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The Economics of Collective Brands

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The Economics of Collective Brands

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Abstract

We consider the consequences of a shared brand name such as geographical names used to identify high quality products, for the incentives of otherwise autonomous firms to invest in quality. We contend that such collective brand labels improve communication between sellers and consumers, when the scale of production is too small for individual firms to establish reputations on a stand alone basis. This has two opposing effects on member firms' incentives to invest in quality. On the one hand, it increases investment incentives by increasing the visibility and transparency of individual member firms, which increases the return from investment in quality. On the other hand, it creates an incentive to free ride on the group's reputation, which can lead to less investment in quality. We identify parmater values under which collective branding delivers higher quality than is achievable by stand alone firms.

1 Introduction

Geographical names have been used to identify high quality products since ancient times. Corinthian wines, almonds from Naxos and Sicilian honey have been renowned for their quality since the 4th century BC (Bertozi, 1995). Other examples include Parma ham, California fruits, Jaffa oranges, and Washington apples. Some of these regional brands, such as spirits from Burgundy, Champagne, Chianti and Cognac are marketed individually by individual producers while others are marketed collectively, either by producer owned firms or by State Trading Enterprises (STEs). Two central features characterize these brands. First, their brand label are perceived as badges of superior quality by consumers who are willing to pay premium prices for them (e.g. Landon and Smith (1998) and Loureiro and McCluskey (2000, 2003)). Second, individual member - producers are generally autonomous firms, which make independent business decisions and retain their own profits, and only share a brand name.

The fact that collective brand labels are associated with superior quality suggests that firms which are members of these brands invest more to maintain brand quality than they would as stand alone firms (or at least are perceived to do so by consumers). This seems surprising. If consumers' perception of the collective brand label's quality is jointly determined by their experience with the qualities provided by different individual members, and if the provision of high quality requires costly investment, it would seem that each member has an incentive to free ride on the investments of fellow members. If so, why are these brand labels perceived as badges of quality?

It is true that in some cases, the perception of superior quality may be partly attributable to exogenous advantages such as climate, soil quality, access to superior inputs, technology and so on. However, even when such natural advantages are present the achievement of superior quality presumably also requires the requisite investment of effort and other resources. The free riding problem might also be mitigated to some extent by monitoring the efforts and investments of individual members to maintain quality standards. However, monitoring is costly and imperfect and is therefore unlikely to eliminate free riding altogether. Thus it would seem that producers have less of an incentive to invest in quality as members of a collective brand than they would as stand alone firms.

The purpose of this paper is to show that, despite the incentive to free ride, members of collective brands may nevertheless have a greater incentive to invest in quality than stand alone firms. Thus institutions like STE's, may increase welfare by providing consumers with better quality.

This has important implications for the current public debate concerning antitrust policy in the agricultural sector. For example, demands to ban STE's and limit regional branding have been voiced during recent rounds of the World Trade Organization negotiations on the grounds that these institutions reduce welfare and market efficiency by endowing their members with market power. Our analysis suggests that these institutions, by facilitating collective branding, can have positive welfare effects by promoting more efficient investment in quality.[1]

The idea is the following. When product quality is difficult to observe before purchase and is revealed to consumers only after consuming the product ('experience goods'), their perception of quality and the amount they are willing to pay for the product is based on past experience with the product - its reputation. Thus the extent to which a firm is able to receive a good return on its investment in quality depends on how well consumers are informed about its past performance. When information about past performance disseminates imperfectly, such as through word of mouth communication, the extent to which consumers are informed is likely to depend on the number of consumers who have experienced the product in the past. In particular, the smaller the firm the less informed it's customers are about its past quality. Small firms may therefore be unable to effectively establish individual reputations on their own and consequently will have little incentive to invest in quality. Here collective branding may come to the

[1] An alternative position expressed in defense of STE's is that they provide economies of scale in production and promotion.

rescue and serve as a vehicle for reputation formation by facilitating the transmission of information about quality to consumers.

Specifically, suppose individual firms which are too small to establish good reputations on their own market their products under a collective brand name, sharing a collective reputation, while otherwise retaining full autonomy. Since their collective brand name covers a larger segment of the market than that of any individual member firm, the customers of each individual member are more likely to have previously experienced or interacted with past customers of the same brand, albeit not with that particular seller. This 'reputation effect' of collective branding increases the value of a good reputation and hence may increase members' incentive to invest in quality even if brand membership has no effect on individual members' market share.

But as noted above, branding may also have an opposing effect on investment incentives. Unless the brand is able to effectively monitor individual investment, sharing a collective reputation may encourage individual members to free ride on the efforts of other members. Therefore the full effect of collective branding on investment in quality is determined by the interaction of these two opposing factors - the fact that, on the one hand, a good collective reputation is more valuable than a stand alone reputation, against the incentive to free ride, on the other.

Accordingly, we analyze the effects of branding in two polar cases. First, as a benchmark, we consider the case in which the brand can deter free riding by perfectly monitoring members' investments and expelling members which don't invest. We show that in that case, since only the reputation effect is operative, a brand member's incentive to invest is always greater than that of a stand alone firm. Moreover, the incentive increases with brand size (the number of firms which are members of the brand) - the larger the brand, the greater the incentive of each member to invest and therefore the more profitable membership is.

We find that, depending on parameter values, this pro - investment effect of collective branding can also extend to the case in which the brand is unable to monitor individual members' investment, overriding the incentive to free ride. In particular, collective brands deliver higher quality than stand alone firms if investment is a sufficiently important ingredient for the attainment of high quality - that is, if the difference between the expected product quality of a firm which invests in quality and one which doesn't is sufficiently large.

