Positioning and Pricing of Conspicuous Goods: A Competitive Analysis

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Abstract

We study competitive positioning and pricing strategies in conspicuous goods markets. For conspicuous products, each consumer values the product less as more consumers own it, thus exhibiting negative consumption externalities. We incorporate the effect of consumption externality for each consumer to be dependent on their location vis-à-vis the location of the firm. Specifically, we assume that a customer 'closer' to a firm may feel more let down if *that* firm caters to too many customers. Our work extends the existing literature by formally recognizing that consumers are heterogeneous in their sensitivity to product exclusivity. We find that for conspicuous goods, product differentiation is lower; a finding that explains otherwise counterintuitive empirical results in the literature. We also show that under some conditions, price competition can be higher in markets with negative consumption externalities. When firms are asymmetric with respect to consumption externality effects, we show that a firm which exerts higher externality tends to charge lower prices. Finally, firms may be better off if they reduce heterogeneity in *their* consumers' sensitivity to consumption externality.

Keywords: *Negative Consumption Externalities, Conspicuous Goods, Pricing, Hotelling Models.*

1 Introduction

Conspicuous consumption differs from mainstream consumption of regularly purchased goods as it satisfies not just material needs but also social needs (Veblen 1899). Mason (1984) observes that the classical economic theories of consumer decision processes may not readily accommodate conspicuous consumption due to the atypical nature of such behavior. For conspicuous products, consumers' need for uniqueness prevails and consumers value the product *less* as more consumers own it, thus exhibiting negative consumption externalities. Examples of conspicuous products include certain types of jewelry, perfumes, designer handbags, watches, high-end cars, and collectibles, where exclusivity is fundamental to the value of the product. Consumers exhibiting such behavior have been at times referred to as snobs (Liebenstein 1950).

Given the 'social need' among consumers for uniqueness in conspicuous goods markets, it raises a number of questions for firms' strategic behavior. For example, what role do externalities play in the positioning decisions of firms? It may appear that when consumers value exclusivity, firms should offer more differentiated products so as to cater to this need for uniqueness, but empirical evidence seems to suggest otherwise. Chao and Schor (1998) in a study of cosmetics find that conspicuous cosmetics are less differentiated. Copernicus Consulting (2001) in a brand trends study also find brand differentiation (in terms of product/service features, advertising and price) to be declining even in conspicuous goods categories. Pricing is another strategic firm decision that may be affected in markets with consumption externalities. Grilo et al. (2001) show that negative externalities always lowers price competition. With a different consumer mix, Amaldoss and Jain (2005) reach similar conclusions. However, increasing price competition among luxury goods manufacturers is becoming more evident (Giacobe 2009). Moreover, it is not obvious whether managers should focus on exclusivity irrespective of the strength of the consumption externalities effect. Prior research in consumer behavior (Sprott et al. 2009) has shown that the strength of the linkage between a specific brand and a consumer's self-concept to be an important determinant of the consumer's price sensitivity. There-

fore, another important question is: when does the need for exclusivity lead to higher or lower price competition?

Prior analytical research seems to indicate that profits are always higher for conspicuous goods. However the role of underlying consumer characteristics in setting the boundary conditions for this result has not been explored. We build on the work of Grilo et al. (2001) and Amaldoss and Jain (2005) to develop a game-theoretic model that integrates the effect of negative consumption externalities on consumer purchase decisions in a spatial competition model, study the model's implications on firms' positioning and pricing decisions, and how it impacts profits.[1] Our work extends the existing literature by formally recognizing that consumers may be heterogeneous in their sensitivity to product exclusivity. In Grilo et al. (2001), all consumers who purchase from a firm get identical 'additional' utility due to consumption externality whereas we model the effect of consumption externality to be higher on those consumers who are located 'closer' to the firms. In essence, we are assuming that a customer closer to a firm may feel more let down if *that* firm caters to too many customers. One possible mechanism which may lead differential effect of consumption externality to manifest itself in consumer's utility could be simply that consumers 'closer' to the firm may identify themselves more strongly with the firm and hence the effect may be stronger for such consumers. Sprott et al. (2009) develop the construct of "brand engagement in self-concept" and show that consumers vary substantially in the degree to which they incorporate brands as part of their self-concept. This implies that the self-defining role of favorite brands varies across consumers and which, in turn, affects consumers' attitudes and behavioral intentions towards the brand (Schau and Gilly 2003). Similarly, Muniz and O'Guinn (2001) find that people vary in their likelihood to engage in identity building and expression through brand communities. This additional relational value provided by the association with the brand (Fournier 1998) and through brand communities is an important source of value (Tynan et al. 2010) and may vary across the customer base of a firm depending on the level of brand engagement of each customer with the brand. Moreover, prior literature has identified that the benefit

[1]Many authors (e.g. Leibowitz and Margolis 1994) point out that network effects do not necessarily have to be externalities, but we use the term externality to be consistent with earlier literature.

of customer-firm interaction doesn't extend evenly to all consumers of a brand because the effect of social network on consumers utility depends primarily on the interactions with immediate 'neighbors'. Berke and Swann (2006) study the effect of network effects in the mobile telecommunications markets and estimate that mobile network choice of an individual is influenced more by other household members than due to a random chosen member of a network. In another study, Tucker (2008) studies the adoption of a video messaging technology by employees of a financial firm and finds support for the hypothesis that the network effect associated with adopting the technology accrued to an employee is mainly due to people that she communicates with. Berke (2009) provides other empirical studies where consumers interact with a limited number of other agents.

Overall, we build on the extant literature on consumption externality, and develop a parsimonious model that allows firms to make positioning and pricing decisions in the context of a consumer behavior model that we believe is potentially more realistic in some market scenarios than the models previously used in this stream of research. In addition, we study both positioning and pricing decisions of firms in an integrated model, whereas in Grilo et al. (2001), the positioning decisions are exogenous to the model. Consequently, our analysis allows us to answer questions that could not be addressed by previous models and provide new insights. For example, we show that in conspicuous goods markets, product differentiation is lower in equilibrium. This may appear surprising at first, but is consistent with previous empirical observation in Chao and Schor (1998) who find that conspicuous cosmetics are less differentiated. This result is driven by the fact that firms realize that increasing market share leads to higher disutility in a negative consumption externality environment. Therefore, firms compensate by reducing the average "transportation cost" for all consumers in the market and offer products closer to the center of distribution of consumer ideal points. Furthermore, while previous research notes that price competition is lower in conspicuous goods markets, we find that price competition could be lower or higher depending on the strength of consumption externality. In our model, when consumption externality coefficient is low, lower product differentiation drives higher price competition. As the consumption externality effect increases, higher demand (due to

lower prices) lowers the value of the product, so reducing prices becomes less attractive to both firms. We also find that reduced heterogeneity among consumers in consumption externality effects through higher brand engagement may have a positive impact on firm profits. This result is consistent with prior behavioral research by Sprott et al. (2009) who have shown that higher brand engagement in self-concept is associated with more positive brand attitudes and reduced price sensitivity to new products allowing firms to charge higher prices.

