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Self-serving Behavior in Price-Quality Competition

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Report Summary

Managers like to think well of themselves, and of the firms that employ them. However, positive illusions can bias a manager's evaluation of market outcomes, self-servingly crediting success on the superior quality of one's own product but blaming failure on the aggressive price of a competitor's offering.

Driving this prediction is the basic idea that individuals are more likely to ascribe good outcomes to forces under one's control, and bad outcomes to forces outside of one's control. In this study, Marco Bertini, Daniel Halbheer, and Oded Koenigsberg suggest and find evidence that price and quality serve this psychological motivation in differing ways.

Their discussion is as follows: Product quality is a defining feature of the firm. A manager's decision to improve quality is perceived to reflect the core competence of the organization and engage the identity and values of its employees. Put differently, what the firm sells is often regarded as an integral part of what the firm is and who its people are. Quality is also controllable and stable. For these reasons, attributing success in the market to the superior quality of one's product enhances the manager's perception of the self and of the firm: positive outcomes are caused by our actions.

Price, however, is often equated to "market conditions." Pricing is seldom considered a core competence of the organization, and thus sits at the fringes. After all, there are many moving parts to figure out, in particular the behaviors of external agents such as customers and competitors. Pricing decisions are characteristically hard to get right. Yet, price is easy to change at short notice. For these reasons, attributing failure in the market to the aggressive price of a competitor's offering sustains the manager's perception of the self and of the firm: negative outcomes are caused by the actions of others.

One experiment and one survey offer empirical evidence that supports their concept of self-serving behavior: Managers who experience sales that exceed expectations respond by increasing product quality and making only minor corrections to price. In contrast, managers who experience sales that lag expectations respond by decreasing price and making only minor corrections to product quality.

Taking this managerial psychology into account, the authors study the profit impact of self-serving behavior and identify conditions under which it increases or decreases firm profitability.

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This research is motivated by the following observation: When the sales of a firm exceed expectations, management often rushes to credit its ability to envision and manufacture products of superior quality, seldom considering the alternative that it priced a standard offering attractively low. Yet, when the situation is reversed, management is typically more comfortable blaming the poor sales performance on the aggressive price of an imprudent competitor, seldom considering the possibility that its product is in fact inferior in quality to the alternatives.

We present experimental and survey evidence of these distorted attributions, the psychology that motivates them, and the price and product quality decisions of managers that ensue. In addition, we develop an analytical model where firms compete in price and quality to understand the profit impact of self-serving behavior. In the model, as in the observation above, managers interpret market outcomes in part to sustain or enhance a positive image of the self and of the firm that employs them. Specifically, we allow managers to make decisions on price and quality after experiencing a positive or negative sales result relative to some expectation, but managers self-servingly explain success in the market by one's own quality and failure by the competitor's price, which in turn distracts them from choosing both decision variables optimally.

To study the implications of self-serving behavior, we consider two types of decision makers, principals and managers. Principals make potential long-term decisions under uncertainty about the competitor's type, whereas managers make short-term decisions when the uncertainty is resolved. This setting mirrors, for instance, a situation where the principal decides about market entry along with an initial price-quality strategy and delegates short-run adjustments of the strategy to the manager. We first solve for equilibrium in the natural benchmark case provided by unbiased decision makers. Next, we study equilibrium in the presence of myopic principals, or of forward-looking principals who anticipate the limitations of managers and set first-period decisions accordingly.

The underlying idea that individuals choose causal attributions to manage sensations and impressions of the self is certainly not new to psychologists (Blaine and Crocker 1993; Leary 2007). Heider (1958, p. 118) made the original observation that explanations are often colored by "a person's own needs and wishes." The research that followed formalizes this insight and documents several instances where individuals distort reality in a direction that sustains or enhances their self-esteem—a phenomenon commonly referred to as positive illusions (Taylor and Brown 1988). In general, scholars have shown that people tend to evaluate themselves more positively than the average person on nearly all socially desirable dimensions (Alicke and Govorum 2005), they are overly confident (Harvey 1997) and overly optimistic (Weinstein 1980), and they routinely misjudge the popularity of their own opinions (Marks and Miller 1987) and their ability to control events (Langer 1975).

In the management literature, this psychology has been applied primarily to test the possible consequences of overconfidence. For example, a series of studies mostly in

economics and finance point to implications for trading behavior (Gervais and Odean 2001), mergers and acquisitions (Malmendier and Tate 2008), market entry (Camerer and Lovo 1999), entrepreneurial euphoria (Cooper and Woo 1988), and innovation (Galasso and Simcoe 2011).

Finally, closer to the subject of our research, a recent survey of European companies reports that 95% of executives whose organizations were at the time engaged in price competition blamed the hostile environment on the irresponsible actions of a rival (Simon-Kucher and Partners 2009). A second study, this time involving executives from companies in Asia, Europe, and the United States, produced a similar result: 86% believed the competition was accountable for the downward spiraling of prices (Simon-Kucher and Partners 2011). Curiously, of all respondents in the samples, senior (C-level) directors reported the strongest convictions.

We aim to contribute to this varied evidence in at least two respects. First, we are interested in studying the causal price and quality attributions managers make with respect to firm performance, not with respect to their own character or ability. Early work on implicit egotism raised the possibility that explanations of one's behavior can spill over into explanations of associated people, objects, or institutions (Greenwald and Banaji 1995). Yet, the scant research in economics (Babcock et al. 1995; Charness and Haruvy 2000) and marketing (Curren, Folkes, and Steckel 1992; Deshpande and Zaltman 1987) that examines managers' attributions assumes the individual as the lone unit of analysis.

Second, we are interested in the responses of managers who experience market outcomes, and the profit consequence of these responses for the firm—not simply in identifying the preceding self-serving attributions, as is the case for example in Bettman and Weitz (1983). In this respect, our paper also adds to the literature on bounded rationality in industrial organization (Ellison 2006; Spiegel 2011). Research in this area examines the exploitation of consumers with limited cognitive abilities by rational firms that use shrouded attributes (Gabaix and Laibson 2006), price dispersion (Spiegel 2006), and other objects that increase complexity and confuse decision-making. It also examines the irrational beliefs and behaviors of managers, broadly focusing on alternative utility functions or on non-equilibrium models (Goldfarb et al. 2012). We contribute to the second topic, introducing the notion of *self-serving behavior* to oligopoly models with differentiated products (Anderson, de Palma, and Thisse 1992). In the present paper, self-serving behavior encompasses beliefs, attributions, and responses about the way managers perceive and use price and quality in a competitive market. Critically, we report conditions when such behavior decreases or increases profits.

Suggestive evidence that market outcomes can bias causal attributions comes from a pilot study conducted with 59 senior managers attending executive education programs at a business school in the United Kingdom. These managers were simply asked to imagine that their company recently launched a new product on the market, and that first-year sales at the

agreed price of £25.00 were expected to reach 10,000 units. One group was then informed that actual sales exceeded the projection by 25%, while the other group was informed that actual sales lagged the projection by 25%. When asked to choose between price and product quality as the best explanation for the respective outcome, 67% of the managers who experienced unexpectedly high sales selected quality and 63% of those who experienced unexpectedly low sales selected price (Wald $\chi^2(1) = 4.83, p = .028$).

Our account of this preliminary result, and the key theoretical argument we advance in the paper, is the idea that price and quality serve the manager's desire for self-enhancement and self-presentation in differing ways. To understand this point, note that causal attributions in general can be described by three main characteristics (Weiner 1986, 2000): whether they are internal or external to the actor (locus of causality), the degree to which they are subject to volitional alternation (causal control), and the degree to which they endure over time (causal stability). We argue that managers hold differing beliefs about price and quality on these dimensions.

Product quality is a defining feature of the firm. The decisions managers make to improve quality are said to reflect the core competence of the organization and engage the identity and values of its employees. Put differently, what the firm sells is often regarded as an integral part of what the firm is and who its people are. Quality is also controllable and stable. For these reasons, attributing success in the market to the superior quality of one's product enhances the manager's perception of the self and of the firm: positive outcomes are caused by our actions.

