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Abstract

This paper addresses the strategic relationship between preannouncement and product positioning of innovations. The modeling framework is based on the premise that the preannouncement can influence the formation of consumer preference for innovations. Among other results, the model yields three counter-intuitive ones, in particular, regarding firms' positioning strategies in duopoly when they have identical expertise and unbiased expectation of consumer preferences. First, we find that if both firms preannounce, the firm with lower (higher) preannouncement impact occupies (leaves) the more favorable market position, and achieves higher (lower) profits than its rival. Second, if one firm preannounces while the other doesn't, the non-announcing (announcing) firm always occupies (leaves) the more favorable market position, and achieves higher (lower) profits than its rival. Finally, if both firms preannounce, they choose identical positions for product introduction, even though they differ in their repositioning cost and differentiate their product positions in preannouncements. In this case the firm with the higher repositioning costs makes higher profits than its competitor. The findings refute the established view that new product preannouncement endows a firm with competitive advantage and serves to preempt the most favorable marketplace.

1. Introduction

New product preannouncement has become a routine practice, especially in high-tech markets. A survey of marketing managers shows that 51% of the respondents across a variety of industries reported the use of preannouncement before introducing new products (Eliashberg and Robertson 1988). According to another managerial survey, a firm has an incentive to preannounce because preannouncement can hype a new product, encourage consumers to delay purchase of rival products, and help obtain feedback from the market about product design (Lilly and Walters, 1997). Recently, Lilly and Walters conducted experiments showing that a product preannouncement can influence the formation of consumer preference for a new product (2000). Their study, similar to Carpenter and Nakamoto's view (1989), also suggests that consumer preference is endogenous, and the preference formation is an updating process. The difference between the two is that consumers update their original preference through *product trial* in Carpenter and Nakamoto's theory but through *exposure to product information* in Lilly and Walter's theory. The result in Lilly and Walters' experiment is strengthened in another experiment by Burke et al (1990), which shows that a product preannouncement can influence consumers' purchase intention.

The effect of preannouncement on consumer preference is also evident in a real-life example and confirmed in an empirical study. The example is Intel, which successfully used preannouncements to manipulate consumer preference towards CPU speed, although memory is in fact the most important attribute of a microprocessor (e.g. Dennis Sellers, ComputerUser.com, April 2001). The empirical study by Nagard-Assayag and Manceau (2001) explicitly tests for the preannouncement impact in the context of indirect network externalities. Specifically, it shows that preannouncement contributes to positive consumer evaluation of new hardware.

A radical innovation represents a new product that shows substantial improvement in technology and consumer benefits (Chandy and Tellis 1998). Disruptive innovation represents a new technology, which initially appeals only to a niche market but later appeals to the mass market (Christensen 2003).

For such products, consumer preference are at best partially formed (Christensen 2003). A preannouncement can affect the formation of consumer preference for such products because consumers do not have strong priors about them. Thus, consumer preference for such innovations can be easily manipulated (Lilly and Walters, 2000).

Because preannouncement can affect consumer preference through the provision of product information, a firm's positioning in the preannouncement is critical. But, since a firm does not immediately deliver the product, it has the option of bluffing. For example, Apple bluffed in its preannouncement of the first generation of the personal digital assistant (PDA) — the Newton MessagePad. In the preannouncement, the company exaggerated the product attribute by stating that the new product can read a user's handwriting even when the user cannot recognize it (Bailey 1993). This claim was untrue. Apple bluffed in order to shift consumer preference toward its technological strength in handwriting recognition.

The relationship between product preannouncement and product positioning gets more complicated if a firm repositions after the preannouncement. In the example above, the preannouncement triggered massive press coverage, in which computer professionals offered comments and opinions about the Newton MessagePad and the PDA overall. The press coverage revealed the market's true preference for the PDA, which was not handwriting recognition but wireless communication[1] (e.g. Yamada 1992; Ratcliffe 1992). Apple, upon knowing the preference, repositioned the MessagePad before its debut by labeling it a "communications assistant" instead of the original "personal digital assistant" (Consumer Electronics Warren Publishing 1993).

Thus, a new product preannouncement has strategic effects on product positioning, especially for radical or disruptive innovations. Only a few papers have acknowledged the existence of such effects (Eliashberg and Robertson 1988; Brockhoff and Rao 1993; Kaul and Rao 1994) and no prior study has formally analyzed the nature of the effects. Kaul and Rao (1994), in their review of models on product positioning and design, highlighted the need to fill the gap.

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[1] This functionality refers to PDA's ability to send and receive information by wireless means.

This study is the first to focus on the strategic interdependence between new product preannouncement and positioning. Specifically, we address the following four questions:

First, should a firm preannounce a new product? A naïve answer would be yes, since a preannouncement seems like an advertisement for the upcoming product and an advertisement by itself may not harm the product. Our analysis, however, shows that this view may not be always true.

Second, if a firm chooses to preannounce, what positioning strategy should it adopt? Should it adopt one that is close or far from its strengths? An obvious answer is that the firm should announce a position matching its strength so that consumer preference can be shifted as close as possible to its strength. Again, our analysis shows that this may not always be the case.

Third, if it is not optimal to position at one's strength, then a related question is: Should a firm exaggerate its strength like Apple did for the Newton Message Pad? Our analysis shows that it depends on the firm's power of influencing consumer preference with a preannouncement.

Fourth, when competition factors in, would the optimal strategy change? In particular, if the competitor also possesses some degree of power to influence consumer preference through a preannouncement and if they both preannounce, which one would occupy the most favorable position?

Our answers to the above questions rest on the following intuition.A firm's decision on a product position is essentially its choice of product attributes to maximize consumer demand (Kaul and Rao 1995). Therefore, the product position should be close to the location of consumer preferences. There are two constraints in positioning close to consumer preferences: the firm's technological expertise and its information about consumer preference. These two factors may not always be in alignment. So, the key issue in product positioning boils down to striking a balance between a firm's technological expertise and consumer preference. We illustrate the trade-off in detail as follows.

First, due to the technological constraints, a firm cannot always choose levels of attributes that are close to consumer preferences. This strategy is especially true for a radical innovation. Recall that the starting premise of this study is that a firm can influence the formation of consumer preferences towards its technological strength with a preannouncement. If its technological strength lies far from consumer preferences, then it can still bluff. However, if consumer preferences are responsive to preannouncements, such bluffing may be costly. The costs involved are repositioning costs if the firm locates away from its announced position and re-engineering costs if the firm locates away from its strength. Examples of repositioning costs include loss of reputation or advertising to communicate the new position. Examples of re-engineering cost include re-tooling of manufacturing facilities or re-training of employees.

Second, the firm may not have market information about where exactly consumer preferences lie. This makes the choice of positioning in the preannouncement risky. The first type of risk is that if it positions too close to its strengths relative to current consumer preference, its preannouncement would fail to generate enough demand. Second, if a firm announces a position too far from its technological strength relative to current consumer preference, it may move the preference away from its strength. Thirdly, in a competitive setting, the preannouncement of the other firm can interact with that of the focal firm and divert consumer preferences to the strength of the competitor.

The paper is organized as follows. In section 2 we briefly discuss the trade-off between costs and benefits of preannouncements which is driving our analysis. The question if and how a monopolist should preannounce is treated in section 3, whereas in section 4 we address these questions for the duopoly case. We close the paper with a discussion of our findings in section 5. All proofs are in a technical appendix available online.

2. Costs and Benefits of Preannouncements

Following Carpenter's model (1989), we represent consumer preferences before (ex ante) and after (ex post) the preannouncement with unimodal ideal point a_0 and a_I, respectively. When making the preannouncement decision, a firm does not know the exact location of the true ex ante preference but has beliefs represented by a Gaussian distribution with $Ea_0 = 0$ and $Var(a_0) = \sigma^2 > 0$. The variance of the distribution measures the firm's uncertainty of ex ante consumer preferences. Preannouncement by the firm has two benefits: it can find out or influence consumer preferences before the firm makes a decision on the product position and design. For example, Lilly and Walters's survey of managers shows that a preannouncement can be used to obtain feedback from consumers about their preference for the announced product (1997). Apple's example also shows how a firm learns consumer preferences from a preannouncement. If a firm chooses not to preannounce, it can get to know consumer preferences by conducting marketing research, which entails certain amount of expenditure. Note the expenditure on marketing research is a fixed cost, not influencing the positioning decision at all. But it does affect the profit from the non-preannouncement decision and consequently enhances a firm's preannouncement incentive. However, since our focus is not on a firm's choice between marketing research and preannouncement, we set the expenditure to zero, without loss of generality. By virtue of this assumption, a firm's preannouncement incentive in the model is only a conservative representation of the real situation.

Preannouncements may seem costless but they are not. If the knowledge a firms gains from a preannouncement shows that its announced design and position does not match consumer preferences, then the firm will need to reposition its product after the preannouncement. If it chooses to do so, it incurs repositioning costs which occur due to a loss of reputation from repositioning and may hurt sales. For example, Hoxmeier (1998) finds that, if a vendor fails to deliver the software functionality as promised in a preannouncement, it jeopardizes its reputation and credibility with consumers. The larger the ex-ante uncertainty concerning consumer preferences the larger are the expected repositioning costs.

A second type of costs, reengineering costs always occur if the product position at introduction does not exactly match a firm's technological expertise The concept of reengineering is adapted from the conventional terminology in the management literature, in which it is defined as a management technique meant to eradicate the old system and start over with a new business process (Hammer and Champy 1993). In this paper, we extend the definition to product positioning in the sense that a firm adjusts its technological expertise in order to better fit in with consumers' needs. Making a preannouncement can reduce the re-engineering costs by moving consumer preferences towards the firm's own technological expertise.

3. Monopoly

We first study a monopoly setting and then extend the model structure to duopoly. In both settings, a firm goes through three stages in decision making, including preannouncement, positioning, and product introduction.

At the first stage, the monopolist decides on whether or not to preannounce and---if it chooses to preannounce---the announced position. If a preannouncement occurs, consumer preference would be influenced such that the ex post ideal point or the influenced preference is a weighted average of the ex ante ideal point and the announced position. Specifically,

$$a_I = (1-\delta\lambda)a_0 + \delta\lambda a_p \qquad (1)$$

where, $\lambda \in [0,1]$ denotes the preannouncement impact, a_I the ex post ideal point, a_0 the ex ante ideal point, a_p the announced position, and δ is an indicator parameter with value of 1 for preannouncement and 0 for non-preannouncement. If $\lambda = 0$ the preannouncement has no impact on consumer preference whatsoever, while for $\lambda = 1$ the monopolist can fully control the preference through its preannouncement. The firm does not know the ex ante ideal point a_0 at the time the preannouncement is made but can observe the actual ex post ideal point a_I between the first and the second stage.

At the second stage, the firm decides on the actual product position before the debut of the new product. If the final position deviates from the announced position, the firm is said to reposition the product.

At the third stage, the firm introduces the product and charges a monopoly price. In Figure 1 we graphically summarize the structure of the model.