1.1 Related Literature

There has been quite a bit of interesting research done in the area of consumption externalities (see Farrell and Saloner 1987, David and Greenstein 1990, Shy 2001 for review). Friedman and Grilo (2005) model consumption externality assuming each consumer's utility rises when similar consumers buy the same good, and falls when sufficiently dissimilar consumers buy the good. They focus on the welfare properties of the resulting equilibrium, and arrive at the number of firms that are viable at equilibrium. Banerji and Dutta (2009) model interaction between groups of agents by means of a graph (local network effects) and find that there exist outcomes in which firms do make positive profits, and market segmentation can arise in equilibrium. Sundarajan (2007) uses a game theoretic model (with incomplete information) in which agents simultaneously and independently decide on adoption in a social network. Simplifying the analysis using network theory, Sundararajan (2007) finds that the symmetric Bayesian equilibria can be Pareto-ranked, and the Pareto optimal equilibrium is the unique coalition-proof equilibrium.

There is a growing body of theoretical research which studies the role of social factors on firm behavior. Balachander and Stock (2009) examine the profitability of offering limited edition products as a part of the product line in the presence of exclusivity seeking consumers. They find that a firm with a lower quality product does not benefit from offering a limited edition whereas a higher quality firm may find such product introductions profitable. Similar to Grilo et al. (2001), Balachander and Stock (2009) also find that price competition is lower when consumers desire exclusivity. Using

a different framework, Amaldoss and Jain (2008) show that limited editions can improve a firm's profits when reference group effects are strong. Amaldoss and Jain (2010) study the strategic impact of reference group effects on firms' decision to offer limited editions in an experimental setting. The focus of these papers is to study firm behavior when each firm commits to limited availability of the product. In contrast, our focus is on product positioning and pricing decisions of firms when each firm satisfies the consumer demand for its product. Amaldoss and Jain (2005) considers two firms located on opposite ends of a market competing to cater to two segments of consumers. One segment (called snobs) desires uniqueness whereas the other segment (called conformists) desires conformity. Their analytical model investigates how equilibrium prices and profits are sensitive to the degree of conformism and snobbishness. Amaldoss and Jain (2005) show that in negative externality markets, more snobs buy a product as its price increases. In contrast, we focus on heterogeneity in consumption externality effects among consumers.

Though related, the research on network goods (Besen and Farrell 1994, Katz and Shapiro 1994) focuses primarily on standardization and technological forces. The wealth signaling literature (Corneo and Jeane 1997, Bagwell and Bernheim 1996) is also related, but consumer behavior literature has shown that consumers need for uniqueness trait may exist irrespective of their wealth status (Tian, Bearden and Hunter 2001). Therefore, it may be useful to model the need for uniqueness directly into the utility function (as we do in this paper) rather than the need for uniqueness affecting utility only when the signal is successful. This paper also complements research in consumer behavior on conspicuous consumption (Berger and Ward 2010, Han et al. 2010, Truong et al. 2008, O'Cass and McEwen 2004) and the research on luxury goods (Vigneron and Johnson 1999).

The rest of the paper is organized as follows. In the next section, we outline the key features of our competitive model. In Section 3, we analyze the model and derive our main results, and outline the intuition behind the results. In Section 4, we present two extensions to the base model. Section 5 presents the conclusions, limitations and possible avenues for future research.

2 Model

We use the Hotelling framework (Hotelling 1929) and assume that the market consists of two firms A and B, each offering one product recognized by subscripts A and B respectively.

2.1 Sequence of Decisions

Consider the following sequence of decisions:

- Stage 1: On a unit interval $[-\frac{1}{2}, \frac{1}{2}]$, we assume that Firm A is located to the left of Firm B and these positions are denoted by a and b respectively.[2] The two firms choose locations a, b simultaneously.

- Stage 2: After the firms have made their location choices, firms simultaneously choose their prices, p_A and p_B.

- Stage 3: Every consumer in the market buys one and only one unit of the product that maximizes his/her utility.

2.2 Model Assumptions

1. We assume that the consumers are distributed uniformly in the unit interval $[-\frac{1}{2}, \frac{1}{2}]$ and the total number of consumers is N. A consumer's position on the line represents the ideal point of his/her preferences. If a firm's product is located at a consumer's ideal point, then it matches the preferences of that consumer perfectly.

2. We assume that consumer reservation price, in the absence of consumption externalities, is denoted by V, and is the same for both products A and B. V is assumed to be sufficiently large so that all consumers buy one of the two products.

[2] We restrict our attention to $|\beta| N\theta < 6t$ so that Firm B is located to the right of Firm A in equilibrium. Parameters β, N, θ and t are defined later.

3. Following Tabuchi and Thisse (1995) and Tyagi (2000), firms are not restricted to locate within the interval of consumers' ideal points i.e. within $[-\frac{1}{2}, \frac{1}{2}]$. Also, as firms choose locations simultaneously, our analysis excludes the possibility of any first mover advantage.

4. The production cost for both firms is assumed to be identical, constant, and is set to zero without loss of generality.

5. Consumers incur quadratic transportation costs. If a consumer located at x incurs a cost of $t\left(x - x_i\right)^2$ to purchase from the firm located at x_i $(i = A, B)$ where t is the transportation cost parameter. This is more realistic as the consumer's marginal disutility of consuming a product away from their ideal point is increasing (Neven 1985).

6. Once firms' locations and prices are determined, the consumers have perfect information about them. We also assume that firms not only have perfect information about their own costs but also the marginal costs of their competitors.

Therefore, the stand-alone value of a product is given by $V - p_i - t\left(x - i\right)^2 \forall\, i = A, B$. We focus on the additional term due to the differential effect of consumption externality next.

2.2.1 Modeling the Effect of Consumption Externality

Let β be the consumption externality parameter. With $\beta < 0$, each consumer is worse off as the number of consumers purchasing from a firm increases. Let n_A represent the clientele size of firm A and n_B represent the clientele size of Firm B. The additional utility for a consumer by purchasing from a firm could be modeled as a direct function of the number of consumers purchasing the same brand, i.e., as a function of n_A and n_B. With this specification, all consumers who purchase from a firm get identical additional utility due to consumption externality. We use this model specification as a benchmark case with which we compare our model results.

