Brand Competition in CPG Industries: Sustaining Large Local Advantages with Little Product Differentiation

Bart J. Bronnenberg*
UCLA Anderson Graduate School of Management
110 Westwood Plaza, Ste B418
Los Angeles, CA 90095
bart.bronnenberg@anderson.ucla.edu.

(first version 7 June 2006)

February 28, 2007

Abstract

In direct competition between national brands of consumer packaged goods (CPG), one brand often has a large local share advantage over the other despite the similarity of the branded products. I present an explanation for these large and persistent advantages in the context of local competition on perceived quality or brand image. The main result of the analysis is a relation between varying degrees of product similarity and equilibrium outcomes of local share advantages. Namely, I find that asymmetric quality positioning and associated local share advantages emerge especially when competing brands are objectively similar. Conversely, local share asymmetries based on brand positioning occur less when brands are dissimilar. This paper provides two reinforcing intuitions for this result. First, if brands are objectively similar, different levels of investment in local quality perceptions co-exist in the same market. Early movers will invest in high perceived quality, whereas late movers have less incentive to invest because of demand sharing and increased price competition. Second, if the local share advantages are divided up between competitors across markets, their persistence is reinforced by multimarket contact. Even if local brand building is free, firms may not want to improve perceived quality in their "weak" markets because it initiates retaliation by the competition in their "strong" markets. The increase in multimarket profits from collusion is larger when the products are similar, because price competition looms large.

JEL Classification: L11, L15, L22, L66, M30, R12

*I thank Ronald Cotterill from the Food Marketing Policy Center for the use of his data. Discussions with and comments from Pradeep Bhardwaj, Pradeep Chintagunta, Jean-Pierre Dubé, Vrinda Kadiyali, and Adam Rennhoff are acknowledged. The paper also benefited from comments made by seminars participants at Carnegie-Mellon University, Duke University, Emory University, Erasmus University Rotterdam, Northwestern University, the Wharton School, the University of California at Berkeley, the University of Michigan, and the University of Toronto. Errors are mine. A practitioner note based on an early version of this paper was written by Booz|Allen|Hamilton and is available from www.strategy-business.com/media/file/sb34_041-research_notes.pdf. This research was funded by NSF grant SES-0644761.

1 Introduction

Brands of consumer package goods (CPG) in the United States often lack meaningful product differentiation on attributes other than brand labels and would be difficult to correctly identify based on taste tests alone (Carpenter, Glazer, and Nakamoto 1994; Trout and Rivkin 2000). If two products are physically identical, except perhaps for brand labels, utility maximizing consumers should be relatively indifferent between them. All else equal, therefore, demand for such brands should be similar or at least not systematically different.

However, this simple intuition does not hold for CPG industries in two ways. First, it is not true that seemingly similar brands have the same market shares in a given market (local asymmetries). Second, the same national brand of repeat purchase goods often has very different market shares across different local markets, even after controlling for the influence of regional or local brands (spatial dispersion and spatial dependence). Consider Figure 1, which shows market shares for the two largest manufacturers of brands of Mexican salsa, Campbell and Frito-Lay, who sell the Pace and Tostitos brands, respectively. Both brands originate in Texas and offer very similar products. The figure demonstrates that the two firms have very different shares within markets. Across markets, the two firms seem to divide the domestic U.S. market in two territories, one for each brand. Tostitos dominates along the East Coast, whereas Pace leads west of the Mississippi. While local market-shares are clearly not constant across *markets*, they are in fact constant across *time.*[1]

Bronnenberg, Dhar and Dubé (2006) show that these patterns are commonplace in CPG industries such as coffee, mayonnaise, margarines, pickles, hotdogs, etc. Given any one market and given the similarity of most national brands in the aforementioned categories, the question addressed in this paper is: What sustains large local market advantages in the face of little product differentiation?

The answers provided in this paper are twofold and focus on the interaction of product similarity (horizontal differentiation) and firms' efforts to influence perceived quality (vertical differentiation). First, the absence of horizontal product differentiation, makes the presence of vertical product differentiation, i.e., differences in quality perceptions, effective in generating sales and profit. That is, I find that the lower the degree of horizontal product differentiation, the more profits increase in vertical differentiation. If quality perceptions are costly to raise, it can be

[1] This fact is illustrated by the fact that Figure 1 represents the annual averages of market shares for 1996, suggesting that the differences in share are not simply due to temporary local marketing programs.

Figure 1: Market shares of two leading manufacturers of mexican salsa

shown that one firm decides to invest in high quality perceptions whereas the other chooses not to invest. This is exactly what happens in many CPG industries. In each local market, a single or a small number of brands invest in quality perceptions through advertising and distribution whereas other products do not invest and play a fringe role (Bronnenberg, Dhar, and Dubé 2006). This creates local asymmetries where the first mover takes the high quality, high share position.

Second, I show that multimarket profits are higher when a brand's market shares have geographic variation. Thus if the national brands dominate in some markets but are dominated in others, they generally have an incentive to sustain this situation relative to having "average" share in all markets, something which requires a form of tacit collusion. It has been argued (Karnani and Wernerfelt 1985) that such multimarket coordination is at work in at least some CPG industries.

Common to these two explanations, I find that the less the degree of product differentiation, the more likely unequal perceived quality and market shares emerge in a given market and persist. In effect, by endogenizing local perceptions of product quality, the main finding of this paper is that when two products are objectively similar, market shares for these products will more likely be different. Conversely, when products are different, market shares are similar across geography, in the sense of globally reflecting objective quality differences rather than strategically managed perceptual deviations from this objective quality.

This paper aims, first, to make a contribution to the literature on horizontal and vertical differentiation (d'Aspremont, Gabszewics, and Thisse 1979; Neven and Thisse 1990; Shaked and Sutton 1981) by outlining how vertical differentiation can be implemented locally and how the willingness to invest in the local vertical attribute depends on the relative importance of the horizontal product attributes or the manufacturer's capacity to horizontally differentiate. Second, the paper aims to answer two fundamental questions about national brand competition. These are (1) When does (the regionalization of) market dominance emerge in CPG industries, and (2) Why does it persist? In the context of the first question, I find that local share asymmetry emerges when horizontal product differentiation is nearly absent or unimportant in the eyes of the customer and when quality perceptions are set locally at some cost. Regionalization of market dominance occurs in my model when these local share asymmetries span multiple contiguous geographical markets. In my model, this happens when there is regionalization of moving first in choosing quality. In turn, the spatial dependence in moving first may be the consequence of geographic roll-out strategies during product launch. In the context of the second question, I find that asymmetric shares for similar brands of packaged goods are stable when each firm has its own region of local brand dominance. In this case, each firm also has a multimarket incentive to sustain local differentiation on perceived quality. Third, an additional contribution of the paper is that I solve for the quality competition game within a logit demand system. Theoretical predictions from this demand system may be more directly testable in future empirical research.

The remainder of this paper is organized as follows. The next section reviews how consumers take non-product attributes such as advertising and distribution as perceptual cues for product quality in CPG industries. Section 3 discusses a family of demand models with local quality perceptions. Section 4 establishes the basic relation between profits, perceived quality and prices in a single market framework. Section 5 shows how asymmetric choices about local perceived quality emerge. It also links these results to sequential entry. Section 6 shows how market share asymmetries can be sustained in a multi-market setting, even when improving quality perceptions is free. Section 7 discusses several empirical examples and interprets the main results in the context of packaged goods. Section 8 concludes with future research directions.

2 Determinants of consumer quality perceptions

An important impetus to quality perceptions of consumer packaged goods remains of course the physical product itself. However, in this paper I allow brand awareness and distribution support such as shelf-space to have effects on perceived quality also.

There is ample support for advertising-driven quality inferences. For instance, Kirmani and Wright (1989) find a positive relation between advertising and consumer expectations about product quality. Further, brand awareness is often a determinant of choice, especially for low involvement decisions (Bettman and Park 1980; Hoyer and Brown 1990; Park and Lessig 1981). In economics, advertising is regarded to increase the willingness to pay for products (for a detailed overview of this large literature see, e.g., Sutton 1991). In addition, there is a large and important literature in economics linking persuasion advertising to inferences about product quality (Bagwell 2003; Caves and Greene 1990; Comanor and Wilson 1974).

There are also studies linking brand distribution and retail support to inferences about brand quality. Simonson (1993) finds that consumers construct preferences for non-durable goods at the point of purchase. In this light, it is reasonable to assume that new customers may take large shelf space allocations for brands as a cue that these brands are popular in a given local market. Therefore, more shelf space and retailer support likely leads to the perception of higher quality for consumer packaged goods. Even if consumers do not acquire brand information themselves (Dickson and Sawyer 1990; Hoyer 1984), broad distribution and shelf space may indirectly allow them to rely on the quality assessments of others.

In sum, while consumers in different markets may face the same physical product when considering a nationally distributed brand, perceptions about the quality of these brands are co-determined by local advertising and distribution (retailing) strategies of firms. Noteworthy in this context is that the U.S. is partitioned in more or less discrete population centers across which there is little consumer arbitrage.[2] This allows for branding strategies to be local. The next section considers a model in which 2 firms can control quality perceptions locally.

3 Model

3.1 Demand

Utility I use an address model of consumer demand. In this model, consumers h are characterized by a position $\mathbf{z}_h$ in a K-dimensional attribute space in $\mathbb{R}^K$. Consumers' ideal points $\mathbf{z}_h$ are not observed by the firm, but their distribution across h is known. Products $i = 1, 2$ are defined by a known address $\mathbf{z}_i \in \mathbb{R}^K$ in the attribute space. Consumers h have a quadratic disutility for distance between ideal points $\mathbf{z}_h$ and the location of products $\mathbf{z}_i$ (d'Aspremont, Gabszewicz, and Thisse 1979). Utility for brand i by household $h = 1, ..., N_m$ in market m is specified by

$$U_{ihm} = Y_h + a_{im} - p_{im} - \frac{\mu}{2} \sum_{k=1}^{K} (z_h^k - z_i^k)^2, \tag{1}$$

[2] In other words, it is generally too expensive for consumers to travel across advertising cells when buying supermarket products. Observationally, this is equivalent to the constraint that consumers are treated as immobile.

where Y_h is income of household h. The local quality attribute a_{im} is a quality perception that is influenced by positioning in the distribution and communication channel and is controllable at the market level. p_{im} is the price of the product in market m. The scalar μ measures the consumer's disutility of products being far away from his ideal point.