Figure 1 about here

Product positioning and pricing determine the market demand for the innovation. To model the demand, we separate the pricing effect from the positioning effect in the following way. The product position dictates the potential demand whereas the price governs the proportion of potential consumers who can afford the innovation. The multiplication of the two effects then gives rise to actual demand. Specifically, the demand function is:

$$s(a_f, a_I, p) = f(p)\alpha(a_f, a_I) \qquad (2)$$

where, α is the potential demand which depends on the monopolist's final position a_f and the ex post ideal point a_I, and $f(p)$ is the proportion of potential consumers choosing to buy the product or the market penetration ratio. Following Carpenter (1989), we treat α as a function of the distance between the product position and the ex post ideal point:

$$\alpha(a_f, a_I) = \alpha_{\max} + \theta(a_f - a_I)^2, \qquad (3)$$

where $\alpha_{\max}$ denotes the maximum potential demand and θ registers the effect of the distance between the actual position a_f and the ideal point a_I. We have $\theta < 0$ because the demand increases in the proximity of the final position to the ideal point (Carpenter 1989). θ also determines the reservation distance between a_f and a_I, the distance beyond which no consumer would buy the product[2]. A high absolute value of θ suggests a low reservation distance. The maximal potential demand $\alpha_{\max}$ is assumed to be sufficiently large to avoid a corner solution for the optimal product position. In the extreme case where the final position matches exactly the ex post ideal point, the monopolist achieves the maximum possible market demand.

Given the demand, the profit function is established as follows:

$$\pi = (p - mc)s(a_f, a_I, p) - \delta c(a_p - a_f)^2 - q(a_f - a_e)^2 \qquad (4)$$

where a_e denotes the firm's technological expertise and the positive parameters c and q parameterize the repositioning cost and the reengineering cost, respectively. In essence, c represents the effect of the incongruence between the announced position and the actual position whereas q does the incongruence

[2]The fact that potential demand has to be nonnegative tells us that $|a_f - a_I| \leq \sqrt{\frac{\alpha_{\max}}{|\theta|}}$.

between the actual position and the technological expertise. Marginal costs are assumed to be constant and denoted by mc, $p - mc$ is the profit margin, and δ is the same preannouncement indicator as in equation (1).

To characterize the optimal behavior of the monopolist in this multi-stage decision problem we take the usual backward-induction approach and consider the three stages in reverse order starting with the product introduction stage. Optimal pricing by the monopolist is characterized in a standard way:

Lemma 1: The optimal price charged by the monopolist satisfies the equation $p^* = \frac{mc}{1 + 1/\varepsilon(p^*)}$ under the condition that the price elasticity at p^*, $\varepsilon(p^*) <$ -1. If $\frac{d\varepsilon(p^*)}{dp} \leq 0$, the optimal price is unique.

This result shows that product positioning doesn't have strategic influence on the price because of the decoupling of the pricing and positioning effect. Although the current literature suggests that product positioning has a strategic effect on pricing, we argue that such an effect may apply to existing products only. For innovative products, especially radical innovations, the price at product introduction may not match the product position. Instead, the price is often used to recover the huge R&D cost (Golder and Tellis 1997; Grunenwald and Vernon 1988). For example, the price of Apple's MessagePad ranged between $700 and $1000 when it was first introduced in 1993. In a nutshell, the mapping from product position to price can be weak for innovative products.

This result allows us to simplify the model by normalizing the profit margin and market penetration ratio to 1. Therefore, we will only focus on the relationship between product preannouncement and positioning in the subsequent analysis. The new profit function becomes:

$$\pi = \alpha(a_f, a_l) - \delta c(a_p - a_f)^2 - q(a_f - a_e)^2 \qquad (5)$$

The decision on the actual position a_f has to take into account all the information available at the positioning stage. If the firm has preannounced at the first stage, then it now needs to consider the distances of the actual position from the preannounced one, from the observed ex post consumer preference point, and from its technological expertise. If the firm has chosen not to preannounce, then the actual position is based on the positions of the (now observed) original consumer preferences and the firm's expertise only.

Lemma 2:

1) If the monopolist preannounces, the optimal final position is

$a_f^*(a_p) = (ca_p + qa_e - \theta a_1)/(c + q - \theta)$ **;**

2) If the monopolist does not preannounce, the optimal final position is $a_{f\_np}^* = (qa_e - \theta a_0)/(q - \theta)$**.**

According to this result, the optimal position at product introduction is a weighted average of the information elements at the first stage, i.e. the announced position (if preannouncement occurs), the consumer preference, and the technological expertise. The weight of each element is given by the value of the corresponding parameter in the firm's profit function. Note, if neither repositioning costs nor the reengineering costs arise (c=0 and q=0), the monopolist would position right at consumer preference and consequently achieve the maximum demand.

Because consumer preference is influenced by the firm's preannouncement, the final position in the preannouncement case can be rewritten as:

$$a_f^*(a_p) = (qa_e - (1-\lambda)\theta a_0 + (c - \lambda\theta)a_p)/(c + q - \theta) \qquad (6)$$

Since the ex post preference contains the effect of the announced position, the total weight of a_p in determining the optimal actual position consists of two parts: own effect (c) and indirect effect ($-\lambda\theta$). Because θ is negative, the marginal effect of the announced position on the actual one is positive. This result implies that, if the monopolist preannounces a position deviating further away from its true capability, it has to deliver a product position less consistent with its technological expertise, ceteris paribus. However, if there is no repositioning cost for any announced position (c = 0) and the preannouncement doesn't have any influence on consumer preference (λ = 0), the optimal actual position would be independent of the announced position. Only in this scenario does a preannouncement have no strategic influence on the product position delivered to the market. When it happens, the monopolist chooses a position based on its expertise and consumer preference only, a result identical with that in the absence of a preannouncement.

Considering the optimal choice at the preannouncement stage, the optimal choice of the announced position has to take into account the subsequent effect on the actual position. Moreover, consumer preference is uncertain to a firm when it preannounces and claims a product position to the public. Taking this into account, the expected profit of the monopolist if it decides to preannounce at this stage reads:

$$\hat{\pi}^{P}(a_p) = \mathrm{E}\Big[\alpha\big(a_f^*(a_p;a_0),(1-\lambda)a_0+\lambda a_p\big)-c\big(a_p-a_f^*(a_p;a_0)\big)^2-q\big(a_f^*(a_p;a_0)-a_e\big)^2\Big], \quad (7)$$

where the expectation is taken with respect to the monopolist's beliefs about the ex ante ideal point, i.e. $a_0 \sim N(0, \sigma^2)$. The monopolist is presumably risk neutral and therefore maximizes this expected profit.

Lemma 3: **If the monopolist preannounces, the optimal announced position is**

$a^*_p = (q(\lambda\theta - c)a_e)/(\lambda^2 q\theta + c((1-\lambda)^2\theta - q))$.

It turns out that the best announced position has a positive linear dependence on the technological expertise. Given the expectation of consumer preference, the result suggests that the monopolist preannounces a product position according to its technological strength. The consistency between the announced position and the technological strength is due to the fact that the monopolist intends to use the preannouncement strategy to move consumer preference towards the strength. A more interesting question is: How should a firm describe the product attributes in the preannouncement? Should it exaggerate, be honest, or be conservative, vis-à-vis its true technological expertise? The following proposition provides the answer.

Proposition 1: **If the monopolist preannounces, *1)* it adopts an exaggerating positioning strategy when** $1 > \lambda > \frac{c}{c+q}$**; *2)* it adopts a conservative positioning strategy when** $\lambda < \frac{c}{c+q}$**; *3)* it adopts an honest positioning strategy when** $\lambda = 1$ **or** $\frac{c}{c+q}$ **.**

We classify the different positioning strategies based on the relationship between the announced position and the technological expertise. When the announced position exceeds the expertise in absolute value ($|a_p| > |a_e|$), the monopolist exaggerates the product attributes in the preannouncement. Otherwise, it positions conservatively ($|a_p| < |a_e|$) or honestly ($|a_p| = |a_e|$).

These results are not obvious. One may think that a firm with a lower preannouncement impact would have stronger incentives to exaggerate in order to compensate for the weakness in its impact. On the other hand, a firm with a higher preannouncement impact would be more conservative in positioning because it does not want to overshoot with its strong impact. However, our results are the opposite.

The intuition is as follows. Note that the announced position can be used as a substitute for the preannouncement impact in influencing the consumer preference. Although a firm faces uncertainty regarding the preference at the time of preannouncement, it can adjust its product position through repositioning after the preannouncement reveals the location of the influenced preference. The repositioning involves costs. Unless the adjusted position locates right at the technological expertise, the firm has to bear the reengineering cost anyway. On the other hand, the preannouncement of a product position serves to develop a consumer preference close to a firm's technological strength and closer if the position is exaggerated. Such an effect becomes stronger with the increase in preannouncement impact. When the marginal benefit of exaggeration (λ) exceeds the marginal cost ($\frac{c}{c+q}$), the firm should do so. When the marginal cost dwarfs the marginal benefit, the firm should underplay the product attributes vis-à-vis its true technological strength in order to avoid incurring overwhelmingly huge repositioning cost. Finally, when the marginal benefit equals the marginal cost, the firm should preannounce a position that truthfully reflects its technological strength. The honest positioning strategy is also viable when the firm is in full control of the preference formation through the preannouncement, because it can usurp the preannouncement impact to make its technological strength the ideal point of the market without the necessity of either repositioning or reengineering.

Notice the repositioning (c) and reengineering cost (q) have opposite effects on the monopolist's incentive to exaggerate, given a preannouncement impact. As the repositioning cost increases, the firm is less likely to engage in exaggeration, since the threshold of the preannouncement impact for such a behavior rises consequently. On the contrary, increasing reengineering costs add incentives to exaggerate, since the threshold declines as a result. The Apple's story can be used as an example to support the result about the exaggeration strategy. In this case, it was worthwhile for Apple to bluff in its preannouncement of the Newton Message Pad, because the claim about the "handwriting recognition" attribute was very attention getting, but the costs of repositioning to the communicability part were not that high (Bailey 1993).

Given the optimal announced and actual position, the monopolist compares the expected profit of a preannouncement with that of non-preannouncement and accordingly decides whether or not to preannounce. With a preannouncement, the firm is able to develop a consumer preference in favor of its technological strength on one hand but has to bear the risk that the ex ante consumer preference is far away from its preannouncement resulting in huge repositioning costs. In the absence of a preannouncement, the risk disappears because the firm only positions after the preference is known but the firm is unable to influence the preference. This is the trade-off between the two decisions.

Proposition 2:

1a) For any set of parameter values (α_{max}, θ, c, q, a_e, σ^2) there exists a unique threshold $\lambda^* \in (0,1)$ such that it is optimal for the monopolist to preannounce if and only if $\lambda \in [\lambda^*, 1]$;

1b) For any set of parameter values (α_{max}, λ, θ, q, a_e, σ^2) there exists a unique threshold $c^* \in (0, \infty]$ such that it is optimal for the monopolist to preannounce if and only if $c \in \left[0, c^*\right]$;

1c) For any set of parameter values (α_{max}, λ, θ, c, a_e, σ^2) there exists a unique threshold $q^* > 0$ such that it is optimal for the monopolist to preannounce if and only if $q \geq q^*$;

2a) If $(1-\lambda)^2 \leq \frac{q}{q-\theta}\left(1-\frac{\theta}{c+q}\right)$, preannouncement is optimal for any level of uncertainty σ^2;

2b) If $(1-\lambda)^2 > \frac{q}{q-\theta}\left(1-\frac{\theta}{c+q}\right)$, there exists a threshold of uncertainty σ^{2*} such that it is optimal for the monopolist to preannounce if and only if $\sigma^2 \in [0, \sigma^{2*}]$.