However, in contrast to the case of perfect monitoring, this is the case only if the brand is kept from getting too large. If too many firms are admitted to the brand, the incentive to free ride necessarily overrides the reputation effect and reduces the incentive to invest, relative to stand alone firms. This is because once the brand is sufficiently large, the marginal contribution of an individual member's investment to the brand's visibility and reputation becomes negligible, in comparison to the payoff from free riding.

In an econometric study of the determinants of reputation in the Italian wine industry, Castriota and Delmastro (2008) show that brand reputation is increasing in the number of bottles produced by the brand and decreasing in the number of individual producers in the brand. This is consistent with our analysis. Keeping output fixed, an increase in the number of individual producers has no reputation effect since the number of units whose quality consumers observe is unchanged. However, it does increase the incentive for free riding (which increases with the number of members), and hence lowers investment incentives and reduces the brand's reputation. Conversely, keeping the number of individual producers fixed, increasing output does not increase the incentive to free ride but does increase the reputation effect and hence increases incentives to invest.

Finally, our analysis suggests that a regional brand may be viewed as an institution to regulate the collective brand size, keeping the number of producers large enough to enable successful reputation building but small enough to discourage individual free riding on the brand name. Thus one might speculate that a regional brand like Champagne wines owes its success not only to unique soil and climate but also to fortuitous natural boundaries which encompass "just the right" number of producers under its brand label.

1.1 Relationship to the Literature

Our emphasis on the centrality of a firms' reputation for quality for its success connects with the large and growing literature on firm reputation with a similar emphasis, e.g., Klein and Leffler (1981) Shapiro (1982), Kreps (1990), Tadelis (1999), Mailath and Samuelson (2001), Horner (2002). Banerjee and Duflo (2000) and Gorton (1996) provide empirical evidence that firms with reputation behave differently from firms without it. All of those papers are concerned with the reputation of individual firms. By contrast, our focus is on the collective reputation of otherwise autonomous firms.

More directly related are papers which explore the relationship between firm size and incentives for reputation formation. These include Andersson (2002), Cabral (2000, 2007), Choi (1997), Dana and Speir (2006), who analyze the effect of expanding the firm's product line (umbrella branding) on its reputation and profit, Cai and Obara (2006), who analyze the effect of horizontal integration on the integrated firms' cost of maintaining its reputation, Rob and Fishman (2005), who show that a firm's investment in quality increases with size, Yacouel (2005) and Guttman and Yacouel (2006), who show that larger firms benefit more from a good reputation. All those papers are concerned with size effects on incentives of an individual firm governed by a centralized decision maker. By contrast, our concern is with the effect of changing the number of member firms of fixed size, each governed by a distinct and autonomous decision maker.

The most closely related literature is the literature on collective reputation, beginning with Tirole (1996). He analyzes how group behavior affects individual incentive to invest (behave honestly). Evans and Guinnane (2007) analyze the conditions under which groups of heterogenous producers can create a common reputation and show that a common reputation can be created only if the members are not too different from each other and if marginal costs are declining. In these papers the group's size is fixed exogenously. By contrast, our focus is precisely on the role of the group size on individual incentives and, in particular, to compare a firm's incentives when standing alone with its incentives as a brand member.

There are also similarities between our approach and the common trait literature (for example Benabou and Gertner, 1993, Fishman 1996), in which observation of one agent's behavior reveals information about a common trait which she shares with other agents in the group. While in that literature the size of the group and the common trait itself are exogenously given, our focus is to understand how inferences about the common trait affect incentives to join the group, and motivate reputation formation.

2 Model - Stand Alone Firms

We consider a market for an experience good - consumers observe quality only after buying, but not at the time of purchase. There are two periods,[2] N risk neutral firms and we normalize the number of consumers per firm to be 1. There are two possible product quality levels, low (l) and high (h). A consumer demands at most one (discrete) unit at each period. Her utility from a unit of low quality is zero and her utility from a unit of high quality is 1. Firms are of two types, H and L, which are distinguished by their technological ability to produce high quality. The probability with which a firm is able to produce high quality depends on its type and whether or not it invests in quality. An L firm produces high quality with probability b whether or not it invests. An H firm produces high quality with probability b if it does not invest but if it invests, it produces high quality with probability $g > b$. All units produced by a firm at any period are of the same quality. The proportion of H firms is f.

Investment is "once and for all": Prior to period 1, each firm decides whether or not to invest and that investment determines the quality of the products it sells at every future period[3]. The cost of investment is fixed at e.[4] We assume that $g - b \geq e$, so that

[2]It will be apparent that the qualitative properties of the model extend straightforwardly to any horizon length, an extension which would complicate algebra and notation without adding insight. The intuition of our analysis should also apply to a repeated game setting in which current quality depends only on current investment.

[3]This captures the idea that investment decisions are relatively inflexible in comparison to prices, which are easy to change.

[4]One could consider a richer model in which the probability of high quality is an increasing function

investment is efficient.

Each consumer is in the market for one period and has a demand for one unit at the most and exits the market at the end of the period. Consumers cannot directly observe a firm's type (whether it is H or L) and are also unable to observe if a firm has invested or not. At period 1, consumers' only information about firms is the prior, f. At the beginning of period 2, each period 2 consumer is informed (through interaction with consumers of the previous generation) about the realized quality of each firm at the preceding period.[5] This information is used to update her expectations about firm quality at the second period.

In order to focus on the reputational effects of collective branding on investment incentives in the most direct possible way, it is convenient (though completely inessential for our main results) to assume that firms have monopolistic market power; That is, if consumers' expected utility from a unit of firm i is v_i, the price of firm i is v_i.[6] Thus branding cannot affect firms' pricing power or market share, and can only affect firms' investment incentives via reputational considerations.

A Bayesian Equilibrium specifies for each firm whether or not it invests and its price at each period, possibly as a function of previous quality realizations. Trivially, there always exists an equilibrium in which no firm invests[7].