Quality perceptions We use the term quality perceptions to allow for the idea that a_{im} is not just driven by objective product characteristics but also by local investments by the firms in regional advertising or shelf-space allocations by retailers.

Brand positions in the physical attribute space I assume that there is one physical attribute z_i^k ($K = 1$). The physical attribute, z_i, is common to all consumers in a market. To rule out a demand-focused explanation of asymmetries, I initially assume that the location of products and consumers is symmetric around zero. Owing to the presence of the multiplier μ, it can be assumed without loss in generality that the position of brand 1 is given by $-\frac{1}{2}$ and of brand 2 by $+\frac{1}{2}$.

Location of consumers' ideal points in attribute space The consumer ideal points $z_h \in \mathbb{R}$ represent the idiosyncratic component of utility. I assume the logistic density for the location of consumers

$$g(z) = \frac{\exp -z}{(1 + \exp -z)^2}, z \in \mathbb{R}^1. \tag{2}$$

Demand Consumers choose that alternative that maximizes their utility. Demand for product i among N_m consumers in market m is thus obtained by integrating the utility equation (1) over the support of product i using the consumer density of equation (2). The utility components Y_h and z_h^2 do not affect choice (they are common to all alternatives). Given the symmetric positions, the utility component z_i^2 ($i = 1, 2$) also drops out of the utility comparisons. What remains is the interaction $z_h z_i$ of the location of consumers and products. Thus the location of the consumers enters the utility comparison as a linear term, and hence demand is given by a logit model.

$$\begin{aligned} s_{im} &= N_m \Pr(U_{ihm} \geq U_{jhm}) \\ &= N_m \frac{\exp[(a_{im} - p_{im})/\mu]}{\sum_{\forall j} \exp[(a_{jm} - p_{jm})/\mu]}, i, j = 1, 2 \end{aligned} \tag{3}$$

For convenience and because its role turns out to be largely passive, markets are all of equal size and total market size is normalized such that $N_m = 1$.

The logit demand formulation has broad appeal in both theoretical (e.g., Anderson, de Palma, and Thisse 1992), as well as empirical work (e.g., Berry, Levinsohn, and Pakes 1995). It is noted that with a uniform distribution for $g(z)$, a linear demand structure is obtained. The results of our analysis generalize to this model. If μ approaches 0, the demand model in equation (3) becomes a vertical model (also called the neoclassical model – see Anderson, de Palma and Thisse 1992, p. 45).

Because I initially wish to separate margin and multi-market contact effects from demand expansion, the model used here does not account for an outside good. This may be justified by realizing that for mature categories such as coffee, Mexican salsas, and alike, demand expansion in response to price changes is small (Nijs et al 2002). Nonetheless, it is desirable to explore the robustness of the main results to the introduction of an outside good. After establishing several results with the standard model, these results will be shown to generalize to the case of demand with an outside good.

3.2 Supply

Marginal costs c_{im} are assumed to be constant and independent of perceived quality. Instead, the cost of creating quality perceptions through advertising and/or distribution is fixed (see, e.g., Anderson, de Palma and Thisse 1992; Bagwell 2003; Sutton 1990). Investments in perceived quality are denoted $K(a_{im})$ and may depend on a_{im}.

4 Analysis

4.1 Perceived quality and prices.

Of initial interest is how perceived quality, a_{im}, affects prices, p_{im}, and profits, π_{im}. In this section, firms compete by first simultaneously deciding how much to invest in quality perceptions a_{im}. Conditional on these choices, firms next simultaneously set prices. Marginal cost c_{im} is initially quality-independent and fixed cost K_{im} is initially zero. Thus, for now, firms can increase perceived quality at no additional cost. Later this assumption will be relaxed.

The profit function for brand i in market m is $\pi_{im} = (p_{im} - c_{im}) \cdot s_{im} - K_{im}$. Given the sequence of decisions, prices are solved first. Caplin and Nalebuff (1991) have shown that a unique Bertrand-Nash equilibrium in prices exists for the demand system in equation (3). The first order condition (f.o.c.) for firm i is equal to

$$\frac{d\pi_{im}}{dp_{im}} = (p_{im} - c_{im}) \cdot s'_{im} + s_{im} = 0, \tag{4}$$

and from this, the implicit equation for the prices of interest is

$$p^*_{im} - c_{im} = \frac{\mu}{1 - s_{im}}, \; i = 1, 2. \tag{5}$$

The price equations are implicit because the right-hand side of the expression for the markup contains prices p_{im}, and perceived quality a_{im} (through s_{im}). Using the last equation to solve for s_{im} and substituting in the profit function gives that at optimal prices

$$\pi_{im}^{*} = p_{im}^{*} - c_{im} - \mu - K_{im}. \tag{6}$$

Define the local perceived quality gap as $a_m \equiv a_{1m} - a_{2m}$. Two useful dependencies of local prices (and profits, given the last equation) on this quality gap are:

Proposition 1 (Optimal Prices)

1. *The price of brand 1 increases and that of brand 2 decreases in a_m.*
2. *The price increase (decrease) is never larger than the increase in the perceived quality differential, i.e.,*

$$0 < \frac{dp_{1m}^{*}}{da_m} < 1, \ \ and \ -1 < \frac{dp_{2m}^{*}}{da_m} < 0$$

Proof: see appendix A

Thus, the price for either brand increases as its perceived quality advantage over the other brand widens. However, neither brand will adjust its price in equal measure to improvements in perceived quality. Consumers get at least part of the utility stemming from the perceived quality improvement. For a related result, see Anderson, de Palma and Thisse (1992), and Anderson and de Palma (2001).

The next proposition considers the comparative statics in the second-stage of the game to provide intuition for the effects of the vertical attribute on pricing and profits, and it provides the basis for the main results in the paper.

Proposition 2 (Perceived quality) *Prices and profits are convex in the perceived quality gap, a_m.*

Proof: see appendix A

Namely, first, as the perceived quality gap between two brands widens, the marginal effect of a_m on prices and profits increases.[3] Proposition 2 therefore implies that low perceived quality brands are less impacted by an increase in perceived quality, than high perceived quality brands are impacted by a comparative decrease. As a consequence, the latter is willing to pay more

[3] The result is not specific to the logit demand function. A linear demand function is obtained by replacing equation (2) with $g(z) = 1$, $z = [-1/2, .., 1/2]$. Then, profits at optimal prices can be shown to equal $\pi_1 = \frac{1}{18}\frac{(3\mu+a_m)^2}{\mu} - K(a_{1m})$ and $\pi_2 = \frac{1}{18}\frac{(3\mu-a_m)^2}{\mu} - K(a_{2m})$, with $a_m = a_{1m} - a_{2m}$. From this formulation, it is clear that the proposition replicates. The convexity result may not hold for other demand systems.

for sustaining a perceived quality gap than the former is willing to pay for closing it, thereby providing the motivation for why asymmetries emerge in the market.

Second, in the case of multiple markets, firms can set a_{im} in each market. By Jensen's inequality, the convexity result then implies that two firms, competing on M markets, would prefer to have a distribution of market-specific quality gaps a_m over an average vertical positioning difference of $\bar{a} = \frac{1}{M}\sum a_m$ in each market.

Before showing that these arguments can produce stable market outcomes, it is useful to formalize and discuss the interaction of horizontal differentiation μ and vertical differentiation $a_m = a_{1m} - a_{2m}$ in the model I consider

Proposition 3 (Interaction)
The marginal effect of quality improvements on profits diminishes in horizontal differentiation for the quality leader but increases for the brand lagging in perceived quality, i.e.,

$$\frac{d}{d\mu}\left(\frac{d\pi_{im}}{da_{im}}\right)\begin{cases} < 0 & if \quad a_{im} > a_{jm} \\ > 0 & if \quad a_{im} < a_{jm} \end{cases}$$

Proof: see appendix A

To illustrate this proposition, consider two extreme cases. First, for μ very small (limiting to 0), the leading firm will price its quality advantage almost completely to the market and still capture all demand. Thus, $\frac{d\pi_{im}}{da_{im}}$ approaches 1 for this firm. For the firm that has the lower perceived quality and zero demand, increasing its quality has no consequence (the quality leader would just drop its price and still get all demand), i.e., $\frac{d\pi_{im}}{da_{im}}$ approaches 0 for the firm that lags in quality. Thus, when products are similar, the lagging firm has no incentive to invest in quality, whereas the leading firm has a positive pay-off to investments in quality.

Second, for $\mu > 0$, there are customers to whom the lower quality product is preferred because it is closer to their ideal points. The leading firm now sets prices taking into account not only the perceived quality advantage but also the adverse quantity effect of pricing too high. The marginal effect of a quality improvement on prices and profits is therefore less than 1. For the lagging firm, the effect of a quality improvement is no longer 0 but positive. I subsequently show (in proposition 5 below) that in the limit, as $\mu \to \infty$, the marginal effect of a quality improvement by both the leading and the lagging firm on profits is $\frac{1}{3}$. Proposition 3 therefore means that as μ increases from 0 to infinity, the marginal effect of perceived quality improvements by the high quality provider on profits continuously decreases from 1 to 1/3 in the case of the higher quality brand and increases from 0 to 1/3 in the case of the lower quality brand.

In sum, when there is little horizontal differentiation, the incentives to maintain/dissolve differences in perceived quality are very different for the high vs. the low quality firm. In contrast, if there is sufficient horizontal differentiation, then the player with the high perceived quality has the same incentive to maintain the quality gap as the low perceived quality player has to close it. It is this contingency that makes that asymmetries in quality choices depend on the existing degree of horizontal product differentiation.

4.2 The case of a single market and free quality improvements

Before showing the existence of asymmetric equilibria and their dependence on μ, I first present a benchmark result against which to compare results later. In this benchmark case, I assume again that fixed cost is zero ($K = 0$). In this case, firms will end up positioning symmetrically at the highest possible quality level (say a_H).

