and if they stay active they choose a price $p_{i,t}$. Inactive firms obtain zero payoffs and move again next period. Consumers then buy their preferred product given the information available to them. Let $Q_t$ be their choice, so that if $\sum_j Q_j \leq 1$.

[5]None of the results depend on this Assumption, but it greatly reduces the number of cases to consider.

## 2.1 Brands and Histories

A history for the firms up to period $t$, $h_t$ is a collection of firm's prices $\{p_{i,t}\}$, messages $\{b_{i,t}\}$, purchasing decisions $\{Q_t\}$ and realizations of the uncertainty $\{\omega_t\}$, with the normalization that if a price is not active at period $t$, $p_{i,t} = \infty$. If no firm has branded its product up to period $t-1$, consumers are unable to distinguish firms from each other. Thus $Q(h_t) = Q(h'_t)$ for all $h_t, h'_t$ such that $b_{i,s} = \emptyset$ for all $i$ and for all $s < s'$ and such that $h'_{t-1}$ can be written as a permutation of $h_{t-1}$ $p_{i,t} = p'_{i,t}$ for all $i$. In words, previous names do not matter without brands. If a firm has branded its product in some previous period $s < t$ and consumers have purchased from the firm in a period $s' > s$, then all future consumers will know the quality of the firm for sure. Further, I assume that once a firm has branded its product, consumers can identify the firm in any history so that I do not longer impose that purchasing decisions are independent of names.

# 3 Benchmark: Branded Collusion

If all firms have branded their product and qualities are known, this framework becomes a model of collusion with vertically differentiated firms. Let $\hat{\mathbf{q}}$ be the collusive agreement so that firm $i$ is active if and only if[6]

$$\sum_{j<i} q_j < F(\omega_t) \leq \sum_{j\leq i} q_j \tag{2}$$

Let $\mathbf{v^i}$ be the vector of profits in the continuation game after firm $i$ deviates. Since the punishment scheme is not the main objective of this paper, I shall leave it unspecified. For future reference notice that under Grim-Trigger Strategies, the highest-surplus creating firm gets the difference between its surplus and the second highest surplus while the others get 0. Let such payoff be $v$. Under Optimal Penal Codes, $\mathbf{v^i} = \mathbf{0}$ for all $i$. Finally, the IC constraints require that

$$\delta q_i(x_i - c_i) \geq (1-\delta)(x_i - c_i) + \delta v_i^i \tag{3}$$

for all $i$ and for all $j \neq i$. Let $\hat{\delta}$ be the lowest $\delta$ such that there exists $\hat{q}$ satisfying these IC constraints.

[6] Similar results can be obtained using market-sharing agreements.

# 4 Results without Brands

Next I consider the possibility of establishing collusive agreements without brands. The agreement can now be broken because a firm who is supposed to remain non-active stays active or because any given firm brands its product. As I will show later, the non-branding constraint is not binding if the inactive constraint is satisfied. This is because branding is punished contemporaneously in the pricing stage by the other firms.

## 4.1 Pareto Frontier

One of the key difficulties of establishing a collusive agreement under vertical differentiation stems from the shape of the Pareto Frontier. More productive firms have to give up more than one unit of their per-period profits for each unit of per-period profits that less productive firms get. It is well-known that this can be solved by allowing transfers between firms. In such a case, the optimal collective agreement requires the most productive firm to sell in every period and make transfers to all other firms so that their IC are satisfied. Since transfers across firms are not allowed, however, firms may avoid brands as a means for cross-subsidizing. Indeed, we show that firms competing without brands have a strictly larger feasible set of payoff vectors.

**Lemma 1.** *The set of feasible payoff vectors for the firms with brands is a strict subset of the set of feasible payoff vectors without brands.*

*Proof.* Let $q$ be the agreement without brands and $\hat{q}$ be the agreement with brands. Assume that for all firms $i = 1, 2, .., n-1$,

$$q_i(\sum_{j=1}^{n} q_j x_j - c_i) = \hat{q}_i(x_i - c_i) \tag{4}$$

it is enough to show that

$$q_n(\sum_{j=1}^{n} q_j x_j - c_n) \geq \hat{q}_n(x_n - c_n). \tag{5}$$

Substituting

$$\hat{q}_n = 1 - \sum_{i=1}^{n-1} \frac{q_i}{x_i - c_i}(\sum_{j=1}^{n} q_j x_j - c_i) \tag{6}$$