The first three results demonstrate the main effects on the preannouncement decision of preannouncement impact, repositioning cost, and reengineering cost, respectively. Specifically, the monopolist should preannounce when the preannouncement impact is sufficiently high, the repositioning cost is sufficiently low, or the reengineering cost is sufficiently high. The rationales are straightforward.

The second set of results delineates the dependence of preannouncement incentive on the preference uncertainty. As shown, the dependence is conditional on the trade-off between the influence of the original consumer preference ($(1-\lambda)^2$) and the multiplication of the relative importance of technological expertise ($\frac{q}{q-\theta}$) and the net positive effects of product positioning ($\left(1-\frac{\theta}{c+q}\right)$).

To explain, note a firm uses preannouncement in order to develop a consumer preference closer to a firm's technological strength. After the preannouncement, the reduced distance would facilitate the firm to position at a place where it can achieve higher potential demand and incur less reengineering costs, compared to non-preannouncement. The denominator $q-\theta$ can be seen as the sum of the decision weights that correspond to the two considerations. Thus, the ratio $\frac{q}{q-\theta}$ registers the relative importance of the technological strength vis-à-vis the consumer preference. The term $1-\frac{\theta}{c+q}$ can also be expressed as $\frac{c+q-\theta}{c+q}$, in which the numerator $c+q-\theta$ denotes the total effects of product positioning whereas the denominator $c+q$ represents the costs of positioning. Together, it means that the net effect of positioning is positive since positioning closer to consumer preference would generate more product demand ($-\theta > 0$).

The monopolist should always preannounce regardless of the preference uncertainty when the relative importance of technological strength multiplied by the net positive effect of positioning dominates the influence of the original consumer preference. The rationale is as follows. Under this condition, the uncertainty about where the original preference is located does not impose much risk for the preannouncement decision since the influence of the original preference is weak vis-à-vis the positive positioning effect and the relative importance of technological strength. Consequently, the firm can easily move the preference closer to its expertise in any uncertainty. However, if the influence of the original preference dominates, then the uncertainty matters. Obviously, the preannouncement decision becomes optimal only for sufficiently low uncertainty.

4. Duopoly

In duopoly, the nature of the risks and the benefits of preannouncement remain the same as in monopoly, but the competition between the two firms has strategic ramifications for both preannouncement and positioning decisions. Take Firm 1 as an example. Suppose Firm 2 preannounces, should Firm 1 follow suit? If it chooses not to, it can sidestep the risks due to the uncertainty of consumer preference, and possibly free-ride the preannouncement impact of its competitor. If it preannounces, then it has to bear the risks. Our analysis shows that the equilibrium preannouncement decisions of the two firms are determined by the preference uncertainty. The level of uncertainty sustained by each firm in equilibrium can be seen as the likelihood of preannouncement. The likelihood is in turn influenced by the firm's preannouncement impact, repositioning cost, as well as its competitor's. Furthermore, the choice of preannouncement affects the actual position of each firm vis-à-vis the ex post preference and the product profitability. A rigorous analysis of the arising strategic effects reveals that in several settings, where competitors differ with respect to preannouncement impact or repositioning costs, standard predictions in the marketing literature concerning behavior and relative performance of the firms is not in accordance with equilibrium behavior. Due to space restrictions we focus in the following analysis on these counterintuitive results -rather than providing an extensive sensitivity analysis of the arising equilibria with respect to all model parameters. The players (Firms 1 and 2) in the preannouncement game go through the same decision sequence as in monopoly. Both firms make non-cooperative decisions simultaneously and all moves in previous stages are observable and common knowledge to both parties. At the first stage, both firms decide whether to preannounce and the announced position if preannouncing. The ex post ideal point is now a weighted average of the ex ante ideal point and the announced position(s). In general, the consumer preference is developed according to the following rule:

$$a_I = (1-\delta_1\lambda_1-\delta_2\lambda_2)a_0+\delta_1\lambda_1 a_{1p}+\delta_2\lambda_2 a_{2p} \quad (7)$$

The meanings of the symbols are identical with those in equation (1), except that the subscript 1 and 2 represent firm 1 and 2, respectively. If a preannouncement occurs, the consumer preference is influenced and uncovered. If neither firm preannounces, the preference is known through market research but not altered. After the preannouncement stage, each firm chooses the actual product position. At the product introduction, the firms engage in Bertrand competition. As in monopoly, we decouple the positioning and the pricing effect on the market demand of a firm's product. Specifically, firm i's demand is

$$s_i(p_i, p_j, a_{if}, a_{jf}, a_I) = f_i(p_i, p_j)\alpha_i(a_{if}, a_{jf}, a_I) \quad (8)$$

α_i is the potential demand which depends on the actual positions of both firms (a_{if}, a_{jf}) as well as the ex post ideal point. f_i denotes the pricing effect on firm i's demand, which again can be understood as the market penetration ratio of firm i's innovation[3]. Following Carpenter (1989), the potential demand of firm i depends on not only the distance of its actual position (a_{if}) from the ex post ideal point but also the distance from its competitor's actual position (a_{jf})($i \neq j; i, j = 1, 2$):

$$\alpha_i(a_{if}, a_{jf}, a_I) = \alpha_{\max} / 2 + \theta_{i1}(a_{if} - a_I)^2 + \theta_{i2}(a_{if} - a_{jf})^2 \qquad (9)$$

The effect of the first distance arises from firm i's own positioning, whereas the effect of the second is due to the competition in product positioning. θ_{i1}, θ_{i2} register the own and competitive positioning effect, respectively. $\theta_{i1} < 0$ and $\theta_{i2} > 0$, because closer proximity to the preference should generate higher demand for own product while intense competition between product position should drive down the demand. In order to prevent the effect of product differentiation from exploding and thus obtain an equilibrium solution, we impose the constraint that $\theta_{i1} < -2\theta_{i2}$ [4]. Furthermore, the two positioning effects are assumed to be symmetric between the two firms for simplicity, i.e. $\theta_{i1} = \theta_{j1}$ and $\theta_{i2} = \theta_{j2}$. The maximum potential demand of each firm is $\alpha_{\max} / 2$, half of that in monopoly. Why? The total potential demand in the market is still $\alpha_{\max}$. However, the two firms are non-cooperative in their decisions on product position. To maximize the own demand, the best actual position each firm should choose is the ex

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[3] $f_i(p_i, p_j)$ is formally defined as a function: $f_i : \{p_i, p_j\} \to [0,1]$. Further, $\frac{df_i(p_i, p_j)}{dp_i} < 0$ and $\frac{\partial^2 f_i(p_i, p_j)}{\partial p_i^2}$, following the standard assumption about a demand function.

[4] This condition ensures that the marginal effect of $| a_{if} - a_I |$ dominates the marginal effect of $| a_{if} - a_{jf} |$. Otherwise, both firms have unbounded incentive to move away from each other. The product differentiation as such would generate infinite amount of potential demand.

post ideal point, at which the two players share in half the total market potential[5]. The profit function is similar to the specification in monopoly with subscript i representing firm i:

$$\pi_i = (p_i - mc_i)s_i(p_i, p_j, a_{if}, a_{jf}, a_I) - \delta_i c_i (a_{ip} - a_{if})^2 - q_i (a_{if} - a_{ie})^2 \qquad (10)$$

where the interpretation of the parameters remains the same as in monopoly.

Given the profit functions, we characterize Sub-game Perfect Equilibria (SPE) of the three stage game. Sub-game perfection ensures credibility and time consistency of the firm's strategies in a sense that the firm's planned action for any potential future contingency would indeed be optimal if this contingency actually realizes (Selten 1975). In our setting the use of a SPE for example rules out strategies where a firm threatens to choose an (irrational) aggressive final position if the competitor would preannounce thereby preventing the competitor from preannouncing. Hence, this equilibrium concept eliminates non-credible positioning strategies and thus reduces the set of Nash Equilibria. In fact, we obtain a unique equilibrium for the subgames at the pricing and positioning stages.

The analysis of the firms' optimal behavior in the duopoly case is significantly more complex than in the monopoly case. Nevertheless it is still possible to explicitly calculate the optimal strategies of both firms in the pricing and positioning stage as well as the optimal preannouncement position each firm should choose if equilibrium behavior induces preannouncement. The equilibrium price and product position (announced and actual position) of each firm bear qualitative resemblance to those in monopoly. In a nutshell, we obtain the following equilibrium solutions regarding the pricing and positioning decisions[6]: 1) the two firms charge identical prices and the pricing decision is independent of the product positioning, 2) the actual position of each firm is a weighted average of the announced position of its own and / or its competitor (if a preannouncement occurs), the technological expertise of both firms, and the

[5] This result can be easily derived by maximizing the potential demand function of each firm with respect to the firm's actual position and solving the two simultaneous best response functions.

[6] The derivation of the equilibria as well as the actual analytical expressions for the equilibrium strategies are given in Appendix B.

ex post ideal point, and 3) if a firm preannounces in equilibrium, the announced position is a linear function of the technological expertise of both firms.

Considering the decision of the two firms whether to preannounce or not, the relevant strategic game between the competitors can be captured in a 2 by 2 matrix where the two firms choose simultaneously between preannouncement (P) and no preannouncement (N). The payoffs in this game are the profits resulting from equilibrium positioning and pricing in each of the four possible scenarios[7] PP, PN, NP or NN. In principle equilibria can occur where both firms preannounce, only one firm preannounces, or none of the firms preannounce. Also, co-existence or non-existence of pure strategy equilibria cannot be ruled out.

Although it is possible to calculate closed-form expressions for all the payoffs in this preannouncement game matrix the complexity of the expressions involved does not allow an analytical characterization of the scenarios leading to these four equilibria. Extensive numerical examinations indicate that high uncertainty (large σ^2) leads to equilibria where no firm preannounces, whereas low uncertainty (small σ^2) there leads to equilibria with preannouncement. This result is in line with our findings for monopoly. However, even in the complete absence of ex ante uncertainty (σ^2=0) it is not necessarily optimal for *both* firms to preannounce. In particular, if both firms' expertise is on the same side of the ex-ante consumer preference with significantly different distance from the ex ante sweet spot, the firm whose expertise is closer to the ex ante preference does not even for σ^2=0 preannounce in equilibrium. If the other's preannouncement moves the ex post preference close to its own expertise, this firm is able to free-ride on this preannouncement very efficiently. Any own preannouncement would either add repositioning costs without significantly reducing the distance between own expertise and ex post preference, or even move the ex post preference beyond the own expertise thereby increasing the distance to the own expertise. Accordingly, in a duopoly concerns about large ex ante uncertainty *or strategic considerations to free-ride* may be responsible for a firms' decision not to preannounce its

[7] The first character gives the preannouncement decision of firm 1, the second character that of firm 2.

product. As our focus in this paper is on the issues of the positioning of preannouncements and products we do not provide a more systematic numerical analysis of the impact of different model parameters on the existence of the four types of equilibria. Rather, we turn to the analysis of preannouncement and product positioning in equilibria where at least one firm preannounces.