Proposition 4 (Single Market) *In the single market equilibrium both firms position at a_H and charge a price of $c + 2\mu$. Profits are equal to $\mu - K$.*

Proof: see appendix A

That is to say, given proposition 1 both brands choose to set perceived quality as high as possible. As a consequence, both brands set equal prices and have equal market shares. The role of μ in this case is that, as expected, profits and prices rise in the degree of horizontal differentiation.[4] In other words, if horizontal differentiation is effectively absent, price competition will drive margins to zero.

I now consider how the above result can be avoided as a function of several realities of brand competition in packaged goods industries: (i) absence of strong horizontal differentiation, (ii) quality perceptions are costly to obtain, (iii) firms meet in multiple geographic markets and may have a first mover advantage in all or part of these markets.

5 Local asymmetries from competition in costly quality perceptions

5.1 Prices

Consider a single market (drop the subscript m momentarily) and fixed costs $K(a_i)$ that depend on the local level of perceived quality a_i. The costs $K(a_i)$ represent investments in quality

[4] Soberman (2005) shows however that in a single market, if consumers differ with respect to their awareness of products, the monotonicity of profits in differentiation may not hold.

positioning (e.g., through advertising or incentivising retailer support). Consumer response to investments in quality perceptions is assumed to be S-shaped (e.g. Dubé, Hitsch, and Manchanda 2005; Little 1979; Villas-Boas 1993). Under fairly general assumptions about cost, this implies that firms would not consider other levels of perceived quality than a_ℓ or a_h, with $a_h > a_\ell$, and where a_ℓ is the quality perception when the firm makes no investment. For instance, if response is sufficiently S-shaped, e.g., as in Villas-Boas (1993), a firm will only consider not investing or investing at where the threshold in response occurs. The assumption that $K(a_\ell) = 0$ also ensures that more than one firm enters in the market. Consumer response at zero investment a_ℓ does not lead to zero demand (e.g., demand is non-zero, even at zero advertising; see, e.g., Little 1979).

As before, firms first set perceived quality a_{im} simultaneously and next choose prices. Demand for brand i is given by equation (3). In a single market context, profit for each of the manufacturing firms is equal to

$$\pi_i = s_i \left(p_i - c\right) - K\left(a_i\right) \tag{7}$$

From the first-order conditions, prices are equal to

$$p_i^* = c + \frac{\mu}{1 - s_i}, \tag{8}$$

whereas profits at optimal prices can be expressed as

$$\pi_i^* = \frac{\mu s_i}{1 - s_i} - K\left(a_i\right). \tag{9}$$

5.2 Perceived quality

Asymmetric positioning Consider first the case where brand 1 is positioned at a_h while brand 2 is positioned at a_ℓ. When is this an equilibrium? Profit at the optimal prices computed above is for brand 1 equal to $\pi_1^* = \mu\Phi - K\left(a_h\right)$, with $\Phi = \dfrac{s_1}{1 - s_1}$. The ratio Φ is the ratio of the demand for the high perceived quality brand over the low perceived quality brand, and it depends on the perceived quality gap $a_1 - a_2$ and on the price gap $p_1 - p_2$ between firms in a market. Proposition 1 implies that $\Phi > 1$, because the brands are priced such that consumers receive at least a part of the utility stemming from quality improvements. Suppose firm 1 considers repositioning to a_ℓ. If so, it shares the market evenly with firm 2 (which is also positioned at a_ℓ) and, from equation 9, its profits would equal $\mu - K(a_\ell)$. Thus, firm 1 will not reposition to a_ℓ as long as $\mu\Phi - K\left(a_h\right) > \mu - K(a_\ell)$.

Firm 2, positioned "low," will not reposition if the payoff of sustaining a_ℓ is larger than that of repositioning to a_h. This implies that $\mu\Phi^{-1} - K(a_\ell) > \mu - K(a_h)$. By combining these results, and substituting that $K(a_\ell) = 0$ neither firm has an incentive to deviate from asymmetric positioning as long as

$$\mu\left(1 - \Phi^{-1}\right) < K(a_h) < \mu(\Phi - 1). \tag{10}$$

Note that $\mu\left(1 - \Phi^{-1}\right) < \mu(\Phi - 1)$ because $\Phi > 1$. Thus, there always a level of fixed costs $K(a_h)$ that makes asymmetric positioning an equilibrium.

Symmetric positioning With symmetric positioning at a_ℓ, the profits for both firms are $\pi_i^* = \mu - K(a_\ell)$. If either firm repositions to a_h, profits of that firm will be $\mu\Phi - K(a_h)$. Thus, if $K(a_h) > \mu(\Phi - 1)$, then repositioning will not occur and a symmetric equilibrium with both firms positioned at a_ℓ holds. Following similar logic, a symmetric equilibrium at a_h is obtained when it is not profitable for either firm to reposition to a_ℓ. This happens when $K(a_h) < \mu\left(1 - \Phi^{-1}\right)$.

The following proposition applies.

Proposition 5 (Costly quality perceptions – single market)

1. (a) *Both brands are positioned symmetrically at a_h if $K(a_h) < \mu\left(1 - \Phi^{-1}\right)$.*
   (b) *Brands are positioned asymmetrically with one at a_h and the other at a_ℓ if $\mu\left(1 - \Phi^{-1}\right) \leq K(a_h) \leq \mu(\Phi - 1)$.*
   (c) *Both brands are positioned symmetrically at a_ℓ if $K(a_h) > \mu(\Phi - 1)$.*
2. (a) *The range of cost $K(a_h)$ over which asymmetric positioning is the only equilibrium decreases monotonically in μ,*
   (b) *with the following limiting bounds*

$$\begin{aligned}
\lim_{\mu\downarrow 0}\left\{\mu\left(1 - \Phi^{-1}\right), \mu(\Phi - 1)\right\} &= \{0, a_h - a_\ell\} \\
\lim_{\mu\to\infty}\left\{\mu\left(1 - \Phi^{-1}\right), \mu(\Phi - 1)\right\} &= \{(a_h - a_\ell)/3, (a_h - a_\ell)/3\}
\end{aligned}$$

Proof: see appendix A

In sum, if it is cheap enough to position at a_h, all firms will do so, whereas if it is too expensive then neither firm will. However, over an intermediate range of cost of investing in quality, one brand will position at a_h and the other at a_ℓ.Thus the cost of "local branding" $K(a_h)$ can cause an asymmetric equilibrium between firms to emerge in a single market. The asymmetry is due to the differences in returns on investment in perceived quality between the high quality and the low quality player discussed in section 4.

The second part of the proposition holds that asymmetric positioning of brands occurs under more general conditions on cost when the degree of horizontal differentiation diminishes.[5] The range $\left\{\mu\left(1-\Phi^{-1}\right),\mu\left(\Phi-1\right)\right\}$ in the second part of the proposition marks the upper and lower limit on costs $K\left(a_h\right)$ for which asymmetric market shares will result. This range can thus be interpreted as a measure of the generality with which an arbitrary cost function $K(a)$, $a>0$, obeys $\mu\left(1-\Phi^{-1}\right)\leq K\left(a_h\right)\leq\mu\left(\Phi-1\right)$. If it is wide, any cost differential will support an asymmetric market outcome as the only equilibrium outcome. The proposition states that when products are objectively the same, $\mu\downarrow 0$, the range is widest. Conversely, if horizontal differentiation is more substantial, the cost range will narrow, reducing the support for asymmetric equilibria, in the limit eliminating it completely.

The proposition above shows the emergence of asymmetric market shares, but makes no prediction about who will choose a_h and who will choose a_ℓ. To resolve this, the next proposition considers the case where firms set perceived quality sequentially and next compete on price simultaneously. With these assumptions, I am trying to model the scenario where one firm is the leader in quality choices, but conditional on quality positioning, a Nash pricing game is played.

Proposition 6 (Sequential moves)

1. (a) *If* $K\left(a_h\right)<\mu\left(1-\Phi^{-1}\right)$, *both firms will choose* a_h *and moving first has no impact on equilibrium outcomes*
   (b) *If* $\mu\left(1-\Phi^{-1}\right)\leq K\left(a_h\right)\leq\mu\left(\Phi-1\right)$ *the first mover in quality will set perceived quality at* a_h *and the late mover will set perceived quality at* a_ℓ.
   (c) $K\left(a_h\right)>\mu\left(\Phi-1\right)$, *both firms will choose* a_ℓ *and moving first has no impact on equilibrium outcomes*

Proof: see appendix A

The first and third case simply echo proposition 5 that when it is sufficiently costly (cheap) to invest both players will play a_ℓ $\left(a_h\right)$.However, when asymmetric equilibria occur, it is always advantageous for the first mover to choose the higher quality perception a_h. Consequently, the follower will choose a_ℓ.

5.3 Graphical interpretation and discussion

In the preceding section, I find that when otherwise undifferentiated firms compete on perceived quality, vertical differentiation emerges endogenously. Figure 2(a) illustrates this finding from the

[5] This result holds also when equation 2 is replaced by $g(z)=1$, $z=[-1/2,...,+1/2]$. In that case demand is linear and the region over which asymmetric choices of quality hold is equal to, $\frac{\Delta a}{3}-\frac{(\Delta a)^2}{18\mu}<K\left(a_h\right)<\frac{\Delta a}{3}+\frac{(\Delta a)^2}{18\mu}$. Clearly, this region widens (monotonically) as μ becomes smaller.

