ELIE OFEK and OZGE TURUT*

A firm planning market entry can attempt to develop a product that is either similar to the incumbent's existing offering (imitation) or entirely novel (innovation). The authors establish that when the incumbent is more aggressive in research and development (R&D), this negatively affects the entrant's marginal return on R&D. Thus, if greater profits produce a strong (weak) desire for the incumbent to increase its R&D level, the entrant will respond by sharply decreasing (increasing) its R&D level. As a result, the incumbent's likelihood of retaining the lead position will exhibit an inverse U-shaped pattern as a function of monopoly and duopoly profits. The authors then examine the impact of uncertainty about the rewards from new products and allow firms to conduct market research to resolve the uncertainty. They characterize the conditions for the entrant's innovation versus imitation decision to reveal information about future rewards to the incumbent. When duopoly profits are uncertain and can be either high (upside potential) or low (downside potential), the entry strategy will be revealing if the upside potential is attractive enough relative to monopoly profits. In contrast, when innovation has uncertain commercial potential (i.e., either valued or not valued by consumers), the entry strategy will be revealing if duopoly profits are unattractive relative to monopoly profits. In these cases, the entrant's innovation–imitation decision is driven by market research; this allows the incumbent to forgo market research and infer the true state of demand from the type of entry strategy it observes.

Keywords: new product development, entry strategy, market research, innovation management

To Innovate or Imitate? Entry Strategy and the Role of Market Research

A firm planning entry into a market dominated by an existing incumbent faces considerable new product challenges. The entrant needs to decide not only how much research-and-development (R&D) effort to devote but also how this effort will be directed. A common dilemma for an entrant is whether to invest in innovative activity aimed at providing entirely novel features or technologically superior functionality or to invest in imitative activity aimed at increasing the variety of alternatives that embody similar technology to the incumbent's current offering. Examples of entrants pursuing either innovation or imitation strategies abound. When Transmeta decided to develop its Crusoe microprocessor, its goal was to offer a creative architecture substantially better than the dominant Intel processor at the time.[1] When Lattice Semiconductor considered entry into the field-programmable gate arrays market in 2002, it opted to provide an innovative device superior to that offered by

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[1]The following quotation appeared on the Transmeta Web site: "On January 19, 2000, Transmeta Corporation introduced Crusoe™, a new microprocessor, into a market long controlled by one dominant company (Intel).... We believe that we produced something truly revolutionary. And that it's destined to change everything" (http://www.transmeta.com/crusoe/index.html [accessed February 24, 2004]).

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dominant firm Xilinx.[2] In contrast, to participate in the data storage industry, in 2001, Hitachi launched a technologically similar storage box to that offered by EMC Corporation, the dominant firm throughout the 1990s (*BusinessWeek* 2002). In another example of imitation, Cypress Semiconductor attempted to enter the radio frequency (RF) clock chip market in 2001 by pursuing a "me-too" strategy. The Cypress product would effectively be a "drop-in" imitation of National Semiconductor's successful RF clock (Murphy 2000).

The pervasiveness of these two distinct new product entry strategies has also been the subject of empirical investigation. Mansfield, Schwartz, and Wagner (1981) find that 60% of patented innovations are imitated within four years from introduction, and Schnaars (1994) documents the prevalence of firms choosing an imitation path in several industries (e.g., beverages, fashion, pharmaceuticals, software). Conversely, many studies depict entrants as seeking to topple the current industry leader by pursuing innovation (e.g., Henderson 1993; Utterback 1994). In these studies, entrants that seemed capable of undertaking innovation or imitation chose the former path in some cases but the latter path in other cases. Why?

The decision whether to innovate or imitate is potentially affected by several factors. First, from a technology development standpoint, it would seem reasonable that imitation is "easier" than innovation. The ability to physically examine the incumbent's existing offering focuses efforts on relatively predictable reengineering rather than on uncharted effort aimed at developing unproven technology or entirely new features. Indeed, Mansfield, Schwartz, and Wagner (1981) find that, on average, imitation costs are 35% lower than innovation costs.

A second factor is that of incumbent reaction. An incumbent facing the threat of rival entry would likely consider innovating. A nonmyopic entrant needs to take such reaction into account when making its own new product decisions. In the aforementioned examples, incumbents such as Intel and EMC were committing R&D resources to developing their own next-generation products when threatened by innovative and imitative entrants, respectively.

A third factor is that of profitability. In this respect, the two new product strategies differ considerably. At best, imitation will result in duopoly profits when both firms offer equally advanced products, whereas innovation may enable a firm to leapfrog the incumbent and reap monopoly rents. Future profit levels determine the return on new product endeavors and thus affect the desirability of firms to pursue one development path over the other and firms' incentives for expending on R&D. To complicate matters, however, there may be considerable uncertainty about these returns at the time firms are setting new product strategy. In the context of the innovation versus imitation dilemma, market uncertainty can be about (1) the level of duopoly profits or (2) the commercial rewards to an innovation. More specifically, market uncertainty about duopoly profits arises when firms do not know how consumers will react to similar products in their choice set, what cross–price elasticity of demand will emerge if technologically similar alternatives are offered, or whether distinct segments will exist for marketing purposes. In the data storage example, it was *ex ante* uncertain how much prices would plummet when Hitachi introduced a copycat storage box. Market uncertainty about innovation rewards arises if firms are unsure whether consumers will value a novel feature or a new functionality being planned or whether consumers will be averse to the costs of switching to "really new products" (Urban, Weinberg, and Hauser 1996). In the microprocessor example, there was considerable uncertainty whether the novel architecture planned by Transmeta would be sufficiently appealing to customers and induce them to switch from Intel-based machines and applications.

Because firms base new product strategy on a comparison of commercial returns relative to development costs (with this task often under the marketing domain; see Crawford and DiBenedetto 2003; Urban and Hauser 1993), when the returns are uncertain, a firm may want to conduct up-front market research to make a more informed decision. The important point to note is that the entrant is vying for the same market the incumbent is serving, and the attainable rewards from launching new products depend on common underlying demand. Thus, firms care not only about what these rewards might be but also about how informed their rival is about them. The following examples illustrate this point: When SAP was planning entry into the mobile enterprise software market, it considered the development of various applications, ranging from those currently offered in the marketplace (imitation) to entirely novel ones (innovation). To inform its decision and formulate profit projections, SAP commissioned an extensive survey of end-user demand for mobile applications. From discussions with analysts, SAP management inferred that among its competitors, it was the only firm to have conducted such a survey (Robbins 2005). Eli Lilly's new product planning group routinely monitors the competitive landscape to detect whether rivals are planning me-too versus breakthrough products and considers what kind of input rivals use to assess market rewards in making their decisions (Morin 2005). In a survey we conducted with executives involved in new product activity, more than 70% stated that they care whether rival new product plans are based on extensive market research (we present more details on this survey subsequently).

In this article, our goal is to shed light on how the entry dilemma of innovation versus imitation is affected by the attainable rewards from each new product path and by market uncertainty about these rewards. Our analysis takes into account the incumbent's response and that firms need to incur R&D effort to carry out their plans. To gain insight, we begin by examining the case in which reward structure is completely known and consider how R&D incentives are affected by changes in the profit levels. We find that the incumbent will always increase its R&D level when duopoly or monopoly profits are higher, and the entrant may respond by lowering its R&D level. Specifically, an imitating entrant will decrease its R&D level with higher monopoly profits, and an innovating entrant will decrease its R&D level with higher duopoly profits. The main intuition for these results is that the entrant has a proactive approach to

[2]Field-programmable gate arrays are semiconductor components that are reconfigurable across uses.

setting its R&D level, in the sense that to earn positive profits, its development efforts must succeed even when the incumbent's R&D efforts fail. Thus, a more aggressive incumbent, which is less likely to fail, reduces this proactive incentive. Conversely, the incumbent only has a reactive approach; it already possesses a product based on the existing technology and thus cares about the success of its R&D efforts only when the entrant is likely to succeed. Because of these divergent R&D sensitivities, we show that the likelihood of the incumbent retaining its dominant industry position will exhibit an inverse U-shaped pattern as a function of profit levels.

Subsequently, we allow for uncertainty regarding the rewards from new products and establish the central feature of our article; namely, when the entry strategy is informed by market research, observing an innovating versus imitating entrant may alter the incumbent's perceptions of future rewards and affect how aggressively it sets its R&D level. In turn, this may affect the entrant's incentives to conduct market research and the new product strategy it ends up choosing. When duopoly profits are *ex ante* uncertain and can be either high (upside potential) or low (downside potential), we find that the entrant has a greater incentive than the incumbent to conduct market research. If the upside potential is attractive (i.e., high-state duopoly profits represent a substantial fraction of monopoly profits), the entrant pursues a different new product strategy depending on what it discovers through market research. Therefore, the incumbent can fully infer the true level of duopoly profits from the entry strategy. If the upside potential of duopoly profits is only moderately attractive, the entrant will sometimes innovate regardless of what it discovers through market research. The entrant benefits from this partially concealing strategy because the incumbent presumes that duopoly profits are likely to be low when it observes an innovating entrant and scales back its R&D level. If the upside potential of duopoly profits is unattractive, the entrant will opt to innovate regardless of what market research uncovers. Consequently, the incumbent cannot infer anything from the entry strategy.

When the commercial rewards to an innovation are *ex ante* uncertain, because consumers may or may not sufficiently value the really new product, the incumbent has a strong incentive to resolve the market uncertainty. However, the way it goes about achieving this differs depending on the attractiveness of duopoly relative to monopoly profits. When duopoly profits are attractive, the entrant imitates regardless of market research results. Because the incumbent cannot infer anything from the entry strategy, it must conduct its own market research. However, when duopoly profits are relatively unattractive, the entrant conducts market research, and its decision to innovate or imitate fully reveals the information discovered; the incumbent can draw a valid inference from the entry strategy and thus will forgo costly market research.

We organize the rest of the article as follows: In the next section, we relate our work to the extant literature. We then develop the basic model when future rewards are known. Subsequently, we introduce market uncertainty and explore how conducting market research interacts with the innovation versus imitation decision. A discussion of the model's assumptions and how they can be relaxed follows. The final section offers managerial implications of the main findings and concludes. (All proofs appear in the first section of the Web Appendix; see http://www.marketingpower.com/jmroct08.)

LITERATURE REVIEW

We relate our work to three research streams: (1) models of technological competition that allow for imitation, (2) literature on the use of market research for new product planning, and (3) models of information acquisition about uncertain demand. We discuss each stream in turn.