Incorporating consumer heterogeneity in consumption externality effect: In our model, the strength of the consumption externality effect varies across consumers. Based on the discussion in Section 1, we model the strength of consumption externality to be higher for a consumer located closer to the firm compared to a consumer located farther away. A consumer whose preferences are matched perfectly by a given firm may feel a stronger consumption externality effect than a consumer who is indifferent between the two firms. In essence, we are assuming that a customer closer to a firm may feel more let down if *that* firm caters to too many customers. A parsimonious way to model this effect is through a multiplicative model of n_i and a measure of distance between the consumer and the firm. Using a linear measure of distance, the externality effect is represented as $\beta n_i \left(K - \theta \mid x - s \mid\right)$ where x is the consumer location and K is sufficiently high so that $[K - \theta \mid x - s \mid] > 0$ for $s = a, b$ and $i = A, B$.[3] For a given β, $|\beta| K$ represents the outer bound to which a consumer's willingness to pay is affected due to consumption externality. θ measures heterogeneity in externality effects among consumers and is linked to the degree to which brand engagement varies among consumers. Similar assumption has been made in de Palma and Leruth (1996) in their model on standardization with quantity competition.[4]

3 Analysis

We use the concept of sub-game perfect equilibrium to solve for equilibrium in prices and locations in this multistage game. We first focus on two benchmark cases which replicate the results in the extant literature. In Case 1, we look at a spatial competition model without the effect of consumption externality. In Case 2, we look at a scenario where all consumers get identical effect of negative

[3]We restrict our attention to $|\beta| > \frac{3t}{KN}$ and $K > \frac{5}{4}\theta$ so as to guarantee existence of equilibrium in this location-price game (See Section 3.3).

[4]In some markets, it is also possible that the strength of the externality effect is highest for an indifferent consumer rather than a consumer whose preferences are perfectly matched by the products in the market. The rationale for this alternate specification is that for a consumer who is indifferent between the two products, the size of the network is the biggest driver of choice between the two products. For example, in the Korean mobile telephony market, Kim and Kwon (2003) use a conditional logit model to demonstrate that consumers prefer carriers with a larger number of subscribers other things being equal. We recognize however that ultimately which specification is most appropriate in a particular context can only be determined through a careful empirical analysis.

consumption externalities. In Section 3.4, we contrast our results against these benchmark cases. For these benchmark cases, we represent the equilibrium prices for Firm i to be p_{ij} and equilibrium locations are given by (a_j, b_j) where j $(j \in 1, 2)$ refers to the benchmark case j.

3.1 Benchmark Case 1

Note that $\beta = 0$ represents absence of consumption externality effects. This case is identical to the model of Tabuchi and Thisse (1995) and only differs from the model in d'Aspremont, Gabszewicz and Thisse (1979) in that the firms are allowed to locate outside the range of consumer preferences. Let p_{A1} and p_{B1} be the prices charged by the firms. For $\beta = 0$, the model can be solved to derive the following results (see Appendix A for details).

$$p_{A1} = p_{B1} = \frac{3}{2}t.$$

The equilibrium locations (a_1, b_1) is given by

$$a_1 = -\frac{3}{4},\ b_1 = \frac{3}{4}. \tag{1}$$

The equilibrium locations are symmetric and each firm captures half the market.[5] The equilibrium firm profits for each firm is $\frac{3}{4}t$.

3.2 Benchmark Case 2

The second benchmark case represents the scenario when all consumers get identical effect of negative consumption externality. Grilo et al. (2001) analyze this model and is a special case of our model discussed in Section 3.4, if we set $\theta = 0$ and $K = 1$. In Appendix A, we find the equilibrium prices,

[5]We observe that the equilibrium firm locations lie outside the interval of consumers' ideal points. Tyagi (2000) elaborates on this issue and provides two specific examples: An example with locational interpretation is the choice of location of shopping malls and designer factory outlets. Even though all consumers may be located within the city (equivalent to consumers' ideal points distributed in a fixed interval), firms can locate their shopping malls (equivalent to product positions) outside the city. Also, the political economy literature discusses the phenomenon of political candidates taking extreme positions - outside of where the views of the voters lie (Glazer, Gradstein and Konrad 1998).

p_{A2} and p_{B2}, to be

$$p_{A2} = -\frac{1}{3}ta_2^2 - ta_2 + \frac{1}{3}tb_2^2 + tb_2 - N\beta, \quad (2)$$

$$p_{B2} = \frac{1}{3}ta_2^2 - ta_2 - \frac{1}{3}tb_2^2 + tb_2 - N\beta. \quad (3)$$

Given the prices in (2) and (3), the firms will choose locations to maximize profits. Substituting and solving for the symmetric equilibrium, we find that the equilibrium locations are as in Benchmark Case 1,

$$a_2 = -\frac{3}{4},\ b_2 = \frac{3}{4}. \quad (4)$$

Substituting the equilibrium locations into (2) and (3), we get

$$p_{A2} = p_{B2} = \frac{3}{2}t - N\beta. \quad (5)$$

In Grilo et al. (2001) model, prices always rise in a negative consumption externalities environment (i.e. when $\beta < 0$). Our results should be contrasted against these results. Next we consider the conditions for the existence of equilibrium in a model with negative consumption externality and consumer heterogeneity, and thereafter solve for the equilibrium firm locations and prices in Section 3.4.

3.3 Existence of Equilibrium

For the equilibrium analysis, we restrict ourselves to symmetric locations of firms. When both firms co-locate, Bertrand competition ensues, and there always exists a unique price equilibrium with prices equal to zero (d'Aspremont, Gabszewicz and Thisse 1979). But, the agglomeration of the two firms is never an equilibrium of the location game since profits are zero (Tabuchi and Thisse 1995). Therefore, firms have an incentive to move away from each other. We first characterize the price pairs such that both firms share the market. This is done by determining the necessary and sufficient conditions for

the marginal consumer to be located in $\left[-\frac{1}{2}, \frac{1}{2}\right]$.[6] The location of the marginal consumer is given by

$$\tilde{x} = \frac{2\left(p_B - p_A\right) + 2t\left(b^2 - a^2\right) + N\theta\beta\left(b + a\right)}{4t\left(b - a\right) - 4KN\beta + 2N\theta\beta + 2N\theta\beta\left(b - a\right)}. \tag{6}$$