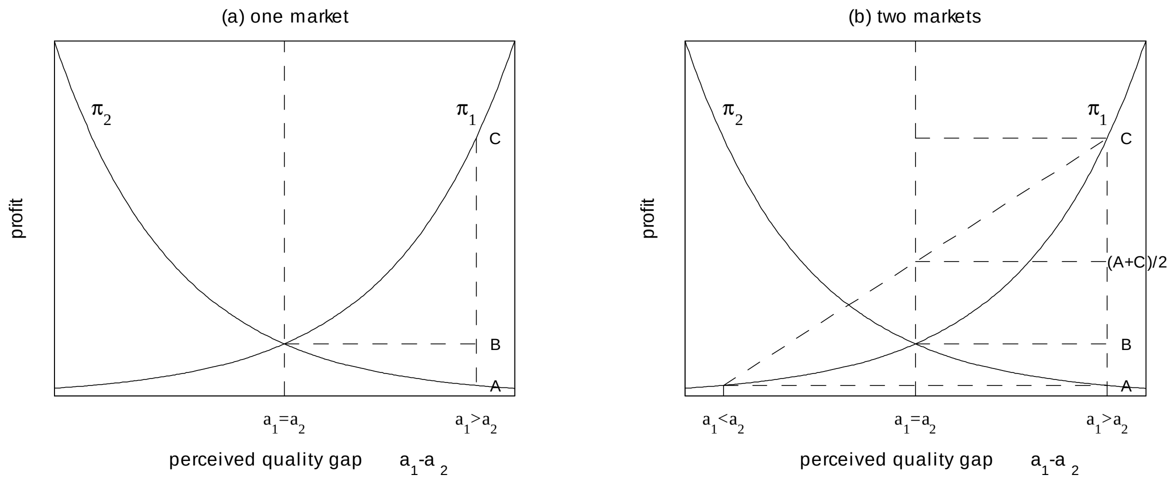

Figure 2: Convexity of profits in quality and asymmetric equilibria

result that profits are convex in differences in perceived quality $a_1 - a_2$. In this example, if firm 1 is positioned at $a_1 = a_h$, and firm 2 is positioned at $a_2 = a_\ell$, then the profit for firm 1 is equal to C $(= \mu\Phi)$. At this combination of quality levels, profits for firm 2 are A $(= \mu\Phi^{-1})$. If both firms have the same level of quality then both of their profits are equal to B $(= \mu)$. The maximum firm 2 is willing to pay for repositioning to a_h is the difference in profits $B - A$, whereas the maximum firm 1 is willing to pay to remain at a_h is equal to $C - B$. Therefore, as long as the cost to produce a_h is between $B - A$ and $C - B$, different quality choices are the equilibrium. The second part of proposition 5 implies that the difference between the intervals $C - B$ and $B - A$ decreases in μ.

Thus, the existence of different market shares for brands selling close substitutes within a market, can be explained as the competitive outcome of making investments in perceived quality, e.g., local brand building. The local distribution of perceived quality depends on the primitives in the model: (i) the cost of high perceived quality $(K(a_h))$, (ii) the degree of horizontal product differentiation μ, (iii) and order of entry. My results can be summarized as follows:

Quality costs The benefit of assuming an S-shaped response in a_{im} is that under general conditions only two levels of perceived quality need to be considered. Under this assumption, the results in this section hold with an arbitrary cost function. Yarrow (1989) considered the specific case of $K(a) = \exp(a)$, and also finds that local asymmetric quality choices may emerge. He does not consider the geographic patterns in CPG brand competition, the effect of sequential quality choices, or as we do momentarily, multimarket contact.

Horizontal differentiation The emergence of asymmetric choices of perceived quality is more general when goods are horizontally undifferentiated. The intuition behind this dependence on μ is that when goods are undifferentiated and quality perceptions are expensive to obtain, there is only "room" for one high quality player in the market. The low quality player realizes there is nothing to gain from imitating the high quality player. In CPG industries, where demand expansion is small compared to gains from substitution, copying the high quality player would result in lower demand and lower margins than the high quality player currently has. These beliefs about expected profits from quality improvements effectively turn the investment in perceived quality by the first mover into a "barrier to copy."

Order of entry When firms move sequentially in setting quality perceptions, the asymmetric equilibria are characterized by the first mover taking the higher quality positioning. In Moorthy (1988), the asymmetric equilibrium is also interpreted to offer a possible advantage to the first entrant. However, in my case, a first mover advantage in perceived quality only emerges strategically when μ is small enough, i.e., only when products that are horizontally similar. In other cases, the analysis suggest that perceptual differences will be absent or competed away. Consistent with this prediction, Golder and Tellis (1993) report that first mover advantages are larger and more persistent for non-durable products than for durable products.

Finally, in CPG industries, perceived quality, retail support, or brand awareness can all be set at a local level. Hence, as a consequence of CPG products often being objectively similar and rolled out gradually over geography so that different firms often have a first mover in different regions (see, e.g., Bronnenberg, Dhar and Dubé, 2006), the central results in this section provide a theoretical basis for why cross-market variability in brand shares in the U.S. emerges.

5.4 The purely vertical model

A special case occurs when $\mu = 0$. This section points out that the prices and quality levels from the logit demand model when $\mu > 0$ are right continuous in μ so that the pure vertical case is a limiting case of the logit demand system already analyzed.

If $\mu = 0$, the demand model in equation (3) becomes the following vertical model

$$s_1 = \begin{cases} 1 & \text{if} \quad a_1 - p_1 > a_2 - p_2 \\ 1/2 & \text{if} \quad a_1 - p_1 = a_2 - p_2 \\ 0 & \text{if} \quad a_1 - p_1 < a_2 - p_2 \end{cases}, \tag{11}$$

where demand is shared between the two players if consumers have the same utility for the two products. Demand for firm 2 is the complement of s_1. What is the outcome of the quality-game in this case? Assume again that a two stage game is played, wherein quality is chosen first and prices second. We maintain the same assumptions about perceived quality, i.e., quality perceptions can be a_h or a_ℓ with $a_h > a_\ell$, with a_ℓ the resulting quality perception when no quality investments are made ($K(a_\ell) = 0$).

Consider a candidate equilibrium where one player chooses a_h and charges an arbitrary amount less than $p_h = c + a_h - a_\ell$, whereas the other sets quality at a_ℓ and charges $p_\ell = c$. At these price, demand for the first firm is 1 and the demand for the second firm is 0.

Given the asymmetric choices for quality, can either of the players improve their profits by changing price? The first player will not raise prices because it will loose its demand to the second player. It will also not cut prices because doing so decreases margins but does not raise demand which is already 1. The second player will not lower prices for it would sell under cost. It will not increase prices because profits will not rise from doing so. Consequently, neither has a profit incentive to choose a different price, i.e., the prices are subgame perfect.

Next, consider quality choices. If the first player charges slightly less than p_h, it will capture all demand. At this price, it makes a profit contribution of (before fixed cost) of $(p - c) \cdot s = a_h - a_\ell$. So, as long as the investment in quality does not exceed $a_h - a_\ell$, the first player will not consider cessation of investment in high quality perceptions. The second player will not consider investing in quality because at the quality chosen by firm 1, it can maximally charge c and hence its profit contribution is 0. It will effectively sit idle, positioning at a_ℓ and charging c but not actually sell anything.

The prices and qualities of the vertical model turn out to be equal to the limiting prices and qualities of the logit model. Specifically, equation (8) shows that the optimal price under logit demand is $c + \mu/(1 - s)$. From the definition of Φ, we can rewrite this as $c + \mu(1 + \Phi)$ for the high quality player and $c + \mu\left(1 + \Phi^{-1}\right)$ for the low quality player. Using the proof of proposition 5, it can be shown that these prices tend to $c + a_h - a_\ell$ and c, respectively, as μ approaches 0 . The quality choices derived in propositions 5 and 6 continue to hold in the case when $\mu = 0$. The central condition on cost in proposition 5, that is $\mu\left(1 - \Phi^{-1}\right) \leq K(a_h) \leq \mu(\Phi - 1)$, limits to $0 \leq K(a_h) \leq a_h - a_\ell$. Indeed, if the cost for the high quality player is in this interval, asymmetric equilibria exist. In the same vein, it is easily checked that the result from proposition 6 continues hold, except that the first case in this proposition never applies at $\mu = 0$.

In sum, the logit demand model with quality choices continuously approaches the vertical model in μ. In addition, the optimal prices and quality levels implied by the logit demand model continuously approach those of the vertical model as products get more and more similar, i.e., as $\mu \downarrow 0$.

6 Sustaining historical asymmetries through multi-market contact

An independent but reinforcing argument for the results in the previous section arises from the practice, common in the domestic CPG sector, that firms meet each other in multiple markets. This creates the possibility of coordination between firms (Bernheim and Whinston 1990). To provide an analytic foundation for a discussion about collusive multi-market equilibria, I make the following assumptions.

First, there are two firms, two markets, and again two levels of perceived quality: high (a_h) and low (a_ℓ).

Second, as is usual in a multi-market contact framework, firms are allowed to interact repeatedly over time (Bernheim and Whinston 1990; Karnani and Wernerfelt 1985).[6]

Third, to show how the consideration of multiple markets and repeated interaction broadens the cases where asymmetric equilibria occur, I will assume that firms can increase perceived quality from low to high at no cost. This constitutes the cost scenario where I previously found that both firms will always position symmetrically at a_h and it is also the scenario where firms are most tempted in the short run to choose a high perceived quality level a_h. The idea behind this assumption is that if asymmetries are sustainable in a multimarket setting, even if it is free to improve quality, they will surely be sustainable if it is costly to improve from a low to a high perceived quality brand.

Fourth, each firm is endowed with one market in which it is the sole provider of a high perceived quality product and one market in which it is the sole provider of a lower perceived quality product. This pre-existing condition is exogenous to the analysis. The subsequent analysis therefore applies to the local advantages derived in the previous section, but it is noteworthy to observe that it also applies to a broad class of local advantages, even those that are fleeting.

As before, firms each maximize multi-market profits by choosing perceived quality a_{im} first

[6] Comparisons to the single period single market game in the previous section are thus not immediate. However, unless consumers accept the idea of each firm taking periodic turns at being the "high-quality" player, a single market repeated game will result in the same equilibrium as the single period game.

and setting prices p_{im} next. Figure 2(b) shows the profit functions π of firms 1 and 2, in a two-market scenario. In the market where firm 1 is positioned at a_h (and firm 2 at a_ℓ) it makes a profit of C. In the other market it is positioned at a_ℓ (and firm 2 at a_h) and makes profits of A. However, if it is free to do so, firm 1 will be tempted to improve quality in the market where it is lagging, because this increases its current multimarket profit (i.e., $B + C > A + C$). I assume that the consequence of not colluding is to remain positioned symmetrically in both markets at a_h forever. First, this is optimal in the short run, if a_h comes at no cost. Second, this is consistent with the idea that when firms have eliminated the perceived quality gap between two brands, such a gap is not easily recreated. In sum, firms in this argument are represented as trading off an immediate profit improvement in their lagging market from A to B with future profit deterioration in strong markets from C to B.