A class of industrial organization waiting games (e.g., Benoit 1985; Katz and Shapiro 1987) allows a second mover to imitate and follow an innovator. Our work differs from this strand in that we do not limit followers to imitation, we allow the incumbent to react through innovation, and we incorporate uncertainty about the rewards. Purohit (1994) models an incumbent's incentives to offer an innovative product. Relative to our framework, in his model, competitors are restricted to costless imitation (or cloning), firms do not invest in R&D, and there is no market uncertainty. Literature on dynamic R&D games (Aghion et al. 2001; Aghion and Howitt 1992) typically imposes either a step-by-step or a leapfrogging evolution structure corresponding to followers pursuing imitation or innovation, respectively. By endogenizing the imitation–innovation decision, our work sheds light on when to expect each of these evolution structures to emerge.

A central focus of this study is the role of market research in new product entry and incumbent response decisions. A growing body of literature in marketing, both academic and practice oriented, highlights this role (e.g., Mohr, Sengupta, and Slater 2005; Ottum and Moore 1997). Recent work on the interplay between market orientation (MO) and new product development (NPD) provides further evidence for this role by measuring how gathering and then strategically using information on consumers affects new product success (Atuahene-Gima 1995). Several studies specifically measure managers' perceptions of how informed their firms are relative to rivals regarding demand for future products (Frambach, Prabhu, and Verhallen 2003). The view that emerges from this stream is that market research has competitive implications for NPD. We contribute to this literature by shedding light on when firms should have greater incentives to conduct market research, how this is linked to their industry position (entrant versus incumbent), and how one firm being informed about the market rewards strategically affects its rival's perceptions and actions.

Finally, a class of models examines the strategic incentives to acquire information for resolving uncertain demand when competing firms need to price or set the quantity of existing products (e.g., Li, McKelvey, and Page 1987; Vives 1988). Firms in our model also decide strategically whether to acquire information, but this information is in the context of new products and has R&D implications. In marketing, Iyer and Soberman (2000) model symmetric firms that consider purchasing information from a strategic vendor to modify their offering, but no R&D decisions are made after the information has been acquired. In contrast, we focus on

how market information affects the R&D decisions (direction and level) of *ex ante* asymmetric firms.

BASIC MODEL SETUP

We assume a market in which a single firm, the incumbent, currently sells a product that embodies the most advanced level of technology and enjoys monopoly status with profits of π_1 ($0 < \pi_1$). A rival firm, the entrant, seeks to sell its own product in this market in the ensuing period. In the first stage (t = 1), the entrant determines its overarching new product strategy. One strategy the entrant can embrace is imitation. If its development efforts succeed, it will be able to offer a product that is technologically similar to the incumbent's current offering.[3] Alternatively, the entrant can attempt innovation. If its development efforts succeed, it will be able to offer a product that is technologically superior to the incumbent's current offering. The incumbent can only attempt innovation, and if its development efforts succeed, it will also be able to introduce a new product that is technologically superior to its current offering. Throughout the article, we use superscript $j = \{e, i\}$ for the entrant and incumbent, respectively. We denote the entrant's action at t = 1 with the subscript $a \in \{n, m\}$ for innovation and imitation, respectively.

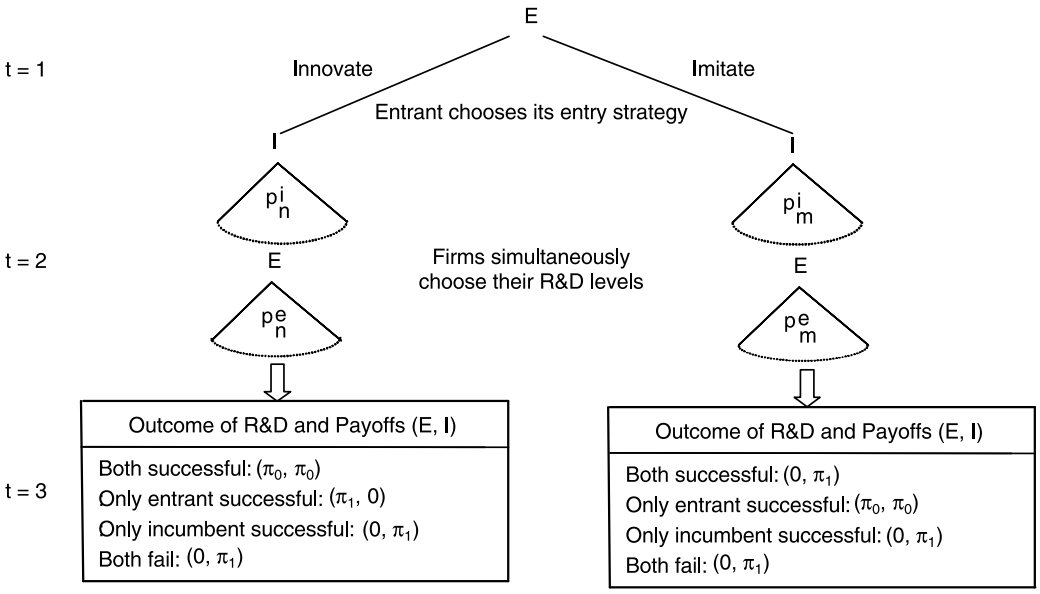
After determining the direction of new product strategy, at t = 2, the firms simultaneously decide on the R&D effort to devote. Each firm's choice of R&D level, denoted by $p^j \in [0, 1]$, is the probability that it will succeed in development conditional on expending the resources associated with that R&D level. We assume a convex quadratic relationship between R&D expenditure and the probability of R&D success p^j. In particular, for innovative effort, this expenditure is $\frac{1}{2}\eta(p^j)^2$, and for imitative effort (relevant only for the entrant), this is $\frac{1}{2}\mu(p^e)^2$. The R&D cost factors satisfy $\mu < \eta$; that is, achieving a given probability of R&D success is less costly for imitation. Each firm needs to develop its new product separately; thus, we assume that R&D success is independent across firms. Note that the incumbent is not forced to expend any resources on innovation, because it can choose $p^i = 0$.[4]

In the third stage (t = 3), each firm earns profits depending on the outcome of its R&D efforts. When a firm is the sole provider of the most advanced technology, it achieves monopoly profits of π_1, whereas its rival with an inferior technology earns profits of π_{-1}. For ease of exposition, we normalize $\pi_{-1} \equiv 0$. If both firms provide equally advanced products (the technology gap between them is 0), either because the entrant has successfully developed an imitation while the incumbent failed at innovation or because both firms' R&D efforts were successful at innovation, they share the market and earn duopoly profits of π_0. We assume that profit levels satisfy $0 \le 2\pi_0 \le \pi_1$. Thus, innovation is drastic, in the sense that it can displace the old technology, and there is dissipation of rents when firms compete in a duopoly with equally advanced technologies (Tirole 1998). Firms in our model are risk neutral and maximize expected payoffs. Figure 1 depicts the time line and specifications of our model setup. Subsequently, we provide a summary of the model assumptions, offer justification for the model's

[3]Although technologically similar, the two firms' products need not be identical. There could be horizontal dimensions along which the products differ (e.g., color, size, design) or differences in the way the products are marketed (e.g., location where available, segments targeted with communications or price discounts).

[4]Because we allow $p^j \in [0, 1]$, the incumbent cannot gain from constraining itself up front to a zero R&D level. Thus, our results would not change if we let the incumbent choose not to innovate at t = 1 and commit to not expending R&D at t = 2. In the "Technical Analyses" section of the Web Appendix (http://www.marketingpower.com/jmroct08), we show that the decision to innovate is a dominant strategy for the incumbent in this case. We thank an anonymous reviewer for asking us to clarify this point.

Figure 1
FLOWCHART OF THE MODEL: TIME LINE OF ACTIONS AND PAYOFFS



main characteristics, and discuss the implications of relaxing several key assumptions.

Innovation Versus Imitation When the Rewards Are Known

In this section, we analyze the basic setup in which firms know the rewards from new product introductions with certainty at the beginning of the game. This serves as a benchmark that enables us to establish important properties of how firms select their R&D levels and to characterize the sensitivity of firms' actions to changes in the profit levels—issues that will be relevant for analyzing the case of uncertain rewards as well.

Recall that in the first stage of the game, the entrant decides whether to pursue innovation or imitation. We define the payoff functions when the entrant chooses to innovate as V_n^e and V_n^i for the entrant and incumbent, respectively. Given each firm's choice of R&D level, p_n^e and p_n^i, and given the profits shown in the left branch of Figure 1, the expected payoffs EV_n^J are as follows:

$$(1)\quad \text{Entrant: } \underset{\text{Max}p_n^e}{EV_n^e} = p_n^e(1-p_n^i)\pi_1 + p_n^e p_n^i \pi_0 - \tfrac{1}{2}\eta(p_n^e)^2, \text{ and}$$

$$\text{Incumbent: } \underset{\text{Max}p_n^i}{EV_n^i} = (1-p_n^e)\pi_1 + p_n^e p_n^i \pi_0 - \tfrac{1}{2}\eta(p_n^i)^2.$$

Similarly, we define the payoff functions when the entrant chooses an imitation strategy as V_m^j (note the subscript m). Given each firm's choice of R&D level, p_m^e and p_m^i, and given the profits shown in the right branch of Figure 1, the expected payoffs EV_m^j are as follows:

$$(2)\quad \text{Entrant: } \underset{\text{Max}p_m^e}{EV_m^e} = p_m^e(1-p_m^i)\pi_0 - \tfrac{1}{2}\mu(p_m^e)^2, \text{ and}$$

$$\text{Incumbent: } \underset{\text{Max}p_m^i}{EV_m^i} = (1-p_m^e)\pi_1 + p_m^e p_m^i \pi_1 + p_m^e(1-p_m^i)\pi_0 - \tfrac{1}{2}\eta(p_m^i)^2.$$

Using backward induction, we first solve for the unique R&D levels the entrant and incumbent would select at t = 2 under Equations 1 and 2 separately. We then solve for the equilibrium at t = 1 by comparing the entrant's expected payoffs from pursuing innovation and imitation.

P_1: The unique subgame perfect equilibrium is for the entrant to innovate iff

$$(3)\quad \frac{\pi_1^2\eta}{[\eta^2 + \pi_0(\pi_1-\pi_0)]^2} > \frac{\pi_0^2\mu}{[\eta\mu + \pi_0(\pi_1-\pi_0)]^2}$$

and to imitate if otherwise.