The price pairs $(p_A,\ p_B)$ for which the marginal consumer is located in $\left[-\frac{1}{2}, \frac{1}{2}\right]$ should satisfy

$$-\frac{1}{2} \leq \frac{2\left(p_B - p_A\right) + 2t\left(b^2 - a^2\right) + N\theta\beta\left(b + a\right)}{4t\left(b - a\right) - 4KN\beta + 2N\theta\beta + 2N\theta\beta\left(b - a\right)} \leq \frac{1}{2}.$$

Assume $4t\left(b - a\right) - 4KN\beta + 2N\theta\beta + 2N\theta\beta\left(b - a\right) > 0$. The price pairs $(p_A,\ p_B)$ for which the marginal consumer is located in $\left[-\frac{1}{2}, \frac{1}{2}\right]$ is given by

$$p_A - p_B < -KN\beta + t\left(b^2 - a^2\right) + t\left(b - a\right) + \theta\beta N\left(b + \frac{1}{2}\right), \tag{7}$$

$$p_A - p_B > t\left(b^2 - a^2\right) - t\left(b - a\right) + KN\beta - \frac{1}{2}N\theta\beta + Na\theta\beta. \tag{8}$$

The price pairs for which a single firm serves the whole market is given by regions *not* captured by inequalities (7) and (8). Since demands are linear and decreasing in own price, in the price domain when they are positive, a Nash equilibrium in pure strategies exists. Differentiating the profit function of Firm A with respect to p_A and the profit function of Firm B with respect to p_B to solve for profit maximization, we get

$$p_A = \frac{1}{3}\theta\beta - K\beta - \frac{1}{3}a^2t + \frac{1}{3}b^2t - \frac{2}{3}at + \frac{2}{3}bt - \frac{1}{3}a\theta\beta + \frac{2}{3}b\theta\beta, \tag{9}$$

$$p_B = \frac{2}{3}\theta\beta - K\beta + \frac{1}{3}a^2t - \frac{1}{3}b^2t - \frac{4}{3}at + \frac{4}{3}bt - \frac{2}{3}a\theta\beta + \frac{1}{3}b\theta\beta. \tag{10}$$

For the prices in (9) and (10) to be equilibrium prices, we need to ensure that they satisfy the inequalities (7) and (8) . Substituting the prices from (9) and (10) in (7) and (8) lead to the following inequalities,

[6] Should a price equilibrium exist, the natural candidate are the prices (which are best response of each other) where the market boundary is in between the two firms, and vice versa. Indeed, we should not expect equilibrium strategies elsewhere; since that would imply that one of the two firms does not completely supply its own hinterland. In this case, that firm would have an incentive to lower its price so as to recover it, contradicting the fact that such a pair is a price equilibria (Gabszewicz and Thisse 1986).

$\frac{1}{3}(a+b)(2bt-2at+N\theta\beta) \leq -KN\beta + t(b^2-a^2) + t(b-a) + \theta\beta N\left(b+\frac{1}{2}\right)$

$\frac{1}{3}(a+b)(2bt-2at+N\theta\beta) \geq t(b^2-a^2) - t(b-a) + KN\beta - \frac{1}{2}N\theta\beta + Na\theta\beta$

Simplifying and assuming symmetric locations, we get

$-t(b-a) + KN\beta - \frac{1}{2}N\theta\beta + Na\theta\beta \leq 0 \leq -KN\beta + t(b-a) + \theta\beta N\left(b+\frac{1}{2}\right)$

Therefore, a sufficient condition for the existence of a unique price equilibrium is $K > \theta\left(b+\frac{1}{2}\right)$.[7] In Appendix B, we show that increasing $|\beta|$ tends to move equilibrium locations closer to the center of distribution of consumers. Therefore, the upper bound on the value of b (the location of Firm B) is $\frac{3}{4}$ as found in Benchmark Case 1. Hence $K > \frac{5}{4}\theta$ is a sufficient condition for the existence of equilibrium in our model.

3.4 Equilibrium Analysis

The equilibrium location of the firms is given by (details are in Appendix B),

$$a = -\frac{3}{4} - \frac{\theta\beta N}{8t}, \tag{11}$$

$$b = \frac{3}{4} + \frac{\theta\beta N}{8t}. \tag{12}$$

Proposition 1: *In markets with negative consumption externality, product differentiation is lower compared to the benchmark cases. Moreover, increasing population density reduces product differentiation further.*

Proof: *Follows by comparing equations (11) and (12) with (1) and (4).* ■

The intuition for the result is as follows. Firms realize that increasing market share leads to higher disutility in a negative consumption externality environment. So, firms try to compensate by reducing the average "transportation cost" for all consumers by differentiating less in markets with negative externality. Our results are consistent with empirical observations in Chao and Schor (1998) who find that conspicuous cosmetics are less differentiated. Note that in the benchmark cases, the equilibrium

[7] Or symmetrically, $K > \theta\left(\frac{1}{2}-a\right)$.

positioning is independent of the degree of negative consumption externality, and firms tend to be maximally differentiated in equilibrium.

Given these equilibrium locations, we note that increasing population density reduces product differentiation $\left(\frac{d(b-a)}{dN} = -\frac{\theta|\beta|}{4t}\right)$. As population density increases, moving to the center of distribution of consumers becomes more important and the market share effect dominates. This is not surprising but couldn't have been obtained with models in extant literature.

3.4.1 Pricing Decisions and Profits

Substituting the equilibrium locations into equations (9) and (10), we get the equilibrium prices to be

$$p_A = p_B = \frac{N^2\theta^2\beta^2}{8t} + \frac{3}{2}N\theta\beta - KN\beta + \frac{3t}{2}. \tag{13}$$

This leads to the following proposition.

Proposition 2: *In markets with negative consumption externalities, price competition is higher compared to markets with no consumption externality iff* $|\beta| < \left(\frac{3}{2}\theta - K\right)\frac{8t}{N\theta^2}$.

Proof: *Follows from equation (13).* ■

When consumer preferences exhibit negative consumption externalities, firms differentiate less, and price competition is fiercer. This contrasts with the results in Grilo et al. (2000) who show that when vanity is at work, price competition is reduced. In the same vein, Laussel et al. (2004) find that the existence of negative consumption externalities softens price competition. Amaldoss and Jain (2005) also find that snobbishness induces higher prices. Our model shows that the extent of price competition is moderated by the strength of negative consumption externalities. When $|\beta|$ is low (and there is substantial heterogeneity in consumption externalities effects), lower product differentiation drives higher price competition. As $|\beta|$ increases, higher demand (due to lower prices) lowers the value of the product, so reducing prices becomes less attractive to both firms. It is the interplay between product differentiation and product valuation that drives price competition. These results

are consistent with the empirical observation in Chao and Schor (1998) who find that the percentage of consumers paying higher prices increases with conspicuousness. In the benchmark cases, price competition effect dominates the market share effect. Because firms are maximally differentiated, it reduces the incentives to lower prices. Furthermore, in benchmark case 2, vanity renders the demand addressed by each firm less elastic, thus reducing the incentives to lower prices.

