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Author(s): Rajesh K. Chandy, Jaideep C. Prabhu and Kersi D. Antia

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What Will the Future Bring? Dominance, Technology Expectations, and Radical Innovation

Are dominant firms laggards or leaders at innovation? The answers to this question are conflicting and controversial. In an attempt to resolve conflicting answers to this question, the authors argue that dominance is a multifaceted construct in which individual facets result in differing (and countervailing) propensities to innovate. To identify the overall effects of dominance, it is necessary to consider the effects of these facets taken together. The authors also study a hitherto ignored yet important driver of innovation, technology expectations, and show that managers have widely divergent expectations of the same new technology. Furthermore, even when their expectations are the same, managers of dominant firms display investment behavior at odds with their counterparts at nondominant firms. The authors use a triangulation of research methods and combine insights from lab studies with those from field interviews, archival data, and a survey of bricks-and-mortar banks' responses to Internet banking.

The relationship between dominance and innovation is one of enduring (and renewed) interest to scholars in marketing, corporate strategy, economics, and sociology, among other fields (Cooper and Schendel 1976; Henderson 1993; Miller 1990; Scherer 1992; Schumpeter 1942). The prognosis from this research has mostly been gloomy, albeit with a hint of hope. First, the gloomy part: Many scholars note that as firms become more dominant, they become more wedded to the status quo and reluctant to embrace radically new products (e.g., Cooper and Schendel 1976; Henderson 1993; Schumpeter 1942). Incremental improvements become firms' preferred mode of action, and dominant firms either spurn radical innovations or, at best, leave them to collect dust on laboratory shelves (e.g., Utterback 1994). As the technological environment turns on the dominant firms, their reluctance to pursue radically new products eventually leads to their weakening and downfall. Dominant firms' very success sows the seeds of their failure. For this reason, some scholars have compared dominant firms to Icarus, the tragic figure from Greek mythology whose success at flying to great heights led to his death

when the sun melted his wings and he plunged into the sea (Miller 1990).

However, reality does not always adhere to the plot of a Greek tragedy; there are some reasons for hope. As Cohen and Levin (1989, p. 1078) state in an extensive review of the literature, the results linking dominance and innovation "are perhaps most accurately described as fragile." Followers of a more recent school of thought note that dominant firms do enjoy some important advantages. For example, dominant firms have greater access to resources, which is a key advantage in trying to build and sustain radically new technologies and markets. Some recent research suggests that large and incumbent firms are often some of the most aggressive radical innovators (e.g., Chandy and Tellis 2000; Zucker and Darby 1997). A casual glance at business periodicals reveals that many dominant firms actively pursue such new technologies and are relatively successful in doing so. What explains this performance? Little is known about why some dominant firms pursue radical innovations aggressively and others do not.

We attempt to reconcile the opposing views on the relationship between dominance and radical innovation. We consider dominance a composite of several facets, each with different and countervailing behavioral effects on firms' propensity to innovate. This viewpoint is in contrast to existing research, which (1) has typically equated dominance with related though conceptually distinct proxies, such as firm size and incumbency, and (2) has rarely integrated the different facets of dominance to assess its overall effect on radical innovation. By examining the behavioral consequences of each facet of dominance and the combined effects of these facets taken together, we attempt to provide a clearer understanding of the relationship between dominance and innovation, something that researchers in the field have repeatedly called for (e.g., Scherer 1992).

Rajesh K. Chandy is Assistant Professor of Marketing, Carlson School of Management, University of Minnesota. Jaideep C. Prabhu is Assistant Professor of Marketing, Judge Institute of Management, University of Cambridge. Kersi D. Antia is Assistant Professor of Marketing and Earl H. Orser/London Life Faculty Fellow, Richard Ivey School of Business, University of Western Ontario. This research was supported by a grant from the Marketing Science Institute. The authors thank Raul Rivadeneyra, Bharat Sud, and Pratik Sharma for help with data collection; Kathy Jocz for help in securing access to managers; and Don Barclay, Mark Bergen, Ed Blair, Niraj Dawar, Raj Echambadi, Robert Fisher, Yany Gregoire, Brigitte Hopstaken, Mike Houston, George John, Eli Jones, Akshay Rao, Gerry Tellis, Mark Vandembosch, Eden Yin, and participants at seminars at University of Houston, University of Central Florida, and University of Minnesota for their valuable input.

We argue that there is another, hitherto overlooked, reason some dominant firms invest aggressively in radical innovation and others do not: managerial expectations. When a radically new technology is nascent, managers confronting the same technology may hold differing expectations about the technology's likely effect on existing products. Specifically, managers may hold at least three differing expectations about the technology's likely effect on existing products:

1. The new technology will enhance the effectiveness of existing products, just as electric motors made dishwashers and laundry machines more powerful.
2. The new technology will make existing products obsolete, just as integrated circuit technology made slide rules obsolete.
3. The new technology will have little or no effect on existing products, just as microwave heating technology hardly affected conventional oven sales.