Given that the analytical expressions for the equilibrium strategies determining announced and actual positions are too complex to allow for comparative statics, we rely on numerical examinations to get insights about the effects of the various factors on the preannouncement and positioning decisions in equilibrium. The key factors under study here are the preannouncement impact and the repositioning costs of a firm. The examination of the effect of one factor focuses on the change of the equilibrium solutions across a range of the factor's value with all the other parameters fixed. Because the game and the solutions are symmetric between the two players, we use the factor of firm 1 for illustration, without loss of generality. To ensure the robustness of our findings, we randomly pick up fifty parameter profiles for each result and verified that the pattern identified in each of our results holds invariably for every observation. Each profile is randomly drawn from a uniform distribution for each parameter with the following ranges: [30, 100] for $\alpha_{\max}$, [6, 20] for θ_{11} (θ_{21}), [0.1, 3] for θ_{12} (θ_{22}), [0.1, 6] for c1 (c2), [0.1, 6] for q1 (q2), [0.1, 6] for a_{1e} (a_{2e}), and [0.1, 50] for σ^2.

The figures we will use to graphically illustrate ours findings are based on the set of parameter values $\theta_{11} = \theta_{21} = 6$, $\theta_{12} = \theta_{22} = 0.5$[8], $c_1 = c_2 = 3$, $q_1 = q_2 = 1$, $\lambda_1 = \lambda_2 = 0.2$, $a_{1e} = a_{2e} = -2$, and $\alpha_{\max} = 30$, where in each figure λ_1 and c_1 varies in a range indicated in the figure. Product positions are depicted under the assumptions that the actual ex ante ideal point coincides with the firms expectation and accordingly $a_0 = 0$. This corresponds to unbiased expectations of the two firms about ex-ante consumer preferences.

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[8] The values are set in order to satisfy the requirement that $\theta_{i1} < -2\theta_{i2}$ and to make the equilibrium solutions more pronounced in pattern.

The analysis yields several surprising results, which shed light on the strategic relationships between the preannouncement strategy and product positioning (actual position) in competitive setting.

Result 1: For firms with identical expertise, if one firm preannounces and the other doesn't in equilibrium, the non-announcing (announcing) firm *always* occupies (leaves) the more favorable marketplace[9], *ceteris paribus*.

This result, as demonstrated in Figure 2[10], denies the established view in marketing that new product preannouncement can help a firm preempt the market (e.g. Porter 1980; Eliashberg and Robertson 1988; Robertson, Eliashberg, and Rymon 1995; Lilly and Walters 1997). In particular, Eliashberg and Robertson (1988) conjectured that a firm can use the preannouncement strategy to preempt the most favorable market segment and leaves the less favorable to followers. The result also casts doubt on the view that a firm can achieve first-mover advantage through a preannouncement (Calantone and Schatzel 2000).

Figure 2 about here

To explain, let us assume---without loss of generality--that firm 1 preannounces while firm 2 does not. With no action of preannouncement, firm 2 sidesteps the risks of preannouncement and the need to reposition. More importantly, because the two firms share the same technological expertise, firm 1's preannouncement leads the consumer preference closer to its own strength and firm 2's as well. In addition, the consumer preference is revealed after firm 1's preannouncement. Thus, firm 2 can free ride firm 1 by positioning at a time the preference is known and at a place with equal distance to the preference vis-à-vis firm 1's position. It can go further by positioning closer to the preference than firm 1, since its choice of product position is free of the constraint imposed by the repositioning cost while firm 1 has to consider the location of the announced position when choosing the actual one. This result is

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[9] More favorable marketplace refers to the position closer to the revealed consumer preference.

[10] Note that we consider in Figure 2 only values of firm 1's preannouncement impact with $\lambda_1 \geq 0.33$. Only for values of λ_1 above this threshold an equilibrium, where only firm 1 preannounces, exists for appropriate values of σ^2. Although the threshold changes with different parameter profiles, the pattern identified in Result 1 holds invariantly.

supported by a real-life example. In September 1997, Circuit City preannounced DIVS (Digital Video Express), the rival format of DVD, in an attempt to win the standard war between the two formats. The preannouncement, however, failed to prevent DVD from becoming the dominant standard. Neither did it help Circuit City preempt the digital video market.

We immediately see from this result that the non-announcing firm or the free-rider also achieves higher expected profit than the announcing firm because it can always choose the same actual position as its competitor and obtain higher profit due to lack of repositioning cost. Relating this result to our discussion on free-riding above, we realize that, in cases where the expertise of competitors lies in the same direction from the ex-ante expected consumer preferences, free riding effects may not only prevent a firm from preannouncing but may also imply that the firm actually gains a competitve advantage by refraining from preannouncing.

Result 2: For firms with identical expertise and unbiased expectation of original consumer preference, given they preannounce simultaneously in equilibrium, 1) the firm with lower (higher) preannouncement impact occupies (leaves) the more favorable marketplace, and 2) the firm with lower preannouncement impact achieves higher expected profit than its rival, *ceteris paribus*.

Intuitively, one may think that higher preannouncement impact should bring a firm closer to the consumer preference and generate more profit than its rival. This result suggests the opposite (Figure 3). On one hand, the preannouncement objectives of the two firms are perfectly aligned due to the common expertise; on the other hand, difference in their preannouncement impacts creates the incentive to differentiate products in the preannouncements. As a result, the consumer preference is skewed towards both firms' technological strength while the announced positions are ranked in order vis-à-vis the expected location of the influenced preference. Since higher impact means that moving the preannouncement closer to the common expertise has larger marginal effect on the ex post preference, it is the firm with higher impact who should preannounce a position closer to the common expertise but further away from the preference. Given equal repositioning cost, the actual positions should follow the same order. We thus obtain the pattern in Figure 2. The incentive for product differentiation disappears in one exceptional case, where the joint preannouncement impacts of the two firms are equal to 1. In this scenario, consumer preference is under their full control and consequently both players position right at the common expertise, which is also the developed consumer preference. Given the first result, it is easy to understand why the firm disadvantaged in preannouncement impact can achieve higher expected profit than its competitor.

Figure 3 about here

Result 3: For firms with identical expertise, unbiased expectation of original consumer preference, and different repositioning cost, given they preannounce simultaneously in equilibrium, 1) they differentiate their product positions in the preannouncements but choose identical position for the product introduction, and 2) the firm with higher repositioning cost achieves higher expected profit than its rival.

This result is intriguing. On an intuitive level, the discrepancy in the announced positions should be reflected in the actual positions. However, the two firms adopt identical actual positions regardless of the repositioning cost of firm 1 (Figure 4) even though they preannounce different positions, if their repositioning costs are not identical. Moreover, given the negative impact of repositioning cost, a higher level of such a cost vis-à-vis its competitor might seem to generate a competitive disadvantage for a firm . But our result shows quite the opposite.

Figure 4 about here

The explanations are as follows. First, notice that identical expertise and preannouncement impact grant both firms the incentive to adopt homogenous position at product introduction. With everything equal, the strategies adopted by one firm should clone those of the other in both preannouncement and product positioning stages. If nothing else but the repositioning cost differs between them, the difference would affect their strategic choices of the announced positions only. Specifically, a firm with lower repositioning cost has more degree of freedom in choosing a product position in the preannouncement. The difference causes a divergence in the announced positions. But it doesn't mean that the final positions would diverge as well.

In order to understand the finding that the firm with higher repositioning costs makes higher profits, one has to keep in mind that an increase in the repositioning cost parameter of a firm has two effects. First, there is the direct effect of increased repositioning costs which of course is detrimental for the firm. Second, there is the indirect effect. If the parameter c_1 goes up Firm 1 moves its preannouncement closer to the ex ante expected preference point and further away from its expertise. This reduces repositioning costs for Firm 1 and generates incentives for Firm 2 to move its announcement closer to its expertise. Due to the assumption that the expertise of both firms is identical this change in the behavior of Firm 2 moves the ex post preference also closer to the expertise of Firm 1. Accordingly, this second indirect effect has a positive impact on Firm 1's profits. The 'burden' of moving the ex post preference close to the common expertise is shifted towards Firm 2. The high repositioning costs c_1 act as a commitment device for Firm 1 that its preannouncement will be close to the ex ante consumer preference and this generates additional incentives for Firm 2 to bear higher repositioning costs in order to move consumer preferences in the direction of the expertise of both firms. Our numerical analysis shows that the positive indirect effect is stronger than the negative direct effect.

5. Discussion

This paper discusses an important topic in marketing, the strategic relationship between new product preannouncement and positioning. A preannouncement has two benefits: first, to gather information about consumer preferences and / or competitive reactions; second, to influence consumer preference. The current literature focuses on the first dimension only (e.g. Eliashberg and Robertson 1988; Robertson 1993; Bayus, Jain, and Rao 2001), despite the importance of the second dimension for new products, especially radical and disruptive innovations. Christensen (2003) points out in his best-seller *Innovator's Dilemma* that disruptive innovations are the key for established firms to sustain their competitive advantage and to survive. However, firms typically do not know consumer preferences for a radical innovation and even consumers themselves are unaware of their needs until the product comes out.

Radical innovations represent a discontinuous jump in improvement of technology (Chandy and Tellis 1998; Henderson and Clark, 1990) and thus consumer preference may also be subject to substantial change for this type of product. Preannouncement can help firms uncover consumer preference, and more importantly, influence the preference to their advantage before it is molded in consumers' mind and hard to change.

By virtue of its effect on the formation of consumer preference, a preannouncement has strategic implications for product positioning. In reality, we observe that firms adopt different positioning strategies in the preannouncement. Some firms exaggerate, some underplay, and others truthfully describe the product attributes in preannouncements. This paper shows analytically the conditions for the variation. Moreover, it examines the implication of preannouncement for the strategic choice of actual product positions adopted by firms in competition. According to our findings, a preannouncement does not guarantee a firm either the preemption of the most favorable position or the achievement of higher profits than its competitors. These results contrast with the established view in the marketing literature (Porter 1980; Eliashberg and Robertson 1988; Robertson, Eliashberg, and Rymon 1995; Lilly and Walters 1997). In particular, the first numerical finding suggests that in cases where the technological expertise of competitors in the market is similar, there is a second-mover advantage. By choosing not to preannounce and wait for its rival to preannounce, a firm can outwit the competitor by occupying the most favorable position in the market.

From a managerial point of view, these results provide normative guidelines for firms making optimal decisions on new product preannouncement and positioning, especially for radical innovations. From a theoretic perspective, they address the research gap highlighted in Kaul and Rao's review on product positioning and design (1994).

Nevertheless, this study has several limitations. First, the consumer decision making process is not taken into account. In the current literature on product positioning, firms' decisions on product position interact with consumers' decision on the product choice. We abstract in our model from consumer decision making for simplicity. This approach prevents us from incorporating heterogeneity in consumer preference in the model. Instead, we have to assume the existence of a modal ideal point as a proxy for consumer preference. Second, due to the decoupling of the pricing and product positioning effects on product demand, a firm's decision on product position is independent of the pricing decision in our model. This outcome runs contrary to a result in the product positioning literature, in which product positioning is generally shown to have a strategic effect on pricing and vice versa. Third, due to the model structure, the equilibrium positioning strategies in the duopoly case are so complex that we cannot provide general analytical existence results and sensititivy analyses for pre-announcement equilibria. Nevertheless, the hypotheses from the numerical analysis can be used as a basis for empirical tests. These limitations remain promising areas for future research.