The degree of price competition determines firm profits. Based on the proposition 2, firm profits are higher than the benchmark cases only when the negative consumption externalities are very strong. Our results indicate that optimal positioning decisions as well as the degree of heterogeneity in consumption externality, play a crucial role in profits realized by firms in equilibrium. Consequently, our results suggest that firms may be better off if they reduce heterogeneity among consumers in consumption externality effects.

3.5 Role of θ in negative externality markets

The θ parameter captures the variance in consumption externality effects on consumer's utility among consumers purchasing from a particular firm. When θ is low, the variation in consumption externality effects among consumers purchasing from a firm is low and vice versa. We study the effect of changes in θ on price competition. Differentiating the equilibrium price with respect to θ, we find

$$\frac{d}{d\theta}(p_A) = \frac{d}{d\theta}(p_B) = \frac{d}{d\theta}\left(\frac{N^2\theta^2\beta^2}{8t} + \frac{3}{2}N\theta\beta - KN\beta + \frac{3t}{2}\right) = -\frac{3}{2}N|\beta|\left(1 - \frac{|\beta|N\theta}{6t}\right). \quad (14)$$

Proposition 3: *An increase in heterogeneity among consumers in effects of negative consumption externality leads to fiercer price competition* $\left(\frac{d}{d\theta}(p_A) = \frac{d}{d\theta}(p_B) < 0\right)$.

Proof: *Follows from Equation (14).* ■

The intuition for this result is as follows. When θ is high, product differentiation is lower, therefore price competition is higher. When θ is low, if firms lower prices, higher demand lowers the utility quite a bit, so firms have incentives to keep prices high. Lower θ is consistent with the notion that

brand engagement in the population of interest may be higher and vice versa. This result is consistent with prior behavioral research by Sprott et al. (2009) who have shown that higher brand engagement in self-concept is associated with more positive brand attitudes and reduced price sensitivity to new products allowing firms to charge higher prices. Although consumer engagement to a brand is key to firm profits in any market (Marketing Week 2010), this result highlights the importance of increasing brand engagement across *all* consumers of a firm in conspicuous goods markets.

4 Model Extensions

4.1 Asymmetric Firms

The base model analyzed in Section 3 assumes that firms are symmetric. We extend the model to understand positioning and pricing strategies of asymmetric firms. Firms may be asymmetric in terms of the extent to which a consumer's willingness to pay is affected due to consumption externality. Let K_A and K_B (with $K_A > K_B$) represent the upper bound on consumption externalities effects for Firm A and B respectively . In this set up, for conspicuous goods, the utility of Firm $B's$ customers is affected to a lesser extent due to consumption externalities than Firm $A's$ customers. Therefore, the location of the marginal consumer is given by the following equation

$$V-p_A-t\left(x-a\right)^2+N\beta\left(\frac{1}{2}+x\right)\left(K_A-\theta\left(x-a\right)\right)=V-p_B-t\left(b-x\right)^2+N\beta\left(\frac{1}{2}-x\right)\left(K_B-\theta\left(b-x\right)\right). \tag{15}$$

Solving the first-order conditions simultaneously, the equilibrium prices are given by

$$p_A = \frac{1}{3}b^2t-\frac{1}{3}a^2t-at+bt+\frac{1}{2}N\theta\beta-\frac{1}{3}N\beta K_A-\frac{2}{3}N\beta K_B-\frac{1}{3}Na\theta\beta+\frac{2}{3}Nb\theta\beta, \tag{16}$$

$$p_B = \frac{1}{3}a^2t-\frac{1}{3}b^2t-at+bt+\frac{1}{2}N\theta\beta-\frac{2}{3}N\beta K_A-\frac{1}{3}N\beta K_B-\frac{2}{3}Na\theta\beta+\frac{1}{3}Nb\theta\beta. \tag{17}$$

In Appendix C, we numerically solve for the equilibrium firm positioning. To solve for the equilibrium locations, we choose the following parameter values: $\theta = 1$, $K_A = 3, K_B = 2, t = 1$, $N = 2$, $\beta = -1$. These parameter values have been chosen such that all the equilibrium constraints

are satisfied.[8] The equilibrium prices are given by $p_A = 3.6667$ and $p_B = 4.3333$.

These prices seem to suggest that in conspicuous goods markets, the firm which endows consumers with stronger effect of consumption externality tends to charge lower prices. The intuition for this result is that an increase in K, increases the consumers disutility associated with consumption externality. Our model suggests that such a firm tends to charge lower prices in order to compensate consumers for the higher disutility incurred by them.

4.2 Presence of Conformists

Until now, our focus has been on understanding optimal firm strategies in the presence of snobs only. However, some consumers may exhibit conforming behavior even in conspicuous goods markets (Amaldoss and Jain 2005). We extend the model to explain equilibrium positioning and pricing in conspicuous goods markets when both snobs and conformists coexist. In this operationalization, there are two types of consumers, a fraction α of consumers are snobs and remaining $(1-\alpha)$ are conformists. We assume that these two types of consumers are distributed uniformly in the line segment $[-0.5, 0.5]$ and independent of each other. For the conformists, the utility increases as more consumers buy from the same firm. Using the same notation, the location of the marginal consumer is given by

$$V - p_A - t\left(x-a\right)^2 - N\beta\left(\frac{1}{2}+x\right)\left(K-\theta\left(x-a\right)\right) = V - p_B - t\left(b-x\right)^2 - N\beta\left(\frac{1}{2}-x\right)\left(K-\theta\left(b-x\right)\right). \tag{18}$$

Solving, the marginal consumer among conformists is

$$x = \frac{2p_A - 2p_B + 2a^2t - 2b^2t + Na\theta\beta + Nb\theta\beta}{4at - 4bt - 4KN\beta + 2N\theta\beta - 2Na\theta\beta + 2Nb\theta\beta}. \tag{19}$$

Using numerical analysis, in Appendix D, we study how equilibrium positioning and pricing are affected by presence of conformists in the market. To solve for the equilibrium locations, we choose the