Price, however, is often equated to "market conditions." Pricing is seldom considered a core competence of the organization, and thus sits at the fringes. After all, there are many moving parts to figure out, in particular the behaviors of external agents such as customers and competitors. Pricing decisions are characteristically hard to get right. Yet, price is easy to change at short notice. For these reasons, attributing failure in the market to the aggressive price of a competitor's offering sustains the manager's perception of the self and of the firm: negative outcomes are caused by the actions of others.

The sections that follow apply different methodologies to document these contrasting beliefs and study their significance for managerial decision-making: The experiment focuses on self-serving behavior in the context of sales performance. The survey shifts the focus on pricing power rather than sales performance. The conclusions summarize the insights from building self-serving behavior into a model of oligopolistic competition in price and quality and discuss implications of our findings. The Appendix presents our model and derives the insights summarized in the conclusions. Specifically, it studies equilibrium in the benchmark case of unbiased decision makers and analyzes the profit impact of the decisions resulting from self-serving behaviors, both in the absence and presence of a principal who anticipates the limitations of the manager.

Empirical Evidence

This section explores our notion of self-serving behavior, serving three purposes. First, we want to demonstrate that the *attribution* of a market outcome to prior price or product quality decisions is contingent on its valence relative to expectations. Specifically, we test the prediction that unexpectedly high sales are ascribed to quality more than to price, while unexpectedly low sales are ascribed to price more than to quality. Second, we want to provide process evidence that the choice of attribution is self-serving. To explore this psychology, we measure and compare *beliefs* about price and quality on the aforementioned characteristics of causal attributions: locus of causality, causal control, and causal stability. Third, we want to show the likely market *responses* that culminate from these beliefs and attributions.

We report the results of one experiment and one survey that address these goals. The experiment builds on the pilot study reported in the Introduction. Simon-Kucher and Partners, a global consulting firm, conducted the survey on our behalf. This survey focuses on attributions, but it does so in the context of pricing power rather than sales performance. Pricing power is a construct often used by investors and analysts to describe the strength of a business relative to competition.

Experiment

Participants. The sample for the experiment comprises 68 graduate students enrolled in master of business administration or executive master of business administration programs at the same institution cited in the pilot study. The average age of this group is 34 years old, the average work experience is 10.6 years, and the average GMAT score is 666 (out of a possible 800). Participants were recruited via e-mail and assigned at random to one of two experimental conditions. They were informed that the research examined managerial behavior in general, that there were no right or wrong answers to the questions, and that they should rely exclusively on their opinions and preferences when responding. Participation was voluntary, with no compensation. The experiment was conducted during class time.

Instructions. Participants considered a scenario describing the launch of a new product, which was not specified. They first read information about the competitive nature of the marketplace. They were told that initial testing of the product and extensive market research estimated a revenue-maximizing price of £25.00. At this price, which was adopted for the launch, the firm anticipated selling 10,000 units in the first full year.

Next, participants were brought forward twelve months to receive the annual sales figures for the industry. Importantly, they discovered that the firm realized sales of 12,500 units (25% above the projection) or 7,500 units (25% below the projection), depending on the version of the stimulus. This difference in sales performance constitutes the experimental manipulation.

Measures. We administered five questions, each with separate scales for price and product quality that include a neutral midpoint. This design feature is meant to support

several possible types of judgments: depending on the question, participants could provide a stronger (weaker) rating to one specific decision variable, rate them equally, or indeed use the midpoint to convey inaction or that there is no relationship.

The first task of participants was to evaluate price and quality (1 = “The price (quality) of the product was lower than needed (anticipated),” 4 = “The price (quality) of the product was just right,” and 7 = “The price (quality) of the product was higher than needed (anticipated)”) as potential explanations for the sales outcome. The second task was to report the preferred price and quality response ahead of the next sales period (1 = “Definitely decrease the price (quality) of the product,” 4 = “Hold the price (quality) of the product constant,” and 7 = “Definitely increase the price (quality) of the product”).

For the analysis of these two questions, we convert absolute scores to deviations from the midpoint of the scale. This transformation allows us to meaningfully assess the valence and strength of the answers against the neutral benchmark and against each other. We use the conventional alpha level of .05 for all statistical tests.

Finally, participants rated price and quality on locus of causality, causal control, and causal stability. Specifically, they indicated to what extent they agree that “Price (Quality) is a defining element of a product’s value proposition” (1 = “Strongly disagree,” and 7 = “Strongly agree”), to what extent “Market forces (e.g., strong competitors demanding customers) play a role in determining the prices (qualities) of the products companies sell” (1 = “A very small role,” and 7 = “A very large role”), and to what extent “Price (Quality) is easy to change” (1 = “Very easy to change,” and 7 = “Very hard to change”), respectively.

Results: Causal attributions. A mixed-factorial analysis of variance with causal attributions as the dependent measure, sales performance (positive, negative) as the between-subjects factor, and decision variable (price, product quality) as the repeated measure shows the expected two-way interaction: $F(1, 66) = 42.66, p < .001$. No other effect is statistically significant.

We predicted that a manager observing unexpectedly high sales is motivated to attribute success to prior quality decisions rather than to prior price decisions. Panel A of Figure 1 illustrates this argument. (Figures follow References throughout.) Specifically, participants interpreted the 25% surplus in sales more as the consequence of high quality ($M = 1.34$) than of a low price ($M = -.17, t(34) = 6.17, p < .001$), relative to competition. The mean score for quality is statistically different from the neutral midpoint of the scale ($t(34) = 8.47, p < .001$), which in this case implies no causal relationship.

The opposite effect is predicted of a manager observing unexpectedly low sales. Panel B of Figure 1 displays the result: participants interpreted the 25% deficit in sales more as the consequence of a high price ($M = 1.18$) than of low quality ($M = -.33, t(33) = 3.44, p = .002$), relative to competition. In this instance, the mean score for price is statistically different from the neutral midpoint of the scale ($t(32) = 6.00, p < .001$).

Results: Beliefs. The pattern of attributions provided by participants can be considered self-serving to the extent that product quality better serves the motivation for self-enhancement and self-presentation than price—that is, if quality is seemingly more central to the firm, less susceptible to external market forces, and more stable over time.

The answers of participants support this argument. Independent mixed-factorial analyses of variance reveal a main effect of decision variable in all three questions. In comparison to price, quality is considered to be a more defining element of a product's value proposition ($M_Q = 5.75$ vs. $M_P = 5.31$; $F(1, 66) = 6.55$, $p = .013$), less susceptible to market forces ($M_Q = 4.97$ vs. $M_P = 6.03$; $F(1, 66) = -33.00$, $p < .001$), and harder to change ($M_Q = 5.04$ vs. $M_P = 3.50$; $F(1, 66) = 22.31$, $p < .001$). No other effect in these analyses is statistically significant.

Results: Responses. We conclude by examining the participants' preferred response to the initial sales result. Common sense suggests that managers repeat behaviors they believe caused desired outcomes and reverse behaviors they believe caused undesired outcomes. Given the self-serving nature of the preceding attributions, this logic leads to the prediction that the preferred response to unexpectedly high sales is to increase product quality, while the preferred response following unexpectedly low sales is to decrease price. The adjustments preferred by participants are depicted in Panel A and B of Figure 2, respectively.

A mixed-factorial analysis of variance reveals a main effect of sales performance ($F(1, 66) = 4.43$, $p = .039$) and, importantly, a significant two-way interaction ($F(1, 66) = 12.19$, $p = .001$). For participants who observed year-end sales of 12,500 units, a positive result that was attributed predominantly to product quality, we see a marginally stronger preference to increase quality ($M = .57$) than to touch price ($M = .14$, $t(35) = 1.97$, $p = .058$). The suggested change to quality is statistically different from the neutral midpoint of the scale, which in this instance indicates inaction ($t(34) = 3.17$, $p = .003$), which now implies inaction. However, for participants who observed year-end sales of only 7,500 units, a negative result that was attributed predominantly to price, we see a stronger preference to decrease price ($M = -1.09$) rather than to touch quality ($M = .30$, $t(33) = -2.87$, $p = .007$). The suggested change to price is statistically different from the neutral midpoint of the scale ($t(32) = 8.67$, $p < .001$).