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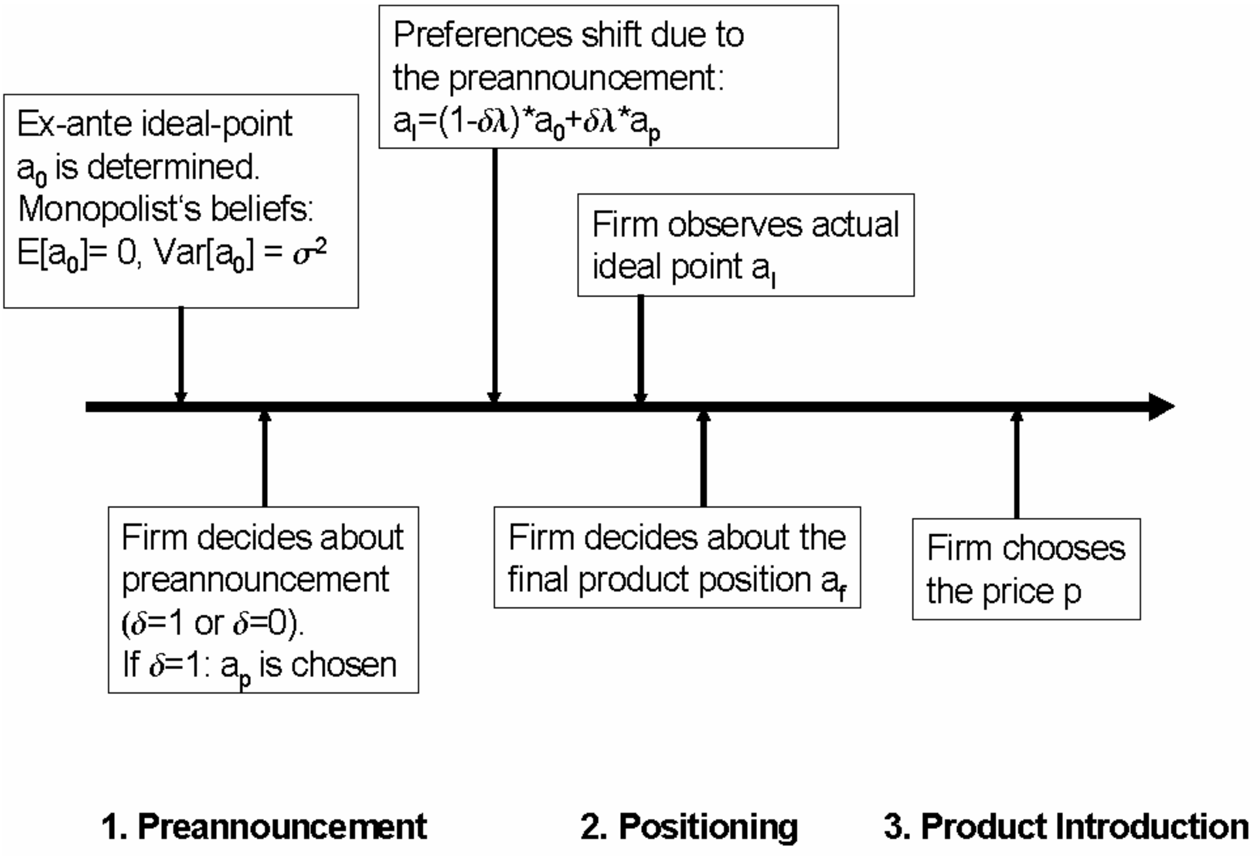


Figure 1: Timeline of the model

Figure 2

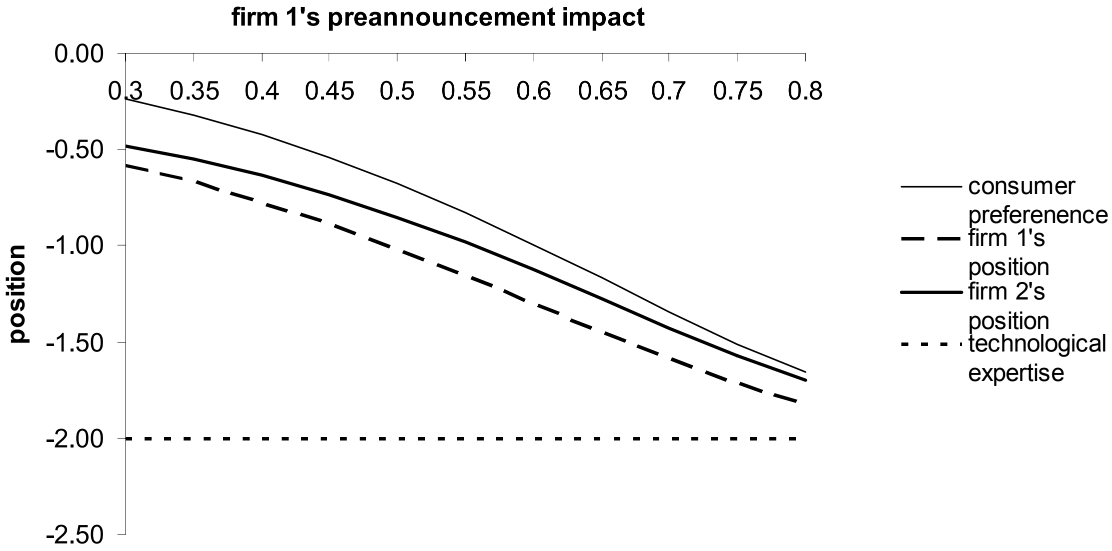


Figure 3

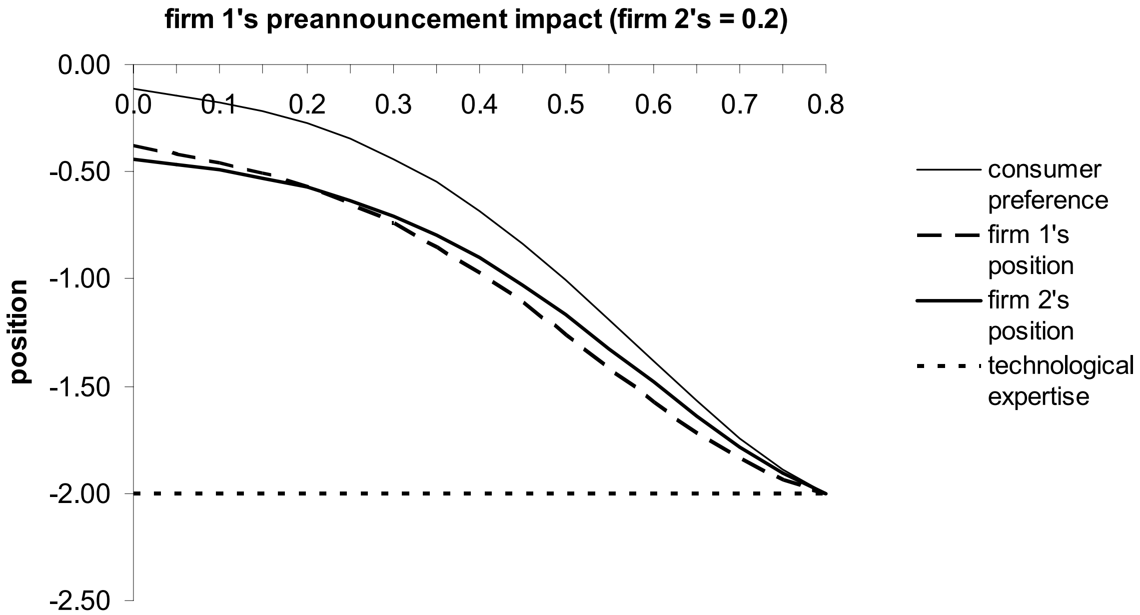
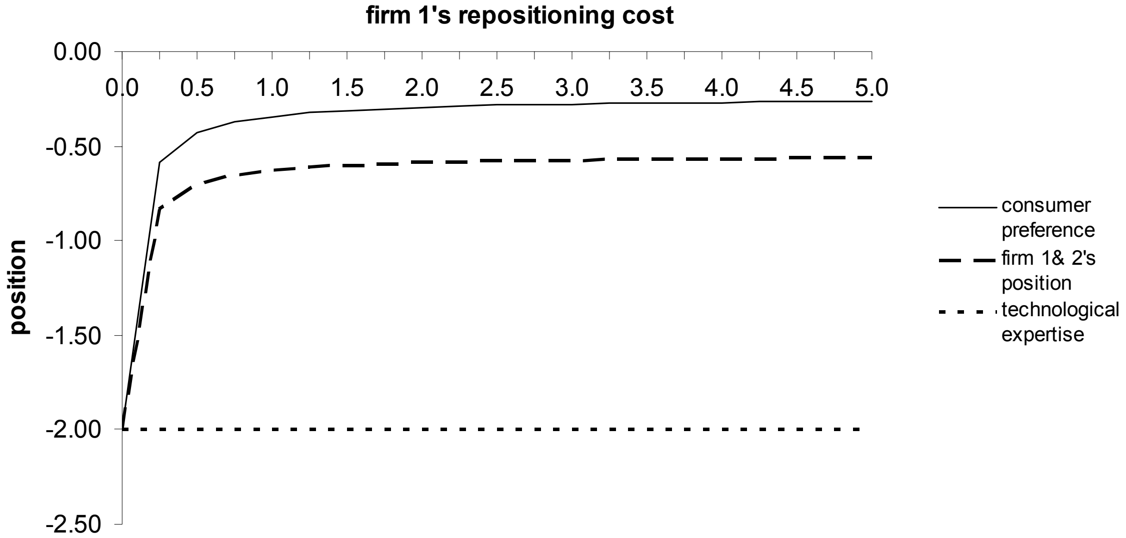


Figure 4


firm 1's repositioning cost
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
position
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
consumer preference
firm 1& 2's position
technological expertise

Appendix A: Proofs of the Propositions for the Monopoly Case

Lemma 1 *The optimal price charged by the monopolist satisfies the equation* $p^* = \frac{mc}{1+\frac{1}{\epsilon(p^*)}}$ *under the condition that the price elasticity at* p^*, $\epsilon(p^*) < -1$. *If* $\frac{d\epsilon(p^*)}{dp} \leq 0$, *the optimal price is unique.*

Proof. Replace $s(p, a_f, a_I)$ in the profit function with $f(p)\alpha(a_f, a_I)$, and take first-order derivative of the profit function with respect to p: $p^* = \frac{-f(p^*)}{f'(p^*)} + mc = \frac{-f(p^*)\alpha}{f'(p^*)\alpha} + mc = \frac{-s(p^*,a_f,a_I)}{s'(p^*,a_f,a_I)} + mc = \frac{-p^*}{\epsilon(p^*)} + mc \Longrightarrow p^* = \frac{mc}{1+\frac{1}{\epsilon(p^*)}}$. For uniqueness, suppose there exist two price schemes p_1, p_2 such that the equation holds. Thus, we have $p_1 = \frac{mc}{1+\frac{1}{\epsilon(p_1)}}$ and $p_2 = \frac{mc}{1+\frac{1}{\epsilon(p_2)}}$. Without loss of generality, assume $p_1 > p_2$. Then, $\epsilon(p_1) > \epsilon(p_2)$, which contradicts $\frac{\partial \epsilon(p)}{\partial p} \leq 0$. Therefore, the equilibrium price is unique. Q.E.D. ■

Lemma 2

1) If the monopolist preannounces, the optimal final position is $a_f^*(a_p) = (ca_p + qa_e - \theta a_I)/(c + q - \theta)$*;*

2) If the monopolist does not preannounce, the optimal final position is $a_{f\_np}^* = (qa_e - \theta a_0)/(q - \theta)$.