We argue that these expectations result in significantly different levels of investment in radical innovation. Moreover, managers who have the same technology expectations may exhibit different investment behavior, depending on their level of dominance in the existing product generation. Studying expectations and their interaction with firms' overall dominance provides a more complete explanation for the empirical disconnect between the pessimistic predictions of much of the literature on dominance and radical innovation and the aggressively innovative behavior of some dominant firms.

In addition, studying expectations helps us understand the dynamics of investment in radical new technology before the actual effects of the technology are evident. Although emerging research focuses on the effects of radically new technologies on existing products (e.g., Anderson and Tushman 1990; Cooper and Schendel 1976), most of this research examines the impact of new technologies in a historical context, after the impact is already evident. It is possible to categorize specific technologies post hoc as having helped, hindered, or had no effect on the existing product category (Utterback 1994), but managers make investment decisions before the effects have taken place. Key decisions are made while the technology is still nascent, when its eventual effect on existing products is far from certain. Yet little research has examined decision making by managers in this "pre-paradigmatic" stage of radical innovation (Dosi 1982).

Moreover, many authors note the importance of a "vision" for the future in promoting radical innovation (see Ohmae 1984). By introducing managers' expectations into the analysis, we present a view of managers as active agents who employ their imaginations in making decisions and who, to a certain extent at least, are instrumental in creating their own futures. We show that "paranoid" firms (e.g., Grove 1996) are the most aggressive innovators.

Finally, we use experimental techniques to investigate the causal relationships among dominance, expectations, and radical innovation, and we use field studies to provide real-world context and insight. Few studies of innovation employ time-series experimentation to examine causality

(Poole et al. 2000; Weick 1967). Our field study enables us to study real-world firms in an industry facing the effects of a radically new technology; specifically, we study how managers of bricks-and-mortar banks responded to the advent of Internet banking. We employ multiple methods—in-depth interviews, survey data, and archival data—to study the impact of dominance and expectations at a unique point in the evolution of Internet banking. The triangulation of research methods yields a rich payoff in terms of empirical insight, a balance of internal and external validity, and robust findings.

Theory

Definitions

The term *dominance* refers to the extent of market power that firms enjoy (Bain 1968; Scherer 1980). A *radical innovation* is a product that requires substantially different technology and marketing skills compared with existing products in the industry (Chandy and Tellis 1998; see also Garcia and Calantone 2002). The greater a firm's emphasis on a radically new product, the more aggressive it is in radical innovation. We define *technology expectations* as managers' beliefs about the likely impact (obsolescence, enhancement, or no effect) of the new technology on existing products.

Conceptual Overview

Investment in a radical innovation is a function of a firm's motivation and ability to do so. Firms with the motivation and ability to invest are likely most aggressive in pursuing the radical innovation. Firms' dominance affects their motivation and ability to invest. Dominant firms are prone to inertia and escalation of commitment, both of which reduce motivation to invest. As a result, dominant firms may show a preference for the status quo; that is, they may continue with the existing product generation. However, dominant firms are also wealthier than nondominant firms and therefore have greater ability to invest in the radical innovation.

Technology expectations have a critical role in driving investment in radical innovation. Specifically, they alter the manner in which managers frame an investment and, by doing so, amplify (or diminish) managers' motivation to pursue radical innovation. The effect of expectations on the motivation to pursue radical innovation results in a corresponding change in firms' investment aggressiveness.

Study Scope and Assumptions

For conceptual and empirical clarity, we restrict our scope to incumbent firms. Thus, we do not attempt to explain the behavior of firms that have no presence in the existing product generation. This approach is in line with previous research, which also focuses on incumbent firms (e.g., Chandy and Tellis 1998; Hannan and Freeman 1989; Scherer 1992). All incumbent firms have a stake in the status quo because they have some investments in the current product generation.

We assume the impact of the new technology on existing products to be an exogenous shock: Individual firms, even powerful ones, have little control (at least in the long run) over whether the new technology enhances, makes obsolete, or has no effect on current products (see Anderson and Tushman 1990; Solow 1956). Although some dominant firms might appear all-powerful and invincible at one point, over the long run few firms control the fates of technologies and industries.

We also assume that managers (even those of wealthy firms) have capital constraints. One consequence of capital constraints is that investing in a new product implies less investment in existing products; that is, there is a trade-off between existing products and new products. Investing in the new product likely makes a firm less competitive in the existing product generation (e.g., Blundell, Griffith, and Van Reenen 1999). The default course of action is therefore to continue investing in the existing product generation; the alternate course of action is to invest in the new product.