Survey

Background and sample. From May to June 2011, Simon-Kucher and Partners conducted an online survey to gauge the opinions of executives on topics including profit orientation, pricing power and competition, inflation, and business outlook. The sample consists of existing and former clients of the company, members of the Professional Pricing Society, and alumni of a business school in Spain. Both consumer (38% of 2,657 responses) and business (62%) markets were surveyed. The five countries with the largest representation were the United States (17%), France (12%), Spain (10%), the United Kingdom (9%), and

Germany (8%). The sector with the highest representation was financial services (19%), followed by healthcare (15%) and travel and hospitality (7%). Forty-one percent of firms in the sample had revenues in excess of €1 billion. Thirty-one percent of responses came from senior directors.

Data. We examine 679 valid responses to two questions related to pricing power. For the purpose of the survey, pricing power was defined as “the ability of a company to capture the money it deserves for the value it delivers to customers.” We view this as an alternative, substantively interesting measure of firm performance.

The executives were asked to assess their company’s performance on pricing power using a five-point scale, with higher numbers indicating better performance. Those that provided high ratings (score of 4 or 5) or low ratings (score of 1 or 2) were then asked to select a maximum of three explanations from the following list: strong (weak) positioning of the brand, premium (commodity) status of the product, friendly (competitive) pricing environment, and fragmented (concentrated) power of customers—where display logic matched the exact wording of these explanations to the respondents’ preceding assessment of pricing power. We coded the first and second attribution as quality related, and the third and fourth explanation as price related. In addition, we coded a respondent’s overall explanation in favor of quality if she provided more explanations from the first set, in favor of price if she provided more explanations from the second set, or balanced if the number of explanations matched across sets.

Result. The prediction is that executives provide price explanations for low pricing power and quality explanations for high pricing power. A multinomial logistic regression of attributions on pricing power confirms this idea. Specifically, we see that executives who reported low pricing power attributed their situation to price in 64.5% of cases, but to quality in only 10.7% of cases (Wald $\chi^2(1) = 25.31, p < .001$). Conversely, executives who reported high pricing power attributed their situation to quality in 70.9% of cases, but to price in only 12.3% of cases (Wald $\chi^2(1) = 87.27, p < .001$).

Discussion

In view of the results, we now formalize our notion of self-serving behavior. A complete account of self-serving behavior includes three ingredients about the way managers perceive and use of price and quality in a competitive market. These elements correspond to the constructs tested in the experiment and survey: (1) beliefs with respect to centrality, control, and stability, (2) attributions to experienced market outcomes, and (3) responses to those outcomes.

The responses are of particular importance for moving forward because they point to possible asymmetries in a manager’s choice of price and quality to prolong success or reverse failure in the market. The empirical evidence collected supports the following notion of self-serving behavior: Managers who experience sales that exceed expectations respond by

increasing product quality and making only minor corrections to price. In contrast, managers who experience sales that lag expectations respond by decreasing price and making only minor corrections to product quality.

In the Appendix, we present a model where managers make decisions about price and quality facing a market outcome above or below expectations. Taking the managerial psychology uncovered in our empirical approach into account, we study the profit impact of self-serving behavior and identify conditions under which it increases or decreases firm profitability.

Conclusion

In summary, a robust finding in psychology is that people perceive themselves readily as the origin of good effects and reluctantly as the origin of ill effects. The objective of this paper was to document and study an analogous self-serving behavior in the way managers interpret and react to market outcomes.

Our initial stimulus for the paper comes from a simple observation: managers tend to distort their attribution of success and failure in the market, systematically crediting product quality and blaming price, respectively. Yet, this observation also implicates specific antecedent and consequent behaviors. First, the psychology of attribution suggests that the motive to self-enhance or to manage audience impressions is served by factors that are internal, controllable, and stable. In the minds of managers, therefore, quality should outrank price on these dimensions. Second, self-serving attributions produce partial responses: managers should react to positive outcomes by investing in quality, overlooking the possibility that an adjustment to price might be equally effective, and react to negative outcomes by lowering price, overlooking the possibility that an adjustment to quality might also restore healthy performance.

The empirical evidence for these three ingredients—beliefs, attributions, and responses—comes from one experiment and one survey. The experiment provides a complete picture of the theory. Namely, we show that price and quality differ on the key characteristics of causal attributions, we show that price and quality differ in their use as attributions for market outcomes, and we show that price and quality differ in their use as responses to those outcomes. These effects are all in the predicted direction. The survey adds external validity by replicating the asymmetry in attributions with an alternative, practically relevant measure of firm performance.

More broadly, research in economics speculates that market forces will ultimately drive out psychological shortcomings, including positive illusions (Kaplan and Ruffle 2004). Yet, many psychologists take the stance that the personal benefits associated with self-enhancement—for example, lower anxiety and greater confidence—promote well being and more effective behavior (Taylor and Brown 1988), which in turn can prolong the distorted attributions and responses reported in the paper.

Questioning whether a particular bias is of consequence in the marketplace seems natural when the presumption is that the bias is self-defeating. But, as shown in the Appendix, our research spells out conditions under which self-serving behavior is advantageous to the firm, in which case it is perhaps more appropriate to raise for future research factors that might perpetuate (moderate) the effect.

For instance, it is clear that self-serving behavior requires some mismatch between expected and realized market outcomes (Campbell and Sedikides 1999). At the same time, expectations are shaped by experiences and intentions that are for the most part positive (Taylor 1991). This reflection not only predicts a certain psychological robustness to self-serving behavior, but it also suggests that perceived failure in the market may be more prevalent than perceived success, which in our theory carries consequences for the attributions and responses that managers are more likely to consider.

The manager's own disposition probably also plays a role. In particular, to the extent that managers hold a positive view of their strengths, skills, and abilities (Tetlock and Levi 1982), it is likely that a stronger and more permanent asymmetry in price-quality attributions and responses is observed. The two surveys briefly cited in the Introduction point in this direction, as seniority in an organization and self-perceptions are positively associated.

Finally, it seems reasonable to expect that self-serving behavior be moderated by the manager's appreciation of her bias. The problem here is that the literature clearly demonstrates the inability of people to introspect. The very tendency to self-enhance can lead the manager to think she is not self-enhancing (Pronin, Lin, and Ross 2002). In addition, motivated reasoning skews the search for information (Kunda 1990) and the standards of proof (Gilovich 1991) in favor of hypotheses that reinforce past behaviors. The model developed in the Appendix requires a forward-looking principal to take advantage of self-serving behavior. Future research could explore other mechanisms and institutions that play a similar role.

Appendix

Model

This section introduces the elements of our model. We begin by detailing the assumptions regarding the firms and consumers, and conclude by laying out the timeline of the model.

Firms. We consider two single-product firms $i = A, B$ that compete over two periods. A principal makes initial decisions in the first period and delegates the second-period responses to a manager. In each period, decision makers simultaneously choose the price p_{it} and the quality improvement Q_{it} for their product, as we explain below.

In line with Buehler and Halbheer (2012), the products are horizontally and vertically differentiated. Horizontal differentiation is à la Hotelling with the two firms being located at the extremes of the characteristics space at $x_A = 0$ and $x_B = 1$. Vertical differentiation captures the notion that quality improvements enhance the value of the product in the eye of the consumer. Specifically, for each product i , quality in period t is captured by an index

$$\theta_{it} = q_i + \omega Q_{it} \tag{A.1}$$

that weights intrinsic quality $q_i \geq 0$ and quality improvements Q_{it} , where $\omega > 0$ is a parameter that measures the consumers' sensitivity to investment-related quality improvements. We consider the two quality components as being equally important and thus normalize ω to unity.