The more interesting possibility is the existence of an 'investment equilibrium' (IE)

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of the amount invested. In that case, the intuition of our analysis suggests that whenever collective branding increases investment incentives, the brand invests more than stand alone firms and delivers higher expected quality.

[5] A more general formulation is that a consumer is informed about the first period quality of $\alpha \leq N$ randomly selected firms. This would complicate algebra but would not alter our basic results.

[6] This could be because consumers have high transportation costs which effectively endows firms with local monopoly pricing power. Alternatively, consider a standard consumer sequential search market setup: A consumer knows only the price distribution but not which firm charges what price, is randomly and costlessly matched with one firm and can either buy from that firm or sequentially search for other firms, incurring a positive search cost at each search. As is well known, these assumptions imply that firms have monopoly pricing power (Diamond, 1971).

[7] In this equilibrium consumers believe that no firm invests, which makes it optimal for firms not to invest.

in which H firms invest (L firms obviously don't invest in any equilibrium since investment has no effect on their quality). How are prices determined in such an equilibrium? At the first period consumers have no information which can enable them to distinguish between firms. Therefore the expected utility from the product of any firm is $fg+(1-f)b$ which is therefore the equilibrium price of each firm. At the second period consumers update their beliefs on the basis of the firms' realized quality at the preceding period (recall that consumers observe the first period quality realization of each firm).

Let $\Pr(H \mid h)$ be the posterior belief at period 2 that a firm is type H given that it produced high quality at period 1 and let $\Pr(H \mid l)$ be the posterior belief at period 2 that a firm is type H given that it produced low quality at period 1. Then by Bayes' Rule,

$$\Pr(H \mid h) = \frac{gf}{gf + b(1-f)}.$$

$$\Pr(H \mid l) = \frac{(1-g)f}{(1-g)f + (1-b)(1-f)}.$$

Thus the second period price of a firm which produced high quality at the first period, p_h, is

$$\begin{aligned} p_h &= g\Pr(H \mid h) + b\Pr(L \mid h) = g\Pr(H \mid h) + b(1 - \Pr(H \mid h)) \\ &= b + (g-b)\Pr(H \mid h) = b + \frac{(g-b)gf}{gf + b(1-f)}. \end{aligned} \tag{1}$$

The second period price of a firm which produced l at the first period, p_l, is

$$\begin{aligned} p_l &= g\Pr(H \mid l) + b\Pr(L \mid l) = g\Pr(H \mid l) + b(1 - \Pr(H \mid l)) \\ &= b + (g-b)\Pr(H \mid l) = b + \frac{(g-b)(1-g)f}{(1-g)f + (1-b)(1-f)}. \end{aligned} \tag{2}$$

Let R be the expected second period revenues of an H firm that invests and R_{-1} the expected second period revenues of an H firm that doesn't invest. Then, since its probability of producing high quality is g if it invests and b if it doesn't,

$$R = gp_h + (1-g)p_l$$

and

$$R_{-1} = bp_h + (1-b)p_l.$$

An H firm's expected gain from investment is $\overline{e}_1 \equiv R - R_{-1}$. By (1) and (2):

$$\overline{e}_1 = (g-b)^2 \left[\frac{gf}{gf + b(1-f)} - \frac{(1-g)f}{(1-g)f + (1-b)(1-f)} \right] \tag{3}$$

Since e is the cost of investment, when firms stand alone an IE exists if and only if $e \leq \overline{e}_1$.

A stand - alone firm has only a limited opportunity to establish a reputation for quality, since at period 2 consumers have only limited information about its past quality - one observation in our formulation. Hence if $e > \overline{e}_1$ an IE does not exist because the cost of investment exceeds the individual firm's expected return from maintaining a good reputation.

We proceed to show below that collective branding can lead to higher quality by increasing the incentive to invest and thus expanding the range of investment costs for which an IE exists. That is, if two or more firms sell their product under a common brand name, an IE may exist even when it does not exist if firms stand alone.

3 Collective Branding

We define a *'high quality $m-$ brand'* as a group of $m > 1$ type H firms which market their products under a common brand name, while retaining full autonomy with respect to all business decisions and retaining their own profits. In particular, members of the brand decide individually whether or not to invest in quality. A *'low quality m brand'* is defined analogously for m type-L firms[8]. We do not explicitly model the process of brand formation or what determines which firms are admitted to its ranks. However, we are implicitly assuming that the high quality brand can discern firms' type and thus admit only high quality firms into its ranks. Indeed, it would never be profitable for H firms to admit any L firms since the latter can only dilute the collective reputation of the former by lowering average quality.

[8]Since investment has no effect on L firms' quality, those firms form brands for a different reason than H firms. Specifically, if consumers can distinguish the number of firms in an H brand, L firms which do not form brands of the same size as those of H firms could be directly identified by consumers as L firms on the basis of brand size alone. In that case L firms are motivated to form separate brands (of equal size) to 'pool' with H firms in the size dimension.

Consumers evaluate a firm's quality on the basis of their experience with the brand label which it carries and not only on the basis of its own past performance. That is, we assume that a consumer who observes the qualities of j units from the same brand label, whether from the same firm or from different firms, forms her belief about the expected quality of any firm associated with that brand on the basis of all j observations. More precisely, suppose that all members of H brands invest. Then a consumer who observes that h members of a brand produced high quality at the first period and $m-h$ produced low quality, believes that the brand is of the high quality type with the probability

$$\Pr(H \mid h, m) = \frac{g^h(1-g)^{m-h}f}{g^h(1-g)^{m-h}f + b^h(1-b)^{m-h}(1-f)}. \tag{4}$$

Thus collective branding provides consumers with more information about individual brand members' expected quality than if those firms stood alone (i.e., owned distinct individual brand names) because instead of getting only one observation of quality per firm, a consumer now effectively gets m observations for each member of the brand. Therefore the reputation of the brand affects the profit of its members more than their stand alone reputation would. Specifically, if all members of a brand produce high quality, consumers are willing to pay a higher price to each brand member than if each member produced high quality as a stand-alone firm. Conversely, if all members of the brand deliver low quality, consumers are willing to pay less for the brand name than they would be willing to pay each firm if it produced low quality on its own.

