Collective Brands

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Abstract

We analyze the effect of a shared brand name, such as geographically designated agricultural brands, on incentives of otherwise autonomous firms to establish a reputation for product quality. On the one hand, brand membership provides consumers with more information about past quality and therefore can motivate investment when the scale of production is too small to motivate stand alone firms to invest. On the other hand, a shared brand name may motivate free riding on the group's reputation, reducing incentives to invest. We identify conditions under which collective branding may deliver higher quality than stand alone firms can achieve.

1 Introduction

A firm's brand name - defined as "a name, term, design, or symbol used by a manufacturer or merchant to identify its products distinctively from others of the same type and usually prominently displayed on its goods and in advertising" - is often its most valuable asset. For example, the market value of Coca Cola would be only a tiny fraction of its current value if it were stripped of its universally recognized brand name. Recognition of a firm's brand name enables consumers to form expectations about the quality of its products. This in turn incentivizes the firm to invest to develop and maintain a reputation for quality.

While most well known brands are individual, there are also many instances in which otherwise autonomous firms share a common brand name, which we refer to as a "collective brand". Important examples include regional agricultural products such as wines (Bordeaux, Barolo, and Riesling, champagne), cheese (Camembert, Parmesan, Brie, Gouda, Stilton, Roquefort, Feta), coffee (Colombian, Ethiopian), and wherever country of origin labeling is salient. These brand names are protected by designation of origin (PDO) and geographical indication (PGI) status which restrict the use of the geographical identification unless the product actually originates from that particular area. While these collective brand names are widely recognized, consumers generally have little awareness of the identities of specific producers which comprise the brand. For example, a bottle of Bordeaux wine is identified by a label that includes detailed information about the vintage (harvest date), the region (Bordeaux), the sub-region (appellation title, such as Margaux) and the winery. Consumers generally recognize the region and sub-region but probably few distinguish among different wineries in those regions (except perhaps for a few "star" wineries).

Another example is franchising which in 2007 accounted for 9.2 percent of total U.S. GDP (Kosova and Lafontaine, 2012) and which spans the range from fast food restaurants to accounting and law firms. Here too consumers are generally better informed about the reputation of the franchise name or logo than about a specific franchisee. Similarly, otherwise independent members of many prestigious professional organizations share a well recognized common logo.

Other related examples include country of origin effects. For example, a consumer who is unfamiliar with a specific make of car is likely to regard it more favorably if it is manufactured in Germany or Japan than in, say Mexico. Similarly, decades ago the "made in Japan" label symbolized poor quality, just as the "made in China" has more recently been perceived as indicative of poor quality.

Since consumers have only limited ability to distinguish the track record of any individual producer from that of the collective brand, individual members of such brands would seem to have less of an incentive to invest in quality than stand alone firms. However, in practice, many collective brand names, such as Bordeaux, or champagne are renowned for quality and consumers are willing to pay premium prices for them (e.g. Landon and Smith, 1998, and Loureiro and McCluskey, 2000, 2003). 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 then achieving superior quality presumably also requires investment of effort and other resources which individual firms would seem to have little incentive to make. The purpose of this paper is to understand how firms within a collective brand are nevertheless incentivized to invest in quality and to contribute to the brand's reputation. In particular, we show that a firm may have a greater incentive to invest in quality when sharing a brand name with other firms and shaping reputation collectively than when standing alone and establishing an individual reputation. This may have important policy implications. For example, critics of marketing boards and state trading enterprises contend that these institutions reduce efficiency and welfare by fostering collusion[1]. By contrast, our analysis suggests that by enhancing reputational incentives, collective brands may actually increase efficiency and welfare by enabling

[1] An alternative view in defense of such organizations is that they provide economies of scale in production and promotion.

higher product quality than could be attained otherwise.

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'), perception of quality and hence the price consumers are willing to pay for the product is shaped by their past experience with the product - its reputation. How much a firm is willing to invest in quality, in turn, depends on how well its customers are informed about its track record. If individual firms are small, relative to the size of the industry, consumers may have only very limited information about the past quality of any individual firm's products. This makes it difficult for consumers to form reliable expectations about a firm's quality which reduces the price they are willing to pay for its products. Moreover, when consumers' perceptions are based on limited information, a single bad outcome may have a disproportionately large adverse effect on the firm's reputation, further reducing its incentive to invest in quality. Here sharing a collective brand name with other firms may facilitate reputation formation by pooling an individual member's history with that of other brand members. Specifically, as the collective brand name covers a larger share of the market than that of any individual member, then, if individual brand members share similar characteristics, consumers have better information about each those firms than if they stood alone. In particular, the price they are willing to pay any brand member now depends not on its individual history but on the history of the entire brand. Therefore a high quality firm commands a higher price as a member of a high quality brand than if it stands alone. This makes a good collective reputation more valuable than that of a good individual reputation, which increases individual members' incentives to invest. Moreover, the fact that consumers' perceptions of quality is formed by the history of the entire brand reduces an individual firm's risk of being tarnished by an unlucky bad outcome, further increasing investment incentives.

But as noted above, sharing a collective reputation may also have an opposing effect on investment incentives by encouraging free riding on the efforts of other members. Therefore the full effect of collective branding on quality is determined by the interaction of these two opposing factors: the fact that collective branding leads to higher prices if all members invest, but may also reduce investment by encouraging free riding.

Accordingly, we analyze the effects of collective branding under two regimes. In the first, termed ‘perfect monitoring’, the brand is able to monitor individual investment and prevent firms which fail to invest from using the brand name. Since then only the reputation effect is operative, a brand member’s incentive to invest is always greater than that of a stand alone firm. Moreover, since consumers’ information increases with brand size (the number of firms in the brand), investment incentives increase monotonically with brand size . Thus under perfect monitoring "bigger is better".

We show that for appropriate parameters this pro - investment effect of collective branding may also apply in a ’no monitoring’ regime, where failure to invest is undetectable and does not lead to exclusion from the brand. Specifically, collective branding can still increase incentives to invest 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, the effect of brand size is not monotonic. That is, increased brand size initially leads to higher quality but once the brand is sufficiently large, the marginal contribution of an individual member’s investment to the brand’s reputation becomes too small to override the incentive to free ride, reducing investment incentives relative to stand alone firms. Thus, in the no monitoring regime, the optimal brand size is large enough to facilitate successful reputation formation but small enough to discourage individual free riding. Our analysis thus suggests that "bigger is better" when effective monitoring is relatively easy, but the optimal brand size may be more limited when monitoring is too costly or difficult.

Empirical Evidence

Casual observation suggests that collective branding is often observed in situations where consumers are unlikely to have much information about individual producers. Thus, the export of agricultural products is often managed by marketing boards and state trading enterprises rather than by the individual producers as foreign consumers are unlikely to recognize individual producers. Similarly, restaurants on highway stops, where there is little repeat business, almost always belong to well known chains. Relatedly, Jin and Leslie (2009) provide evidence that chain restaurants - which share a collective brand name - maintain better hygiene than non-chain restaurants.

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. 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, consistent with our analysis, 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. In an experimental study, Huck and Lűncer (2009) find that more sellers invest in quality when buyers are informed about the average past quality of all sellers - which corresponds to a collective brand in our model - than when they only know the record of the seller from whom they actually buy. And consistent with our analysis, when the number of sellers increases, the average quality declines.