Our treatment of product quality reflects the intuition that innovations vary significantly in the speed in which they can be conceived and implemented. We assume that intrinsic quality q_i is technology driven and exogenously given. The firm therefore cannot adjust q_i in the short run, but she can influence product quality by investing in quality improvements Q_{it} (just as she can adjust price in the short run). Quality improvements can take different forms, including some enhancements to the product itself or changes to packaging, service quality, and commercial activities (advertising, product endorsements, etc.). The investment cost function for a quality improvement is quadratic and given by $k(Q_{it}) = \beta Q_{it}^2$, where $\beta > 0$. The marginal cost of output with intrinsic quality q_i is $c_i \geq 0$.

Firm i has two possible types, a low type ($k = L$) and a high type ($k = H$). The type of firm i is captured by its intrinsic quality q_i^k , where $q_i^H > q_i^L$. We assume that intrinsic quality is private information, and that each firm expects the rival's intrinsic quality to be high with probability λ and low with probability $1 - \lambda$, where $\lambda \in (0, 1)$. The firms are symmetric in the sense that intrinsic quality is the same for a given type k . Specifically, this means that $q_1^L = q_2^L$ and $q_1^H = q_2^H$ for $i = A, B$.

Below, we consider two types of principals: myopic and forward looking. The critical distinction between these two types is the ability to anticipate the self-serving nature of the

manager. Specifically, forward-looking principals take into account that, depending on the first-period outcome, self-serving managers leave one variable fixed and make second-period responses on the other variable only—as suggested by the empirical evidence. In contrast, myopic principals fail to take into account the managers’ self-serving behavior.

Consumers. We consider a market with a mass of N consumers and normalize N to unity without loss of generality. Consumers have unit demand and thus purchase one unit from one of the two firms. A consumer buying product i derives conditional indirect utility

$$v_{it} = \theta_{it} - \tau |x - x_i| + y - p_{it}, \quad (\text{A.2})$$

where θ_{it} is the quality, $x \in [0, 1]$ is the consumer’s most preferred product characteristic, and y is the consumer’s income (see Anderson, de Palma and Thisse (1992) for a comprehensive treatment of discrete choice models).

The parameter τ measures the consumer’s sensitivity to horizontal mismatch $|x - x_i|$, and is normalized to unity. Each consumer is characterized by her most preferred product characteristic x , which is drawn independently across consumers from a uniform distribution over the interval $[0, 1]$. We assume that individual consumer characteristics are private knowledge and that the distribution of characteristics is common knowledge.

We define $D_{it}(\mathbf{p}_t, \theta_t)$ as the demand for the product of firm i in period t as a function of prices $\mathbf{p}_t = (p_{At}, p_{Bt})$ and qualities $\theta_t = (\theta_{At}, \theta_{Bt})$. Demand for product i can be derived from the conditional indirect utility function in (A.2) and it is given by

$$D_{it}(\mathbf{p}_t, \theta_t) = \frac{1}{2} + \frac{(\theta_{it} - \theta_{jt}) - (p_{it} - p_{jt})}{2}, \quad i \neq j. \quad (\text{A.3})$$

Substituting the qualities from (A.1) into the demand function $D_{it}(\mathbf{p}_t, \theta_t)$, we can write demand as a function of price and quality improvements as $D_{it}(\mathbf{p}_t, \mathbf{Q}_t)$, where $\mathbf{Q}_t = (Q_{At}, Q_{Bt})$ denotes the vector of quality improvements.

Timeline. At the beginning of the first period, after learning the type of their firm, principals simultaneously choose prices and quality improvements (and hence product qualities). At the beginning of the second period, managers learn their competitor’s type from the observed prices and qualities. With this knowledge, managers simultaneously implement responses for price and quality improvements. Figure 3 summarizes the sequence of events.

Analysis

We now analyze the profit impact of self-serving behavior. We first consider the benchmark case provided by unbiased decision makers. In our context, unbiased decision makers are rational in the sense that managers are not self-serving (they respond by adjusting price and quality) and principals are aware of this (they are forward looking). Next, we study equilibrium in the presence of self-serving behavior with principals that are myopic or forward looking.

We assume that consumers learn intrinsic product quality at the end of the first period, which implies that firms do not have an incentive to misreport their type through signaling in the first period (Cho and Kreps 1987, Spence 1973). Further, we assume that the market is covered and that both firms have positive sales in equilibrium. To facilitate the exposition, we have relegated the proofs to a separate section.

Unbiased decision makers. With unbiased decision makers, principals make their price and quality decisions under uncertainty regarding the competitor's type, taking the managers' responses in the second period into account. Managers learn the competitor's type and implement their responses under complete information. To solve for the subgame perfect equilibrium, we use backward induction to first determine the managers' optimal responses, and then determine the principals' optimal decisions.

At this point, we introduce some additional notation. Depending on the realization of types, there are four possible first-period outcomes inferred from prices and qualities: Both firms are of type L (outcome LL), firm A is of type L and firm B is of type H (outcome LH), firm A is of type H and firm B is of type L (outcome HL), and both firms are of type H (outcome HH). To capture the dependence on the outcomes, we write the demand functions as $D_{it}^{kl}(\mathbf{p}_t, \mathbf{Q}_t)$. For example, $D_{i2}^{HL}(\mathbf{p}_2, \mathbf{Q}_2)$ is firm i 's demand in period $t = 2$ when firm A is of type H and firm B is of type L. Figure 4 uses the same notation for the profit functions and gives the profits for each outcome.

At the beginning of the second period, the firm types have become common knowledge. An unbiased manager i maximizes its product market profit net of the cost for providing the quality improvement and thus chooses the price and the quality improvement so as to

$$\max_{p_{i2}, Q_{i2}} \pi_{i2}^{kl}(\mathbf{p}_2, \mathbf{Q}_2) = (p_{i2} - c_i) D_{i2}^{kl}(\mathbf{p}_2, \mathbf{Q}_2) - \beta(Q_{i2})^2, \quad (\text{A.4})$$

where kl indexes demand (and thus profits) for a given first-period outcome. We denote firm i 's optimal price and quality improvement in the second period for a given outcome kl by \hat{p}_{i2}^{kl} and \hat{Q}_{i2}^{kl} , respectively. The optimal second-period profits are denoted by $\hat{\pi}_{i2}^{kl}$.

In the first period, the principals are unaware of their competitor's type. Thus, in contrast to the second period, the initial decision problem suffers from incomplete information (Fudenberg and Tirole 1991). That is, principals condition their decisions solely on their own firm type, taking into account that the competitor can be of type H with probability λ , or type L with probability $1 - \lambda$. In the Bayesian equilibrium, an unbiased principal i chooses the price and the quality improvement so as to maximize the overall expected profits:

$$\begin{aligned} \max_{p_{i1}, Q_{i1}} \pi_{i1}^k(\mathbf{p}_1, \mathbf{Q}_1) = & (1 - \lambda)[(p_{i1} - c_i) D_{i1}^{kL}(\mathbf{p}_1, \mathbf{Q}_1) - \beta(Q_{i1})^2 + \hat{\pi}_{i2}^{kL}] \\ & + \lambda[(p_{i1} - c_i) D_{i1}^{kH}(\mathbf{p}_1, \mathbf{Q}_1) - \beta(Q_{i1})^2 + \hat{\pi}_{i2}^{kH}]. \end{aligned} \quad (\text{A.5})$$

We denote firm i 's optimal price and quality improvement in the first period by \hat{p}_{i1}^k and \hat{Q}_{i1}^k , respectively. The corresponding optimal expected profits are denoted by $\hat{\pi}_{i1}^k$.

It is noteworthy that the subgame perfect equilibrium coincides with the solution obtained by solving for equilibrium separately in each period when managers are unbiased. Thus, in this benchmark case it does not matter whether principals are myopic or forward looking. However, as we now demonstrate, this is no longer the case when managers are self-serving.

Myopic principals. There is overwhelming experimental evidence that people lack the ability to do backward induction (Smith 2010). We therefore first analyze the profit impact of managers' self-serving attributions when principals are myopic. In this case, principals do not take into account that managers are self-serving when responding to market outcomes.

At the beginning of the second period, the firm types are common knowledge. In addition, the managers have learned whether first-period sales exceeded or lagged expectations. The next result summarizes the managers' evaluations of their respective sales performance.