It is useful to examine how the entrant's decision to innovate or imitate is affected by the profit levels and cost factors. The left-hand side of Equation 3 increases in π_1, whereas the right-hand side decreases in π_1, and the reverse is true for π_0. Intuitively, the higher the monopoly rewards to technology leadership (π_1), the more inclined the entrant is to innovate, and the greater the duopoly profits when at the same technology level, the more inclined the entrant is to imitate. The dependence on the innovation cost factor is straightforward; a low η induces the entrant to innovate, whereas a high η induces the entrant to imitate. The dependence on the imitation cost factor is more qualified. In general, a low μ makes imitation more attractive because product development is easy. However, expected innovation payoffs can exceed expected imitation payoffs even when μ is negligible, in which case the entrant would prefer to innovate regardless of μ. Intuitively, this occurs when π_1 is high relative to π_0 and η is moderate. For example, if monopoly profits are positive but duopoly profits are zero, there is no return to imitation, and the entrant would prefer to innovate even if the imitation is easy to develop (small μ).

We now examine how changes in duopoly and monopoly profits affect equilibrium R&D levels, and we highlight the implications for market evolution tendencies. We first formalize how each firm is prompted to respond to more aggressive R&D by its rival.

P_2: For the entrant, R&D levels form strategic substitutes, but for the incumbent, they form strategic complements.

P_2 suggests a fundamental contrast in the competitive responsiveness of the two firms. If the incumbent becomes more aggressive and increases its R&D level, this negatively affects the entrant's marginal return on R&D and induces the entrant to be less aggressive in setting its R&D level. In contrast, when the entrant becomes more aggressive, this positively affects the incumbent's marginal return on R&D and induces the incumbent to be more aggressive in setting its R&D level. The intuition can be gleaned by examining the expected payoff expressions (Equations 1 and 2). Because the incumbent has an existing product that it can sell, it cares about the success of its R&D efforts (p_a^i) only when the entrant succeeds (p_a^e). Therefore, the incumbent has a reactive incentive to increase its R&D level when the entrant wants to select a higher R&D level. However, the entrant does not have a product to offer at the outset and thus has a strong proactive (or stand-alone) incentive; in the sense that it cares about the success of its R&D efforts (p_a^e) even when the incumbent fails ($1-p_a^i$), a higher incumbent R&D level makes the incumbent less likely to fail and thus reduces the proactive incentive for the entrant. In many respects, the intuition for P_2 is similar to the situation two track runners face when one of them leads. If the front-runner speeds up (slows down), the second runner perceives a lower (higher) chance of overcoming his or her deficit and thus slows down (speeds up) in response. Conversely, if the second runner speeds up (slows down) the front-runner perceives a higher (lower) threat of being overtaken and thus speeds up (slows down) as well. Note that this contrast in competitive responsiveness holds for both innovative and imitative entry and helps explain the next two results.

Result 1: As duopoly profits π_0 increase, under an entrant imitation strategy, both firms increase their R&D level, but under an entrant innovation strategy, the incumbent increases its R&D level and the entrant decreases its R&D level.

Result 1 reveals that when the entrant attempts innovation, there is an opposite R&D response by the firms to greater duopoly profits. To understand the intuition, note that each firm considers two effects of a change in the profit level. The first is a direct effect, which reflects the impact on the return to R&D effort, when rival actions are held constant. The second is a competitive effect, which reflects

the impact on the return to R&D effort due to the rival's direct incentive to adjust its R&D. The latter effect is related to whether actions form strategic substitutes or complements (per P_2). When the entrant attempts innovation, as π_0 increases, the incumbent has a strong positive direct effect and increases its R&D level, but this results in a negative competitive effect for the entrant (due to strategic substitutability), which overshadows the entrant's positive direct effect and induces it to select a lower R&D level.[5] When the entrant attempts imitation, an increase in π_0 produces a positive direct effect for the entrant but a negative direct effect for the incumbent. Therefore, the entrant has an incentive to select a high R&D level. In response, the incumbent has a positive competitive effect (due to strategic complementarity) that modestly overshadows its negative direct effect. Consequently, as π_0 increases, the entrant increases p_m^{e*} more sharply than the incumbent increases p_m^{i*}.

Result 2: As monopoly profits π_1 increase, under an entrant imitation strategy, the incumbent increases its R&D level, whereas the entrant decreases its R&D level, and under an entrant innovation strategy, both firms increase their R&D levels.

The intuition for Result 2 is straightforward. Under imitation, the incumbent has a positive direct benefit from an increase in π_1. The entrant only has a competitive effect, which is negative (strategic substitutability). Under innovation, an increase in π_1 produces a strong positive direct effect for the entrant. The incumbent only has a competitive effect and reacts by increasing its R&D level (due to strategic complementarity). Consequently, as monopoly profits increase, the entrant increases p_n^{e*} more sharply than the incumbent increases p_n^{i*}.

Considering all the findings in this section, we can make the following observations regarding the likelihood of the incumbent retaining its industry position ("incumbent dominance"): The probability of incumbent dominance is given by $ID_n = (1 - p_n^{e*})$ and $ID_m = [(1 - p_m^{e*}) + p_m^{e*} p_m^{i*}]$ when the entrant innovates and imitates, respectively. From Results 1 and 2, the sensitivities of these probabilities to π_0 and π_1 have opposite signs.[6] From Equation 3 in P_1, there are cutoffs $\underline{\pi}_1(\pi_0, \eta, \mu)$ and $\underline{\pi}_0(\pi_1, \eta, \mu)$, such that the entrant prefers to innovate iff $\pi_1 > \underline{\pi}_1(\pi_0, \eta, \mu)$ and to imitate iff $\pi_0 > \underline{\pi}_0(\pi_1, \eta, \mu)$. Consequently, as Figure 2 schematically illustrates, the likelihood of incumbent dominance exhibits an inverse U-shaped relationship as a function of both profit levels. In the concluding section, we discuss the implications of these patterns for research on incumbent dominance and order-of-entry effects.

Innovation Versus Imitation When the Rewards Are Uncertain

In the previous section, we analyzed the entrant's innovation versus imitation decision and the incumbent's reaction, focusing on the technology development uncertainties inherent in such decisions. We assumed that firms could entirely anticipate the profit levels attainable given the joint outcomes of R&D efforts (as reflected in Figure 1). However, in reality, when firms are in the product planning phase, they often face considerable market uncertainty about the rewards from new product introductions. We have established that relative profit levels (π_0 versus π_1) can have a significant impact on entry strategy (P_1) and that changes in profit levels can have diverging effects on firms' R&D efforts (Results 1 and 2). We now attempt to understand how market uncertainty affects the innovation versus imitation dilemma. In what follows, we explore two types of market uncertainty—uncertainty about duopoly profits and uncertainty about innovation rewards—and examine firms' incentives to resolve the uncertainty through up-front market research.

[5]The incumbent has a second-order positive competitive effect (due to the entrant's positive direct effect combined with strategic complementarity). In the proofs of Results 1 and 2, we formalize the competitive effects.

[6]Specifically, it is easy to verify that $\partial(1 - p_n^{e*})/\partial\pi_0 > 0$, $\partial(1 - p_m^{e*} + p_m^{e*} p_m^{i*})/\partial\pi_0 < 0$ and that $\partial(1 - p_m^{e*} + p_m^{e*} p_m^{i*})/\partial\pi_1 > 0$, $\partial(1 - p_n^{e*})/\partial\pi_1 < 0$. Note that the same patterns also hold with respect to the innovation cost factor η (see the "Proofs" section of the Web Appendix; http://www.marketingpower.com/jmroct08).