Online hiring markets also provide evidence for reputational effects of collective branding. Stanton and Thomas (2015) find that employers are willing to pay more to inexperienced online workers (which have yet to establish individual reputation) affiliated with outsourcing agencies than to inexperienced independent contractors and that this advantage dissipates over time as employers learn about individual productivity.

Related Literature

The centrality of *individual* firms' reputation for quality for their success is the theme of a very large literature (see the survey article of Bar Issac and Tadelis (2008)). By contrast our concern is to understand the role of a collective reputation on the fortunes of otherwise autonomous firms. Tirole (1996) analyzes how group behavior affects individual incentives to invest (behave honestly) when the group size is fixed exogenously. By contrast, our focus is precisely on the role of the group size on individual investment incentives.

Our analysis is also related to a substantial literature on *brand extension* and *umbrella branding*, the practice of multiproduct firms to use the same brand name on otherwise unrelated products (Andersson (2002), Cabral (2000, 2009), Cai and Obara (2009), Choi (1998), Choi, J. and D.S Jeon. (2007), Hakenes and Peitz (2008,2009), Miklos-Thal (2012), Rasmusen (2016), Wernerfelt (1988)) [2]. Both collective branding and umbrella branding provide firms with greater incentives to invest in quality than if products are branded separately. The main difference is that in an umbrella brand a central authority makes investment decisions for each of the brand's products and internalizes the effect of each individual product's quality on the reputation of the entire brand. By contrast, in a collective brand, individual members are concerned only with the effect of their investment decisions on the value of their own product and we show that nevertheless collective branding can support higher quality than stand alone firms.

Our analysis can also contribute to understanding the role of cooperatives. While the conventional approach (e.g., Sexton and Sexton, 1987) views cooperatives as a means of joint integration allowing for the exploitation of scale economies, market power and risk pooling, our analysis suggests an additional important function of cooperatives— joint signaling of information. [3]

2 The 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 and N risk neutral firms. There are two possible product qualities, low (l) and high (h). Firms are of two types,

[2] Relatedly Rob and Fishman (2005) show that a firm's investment in quality increases with size and Guttman and Yacouel (2007) show that larger firms benefit more from a good reputation.

[3] Another literature which addresses related issues is the common trait literature (e.g., Benabou and Gertner, 1993, Fishman 1996), in which an individual's behavior reveals information about a common trait that she shares with other group members.

H and L, which are distinguished by their technological ability to produce high quality. An L firm produces high quality with probability b at each period 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 at each period, where $1 \geq g > b > 0$.[4] In either case the realized quality at period 2 is independent of its realization at period 1. The cost of investment is fixed at $e > 0$ and investment is "once and for all": Prior to period 1, each firm decides whether or not to invest and that, along with its type, determines the probability with which it produces high quality at periods 1 and 2. We denote by N_H and N_L the total number of H and L firms respectively, $N_L \geq N_H$, and by $r = \frac{N_H}{N_H+N_L}$ the proportion of H firms in the market.

There is measure 1 of identical consumers. At each period a consumer demands at most one (discrete) unit. Her utility from a low quality unit is zero, from a high quality unit is 1 and her utility from any additional unit is zero.[5]

In order to disentangle reputational effects of collective branding on investment incentives from possible collusive (anti competitive) effects, it is convenient to assume that firms have monopolistic market power. Specifically, each consumer is randomly matched with one firm. At each period she can either buy from that firm or not buy at all, and she buys a unit if her expected utility from a unit at that period is greater or equal to the price she pays. [6] Thus, if consumers' expected utility from a unit of firm i is v_i, firm i's price is v_i. Thus collective branding does not increase firms' pricing power or market share, and can only affect firms' investment incentives via reputational effects.

Consumers cannot directly observe a firm's type (H or L) and also do not observe

[4] The analysis is essentially unchanged if $g < 1$ and $b \geq 0$. Under either formulation period 1 outcomes do not reveal firm type perfectly.

[5] The analysis is unchanged if there are successive generations of consumers who live for one period. In particular, the reason that brands provide greater incentives for investment than stand alone firms is that period 2 consumers are informed about the period 1 outcomes of all firms in the brand and evaluate individual firm type based on the entire brand's performance. From this perspective it is immaterial whether consumers at period 2 previously bought from that firm or are in the market for the first time.

[6] This could be because consumers have high transportation or search costs which effectively endow firms with local monopoly pricing power.

if it has invested. Firms learn their type only after investing. The sequence of events is as follows. First each firm decides whether or not to invest. Then the market opens at period 1. At this period consumers decide whether or not to buy from the firm with which they are matched when their only information about firms is r. At the beginning of period 2, before buying, consumers learn the realized quality of *each* firm at the preceding period (e.g., by interacting with customers of other firms or reading online product reviews) and update their beliefs.

Remark 1: The assumption that firms do not know their type at the time of investment simplifies the analysis by enabling firms to calculate the profit from investment using the relatively simple updating rule, (1), derived below. It is also realistic. An individual may be attracted to a certain profession but she only learns about her aptitude for that profession by actually studying it. If firms know their type before investing, the updating rule below is also approximately correct if N_L and N_H are large.

Let $s_i = 0$ if firm i produced a low quality unit at period 1 and $s_i = 1$ if firm i produced a high quality unit at period 1. Let $S = (s_1, s_2, ..., s_N)$ be the industry profile of realized qualities. A consumer's belief about firm i is the probability with which she believes that the firm is type H and has invested.[7] As was mentioned above, at period 2 consumers are perfectly informed about S and thus their beliefs at period 2 may depend on S. Let $B_2(S)$ denote consumers' updated beliefs at period 2, where $B_2 : S \longrightarrow [0,1]^N$.

A firm's profit is the sum of its revenues at periods 1 and 2 less the investment cost, e, if it invests. A firm's strategy is whether or not to invest and is denoted by $f \in \{I, NI\}$, where I means "invest" and NI means "don't invest".[8]

An *equilibrium* is a strategy f for each firm and consumer beliefs $B_2(S)$ such that:

- Each firm's strategy f maximizes its profit, given the strategies of all other firms and consumer beliefs.

[7] As far as a consumer is concerned, an H firm which has not invested is equivalent to an L firm since both produce high quality with the same probability.

[8] We do not formally include a firm's price as part of its strategy since we assume that its price always equals consumers' expected utility.

- $B_2(S)$ is consistent with firms' strategies.

- Consumers maximize their expected utility (i.e., they buy if and only if the price is less or equal to the expected value of the good).