Proof. The results are obtained by taking first-order derivative of the profit function for the preannouncement and non-preannouncement decision, respectively. Q.E.D. ■

Lemma 3 *If the monopolist preannounces, the optimal announced position is* $a_p^* = (a_e q(\lambda\theta - c))/(\lambda^2 q\theta + c((1-\lambda)^2\theta - q))$.

Proof. When the firm makes decision on announced position, it faces uncertainty about consumer preference and chooses the position based on the expected value of the preference, which is normalized to 0 without loss of generality. The expected profit if it preannounces is: $E\pi^p = \alpha_{\max} + \theta((a_e q + a_p(c(1-\lambda) - \lambda q))/(c + q - \theta))^2 + \theta(1-\lambda)^2((c+q)/(c+q-\theta))^2\sigma^2 - c(a_p - Ea_f)^2 - q(Ea_f - a_e)^2 - (c+q)((1-\lambda)\theta/(c+q-\theta))^2\sigma^2$, where $Ea_f = (a_e q + a_p(c - \lambda\theta))/(c + q - \theta)$. Maximizing over a_p, we get the result. The profit function is concave because $\theta < 0$. Q.E.D. ■

Proposition 1 *If the monopolist preannounces, 1) it adopts an exaggerating positioning strategy when* $1 > \lambda > \frac{c}{c+q}$*; 2) it adopts a conservative positioning strategy when* $\lambda < \frac{c}{c+q}$*; 3) it adopts an honest positioning strategy when* $\lambda = 1$ *or* $\lambda = \frac{c}{c+q}$*.*

Proof. Notice that a_p^* and a_e move in the same direction, because $\frac{\partial a_p^*}{\partial a_e} > 0$. Bluffing is defined here as exaggeration of one's technological capability in preannouncement vis-a-vis its true expertise. In mathematical terms, bluffing occurs when $\frac{a_p^*}{a_e} > 0$ and $|a_p^*| > |a_e|$, which means that the announced position is in the same direction as the technological expertise but is greater than the expertise in size. $|a_p^*| = (|a_e|q(\lambda\theta - c))/(\lambda^2 q\theta + c((1-\lambda)^2\theta - q))$. Thus, bluffing depends on whether $q(\lambda\theta - c)/(\lambda^2 q\theta + c((1-\lambda)^2\theta - q)) > 1$, which can be translated to the inequality $\lambda > c/(q+c)$ (remember $\theta < 0$). So, if $\lambda > c/(q+c)$, the monopolist tends to bluff. Conservative positioning occurs when $|a_p^*| < |a_e|$, and honest positioning occurs when $|a_p^*| = |a_e|$. Straightforward algebra shows that these inequalities hold when $\lambda < \frac{c}{c+q}$ and $\lambda = \frac{c}{c+q}$, respectively. In particular, when $\lambda = 1$, $|a_p^*| = |a_e|$ as well. Q.E.D. ■

Proposition 2
1a) For any set of parameter values $(\alpha_{\max},\theta,c,q,a_e,\sigma^2)$ *there exists a unique threshold* $\lambda^* \in (0,1)$ *such that it is optimal for the monopolist to preannounce if and only if* $\lambda \in [\lambda^*, 1]$*;*
1b) For any set of parameter values $(\alpha_{\max},\theta,q,a_e,\sigma^2)$*, there exists a unique threshold* $c^* > 0$ *such that it is optimal for the monopolist to preannounce if and only if* $c \in [0, c^*]$*;*
1c) For any set of parameter values $(\alpha_{\max},\lambda,\theta,c,a_e,\sigma^2)$*, there exists a unique threshold* $q^* > 0$ *such that it is optimal for the monopolist to preannounce if and only if* $q \in [q^*, \infty)$*;*
2a) If $(1-\lambda)^2 \le \frac{q}{q-\theta}(1 - \frac{\theta}{c+q})$*, preannouncement is optimal for any uncertainty* σ^2*;*
2b) if $(1-\lambda)^2 > \frac{q}{q-\theta}(1 - \frac{\theta}{c+q})$*, there exists a unique threshold of uncertainty* σ^{2*} *such that it is optimal for the monopolist to preannounce if and only if* $\sigma^2 \in [0, \sigma^{2*}]$*.*

Proof. The expected profit under preannouncement is calculated by inserting the expressions for $a_f^*(a_p), a_p^*$ and a_I into the profit function of the monopolist, setting $\delta = 1$ and taking the expectation with respect to a_0. Taking into account that $\mathbb{E}a_0 = 0$ and $\mathbb{E}a_0^2 = \sigma^2$ and collecting terms gives

$$\mathbb{E}\pi^p = \alpha_{max} + \frac{(1-\lambda)^2 cq\theta}{cq - \theta(c(1-\lambda)^2 + \lambda^2 q)} a_e^2 + \frac{\theta(1-\lambda)^2(c+q)}{c+q-\theta}\sigma^2.$$

If the monopolist does not preannounce, it is easy to see that the optimal final position is given by $a_f^{np} = \frac{qa_e - \theta a_0}{q-\theta}$. Inserting this expression into the profit function, setting $\delta = 0$ and $a_I = a_0$ and taking the expectation with respect to a_0 gives the expected profit if no preannouncement is made:

$$\mathbb{E}\pi^{np} = \alpha_{max} + \frac{q\theta}{q-\theta}a_e^2 + \frac{q\theta}{q-\theta}\sigma^2.$$

The difference between these two expressions can be simplified to:

$$\begin{aligned} diff := \mathbb{E}\pi^p - \mathbb{E}\pi^{np} \quad = \quad & \frac{\lambda q^2\theta((2-\lambda)c - \lambda\theta)}{(q-\theta)(\theta(1-\lambda)^2 c + \theta\lambda^2 q - cq)}a_e^2 \\ & + \frac{\theta(c+q)((1-\lambda)^2(q-\theta) - q) + q\theta^2}{(q-\theta)(c+q-\theta)}\sigma^2 \end{aligned}$$

1a) The preannouncement decision depends on the difference between the expected profit under the two decision schemes (i.e. preannouncement and no preannouncement): $diff = \mathbb{E}\pi^p - \mathbb{E}\pi^{np}$. For the two extreme cases $\lambda = 0$ and $\lambda = 1$ we get: $diff(\lambda = 0) = \frac{-c\theta^2\sigma^2}{(q-\theta)(c+q-\theta)} < 0$ and $diff(\lambda = 1) = -\theta q(a_e^2 + \sigma^2)/(q-\theta) > 0$. Furthermore,

$$\begin{aligned} \frac{\partial diff}{\partial \lambda} &= \frac{\partial \mathbb{E}\pi^p}{\partial \lambda} \\ &= \frac{2(1-\lambda)(-\theta)(a_e^2 cq^2(c+q-\theta)(c-\lambda\theta) + (c+q)\sigma^2(\lambda^2 q\theta - c(q-(1-\lambda)^2\theta))^2)}{(c+q-\theta)(\lambda^2 q\theta - c(q-(1-\lambda)^2\theta))^2} > 0. \end{aligned}$$

The expression $diff$ is continuous in λ and therefore for any admissible constellation of the other parameters there exists a λ^* such that $diff(\lambda^*) = 0$. Because $\frac{\partial diff}{\partial \lambda} > 0$, $\forall \lambda \in (\lambda^*, 1]$, $diff = \mathbb{E}\pi^p - \mathbb{E}\pi^{np} > 0$ and therefore preannouncement is optimal; $\forall \lambda \in [0, \lambda^*)$, $diff = \mathbb{E}\pi^p - \mathbb{E}\pi^{np} < 0$ and the monopolist should not preannounce.

1b) The derivative of $diff$ with respect to c reads:

$$\begin{aligned} & \frac{\partial diff}{\partial c} \\ &= \frac{1}{(c+q-\theta)^2(q-\theta)(cq - c\theta(1-\lambda)^2 - q\theta\lambda^2)^2} * \\ & \quad \Big[(1-\lambda)^2(q-\theta)(c+q-\theta)^2\theta^2(cq - c\theta(1-\lambda)^2 - q\theta\lambda^2)^2 * \\ & \quad \Big(\frac{-\sigma^2}{(c+q-\theta)^2} - \frac{a_e^2\lambda^2 q^2}{(cq - c\theta(1-\lambda)^2 - q\theta\lambda^2)^2}\Big)\Big] \end{aligned}$$

Considering the signs of each individual term in this product shows that $\frac{\partial diff}{\partial c} < 0$. At $c = 0$, $diff = \frac{-a_e^2 q\theta}{q-\theta} + \sigma^2\frac{q\theta}{q-\theta}((1-\lambda)^2 - 1) > 0$. For $c \to \infty$ the expression $diff$

converges to $\frac{\lambda\theta q^2(2-\lambda)}{(q-\theta)(\theta(1-\lambda)^2-q)}a_e^2 + \frac{(1-\lambda)^2\theta(q-\theta)-q\theta}{q-\theta}\sigma^2$. Depending on the parameter values this expression might have any sign. If this expression is negative, monotonicity of $diff$ with respect to c implies that there is a unique finite threshold $c^* > 0$ such that $diff \geq 0$ if and only if $c \leq c^*$. If $diff$ stays positive for $c \to \infty$ preannouncement is optimal for all c and we have $c^* = \infty$.

1c) The derivative of $diff$ with respect to q reads:

$$\frac{\partial diff}{\partial q}$$

$$= \frac{1}{(c+q-\theta)^2(q-\theta)^2(cq-c\theta(1-\lambda)^2-q\theta\lambda^2)^2} * \\ (\theta^2[-a_e^2\lambda q(c+q-\theta)^2(-c(2-\lambda)+\lambda\theta)(cq(2-(2-\lambda)\lambda)-2c\theta(1-\lambda)^2- \\ \lambda^2 q\theta)+\sigma^2(c+(2-\lambda)(q-\theta))(c+\lambda(q-\theta))(cq-c\theta(1-\lambda)^2-q\theta\lambda^2)^2])$$

Considering the signs of each individual term in this product shows that $\frac{\partial diff}{\partial q} > 0$. At $q = 0$, $diff = \frac{c\theta\sigma^2(1-\lambda)^2}{c-\theta} < 0$. For $q \to \infty$ the $diff$ converges to $\frac{(2-\lambda)c-\lambda\theta}{\lambda}a_e^2 - \theta(1-(1-\lambda)^2)\sigma^2 > 0$. for $q \to \infty$ cannot be generally determined but depends on the values of the other parameters. Monotonicity of $diff$ with respect to q implies that there is a unique finite threshold $q^* > 0$ such that $diff \geq 0$ if and only if $c \geq q^*$.