Figure 2
LIKELIHOOD OF INCUMBENT DOMINANCE AS A FUNCTION OF PROFIT LEVELS

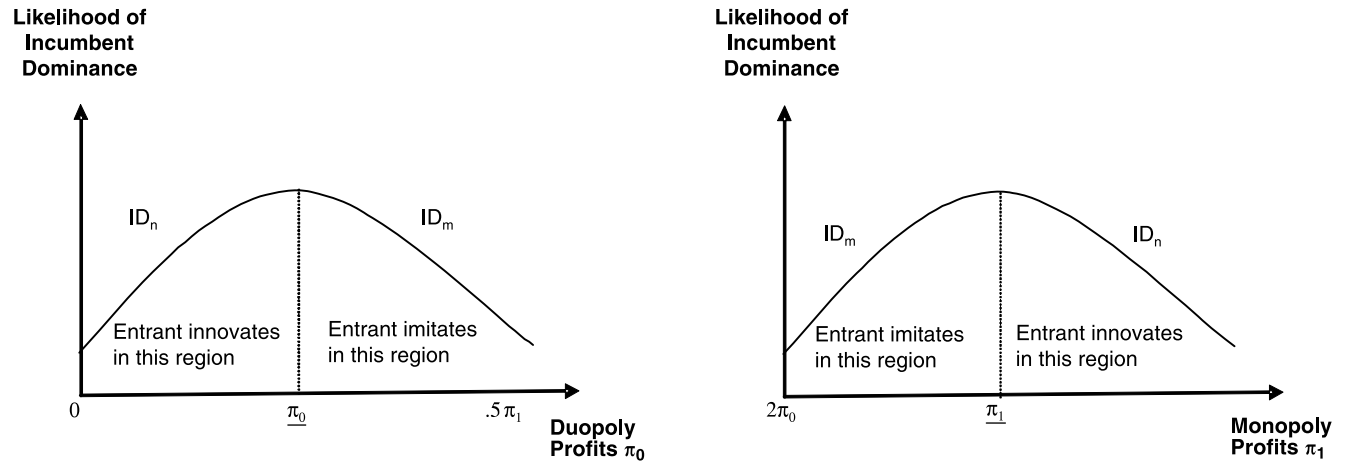


Figure 3
THE CHARACTERISTICS OF MARKET UNCERTAINTY AND MARKET RESEARCH IN OUR MODEL

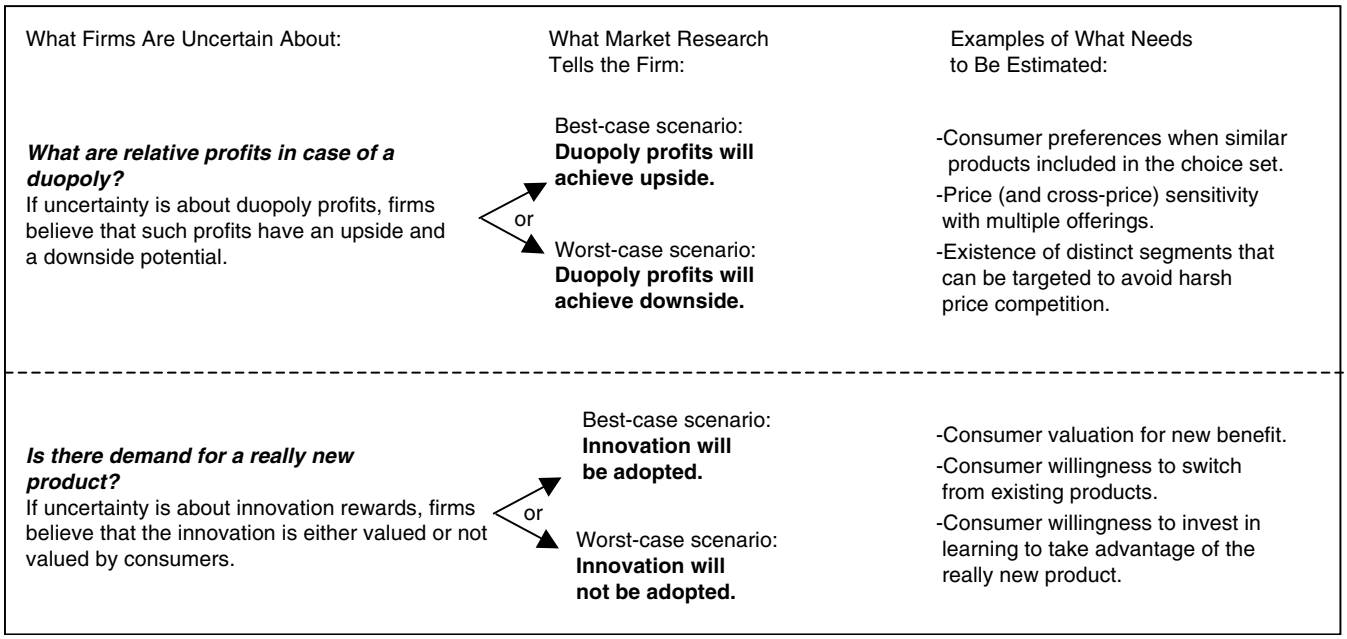


Figure 3 summarizes the characteristics of market uncertainty and market research in our model. As reflected in the figure, we assume that market uncertainty takes a simple form; there is a best-case and a worst-case scenario. By conducting market research, a firm uncovers which of the two scenarios will occur. There is evidence that managers approach market uncertainty, and the associated gains from market research, in a manner that is consistent with this characterization—particularly when the nature of their decision has a "go/no go" flavor (Crawford and DiBenedetto 2003; Urban, Weinberg, and Hauser 1996). In the case of duopoly profit uncertainty, in which the market has been dominated by a monopolist incumbent, it is not clear *ex ante* what profits can be sustained when two equally advanced products are available. Market research examines how consumers react to similar products in their choice set. For example, if consumers in a conjoint study exhibit high cross–price sensitivity (switching from one option to the other with a small price differential in the choice simulator) and if the shift in demand is primarily among two similar options (while demand for a third option remains constant), we assume that this indicates to the firm that the worst-case scenario will happen. Alternatively, if the cross–price sensitivity is discovered to be low or if market research uncovers dimensions (e.g., location, ancillary services, exterior design) that allow differentiation, this indicates to the firm a best-case scenario outcome.[7] In the case of innovation reward uncertainty, market ambiguity pertains to how consumers will react to a really new product (Veryzer 1998). Because really new products offer entirely new benefits and often require significant behavior change relative to existing products, consumer adoption is unclear *ex ante*. Market research examines the importance of the novel benefits to consumers and how averse they are to incurring any switching and learning costs. For example, from a conjoint task in which consumers are first prompted to imagine using the really new product in different situations (Hoeffler 2003), if the responses reveal that the new features are unimportant in relation to existing attributes and expose a low purchase intent, we assume that this indicates to the firm that the worst-case scenario will happen. Alternatively, if the responses reveal that the new features are important and expose a high purchase intent, this indicates that the best-case scenario will happen.[8]

In our analysis, we treat market uncertainty as a random variable that is exogenous to the firms and independent of the internally driven R&D success probabilities (p_a^j). We examine each type of market uncertainty separately. Therefore, when firms are uncertain about duopoly profits, we assume that there is no uncertainty about innovation rewards and that firms know that the innovation will be adopted. For example, consider the microprocessor industry. When Intel introduces a next-generation chip that is much faster and consumes less power, it is fairly certain that the chip will be adopted and render previous generations obsolete. However, what is not obvious is what will happen to prices if AMD introduces a similarly capable processor. Conversely, when firms are uncertain about innovation rewards, we assume that they know how competition will affect duopoly relative to monopoly profits. For example, consider the biotech implant category. When the con-

[7]For an example of a market research application to determine the outcome when a similar (me-too) product is introduced into the set, see Haaijer and colleagues (1998).

[8]For example, car manufacturers in the 1990s were uncertain about consumers' willingness to change their habits and adopt electric vehicles (for a market research application in this context, see Urban, Weinberg, and Hauser 1996).

cept of bioresorbable implants emerged as a possible alternative to metallic implants, there was much uncertainty as to whether physicians would adopt it given their years of experience with the existing solution. However, managers at the incumbent firm Synthes believed that if multiple players developed such an innovation and physicians adopted it, profits would be low (Gourville 2002, 2005). Subsequently, we discuss our assumptions regarding market uncertainty and market research and explain how several of them can be relaxed.

Market Uncertainty About Duopoly Profits

To capture this source of market uncertainty, let $\tilde{\pi}_0$ take on two possible values at the start of the game: $\tilde{\pi}_0 = \pi_{0L}$ in the "low" state (worst-case scenario), which occurs with probability x, and $\tilde{\pi}_0 = \pi_{0H}$ in the "high" state (best-case scenario), which occurs with probability 1 – x, where $x \in (0, 1)$. For simplicity, let $\pi_{0L} = 0$, which implies that in the low state, firms must compete so intensely for demand that profits will be zero.[9] Thus, the entrant would not want to imitate in the low state. The high state reflects the upside potential and can be expressed as $\pi_{0H} \equiv \gamma\pi_1$, $\gamma \in (0, ½]$, where γ is the ratio of upside duopoly to monopoly profits.

When a firm knows the true realization of $\tilde{\pi}_0$ at the start of the game, we call the firm "informed"; otherwise, we refer to them as "uninformed." An uninformed firm's expected payoff expressions are similar to Equations 1 and 2 except that we replace π_0 with $E\tilde{\pi}_0 = (1 - x)\gamma\pi_1$. At the start of the game (t = 0), firms simultaneously decide whether to conduct market research, which comes at a cost of $C_{mr} > 0$ and provides perfect information about the true level of $\tilde{\pi}_0$. Four information structures can arise, as Figure 4 depicts. From t = 1 onward, the game proceeds as it did previously.

We now investigate the equilibrium of the entire game and determine how the decision to conduct market research interacts with the entrant's decision to innovate or imitate. When only the entrant is informed (MR^e, $\overline{MR}^i$), the equilibrium concept used will be Bayesian perfection (Fudenberg and Tirole 1991). If the entrant pursues the same entry strategy regardless of what it discovers through market research, this will constitute a "pooling" equilibrium, and if it pursues a different strategy for each realization of $\tilde{\pi}_0$, this will constitute a "separating" equilibrium.

P_3: For any $x \in (0, 1)$, there is a $\dot{\gamma}(x)$ and a γ_s [$\dot{\gamma}(x) < \gamma_s$] such that the unique perfect Bayesian equilibrium of the entire game satisfies the following:

(a) For $\gamma_s < \gamma$ and when C_{mr} is not too high, only the entrant conducts market research. The entrant innovates if $\tilde{\pi}_0 = \pi_{0L}$ and imitates if $\tilde{\pi}_0 = \pi_{0H}$.

(b) For $\dot{\gamma}(x) < \gamma < \gamma_s$ and when C_{mr} is not too high, only the entrant conducts market research. The entrant innovates if $\tilde{\pi}_0 = \pi_{0L}$ but mixes between imitation and innovation if $\tilde{\pi}_0 = \pi_{0H}$.

(c) For $\gamma < \dot{\gamma}(x)$, neither the entrant nor the incumbent conducts market research, regardless of the cost. The entrant always innovates.

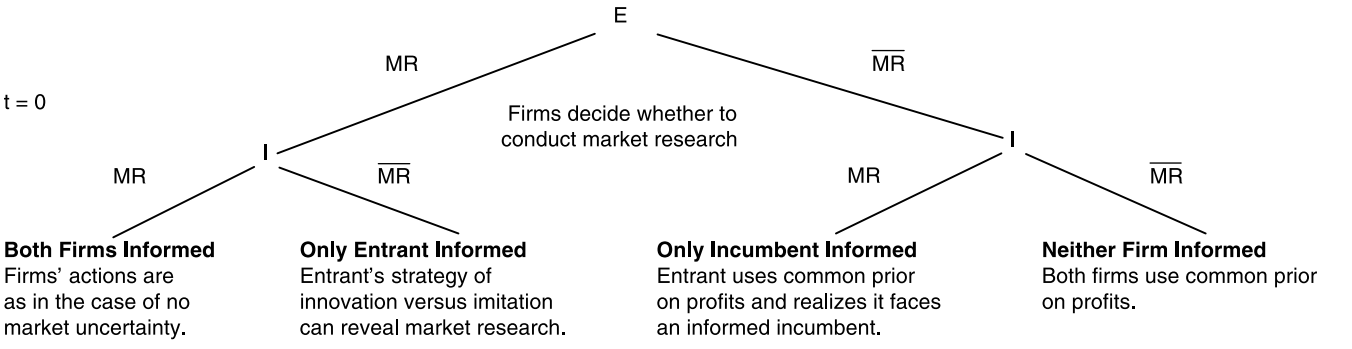
To understand the intuition, it is important to recognize two central considerations that affect firms' incentives to conduct market research: the own-learning benefit and the rival R&D effect. The own-learning benefit is the expected payoff gain to a firm from being able to adjust its R&D actions to the true realization of profits, while holding the competitor's actions constant. The own-learning effect is positive and increases in γ, the ratio of upside duopoly to monopoly profits. This is due to a combination of expectation and variance factors. All else being equal, the greater the γ, the greater are the expected duopoly profits, and an uninformed entrant will tend to imitate (consistent with P_1). Thus, the greater the γ, the more the entrant stands to gain from learning whether duopoly profits are high or low because, in the latter case, it should innovate instead. In addition, all else being equal, the greater the γ, the greater is the difference between the best- and the worst-case duopoly profits (i.e., the variance), and we know from Result 1 that both firms want to adjust their R&D levels to the value of π_0. Thus, the greater the γ, the more dramatic is the R&D adjustment, and the more firms stand to gain from knowing what duopoly profits are.