We seek to characterize symmetric pure strategy equilibria in which all firms invest - henceforth termed *Investment Equilibria (IE).* If a randomly chosen firm invests, its expected quality is $rg + (1 - r)b$ and if it doesnt invest its quality is b. Thus, as there are two periods, investment is efficient whenever $e \leq 2r(g - b)$. The market can achieve this outcome if consumers directly observe firm type and investment. In that case, at each period, consumers pay g to H firms which invest and only b to L firms and H firms which don't invest and hence firms optimally invest whenever $e \geq 2r(g - b)$. Since, however, consumers can only infer firm type at period 2 based on period 1 outcomes, investment can only affect prices at period 2. Hence the 'second best' efficient outcome is that firms invest whenever $e \leq r(g - b)$. However, even this outcome is achievable only if period 1 outcomes reveals firm type *perfectly* - i.e., if $g = 1$ and $b = 0$. Since, however, under our assumptions period 1 quality only reveals firms type imperfectly, consumers are unwilling to pay g even if period 1 quality is high and are willing to pay more than b even if period 1 quality is low. Thus equilibrium investment incentives are reduced below the 'second best' efficient level and, as the analysis immediately below shows in detail, an investment equilibrium can only exist if $e < r(g - b)$.[9]

Suppose an IE exists. At period 1 consumers believe that any firm is type H with probability r. Therefore, given that all firms invest, at period 1 the expected utility from any firm - and hence its price - is $rg + (1 - r)b$. At period 2, consumers are informed about S and update their beliefs. Let $\Pr(H \mid s_i, S_{-i})$ be the posterior probability - and hence consumers' belief[10] - at period 2 that a randomly selected firm i is type H when

[9] Trivially, there always exists an equilibrium in which no firm invests. In this equilibrium consumers believe that no firm invests, which makes it optimal for firms not to invest.

[10] For any realization of s_i, S_{-i} consistent with firms' strategy, consumers' equilibrium beliefs must be consistent with Bayesian updating.

its realized quality at period 1 is s_i and those of the other firms is $S_{-i} \equiv (S \backslash s_i)$, and let $E_{S_{-i}} \Pr(H \mid s_i, S_{-i})$ be the *expected* (with respect to S_{-i}) consumer belief at period 2, *as evaluated by firm i at period 0, before investing,* that firm i is type H, conditional on it realized quality at period 1 being s_i. Then:

$$\begin{aligned} E_{S_{-i}} \Pr(H \quad \mid \quad s_i, S_{-i}) &= \sum_{S_{-i}} \Pr(H \mid s_i, S_{-i}) \Pr(S_{-i} \mid s_i) = \sum_{S_{-i}} \frac{\Pr(H, s_i, S_{-i})}{\Pr(s_i, S_{-i})} \frac{\Pr(s_i, S_{-i})}{\Pr(s_i)} \\ &= \sum_{S_{-i}} \frac{\Pr(H, s_i, S_{-i})}{\Pr(s_i)} = \frac{\Pr(H, s_i)}{\Pr(s_i)} = \Pr(H \mid s_i). \end{aligned} \tag{1}$$

Thus if $p(s_i)$ is a firm's expected second period price - as evaluated at the time it invests - conditional on its realized quality being s_i,

$$\begin{aligned} p(s_i) &= gE_{S_{-1}} \Pr(H \mid s_i, S_{-i}) + b(1 - E_{S_{-1}} \Pr(H \mid s_i, S_{-i})) \\ &= g \Pr(H \mid s_i) + b(1 - \Pr(H \mid s_i)) \end{aligned}$$

Since an H firm which invests produces high quality with probability g and an L firm produces high quality with probability b, Bayes' rule gives (henceforth we omit subscript i):

$$\Pr(H \mid h) = \frac{gr}{gr + b(1-r)}$$

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

and thus:

$$\begin{aligned} p(h) &= g \Pr(H \mid h) + b(1 - \Pr(H \mid h)) \\ &= b + (g-b) \Pr(H \mid h) = b + \frac{(g-b)gr}{gr + b(1-r)} \end{aligned} \tag{2}$$

and similarly:

$$\begin{aligned} p(l) &= g \Pr(H \mid l) + b(1 - \Pr(H \mid l)) \\ &= b + (g-b) \Pr(H \mid l) = b + \frac{(g-b)(1-g)r}{(1-g)r + (1-b)(1-r)}. \end{aligned} \tag{3}$$

Let R and R_- be the expected second period revenues of a firm that invests and doesn't invest respectively:

$$R = r\left[gp(h) + (1-g)p(l)\right] + (1-r)\left[bp(h) + (1-b)p(l)\right] \tag{4}$$

and

$$R_- = bp(h) + (1-b)p(l) \tag{5}$$

Thus an H firm's expected gain from investment is $e^* \equiv R - R_-$ and thus by (2) - (5):

$$e^* = r(g-b)^2\left[\frac{gr}{gr + b(1-r)} - \frac{(1-g)r}{(1-g)r + (1-b)(1-r)}\right].$$

Proposition 1 *When firms stand alone an IE exists if and only if $e \leq e^*$.*

Note that the expression on the RHS of the preceding equation in square brackets $< \frac{gr}{gr+b(1-r)} < 1$, and thus $e^* < r(g-b)^2 < r(g-b)$. Thus if $e^* < e \leq r(g-b)$, an IE does not exist although, as discussed above, investment is efficient.

For example, if $r = 0.5$, $g = 0.9$ and $b = 0.1$, $e^* = 0.256$ but $r(g-b) = 0.4$. Thus an equilibrium in which stand alone firms invest exists only if $e \leq 0.256$, while the second best outcome is that firms invest if $e \leq 0.4$.

We now proceed to show that collective branding can raise investment incentives closer to the second best level by making information from period 1 performance less noisy.

3 Collective Branding

In this section we extend the setting of the previous section to allow otherwise autonomous firms to market their products under a shared brand name and show that then IE may exist when they would not exist in the stand alone setting. A stand alone firm faces several disincentives to invest. First, it may turn out to be an L type in which case its investment is wasted. Second, even if it is type H, it may be unlucky and produce low quality at period 1, in which case again investment has no effect on its period 2 price and is wasted. Third, because period 1 quality is only a noisy signal of firm type, consumers' willingness to pay at the second period is relatively low even if period 1 quality is high, further dampening the incentive to invest. Collective branding cannot mitigate the first factor, but it can partially insure against the severity of the other two factors. Specifically, period 1 outcomes are more informative under collective branding than when firms stand alone, since consumers' inference about a firm's type now draws on the history of all the members of its brand, rather than only on its own history. Therefore, good outcomes can increase consumers' willingness to pay for the collective brand, relative to stand alone firms, making investment more attractive. Moreover, investment is now less risky, since even a firm which is unlucky at period 1 may still command a high price at period 2 if the other members of its brand are more successful.

The timing of events is now modified as follows. After firms invest, collective brands are formed as described immediately below. It is convenient to assume that consumers are aware of firms' brand affiliation only at the second period, so that at period 1 consumers' beliefs and firms' revenue are the same as in the stand alone setting. Thus any effect of branding on investment incentives can now only be due to its effect on second period revenues[11].

Formally, a *collective brand assignment* is a partition of the N firms. Let $\wp$ be the set of all the possible partitions of the N firms and let $P \in \wp$. Each element $Q \in P$ is called a collective brand and each firm $i \in Q$ assigned to Q by P is called a member of brand Q. A *brand assignment rule* determines the assignment of individual firms to brands. Let $\pi_i(Q)$ denote firm $i's$ profit as a member of brand Q and let π_i be its profit if it stands alone.

In this setting firms' strategies and consumers' beliefs at period 2 may depend not

[11] This assumption has no qualitative effect on the main results.

only on S but also on P. That is,

$$f : \wp \longrightarrow \{I, NI\}$$

$$B_2 : \wp \times S \longrightarrow [0,1]^N$$

We define a BE (Brand Equilibrium) by $P \in \wp, f$, B_2 such that:

E.1 Each firm's strategy f maximizes its profit, given the strategies of all other firms and consumer beliefs.