Lemma 1 (Sales Performance). *At the end of the first period, the sales of both firms are above expectations (outcome LL), the sales of firm A are below expectations and the sales of firm B are above expectations (outcome LH), the sales of firm A are above expectations and the sales of firm B are below expectations (outcome HL), or the sales of both firms are below expectations (outcome HH).*

To grasp the intuition for deviations of sales from expectations, consider first the outcome LL: Firm A's sales are above expectations when firm B is a "weak" competitor also offering low quality. Instead, if firm B were of type H, firm A's sales would be below expectations because firm B is a "strong" competitor offering relatively high quality. Similarly, firm B has sales below expectations if firm A is of type H. In contrast, if firm B were of type L, firm A's sales would be above expectations due to its higher quality.

In line with our experimental findings, we assume that manager i maintains the first-period price and implements a response with quality when the first-period sales exceed expectations. Instead, if the first-period sales lag expectations, we assume that manager i maintains the first-period quality and implements a response with price.

Lemma 1 shows that managers hold first-period prices when the competitor turns out to be of type H. If the competitor turns out to be of type L instead, managers hold first-period qualities.

We present the managers' profit maximization problems for the outcome LH. In this case, the manager of firm A holds to the (given) first-period quality \bar{Q}_{A1}^L and the manager of firm B holds to the (given) first-period price \bar{p}_{B1}^H . Specifically, the managers of firms A and B

solve the following:

$$\begin{aligned}\max_{p_{A2}} \pi_{A2}^{LH}(p_{A2}, Q_{B2}) &= (p_{A2} - c_A) D_{A2}^{kl}(p_{A2}, \bar{p}_{B1}^H, \bar{Q}_{A1}^L, Q_{B2}) - \beta(\bar{Q}_{A1}^L)^2 \\ \max_{Q_{B2}} \pi_{B2}^{LH}(p_{A2}, Q_{B2}) &= (\bar{p}_{B1}^H - c_B) D_{A2}^{kl}(p_{A2}, \bar{p}_{B1}^H, \bar{Q}_{A1}^L, Q_{B2}) - \beta(Q_{B2})^2.\end{aligned}$$

It should be evident that these profit maximization problems are constrained versions of problems in (A.4) in the context of unbiased managers. We denote the managers' optimal decisions by \bar{p}_{A2}^{LH} and \bar{Q}_{B2}^{LH} and the corresponding optimized firm profits by $\bar{\pi}_{A2}^{LH}$ and $\bar{\pi}_{B2}^{LH}$.

Importantly, the optimal responses are functions of the first-period decisions \bar{p}_{B1}^H and \bar{Q}_{A1}^L . Therefore, the decision problems are linked across periods. Because principals are myopic, they do not take this link into consideration when setting first-period prices and quality improvements.

In the first period, the principals do not know their competitor's type. A myopic principal i chooses the price and the quality improvement so as to maximize the expected first-period profits:

$$\begin{aligned}\max_{p_{i1}, Q_{i1}} \pi_{i1}^k(\mathbf{p}_1, \mathbf{Q}_1) &= (1 - \lambda)[(p_{i1} - c_i) D_{i1}^{kL}(\mathbf{p}_1, \mathbf{Q}_1) - \beta(Q_{i1})^2] \\ &+ \lambda[(p_{i1} - c_i) D_{i1}^{kH}(\mathbf{p}_1, \mathbf{Q}_1) - \beta(Q_{i1})^2].\end{aligned}\tag{A.6}$$

This decision problem is equivalent to the profit maximization problems in (A.5) where principals are unbiased. To see this, recall that first-period decisions do not have a commitment value in the benchmark model and that myopic principals ignore this strategic effect. We denote the optimal decisions by \bar{p}_{i1}^k and \bar{Q}_{i1}^k and the corresponding optimized expected profits by $\bar{\pi}_{i1}^k$. The overall expected profits are given by $\bar{\Pi}_{i1}^k \equiv \bar{\pi}_{i1}^k + (1 - \lambda)\bar{\pi}_{i2}^k + \lambda\bar{\pi}_{i2}^k$.

A comparison of the overall expected profits to those in the benchmark case allows us to calculate the cost of self-serving behavior. We derive the following result.

Proposition 1 (Profit Comparison). *If principals are myopic and managers are self-serving, the overall expected profits of firm i in equilibrium are lower than in the benchmark case with unbiased decision makers, irrespective of the probability λ with which the rival offers high intrinsic quality.*

The result that self-serving behavior leads to lower expected firm profits is quite intuitive: The managers could always do better by responding to a market outcome with price adjustments and quality improvements. To put Proposition 1 into perspective, it is important to notice that the principals' myopia does not affect the profit impact of self-serving behaviors, which solely results from a distorted price or quality response. However, this myopia prevents the principals from exploiting the manager's psychological limitation. The

following analysis resolves this myopia, portraying sophisticated principals who are forward looking.

Forward-looking principals. We demonstrated that the managers' self-serving behavior result in lower expected firm profits when principals are shortsighted. We now consider the case of more sophisticated principals. Specifically, we investigate how forward-looking principals can exploit the manager's self-serving behavior in order to increase expected firm profits. To solve for the subgame perfect equilibrium, we start by analyzing the managers' responses and follow with analyzing the principals' decisions.

At the beginning of the second period, the firm types have become common knowledge and the sales performance has been evaluated (see Lemma 1). Again, there are four outcomes, and we restrict attention to the managers' profit maximization problems for the outcome LH. With self-serving behavior, the manager of firm A maintains the (given) first-period quality \tilde{Q}_{A1}^L and the manager of firm B maintains the (given) first-period price \tilde{p}_{B1}^H . Specifically, the managers of firms A and B solve the following problems:

$$\begin{aligned}\max_{p_{A2}} \pi_{A2}^{LH}(p_{A2}, Q_{B2}) &= (p_{A2} - c_A) D_{A2}^{kl}(p_{A2}, \tilde{p}_{B1}^H, \tilde{Q}_{A1}^L, Q_{B2}) - \beta(\tilde{Q}_{A1}^L)^2 \\ \max_{Q_{B2}} \pi_{B2}^{LH}(p_{A2}, Q_{B2}) &= (\tilde{p}_{B1}^H - c_B) D_{A2}^{kl}(p_{A2}, \tilde{p}_{B1}^H, \tilde{Q}_{A1}^L, Q_{B2}) - \beta(Q_{B2})^2.\end{aligned}$$

We denote the managers' optimal responses by \tilde{p}_{A2}^{LH} and \tilde{Q}_{B2}^{LH} and the corresponding optimized firm profits by $\tilde{\pi}_{A2}^{LH}$ and $\tilde{\pi}_{B2}^{LH}$. In contrast to the previous case, forward-looking principals consider the link between decision problems across periods and set their first-period decisions accordingly.

In the first period, the principals do not know their competitor's type. Thus, principal i conditions her decisions solely on her own firm type. Importantly, the principal knows that one of her first-period decisions will be carried over to the second period.

We continue to present the decision problem for the outcome LH, and illustrate firm A's decision only. In the Bayesian equilibrium, a forward-looking principal chooses the price and the quality improvement so as to maximize the expected overall profits:

$$\begin{aligned}\max_{p_{A1}, Q_{A1}} \pi_{A1}^L(p_1, Q_1) &= (1 - \lambda)[(p_{A1} - c_A) D_{A1}^{LL}(p_1, Q_1) - \beta(Q_{A1})^2 + \tilde{\pi}_{A2}^{LL}] \\ &\quad + \lambda[(p_{A1} - c_A) D_{A1}^{LH}(p_1, Q_1) - \beta(Q_{A1})^2 + \tilde{\pi}_{A2}^{LH}],\end{aligned}\tag{A.7}$$

where $\tilde{\pi}_{A2}^{LH} = \pi_{A2}^{LH}(p_{A2}(\tilde{p}_{B1}, Q_{A1}), \tilde{p}_{B1}, Q_{A1}, Q_{B2}(\tilde{p}_{B1}, Q_{A1}))$ by definition (and similarly for $\tilde{\pi}_{A2}^{LL}$). We denote firm A's optimal decisions by \tilde{p}_{i1}^k and \tilde{Q}_{i1}^k and the corresponding optimized expected overall profits by $\tilde{\pi}_{i1}^k$.