Let π_1^* denote multimarket profits with asymmetric positioning, i.e., $\pi_1^* = A{+}C = \left(\Phi^{-1} + \Phi\right)\mu - 2K$ (with Φ as defined before). The payoff for a one-time deviation for firm 1 is $\pi_1^d = B + C = (1 + \Phi)\,\mu - 2K$. After firm 2 observes that it is attacked in its best market by firm 1, next period it optimally repositions in market 1 from a_ℓ to a_h. The payoff for both firms is now equal to $\pi_i^0 = B + B = 2\mu - 2K$ forever. The following proposition holds:

Proposition 7 (multimarket contact)

1. *If both firms each have a market in which they lead, they both make more profits than if they share each market equally.*
2. *The minimum discount factor, i.e., future valuation, that resists short term deviation and sustains the local asymmetries is equal to the ratio of each firm's smaller and larger market share, i.e.,* $\delta^* = \Phi^{-1}$
3. *The minimum discount factor needed to sustain local asymmetries (δ^*) increases monotonically from 0 in μ, the degree of product differentiation.*

Proof: see appendix A

The first part of the proposition states that $\pi_i^* > \pi_i^0$, i.e., that there is always a profit incentive to sustain spatial concentration of demand. As stated before, this result is implied by proposition 2. Indeed, with asymmetric positioning for both firms in both markets, the perceived quality gap in market 1 is $a_h - a_\ell$, whereas in market 2 it is $-a_h + a_\ell$. The positioning difference when both competitors position at a_h is equal to 0 in both markets. It follows from the proposition that for both firms $\pi(a_h - a_\ell) + \pi(-a_h + a_\ell) > 2\pi\,(0)$.

The second part of the proposition notes that in order for the multimarket collusion to hold, the discount rate has to exceed Φ^{-1}. Given that $\Phi > 1$ by construction, it follows that $0 < \delta^* < 1$.

As a matter of interpretation, the more asymmetric existing outputs are, the less forward looking managers need to be to sustain them.

The third part of the proposition is based on the result that $\partial\delta^*/\partial\mu > 0$. This result implies that as markets are less and less differentiated, even myopic managers will resist the temptation to reposition to gain higher perceived quality. This is for 2 reasons. First, the post-deviation drop in profits $C - B$ in Figure 2 from competing head-to-head will become larger with less product differentiation, i.e., the long term punishment increases as μ decreases. Second, the short term incentive to deviate $B - A$ will go to zero as μ becomes smaller, i.e., the short term benefit of deviation decreases.

The interpretation of this result is that once a CPG industry has a geographic distribution of leading brands, for instance because order-of-entry was geographically distributed (Bronnenberg, Dhar and Dubé, 2006), these leading brands have an incentive not to compete too fiercely in the markets where they are lagging for fear of "commoditizing" the market, which would make all firms worse off in the future.

7 Discussion

7.1 Interpretation of different equilibria

It is instrumental to summarize the different cases that we have considered in the previous sections on single and multimarket equilibria. Figure 3 summarizes the results in this paper by outlining the equilibria that exist for alternative values of the three variables of our competitive analysis of the CPG industry: (i) the costs of creating local perceived quality $K(a_h)$, (ii) the degree of objective horizontal differentiation μ, and (iii) the sequence of choosing quality.[7] To visualize the results, we use a numerical example. The numerical scenario considered here uses $a_h = 1$ and $a_\ell = 0$.[8]

Zone I outlines the cases where the cost difference between positioning high and low is so large that both products position low in all markets. Because it does not pay to invest in a single market, there is no profit incentive to invest in a multimarket contact framework either.

Zone II represents the cases covered in section 5 where a single-market asymmetric equilibrium exists. The graph illustrates proposition 5 (part 2), that the range of $K(a_h)$ over which

[7] For completeness, the discount rate δ is a fourth variable, but its role is not central to the analysis.

[8] The discussion does not seem to be affected by other numerical choices for a_h and a_ℓ.

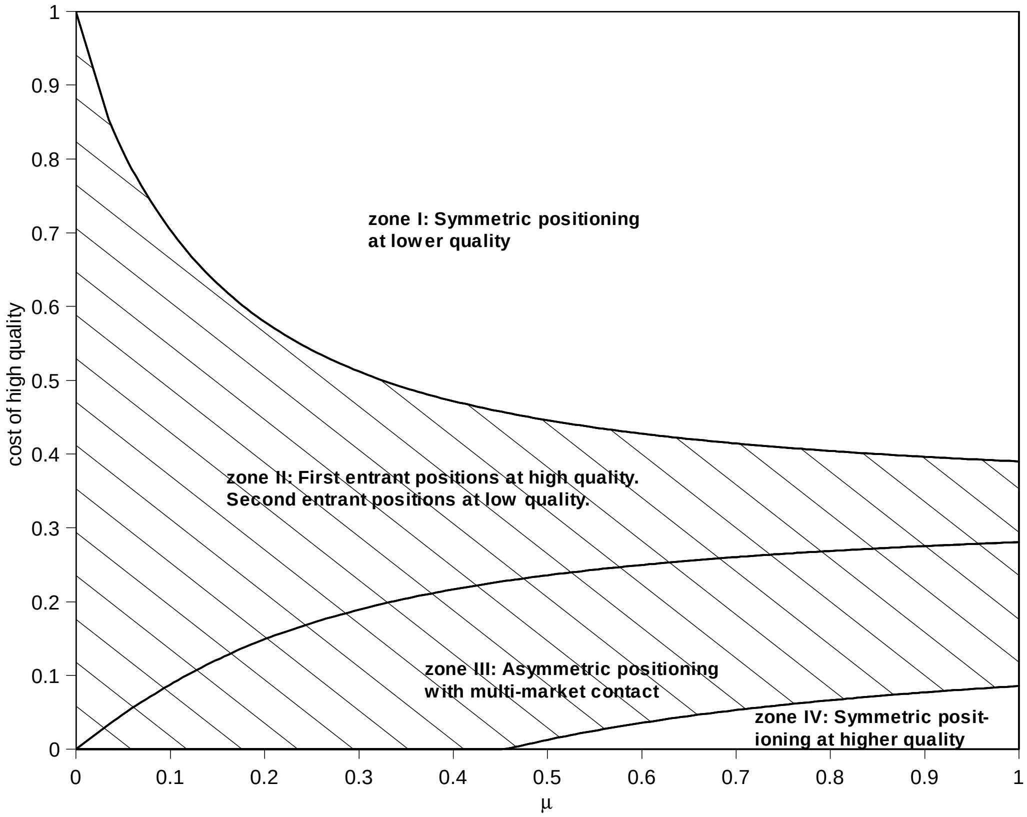

Figure 3: Equilibria for product differentiation μ, and cost $K(a_h)$.

asymmetric equilibria are obtained becomes smaller as μ increases. Per the same proposition, the range will eventually shrink from $[0 \; a_h - a_\ell]$ (in the numerical example [0 1]) to a single point, $(a_h - a_\ell)/3$ (in the numerical example 1/3). Because asymmetric positioning is an equilibrium in a single market, if the two firms compete independently on more than one market, a particular firm may lead in all markets, in several, or in none, depending on local entry patterns. If order of entry across these markets is spatially dependent, regional dominance by firms across a set of local markets will emerge.

Zone III identifies the cases covered by multi-market contact. In this case, firms do not compete independently across two markets, but rather take into account how their actions in one market affect their future success in other markets. Zone III outlines the circumstances when asymmetric equilibria are sustainable in two markets but not in a single market. The cost difference between positioning high or low in this zone is so small that in a single market, all products would position at a_h. However, realizing that they are better off having monopoly power in at least a fraction of the markets, in a multi-market context, firms prefer to position asymmetrically if they value the future enough. Figure 3 was created with $\delta = 0.75$. Thus even if firms only value next period's profits at 75% of current profits, the area over which asymmetric positioning emerges (zone III), relative to a single market case, is very substantial.

Finally, zone IV contains all cases where firms position at a_h in all markets. As the firm's value for future profits increases, the fourth zone diminishes (as an example, if $\delta = 0.90$, zone IV is no longer visible in Figure 3).

Zones II and III combine to give all cases where asymmetric positioning equilibria may occur. One of the central results of the analysis is that the occurrence of asymmetric equilibria is strongly dependent on horizontal differentiation. Indeed, Figure 3 illustrates once more that sustained asymmetric market shares as in Figure 1 is more likely to happen with undifferentiated than with differentiated goods.

A few elaborations of these results exist, which I mention here without proof. First, it can be shown that the presence of an outside good does not affect Figure 3 substantively, as long as the outside good is not too large. Second, the main results of the paper are not materially affected if we consider competition more than 2 markets even when the number of markets in which firms lead is not symmetric. Third and finally, the base scenario in the multimarket case contained the assumption that improvements in perceived quality come at no costs. Relaxing this assumption makes that the argument in this section holds even stronger. That is to say, we obtain the exact same result as before, except that the minimum discount rate at which asymmetric equilibria are sustain decreases even further.

7.2 An empirical example

This analysis is motivated by the common existence of locally asymmetric market shares for weakly differentiated national brands in categories such as Mexican salsas. The main result of this paper is that such local asymmetries exist across brands –and if entry is distributed across geography– across markets, *especially* for undifferentiated consumer goods. This was illustrated in Figure 1.