E.2 $B_2(\wp, S)$ is consistent with firms' strategies.

E.3 (individual rationality) For each $Q \in P$ and $i \in Q$, $\pi_i(Q) \geq \pi_i$. That is, if a firm is assigned to brand Q by P, membership in Q must be at least as profitable as standing alone.

E.4 $\nexists i, Q \in P$ s.t. $: \forall j \in Q,\ i \notin Q,\ i \in Q' \in P,\ \pi_j(Q \cup \{i\}) \geq \pi_j(Q), \pi_i(Q \cup \{i\}) \geq \pi_i(Q')$, with the inequality strict for at least one j or i. That is, adding an additional member to brand $Q \in P$ can not increase both its profit and the profit of existing (assigned) members of Q.

We refer to the number of firms which are members of a brand as the *brand size* and define a BIE as a BE in which all firms invest.

We shall focus on BIE in which all brands are the same size and in which all members of each brand are the same type. Specifically, for any $m \in \{1, ..., N_H\}$, such that $\dfrac{N_H}{m}$ and $\dfrac{N_L}{m}$ are integers, let $n_H^m = \dfrac{N_H}{m}$ and $n_L^m = \dfrac{N_L}{m}$ and define an m - *partition* as a partition $P \in \wp$ that consists of n_H^m brands, each of which has exactly m type H members - henceforth called H *brands* - and n_L^m brands each of which has exactly m type L members - henceforth called L *brands*. This definition implies that the proportion of H brands in the market is r. Finally, an $m - partition$ BIE is an $m - partition$ which is a BIE.

The preceding definition implies that the "brand" is able to discern firms' types although consumers are not. This seems natural and realistic, as firms are professional 'insiders' who are familiar with and well informed about the characteristics and qualifications required to produce high quality and are able to recognize these characteristics or their absence in fellow professionals, while consumers are 'outsiders' with no such knowledge or familiarity. For example, a scientist or scholar in a specific discipline can easily recognize or determine the professional status and qualifications of other scientists or scholars in the same field, but it is very difficult for even highly educated laypersons outside the specific field to do so. Moreover, our definition only requires that brand management is able to recognize firms' type, not that every firm is able to do so. While in the text we assume that the brand can perfectly and costlessly distinguish firm type, in section 5.4 of the Appendix it is shown that if the brand size is sufficiently large, the main results of this section continue to hold even if the brand can only distinguish firm type imperfectly.

We focus on equilibria in which all brand members are of the same type as these equilibria are designed to maximize incentives to invest. Specifically, if consumers' perception of a firm's type is determined by the realized qualities of all the members of its brand, then, if firms invest, a firm is perceived to be type H with higher probability - and hence receives a higher expected price at period 2 - if all its fellow brand members are H (which produce high quality with higher probability) than if some members are L (which produce high quality with lower probability). Conversely, membership in an "all L" brand minimizes the probability that an L firm will be perceived as type H. Thus segregating brands by type provides the highest boost to investment incentives. Moreover, as in an $m-partition$, L and H brands are the same size, brand size on its own does not reveal its members' type. By contrast, if the size of H and L brands differed systematically, brand size would perfectly reveal firms' type to consumers, which in turn would obviate the incentive to invest[12].

[12] If consumer could perfectly distinguish firm type, then in an investment equilibrium they would

We analyze $m-partition\ BIE$ under two alternative regimes. Under *perfect monitoring*, firms which don't invest are excluded from membership in H brands. The interpretation is that the "brand" can detect if a firm has invested and exclude those which don't. By contrast, in the *no-monitoring* regime, membership in an H brand cannot be conditioned on investment. The interpretation is that failure to invest is undetectable and cannot jeopardize brand membership.

3.1 Perfect Monitoring

In this section we analyze the effects of collective branding on investment incentives under perfect monitoring. Let e_m be the largest value of e for which an $m-partition\ BIE$ exists under perfect monitoring.

Proposition 2 *Corresponding to every* $m \in \{2, ..., N_H\}$ *such that* $\frac{N_H}{m}$ *and* $\frac{N_L}{m}$ *are integers:*

(i) $e_m > e^*$.

(ii) e_m *is strictly increasing in* m.

Proof of proposition: The proof is by construction. Let the brand assignment rule be: Each H firm which invests is assigned to an H brand of size m and each L firm is assigned to an L brand of size m. If an H firm doesn't invest, it is assigned to one of the L brands (recall that under perfect monitoring such exclusion from H brand membership is feasible) and one L firm is assigned to an H brand in its place (so that in this case one of the H brands ends up with $m-1$ type H members and one type L member, and one L brand ends up with $m-1$ type L members and one type H member)[13]. Let consumer beliefs (at period 2) be: a stand alone firm or a firm which is a member of a brand of size $\neq m$ is either type L or has not invested.

believe that firms invest, eliminating the incentive to invest. By contrast, firms are motivated to invest to reveal their type when consumers infer firm type from period 1 performance.

[13] This rule ensures that the 'threat' to exclude H firms which fail to invest from membership in H brands does not change brand sizes and hence does not affect consumer beliefs which depend on brand size.

Thus if all firms invest there are n_H^m H brands, each member of which is type H and n_L^m L brands, each member of which is type L. Let a brand's *record* be the total number of high quality units produced by all the members of the brand at period 1. Denote the record of brand i of size m as $s_i^m \in \{0, 1, ..., m\}$, let $S^m = (s_1^m, ..., s_{n_H^m + n_L^m}^m)$, and let $S_{-i}^m \equiv (S^m \backslash s_i^m)$. Let $\Pr(H^m \mid s_i^m, S_{-i}^m)$ be the posterior probability, and therefore consumers' belief at period 2, that, given S_{-i}^m, and s_i^m, brand i of size m, is an H brand. To simplify notation, in the remainder of the proof we omit the subscript and superscript of s_i^m when this does not lead to any ambiguity. By a completely analogous argument to (1), consumers' *expected* (with respect to S_{-i}^m) belief - *as evaluated at the time of investment* - that a brand with record s is an H brand is given by:

$$\Pr(H^m \mid s) = \frac{rg^s(1-g)^{m-s}}{rg^s(1-g)^{m-s} + (1-r)b^s(1-b)^{m-s}} \tag{6}$$

Thus, conditional on the brand's realized record being s, the expected revenue (price) of each member of an brand of size m at period 2 is given by $p^m(s)$:

$$\begin{aligned} p^m(s) &= g \Pr(H^m \mid s) + b(1 - \Pr(H^m \mid s)) \\ &= b + (g-b) \Pr(H^m \mid s) \end{aligned} \tag{7}$$

Let R_L^m be a firm's expected revenue at period 2 - as evaluated at the time of investment - conditional on turning out to be type L and a member of an L brand of size m. Then

$$R_L^m \equiv \sum_{s=0}^{m} \binom{m}{s} b^s (1-b)^{m-s} p^m(s) \tag{8}$$

Similarly, let R_H^m be a firm's expected revenue at period 2 - as evaluated at the time of investment - conditional on turning out to be type H and a member of an H brand of size m. Then

$$R_H^m = \sum_{s=0}^{m} \binom{m}{s} g^s (1-g)^{m-s} p^m(s) \tag{9}$$

Thus, at the time of investment, the expected revenue of a firm which invests is:

$$R^m = rR_H^m + (1-r)R_L^m \tag{10}$$

Given that all other firms invest, a firm's expected profit if it invests is $R^m - e$ while if it doesn't invest its expected profit is R_L^m. Thus investment is optimal if $R^m - R_L^m \geq e$. The following lemma is proved in the Appendix.