2a) Note that $diff$ is a linear expression in σ^2 where the coefficient of σ^2 reads $\frac{\partial diff}{\partial \sigma^2} = \frac{\theta(c+q)((1-\lambda)^2(q-\theta)-q)+q\theta^2}{(q-\theta)(c+q-\theta)}$. If $(1-\lambda)^2 \leq \frac{q}{q-\theta}(1-\frac{\theta}{c+q})$ the coefficient of σ^2 is non-negative. Furthermore, for $\sigma^2 = 0$ we have $diff = \frac{\lambda q^2\theta((2-\lambda)c-\lambda\theta)}{(q-\theta)(\theta(1-\lambda)^2 c+\theta\lambda^2 q-cq)}a_e^2 > 0$. Therefore, $diff > 0$ for all $\sigma^2 \geq 0$.

2b) If $(1-\lambda)^2 > \frac{q}{q-\theta}(1-\frac{\theta}{c+q})$ the coefficient of σ^2 in $diff$ is negative. Therefore $diff < 0$ for σ^2 sufficiently large and due to the monotonicity of $diff$ with respect to σ^2 there must exist a unique threshold σ^{2*} such that $diff \geq 0$ iff $\sigma^2 \in [0, \sigma^{2*}]$. Q.E.D. ■

Appendix B: The Duopoly Case

We analyze the three-stage game described above by backward induction starting with the price setting stage. Since our focus is on the preannouncement and final positioning decisions of the firm we are interested in keeping pricing effects and production costs symmetric. To this end we assume that $f_i = f_j = f$, $e_i = e_j = e$ and concentrate on symmetric equilibria of the Bertrand game. Denote by $\epsilon_i(p_i, p_j) < 0$ the price elasticity of demand for the product of firm i. Obviously, under our assumptions we have $\epsilon_i(p,p) = \epsilon_j(p,p)$ and call this expression $\epsilon(p)$. It is an easy exercise to verify that under the standard assumption that price elasticity of demand is non-increasing in p there exists a unique Nash equilibrium of the this simple pricing game.

Proposition 3 *Given our assumptions and* $\frac{\partial \epsilon_i(p_i,p_j)}{\partial p_i} \leq 0$, $\frac{d\epsilon}{dp} \leq 0$ *there exists a unique price*

$$p^* = \frac{e}{1 + \frac{1}{\epsilon(p^*)}}$$

such that $p_i = p_j = p^*$ *is a Nash equilibrium of the pricing game.*

Proof. Since preannoucement and positioning decisions are taken at prior stages, at the third stage firm i chooses p_i in order to maximize

$$\tilde{\pi}_i = (p_i - e) f(p_i, p_j) \mathbb{E} \alpha_i(a_{if}, a_{jf}, a_I).$$

First we verify that (p^*, p^*) is indeed a Nash equilibrium. Given that $p_j = p^*$ the first order condition of firm i reads

$$f(p_i, p^*) + (p_i - e) f_1(p_i, p^*) = 0,$$

which is equivalent to

$$1 + \frac{p_i - e}{p_i} \epsilon_i(p_i, p^*) = 0,$$

where the subscript '1' here denotes a partial differential with respect to the first variable. Straightforward calculations show that this condition is satisfied by p^*. The second order condition reads

$$\frac{e}{p_i^2} \epsilon_i(p_i, p^*) + \frac{p_i - e}{p_i} \epsilon_{i1}(p_i, p^*) < 0$$

which show that p^* is indeed a maximum and accordingly (p^*, p^*) is a Nash equilibrium. Uniqueness follows directly from the assumption that $\frac{d\epsilon}{dp} \leq 0$. Q.E.D. ■

Due to our assumption that price-elasticities do not depend on preannouncements or product positions the pricing stage does not provide any strategic incentives for the preannouncement and final positioning states. It does however determine the marginal profits created by an increase in the market potential of firm i and hence determines the weight of consumer base expansion compared to repositioning and product development costs. This assumption, although slightly restrictive, allows us to explicitly solve for the equilibria of the entire three stage game. In what follows we write $\tilde{\theta}_{i,k} = (p^* - e)f(p^*, p^*)\theta_{i,k}, k \in \{1, 2\}$ and $\tilde{\theta}_{i,0} = (p^* - e)f(p^*, p^*)\alpha_{max}/2$.

Let us now turn to the final positioning stage. At this stage both firms know whether preannouncements have been made (δ_1, δ_2) at the first stage and, in case there were preannouncements, also their positions (a_{1p}, a_{2p}). Furthermore, they have already learned the exact position of the center of consumer preferences a_I and correctly anticipate the equilibrium on the pricing stage. Knowing a_{1p}, a_{2p} and a_I firms can of course also infer the original position of the consumer preferences, a_0. In a Nash equilibrium (a^*_{1f}, a^*_{2f}) of this subgame the choice a_{if} of firm i in the final positioning stage then has to satisfy

$$a^*_{if} \in \arg\max_{a_{if} \in \mathbb{R}} \left[\tilde{\theta}_{i0} + \tilde{\theta}_{i1}(a_{if} - a_I)^2 + \tilde{\theta}_{i2}(a_{if} - a^*_{jf})^2 - \delta_i c_i (a_{if} - a_{ip})^2 - q_i (a_{if} - a_{ie})^2\right].$$

The following proposition shows that there exists a unique Nash equilibrium on the final positioning stage where the final position is a linear function of the own and the competitors' preannouncement, the own and the competitor's expertise and the center of consumer preferences.

Proposition 4 *There exists a unique Nash-equilibrium* $(a^*_{1f}(\delta_1, \delta_2, a_{1p}, a_{2p}, a_I), a^*_{2f}(\delta_1, \delta_2, a_{1p}, a_{2p}, a_I))$ *in the final positioning stage, where*

$$a^*_{if}(\delta_i, \delta_j, a_{ip}, a_{jp}, a_I) = K_i^{Po}\delta_i a_{ip} + K_i^{Pc}\delta_j a_{jp} + K_i^{Eo} a_{ie} + K_i^{Ec} a_{je} + K_i^{C} a_I, \ i = 1, 2 \qquad (A1)$$

with $K_i^{Po} > 0, K_i^{Pc} < 0, K_i^{Eo} > 0, K_i^{Ec} < 0, K_i^{C} > 0$.

Proof. We calculate the reaction functions of player $i \in \{1, 2\}$ for a subgame following the stage-one actions $\delta_1, \delta_2, a_{1p}, a_{2p}$. Assuming that the competitor chooses a_{jf} player i maximizes

$$\tilde{\theta}_{i0} + \tilde{\theta}_{i1}(a_{if} - a_I)^2 + \tilde{\theta}_{i2}(a_{if} - a_{jf})^2 - \delta_i c_i (a_{if} - a_{ip})^2 - q_i (a_{if} - a_{ie})^2$$

with respect to a_{if}. From the first order condition we get

$$a_{if} = \frac{1}{-\tilde{\theta}_{i1} - \tilde{\theta}_{i2} + \delta_i c_i + q_i}(-\tilde{\theta}_{i1} a_I + \delta_i c_i a_{ip} + q_i a_{ie} - \tilde{\theta}_{i,2} a_{jf}).$$

for $i = 1, 2,\ j \neq i$. The second order condition for a maximum reads $\tilde{\theta}_{i1} + \tilde{\theta}_{i2} - \delta_i c_i - q_i < 0$ and is satisfied because of our assumption that $\theta_{i1} < -2\theta_{i2}$. Solving this pair of linear equations yields a solution of form (A1) with

$$
\begin{aligned}
K_i^{Po} &= \frac{c_i(-\tilde{\theta}_{j1} - \tilde{\theta}_{j2} + \delta_j c_j + q_j)}{(-\tilde{\theta}_{i1} - \tilde{\theta}_{i2} + \delta_i c_i + q_i)(-\tilde{\theta}_{j1} - \tilde{\theta}_{j2} + \delta_j c_j + q_j) - \tilde{\theta}_{i2}\tilde{\theta}_{j2}} \\
K_i^{Pc} &= \frac{-\tilde{\theta}_{i2} c_j}{(-\tilde{\theta}_{i1} - \tilde{\theta}_{i2} + \delta_i c_i + q_i)(-\tilde{\theta}_{j1} - \tilde{\theta}_{j2} + \delta_j c_j + q_j) - \tilde{\theta}_{i2}\tilde{\theta}_{j2}} \\
K_i^{Eo} &= \frac{q_i(-\tilde{\theta}_{j1} - \tilde{\theta}_{j2} + \delta_j c_j + q_j)}{(-\tilde{\theta}_{i1} - \tilde{\theta}_{i2} + \delta_i c_i + q_i)(-\tilde{\theta}_{j1} - \tilde{\theta}_{j2} + \delta_j c_j + q_j) - \tilde{\theta}_{i2}\tilde{\theta}_{j2}} \\
K_i^{Ec} &= \frac{-\tilde{\theta}_{i2} q_j}{(-\tilde{\theta}_{i1} - \tilde{\theta}_{i2} + \delta_i c_i + q_i)(-\tilde{\theta}_{j1} - \tilde{\theta}_{j2} + \delta_j c_j + q_j) - \tilde{\theta}_{i2}\tilde{\theta}_{j2}} \\
K_i^{C} &= \frac{-\tilde{\theta}_{i1}(-\tilde{\theta}_{j1} - \tilde{\theta}_{j2} + \delta_j c_j + q_j) + \tilde{\theta}_{i2}\tilde{\theta}_{j1}}{(-\tilde{\theta}_{i1} - \tilde{\theta}_{i2} + \delta_i c_i + q_i)(-\tilde{\theta}_{j1} - \tilde{\theta}_{j2} + \delta_j c_j + q_j) - \tilde{\theta}_{i2}\tilde{\theta}_{j2}}
\end{aligned}
$$

It follows from $\theta_{i1} < -2\theta_{i2}$ that the denominator is positive. The signs of the coefficients follow directly. Q.E.D. ■

Having characterized the subgame-perfect equilibria for all subgames generated by all possible combinations of actions in the preannouncement stage we are now in a position to examine the equilibrium strategies at this initial stage of the game. A strategy for player i at this stage is a pair $(\delta_i, a_{ip}) \in \{0, 1\} \times \mathbb{R}$ where the positioning of the preannouncement is only relevant if $\delta_i = 1$. The objective of player i, given an action (δ_j, a_{jp}) of player j, is:

$$
\begin{aligned}
\max_{(\delta_i, a_{ip})} \quad & \mathbb{E}[(p_i^* - e_i) f_i(p_i^*, p_j^*) \alpha(a_{if}^*(\delta_i, \delta_j, a_{ip}, a_{jp}, a_I), a_{jf}^*(\delta_j, \delta_i, a_{jp}, a_{ip}, a_I), a_I) \\
& -\delta_i c_i (a_{if}^*(\delta_i, \delta_j, a_{ip}, a_{jp}, a_I) - a_{ip})^2 - q_i (a_{if}^*(\delta_i, \delta_j, a_{ip}, a_{jp}, a_I) - a_{ie})^2]
\end{aligned}
$$

Taking into account

$$a_I = (1 - \delta_i \lambda_i - \delta_j \lambda_j) a_0 + \lambda_i \delta_i a_{ip} + \lambda_j \delta_j a_{jp}$$

and inserting the linear equilibrium functions a_{if}^* derived in proposition 4 it can be shown that in case preannouncements are optimal the reaction functions determining a_{ip} are linear in a_{jp}, a_{ie} and a_{je}. Furthermore for each constellation of preannouncements (none, one or both firms preannounce) the equilibrium values of $a_{ip},\ i = 1, 2$ are unique and can be explicitly calculated. Together we have

Proposition 5 *(i) For each pair $(\delta_1, \delta_2) \in \{0,1\}^2$ there exists a unique pair of linear functions a^*_{ip} of the form*

$$a^*_{ip}(\delta_j) = L_i^{Eo}(\delta_j)a_{ie} + L_i^{Ec}(\delta_j)a_{je} \quad i = 1,2 \tag{A2}$$

such that, whenever there is a subgame perfect equilibrium of the game with $(\delta_1, \delta_2) = (\delta_1^*, \delta_2^*)$, the preannouncements positioning strategy of player i in this equilibrium is given by $a_{ip} = a^*_{ip}(\delta_j), i = 1,2, j \neq i$.