The rival R&D effect captures the change in a firm's expected payoffs when it decides to conduct market research as a result of the competitor modifying its R&D actions in response. In the case of uncertain duopoly profits, both firms expect their rival to be more aggressive if

[9]Our results hold for $0 < \pi_{0L}$. The only restriction we need is that when the low state materializes, the entrant strictly prefers to innovate. In the "Technical Analyses" section of the Web Appendix (http://www.marketingpower.com/jmroct08), we derive the upper bound on π_{0L} and show that our results are robust for at least the range $\pi_{0L} \in [0, ½\pi_{0H}]$.

Figure 4

INFORMATION STRUCTURE AT T = 0 (MR = CONDUCT MARKET RESEARCH, $\overline{MR}$ = DO NOT CONDUCT)



they conduct market research.[10] In summary, the own-learning benefit encourages firms to conduct market research, whereas the rival R&D effect discourages them from doing so.

In P_{3a}, $\gamma_s < \gamma$, the own-learning benefit for the entrant is the dominant effect. In this region, the returns to choosing imitation if $\tilde{\pi}_0 = \pi_{0H}$ are large for the entrant, but the entrant would definitely want to avoid spending on imitation efforts if $\tilde{\pi}_0 = \pi_{0L}$ (in which case there is no return on the R&D investment). As long as market research is not too costly, the entrant conducts market research, and its choice of innovation or imitation is driven by the information discovered. Consequently, the incumbent can fully infer the true duopoly profit level from the entrant's new product strategy.

In P_{3b}, $\dot{\gamma}(x) < \gamma < \gamma_s$, the entrant conducts market research, and if it finds that duopoly profits are low, it will surely innovate, but even if it finds that duopoly profits are high, it might still innovate. Recall from Result 1 that when the entrant innovates and duopoly profits are known to be high, the incumbent selects an aggressive R&D level, but when duopoly profits are uncertain to the incumbent and it observes an innovating entrant, it will presume that duopoly profits are more likely to be low and choose a nonaggressive R&D level. This is what makes an innovation route attractive for the entrant when it discovers that $\tilde{\pi}_0 = \pi_{0H}$. We highlight that absent an incumbent response, the entrant would imitate if it found that duopoly profits are high in this region and would not mix; thus, the entrant takes into account the information-revealing aspect of its actions.

In P_{3c}, $\gamma < \dot{\gamma}(x)$, the upside potential of duopoly profits is relatively unattractive, and the entrant prefers to innovate even if it knows that the state is high. There is also little variance in duopoly rewards to affect R&D selection substantially. Thus, the own-learning benefit is small for both firms. At the same time, the rival R&D effect is negative and produces a disincentive to conduct market research. Another way to think about this outcome is that if a firm conducts market research in this region, it should bear in mind that the gains from being able to adjust its actions to the true state of demand are limited, but in doing so, it will trigger a stronger R&D response from its rival.

These findings suggest that the entrant's innovation versus imitation decision has important strategic implications when combined with the decision to conduct market research. The entrant needs to take into account the revealing properties of its entry strategy and that by conducting market research, it tends to induce a more aggressive incumbent reaction. As for the incumbent, it must determine whether its rival is informed about future rewards and whether a certain type of entry strategy is indicative of what duopoly profits will be. Only if the upside potential of duopoly profits is deemed to be attractive enough can the incumbent fully free ride on the entrant's market research efforts and become informed by sensing the type of entry strategy pursued. If this is not the case, the incumbent cannot draw a conclusive inference when it observes an entrant that innovates; the entrant may have conducted market research and discovered that duopoly profits are high but chose to pursue innovation so as to soften the incumbent's R&D level.

[10]To explain why and gain more insight into the rival R&D effect, we examine each firm separately. The incumbent views the R&D level of an uninformed entrant as lower than the expected R&D level of an informed entrant. Thus, if the entrant conducts market research, it is perceived as a "tougher" competitor; because of strategic complementarity, the incumbent will select a higher R&D level. In a similar vein, the entrant views the R&D level of an uninformed incumbent as higher than the expected R&D level of an informed incumbent. Thus, if the incumbent conducts market research, it is perceived as a "softer" competitor; because of strategic substitutability, the entrant will select a higher R&D level. We formalize these claims in the "Technical Analyses" section of the Web Appendix (http://www.marketingpower.com/jmroct08).

Market Uncertainty About Really New Products

We now turn to the case in which firms are uncertain whether an innovation will be commercially viable or will totally flop. As we noted, such innovations are often dubbed really new products, and consumer adoption of them is *ex ante* unclear because they offer entirely novel benefits and may require substantial behavior adaptation (Veryzer 1998). To capture this source of market uncertainty in a parsimonious way, we assume that with *ex ante* probability $z \in (0, 1)$, the innovation is not commercially viable (a worst-case scenario of being "not valued" by customers), and a firm can secure positive profits at $t = 3$ only if it possesses the old technology. In this case, if the entrant chooses imitation and its R&D efforts succeed, both firms will earn duopoly profits (π_0); otherwise, the incumbent will keep earning monopoly profits (π_1). With *ex ante* probability $1 - z$, the innovation is commercially viable (a best-case scenario of being "valued" by customers), and a sole innovator will reap monopoly profits, or if both firms succeed in developing the innovation, they will earn duopoly profits. Recall that we now assume no uncertainty in how the market reacts to similar products; thus, firms know duopoly profits (which are taken to be positive), and we continue expressing them as $\pi_0 \equiv \gamma\pi_1$, where γ is the ratio of duopoly to monopoly profits. When innovation is valued, payoffs are identical to those from the basic model (Figure 1), and when innovation is not valued, payoffs are as in Figure 5.

We examine firms' incentives to resolve this type of market uncertainty. Firms simultaneously decide whether to conduct market research at $t = 0$, and again four information structures are possible, as Figure 4 depicts. The following proposition characterizes the equilibrium of the game when C_{mr} is not too high (subsequently, we consider higher market research costs).

P_4: There is a γ_s' and a $\underline{\gamma}$ ($\gamma_s' < \underline{\gamma}$) such that when $0 < C_{mr} < \overline{C}_{mr}$, the unique perfect Bayesian equilibrium of the entire game satisfies the following:

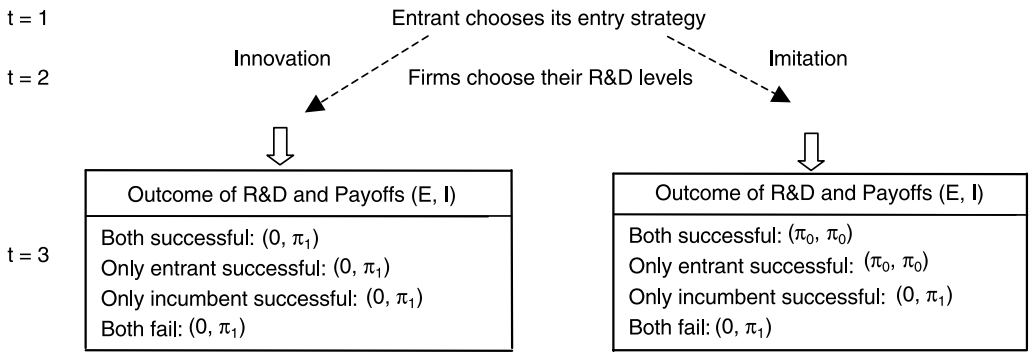
(a) For $\underline{\gamma} < \gamma$, both the entrant and the incumbent conduct market research. The entrant always imitates.

(b) For $\gamma_s' < \gamma < \underline{\gamma}$, both the entrant and the incumbent conduct market research. The entrant innovates if innovation is valued and imitates if otherwise.

(c) For $\gamma < \gamma_s'$, only the entrant conducts market research. The entrant innovates if innovation is valued and imitates if otherwise.

This case differs from that of uncertainty about duopoly profits, most starkly because there is a wide range of parameter values in which the incumbent conducts market research. To explain the intuition, we again decompose the effects of conducting market research into the own-learning benefit and the rival R&D effect. The former is now related

Figure 5
PAYOFFS WHEN THE INNOVATION IS NOT VALUED



to each firm's desire to avoid expending R&D on the innovation if it learns that it is not valued. In this case, the rival R&D effect is positive (i.e., a firm makes its rival less aggressive in R&D by conducting market research); the intuition for this will become clear as we explain each of the subcases.

In P_{4a}, $\underline{\gamma} < \gamma$. To understand why both firms conduct market research, we examine what happens when each firm separately considers deviating. Note that in this relatively high range for γ, the entrant always imitates, so its entry strategy will not reveal any information. Therefore, if the incumbent forgoes market research, it selects a single R&D level. This level is too conservative in the event that the innovation is valued. The informed entrant will respond to this by choosing an aggressive R&D level (due to strategic substitutability). By conducting market research, the incumbent averts this possibility and actually lowers the R&D level of the entrant (i.e., a positive rival R&D effect). Conversely, if the entrant forgoes market research, it believes with probability z that the innovation is not valued, in which case it does not need to worry about the success of the incumbent's efforts. This will lead the imitating entrant to overinvest in R&D (consistent with Result 2). The informed incumbent realizes this and will be induced to set an aggressive R&D level if it learns that the innovation is valued (due to strategic complementarity). Therefore, the entrant is better off conducting market research. These positive rival R&D effects reinforce the positive own-learning benefit of each firm.

In P_{4b}, $\gamma_s' < \gamma < \underline{\gamma}$. In this region, although the entrant conducts market research and its new product strategy is driven by the information learned, the incumbent also conducts market research. We obtain this result because if the incumbent forgoes market research, the entrant will find it optimal to change its new product strategy and imitate so that it does not reveal any information about innovation rewards. By conducting market research, the incumbent can adjust its R&D level to the true state of the world (a positive own-learning benefit) and avoid the entrant's attempt to conceal information to its detriment.

In P_{4c}, $\gamma < \gamma_s'$. In this region, duopoly profits are relatively low, and imitation is a less attractive fall-back option for the entrant. An entrant will want to innovate if it knows that innovation is valued, but it will prefer to imitate otherwise. This produces a large own-learning benefit for the entrant and drives it to conduct market research. Because the entrant's strategy is different depending on what it learns (i.e., a separating equilibrium), the incumbent does not need to incur C_{mr} and can infer whether innovation is valued by observing the entry strategy.

When we reflect more broadly on P_4, two conclusions emerge. First, with market uncertainty about the rewards to a really new product, the incumbent firm wants to be informed at all times. Thus, if the incumbent cannot free ride on the entrant by drawing an inference from the innovation versus imitation decision, it will undertake its own market research. Second, as Figure 6 shows, the conditions for the entry strategy to reveal information to the incumbent are in some sense opposite between the two types of market uncertainty. With duopoly profit uncertainty, the upside duopoly potential must be attractive enough to prompt the entrant to undertake market research and act in a revealing way, whereas with innovation reward uncertainty, duopoly profits must be relatively unattractive for this to occur.