Lemma 1 *For every $m \geq 1$, $R^m - R_L^m$ is increasing with m .*

Let $\varepsilon_m \equiv R^m - R_L^m$. By equations (4) and (8) - (10), $R^1 = R$, and by (5) and (8), $R_L^1 = R_-$. Hence by Lemma 1, and the definition of e^* it follows that for $m \geq 2$:

$$\varepsilon_m = R^m - R_L^m > R^1 - R_L^1 = R - R_- = e^*.$$

Let $e_m = \varepsilon_m$. Thus, if $m \geq 2$, $R^m - R_L^m > e^*$ and thus investment is optimal if $e > e^*$

Since by (6) - (8), $R_L^m \geq b$, and since, given consumer beliefs, a stand alone firm's profit is b (whether or not it invests), it follows that brand membership is more profitable for an L firm, and a fortiori for an H firm, than standing alone, and thus condition *E.3* is satisfied. It is also obvious that condition *E.4* is satisfied. This completes the proof of part (i) of the proposition[14]. Part (ii) then follows directly from Lemma 1.■

Thus there are multiple brand $m - partition\ BIE$, and these may be ranked in terms of their effect on investment: The larger the brand size, m, the greater investment incentives are and the greater the range of investment costs for which IE exist.[15] The

[14]The above equilibrium was constructed under the assumption that there exists m such that $\frac{N_H}{m}$ and $\frac{N_L}{m}$ are integers. However, such equilibria exist more generally. Specifically, for any m such that $\frac{N_H}{m}$ is an integer (which always the case for $m = N_H$), let $I\{\frac{N_L}{m}\}$ be the largest integer $\leq \frac{N_L}{m}$, let there be $\frac{N_H}{m}$ H brands, $I\{\frac{N_L}{m}\}L$ brands and $N_L - I\{\frac{N_L}{m}\}m$ stand alone L firms. Then, although the construction is more complicated, a similar equilibrium to that of proposition 2 may be constructed in which the profit of stand alone L firms is b.

[15]This suggests that the equilibrium brand size $m = N_H$ is supported by more plausible consumer beliefs than $m < N_H$. Specifically, as is shown in the proof of the proposition, equilibria in which $m < N_H$ require that consumers believe that a brand of size larger than m is either type L or type H which doesn't invest. But, it is precisely the H firms which would profit, while L firms would lose, if the brand size increased, as long as consumers believed that a brand size $> m$ with a record greater or equal to that of a brand of size m is at least as likely to invest. By contrast, consumers appropriately associate a brand size larger than N_H with lower quality because such a brand must include at least some L firms.

reason is that the larger the brand's size, the better informed consumers are about the brand's type and the higher the price they are willing to pay to an H brand, on average. In particular, for the parameters in the example at the end of the preceding section, $r = 0.5, g = 0.9.b = 0.1$, the table below gives the equilibrium values for different values of m (calculated on the basis of equations (7) - (10) in the preceding proof), where R_L^m and R_H^m are the expected price of an L and H firm respectively and e_m is the expected return from investment (equivalently, the highest investment cost at which an investment equilibrium is sustainable).

m	R_L^m	R_H^m	e_m
1	0.244	0.5	0.256
2	0.1878	0.8122	0.3122
3	0.14048	0.85952	0.35952

Thus even small brand sizes may have a sizable impact on equilibrium prices and investment incentives.

3.2 No-Monitoring

We now turn to examine the extent to which the analysis of the previous section applies in the "no-monitoring" setting. In this setting failure to invest cannot prevent a firm from using the brand label and thus the incentive to free ride on other brand members' investment cannot be ruled out. Thus, in general, firms have less of an incentive to invest than in the perfect monitoring regime. Nevertheless, the following proposition establishes that if g is sufficiently large, collective branding can still incentivize investment when stand alone firms will not invest. The reason is as follows. Suppose $g = 1$. In that case consumers expect a "perfect record" from H brands and thus believe that a brand with even a single low quality unit at period 1 is the L type with probability 1. Thus the period 2 price of a brand with any low quality units at period 1 is b. At the same time, since the precision of consumers' information increases with m, the price of a brand with a perfect record increases with m. Thus, given that all other members of an H brand invest, an individual firm's upside from investing increases with m while, on the downside, failure to invest drags the brand's price down to b with fixed probability $1-b$. Thus when $g=1$, investment incentives increase monotonically with m even under no-monitoring. By extension, this implies that if $g<1$ is sufficiently large, then even under no-monitoring, investment incentives under collective branding may be higher than those of stand alone firms

More formally, let $\widetilde{e}_m$ be the largest value of e for which an $m-partition\ BIE$ exists under no-monitoring.

Proposition 3 *Under no-monitoring, for every $m \in \{2,...,N_H\}$ such that $\frac{N_H}{m}$ and $\frac{N_L}{m}$ are integers there is $g(m)<1$ such that if $g \geq g(m)$, $\widetilde{e}_m > e^*$.*

Proof: The proof is based on an analogous construction to the one in proposition 2. In contrast to the perfect monitoring setting, here the brand assignment rule cannot condition brand membership on investment, only on type. Let the brand assignment rule be that every H firm is assigned to an H brand of size m and every L firm is assigned to an L brand of size m. Suppose that all firms invest, and let s_i^m, S^m, S_{-i}^m , $p^m(s)$, R_H^m, R_L^m and R^m and consumer beliefs be the same as in the proof of proposition 2. Thus, at the time of investment, the expected revenue of a firm which invests is R^m. Let R_{-1}^m be the expected revenue of a firm which doesn't invest. If it turns out to be type H, then whether or not it invested, it will be assigned to an H brand (in which all $m-1$ other members invest) and if it turns out to be type L it will assigned to an L brand. Thus [16]

$$R_{-1}^m = r\sum_{s=0}^{m-1}\binom{m-1}{s}g^s(1-g)^{m-1-s}\left[(1-b)p^m(s)+bp^m(s+1)\right]+(1-r)R_L^m \qquad (11)$$

Let $\widetilde{\varepsilon}_m \equiv R^m - R_{-1}^m$. Thus investment is optimal if $e \leq \widetilde{\varepsilon}_m$.

The following lemma, proved in the appendix, shows that an analogous result to Lemma 1 applies under no monitoring if $g=1$.

[16] $\binom{m-1}{s}g^s(1-g)^{m-1-s}$ is the probability that the other, $m-1$ investing firms, produce s high quality units. With probability $1-b$ the firm which doesn't invest produces low quality in which case the brand produces s high quality units and each member receives the price $p^m(s)$. With probability b the m-th firm produces high quality and the price is $p^m(s+1)$.