Formally, the expected second period price of a high quality $m-$ brand which produced h high quality units at the first period, p_h^m, is,

$$\begin{aligned} p_h^m &= g\Pr(H \mid h, m) + b\Pr(L \mid h, m) = g\Pr(H \mid h, m) + b(1-\Pr(H \mid h, m)) \\ &= b + (g-b)\Pr(H \mid h, m). \end{aligned} \tag{5}$$

As we show below the preceding implies that a good brand reputation is more valuable to its members than a good stand alone reputation and that members of a collective brand have a greater incentive to invest in quality than stand alone firms. We call this the *reputation effect* of branding. However, brand membership may also have a countervailing effect by motivating firms to free ride on other members' investment. The effect of collective branding on investment thus depends on the interaction of these opposing effects. Branding increases incentives to invest and leads to higher quality if the reputation effect dominates but can lead to lower quality if the free riding effect dominates. Our purpose in the following analysis is to determine the conditions under which brands have a greater incentive to invest in quality than stand alone firms, and to determine the effect of the brand size (the number of firms which are members of the brand) on incentives to invest.

In what follows we shall mainly be concerned with high quality brands and so the term 'm brands' will refer to high quality brands unless otherwise indicated.

Analogously to the stand alone setting, we define a *m Brand IE* as an equilibrium in which *each* member of the brand invests. Such an equilibrium exists if and only if (i) given that every other member invests, investment is individually optimal for each brand member (ii) it is more profitable for a firm to be a member of the brand (and invest) than to stand alone.

More formally, in analogy to the stand alone setting, let R^m be the expected second period revenues of an individual member of a high quality *m-brand* when every member invests, let R^m_{-1} be the expected second period revenues of an individual member when it alone does not invest but all other members do invest, and let $\Pr(h \mid H, m)$ be the probability that the brand produces h high quality goods when all the firms invest. Then:

$$R^m = \sum_{h=0}^{m} \Pr(h \mid H, m) p^m_h \tag{6}$$

and

$$R^m_{-1} = (1-b) \sum_{h=0}^{m-1} \Pr(h \mid H, m-1) p^m_h + b \sum_{h=0}^{m-1} \Pr(h \mid H, m-1) p^m_{h+1}.$$

In a *m Brand IE,* a firm's return from investing as a brand member, $R^m - e$, must exceed the return from free riding, R^m_{-1}, and exceed the return from standing alone, $max\{R_{-1}, R-e\}$. Thus a *m Brand IE* exists if and only if:

$$R^m - e \geq max\{R^m_{-1}, R_{-1}, R-e\}.$$

Let $\overline{e}_m$ satisfy the preceding inequality with equality:

$$\overline{e}_m = R^m - max\{R^m_{-1}, R_{-1}, R - \overline{e}_m\}. \tag{7}$$

That is, $\overline{e}_m$ is the largest investment cost for which a m *Brand IE* exists. Thus $\overline{e}_m$ measures the incentive to invest - the larger is $\overline{e}_m$ the greater the incentive to invest. Thus a firm has a greater incentive to invest as a member of a m brand than as a stand alone firm if $\overline{e}_m > \overline{e}_1$. Our goal is to determine when branding leads to higher investment, i.e., when $\overline{e}_m$ is larger than $\overline{e}_1$.

We shall consider separately two distinct cases. In the first case, called '*perfect monitoring'*, free riding is precluded by an internal monitoring mechanism which can perfectly discern whether or not members invest and expels those which don't from the brand (thus preventing those firms from marketing their products under the brand label). In that case, free riding is not an option and so incentives to invest are driven by the size effect only. In the second case, '*no monitoring*', the brand is unable to monitor its members and prevent them from free riding.

3.1 Perfect Monitoring

Suppose that the brand can perfectly monitor its members' investment and expel firms which don't invest from the brand. The following proposition states that in that case the incentive to invest increases with the brand size, m; that is, $\overline{e}_m$ is strictly increasing with m.

Proposition 1 *Under perfect monitoring,* $\overline{e}_m$ *is strictly increasing with* m*.*

Thus under perfect monitoring, collective branding leads to higher quality by facilitating the existence of an IE when it could otherwise not exist. The intuition is the following. Under perfect monitoring there is no opportunity to free ride so only the reputation effect is operative. But that effect increases with brand size because the larger the brand, the more observations consumers receive about the brand's type. Therefore, given that the brand is type H and that all members invest, the larger the brand the more positive signals consumers receive on average and therefore the higher the price they are willing to pay for that brand label. Therefore, under perfect monitoring, members of a collective brand always have a greater incentive to invest than stand alone firms. Moreover, this incentive is greater the larger the brand.

3.2 No Monitoring

More realistically, the brand is unable to perfectly enforce investment by individual members. Therefore, we now consider the other extreme case, in which each brand member decides on its own whether or not to invest and that decision is undetectable by other brand members. We've seen that under perfect monitoring, branding increases the incentive to invest. This is not always the case without monitoring because of the incentive to free ride. We proceed to derive the conditions under which the reputation effect overrides the incentive to free ride so that branding also leads to higher quality even in the absence of monitoring.

We first note, as shown in the appendix,[9] that R^m and R^m_{-1} are increasing in m. Therefore, $R^m \geq R$ and $R^m_{-1} \geq R_{-1}$; that is, if there is no monitoring brand membership is more profitable than standing alone, whether the firm chooses to invest or not. Thus, by equation (7),

$$\overline{e}_m = R^m - R^m_{-1}.$$

The following proposition characterizes parameters for which collective branding increases investment incentives relative to stand alone firms. In particular, collective branding leads to greater investment incentives if the difference between the expected quality of a firm which invests and one which doesn't is sufficiently large and/or if the proportion of H firms in the firm population is sufficiently small.