Hence, I show that

$$(1 - \sum_{i=1}^{n-1} \frac{q_i}{x_i - c_i} (\sum_{j=1}^{n} q_j x_j - c_i)(x_n - c_n) \leq q_n (\sum_{j=1}^{n} q_j x_j - c_n) \tag{7}$$

which can be rewritten as

$$1 - \sum_{i=1}^{n-1} \frac{q_i}{x_i - c_i} (\sum_{j=1}^{n} q_j x_j - c_i) \leq \frac{q_n}{x_n - c_n} (\sum_{j=1}^{n} q_j x_j - c_n) \tag{8}$$

This expression is equivalent to

$$\sum_{i=1}^{n} \frac{q_i}{x_i - c_i} (\sum_{j=1}^{n} q_j x_j - c_i) \geq 1 \tag{9}$$

for any $q_n$. Notice that since all $x_i - c_i > 0$, LHS is minimized by choosing $q_k = 1$ for any $k$ and in such case the condition is satisfied trivially. $\square$

## 4.2 Collusive Agreement

For a given equilibrium agreement $\mathbf{q}$, let $\mu(p)$ represent the beliefs that consumers have regarding the identity of a firm that offers its product at a price $p$. Consistency requires that if in a given period there is only one firm offering its product and chooses the equilibrium price $p^* = \sum q_j x_j$, $\mu(p^*) = \mathbf{q}$. Consumers must also make beliefs regarding non-deviators but I do not need to impose any structure on such beliefs. Let $\mu'(p)$ be the belief attached to the firm offering the equilibrium price if there is a competitor offering $p$[7] Let the continuation value of player $i$ be $\mathbf{v_i}$. The IC constraint is

$$\delta q_i (\sum q_j x_j - c_i) \geq (1 - \delta) v_i + \delta (p - c_i) \tag{10}$$

for all $p$ such that the deviating firm sells its product. Notice that for every $p$, there is a set of firms for which the deviation is dominated. I shall require that beliefs satisfy the Intuitive Criterion so that $\mu(p)$ puts zero weight on those firms. Formally, $\mu_i(p) = 0$ for all $i$ such that $\delta q_i (\sum q_j x_j - c_i) \geq$

[7] Throughout, and to save notation, I specify the beliefs in case that a single firm deviated. Beliefs could be extended to multiple deviations in the obvious way.

$(1-\delta)v_i + \delta(p - c_i)$. Finally, notice that given some off-the-equilibrium path belief, the highest price that a deviator can charge and still sell is.

$$\tilde{p}(\mu(p)) = \sum \mu_i(p)x_i - \min\{0, \sum(q_i - \mu_i'(p))x_i\} \tag{11}$$

Notice that if $\sum(q_i - \mu_i')x_i < 0$, the non-deviating firm becomes more attractive but since the price is fixed is offering a positive surplus that the deviating firm has to meet. On the other hand if $\sum(q_i - \mu_i')x_i > 0$, the non-deviating firm is offering negative surplus and will not sell but the deviating firm cannot charge a price above its surplus since consumers would prefer not to buy. Thus, the set of off-the-equilibrium-path beliefs induce a set of deviating prices that support themselves, as the set of solutions of such equation. Notice that

$$p_{min} = x_n - \min_{q,\mu'} \sum(q_i - \mu_i'(p))x_i = 2x_n - x_1 \tag{12}$$

belongs to the set since consumers know that the quality provided by the deviator is at least $x_n$ and that the other firm is no better than $x_1$. Condition (1) ensures that such a price is positive. Finally notice that a firm cannot gain by mimicking the equilibrium price since consumers get no surplus from buying to this firm.

## 4.3 Punishment Phase

To conclude the Section, we provide a construction of a strategy profile that implements harsh punishments for deviators, supporting an equilibrium without brands. Consider any deviation by firm $i$ at a price $p$. In the following period, the two most efficient firms brand their products. If one of them is the deviator, it is asked to sell in the first period at a negative price, equal in absolute value to its continuation payoff. Otherwise, the second most efficient firm $j$ prices at $v_{i^*} - (x_{i^*} + (x_j - c_j)$ and the other firm prices at $v_{i^*}$, while consumers buy from the most efficient firm. This is an equilibrium for any $v_{i^*} \in [0, v]$[8].