Lemma 2 *Under no- monitoring, if $g = 1$, $\widetilde{\varepsilon}_m$ is strictly increasing in m for $m \geq 1$.*

By equations (4) and (8) - (10), $R^1 = R$, and by (5), (8) and (11), $R^1_{-1} = R_{-}$. Hence $\widetilde{\varepsilon}_1 = R^1 - R^1_{-1} = e^*$. Thus it follows from the lemma that if $g = 1$, then $\widetilde{\varepsilon}_m > e^*$ for all $m > 1$. By equations (6) - (11), $\widetilde{\varepsilon}_m$ is continuous in g, implying that there is $g(m) < 1$, such that for $g \geq g(m)$, $\widetilde{\varepsilon}_m > e^*$. Finally, let $\widetilde{e}_m = \widetilde{\varepsilon}_m$.

Given consumer beliefs, the revenue of a firm which stands alone is $b < R^m_{-1}$ where the inequality follows from (7) and (11). Thus conditions E.3 and E.4 are satisfied. This completes the proof. ■

However, while when $g = 1$, investment incentives increase monotonically with m even without monitoring, this is not the case if $g < 1$. That is because then the negative effect of any single bad outcome on the brand's reputation decreases with m and hence, once the brand is sufficiently large, becomes too small to overcome incentives to free ride. Formally:

Proposition 4 *Under no-monitoring, for every $g < 1$, there is $m(g)$ such that for $m \geq m(g)$, $\widetilde{e}_m \leq e^*$.*

Proof: In the Appendix.

Thus if N_H is sufficiently large, the collective brand size must be smaller than N_H in order to incentivize investment beyond that of stand alone firms.

One way in which a collective brand may restrict brand size is by strategically manipulating the geographical location of producers which are entitled to use the brand name. For example, In the case of regional agricultural products, for example, brand size may be effectively restricted by appropriate definition of the boundaries of the geographic area which is entitled to use the collective brand name. For example in 2008, INAO, the organization that regulates France's appellation system, approved a proposal allowing for the expansion of the Champagne region in response to precipitous increase in worldwide demand ('Wine spectator', march 14, 2008), which suggests that the number of producers could also be restricted by contracting the region's geographical boundaries.

3.3 Relationship to Umbrella Brands

Umbrella branding is the practice by which multiproduct firms market otherwise unrelated products under the same brand name in order to signal quality. How do the incentives of collective brands to invest in reputation compare with those of umbrella brands? To address this question in our setting, consider an m partition each element of which is now a multiproduct firm which makes investment decisions for, bears the investment costs of and owns the the profits of each 'member' (product). Thus, if the umbrella brand is size m, and the price of each of its members (products) is p, the brand's revenue is pm. We compare the umbrella brand's investment incentives with those of the collective brand under no-monitoring.

In the case of collective brands under no-monitoring, the highest investment cost for which a BIE exists for an m partition is $\widetilde{e}_m = R^m - R^m_{-1}$. If the umbrella brand of size m invests in all its members, then its second period expected profit is $m(R^m - e)$. For the same reason, if it invests in only $m-1$ of its products, its profit is $m(R^m_{-1} - e) + e$. Thus an umbrella brand of size m invests in all its products if:

$$m(R^m - e) - m(R^m_{-1} - e) - e = m(R^m - R^m_{-1}) - e = m\widetilde{e}_m - e \geq 0$$

Thus, while a BIE exists for collective brands only if $e \leq \widetilde{e}_m$, in the case of umbrella brands it exists if $e \leq m\widetilde{e}_m$. Thus umbrella branding incentivizes investment more than collective branding.

The intuition for this is straightforward. In the cases of both collective brands and umbrella brands, a low quality realization of one member reduces the reputation of the entire brand. In the case of the collective brand, individual members are only concerned about how this affects the value of their own product. By contrast, the umbrella brand internalizes the effect of its investment in each of its products on the reputation of its entire product line.

3.4 Costly Monitoring

We have considered two polar regimes; *perfect monitoring*, in which only H firms which invest join H brands, and *no monitoring*, in which non - investors cannot be excluded from membership in H brands and therefore invest only if investment is individually optimal. Consider an intermediate case in which the brand cannot detect failure to invest and, accordingly, membership in an H brand requires a firm to incur a fixed cost of c to verify that it invests - for example by hiring a reliable external auditor to certify its investment[17]. Then, a brand member's profit is $R^m - e - c$ while the profit from standing alone is b. Thus, a BIE exists for the m partition if $R^m - (e + c) > b$. Thus, since R^m increases with m, investment incentives and H firms' profit increase with m, just as in the case of perfect monitoring without monitoring costs. Under this scenario, there is a minimal brand size - the brand must be large enough for reputational gains associated with increased size to cover monitoring costs in addition to investment costs. Alternatively, monitoring costs might reasonably increase with brand size. Under this scenario, the optimal brand size balances the decreasing marginal informational advantages of increased brand size against the increasing monitoring costs.

3.5 Applications

As discussed in the introduction, collective brands to which our analysis is applicable include regional agricultural products protected by designation of origin (PDO) and geographical indication (PGI) status. Use of geographical identification for products covered by these laws is restricted to those which actually originate from that particular area. From the perspective of our model, it is reasonable to interpret producers within the specified boundaries of a geographical region as being of the same 'type'. Although individual producers are autonomous enterprises, production is highly regulated and consumers generally identify the generic geographical name rather than those of individual producers. For example, the Champagne winemaking community, under the auspices of

[17] Alternatively and equivalently, the cost c is shared by all brand members.

the Comite' Interprofessionnel du vin de Champagne (CIVC), imposes a comprehensive set of rules and regulations specifying most aspects of viticulture for all wine produced in the region, including pruning, vineyard yield, the degree of pressing, and the time that wine must remain on its lees before bottling. Only wines which are locally produced and meet these requirements may be labelled Champagne and there is no evidence for exclusion of producers which do meet them. This industry description is broadly consistent with our model of collective branding under perfect monitoring - reputation for quality and prices increase with brand size within the confines of the geographical region.

Like regional agricultural brands, franchisees are independent firms which are designed to be highly standardized. Franchisors tend to monitor franchisees quite closely, by contractually requiring that the service be in accordance with the pattern determined by the franchisor, through field support, external service audits, peer review and consumer feedback (Spinelli Jr, Rosenberg, Birley, 2004).[18] One difference between these brands and agricultural brands is that franchisors typically collect a royalty from franchisees' revenues and thus, like umbrella brands, benefit from the investment of each outlet. In practice, in many cases, the royalty schedule is a small percentage; for example McDonald is 4 percent. In such cases, investment incentives should be quite similar to that of agricultural brands. When royalty schedules are relatively high, franchises shares characteristics of collective brands and umbrella brands which implies that incentives are closer to those of umbrella brands than pure collective brands like regional agricultural brands. In either case, our analysis suggests that franchise profits increase with brand size. Indeed, leading franchise chains are huge and seem to strive for unlimited growth.

For example, in the US alone, there are over 20,000 Subway, 14,000 McDonalds , 7000

[18] There is some evidence that monitoring by franchisors is imperfect. For example, Jin and Leslie (2008) show that within a chain, company owned restaurants tend to have better hygiene than franchisee owned restaurants, suggesting at least some free riding by franchisees on the chain reputation. Relatedly, Ater and Rigby (2012) show that chain outlets at locations in which repeat business is infrequent tend to be company owned, possibly to save on monitoring costs at locations in which individual incentives to free ride are particularly strong.