[8] Note that the equilibrium locations are symmetric because we consider asymmetry in K. Modeling asymmetry in brand engagement across consumers of the two firms or modeling asymmetry in quality of products offered by the two firms (represented by asymmetry in consumer's willingness to pay) will lead to asymmetric equilibrium locations.

following parameter values: $\theta = 1$, $K = 2$, $t = 1$, $N = 2$, $\beta = -1$, $\alpha = 0.75$. Based on the numerical analysis, we conclude that the presence of conformists diminishes the propensity to agglomerate towards the center of distribution of consumers. Note that equilibrium analysis discussed in Section 3 does not naturally extend to positive consumption externality environments as the equilibrium existence conditions lead to multiplicity of price equilibria being generated.[9]

5 Summary and Conclusions

Our objective in this paper is to understand product differentiation and pricing in conspicuous goods markets. We allow the effect of consumption externality to depend on a consumer's location vis-à-vis the location of the firm. Specifically, we assume that the effect of consumption externality is stronger on those consumers who are located 'closer' to the firms. In essence, we are assuming that a customer closer to a firm may feel more let down if *that* firm caters to too many customers. We find that product differentiation is lower in markets with negative consumption externalities. Also, the price competition could be higher compared to a market with no consumption externalities depending on the strength of the consumption externality effect. In particular, price competition could be higher if $|\beta|$ is below a threshold. Therefore, even in product categories with negative externalities, our analysis cautions against the blanket use of marketing strategies intended to create an exclusive image for a product. Managers should probably focus on exclusivity only when negative consumption externalities are very strong. We also show that in negative externality markets, firms are better off if they reduce heterogeneity among consumers in consumption externality effects. This suggests that enhancing brand engagement and targeting specific niches of a market may be a viable marketing strategy in conspicuous goods markets. In an extenstion, we study the product positioning and pricing strategies of asymmetric firms. We show numerically that in case of asymmetric firms, the firm whose consumers get stronger effect of consumption externality tends to charge lower prices. In another extension, we numerically analyze the scenario where some consumers may exhibit conforming

[9] Grilo et al. (2001) discuss equilibrium under conformity in greater detail.

behavior even in conspicuous goods markets and show that the presence of conformists diminishes the propensity of firms to agglomerate towards the center of distribution of consumers.

We have made a number of simplifying assumptions. One such assumption is that all consumers buy one and only one product. In a more general setting, some consumers may opt out in a conspicuous goods market. Depending on equilibrium firm locations, two cases may arise in an uncovered market equilibrium: the consumers who opt out are located at the ends of the market, or they are located between the market segments of the two firms. In the first case, it just reduces the size of the market of interest but in the latter case, each firm acts a local monopolist and avoids competition.

In our model, each firm makes one and only one product. However, in some markets, a firm may produce two different products sold in two different markets but the value of one product depends on the demand for the other (Chen and Xie 2007). Extending our analysis to such a setting where cross market network effects exist is also an interesting avenue for future research.

The results of our analysis are obtained under a specific modeling assumption of consumption externality. Using a different specification may have an effect on the results highlighting opportunities for future research. However, it is worthwhile to note that there are instances where recommendations from prior empirical research are consistent with our model predictions.

We have assumed that firms choose their locations simultaneously. Understanding the optimal positioning and pricing decisions under sequential entry may provide us with additional insights into the role of externality in spatial competition models, especially in the area of diffusion of new products. It may also be interesting to study how firms' strategic decisions over time are affected due to consumption externalities among consumers. For example, when consumers value exclusivity, it might lead to lower demand in later periods. Thus, exclusivity may be an important source of demand uncertainty affecting firms production decisions (Desai et al. 2007). Analyzing such a dynamic game is another potential avenue for further research.

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Technical Appendix

Appendix A

We solve for the equilibrium positioning and pricing decisions for the first benchmark case For $\beta = 0$, we have a two stage model. The marginal consumer is located at $\frac{p_{B1}-p_{A1}+t\left(b_1^2-a_1^2\right)}{2t(b_1-a_1)}$.

Therefore, Firm A market share = $\left[\frac{1}{2}+\frac{p_{B1}-p_{A1}+t\left(b_1^2-a_1^2\right)}{2t(b_1-a_1)}\right]$ and Firm B market share

$= \left[\frac{1}{2}-\frac{p_{B1}-p_{A1}+t\left(b_1^2-a_1^2\right)}{2t(b_1-a_1)}\right]$.

Firm A profits are given by $\pi_A = p_{A1}\left[\frac{1}{2}+\frac{p_{B1}-p_{A1}+t\left(b_1^2-a_1^2\right)}{2t(b_1-a_1)}\right]$. Firm A will choose p_{A1} to maximize profits. Therefore, $\frac{d\pi_A}{dp_{A1}} = 0$. Similarly, $\frac{d\pi_B}{dp_{B1}} = 0$.

$p_{A1} = -a_1 t + b_1 t - \frac{1}{3}a_1^2 t + \frac{1}{3}b_1^2 t$

$p_{B1} = -a_1 t + b_1 t + \frac{1}{3}a_1^2 t - \frac{1}{3}b_1^2 t$

Solving these simultaneously, we get

$$p_{A1} = \frac{t}{3}\left[3\left(b_1-a_1\right)+\left(b_1^2-a_1^2\right)\right], \tag{A.1}$$

$$p_{B1} = \frac{t}{3}\left[3\left(b_1-a_1\right)-\left(b_1^2-a_1^2\right)\right]. \tag{A.2}$$

Substituting the equilibrium prices into the firms profit function and realizing that firms choose locations to maximize profits, we have $\frac{d\pi_A}{da_1} = 0$. Similarly, $\frac{d\pi_B}{db_1} = 0$. Solving we get, $a_1 = -\frac{3}{4}$ and $b_1 = \frac{3}{4}$. Substituting the equilibrium locations into (A.1) and (A.2), we get $p_{A1} = p_{B1} = \frac{3}{2}t$.

Now let us analyze the second benchmark case where consumers get identical effect of negative consumption externality.

The location of the marginal consumer is given by the following equation

$$V - p_{A2} - t\left(x-a\right)^2 + N\beta\left(\frac{1}{2}+x\right) = V - p_{B2} - t\left(b-x\right)^2 + N\beta\left(\frac{1}{2}-x\right). \tag{A.3}$$

Solving, the location of the marginal consumer is given by

$$\tilde{x} = \frac{p_{B2}-p_{A2}+t\left(b_2^2-a_2^2\right)}{-2N\beta+2t\left(b_2-a_2\right)}.$$

where $\beta < 0$.