(ii) There exists a subgame-perfect equilibrium of our three stage game with $(\delta_1, \delta_2) = (\delta_1^*, \delta_2^*) \in \{0,1\}^2$ if

(a)

$$g_i(\delta_i^*, \delta_j^*, a^*_{ip}(\delta_j^*), a^*_{jp}(\delta_i^*)) \geq max_{a_{ip}} g_i(1-\delta_i^*, \delta_j^*, a_{ip}, a^*_{jp}(\delta_i^*)) \quad i = 1,2, j \neq i, \tag{A3}$$

where

$$\begin{aligned} & g_i(\delta_i, \delta_j, a_{ip}, a_{jp}) \\ = \; & \tilde{\theta}_{i1}(a^*_{if}(\delta_i, \delta_j, a_{ip}, a_{jp}) - (\lambda_i\delta_i a_{ip} + \lambda_j \delta_j a_{jp}))^2 \\ & + \tilde{\theta}_{i2}(a^*_{if}(\delta_i, \delta_j, a_{ip}, a_{jp}) - a^*_{jf}(\delta_j, \delta_i, a_{jp}, a_{ip}))^2 \\ & - \delta_i c_i (a^*_{if}(\delta_i, \delta_j, a_{ip}, a_{jp}) - a_{ip})^2 - q_i(a^*_{if}(\delta_i, \delta_j, a_{ip}, a_{jp}) - a_{ie})^2 \\ & - (-\tilde{\theta}_{i1}(K_i^C - 1)^2 - \tilde{\theta}_{i2}(K_i^C - K_j^C)^2 + (\delta_i c_i + q_i)(K_i^C)^2)(1 - \delta_i\lambda_i - \delta_j\lambda_j)^2\sigma^2 \end{aligned}$$

(b)

$$\begin{aligned} D \;=\; & -\tilde{\theta}_{i1}(K_i^{Po} + \lambda_i(K_i^C - 1))^2 - \tilde{\theta}_{i2}(K_i^{Po} - K_j^{Pc} + \lambda_i(K_i^C - K_j^C))^2 \\ & + c_i(K_i^{Po} + \lambda_i K_i^C - 1)^2 + q_i(K_i^{Po} + \lambda_i K_i^C)^2 \\ > \; & 0 \end{aligned} \tag{A4}$$

holds for $\delta_i = \delta_i^*$ and $\delta_j \in \{0,1\}, i = 1,2, \; j \neq i$.

Proof. At the first stage of the game player i maximizes his expected payoff taking into account that both players will follow the unique subgame-perfect equilibria in all subgames of stages two and three. Therefore, the objective of player i, expecting an action (δ_j, a_{jp}) of player j, is:

$$
\begin{aligned}
&\max_{(\delta_i,a_{ip})} \\
&\qquad \mathbb{E}[(p_i^* - e_i)f_i(p_i^*,p_j^*)\alpha(a_{if}^*(\delta_i,\delta_j,a_{ip},a_{jp},a_I),a_{jf}^*(\delta_j,\delta_i,a_{jp},a_{ip},a_I),a_I) \\
&\qquad -\delta_i c_i(a_{if}^*(\delta_i,\delta_j,a_{ip},a_{jp},a_I)-a_{ip})^2 - q_i(a_{if}^*(\delta_i,\delta_j,a_{ip},a_{jp},a_I)-a_{ie})^2] \\
&= \mathbb{E}[\tilde{\theta}_{i1}(a_{if}^*(\delta_i,\delta_j,a_{ip},a_{jp},(1-\lambda_i\delta_i-\lambda_j\delta_j)a_0+\lambda_i\delta_i a_{ip}+\lambda_j\delta_j a_{jp}) \\
&\qquad -((1-\lambda_i\delta_i-\lambda_j\delta_j)a_0+\lambda_i\delta_i(a_{ip}+\lambda_j\delta_j a_{jp}))^2 \\
&\qquad +\tilde{\theta}_{i2}(a_{if}^*(\delta_i,\delta_j,a_{ip},a_{jp},(1-\lambda_i\delta_i-\lambda_j\delta_j)a_0+\lambda_i\delta_i a_{ip}+\lambda_j\delta_j a_{jp}) \\
&\qquad\qquad -a_{jf}^*(\delta_j,\delta_i,a_j^P,a_{ip},(1-\lambda_i\delta_i-\lambda_j\delta_j)a_0+\lambda_i\delta_i a_{ip}+\lambda_j\delta_j a_{jp}))^2 \\
&\qquad -\delta_i c_i(a_{if}^*(\delta_i,\delta_j,a_{ip},a_{jp},(1-\lambda_i\delta_i-\lambda_j\delta_j)a_0+\lambda_i\delta_i a_{ip}+\lambda_j\delta_j a_{jp})-a_{ip})^2 \\
&\qquad -q_i(a_{if}^*(\delta_i,\delta_j,a_{ip},a_{jp},(1-\lambda_i\delta_i-\lambda_j\delta_j)a_0+\lambda_i\delta_i a_{ip}+\lambda_j\delta_j a_{jp})-a_{ie})^2] \\
&= \tilde{\theta}_{i1}((K_i^{Po}+(K_i^C-1)\lambda_i)\delta_i a_{ip}+(K_i^{Pc}+(K_i^C-1)\lambda_j)\delta_j a_{jp}+K_i^{Eo}a_{ie}+K_i^{Ec}a_{je})^2 \\
&\qquad +\tilde{\theta}_{i2}((K_i^{Po}-K_j^{Pc}+\lambda_i(K_i^C-K_j^C))\delta_i a_{ip}+(K_i^{Pc}-K_j^{Po}+\lambda_j(K_i^C-K_j^C))\delta_j a_{jp} \\
&\qquad\qquad +(K_i^{Eo}-K_j^{Ec})a_{ie}+(K_i^{Ec}-K_j^{Eo})a_{je})^2 \\
&\qquad -\delta_i c_i((K_i^{Po}+K_i^C\lambda_i-1)\delta_i a_{ip}+(K_i^{Pc}+K_i^C\lambda_j)\delta_j a_{jp}+K_i^{Eo}a_{ie}+K_i^{Ec}a_{je})^2 \\
&\qquad -q_i(K_i^{Po}+K_i^C\lambda_i)\delta_i a_{ip}+(K_i^{Pc}+K_i^C\lambda_j)\delta_j a_{jp}+(K_i^{Eo}-1)a_{ie}+K_i^{Ec}a_{je})^2 \\
&\qquad +(\tilde{\theta}_{i1}(K_i^C-1)^2\tilde{\theta}_{i2}(K_i^C-K_j^C)^2-(\delta_i c_i+q_i)(K_i^C)^2)(1-\delta_i\lambda_i-\delta_j\lambda_j)^2\sigma^2,
\end{aligned}
$$

where in the last equality we have used $\mathbb{E}a_0 = 0, \mathbb{E}(a_0)^2 = \sigma^2$. Differentiating with respect to a_{ip} shows that, if firm i decides to preannounce, the position of this preannouncement should be given by

$$
a_{ip}(\delta_j,a_{jp}) = \gamma_{i1}\delta_j a_{jp}+\gamma_{i2}a_{ie}+\gamma_{i3}a_{je}, \tag{A5}
$$

where

$$
\begin{aligned}
\gamma_{i1} &= \frac{1}{D}(\tilde{\theta}_{i1}(K_i^{Po}+\lambda_i(K_i^C-1))(K_i^{Pc}+\lambda_j(K_i^C-1))+\tilde{\theta}_{i2}(K_i^{Po}-K_j^{Pc}+\lambda_i(K_i^C-K_j^C)) \\
&\quad \cdot(K_i^{Pc}-K_j^{Po}+\lambda_j(K_i^C-K_j^C))-((c_i+q_i)(K_i^{Po}+\lambda_i K_i^C)-c_i)(K_i^{Pc}+\lambda_j K_i^C)) \\
\gamma_{i2} &= \frac{1}{D}(\tilde{\theta}_{i1}(K_i^{Po}+\lambda_i(K_i^C-1))K_i^{Eo}+\tilde{\theta}_{i2}(K_i^{Po}-K_j^{Pc}+\lambda_i(K_i^C-K_j^C))(K_i^{Eo}-K_j^{Ec}) \\
&\quad -c_i(K_i^{Po}+\lambda_i K_i^C)K_i^{Eo}-q_i(K_i^{Po}+\lambda_i K_i^C)(K_i^{Eo}-1)) \\
\gamma_{i3} &= \frac{1}{D}(\tilde{\theta}_{i1}(K_i^{Po}+\lambda_i(K_i^C-1))K_i^{Ec}+\tilde{\theta}_{i2}(K_i^{Po}-K_j^{Pc}+\lambda_i(K_i^C-K_j^C))(K_i^{Ec}-K_j^{Eo}) \\
&\quad -(c_i+q_i)(K_i^{Po}+\lambda_i K_i^C)K_i^{Ec}
\end{aligned}
$$

and D is given in (A4). In all these terms $\delta_i = 1$ should be inserted in the expressions for the $K_\cdot^\cdot$ coefficients. Given that the second order condition $D > 0$ holds this is indeed a maximum. This implies that in cases where $\delta_i = \delta_j = 1$ there exists a unique intersection of the reaction functions (A5) whereas the optimal preannouncement in case of $\delta_j = 0$ is given by $a^*_{ip} = \gamma_{i2} a_{ie} + \gamma_{i3} a_{je}$. In both cases if a preannouncement is made by i in equilibrium it is of the form (A2) with

$$\begin{aligned} L_i^{Eo}(\delta_j) &= \frac{\gamma_{i2} + \delta_j \gamma_{i1} \gamma_{j3}}{1 - \delta_j \gamma_{i1} \gamma_{j1}} \\ L_i^{Ec}(\delta_j) &= \frac{\gamma_{i3} + \delta_j \gamma_{i1} \gamma_{j2}}{1 - \delta_j \gamma_{i1} \gamma_{j1}}. \end{aligned}$$

To check whether a profile $((\delta^*_1, \delta^*_2), (a^*_{1p}(\delta^*_2), a^*_{2p}(\delta^*_1)))$ is indeed an equilibrium we finally have to check whether for each player i the expected payoff under the preannouncement decision δ^*_i is indeed greater or equal than the maximal possible expected payoff under the reverse decision given the equilibrium preannouncement position of the opponent. Obviously the corresponding conditions are given by (A3). Q.E.D. ■

An important implication of propositions 4 and 5 is that the degree of ex-ante uncertainty about consumer preferences (σ^2) influences the decision whether to make a preannouncement but in equilibrium does not influence the position of the preannouncement.