Pizza Hut, 11000 Starbucks and 13000 H&R Block tax preparation locations. [19]

4 Discussion

This paper has shown that collective branding may be a more effective means of incentivizing firms to invest in quality than individual branding. It is useful to review the role and importance of our main assumptions for this result.

Period 1 outcomes do not reveal firm type perfectly. If period 1 outcomes reveal firm type perfectly - i.e. $g = 1$ and $b = 0$ - then collective brands would not inform consumers more than stand alone firms and thus could not incentivize investment more than individual brands.

Two types of firms. If all firms are type H, and consumers don't observe investment, an IE could not exist for any investment costs if $g < 1$. Specifically, in an IE consumers believe that firms invest. Thus if if all firms are type H, consumers must attribute low quality at period 1 to 'bad luck'. Then period 2 prices would be independent of period 1 outcomes, obviating the incentive to invest. By contrast, with two types of firms, low quality outcomes are associated with type L firms and thus lead to lower period 2 prices.

Realized quality at different periods are independent random variables. This is a standard in models of reputational dynamics (e.g., Holmstrom (1999), Mailath and Samuelson (2001)). If period 1 quality perfectly predicted period 2 quality, consumers would not need additional information at period 2 and collective branding could not incentivize investment more than stand alone firms.

The brand can screen firm type better than consumers. Collective brands can inform consumers better than stand alone firms only if members of the same brand

[19] However, it should be noted that the number of chain outlets or locations can greatly exaggerate the number of "brand members" since franchisees often own multiple units. Indeed, the policy of many large chains is to actively encourage franchisees to take on multiple outlets. For example, Domino's Pizza and Subway offer reduced fees for franchisees that acquire further units (https://www.businessfranchise.com/special-features/multiple). According to NatWest/BFA Franchise Survey 2008, one fifth of franchisees own multiple units, with an average of seven units each.

are expected to be of the same type, which requires that the brand is able to screen firm type better than consumers. Absent this, collective brands could not incentivise investment more than stand alone firms. The reasonableness of this assumption was discussed above.

Other Signalling Mechanisms. Broadly, our analysis implicitly assumes that consumers can only learn about a firm's type based on its past performance - its reputation. In general, there may be other ways for firms to signal private information about quality. One possibility is price signalling. Bagwell and Riordan (1991) show that firms may use prices to signal quality if L and H firms have different production costs and some consumers are perfectly informed, which does not apply in our setting. Another possibility is warranties. If it is possible to objectively evaluate quality ex post and if variations in quality can be attributed in full to the producer, then warranties which compensate consumers in full when quality turns out to be low could serve as an alternative route to quality assurance. However, there are several reasons why this route may not be practicable. First, assessment of quality is often subjective and impossible or very costly to measure or verify in court while still being observed by consumers (in the parlance of contract theory, quality is often observable but not *verifiable*). Moreover, even if quality can be successfully and objectively proven, enforcing the warranty may involve costly (and uncertain) litigation, effectively obviating their value to consumers. It is also possible that firms may earn a reputation for honoring warranties. But forming such a reputation faces the same issues as forming a reputation for quality. Also, in many cases, a full warranty may run into moral hazard on the consumer side (see Tirole, 1988, p 106). If the eventual performance of a product depends on the way the consumer uses it as well as actual quality, consumers have little incentive to care if the product if they are confident of full reimbursement in case of breakdown.

One may wonder if, as the brand can screen firm type, it could certify firm type directly, without relying on reputational considerations? Again, while the brand may be able to recognize firm type, it seems unlikely that such information could be verified objectively to effectively exclude L firms from branding themselves as type H. Another possibility is third party certification. But this is costly and, as such certification would be paid for by firms, it may be subject to moral hazard and therefore unreliable. For example, following the financial crisis, a congressional panel accused credit rating agencies of issuing favorable assessments of mortgage-backed securities that proved to be worthless. In another notorious example, a private food safety auditing firm awarded the Peanut Corporation of America a "superior" rating shortly before the company's products caused a nationwide salmonella outbreak that killed nine people and sickened over 22,000.

More fundamentally, as was argued above, investment equilibria can only exist if consumers face residual uncertainty about firms' types. If brands could credibly certify firm type and consumers do not observe investment, then consumers would have to attribute low quality realizations of certified H firms to bad luck, rather than underinvestment. In that case a firm's period 1 outcome would not affect consumers' willingness to pay, obviating the incentive to invest! Thus, in our setting, reputation formation seems to be the most effective way for consumers to incentivize investment in quality.

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5 Appendix

5.1 Proof of Lemma 1

By equations (6), (7) and (9)

$$\begin{aligned}
R_H^m &= b+(g-b)\sum_{s=0}^{m}\binom{m}{s}g^s(1-g)^{m-s}\frac{rg^s(1-g)^{m-s}}{g^s(1-g)^{m-s}q+b^s(1-b)^{m-s}(1-r)} \\
&= b+(g-b)\sum_{s=0}^{m}\binom{m}{s}g^s(1-g)^{m-s}\frac{r}{r+(1-q)x_s^m} \\
&= b+(g-b)\sum_{s=0}^{m}\binom{m}{s}g^s(1-g)^{m-s}k_s^m
\end{aligned}$$

where

$$x_s^m \equiv \frac{b^s(1-b)^{m-s}}{g^s(1-g)^{m-s}} \quad \text{and } k_s^m \equiv \frac{r}{r+(1-r)x_s^m}$$

Let S be a binomial random variable with the parameters (m, g). Let

$$X^m \equiv \frac{b^S(1-b)^{m-S}}{g^S(1-g)^{m-S}} \quad \text{and } K^m \equiv \frac{r}{r+(1-r)X^m}$$

Note that

$$E(X^{m+1} \mid X^m) = g\frac{b^{S+1}(1-b)^{m-S}}{g^{S+1}(1-g)^{m-S}} + (1-g)\frac{b^S(1-b)^{m+1-S}}{g^S(1-g)^{m+1-S}} = bX^m + (1-b)X^m = X^m$$

implying that $X^1, X^2, X^3, ...$ is a martingale. Since $X^m \geq 0$, K^m is a strictly convex function of X^m, then by Jensen's Inequality, $EK^{m+1} > EK^m$. Hence,

$$R_H^{m+1} = b+(g-b)\sum_{s=0}^{m+1}\binom{m+1}{s}g^s(1-g)^{m+1-s}k_s^{m+1} > b+(g-b)\sum_{s=0}^{m}\binom{m}{s}g^s(1-g)^{m-s}k_s^m = R_H^m$$

which proves that R_H^m is increasing with m.