Deriving the FOC for profit maximization and solving the expressions for p_{A2} and p_{B2} simultaneously, we get

$$p_{A2} = -\frac{1}{3}ta_2^2 - ta_2 + \frac{1}{3}tb_2^2 + tb_2 - N\beta, \tag{A.4}$$

$$p_{B2} = \frac{1}{3}ta_2^2 - ta_2 - \frac{1}{3}tb_2^2 + tb_2 - N\beta. \tag{A.5}$$

Given the prices, the firms will choose locations to maximize profits. Substituting the prices and solving for the symmetric equilibrium, we again find that the equilibrium locations are as in Benchmark Case 1

$$a_2 = -\frac{3}{4},\ b_2 = \frac{3}{4}. \tag{A.6}$$

Substituting the equilibrium locations into (A.4) and (A.5), we get $p_{A2} = p_{B2} = \frac{3}{2}t - N\beta$.

Note that the existence of price equilibrium (when the marginal consumer is located between the two firms) is guaranteed in this case.

Appendix B

The location of the marginal consumer is given by the following equation

$$V - p_A - t\left(x-a\right)^2 + N\beta\left(\frac{1}{2}+x\right)\left(K-\theta\left(x-a\right)\right) = V - p_B - t\left(b-x\right)^2 + N\beta\left(\frac{1}{2}-x\right)\left(K-\theta\left(b-x\right)\right) \tag{B.1}$$

Solving, the location of the marginal consumer is given by

$$\tilde{x} = \frac{-2p_A + 2p_B - 2a^2t + 2b^2t + Na\theta\beta + Nb\theta\beta}{4t\left(b-a\right) - 4KN\beta + 2N\theta\beta + 2N\theta\beta\left(b-a\right)}.$$

where $\beta < 0$.

The firms' are ex-ante identical, so a candidate equilibrium will have the marginal consumer located between the two firms.

The firms will choose prices to maximize profits. The first derivative of profits with respect to prices is given by

$\frac{d\pi_A}{dp_A} = \frac{d}{dp_A}\left(p_A\left(\frac{1}{2} - \frac{-2p_A+2p_B-2a^2t+2b^2t+Na\theta\beta+Nb\theta\beta}{4at-4bt+4KN\beta-2N\theta\beta+2Na\theta\beta-2Nb\theta\beta}\right)\right)$
$\frac{d\pi_B}{dp_B} = \frac{d}{dp_B}\left(p_B\left(\frac{1}{2} - \left(-\frac{-2p_A+2p_B-2a^2t+2b^2t+Na\theta\beta+Nb\theta\beta}{4at-4bt+4KN\beta-2N\theta\beta+2Na\theta\beta-2Nb\theta\beta}\right)\right)\right)$

The leads to the following FOC's for profit maximization are

$$\frac{(2p_B - 4p_A - 2a^2t + 2b^2t - 2at + 2bt - 2KN\beta + N\theta\beta + 2Nb\theta\beta)}{2\,(2bt - 2at - 2KN\beta + N\theta\beta - Na\theta\beta + Nb\theta\beta)} = 0, \quad \text{(B.2)}$$

$$-\frac{(4p_B - 2p_A - 2a^2t + 2b^2t + 2at - 2bt + 2KN\beta - N\theta\beta + 2Na\theta\beta)}{2\,(2bt - 2at - 2KN\beta + N\theta\beta - Na\theta\beta + Nb\theta\beta)} = 0. \quad \text{(B.3)}$$

Solving the expressions for p_A and p_B simultaneously, we get

$$\begin{aligned} p_A &= \frac{1}{3}b^2t - \frac{1}{3}a^2t - at + bt - KN\beta + \frac{1}{2}N\theta\beta - \frac{1}{3}Na\theta\beta + \frac{2}{3}Nb\theta\beta, \\ p_B &= \frac{1}{3}a^2t - \frac{1}{3}b^2t - at + bt - KN\beta + \frac{1}{2}N\theta\beta - \frac{2}{3}Na\theta\beta + \frac{1}{3}Nb\theta\beta. \end{aligned}$$

Substituting, we find that $p_B - p_A = -\frac{1}{3}(a+b)(2bt - 2at + N\theta\beta)$.

Given the prices, the firms will choose locations to maximize profits. The first order conditions for profit maximization can be written as

$\frac{d}{da}\left(p_A\left(\frac{1}{2} - \frac{-2p_A+2p_B-2a^2t+2b^2t+Na\theta\beta+Nb\theta\beta}{4at-4bt+4KN\beta-2N\theta\beta+2Na\theta\beta-2Nb\theta\beta}\right)\right) = 0$
and $\frac{d}{db}\left(p_B\left(\frac{1}{2} - \left(-\frac{-2p_A+2p_B-2a^2t+2b^2t+Na\theta\beta+Nb\theta\beta}{4at-4bt+4KN\beta-2N\theta\beta+2Na\theta\beta-2Nb\theta\beta}\right)\right)\right) = 0$

Substituting the prices and solving for the symmetric equilibrium,

$$a = -\frac{3}{4} - \frac{\theta\beta N}{8t}, \quad \text{(B.4)}$$

$$b = \frac{3}{4} + \frac{\theta\beta N}{8t}. \quad \text{(B.5)}$$

Substituting the values of the equilibrium locations, we get the equilibrium prices to be

$$p_A = p_B = \frac{N^2\theta^2\beta^2}{8t} + \frac{3}{2}N\theta\beta - KN\beta + \frac{3t}{2}. \quad \text{(B.6)}$$

The equilibrium prices can be rearranged as: $p_A = p_B = 2\left(\frac{3}{2}\sqrt{t} - \frac{N\theta|\beta|}{4\sqrt{t}}\right)^2 + NK|\beta| - 3t$.

To ensure that the prices are greater than zero in equilibrium in markets with negative consumption externalities, we can observe that $\left(|\beta| > \frac{3t}{KN}\right)$ is a sufficient condition.

The second order conditions for profit maximization is:

$-\frac{N^2t\theta^2\beta^2+36Nt^2\theta\beta-32KNt^2\beta+36t^3}{6N^2\theta^2\beta^2+72Nt\theta\beta-48KNt\beta+72t^2} < 0$. A sufficient condition for the second order profit maximization condition to exist is $K > \frac{5}{4}\theta$.