Hypotheses

Are dominant firms more or less likely than nondominant firms to invest aggressively in a radical innovation? Schumpeter (1942) first highlighted the role of market power in innovation, arguing that dominance favors radical innovation. Many researchers have since steadily attempted to test Schumpeter's hypothesis empirically (see Cohen 1995; Scherer 1992), yet few researchers provide a behavioral rationale for dominant firms' radical innovation behavior (Scherer 1992). Indeed, prominent researchers have criticized the atheoretical nature of work in the field (Cohen 1995). We highlight the multifaceted nature of dominance and provide behavioral explanations of how each facet affects dominant firms' investment in innovation. We also consider how these facets taken together influence the overall impact of dominance on investment in radical innovation.

The Many Faces of Dominance

Consider Microsoft or Intel today. Both firms are well entrenched and thus have larger investments in their current markets than do other firms. They also have greater market shares than do other firms. Finally, both firms are wealthier and have greater access to resources than do other firms. These three facets—greater investments, greater market shares, and greater resources—define dominance (see Bain 1968; Borenstein 1990, 1991). These three facets may also have different impacts on dominant firms' motivation and ability to pursue radical innovation. Although there is a substantial literature on some behavioral effects, such as escalation of commitment and inertia, previous research has not linked these effects to the three facets of dominance or brought together these effects to understand the overall influence of dominance on radical innovation (see Cohen 1995; Scherer 1992). By doing so, we hope to clarify the conflicting views in the literature on dominance and radical innovation.

Escalation of commitment: The effect of investments. The theory of escalation of commitment attempts to explain why people continue to pursue courses of action even after it is irrational to do so (Boulding, Morgan, and Staelin 1997; Staw 1981). According to this theory, managers frame the decision to invest in a new product relative to continuing with the initial commitment to the old product. The more committed managers are to the old course of action, the greater the loss they perceive in the decision to switch to the new course of action (Bazerman 1994). Loss aversion (Kahneman and Tversky 1979) therefore causes managers to be unlikely to switch from the old course of action (Brockner and Rubin 1985) and to place less emphasis on the new compared with the old course of action. By definition, all incumbents have some investment in (and therefore some commitment to) the existing product generation (see Brockner and Rubin 1985; Staw 1981). However, because dominant firms have more investments in the existing product than do other firms, they are especially prone to escalate their commitment to the existing product compared with the radical innovation. Thus,

H_{1a}: The larger a firm's investments in the existing product generation, the less aggressively its managers invest in the radical innovation relative to the existing product generation.

Inertia: The effect of market success. Incumbent managers' susceptibility to inertia, and their resulting preference for the status quo, is well documented in prior research (Hannan and Freeman 1989; Nelson and Winter 1982). All incumbents are prone to inertia, but as with escalation of commitment, dominant incumbents may be especially susceptible to it. A major source of inertia in a firm is its perceived success in its current course of action (see Leonard-Barton 1992; Nelson and Winter 1982). The more successful the firm perceives its current course of action, the more it reinforces its commitment to that course of action. A strong market position signals the validity of the firm's decision-making procedures; it legitimizes precedents and causes them to become normative standards for the future (Hannan and Freeman 1989; Nelson and Winter 1982). The firm subsequently makes decisions about the future simply based on inertia from the past. According to this argument, the stronger a firm's market position, the greater are the inertial constraints it faces. Dominant firms therefore are less motivated to switch from the status quo, and they likely invest less aggressively in radical innovation than do nondominant firms. Therefore,

H_{1b}: The stronger a firm's market position in the existing product generation, the less aggressively its managers invest in the radical innovation relative to the existing product generation.

The wealth effect. The escalation of commitment and inertia arguments do not, however, account for dominant firms' having more resources than other firms. The greater wealth of dominant firms provides them with greater ability to invest in radical innovation. Greater wealth also cushions dominant firms from the risk of failure inherent in radical innovation (Nohria and Gulati 1996); thus, dominant firms

have the means to experiment extensively in research and development, which could result in dominant firms investing more in a new product. Managers of dominant firms may also invest heavily in radically new products rather than existing products because they might stand a greater chance of making the new idea a marketplace success than would firms with few financial and marketing resources. For example, dominant firms likely have larger sales forces, which enables them to ensure greater distribution of a fledgling product (Chandy and Tellis 2000). Thus,

H_{1c}: The greater a firm's wealth, the more aggressively its managers invest in the radical innovation relative to the existing product generation.