Conversely, the study implies that incentives to create and sustain perceived quality differentiation are less strong when products are horizontally differentiated. For discussion purposes, I present one example of such a category: breakfast cereals. Breakfast cereals are a good example

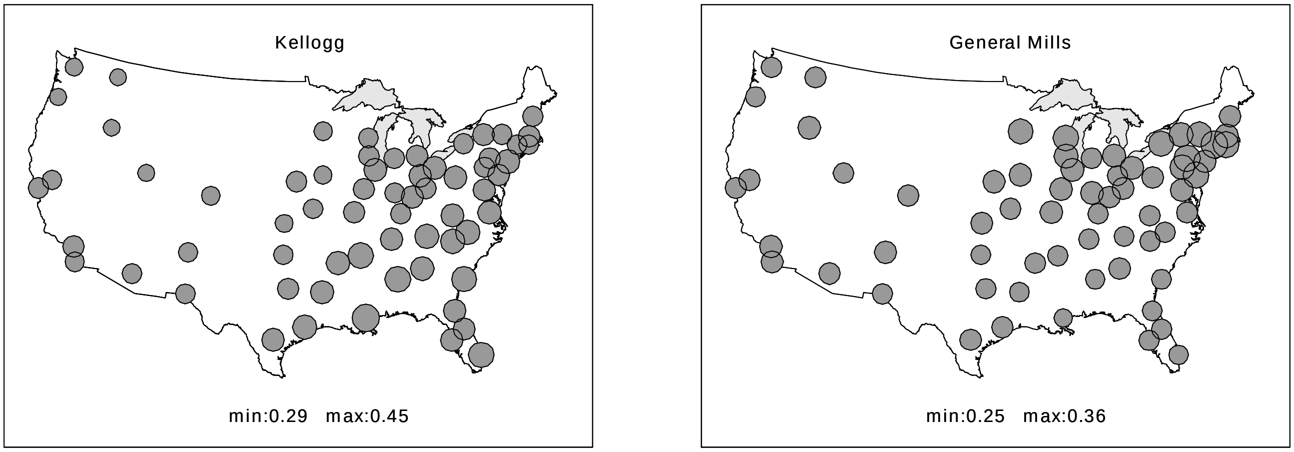

Figure 4: Local market share of two leading manufacturers in cereals

of a horizontally differentiated category (see also Nevo 2001) because consumers are capable of distinguishing the different products sold, say, Corn Flakes and Cheerios, and there is no common preference ordering.

The arguments presented here predict that there should be much variation in local shares in the Mexican salsa category but not in the cereal category. If, in addition, the main brands in both industries are roughly symmetric (e.g., if the national brand pairs are of similar objective quality and all cater to the mass market), then the local ratio between the leading brand's share and the second brand's share is predicted to be large in the case of Mexican salsas but close to unity for the breakfast cereals. Figures 1 and 4 show that this is indeed what happens.[9]

Table 1 presents three measures of share asymmetry across and within markets for the Mexican salsa and breakfast cereal industries. The first and second measure quantify share asymmetries within markets. In the competition between Pace and Tostitos, the average size of the local leader is 2.65 that of the second brand. In the competition between Cornflakes and Cheerios, this ratio is 1.35 (only 1.22. in the competition between Kellogg and General Mills).[10] In the case of Mexican salsa, the leading brand is in almost half of the markets twice as large as the lagging brand. In the case of breakfast cereals this occurs not even once. The third measure is the standard deviation across markets of the log share ratio. It quantifies whether market share

[9] The figure for breakfast cereal brands as opposed to manufacturers is very similar to Figure 4.

[10] This measure can be redefined to reflect differences in the national shares of brands. That is, if the national brands are not symmetric, we use within market asymmetries adjusted for the national asymmetry in share. These adjustments do not materially change the example in the table.

	Mexican salsa	breakfast cereals	
	Campbell (Pace) vs. Frito Lay (Tostitos)	Kellogg vs General Mills	Corn Flakes vs Cheerios
markets with $\left(\frac{\text{leading share}_m}{\text{lagging share}_m}\right) > 2$	28/64	0/65	0/65
mean $\left(\frac{\text{leading share}_m}{\text{lagging share}_m}\right)$	2.65	1.22	1.35
standard deviation (log(share ratio$_m$))	0.90	0.16	0.32

Table 1: Differences in spatial variability and asymmetry

leadership and dominance is constant across markets. A large value on this ratio is an indication that both brands have their own geographic territory of high-share markets in direct competition with each other.[11] From Table 1, it is clear that the measure of spatial variability is much larger in the Mexican salsa than in the breakfast cereal industry.

In sum, the contrast between these industries exemplifies the results of the analysis.

8 Conclusion

There are many reasons why competing firms of undifferentiated goods face different initial conditions in a given market, e.g., order-of-entry effects on brand perceptions (e.g., Bronnenberg, Dhar and Dubé 2006) or on shelf-space (Bowman and Gatignon 1990; Robinson and Fornell 1985). These phenomena can lead to initial differences in market shares and profitability. I find that such initial differences can be sustained under conditions commonly observed in CPG industries: the leading national brands sell objectively similar products, order of entry and costly investments in perceived quality are local, and firms meet in multiple markets. This paper has shown that local asymmetries can arise with little or no objective differentiation and may be sustained despite immediate competition between products. The following explanation for this observation was presented.

First, firms can create a local form of vertical differentiation through costly quality positioning of their products. If the cost of positioning is high enough, there is room for only one high quality player in each market and asymmetric shares will emerge based on the order in which firms position themselves on quality. Second, these asymmetries are often geographically dispersed.

[11] It is noted that a low value is not evidence of the absence of local asymmetries, but rather of the absence of geographic differences in the asymmetries.

This happens for instance because products are rolled out geographically, making the order in which firms enter and choose quality vary by region as in Bronnenberg, Dhar, and Dubé (2006). Third, these asymmetric quality perceptions are sticky. In this paper, I formalized that this stickiness can be an outcome of firms engaging in a collusive arrangement wherein competitors share "high demand" markets with monopoly power across regions.

I find that emergence and sustenance of spatial concentration should be expected *especially* when goods are physically similar, i.e., when demand side arguments for asymmetric market shares are weak. If goods are the same, initial market conditions persist, whereas if products are differentiated, these initial market conditions will not be sustainable. Indeed, in the latter case, all competitors tend to compete for a "fair share" in all local markets. Thus, "initial market conditions," e.g., product launch strategies and early differences in perceived quality matter most in undifferentiated categories and are therefore strategically important in CPG industries.

There are several areas for future research. First, in the present paper, I assumed the presence of only two brands. Whereas duopolies do of course duopolies exist, there is value in analyzing the case of more entrants. Second, the present study uses a static model of consumer preferences. In this model, local brand advantages are sustained because firms have a long term incentive to maintain consumer perceptions of quality differentiation. That is, the persistence of the quality differences within a market is driven by firms. An alternative argument, beyond the scope of this paper, but worthwhile for future study, is that consumer perceptions or advertising effects are sticky (e.g., Doraszelski and Markovich 2005; Dubé, Hitsch, and Rossi 2006). Although speculative, positive carry-over in consumer preferences and firms' competition in multiple markets may interact to produce even more stable asymmetric outcomes than those found here.

References

[1] Anderson, Simon P., André de Palma (1988), "Spatial Price Discrimination with Heterogenous Products," *the Review of Economic Studies*, vol 55, 573-592.

[2] ————, ———— (2001), "Product Diversity in Asymmetric Oligopoly: Is the Quality of Consumer Goods too Low?" *the Journal of International Economics*, vol 49, 113-135.

[3] ————, ————, and Jacques-François Thisse (1992), "*Discrete Choice Theory of Product Differentiation*," MIT press, Cambridge MA.

[4] Bagwell, K. (2003), "The Economic Analysis of Advertising," forthcoming in the *Handbook of Industrial Organization*, Vol. 3, eds. Robert Porter and Mark Armstrong.

[5] Berry, Steven, James Levinsohn and Ariel Pakes (1995), "Automobile Prices in Market Equilibrium," *Econometrica*, vol 63:4 (July), 841-890.

[6] Bernheim, B. Douglas and Michael D. Whinston (1990), "Multi-market Contact and Collusive Behavior," *Rand Journal of Economics*, vol 21:1 (Spring), 1-26.

[7] Bettman, James R. and C. Whan Park (1980), "Effects of Prior Knowledge and Experience and Phase of the Choice Process on Consumer Decision Processes: A Protocol Analysis," Journal of Consumer Research, 7 (December), 234-48.

[8] Bowman, Douglas, and Hubert Gatignon (1996), "Order of Entry as a Moderator of the Effect of the Marketing Mix on Market Share," *Marketing Science*, vol 15:3, 222-242

[9] Bronnenberg, Bart J., Sanjay Dhar, and Jean-Pierre Dubé (2006), "Market Structure and the Geographic Distribution of Brand Shares in Consumer Package Goods Industries," working paper.

[10] Caplin, Andrew and Barry Nalebuff (1991), "Aggregation and Imperfect Competition: On the Existence of Equilibrium," *Econometrica*, vol 59, 26-61.

[11] Carpenter, Gregory S, Rashi Glazer, and Kent Nakamoto (1994), "Meaningful Brands from Meaningless Differentiation: The Dependence on Irrelevant attributes," *Journal of Marketing Research,* vol 31:3 (August), 339-350.

[12] Comanor, W.S. and T.A. Wilson (1974), *Advertising and Market Power*, Cambridge, MA: Harvard University Press.

[13] d'Aspremont C., J.J. Gabszewicz, and J.-F. Thisse (1979), "On Hotellings 'Stability in Competition,"' *Econometrica,* 47:1145-1150

[14] Dickson, Peter and Alan G. Sawyer (1990), "The Price Knowledge and Search of Supermarket Shoppers," *Journal of Marketing*, vol 54 (July), 42-53.

[15] Doraszelski, Ulirch, and Sarit Markovich (2005), "Advertising Dynamics and Competitive Advantage," forthcoming in *Rand Journal of Economics*

[16] Dubé, Jean-Pierre H., Günter J. Hitsch, Peter E. Rossi (2006), "Do Switching Costs Make Markets Less Competitive," *working paper*, University of Chicago

[17] Dubé, Jean-Pierre H., Günter J. Hitsch, Puneet Manchanda (2005), "An Empirical Model of Advertising Dynamics," *Quantitative Marketing and Economics*, 3 (2), 107-144

[18] Golder, Peter N. and Gerard J. Tellis [1993], "Pioneer Advantage: Marketing Logic or Marketing Legend?" *Journal of Marketing Research*, 30 (May), 158-70

[19] Hoyer, Wayne D. (1984), "An Examination of Consumer Decision Making for a Common Repeat Purchase Product," *Journal of Consumer Research*, vol 11 (December), 822-829.