The findings in P_4 hold as long as market research is not prohibitively costly; otherwise, neither firm would expend the resources necessary to become informed. Thus, in P_{4a} and P_{4b}, the question is, Which firm drops out first and forgoes market research as costs increase beyond $\overline{C}_{mr}$? The next result provides the answer.

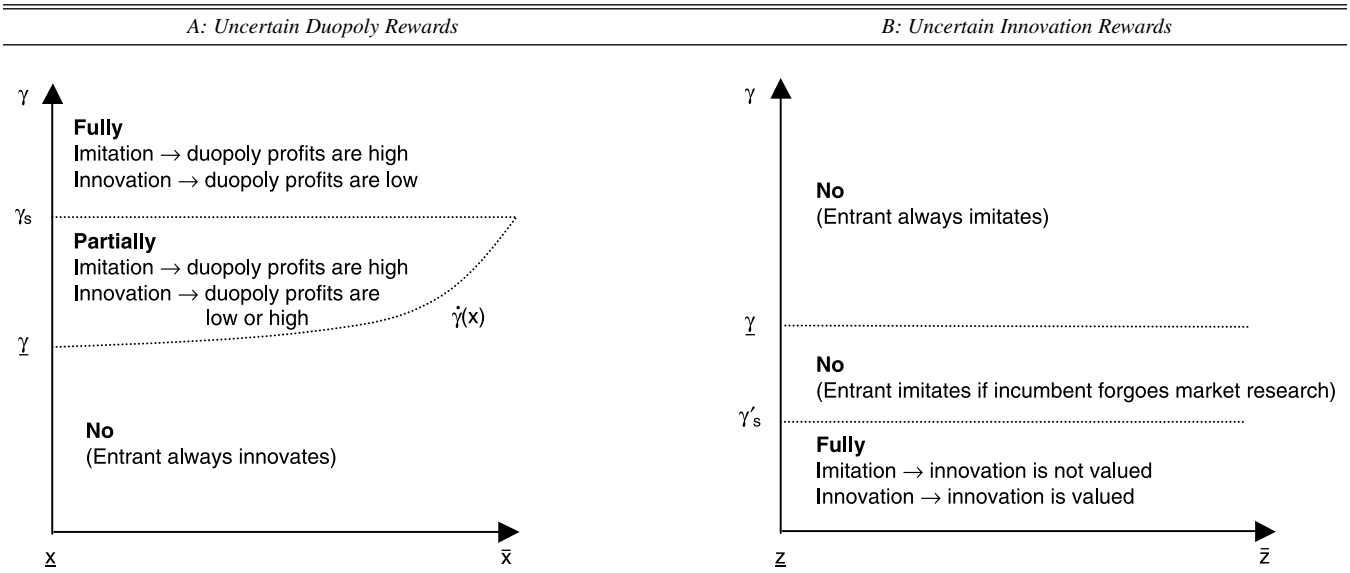
Result 3: When $\gamma_s' < \gamma$, the incumbent conducts market research at higher cost levels (i.e., the entrant drops out first).

The intuition for this result is that the entrant tends to imitate when $\gamma_s' < \gamma$ (attractive duopoly profits) and to choose a high R&D level. An uninformed incumbent is prompted to react with an aggressive R&D level (per P_2), but this effort is entirely wasted if innovation is not valued. Thus, the incumbent has a higher own-learning benefit from market research.

Do Firms Care Whether Rivals Conduct Market Research? External Support for Assumptions on Firms' Strategic Considerations

In this section, we analyze the strategic implications of firms conducting market research relevant for new product planning. Our analysis is based on the nontrivial premise that when making NPD decisions, firms consider how

Figure 6
DOES THE ENTRY STRATEGY REVEAL INFORMATION ABOUT FUTURE REWARDS?



γ = ratio of duopoly to monopoly profits (π_{0H}/π_1 or π_0/π_1)
x = probability that duopoly profits are low ($0 < \underline{x} < .5 < \bar{x} < 1$)
z = probability that commercial potential for innovation is low ($0 < \underline{z} < .5 < \bar{z} < 1$)

informed their rival is regarding the potential rewards from new products (and vice versa, rivals consider how informed they are). To examine whether this premise is realistic and reflects actual managerial behavior, we administered a survey. The goal of the survey was to test whether firms believe that market research by their rival has strategic relevance, whether they draw inferences from their rival's actions regarding the results of market research, and whether the direction of the inferences is consistent with our model suppositions. The survey was sent to 94 managers involved in new product activity in their respective companies. These managers participated in an executive education course on the marketing of innovative technologies at a major U.S. business school. The survey was conducted online through a secure Web site, and participants were offered a gift worth $25 as compensation. Participants were told that the survey was part of research intended to understand managerial decision making in NPD, that there were no right or wrong answers, and that they should answer to the best of their knowledge and industry experience. We received 53 completed online forms (a response rate of 56.4%).[11] In the Web Appendix (http://www.marketingpower.com/jmroct08), we provide more details on the profile of participants and the survey questions (see the section "Support for the Model and Its Findings").

The first few questions were general in nature. Respondents were asked to consider how often firms conduct market research as part of NPD (Q1) and were prompted to list market research activities that could inform different types of profitability assessments (Q2 and Q3). Of the 53 respondents, 50 (>90%) articulated specific market research activities, attesting to the relevance of such research for NPD when it comes to innovation and imitation situations. We classify the responses to the remaining questions into two areas.

The importance of strategic considerations around market research in NPD. Of the respondents, 71.7% indicated that their firm should care whether rivals base new product plans on extensive market research (Q5), which was significantly greater than the 28.3% who reported that their firm should not care ($\chi^2 = 9.98$, $p < .01$, using a binomial test for proportions; Snedecor and Cochran 1989).[12] Of those who responded that their firm should care, more than half (41% of the entire sample) specifically indicated that rival plans are more worrisome when they are based on market research. After responding to several other questions, survey participants were probed again on this issue but from the reverse standpoint of being the informed firm (Q9). A majority of respondents indicated that they should care whether rivals know that their firm's new product plans are based on extensive market research. In particular, 66% agreed with the statement that they would care because this

[11]Analysis of early and late responses (Armstrong and Overton 1977) did not reveal significant differences. We pretested the survey with executives to ensure that the questions were intuitive and nonconfusing.

[12]We reflect on the notion that not all respondents indicated that their firm should care about rivals' market research. In some cases, this could be due to firms presuming that their rivals will not conduct such research, either because it is prohibitively costly or, consistent with our analysis, because rivals have a lower incentive to conduct market research than they do. Note also that 22.6% of the responses to Q1 of the survey indicated that firms conduct market research in connection with NPD less than 25% of the time. Therefore, managers in these situations may not be concerned about the issue. Finally, the possibility that some respondents were not familiar enough with this particular aspect of NPD cannot be ruled out.

might cause rivals to be more concerned and affect rivals' actions directly, and 79.2% agreed that they would care because rivals would draw inferences from their NPD strategy. These percentages are statistically greater ($p < .01$) than 11.3%, the percentage of respondents who indicated that their firm should not care whether rivals know about their market research.

Market research and drawing strategic inferences. The survey probed whether incumbent firms consider updating beliefs about uncertain rewards on the basis of the new product strategy of entrants. A majority of respondents indicated that if an entrant emphasizes market research, observing its new product plans would cause them to think differently about expected rewards in a manner consistent with our model. This was true in the case of both innovative entry, regarding a higher perception of the market potential for a novel product (60.4%, Q6), and imitative entry, regarding the perception of higher duopoly profits (77.4%, Q7).[13]

The survey also examined the incumbent's desire to conduct market research when facing an entrant that has conducted such research (Q8). More than two-thirds of respondents (67.9%) indicated that knowing the entrant's NPD strategy enables them to infer the results of market research. Furthermore, 47.2% agreed with the statement that as an incumbent, they would find it necessary to conduct market research only if they could not learn what new product strategy the entrant was pursuing, compared with 20.8% who agreed with the statement that they should unconditionally conduct market research ($t = 2.81$, $p < .01$, using a paired t-test). Despite the limitations of our survey, we believe that having 53 managers respond in a way that is consistent with our key assumptions on firm behavior lends support to the underpinnings of our model and the strategic considerations involved.

[13]In both questions, the number of respondents who replied in a manner consistent with beliefs being updated upward was statistically significant compared with the number who reported that they would update downward or to the number who indicated no change (at the 1% and 5% levels, respectively, using the appropriate chi-square test).

RELAXING MODEL ASSUMPTIONS AND LIMITATIONS

In our model setup, we made various assumptions. Some were made for convenience, and relaxing them would not change the nature of our findings but would complicate the analysis; others were made to best reflect the problem we wanted to study. Table 1 summarizes the main modeling assumptions and specifies how we relaxed them or whether they are binding (i.e., essential for the results reported in the article to hold). We briefly discuss the implications of relaxing the nonbinding assumptions (for complete details, see the "Technical Analyses" section of the Web Appendix at http://www.marketingpower.com/jmroct08) and provide justification for the binding ones.

Innovation Does Not Increase Attainable Profits

We assumed that a firm's profits are determined by whether it possesses a superior, a similar, or an inferior product to its rival. Thus, if the entrant and incumbent have equally advanced products, either because the entrant imitated and the incumbent failed to innovate or because both innovated successfully, the same duopoly profits would apply. This formulation is consistent with many articles in the literature on innovation (theoretical and empirical; e.g., Aghion et al. 2005; Grossman and Helpman 1991) and arises in many commonly used demand structures (see Budd, Harris, and Vickers 1993, pp. 543–44). However, it is conceivable that when an innovation is introduced, it expands demand considerably or enables the firm to charge much higher premiums so that profit levels are different under the two entry strategies. We extend the model so that when a firm successfully innovates, it earns profits of $\delta\pi_1$ as a monopolist and $\delta\pi_0$ as a duopolist, $\delta \geq 1$. We find that when $1 \leq \delta < \pi_1/(\pi_1 - \pi_0)$, all our results are qualitatively unaffected because R&D levels continue to form strategic complements for the incumbent. When $\pi_1/(\pi_1 - \pi_0) \leq \delta$, for both firms, R&D levels form strategic substitutes, but the entrant's strategic effect is more negative. Thus, although some comparative statistics need to be qualified, we can still support all our conclusions, including those under market uncertainty, in certain regions of the parameter space.