Proposition 2 *(i) Given b and $f > 0$, there is $g^* < 1$ such that if $1 \geq g \geq g^*$, then there is $m' > 1$ such that $\overline{e}_{m'} > \overline{e}_1$.*

[9] The proof that R^m is increasing in m is in the proof of Proposition 1. The proof that R^m_{-1} is increasing is analagous.

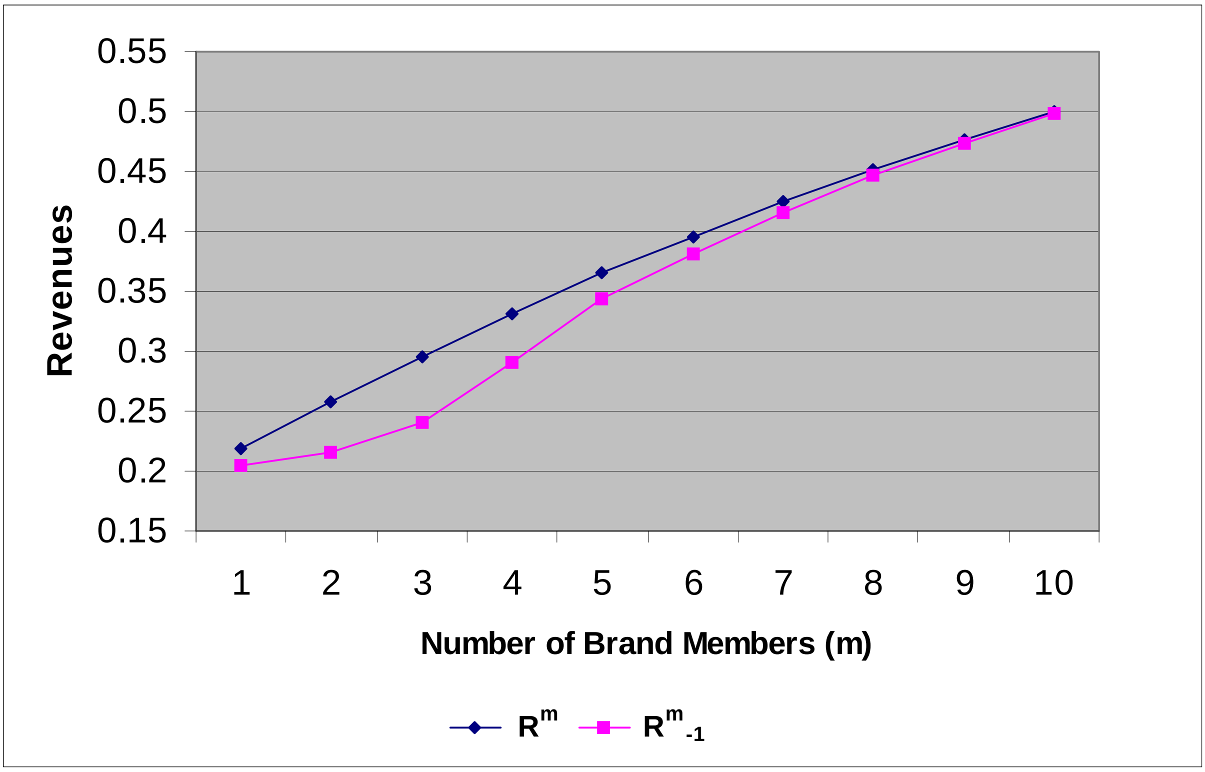

Figure 1:

(ii) Given b and g, there is $f^* > 0$ such that if $0 < f \leq f^*$ then there is $m' > 1$ such that $\overline{e}_{m'} > \overline{e}_1$.

(iii) In every case, if $g < 1$, $\overline{e}_m < \overline{e}_1$ if m is sufficiently large

In words, if g is relatively large or f is relatively small, there is a brand size for which each member has a greater incentive to invest than a stand alone firm. However, in contrast to the perfect monitoring case, part (iii) of the proposition states that unless $g = 1$, if the brand is sufficiently large, the collective brand's incentive to invest is lower than that of stand alone firms.

The proposition is illustrated in the figure, where R^m and R^m_{-1} are sketched for the parameters $b = 0.2$, $g = 0.95$ and $f = 0.2$. For these parameters, $\overline{e}_1 = 0.015$, which in the figure is represented by the vertical distance between R and R_{-1}, at $m = 1$. For $m = 2, 3, 4, 5$ and 6, $\overline{e}_m > \overline{e}_1$ (where $\overline{e}_m$ is represented by the distance between R^m and

R^m_{-1}). Thus, for example if $e = 0.02$, a stand alone firm would not invest but a brand of size between 2 and 5 would invest even in the complete absence of monitoring. Again, if $e = 0.02$, and the brand has 6 or more members, it will not invest because free riding dominates the reputation effect.

The key to understanding the intuition behind the Proposition is that $R^m - R^m_{-1}$ reflects the adverse effect of a *single* low quality observation on the brand's reputation. Consider first the extreme case where $g = 1$; that is, if an H firm invests, it produces high quality with certainty. In that case, if the brand produces even a single low quality unit, consumers will believe that the brand is type L (with probability 1) regardless of how many high quality units it produces and be unwilling to pay it more than b. On the other hand, if all members invest, the consumers' posterior probability that the brand is type H, and hence the price they are willing to pay, increases with brand size. Thus when $g = 1$, the loss from unilateral shirking always increases with m and therefore the larger the brand size, the greater the incentive to invest.