Acknowledging the link across periods, principal A takes into account that the choice of the first-period quality improvement not only affects first-period profits, but also second-period profits (a similar reasoning applies for the price). This strategic effect operates

in three ways: First, there is a direct effect on profits because the first-period quality choice determines quality in the second period. Second, there is a (price-mediated) indirect effect that operates through the own best-reply function $p_{A2}(p_{B1}, Q_{A1})$. Third, there is (quality-mediated) indirect effect that operates through the rivals best-reply function, affecting its choice of the quality improvement in the second-period and hence firm A's profits. Clearly, there are similar strategic effects of the choice of Q_{A1} on $\tilde{\pi}_{A2}^{LL}$.

To calculate the cost of self-serving behavior, we compare the expected overall profits to those in the benchmark case. Because all that matters are differences in intrinsic qualities, we conveniently set $q_L = 0$ and $q_H = \frac{1}{2}$ in order to ensure that the market is covered and that both firms have positive market share. Clearly, the comparison of the overall expected profits depends on whether firm i is of type L or H. We consider each case in turn, starting with the case where firm i is of type L.

Lemma 2 (Type L). *Suppose that firm i is of type L, principals are forward looking, and managers are self-serving. Then, if $\lambda < 0.93$, the overall expected profits of firm i are higher in equilibrium than in the benchmark case with unbiased decision makers.*

The sources of higher profits are distorted price and quality decisions in the first-period. Essentially, a forward-looking principal exploits the self-serving behavior of the managers to strategically alter competition in the second period. To intuitively understand the principal's incentives to distort first-period decisions, consider the tradeoff that emerges from the overall expected profits in (A.7): While distortions of the price and quality improvement in the first period necessarily reduces first-period profits, they can increase the second-period profits $\tilde{\pi}_{A2}^{LL}$ and $\tilde{\pi}_{A2}^{LH}$, respectively. Abstracting from indirect effects, the principal has an incentive to lower the first-period price for the firm to have a price advantage if the outcome is LL (as the manager maintains the price and $\frac{\partial \tilde{\pi}_{A2}^{LL}}{\partial p_{A1}} < 0$), and to increase the first-period quality improvement for the firm to have a quality advantage if the outcome is LH (as the manager maintains the quality improvement and $\frac{\partial \tilde{\pi}_{A2}^{LH}}{\partial Q_{A1}} > 0$). However, once the probability λ that the competitor is of type H surpasses a certain threshold, the provision of high quality is too costly and profits are lower than in the benchmark case.

Lemma 3 (Type H). *Suppose that firm i is of type H, principals are forward looking, and managers are self-serving. Then, if $\lambda > 0.22$, the overall expected profits of firm i are higher in equilibrium than in the benchmark case with unbiased decision makers.*

The intuition for this result is similar to that of Lemma 2: In the present case, the principal has an incentive to lower the first-period price for the firm to have a price advantage if the outcome is HL, and to increase the first-period quality improvement for the firm to have a quality advantage if the outcome is HH. However, if λ falls below a certain threshold, the expenditures to provide high quality are too high and profits are lower than in the benchmark case.

In summary, we find that a forward-looking principal can be better off if she distorts price downwards to have a price advantage if the market outcome is positive (outcomes LL or HL) and distorts quality upwards to have a quality advantage if the market outcome is negative (outcomes LH or HH). These distortions have a profit impact in the second period because managers are self-serving. Thus, taken together, Lemmata 3 and 2 lead to the following result.

Proposition 2 (Profit Comparison). *Suppose that principals are forward looking and managers are self-serving. Then, if $0.22 < \lambda < 0.93$, overall expected profits of firm i are higher in equilibrium than in the benchmark case with unbiased decision makers.*

Proofs

Standard analysis shows that all profit functions are concave if $\beta > \frac{\omega^2}{8\tau}$. Under our assumptions, this condition requires that $\beta > \frac{1}{8}$. As all asymmetries in the model stem from the demand side, we normalize the marginal cost of output c_i to zero and set the cost parameter $\beta = \frac{1}{2}$ when reporting the results.¹ In order to ensure that the market is covered and that both firms have positive sales in equilibrium, we assume that $q^H - q^L < \frac{3}{2}$.

Unbiased Decision Makers. The optimal price and the optimal quality improvement are the solutions to the necessary and sufficient first-order conditions of $\pi_{i2}^{kl}(\mathbf{p}_2, \mathbf{Q}_2)$ given in (A.4). Standard analysis yields

$$\hat{p}_{i2}^{kl} = 1 + \frac{q_i^k - q_j^l}{2} \quad (\text{A.8})$$

and

$$\hat{Q}_{i2}^{kl} = \frac{1}{2} \left(1 + \frac{q_i^k - q_j^l}{2} \right). \quad (\text{A.9})$$

Substituting the optimal decisions \hat{p}_{i2}^{kl} and \hat{Q}_{i2}^{kl} back into the profit function, we obtain

$$\hat{\pi}_{i2}^{kl} = \frac{3 \left(2 + q_i^k - q_j^l \right)^2}{32}. \quad (\text{A.10})$$

Notice that in equilibrium a higher quality improvement (and thus higher quality) goes along with a higher price as $\hat{p}_{i2}^{kl} = 2\hat{Q}_{i2}^{kl}$.

The optimal first-period prices and quality improvements solve the necessary and sufficient first-order conditions of $\pi_{i1}^k(\mathbf{p}_1, \mathbf{Q}_1)$ given in (A.5). The optimal type-contingent prices are:

¹The proofs for the general case are available from the authors upon request.

$$\hat{p}_{i1}^k = \begin{cases} 1 - \frac{2\lambda(q^H - q^L)}{3} & \text{if } k = L \\ 1 + \frac{2(1-\lambda)(q^H - q^L)}{3} & \text{if } k = H. \end{cases} \quad (\text{A.11})$$

The optimal type-contingent first-period quality improvements are:

$$\hat{Q}_{i1}^k = \begin{cases} \frac{1}{2} - \frac{\lambda(q^H - q^L)}{3} & \text{if } k = L \\ \frac{1}{2} + \frac{(1-\lambda)(q^H - q^L)}{3} & \text{if } k = H. \end{cases} \quad (\text{A.12})$$

Substituting the optimal decisions \hat{p}_{i1}^k and \hat{Q}_{i1}^k back into the profit function in (A.5), we obtain the optimized overall expected profits:

$$\hat{\pi}_{i1}^k = \begin{cases} \frac{3}{4} - \frac{\lambda(q^H - q^L)(84 - (9 + 16\lambda)(q^H - q^L))}{96} & \text{if } k = L \\ \frac{3}{4} + \frac{(1-\lambda)(q^H - q^L)(84 + (25 - 16\lambda)(q^H - q^L))}{96} & \text{if } k = H. \end{cases} \quad (\text{A.13})$$

Notice that in equilibrium a higher quality improvement (and thus higher quality) goes along with a higher price as $\hat{p}_{i1}^{kl} = 2\hat{Q}_{i1}^{kl}$.

Myopic Principals. In the second period, there are four cases: Outcome LL, outcome LH, outcome HL, and outcome HH. We consider each case in turn.