Appendix C

In this case, the location of the marginal consumer is found using the equation

$$V-p_A-t\left(x-a\right)^2+N\beta\left(\frac{1}{2}+x\right)\left(K_A-\theta\left(x-a\right)\right)=V-p_B-t\left(b-x\right)^2+N\beta\left(\frac{1}{2}-x\right)\left(K_B-\theta\left(b-x\right)\right) \tag{C.1}$$

The location of the marginal consumer is given by

$$\widetilde{x}=-\frac{(-2p_A+2p_B-2a^2t+2b^2t+N\beta K_A-N\beta K_B+Na\theta\beta+Nb\theta\beta)}{4at-4bt-2N\theta\beta+2N\beta K_A+2N\beta K_B+2Na\theta\beta-2Nb\theta\beta}.$$

The firms will choose prices to maximize profits. Setting the first derivative of profits with respect to prices,

$$\begin{aligned}
-\frac{(2p_B-4p_A-2a^2t+2b^2t-2at+2bt+N\theta\beta-2N\beta K_B+2Nb\theta\beta)}{2\left(2at-2bt-N\theta\beta+N\beta K_A+N\beta K_B+Na\theta\beta-Nb\theta\beta\right)} &= 0,\\
\frac{(4p_B-2p_A-2a^2t+2b^2t+2at-2bt-N\theta\beta+2N\beta K_A+2Na\theta\beta)}{2\left(2at-2bt-N\theta\beta+N\beta K_A+N\beta K_B+Na\theta\beta-Nb\theta\beta\right)} &= 0.
\end{aligned}$$

Solving the first-order conditions simultaneously, the equilibrium prices are given by

$$p_A = \frac{1}{3}b^2t-\frac{1}{3}a^2t-at+bt+\frac{1}{2}N\theta\beta-\frac{1}{3}N\beta K_A-\frac{2}{3}N\beta K_B-\frac{1}{3}Na\theta\beta+\frac{2}{3}Nb\theta\beta, \tag{C.2}$$

$$p_B = \frac{1}{3}a^2t-\frac{1}{3}b^2t-at+bt+\frac{1}{2}N\theta\beta-\frac{2}{3}N\beta K_A-\frac{1}{3}N\beta K_B-\frac{2}{3}Na\theta\beta+\frac{1}{3}Nb\theta\beta. \tag{C.3}$$

To determine the equilibrium locations, the first order conditions can be written as

$$\begin{aligned}
\frac{d}{da}\left(p_A\left(\frac{1}{2}-\frac{(-2p_A+2p_B-2a^2t+2b^2t+N\beta K_A-N\beta K_B+Na\theta\beta+Nb\theta\beta)}{4at-4bt-2N\theta\beta+2N\beta K_A+2N\beta K_B+2Na\theta\beta-2Nb\theta\beta}\right)\right) &= 0,\\
\frac{d}{db}\left(p_B\left(\frac{1}{2}-\left(-\frac{(-2p_A+2p_B-2a^2t+2b^2t+N\beta K_A-N\beta K_B+Na\theta\beta+Nb\theta\beta)}{4at-4bt-2N\theta\beta+2N\beta K_A+2N\beta K_B+2Na\theta\beta-2Nb\theta\beta}\right)\right)\right) &= 0.
\end{aligned}$$

Solving numerically, we get the following five solutions for equilibrium locations:

$$[a = -0.5, b = 0.5], [a = -0.5, b = 4.1056], [a = 2.8166, b = 0.5],$$
$$[a = -0.5, b = -3.1056], [a = -3.8166, b = 0.5]$$

Based on the second order conditions, the equilibrium locations for profit maximization is given by

$$a = -0.5, b = 0.5. \tag{C.4}$$

Substituting the equilibrium locations, the equilibrium prices are given by

$$p_A = 3.6667, \tag{C.5}$$

$$p_B = 4.3333 \tag{C.6}$$

Appendix D

Let α fraction of consumers in the market be snobs and $(1-\alpha)$ fraction of consumers be conformists. For the conformists, the utility increases as more consumers buy from the same firm. Using the same notation, the marginal consumer is given by

$$V - p_A - t(x-a)^2 - N\beta\left(\tfrac{1}{2} + x\right)(K - \theta(x-a)) = V - p_B - t(b-x)^2 - N\beta\left(\tfrac{1}{2} - x\right)(K - \theta(b-x))$$

Solving, the marginal consumer among conformists is

$$x = \frac{2p_A - 2p_B + 2a^2t - 2b^2t + Na\theta\beta + Nb\theta\beta}{4at - 4bt - 4KN\beta + 2N\theta\beta - 2Na\theta\beta + 2Nb\theta\beta}.$$

Adding the demand from snobs and conformists, we have the demand for Firm A is

$$\alpha\left(\tfrac{1}{2} + \tfrac{-2p_A+2p_B-2a^2t+2b^2t+Na\theta\beta+Nb\theta\beta}{4t(b-a)-4KN\beta+2N\theta\beta+2N\theta\beta(b-a)}\right) + (1-\alpha)\left(\tfrac{1}{2} + \tfrac{2p_A-2p_B+2a^2t-2b^2t+Na\theta\beta+Nb\theta\beta}{4at-4bt-4KN\beta+2N\theta\beta-2Na\theta\beta+2Nb\theta\beta}\right)$$

Similarly, for Firm B, the demand is given by

$$\alpha\left(\tfrac{1}{2} - \tfrac{-2p_A+2p_B-2a^2t+2b^2t+Na\theta\beta+Nb\theta\beta}{4t(b-a)-4KN\beta+2N\theta\beta+2N\theta\beta(b-a)}\right) + (1-\alpha)\left(\tfrac{1}{2} - \tfrac{2p_A-2p_B+2a^2t-2b^2t+Na\theta\beta+Nb\theta\beta}{4at-4bt-4KN\beta+2N\theta\beta-2Na\theta\beta+2Nb\theta\beta}\right)$$

Solving for the equilibrium prices for the following numerical values: $\theta = 1$, $K = 2$, $t = 1$, $N = 2$, $\beta = -1$, $\alpha = 0.75$, we get

$$p_A = \frac{1}{3a - 3b + 3}\left(10a - 14b + ab^2 + a^2b - 2a^2 - a^3 + 2b^2 - b^3 + 18\right),$$
$$p_B = \frac{1}{3a - 3b + 3}\left(14a - 10b - ab^2 - a^2b + 2a^2 + a^3 - 2b^2 + b^3 + 18\right).$$

Substituting and solving for the symmetric equilibrium, we get a number of real and imaginary roots but the second derivative of profits is negative only the locations mentioned below, so it is a candidate equilibrium.

$$\begin{aligned} a &= -1.1067, \\ b &= 1.1067. \end{aligned}$$

Substituting the equilibrium locations, the equilibrium prices are given by $p_A = p_B = 2.351\,7$.