If $g < 1$ but still close to 1, a low quality observation still has a large effect on consumers' posterior if the brand is not too large. However, this effect becomes negligible once the brand becomes very large. Thus branding still delivers greater investment incentives than stand alone firms provided the brand size is not too large.

By contrast, if g is small consumers expect a large number of low quality units even when all brand members invest. Therefore, the marginal effect of one additional low quality unit on consumers' posterior is small. Hence, when g is relatively small the incentive to invest is correspondingly small.

Similar reasoning applies with respect to f; the lower is the prior that the brand is H, the greater the adverse effect of a single low quality observation on the posterior probability. Hence, if f is small, the expected damage from unilateral shirking on the brand's reputation is large enough to overcome the gain from free riding as long as the brand is not too large.

Is there an optimal brand size? For a given value of the investment cost, say e_0, all values of m for which $e_m > e_0$ are equally efficient in the sense that each of these brand sizes lead to the efficient outcome of investment by H firms. Thus in the example sketched in Figure 1, if $e = 0.015$, brands of size $2, 3, 4$ and 5 are equally efficient. The same is not true with respect to firms' profits, however. For a given value of e, the larger the brand size, the more information consumers have and therefore the higher the price they are willing to pay to an H brand, on average. Therefore, given e_0, the brand size which maximizes firms' profits[10] is the largest m satisfying the requirement that $e_m > e_0$. Thus in our example, the brand size which maximizes firms' expected profit is 5.

An alternative notion is that the socially optimal brand size is the one under which the efficient outcome is realized in the widest range of circumstances; that is, that the larger is $\overline{e}_m$, the better. Proposition 1 implies that in this sense there is indeed a socially optimal brand size which maximizes $\overline{e}_m$. In the example, the brand size which is optimal in this sense is 3 where $\overline{e}_3 = 0.055$.

4 Concluding Remarks

Collective Brands and State Trading Enterprises are often perceived as a means of fostering collusion and therefore as an obstacle to efficient markets. On these grounds, they have been targeted by free market advocates in recent WTO rounds. Here we take a contrasting view, arguing that by affecting reputational incentives, these institutions can increase efficiency and welfare by enabling higher product quality than would be attainable in their absence.

There are interesting parallels between our characterization of collective brands as vehicles of reputation formation and franchisees of chain stores and restaurants. Like a member of a collective brand, a franchisee is affected by and affects the reputation of the entire chain. Therefore it may be motivated to free ride on the chain's reputation and for this reason is closely regulated by chain ownership. Indeed, Jin and Leslie (2008)

[10] The reverse is true for L firms - the larger the brand size and the more information consumers have, the lower their profit. Nevertheless in equilibrium, these firms must form brands of the same size as H firms to keep from being detected as L firms on the basis of brand size alone. Cf footnote 4.

present evidence, that chain-affiliation is indeed a source of reputational incentives which may drive chain restaurants to have better hygiene than independent restaurants. They also find that franchisees invest less in hygiene than company owned restaurants of the same chain, which they interpret as evidence of free riding by franchisees on the chain reputation.

In contrast to franchises, the collective brand has no centralized ownership or control and each member is an autonomous firm. What we have shown is that despite incentives for free riding, collective branding can create greater reputational incentives than is possible with stand alone firms, even in the absence of a centralized ownership and even in the complete absence of any regulation or monitoring.

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5 Appendix

The following lemma presents a decomposition of R^m that proves useful in the proofs below.

Lemma 1 *(i)*

$$R^m = \sum_{h=0}^{m-1} \Pr(h \mid H, m-1) \left[g p_{h+1}^m + (1-g) p_h^m \right] \tag{8}$$

(ii)

$$R_{-1}^m = \sum_{h=0}^{m-1} \Pr(h \mid H, m-1) \left[b p_{h+1}^m + (1-b) p_h^m \right]$$

Proof of (*i*): Let us divide the m members into two separate groups, the first of which includes $m-1$ members and the second includes the remaining member. Suppose that the first group produces h, $0 \leq h \leq m-1$ high quality and $m-1-h$ low quality units. Since the mth firm is also investing, its success probability is g and therefore the expected revenue of each brand member is,

$$R^m = g p_{h+1}^m + (1-g) p_h^m.$$

Since the probability that the first group produces h high quality units is $\Pr(h \mid H, m-1)$,

$$R^m = \sum_{h=0}^{m-1} \Pr(h \mid H, m-1) \left[g p_{h+1}^m + (1-g) p_h^m \right].$$

which completes the proof of (i)

Proof of (*ii*): Let us divide the m members into two separate groups, the first of which includes $m-1$ members which invest and the second of which includes the remaining single member which doesn't invest. Suppose that the first group produces h high quality and $m-1-h$ low quality units. Since the mth firm does not invest, its success probability is b and therefore the expected revenue of each brand member is,

$$R_{-1}^m = b p_{h+1}^m + (1-b) p_h^m.$$

Since the probability that the first group produces h high quality units is $\Pr(h \mid H, m-1)$,

$$R_{-1}^{m} = \sum_{h=0}^{m-1} \Pr(h \mid H, m-1)\left[bp_{h+1}^{m} + (1-b)p_{h}^{m}\right].$$

which completes the proof of (ii).