(i) Outcome LL. The managers respectively solve:

$$\max_{Q_{A2}} \pi_{A2}^{LL}(\bar{p}_{A1}^L, \bar{p}_{B1}^L, Q_{A2}, Q_{B2}) \quad \text{and} \quad \max_{Q_{B2}} \pi_{B2}^{LL}(\bar{p}_{A1}^L, \bar{p}_{B1}^L, Q_{A2}, Q_{B2}),$$

Firm i's optimal decision is $\bar{Q}_{i2}^{LL} = \bar{p}_{i1}^{LL}/2$. Substituting for the first-period prices from (A.11), we obtain:

$$\bar{Q}_{i2}^{LL} = \frac{1}{2} - \frac{\lambda(q^H - q^L)}{3}.$$

Substituting the latter values into the profit function, firm i's optimized profits are:

$$\bar{\pi}_{i2}^{LL} = \frac{(3 - 2\lambda(q^H - q^L))(9 + 2\lambda(q^H - q^L))}{72}.$$

(ii) Outcome LH. The managers respectively solve:

$$\max_{P_{A2}} \pi_{A2}^{LH}(P_{A2}, \bar{p}_{B1}^H, \bar{Q}_{A1}^L, Q_{B2}) \quad \text{and} \quad \max_{Q_{B2}} \pi_{B2}^{LH}(P_{A2}, \bar{p}_{B1}^H, \bar{Q}_{A1}^L, Q_{B2}).$$

The firms' optimal decisions are:

$$\bar{p}_{A2}^{LH} = 1 - \frac{(1+\lambda)(q^H - q^L)}{3} \quad \text{and} \quad \bar{Q}_{B2}^{LH} = \frac{1}{2} + \frac{(1-\lambda)(q^H - q^L)}{3}.$$

By substitution, the firms' profits are:

$$\begin{aligned} \bar{\pi}_{A2}^{LH} &= \frac{(3 - 2(q^H - q^L))(9 - 2(1 + 2\lambda)(q^H - q^L))}{72} \\ \bar{\pi}_{B2}^{LH} &= \frac{(3 + 2(1 - \lambda)(q^H - q^L))(9 + 2(1 + 3\lambda)(q^H - q^L))}{72}. \end{aligned}$$

(iii) Outcome HL. The managers respectively solve:

$$\max_{Q_{A2}} \pi_{A2}^{HL}(\bar{p}_{A1}^H, p_{B2}, Q_{A2}, \bar{Q}_{B1}^L) \quad \text{and} \quad \max_{p_{B2}} \pi_{B2}^{HL}(\bar{p}_{A1}^H, p_{B2}, Q_{A2}, \bar{Q}_{B1}^L).$$

The firms' optimal decisions are:

$$\bar{Q}_{A2}^{HL} = \frac{1}{2} + \frac{(1-\lambda)(q^H - q^L)}{3} \quad \text{and} \quad \bar{p}_{B2}^{HL} = 1 - \frac{(1+\lambda)(q^H - q^L)}{3}.$$

By substitution, the firms' profits are:

$$\begin{aligned} \bar{\pi}_{A2}^{HL} &= \frac{(3 + 2(1 - \lambda)(q^H - q^L))(9 + 2(1 + 3\lambda)(q^H - q^L))}{72} \\ \bar{\pi}_{B2}^{HL} &= \frac{(3 - 2(q^H - q^L))(9 - 2(1 + 2\lambda)(q^H - q^L))}{72}. \end{aligned}$$

(iv) Outcome HH. The managers respectively solve:

$$\max_{p_{A2}} \pi_{A2}^{HH}(p_{A2}, p_{B2}, \bar{Q}_{A2}^H, \bar{Q}_{B1}^H) \quad \text{and} \quad \max_{p_{B2}} \pi_{B2}^{HH}(p_{A2}, p_{B2}, \bar{Q}_{A2}^H, \bar{Q}_{B1}^H).$$

The firms' optimal decisions are:

$$\bar{p}_{A2}^{HH} = 1 \quad \text{and} \quad \bar{p}_{B2}^{HH} = 1.$$

By substitution, firm i's optimized profits are:

$$\bar{\pi}_{i2}^{HH} = \frac{(9 + 2(1 - \lambda)(q^H - q^L))(3 - 2(1 - \lambda)(q^H - q^L))}{72}.$$

The optimal first-period decisions are given by (A.11) and (A.12). Substituting \bar{p}_{i1}^k and \bar{Q}_{i1}^k back into the profit function in (A.6), we obtain the optimized expected first-period profits:

$$\bar{\pi}_{i1}^k = \begin{cases} \frac{(3-2\lambda)(q^H-q^L)^2}{24} & \text{if } k = L \\ \frac{(3+2(1-\lambda)(q^H-q^L))^2}{24} & \text{if } k = H. \end{cases} \quad (\text{A.14})$$

Proof of Lemma 1. Firm i's expected demand is given by $\bar{D}_{i1}^k = (1-\lambda)D_{i1}^{kL} + \lambda D_{i1}^{kH}$.

Substituting optimal prices and quality improvements from (A.11) and (A.12) into \bar{D}_{i1}^k yields:

$$\bar{D}_{i1}^k = \begin{cases} \frac{1}{2} - \frac{\lambda(q^H-q^L)}{3} & \text{if } k = L \\ \frac{1}{2} + \frac{(1-\lambda)(q^H-q^L)}{3} & \text{if } k = H. \end{cases} \quad (\text{A.15})$$

Firm i's actual demands in a given outcome follow in a straightforward way by substituting the corresponding optimal decisions into the demand function:

$$\bar{D}_{i1}^{kl} = \begin{cases} \frac{1}{2} + \frac{1}{3}(q_i^k - q_j^l) & \text{if } k \neq l \\ \frac{1}{2} & \text{if } k = l, \end{cases} \quad (\text{A.16})$$

Comparing actual sales to expected sales yields:

$$\bar{D}_{i1}^{kl} - \bar{D}_{i1}^k = \begin{cases} \frac{\lambda(q^H-q^L)}{3} & \text{if } k = l \\ \frac{(\lambda-1)(q^H-q^L)}{3} & \text{if } k \neq l, \end{cases} \quad (\text{A.17})$$

which establishes the result. \square

Proof of Proposition 1. The overall expected profits follow from adding up the profits across periods, resulting in $\bar{\Pi}_{i1}^k \equiv \bar{\pi}_{i1}^k + (1-\lambda)\bar{\pi}_{i2}^k + \lambda\bar{\pi}_{i2}^k$. Specifically, we derive:

$$\bar{\Pi}_{i1}^k = \begin{cases} \frac{3}{4} - \frac{\lambda\Delta^q(18-(1+\lambda(4+\lambda))\Delta^q)}{18} & \text{if } k = L \\ \frac{3}{4} + \frac{(1-\lambda)\Delta^q(3(5-\lambda)+2(2-\lambda(1+\lambda))\Delta^q)}{18} & \text{if } k = H, \end{cases} \quad (\text{A.18})$$

where $\Delta^q \equiv q^H - q^L$. Comparing the overall expected profits to the ones in the benchmark case given in (A.18) yields:

$$\begin{aligned} \bar{\Pi}_{i1}^k - \hat{\pi}_{i1}^k &= \begin{cases} -\frac{\lambda \Delta^q (36 + \Delta^q (11 - 16\lambda (1 + \lambda)))}{288} & \text{if } k = L \\ -\frac{(1 - \lambda) \Delta^q (4(3 + 12\lambda) + \Delta^q (11 - 16\lambda + 32\lambda^2))}{288} & \text{if } k = H. \end{cases} \end{aligned} \quad (\text{A.19})$$

Recalling that $q^H - q^L < \frac{3}{2}$ (in order to ensure that both firms have positive sales), it follows that $\bar{\Pi}_{i1}^L - \hat{\pi}_{i1}^L < 0$ for all λ . As $11 - 16\lambda + 32\lambda^2 > 0$ for all λ , it is immediate that $\bar{\Pi}_{i1}^H - \hat{\pi}_{i1}^H < 0$, which establishes the claim. \square

Forward-Looking Principals. In the second period, there are four cases: Outcome LL, outcome LH, outcome HL, and outcome HH. We consider each case in turn.

(i) Outcome LL. The managers respectively solve:

$$\max_{Q_{A2}} \pi_{A2}^{LL}(\tilde{p}_{A1}^L, \tilde{p}_{B1}^L, Q_{A2}, Q_{B2}) \quad \text{and} \quad \max_{Q_{B2}} \pi_{B2}^{LL}(\tilde{p}_{A1}^L, \tilde{p}_{B1}^L, Q_{A2}, Q_{B2}).$$

This yields $\bar{Q}_{i2}^L = \frac{\tilde{p}_{i1}^L}{2}$ as the optimal decision.