Table 1
MODEL ASSUMPTIONS

Basic Model	*How to Relax the Assumption*
1. Innovation does not increase attainable profits.	Profit levels are higher under innovation than imitation by a factor of $\delta > 1$, $\{\delta\pi_1, \delta\pi_0\}$.
2. Firms receive the same duopoly profits.	The incumbent has an advantage in duopoly profits: $\pi_0^i > \pi_0^e$.
3. The entrant cannot produce an imitative product if it fails to innovate.	If the entrant fails to innovate, it produces an imitation with a probability of σ.
4. Firms have equal R&D capabilities.	The incumbent has better innovation R&D capabilities than the entrant: $\eta^i < \eta^e$.
5. The R&D cost function is convex.	Binding
6. Capital markets are efficient.	Binding
Model with Market Uncertainty	
7. The decision to conduct market research is observable.	Market research decision is unobservable; firms can be secretive or overt about market research.
8. The entrant's new product strategy is observable.	The entrant's decision to innovate or imitate is unobservable.
9. R&D investments are one shot and unobservable.	R&D investments are dynamic and observable.
10. As γ increases, the expected value and variance of duopoly profits increase.	Two extensions: (1) $E(\tilde{\pi}_0)$ constant as $V(\tilde{\pi}_0)$ increases, and (2) $V(\tilde{\pi}_0)$ constant as $E(\tilde{\pi}_0)$ increases.
11. Market uncertainty and technology uncertainty are independent.	Binding
12. Market research is accurate, and its scope of discovery is bounded.	Binding

Firms Receive the Same Duopoly Profits

We made this assumption for simplicity, and it reflects situations in which there are no incumbent advantages. In an extension, we incorporated a parameter $u \in [1, 2]$ that measures the degree of incumbent duopoly advantage, such that $\pi_0^i = u\pi_0$ and $\pi_0^e = (2 - u)\pi_0$. The analysis reveals that the R&D competitive responsiveness is exactly as in P_2 $\forall u$ and that, with market uncertainty, we obtain the same outcomes as in P_3 and P_4 if u is not too large. If $u \to 2$, we can get a new type of equilibrium in which only the incumbent conducts market research as a result of a high own-learning benefit.

The Entrant Cannot Produce an Imitative Product if It Fails to Innovate

We treated innovation and imitation efforts as different in nature. This is reasonable when innovation requires novel development processes so that know-how gained from attempting innovation cannot be used to imitate. To relax this assumption, we let $0 \le \sigma \le 1$ be the probability that the entrant can introduce an imitative product given that it has attempted innovation. When σ is not too high, all our findings hold (by continuity). As σ increases, the entrant finds innovation more appealing because imitation rewards are virtually guaranteed, and the firms' payoff expressions become similar ($EV_n^e \underset{\sigma \to 1}{\to} EV_n^i$). Consequently, the two firms will have the same competitive responsiveness, and changes in the model parameters will have the same effect on both. Because the entrant only considers innovation as $\sigma \to 1$, there is no signaling value to its new product plans (but also no entry strategy dilemma, which is the focus of this article).

Firms Have Equal R&D Capabilities

For simplicity, we assumed no asymmetries in the innovation cost factor (η) across firms. Indeed, the common R&D cost factor can be interpreted as reflecting the access of all firms to the same basic research (from universities or government institutions) or to general purpose technologies (Bresnahan and Trajtenberg 1995) that dictate a common difficulty associated with development. If we assume that the incumbent has an R&D advantage for innovation ($\eta^i < \eta^e$), the entrant is more inclined to imitate than in our setup. However, none of our findings are qualitatively affected.

The R&D Cost Function Is Convex

This assumption reflects diminishing returns to engineering effort. It is justified when larger R&D teams face more coordination issues or because finding relevant personnel becomes increasingly difficult. This cost assumption also guarantees that the second-order conditions are met for an interior equilibrium solution for the R&D levels.

Capital Markets Are Efficient

We assumed that firms have access to funds for carrying out their decisions. If firms need external sources of funding, we are implicitly assuming that the financial community recognizes the potential return on investment and is willing to provide the optimal resources. However, if a firm's ability to undertake new product effort is private information, it might need to demonstrate some significant progress in R&D before receiving such external funding. Incorporating these strategic financial aspects would require significant changes to the model setup (e.g., the inclusion of more stages to the game, additional strategic players, a consideration of the signaling aspects of financing amount on R&D capability). Such an analysis might qualify some of our findings; we leave this for further research.[14]

The Decision to Conduct Market Research Is Observable

If firms are equally capable of conducting and funding market research, relaxing the observability assumption has no impact on our findings, because firms will correctly conjecture in any equilibrium whether their rival has conducted market research. However, if firms are not equally capable (e.g., because of differences in their marketing skills, because of managerial prioritization) and market research competence is private information, the unobservability of market research raises a worthwhile extension. In particular, we added a stage in which a firm decides whether to be secretive or overt about its market research efforts. A firm has either weak or strong market research competence, corresponding to high or low costs. A firm can conduct market research only if its costs are low. We find that with uncertainty about duopoly profits, firms prefer to be secretive, but with uncertainty about innovation rewards, firms prefer to be overt. The reason for this behavior is in line with our intuitions in P_3 and P_4. If the rival becomes more aggressive because it knows that the firm is informed (negative rival R&D effect), the firm is better off keeping this a secret. Thus, by being secretive, a firm may find it beneficial to conduct market research even when the upside potential of duopoly profits is relatively unattractive [$\gamma < \hat{\gamma}(x)$]. Conversely, if the rival becomes less aggressive because it knows that the firm is informed (positive rival R&D effect), the firm should publicize having conducted market research.

The Entrant's New Product Strategy Is Observable

This assumption is reasonable because many predevelopment activities are visible (e.g., building research labs, hiring specific personnel, acquisitions), and firms often preannounce their product roadmaps (Eliashberg and Robertson 1988; Mohr, Sengupta, and Slater 2005). Rapid leakage of NPD plans across firms has also been shown empirically (Mansfield 1985). We relaxed this assumption as follows: Firms do not observe any of their rivals' previous actions when they reach $t = 2$ and must form beliefs about them (that are correct in equilibrium). We find that with both types of market uncertainty, if C_{mr} is small enough, both firms will conduct market research $\forall\gamma$; otherwise, the equilibrium outcomes in terms of conducting market research are similar to those in P_3 and P_4.

R&D Investments Are One Shot and Unobservable

We made this assumption for simplicity. If firms make observable R&D decisions across multiple periods, their prior investments can signal what they have learned from market research. In an extension, we analyzed the case in which R&D is undertaken in two consecutive periods. We find that any R&D signaling implications have only a

[14]We thank an anonymous reviewer for pointing out this issue. We thank the editor for asking us to consider the extension described in the next item on firms' desire to keep market research efforts secret or overt.

second-order effect and do not qualitatively change our findings.

As γ Increases, the Expected Value and Variance of Duopoly Profits Increase

In an extension of the uncertain duopoly case, we show that if the expected value of $\tilde{\pi}_0$ is constant, for low variance, neither firm conducts market research, and for high variance, only the entrant does. Separately, we show that if the variance of $\tilde{\pi}_0$ is constant, for low expected value, neither firm conducts market research, and for high expected value, only the entrant does. These models are much more complex because they require π_{0H} and π_{0L} to move in a specific pattern (that may be a function of x) and also require minimal levels of expected value and variance. Thus, our structure delivers the same insights and is more parsimonious.

Market Uncertainty and Technology Uncertainty Are Independent

This captures the notion that whether the firm's engineers manage to develop a new product does not govern the market demand for it. Our characterization is in line with how managers evaluate R&D projects. For example, Mansfield and Wagner (1975) survey managers and distinguish between the probability of technical completion (corresponding to our probability of R&D success) and the probability of economic success (corresponding to our probability that duopoly profits are high or that innovation is valued). Our assumption is also consistent with "Tier 3" R&D, as described in the work of Hauser (1998), whose research is based on field interviews.

Market Research Yields Accurate Information, and Its Scope of Discovery Is Bounded

For simplicity, we assumed that market research perfectly informs firms about the reward structure. For our findings to hold, market research should be accurate enough so that firms sufficiently trust it and adjust their actions when the results indicate a best-case versus worst-case scenario. However, in practice, market research can be noisy. When duopoly profits are uncertain, there is an issue of consumers not being used to choosing among multiple competing options or to prices that differ from those in the marketplace today. As a result, participants' responses, for example to a conjoint task, could be unreliable in such instances. There are also challenges in picking up the relevant effects, requiring the researcher to construct the studies carefully by including appropriate options and employing suitable estimation methods.[15] When the rewards to a really new product are uncertain, consumers' willingness to pay for novel benefits and to incur switching costs may be difficult to gauge before actual launch. Although recent advances in the field provide promising ways to overcome these challenges (Hoeffler 2003; Urban, Weinberg, and Hauser 1996), market research may still be inaccurate in some instances.

We also assumed that firms approach market research with a sense of what the best- and worst-case scenarios are (see Figure 3). This simplified the analysis and reflects situations in which firms grasp the scope of possible outcomes but are not sure which is correct (e.g., which of two industry reports making divergent predictions is true). However, in reality, market research may uncover factors that were not originally conceived and yield estimates that over- or undershoot firms' prior. For example, if market research defines new segments that were not considered, firms may be able to partition consumers in a way that results in higher duopoly profits than the initial upside potential was believed to be. To capture such effects, more market research outcomes than we have assumed need to be included, and firms should possibly be allowed to conduct different types of market research. This is a worthwhile extension for further research.

DISCUSSION OF MODEL IMPLICATIONS AND CONCLUSION

A market dominated by an incumbent firm is ripe for challenging entrants. A major business dilemma such entrants face is whether to direct R&D efforts toward delivering an innovative new product or to set sights more conservatively on the imitation of current offerings. Navigating this dilemma involves accounting not only for the inherent R&D uncertainties but also for the market-related uncertainties and the desire to resolve them through market research. At the same time, incumbents need to anticipate, interpret, and react to entrant behavior if they want to sustain their industry position. Our findings offer several important implications for firms in this context.

Main Managerial Conclusions and Examples

A central issue we analyzed is how the type of market uncertainty firms face affects their actions in the new product planning phase. Tables 2 and 3 summarize the managerial implications of our analysis for each type of market uncertainty, respectively. The tables give entrants guidance on when to select a strategy of innovation or imitation and in what way this is based on market research. In turn, they give incumbents advice on whether they can draw inferences about the market rewards from the entrant's new product strategy, that is, guidance on when they can free ride on the entrant's market research efforts. We highlight the key managerial takeaways from the tables and present anecdotal examples to illustrate their real-world relevance. Additional examples based on field interviews appear in the Web Appendix (http://www.marketingpower.com/jmroct08) and are classified according to their connection to the model findings (see the section there on "Support for the Model Assumptions and Its Findings").