Substitute equations (6) and (7) into (8) yielding

$$\begin{aligned}
R_L^m &= b+(g-b)\sum_{s=0}^{m}\binom{m}{s}b^s(1-b)^{m-s}\frac{rg^s(1-g)^{m-s}}{g^s(1-g)^{m-s}r+b^s(1-b)^{m-s}(1-r)} \\
&= b+(g-b)\sum_{s=0}^{m}\binom{m}{s}g^s(1-g)^{m-s}\frac{qx_s^m}{qx_s^m+(1-q)}
\end{aligned}$$

Since $\frac{rX^m}{rX^m+1-r}$ is a concave function of X^m, by Jensen's Inequality

$$E\frac{rX^{m+1}}{rX^{m+1}+1-r} < E\frac{rX^m}{rX^m+1-r}$$

implying

$$\begin{aligned} R_L^{m+1} &= b + (g-b)\sum_{s=0}^{m+1}\binom{m+1}{s} g^s(1-g)^{m+1-s}\frac{rx_s^{m+1}}{rx_s^{m+1}+1-r} \\ &< b + (g-b)\sum_{s=0}^{m}\binom{m}{s} g^s(1-g)^{m-s}\frac{rx_s^{m}}{rx_s^{m}+1-r} = R_L^m \end{aligned}$$

which proves that R_L^m is decreasing with m. Thus and since by (10) $R^m - R_L^m = r(R_H^m - R_L^m)$, it is increasing with m. ■

5.2 Proof of Lemma 2

Proof: When $g = 1$, the $m-1$ investing firms produce high quality with certainty. If the mth firm doesn't invest it produces high quality with probability b, in which case its revenues (and that of every other member of the brand) are R^m. With probability $1-b$ it produces low quality in which case $s = m-1$ and, by equations (6) and (7) $\Pr(H^m \mid m-1) = 0$ and $p^m(s) = b$. Hence,

$$R_{-1}^m = r\left[bR_H^m + (1-b)b\right] + (1-r)R_L^m$$

Hence, and by equation (10) if $g = 1$,

$$R^m - R_{-1}^m = rR_H^m - r\left[bR_H^m + (1-b)b\right] = r(1-b)(R_H^m - b)$$

It follows that

$$\widetilde{\varepsilon}_m = R^m - R_{-1}^m = r(1-b)(R_H^m - b)$$

Since by Lemma 1 R_H^m is increasing with m, it follows that $\widetilde{\varepsilon}_m$ is increasing with m. ■

5.3 Proof of Proposition 4

The proof is using the following Claim.

Claim

$$R_H^m = \sum_{s=0}^{m-1}\binom{m-1}{s} g^s(1-g)^{m-1-s}\left[gp^m(s+1) + (1-g)p^m(s)\right] \tag{12}$$

Proof of the Claim: Let s' be the number of high quality units produced by any given group of $m-1$ members of an H brand of size m. Since the mth firm invests, it produces high quality with probability g and low quality with probability $1-g$. Hence, the brand produces $s'+1$ high quality units and receives a price of $p^m(s'+1)$ with probability g and produces s' high quality units and receives a price of $p^m(s')$ with probability $1-g$. Since the probability that $m-1$ members produce s' high quality units is $\binom{m-1}{s'}g^{s'}(1-g)^{m-1-s'}$ it follows that

$$R_H^m = \sum_{s=0}^{m-1}\binom{m-1}{s}g^s(1-g)^{m-1-s}\left[gp^m(s+1)+(1-g)p^m(s)\right]$$

which proves the Claim.

Using equations (10) - (12)

$$\begin{aligned}\widetilde{\varepsilon}_m &= R^m - R_{-1}^m = rR_H^m - r\sum_{s=0}^{m-1}\binom{m-1}{s}g^s(1-g)^{m-1-s}\left[(1-b)p^m(s)+bp^m(s+1)\right] \\ &= r(g-b)\sum_{s=0}^{m-1}\binom{m-1}{s}g^s(1-g)^{m-1-s}\left[p^m(s+1)-p^m(s)\right]\end{aligned}$$

Substituting for $p^m(s)$ from equations (6) and (7) and recalling from the proof of Lemma 1 that $x_s^m \equiv \frac{b^s(1-b)^{m-s}}{g^s(1-g)^{m-s}}$:

$$\widetilde{\varepsilon}_m = r(g-b)^2\sum_{s=0}^{m-1}\binom{m-1}{s}g^s(1-g)^{m-1-s}\frac{r(1-q)(x_s^m - x_{s+1}^m)}{\left[r+(1-r)x_{s+1}^m\right]\left[r+(1-r)x_s^m\right]}.$$

Substituting

$$x_s^m - x_{s+1}^m = \frac{b^s(1-b)^{m-s}}{g^s(1-g)^{m-s}} - \frac{b^{s+1}(1-b)^{m-s-1}}{g^{s+1}(1-g)^{m-s-1}} = \frac{b^s(1-b)^{m-s-1}}{g^s(1-g)^{m-s-1}}\left(\frac{1-b}{1-g}-\frac{b}{g}\right)$$

yields

$$\widetilde{\varepsilon}_m = r(g-b)^2\sum_{s=0}^{m-1}\binom{m-1}{s}b^s(1-b)^{m-s-1}\frac{r(1-r)\left(\frac{1-b}{1-g}-\frac{b}{g}\right)}{\left[q+(1-r)x_{s+1}^m\right]\left[r+(1-r)x_s^m\right]}.$$

Hence, and since $\lim_{m\to\infty}x_s^m=\infty$ and $\sum_{s=0}^{m-1}\binom{m-1}{s}b^s(1-b)^{m-s-1}=1$ it follows that

$$\lim_{m\to\infty}\widetilde{\varepsilon}_m = 0$$

and the lemma follows immediately. ■

5.4 Imperfect Screening

Let $\theta_h < 1$ be the probability that a type H firm is correctly identified by a brand and $\theta_l < 1$ the probability that a type L firm is correctly identified. Thus a member of an H brand is actually type H with probability θ_h and is actually type L with probability $1 - \theta_L$. We show that for large m, under perfect monitoring, collective branding can incentivize investment more than stand alone firms even if θ_h and θ_l are significantly less than 1. The probability that a randomly selected member of an H brand produces high quality is now $\pi_H = \theta_h\ g + (1 - \theta_l)b$ and the probability that a member of an L brand produces high quality is $\pi_L = \theta_l b + (1 - \theta_l)g$.

If a firm invests and turns out to be type H, it joins an H brand with probability θ_h and an L brand with probability $1-\theta_h$. Thus its expected revenue is $\theta_h p_h + (1-\theta_h)p_l$,where p_h and p_l are the expected prices of H and L brands respectively. If it invests and turns out to be type L, it joins an L firm with probability θ_l and an H brand with probability $1 - \theta_l$ and its expected revenue is $\theta_l p_l + (1 - \theta_l)p_h$. Thus the expected revenue of a firm which invests is $\widehat{R} = r(\theta_h p_h + (1 - \theta_h)p_l) + (1 - r)(\theta_l p_l + (1 - \theta_l)p_h)$. If a firm doesn't invest it must join an L brand and its expected profit is only p_l. Then an investment equilibrium exists if $e \leq \widehat{R} - p_l$. For large m, $p_h \rightarrow \pi_H$ and $p_l \rightarrow \pi_L$ and $\widehat{R} \rightarrow r(\theta_h \pi_h + (1-\theta_h)\pi_l) + (1-r)(\theta_l \pi_l + (1-\theta_l)\pi_h)$. For paramaters: $\{\theta_h = \theta_l = 0.9, r =$

$0.5, g = 0.9, b = 0.1\}$, $\widehat{R} - p_l \rightarrow 0.32$ for large m while it was seen in section 2 that for these paramters $e^* = 0.256$. Thus for large m there is investment if $e \leq 0.32$, while if firms stand alone there is investment only if $e \leq 0.256$, about a 25 percent increase in investment incentives. For the same paramaters, if $\theta_h = \theta_l = 0.85$, $\widehat{R} - p_l \rightarrow 0.28$, about a 9 percent increase.