(ii) Outcome LH. The managers respectively solve:

$$\max_{p_{A2}} \pi_{A2}^{LH}(p_{A2}, \tilde{p}_{B1}^H, \tilde{Q}_{A1}^L, Q_{B2}) \quad \text{and} \quad \max_{Q_{B2}} \pi_{B2}^{LH}(p_{A2}, \tilde{p}_{B1}^H, \tilde{Q}_{A1}^L, Q_{B2}).$$

This yields the following optimal decisions:

$$\tilde{p}_{A2}^{LH} = \frac{\tilde{p}_{B1}^H + 2(1 + q^L - q^H + \tilde{Q}_{A1}^L)}{4} \quad \text{and} \quad \tilde{Q}_{B2}^{LH} = \tilde{p}_{i1}^L.$$

(iii) Outcome HL. The managers respectively solve:

$$\max_{Q_{A2}} \pi_{A2}^{HL}(\tilde{p}_{A1}^H, p_{B2}, Q_{A2}, \tilde{Q}_{B1}^L) \quad \text{and} \quad \max_{p_{B2}} \pi_{B2}^{HL}(\tilde{p}_{A1}^H, p_{B2}, Q_{A2}, \tilde{Q}_{B1}^L).$$

This yields the following optimal decisions:

$$\tilde{Q}_{A2}^{HL} = \tilde{p}_{j1}^L \quad \text{and} \quad \tilde{p}_{B2}^{HL} = \frac{\tilde{p}_{A1}^H + 2(1 + q^L - q^H + \tilde{Q}_{B1}^L)}{4}.$$

(iv) Outcome HH. The managers respectively solve:

$$\max_{p_{A2}} \pi_{A2}^{HH}(p_{A2}, p_{B2}, \tilde{Q}_{A2}^H, \tilde{Q}_{B1}^H) \quad \text{and} \quad \max_{p_{B2}} \pi_{B2}^{HH}(p_{A2}, p_{B2}, \tilde{Q}_{A2}^H, \tilde{Q}_{B1}^H).$$

This yields the following optimal decisions:

$$\tilde{p}_{A2}^{HH} = \frac{3 + \tilde{Q}_{A1}^H - \tilde{Q}_{B1}^H}{3} \quad \text{and} \quad \tilde{p}_{B2}^{HH} = \frac{3 - \tilde{Q}_{A1}^H + \tilde{Q}_{B1}^H}{3}.$$

First Period. The optimal decisions are derived in a straightforward way and are given by:

$$\begin{aligned} \bar{p}_{i1}^L &= \frac{240 + \lambda[47 + 14\Delta^q] - 2\lambda^2[61 - 60\Delta^q] - 3\lambda^3[41 - 4\Delta^q] + 4\lambda^4[25 - 24\Delta^q]}{6(40 + 46\lambda - 25\lambda^2 - 20\lambda^3 + 7\lambda^4)} \\ \bar{p}_{i1}^H &= \frac{66 + 68\lambda - 41\lambda^2 - 30\lambda^3 + 9\lambda^4 - 12\Delta^q(1 + \lambda)^2(3 - 4\lambda + \lambda^2)}{3(40 + 46\lambda - 25\lambda^2 - 20\lambda^3 + 7\lambda^4)} \\ \bar{Q}_{i1}^L &= \frac{60 + 6\lambda[12 + 7\Delta^q] - 3\lambda^2[11 - 9\Delta^q] - \lambda^3[35 + 24\Delta^q] + \lambda^4[10 - 3\Delta^q]}{3(40 + 46\lambda - 25\lambda^2 - 20\lambda^3 + 7\lambda^4)} \\ \bar{Q}_{i1}^H &= \frac{66 + 42\lambda - 37\lambda^2 - 18\lambda^3 + 7\lambda^4 - 12(q^L - q^H)(3 - \lambda - 3\lambda^2 + \lambda^3)}{3(40 + 46\lambda - 25\lambda^2 - 20\lambda^3 + 7\lambda^4)}, \end{aligned}$$

where $\Delta^q \equiv q^H - q^L$. □

The proofs of Lemmata 2 and 3 are similar to that of Proposition 1 and therefore omitted. Proposition 2 follows immediately from the two Lemmata.

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Figure 1

Causal Attribution(s) for Sales Exceeding or Lagging Expectations

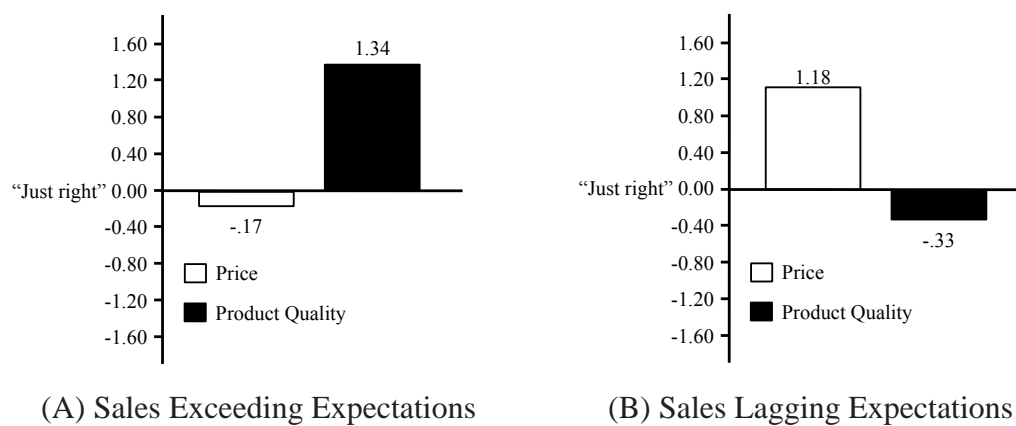
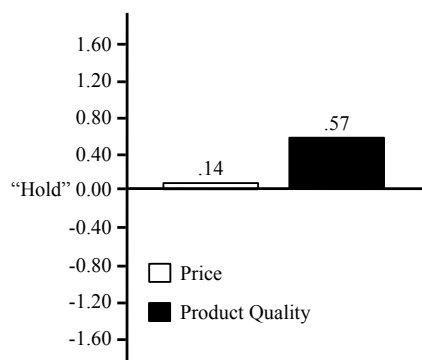
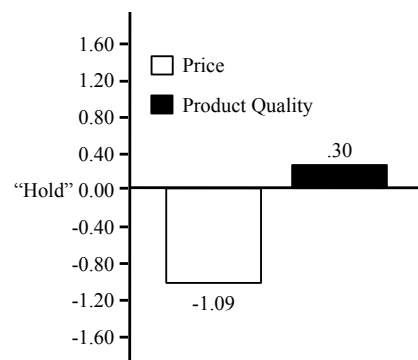


Figure 2

Response(s) to Sales Exceeding or Lagging Expectations



(A) Sales Exceeding Expectations



(B) Sales Lagging Expectations

Figure 3

Sequence of Events

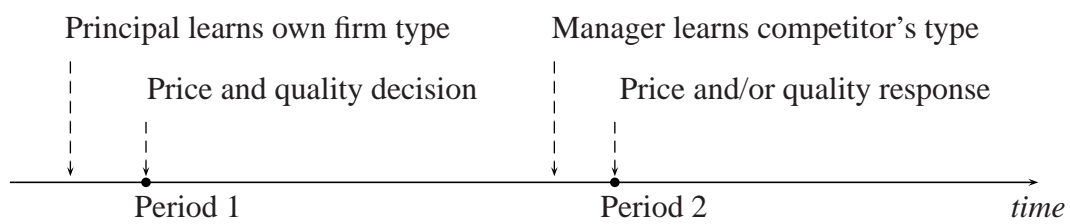


Figure 4

Outcomes and Corresponding Profits

		Firm B	
		L	H
Firm A	L	π_{A2}^{LL} π_{B2}^{LL}	π_{A2}^{LH} π_{B2}^{LH}
	H	π_{A2}^{HL} π_{B2}^{HL}	π_{A2}^{HH} π_{B2}^{HH}