Market uncertainty about duopoly profits (Table 2). When firms face this type of uncertainty and the upside potential of duopoly profits (i.e., in a best-case scenario) is attractive enough relative to monopoly profits, there is great benefit for the entrant in conducting market research

[15]We thank Bryan Orme of Sawtooth Software Inc. for his input on this matter. Huber, Orme, and Miller (1999) provide an excellent discussion of what properties a choice simulator should have to be able to assess the impact of similar products in the set. In particular, the simulator should display differential substitution (i.e., allow a new offering to take disproportionate share from a similar alternative rather than other options) and differential enhancement (i.e., allow pairs of similar options to be sensitive to small differences between them). Huber, Orme, and Miller also provide a technique (randomized first choice) to account for these effects.

Table 2
MANAGERIAL IMPLICATIONS: FIRMS FACE MARKET UNCERTAINTY ABOUT DUOPOLY PROFITS

	If Upside Potential of Duopoly Relative to Monopoly Profits Is … (i.e., if Duopoly Profits in the Best-Case Scenario Are ...)		
	Very Attractive	*Moderately Attractive*	*Unattractive*
Entrant	Yes	Yes	No
Will market research affect my entry strategy?			
Should I innovate or imitate?	If learn duopoly profits high ⇒ imitate low ⇒ innovate	If learn duopoly profits high ⇒ imitate or consider innovate (to conceal) low ⇒ innovate	Always innovate
Incumbent	Yes. If entrant imitates ⇒ high innovates ⇒ low	Yes (partially). If entrant imitates ⇒ high innovates ⇒ low or high	No
Can I draw an inference from the entry strategy about duopoly profits?			
Do I learn more information if I conduct market research?	No	Only if entrant innovates (if I conduct market research, entrant sets aggressive R&D)	Yes

because the findings will affect its entry strategy.[16] If the information the entrant learns confirms the optimistic scenario and imitation is pursued, the incumbent can infer that duopoly profits are definitely high. Conversely, if the information the entrant learns substantiates the pessimistic scenario, innovation should be pursued. The incumbent can infer from this that duopoly profits are likely to be low (and this inference is more conclusive the more attractive the upside potential was believed to be). We give two examples consistent with these prescriptions.

The first is the Cypress Semiconductor example we mentioned previously. Cypress management believed that the RF clock market would continue to grow rapidly in the early 2000s (Murphy 2000). This suggested a high upside potential for duopoly profits as long as prices remained relatively stable with multiple suppliers (which was the source of uncertainty). After market research indicated a favorable outlook, the firm publicly announced plans to introduce an RF clock of similar configuration to that offered by National Semiconductor. The second example is SAP, a global enterprise software firm. In 2005, SAP considered entry into the mobile applications market (e.g., laptops, global positioning system–enabled devices) dominated by Siebel. Despite the competition, management believed that healthy duopoly profits could be sustained if customers that had not yet adopted were interested in mobile software applications (Robbins 2005); this led to an initial assessment of moderate to high upside potential for duopoly profits and prompted SAP to conduct an extensive survey of potential users through IDC.

At the other extreme (the right-most column of Table 2), if under a best-case scenario duopoly profits are relatively unattractive, an incumbent that senses an innovating entrant should not draw any inference regarding duopoly profits. This is because the entrant will innovate regardless of what it learns through market research. That said, a firm should realize that conducting market research causes its rival to be more aggressive, and this can affect the net benefit from being informed. If possible, a firm should try to conceal its market research efforts. Some evidence for this was provided by the president of Sawtooth Software Inc. (Bryan Orme), who indicated that when firms commission conjoint studies for analyzing market reaction to innovations that will compete in a similar space, they tend to request strict secrecy about conducting these studies.

Market uncertainty about the profitability of a really new product (Table 3). In this case, firms should ask whether duopoly profits are relatively attractive. If so, the entrant should imitate. The incumbent needs to realize that it cannot infer anything from the entry strategy and should conduct its own market research to learn the commercial value of the really new product. Conversely, if duopoly profits are regarded as relatively unattractive, the entrant should conduct market research and base its new product strategy on the information learned. Consequently, the incumbent can draw an accurate inference from the innovation–imitation decision. We offer two examples consistent with these prescriptions.

The software division of Rockwell Automation was considering the development of new simulation software for manufacturing processes, but it was unsure whether customers would place enough value on it and upgrade their existing software. The company had been the dominant provider of such simulation solutions at the time, but it was concerned about possible imitation by rivals. From the firm's experience with software applications previously launched in this market, it knew that different end-user segments could be targeted. Thus, duopoly profits were assumed to be relatively high whenever similarly advanced solutions were offered. Rockwell believed that it was imperative to understand the return on the novel simulation concept before committing resources and thus hired an external firm to field an extensive market survey (Bapat 2006). Note that because duopoly profits were considered relatively high, rival plans to imitate were not a strong signal to Rockwell that the innovative simulator would not be

[16]In our discussions with managers, the following circumstances lead firms to believe that the upside potential of duopoly profits is attractive: The incumbent's revenues have exhibited year-on-year growth, the incumbent's success with the existing product is linked to a customer trend that is gaining momentum (e.g., clients' need to upgrade old equipment), the incumbent accommodated entry in related markets in the past (e.g., did not initiate fierce price wars), and the firms identified sizable customer segments that have not yet been targeted.

Table 3
MANAGERIAL IMPLICATIONS: FIRMS FACE MARKET UNCERTAINTY ABOUT INNOVATION REWARDS

	If Duopoly Profits Relative to Monopoly Profits Are …		
	Very Attractive	*Moderately Attractive*	*Unattractive*
Entrant	No	Yes	Yes
Will market research affect my entry strategy?			
Should I innovate or imitate?	Always imitate	If learn innovation is valued ⇒ innovate not valued ⇒ imitate	If learn innovation is valued ⇒ innovate not valued ⇒ imitate
Incumbent	No	No (if I forgo market research, entrant imitates)	Yes. If entrant imitates ⇒ not valued innovates ⇒ valued
Can I draw an inference from the entry strategy about innovation rewards?			
Do I learn more information if I conduct market research?	Yes	Yes	No

valued. In another example, in 2002, Cisco was set to enter the network storage market and planned to offer an innovative solution that tapped into a client's local area network (LAN). The leading solutions at the time were based on creating a dedicated network, separate from the LAN, called SAN (storage area network). Brocade, a dominant SAN switch provider at the time, learned of these plans from customers who had been polled by Cisco about the new approach (Buiocchi 2005). The incumbent Brocade had been skeptical about demand for a LAN-based solution, but after learning that these were Cisco's entry plans and that they were based on customer input, Brocade also decided to develop LAN-based switches. Furthermore, the perception was that duopoly profits would be relatively low because of modest market growth (resulting from the information technology slump after the dot-com bust) and because fierce price competition with Cisco could be anticipated.

Implications for MO and Order-of-Entry Effects

MO and NPD. The marketing literature has devoted much attention to the MO concept, which encompasses two primary subconstructs: customer orientation and competitor orientation. These pertain to the gathering, dissemination, and strategic use of information about customer needs and about competitors' capabilities and actions, respectively (Kohli and Jaworski 1990). It has been proposed that NPD is a specific business activity for which MO can engender superior commercial performance (Slater and Narver 1994), and technology orientation, which reflects investment in technological know-how, is typically also measured. Our findings have three main implications for this stream. First, we show that a firm's industry position—incumbent or entrant—matters for the incentives to engage in market research and, thus, to adopt a customer-oriented approach to NPD. We further show that a competitor orientation can have an additional benefit for an incumbent, enabling it to draw inferences from the type of entry about expected rewards. This suggests that MO studies in NPD contexts should control for a firm's industry position and examine when an optimal reaction to a customer-oriented rival is to be competitor oriented. Second, we found that when a firm conducts market research, its rival may become more aggressive in R&D. This indicates that a technology orientation may be an optimal reaction to a customer-oriented firm, reinforcing the point that it may be misleading to prescribe a specific orientation to all firms in a given context (as is common in this literature). Further research could allow for multiple orientations and consider factors that moderate the desire of all firms to adopt the same orientation. Third, our findings show that the desire to engage in customer-oriented activities can depend on the type of market uncertainty firms face. The extant literature (e.g., Gatignon and Xuereb 1997) has not controlled for the source of market uncertainty. In summary, our work can help guide further research and managerial implications in this promising area of linking MO and NPD.

Incumbent dominance and order-of-entry effects. A question that has garnered much attention in both marketing and strategy is whether a firm that attains market leadership with a current offering is likely to stay in the lead over time (for a review, see Chandy and Tellis 2000). For this context, our analysis underscores the need to account for the specific strategy of later entrants—that is, innovation or imitation. This entry decision affects firms' incentives to undertake subsequent actions (e.g., R&D) that in turn affect the likelihood of incumbent dominance. This brings up two issues. First, our findings shed light on the impact of various factors—profit levels, development costs, and type of market uncertainty. For example, according to P_1 and Result 1, there should be a positive correlation between duopoly profits and incumbent dominance if entrants pursue innovation, whereas the reverse should be true if entrants pursue imitation (see the inverted U-shaped pattern in Figure 2). According to P_3, when there is market uncertainty about duopoly rewards, we can expect less incumbent dominance because entrants tend to innovate and set aggressive R&D agendas.

Second, our findings are relevant for work on order-of-entry effects. In their seminal work, Lieberman and Montgomery (1988) distinguish between different modes of later entry and warn pioneer managers to be wary of imitators on the one hand and the possibility of being leapfrogged by innovating entrants on the other hand. Kerin, Varadarajan, and Peterson (1992) echo these issues and add that entrants must consider both innovation and imitation as viable strategies. However, this literature does not explain when to expect each of these entry strategies. Thus, our findings

across P_1–P_4 have concrete implications for this stream because we (1) endogenize the entry strategy and provide clear intuition on when to expect imitation versus innovation and (2) establish how aggressively each firm should pursue NPD.

In their recent review, Hauser, Tellis, and Griffin (2006) emphasize that product development success depends on a combined understanding of customers, technology, and competition. They also devote an entire section to the topic of strategic market entry and incumbent defense. We believe that our work brings together these three critical aspects of product development and sheds new light on how they shape the behavior of different industry players. Our findings offer managers contemplating entry into new markets or those defending their leadership position valuable insights into the actions they should undertake and on what to expect from competitors.

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