Substituting directly from the lemma, we have-

$$R^{m} - R_{-1}^{m} = (g-b)\sum_{h=0}^{m-1} \Pr(h \mid H, m-1)\left[p_{h+1}^{m} - p_{h}^{m}\right] > 0. \tag{9}$$

5.1 Proof of proposition 1

We first show that R^m is increasing in m. Substituting (8) for R^m, (6) for R^{m-1}, and (5) for p_h^m and rearranging:

$$\begin{aligned}
& R^{m} - R^{m-1} \\
= & \sum_{h=0}^{m-1} \Pr(h \mid H, m-1)\left[gp_{h+1}^{m} + (1-g)p_{h}^{m}\right] - \sum_{h=0}^{m-1} \Pr(h \mid H, m-1)p_{h}^{m-1} \\
= & \sum_{h=0}^{m-1} \Pr(h \mid H, m-1)\left[gp_{h+1}^{m} + (1-g)p_{h}^{m} - p_{h}^{m-1}\right] \\
= & (g-b)\sum_{h=0}^{m-1} \Pr(h \mid H, m-1)\left\{g\Pr(H \mid h+1, m) + (1-g)\Pr(H \mid h, m) - \Pr(H \mid h, m-1)\right\}.
\end{aligned}$$

Using equation (4)

$$\begin{aligned}
& R^{m} - R^{m-1} \\
= & (g-b)\sum_{h=0}^{m-1} \Pr(h \mid H, m-1)\left\{g\frac{g^{h+1}(1-g)^{m-h-1}f}{g^{h+1}(1-g)^{m-h-1}f + b^{h+1}(1-b)^{m-h-1}(1-f)}\right. \\
& +(1-g)\frac{g^{h}(1-g)^{m-h}f}{g^{h}(1-g)^{m-h}f + b^{h}(1-b)^{m-h}(1-f)} \\
& \left. -\frac{g^{h}(1-g)^{m-h-1}f}{g^{h}(1-g)^{m-h-1}f + b^{h}(1-b)^{m-h-1}(1-f)}\right\}.
\end{aligned}$$

Define $X^h \equiv \frac{1-f}{f}\left(\frac{b}{g}\right)^h (\frac{1-b}{1-g})^{m-h-1}$. Then,

$$\begin{aligned}
& R^m - R^{m-1} \\
= \ & (g-b)\sum_{h=0}^{m-1}\Pr(h \mid H, m-1)\left(\frac{g}{1+\frac{b}{g}X^h} + \frac{1-g}{1+\frac{1-b}{1-g}X^h} - \frac{1}{1+X^h}\right) \\
= \ & (g-b)\sum_{h=0}^{m-1}\Pr(h \mid H, m-1)\cdot \\
& \frac{g\left(1+\frac{1-b}{1-g}X^h\right)\left(1+X^h\right)+(1-g)\left(1+\frac{b}{g}X^h\right)\left(1+X^h\right)-\left(1+\frac{b}{g}X^h\right)\left(1+\frac{1-b}{1-g}X^h\right)}{\left(1+\frac{b}{g}X^h\right)\left(1+\frac{1-b}{1-g}X^h\right)\left(1+X^h\right)}.
\end{aligned}$$

Define N^h as

$$\begin{aligned}
N^h \ \equiv \ & g\left(1+\frac{1-b}{1-g}X^h\right)\left(1+X^h\right)+(1-g)\left(1+\frac{b}{g}X^h\right)\left(1+X^h\right) \\
& -\left(1+\frac{b}{g}X^h\right)\left(1+\frac{1-b}{1-g}X^h\right).
\end{aligned}$$

Since $(g-b)\Pr(h \mid H, m-1) > 0$ and

$$\left(1+\frac{b}{g}X^h\right)\left(1+\frac{1-b}{1-g}X^h\right)\left(1+X^h\right) > 0,$$

$R^m > R^{m-1} > 0$ if $N^h > 0$ for all h. Manipulating N^h,

$$\begin{aligned}
N^h \ = \ & g\left(1+\frac{2-g-b}{1-g}X^h+\frac{1-b}{1-g}X^{h2}\right)+(1-g)\left(1+\frac{g+b}{g}X^h+\frac{b}{g}X^{h2}\right) \\
& -\left(1+\frac{b+g-2bg}{g(1-g)}X^h+\frac{b(1-b)}{g(1-g)}X^{h2}\right) \\
= \ & g^2\left[2-g-b+(1-b)X^h\right]+(1-g)^2\left(g+b+bX^h\right) \\
& -\left[b+g-2bg+b(1-b)X^h\right] \\
= \ & g^2(2-g-b)+(1-g)^2(g+b)-(b+g-2bg) \\
& +\left[g^2(1-b)+(1-g)^2b-b(1-b)\right]X^h \\
= \ & \frac{X^h}{g(1-g)}\cdot \\
& \left[g^2(2-g-b+g+b-2)+g\left(1-2b-1+2b\right)+b-b\right. \\
& \left.+(g^2-bg^2+b-2gb+g^2b-b+b^2)X^h\right] \\
= \ & \frac{X^h}{g(1-g)}(g-b)^2 > 0. \qquad (10)
\end{aligned}$$

Thus, $R^m - R^{m-1} > 0$ for every m and it follows that R^m is increasing with m.

Under perfect monitoring, it is not an option to be a brand member and not invest and therefore, by (7)

$$\bar{e}_m = R^m - max\{R_{-1}, R - \bar{e}_m\}.$$

Since neither R nor R_{-1} are a function of m and R^m is increasing with m, $\bar{e}_m$ is increasing with m. This completes the proof of the proposition.

5.2 Proof of Proposition 2

We prove parts (i) and (ii) by showing that (i) and (ii) hold for $m' = 2$. That is, we will show that: (i) Given b and $f > 0$, there is $g^* < 1$ such that if $g > g^*$, then $R^2 - R^2_{-1} > \bar{e}_1$ and (ii) : Given b and g, there is $f^* > 0$ such that if $0 < f \leq f^*$ then $R^2 - R^2_{-1} > \bar{e}_1$.