[20] ———— and Steven P. Brown (1990), "Effects of Brand Awareness on Choice for a Common, Repeat-Purchase Product," Journal of Consumer Research, 17 (September), 141-8.

[21] Karnani, Aneel and Birger Wernerfelt (1985), "Multiple Point Competition," *Strategic Management Journal*, vol 6, 87-96

[22] Kirmani, Amna, and Peter Wright (1989), "Money Talks: Perceived Advertising Expense and Expected Product Quality," *Journal of Consumer Research*, vol 16:3, 344-353

[23] Klemperer, Paul (1992), "Equilibrium Product Lines: Competing Head to Head May Be Less Competitive," *American Economic Review*, 82:4, 740-755.

[24] Moorthy, K. Sridhar (1988), "Product and Price Competition in a Duopoly," *Marketing Science*, vol 7:2 (Spring), 141-165.

[25] Neven, Damien, and Jacques-François Thisse (1990), "On Quality and Variety Competition," in: *Economic Decision-Making: Gammes, Econometrics, and Optimisation*, J.J. Gabszewicz, J.-F. Richard, and L.A. Wolsey, eds., Elsevier Science Publishers B.V.

[26] Nevo, Aviv (2001), "Measuring Market Power in the Ready-to-Eat Cereal Category," *Econometrica,* 69(2), 307-342.

[27] Nijs, Vincent R., Marnik G. Dekimpe, Jan-Benedict E.M. Steenkamp, and Dominique M. Hanssens (2002), "The Category Demand Effects of Price Promotions," *Marketing Science*, vol 20:1 (Winter), 1-22

[28] Park, C. Whan and V. Parker Lessig (1981), "Familiarity and Its Impact on Consumer Biases and Heuristics," Journal of Consumer Research, 8 (September), 223-30.

[29] Robinson, William T. and Claes Fornell (1985), "Sources of Market Pioneer Advantages in Consumer Goods Industries," *Journal of Marketing Research*, vol 22 (August), 305-317.

[30] Shaked A., and J. Sutton (1983), "Natural Oligopolies," *Econometrica*, vol 51, 1469-1483

[31] Shaked A., and J. Sutton (1981), "Relaxing Price Competition through Product Differentiation," *Review of Economic Studies*, 49, 3-13.

[32] Simonson, Itamar (1993), "Get Closer to Your Customers by Understanding How They Make Choices," *California Management Review*, vol 35:4, Summer, 68-84.

[33] Soberman, David (2002), "Questioning Conventional Wisdom about Competition in Differentiated Markets," *Quantitative Marketing and Economics*, 3:1, 41:70.

[34] Sutton, John (1991), *Sunk Costs and Market Structure*, MIT Press, 1991

[35] Trout, Jack and Steve Rivkin (2000), *Differentiate or Die*, John Wiley & Sons Inc., New York, NY.

[36] Villas-Boas, J. Miguel (1993), "Predicting Advertising Pulsing Policies in an Oligopoly: A Model and Empirical Test," *Marketing Science*, 12, 88-102.

[37] Yarrow, George (1989), "The Kellogg's Cornflakes Equilibrium and Related Issues," *Working paper*, Hertford College, Oxford.

A Proofs

Proof of proposition 1 For convenience, drop all subscripts m. Recall that

$$s_1 = \frac{\exp\left[(a-p_1)/\mu\right]}{\exp\left[(a-p_1)/\mu\right] + \exp\left[(-p_2)/\mu\right]}, a = a_1 - a_2 \tag{A.1}$$

Some useful relations are $\frac{ds_1}{dp_1} = -\frac{1}{\mu}s_1(1-s_1)$, $\frac{ds_1}{dp_2} = \frac{1}{\mu}s_1 s_2$, $\frac{ds_1}{da} = \frac{1}{\mu}s_1(1-s_1)$. Taking the first order condition for firm 1 gives,

$$F(p_1, p_2, a) \equiv p_1 - c_1 - \frac{\mu}{1-s_1} = 0 \tag{A.2}$$

The total differential of this function is $F_{p_1}dp_1 + F_{p_2}dp_2 + F_a da = 0$. Writing $\Phi \equiv s_1/s_2$, it is easy to show that

$$F_{p1} = 1 - \frac{\mu \cdot d\left(1-s_1\right)^{-1}}{dp_1} = 1 - \mu\left(1-s_1\right)^{-2}\frac{ds_1}{dp_1} = 1 + \Phi \tag{A.3}$$

It can further be shown that F_{p2} and F_a are both equal to $-\Phi$. Substitution in the total differential for F gives

$$\left(1+\Phi\right)dp_1 - \Phi dp_2 - \Phi da = 0 \tag{A.4}$$

Now, totally differentiate the first order condition for firm 2.

$$G(p_1, p_2, a) \equiv p_2 - c_2 - \frac{\mu}{s_1} = 0 \tag{A.5}$$

The total differential of this function is $G_{p_1}dp_1 + G_{p2}dp_2 + G_a da = 0$. Once more it is easy to show that

$$G_{p1} = -\frac{1}{\Phi}, \quad G_{p2} = 1 + \frac{1}{\Phi}, \quad G_a = \frac{1}{\Phi} \tag{A.6}$$

Substitution in the total differential of G gives

$$-\frac{1}{\Phi}dp_1 + \left(1 + \frac{1}{\Phi}\right)dp_2 + \frac{1}{\Phi}da = 0 \tag{A.7}$$

Finally, combining (A.4) and (A.7), gives that

$$\frac{dp_1^*}{da} = \frac{\Phi^2}{1+\Phi+\Phi^2} > 0, \quad \frac{dp_2^*}{da} = \frac{-1}{1+\Phi+\Phi^2} < 0. \tag{A.8}$$

This proofs proposition 1. The result states further that changes in a are never priced by the firm to the market completely. Indeed, it may be noted from the definition of Φ that the sensitivity of p_1 to changes in a is always between 0 and 1. ■

Proof of proposition 2 Once again, the subscript m is dropped from the notation. It needs to be shown that the profits of both firms are convex in a. Thus, the second order derivative of profits with respect to a needs to be evaluated at the equilibrium prices. It is sufficient that

$$\frac{d\left(\frac{d\pi_i^*}{dq}\right)}{da} = \frac{d^2\pi_i^*}{da^2} = \frac{d^2p_i^*}{da^2} > 0, \quad i = 1, 2, \tag{A.9}$$

where the last equality relation follows from equation (6). To simplify the derivation, I can use the expressions in (A.8) and take the derivative of both expressions with respect to a.

$$\frac{d^2 p_i}{da^2} = \frac{df_i(\Phi)}{d\Phi}\frac{d\Phi}{da} \tag{A.10}$$

with $f_i(\Phi)$ given by the RHS of equation (A.8). It can be shown that

$$\frac{df_1(\Phi)}{d\Phi} = \frac{2\Phi + \Phi^2}{(1+\Phi+\Phi^2)^2} > 0 \quad \text{and} \quad \frac{df_2(\Phi)}{d\Phi} = \frac{2\Phi + 1}{(1+\Phi+\Phi^2)^2} > 0 \tag{A.11}$$

Recalling that $\Phi = \exp\left[\left(-p_1 + p_2 + a\right)/\mu\right]$, the derivative $d\Phi/da$ of the ratio of shares at optimal prices with respect to a is

$$\begin{aligned}
\frac{d\Phi}{da} &= \frac{d\left(\exp\left[\left(-p_1^* + p_2^* + a\right)/\mu\right]\right)}{da} \\
&= \exp\left[\left(-p_1^* + p_2^* + a\right)/\mu\right] \times \frac{d\left(\left(-p_1^* + p_2^* + a\right)/\mu\right)}{da} \\
&= \Phi \cdot \frac{1}{\mu}\left(-\frac{dp_1^*}{da} + \frac{dp_2^*}{da} + 1\right) && \text{(A.12)} \\
&= \frac{1}{\mu}\frac{\Phi^2}{1+\Phi+\Phi^2} > 0 && \text{(A.13)}
\end{aligned}$$

Substitution of (A.11) and (A.12) into (A.10) proves that the profits of both firms are convex in a. ■

Proof of proposition 3 Without loss in generality, drop the market subscript m, and define $a = a_1 - a_2$. Note that,

$$\frac{d^2 \pi_i}{d(a)\, d(\mu)} = \frac{d^2 p_i^*}{d(a)\, d(\mu)} \tag{A.14}$$

Using equation (A.8), I can write,

$$\frac{d^2 \pi_i}{d(a)\, d(\mu)} = \frac{df_i(\Phi)}{d\Phi}\frac{d\Phi}{d\mu}. \tag{A.15}$$

From (A.11), $\frac{df_i(\Phi)}{d\Phi} > 0$, and therefore the sign of the LHS of (A.15) is equal to the sign of $\frac{d\Phi}{d\mu}$. Rearrange the definition of Φ at optimal prices to obtain the implicit equation that

$$\Phi = \exp\left(\left(a - p_1^* + p_2^*\right)/\mu\right) \tag{A.16}$$

with $p_1^* - c = \mu/(1-s_1) = \mu(1+\Phi)$, $p_2^* - c = \mu/(1-s_2) = \mu(1+\Phi^{-1})$. Thus, at optimal prices $\Phi = \exp\left(\frac{a}{\mu} - \Phi + \frac{1}{\Phi}\right)$. From this equation, take the derivative to obtain that

$$\frac{d\Phi}{d\mu} = -\exp\left(\frac{a}{\mu} - \Phi + \frac{1}{\Phi}\right)\left(\frac{a}{\mu^2} + \frac{d\Phi}{d\mu} + \frac{1}{\Phi^2}\frac{d\Phi}{d\mu}\right) = -\Phi\left(\frac{a}{\mu^2} + \frac{d\Phi}{d\mu} + \frac{1}{\Phi^2}\frac{d\Phi}{d\mu}\right) \tag{A.17}$$