**Lemma 2.** *Any continuation payoff vector $v$ such that $v_{i^*} \in [0, v]$ and $v_j = 0$ for $j \neq i^*$ is implementable without brands.*

[8]Similar arrangements are possible for other punishments. For the purposes of this paper, however, it suffices to see that $\mathbf{v}_i = \mathbf{0}$ is implementable with or without brands.

## 5 Branded vs Non-Branded Collusion

Finally, I compare the relative efficiency of optimal agreements with brands and without brands.

**Proposition 3** (Main Result)**.** *For all belief systems $\mu(p)$ satisfying the Intuitive Criterion, $\delta^* < \hat{\delta}$*

*Proof.* To establish the result I show that if a given payoff vector is implementable with Brands it is also implementable without Brands and that the payoff vector is in the Interior of the Set. Thus, let $\pi$ be such a vector of equilibrium payoffs induced by some agreement $\hat{\mathbf{q}}$ implementable with Brands for a discount factor $\hat{\delta}$. Clearly $\pi$ is feasible without Brands by Lemma 1. Further, since $\hat{\mathbf{q}}$ lies in the interior of the $n-1$ dimensional simplex and so $\pi$ lies in the Interior of the Feasible Set. Notice that if $\pi$ is IC with Brands

$$\delta\pi_k \geq (1-\delta)(x_k - c_k) + \delta v_k^k \tag{13}$$

Since by Lemma 2 I can take $v^k$ to be the same with or without brands it suffices to show that the contemporaneous profits for $k$ if $k$ deviates do not exceed $x_k$. First, I specify an equilibrium strategy profile that deters deviations in the Branding stage. If a firm brands its product in any period $t$, the most efficient non-deviant firm becomes active and offers its product at a price $p = x_n$. Thus, the contemporaneous deviating payoff is at most $x_{i^*} - c_{i^*} - x_n \leq x_k$. If two non-deviant firms remain active, consumers buy from the deviator, thus deterring further deviations. Finally in the following period, the two most productive firms brand its product (if they had not done so up to now) and follow the strategies specified in the continuation after a price deviation. Now notice that if $p > x_1$, no consumer buys and so the deviation is dominated for all types. If $x_{k+1} < p \leq x_k$, and (13) holds, the deviation is dominated for all firms whose quality is higher than $k$. But then, if consumers have beliefs satisfying the Intuitive Criterion, $\mu_j(p) = 0$ for all $j \leq k$. Thus, consumers get negative surplus from the deviator and should not buy. Finally, if $p \leq x_n$, the deviation is dominated for all firms. Therefore, if $\pi$ is implementable for a discount factor $\delta$ with Brands, then $\pi$ is implementable without brands. Finally notice that since $\pi$ lies in the interior of the feasible set, there exists another IC payoff vector $\pi^*$, such that $\pi^* > \pi$. Thus, all IC constraints are relaxed and $\delta^* < \hat{\delta}$. □

The argument is rather simple. First, Lemma 1 implies that any payoff vector feasible with Brands is also feasible without brands. Second, if a firm has no incentives to deviate in the presence of Brands, it must be that its equilibrium payoff exceeds their single-period monopoly profits when consumers know its quality. Thus, any price deviation induces beliefs that put probability zero on those firms whose quality is above the price. But clearly, this leads consumers to abstain from buying from such a firm.

### 5.1 Branding and Beliefs

We have assumed throughout that Brands perse do not carry information, in the sense that consumers beliefs do not depend on the specific content of the Brand. That is, if a firm deviates in a given period and sends a message $b_{i,t} = M_i$, consumers beliefs about the identity of the firm cannot depend on her true identity *before any purchase has been made*. In this sense, Brands allow consumers to relate current producers with previous purchasing experiences. However, Proposition 3 would hold naturally if Brands have meaning. The reason is that the price that a firm can charge in such a case is at most its true quality, which is the price they charge with Brands.

## 6 Heterogenous Consumers and Elastic Demand

In this Section we study the limits of this results under more general preferences. Let $v(\theta, x)$ be the value that a consumer of type $\theta$ attaches to a good of quality $x$, with $\theta$ distributed according to $F(\theta)$. We shall assume that $v$ is increasing in both arguments and that it satisfies the standard single-crossing condition, so $v(\theta, x) - v(\theta, x') \geq v(\theta', x) - v(\theta', x')$. Further, we assume that the monopolist would choose to offer a single product[9].