Substituting $m = 2$ in equation (9) yields

$$R^2 - R^2_{-1} = (g - b)\left\{\Pr(0 \mid H, 1)\left[p_1^2 - p_0^2\right] + \Pr(1 \mid H, 1)\left[p_2^2 - p_1^2\right]\right\}.$$

Substituting equation (5) and equation (4) yields

$$\begin{aligned}\frac{R^2 - R^2_{-1}}{(g-b)^2} &= (1-g)\left[\frac{g(1-g)f}{g(1-g)f + b(1-b)(1-f)} - \frac{(1-g)^2 f}{(1-g)^2 f + (1-b)^2(1-f)}\right] \\ &\quad + g\left[\frac{g^2 f}{g^2 f + b^2(1-f)} - \frac{g(1-g)f}{g(1-g)f + b(1-b)(1-f)}\right].\end{aligned}$$

Defining

$$z \equiv \frac{b}{g}, \qquad s \equiv \frac{1-b}{1-g}, \qquad c = \frac{1-f}{f}$$

we get

$$\frac{R^2 - R^2_{-1}}{(g-b)^2} = \frac{1-g}{1+zsc} - \frac{1-g}{1+s^2c} + \frac{g}{1+z^2c} - \frac{g}{1+szc}.$$

Recalling that $\bar{e}_1 = R - R_{-1}$ and substituting (3) for $R - R_{-1}$ it follows that

$$\frac{R^2 - R^2_{-1} - \bar{e}_1}{(g-b)^2} = \frac{1-g}{1+zsc} - \frac{1-g}{1+s^2c} + \frac{g}{1+z^2c} - \frac{g}{1+szc} - \frac{1}{1+zc} + \frac{1}{1+sc}.$$

Rearranging,

$$\frac{R^2 - R^2_{-1} - \bar{e}_1}{(g-b)^2} = \frac{\frac{(g-b)^2c^2}{(1-g)g}}{1 + (z+s)\,c + zsc^2} \cdot B$$

where

$$
\begin{aligned}
B &\equiv z\frac{(z+s+zsc)+z^2sc}{1+(z+s)\,zc+z^3sc^2}-s\frac{(z+s+zsc)+zs^2c}{1+(z+s)\,sc+zs^3c^2} \\
&= \frac{(s-z)(1+zsc)\left[(zsc)^2-(z+s+zsc)\right]}{\left[1+(z+s)\,zc+z^3sc^2\right]\left[1+(z+s)\,sc+zs^3c^2\right]}.
\end{aligned}
$$

Note that $R^2-R^2_{-1}>\bar{e}_1$ if and only if $B>0$.

Since the denominator of the preceding expression is positive and $z<1$ and $s>1$, then $B>0$ if and only if $Y\equiv(zsc)^2-(z+s+zsc)>0$.

Y is quadratic with a single positive root, c^*, and is positive for all $c\geq c^*$. Since f is strictly decreasing with c it follows that there exists $f^*=1/(1+c^*)>0$ such that if $0<f<f^*$ then $Y>0$ and $B>0$ which completes the proof of (ii)

To prove (i), express Y in terms of g, b and c.as follows:

$$
Y=\left(\frac{b}{g}\frac{1-b}{1-g}c\right)^2-\frac{b}{g}-\frac{1-b}{1-g}-\frac{b}{g}\frac{1-b}{1-g}c. \tag{11}
$$

It is easily seen that as $g\rightarrow 1$, $Y\rightarrow\infty$. Since Y is continuous in g,it follows that there exists $g^*<1$ such that $Y>0$ for all $g>g^*$, which proves (i).

Thus, by (i) and (ii), the proposition is satisfied for $m'=2$,which completes the proof of parts (i) and (ii) of the proposition.

To prove part (iii), substitute equation (4) in equation (9):

$$
\begin{aligned}
R^m-R^m_{-1} &= (g-b)^2\sum_{h=0}^{m-1}\Pr(h\mid H,m-1)\cdot \\
&\quad \left[\tfrac{g^{h+1}(1-g)^{m-h-1}f}{g^{h+1}(1-g)^{m-h-1}f+b^{h+1}(1-b)^{m-h-1}(1-f)}-\right. \\
&\quad \left.\tfrac{g^{h}(1-g)^{m-h}f}{g^{h}(1-g)^{m-h}f+b^{h}(1-b)^{m-h}(1-f)}\right] \\
&= (g-b)^2\sum_{h=0}^{m-1}\Pr(h\mid H,m-1)A^m_h
\end{aligned} \tag{12}
$$

where

$$
A^m_h=\frac{1}{1+\frac{b(1-g)}{g(1-b)}cq^m}-\frac{1}{1+cq^m}\qquad\text{and}\qquad q=\left(\frac{b}{g}\right)^{\frac{h}{m}}\left(\frac{1-b}{1-g}\right)^{\frac{m-h}{m}}.
$$

Note that $q>0$ and is strictly decreasing with h. Hence, for any given m, there is at most one value of h, denoted h^*, for which $q=1$. If $h<h^*$, then $q>1$, implying

$\lim_{m\to\infty} q^m = \infty$ and it follows that $\lim_{m\to\infty} A_h^m = 0$. If $h > h^*$, then $q < 1$, implying $\lim_{m\to\infty} q^m = 0$ and it follows that $\lim_{m\to\infty} A_h^m = 0$. If $h = h^*$, then $q = 1$, in which case $A_{h^*}^m$ is some finite number.

Hence, from equation (12)

$$
\begin{aligned}
& \lim_{m\to\infty} \frac{\left(R^m - R_{-1}^m\right)}{(g-b)^2} \\
= & \lim_{m\to\infty} \left\{ \sum_{h=0}^{h^*-1} \Pr(h \mid H, m-1) A_h^m + \Pr(h^* \mid H, m-1) A_{h^*}^m + \sum_{h=h^*+1}^{m-1} \Pr(h \mid H, m-1) A_h^m \right\} \\
= & \ 0
\end{aligned}
$$

since $\lim_{m\to\infty} \Pr(h^* \mid H, m-1) = 0$. This completes the proof of part (iii), which completes the proof of the proposition.

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