Rearranging gives that

$$\frac{d\Phi}{d\mu} = -\frac{a}{\mu^2}\frac{\Phi^2}{(1+\Phi+\Phi^2)}, \tag{A.18}$$

which is strictly negative (positive) as long as $a > 0$ ($a < 0$). Now, going back to equation (A.15), I get for firm i

$$\frac{d^2\pi_i}{d(a)\,d(\mu)} = \frac{df_i(\Phi)}{d\Phi}\frac{d\Phi}{d\mu}\begin{cases} < 0 & \text{if} \quad a > 0 \\ > 0 & \text{if} \quad a < 0 \end{cases} \tag{A.19}$$

Thus, the smaller μ, the more (less) profits rise in quality for the quality leader (lagger). ■

Proof of proposition 4 This result is implied by proposition 1. If both firms have high perceived quality they both set prices of $c + 2\mu$. These prices stem from $p_i^* = c_i + \mu/(1 - s_i)$, and from the obvious result that if both have the same positioning $s_i = 1/2$. It is easily verified that there are no unilateral deviations from this proposed equilibrium. ■

Proof of proposition 5

1. Proof is given in the text preceding proposition 1

   (a) It needs to be shown that $\mu(\Phi - 1) - \mu\left(1 - \Phi^{-1}\right)$ is decreasing in μ. First, from the text preceding the proposition, $\mu(\Phi - 1)$ and $\mu\left(1 - \Phi^{-1}\right)$ may be interpreted as the profit before quality investment for the high quality and low quality firm, respectively. Without loss in generality, firm 1 invests in local branding and firm 2 does not. For any positive quality gap a

   $$\mu(\Phi - 1) = \int_0^a \left(\frac{d\pi_1}{d\alpha}\right) d\alpha \text{ and } \mu\left(1 - \Phi^{-1}\right) = -\int_0^a \left(\frac{d\pi_2}{d\alpha}\right) d\alpha \tag{A.20}$$

   Or,

   $$\mu(\Phi - 1) - \mu\left(1 - \Phi^{-1}\right) = \int_0^a \left(\frac{d\pi_1}{d\alpha} + \frac{d\pi_2}{d\alpha}\right) d\alpha \tag{A.21}$$

   Taking derivatives with respect to μ, and using proposition 3 gives the final result, i.e., because both $\frac{d^2\pi_1}{d\alpha d\mu}$ and $\frac{d^2\pi_2}{d\alpha d\mu}$ are negative

   $$\int_0^a \left(\frac{d^2\pi_1}{d\alpha d\mu} + \frac{d^2\pi_2}{d\alpha d\mu}\right) d\alpha < 0 \tag{A.22}$$

   (b) It is obvious that $\lim_{\mu\downarrow 0}\mu\left(1 - \Phi^{-1}\right) = 0$. Applying l'Hopital's rule to $\lim_{\mu\downarrow 0}\mu(\Phi - 1)$, I get

   $$\lim_{\mu\downarrow 0}\mu(\Phi - 1) = \lim_{\mu\downarrow 0} -\frac{\Phi'}{1/\mu^2} = \lim_{\mu\downarrow 0}\frac{(a_h - a_\ell)\,\Phi^2}{(1 + \Phi + \Phi^2)} = (a_h - a_\ell) \tag{A.23}$$

   For $\mu \to \infty$, again, applying l'Hopital's rule,

   $$\lim_{\mu\to\infty}\mu(\Phi - 1) = \lim_{\mu\to\infty} -\frac{\Phi'}{1/\mu^{-2}} = \lim_{\mu\to\infty}\frac{(a_h - a_\ell)\,\Phi^2}{(1 + \Phi + \Phi^2)} = \frac{(a_h - a_\ell)}{3}. \tag{A.24}$$

   Further,

   $$\lim_{\mu\to\infty}\mu\left(1 - \Phi^{-1}\right) = \lim_{\mu\to\infty} -\frac{\Phi'}{\Phi^2/\mu^{-2}} = \lim_{\mu\to\infty}\frac{(a_h - a_\ell)}{(1 + \Phi + \Phi^2)} = \frac{(a_h - a_\ell)}{3}. \tag{A.25}$$

   This completes the proof. ■

Proof of proposition 6 Suppose that firms set quality sequentially, with firm 1 choosing first. Depending on the combination of firm 1's and firm 2's quality choices, firm 2 receives at optimal prices, payoffs $\pi_2(a_1, a_2)$ as follows:

$$\begin{aligned} \pi_2(a_h, a_h) &= \mu - K(a_h) && \text{if} \quad a_1 = a_h, a_2 = a_h \\ \pi_2(a_\ell, a_h) &= \Phi\mu - K(a_h) && \text{if} \quad a_1 = a_\ell, a_2 = a_h \\ \pi_2(a_h, a_\ell) &= \Phi^{-1}\mu - K(a_\ell) && \text{if} \quad a_1 = a_h, a_2 = a_\ell \\ \pi_2(a_\ell, a_\ell) &= \mu - K(a_\ell) && \text{if} \quad a_1 = a_\ell, a_2 = a_\ell \end{aligned} \tag{A.26}$$

First, use these payoffs to derive the response functions of firm 2. If firm 1 plays a_h then

$$\pi_2 = \begin{cases} \pi_2(a_h, a_h), & \text{and } a_2 = a_h \text{ if} \quad \mu\left(1 - \Phi^{-1}\right) > K(a_h) \\ \\ \pi_2(a_h, a_\ell), & \text{and } a_2 = a_\ell \text{ if} \quad \mu\left(1 - \Phi^{-1}\right) < K(a_h) \end{cases}, \tag{A.27}$$

whereas, if firm 1 plays a_ℓ then,

$$\pi_2 = \begin{cases} \pi_2(a_\ell, a_h), & \text{and } a_2 = a_h \text{ if} \quad \mu(\Phi - 1) > K(a_h) \\ \\ \pi_2(a_\ell, a_\ell), & \text{and } a_2 = a_\ell \text{ if} \quad \mu(\Phi - 1) < K(a_h) \end{cases} \tag{A.28}$$

Note that $\left(1 - \Phi^{-1}\right) \leq (\Phi - 1)$. Given that firm 1 moves first, it can use all this knowledge. To do so it has to consider three scenarios.

1. Case I: $K(a_h) < \mu\left(1 - \Phi^{-1}\right)$ where firm 2 always plays a_h. In this case, firm 1 also plays a_h.

2. Case II: $\mu\left(1 - \Phi^{-1}\right) < K(a_h) < \mu(\Phi - 1)$, where firm 2 always plays the opposite of firm 1. If firm 1 plays a_h, then firm 2 plays a_ℓ, and firm 1's profit is $\mu\Phi - K(a_h)$. If firm 1 plays a_ℓ then firm 2 plays a_h and firm 1's profits are $\mu\Phi^{-1} - K(a_\ell)$. Hence firm 1 will play a_h if profits are higher than when playing a_ℓ, i.e., $\mu\Phi - K(a_h) > \mu\Phi^{-1} - K(a_\ell)$, or:

$$K(a_h) < \mu\left(\Phi - \Phi^{-1}\right) \tag{A.29}$$

   Is this always true in case II? Case II implies that $\mu\left(1 - \Phi^{-1}\right) < K(a_h) < \mu(\Phi - 1)$. Because $\mu(\Phi - 1) < \mu\left(\Phi - \Phi^{-1}\right)$, $K(a_h) < \mu(\Phi - 1)$ implies that $K(a_h) < \mu\left(\Phi - \Phi^{-1}\right)$. Hence, with asymmetric equilibria (case II), firm 1 will always position at a_h.

3. Case III: $K(a_h) > \mu(\Phi - 1)$, where firm 2 always plays a_ℓ. In this case, it is easy to see that firm 1 plays a_ℓ. ■

Proof of proposition 7

1. Let firm 1 be positioned at a_h in market 1 while firm 2 is positioned at a_ℓ. In market 2 the opposite happens. Denote the ratio of output of product 1 to that of product 2 at optimal prices in market 1 again by $\Phi \equiv s_{11}^*/s_{21}^*$. Further, denote the equilibrium profits of firm i by $\pi_i^* \equiv \sum_m \pi_{im}^* = \pi_{i1}^* + \pi_{i2}^*$. Given equal cost, the prices of products mirror each other across markets, i.e. $p_{11}^* = p_{22}^*$, and $p_{12}^* = p_{21}^*$. From the definition of the ratio of outputs, it is therefore obvious that in market 2, $s_{12}^*/s_{22}^* = \Phi^{-1}$. By proposition 1, $\Phi > 1$, i.e., in market

1, firm 1 is the product with the higher perceived quality, prices, and demand. Equations (5) and (6) give that

$$\pi_{im}^* = \frac{s_{im}}{1 - s_{im}} \cdot \mu - K \tag{A.30}$$

Therefore, with asymmetric positioning, multi-market profits are

$$\pi_i^* = \sum_m \pi_{im}^* = \left(\Phi + \Phi^{-1}\right)\mu - 2K, \; i = 1, 2. \tag{A.31}$$

From this formulation it is clear that multimarket profit is lowest when $\Phi = 1$. Therefore the following inequality always holds

$$\mu\Phi + \mu\Phi^{-1} - 2K \geq 2\mu - 2K. \tag{A.32}$$

2. The second part of the proposition implies that existing reciprocal asymmetries are sustainable –even when breaking them is free– as long as firms value future profits sufficiently. Specifically, firm 1 resists the temptation to reposition from a_ℓ to a_h if a periodic profit of π_i^*, is valued higher than a one time profit of π_i^d followed by a periodic profit of π_i^0. This valuation is met for all discount rates δ that satisfy

$$\pi_i^*(1 + \delta + \delta^2 + \cdots) > \pi_i^d + \pi_i^0(\delta + \delta^2 + \delta^3 \cdots). \tag{A.33}$$

Hence, when $\delta > \delta^* \equiv \frac{\pi_i^d - \pi_i^*}{\pi_i^d - \pi_i^0} = \frac{1}{\Phi}$ firm 1 does not reposition. By symmetry, the same holds for firm 2.

3. I need to show that $\frac{d\delta^*}{d\mu} > 0$ or equivalently that $\frac{d\Phi}{d\mu} < 0$ as long as $\Phi > 1$. This was already shown in equation (A.18) ■