Let $\theta(x)$ be the threshold consumer that maximizes profits of a firm offering a product $x$. Notice that $\pi(x) = (1 - F(\theta(x)))v(\theta(x), x)$. Notice that this function is convex in $x$ because of single-crossing and optimality of $\theta(x)$. The following result provides a Necessary Condition for Lemma 1 to hold.

[9]This assumption greatly simplifies the problem by allowing us to concentrate on collusive agreements represented by $q$.

**Lemma 4.** *The set of feasible payoffs with brands is a strict subset of the set of feasible payoffs without brands only if*

$$\begin{aligned}\sum q_i \pi(x) &= \sum q_i \max_{\theta_i}\{(1-F(\theta_i(x)))v(\theta_i, x_i) \\ &\leq \max_{\theta}(1-F(\theta))\sum q_i v(\theta, x_i)\end{aligned}$$

*for all* $q_i \in \Delta^n$

Clearly, if this condition is not met, there are payoff combinations that are reachable with Brands but not without them. Intuitively, Branding allows firms to choose their price to maximize individual profits, while without Brands firms are bound to choose the same price. If this loss exceeds the benefits of cross-subsidization, then the set of feasible payoffs without Brands is not a superset of the set of feasible payoffs without Brands. This renders the techniques used in the Proof of Proposition 3 invalid.

Finally, notice that a Sufficient Condition for 4 to hold is that these prices are constant, i.e., that the threshold consumer $\theta(x_i) = \theta$ for all $x_i$. In such a case, $\pi(x)$ is linear in $x$ and a straightforward modification of the argument presented in the Proof of Lemma 1 applies.

These conditions are very restrictive and, generically, they are met only by a linear function $v(\theta, x) = \alpha + \beta\theta x$ for some $\alpha \geq 0,\ \theta > 0$ . In the remaining of this Section I show that the result presented above extends to this utility function.

**Proposition 5.** *Suppose that* $v(\theta, x)$ *is linear. Then,* $\hat{\delta} > \delta^*$.

*Proof.* Since $v(\theta, x)$ is linear, for every $x$, the threshold consumer is $\theta = \theta^*$ and prices are $p(x) = v(\theta^*, x)$ is linear in $x$ and so $\pi(x)$ is also linear. An straightforward modification of Lemma 1 shows that if $\hat{\pi}$ is feasible with Brands it is also feasible without Brands. Suppose $\hat{\pi}$ is implementable at $\delta$ with Brands, then we have that

$$\delta\hat{\pi}_i \leq (1-\delta)\max_{p_i}\{p_i Q(p_i, p_j; x_i, x_j)\} + \delta v^i \tag{14}$$

for every $j \neq i$ and for every $i$, where $Q(p_i, p_j; x_i, x_j)$ is the quantity sold by firm $i$ given its price, and the price and identity of its competitor. Since $v$ satisfies the Single-Crossing Property, this deviation payoff is decreasing in $x_j$. Thus, the most restrictive of such constraints applies for the lowest-quality rival. It follows that $\max_p\{pQ(p, p_j; x_i, x_j\} \leq \max_p\{pQ(p, p_q; x_i, x_q\}$.

Finally, a modification of the argument presented in Proposition 3 implies that $\mu(p)$ must have zero probability on all firms $j$ such that $p \leq v(\theta^*, x_j)$. Again, by linearity, this implies that $Q(p, p_q; x_{\mu(p)}, x_q) \leq Q(p, p_q; x_j, x_q)$ for all $q$. Thus, these Constraints are also sufficient for the problem without Brands and the result follows. $\square$

# 7 Conclusions

In this paper we have provided a theoretical link between branding and collusion in vertically differentiated markets. Our main result is that collusion is easier to sustain without brands. The reason is twofold. First, if firms are undistinguishable to consumers, they can relax their incentive constraints by cross-subsidizing each other. Second, firms who deviate are punish by consumers who hold *intuitive* beliefs about the identity of deviators. Interestingly, in the present paper, as opposed to most of the literature, intuitive beliefs support a pooling equilibrium without disclosure. This is the main theoretical novelty of our work.

While cross-subsidization and punishments are likely to be present more generally, the techniques used in this paper crucially rely on a restriction on the utility function of consumers. By branding, different firms may position in a different price and quantity mix and, therefore, may obtain higher profits than without brands. Future work may shed light on the conditions in the utility function under which branding yields higher profits and facilitates collusion.

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