Taken together, what are the overall effects of dominance on managers' investment aggressiveness in radical product innovation? Recent evidence suggests that, overall, dominant firms are likely more aggressive in their investments in a radically new product than are other firms. Radical innovations are resource intensive and could become increasingly so over time (e.g., Chandy and Tellis 2000; Jelinek and Schoonhoven 1990). In addition, the innovation ethic is now more widespread among managers, including those of dominant firms. This awareness of the need for innovation is partly a result of a significant recent literature on the (beneficial and destructive) effects of innovation (e.g., Christensen 1997; Hamel 1999), combined with the many consulting and education activities by the authors and followers of this literature (e.g., Hamel 2001; Mack 1999). The implication of these arguments is that any increased inertia and escalation of commitment that comes with dominance might be outweighed by the benefits of greater wealth. In light of these findings, we propose the following:

H_{1d}: Overall, managers of dominant firms invest more aggressively in the radical innovation relative to the existing product generation than do managers of nondominant firms.

Expectations and Radical Innovation

In the subsequent paragraphs, we develop hypotheses on the role of technology expectations in radical innovation decisions in general. We then consider how these expectations influence dominant and nondominant firms. Throughout the section, we compare the condition in which managers expect the new technology to enhance the existing technology or to make it obsolete with the case in which they expect the new technology to have no impact on existing technology. Thus, the no-effects expectation is the benchmark against which we compare the other two types of expectations: obsolescence and enhancement.

Obsolescence versus no-effect expectations. Expectations of obsolescence cause managers to be less secure about their current course of action (e.g., Jassawala and Shashittal 1998). In this case, the new technology has a negative effect on the success of the current course of action, based as it is on the old, soon-to-be-obsolete technology. Managers who expect obsolescence therefore perceive that continuing with the existing technology will lead to a major loss in market position. Conversely, managers who expect

the new technology to have no effect on existing products perceive no such loss (and, therefore, no effect on the success of the current course of action) (see Clark and Montgomery 1996; Grove 1996). Thus,

H₂: Managers who expect the radical innovation to make existing products obsolete invest more aggressively in the radical innovation relative to the existing product generation than do those who expect the new technology to have no effect on existing products.

Enhancement versus no-effect expectations. What if managers expect that investing in the new technology is likely to enhance the performance of existing products? We argue that these managers invest less aggressively in the new technology than do managers who expect the technology to have no effect. The rationale for this hypothesis rests on the absence of a compelling incentive to switch emphasis from an existing technological base that is expected to be only enhanced by the new technology. Specifically, managers who expect enhancement do not frame investing in the new technology and continuing with the old technology as competing courses of action. Moreover, they perceive that the existing technology plays a significant, enhanced role in the market (e.g., Jassawala and Shashittal 1998). They therefore expect the new technology to have a positive effect on the success of the current course of action. Because the new technology is an exogenous shock, this positive outcome occurs regardless of a firm's own investments in the new technology (Solow 1956). The managers' perceptions of greater success by maintaining the current course of action feeds their inertia (Henderson 1993; Nelson and Winter 1982) and reinforces their commitment to the existing technology. Managers who expect no effect, however, experience less inertia and escalation of commitment, because they receive no such reinforcement. Thus,

H₃: Managers who expect the radical innovation to enhance existing products invest less aggressively in the radical innovation relative to the existing product generation than do those who expect the new technology to have no effects on existing products.

Interaction of Dominance and Expectations

As we noted previously, there is considerable empirical evidence that some dominant firms invest aggressively in radical new technologies and others do not. What explains this variation in dominant firms' investment in radical innovation? In an attempt to address this question, we examine the interaction effects of firm dominance and managers' technology expectations on the level of investment in radical innovation.

Under expectations of obsolescence, managers of all firms, dominant and nondominant, perceive that maintaining the current course of action will cause a loss in market position. However, dominant firms have more to lose from obsolescence than do their nondominant competitors. Specifically, dominant firms risk losing their strong market position because their success is based on the old technology. Thus, managers of dominant firms perceive the new technology to be a greater threat to their market position than do managers of nondominant firms. Therefore, managers of dominant firms are even more motivated than are those of nondomi-

nant firms to break out of their inertia, reduce their commitment to the existing product generation, and invest aggressively in radical innovation. Thus,

H₄: Dominant firm managers who expect the radical innovation to make existing products obsolete invest more aggressively in the radical innovation relative to the existing product generation than do nondominant firm managers with the same expectations.

We noted previously that when managers expect the new technology to enhance the performance of the existing technology, managers of both dominant and nondominant firms might invest less aggressively than they would otherwise. However, dominant firms expect to gain more than nondominant firms would from the positive influence of the new technology. Specifically, given dominant firms' stronger market position, any positive influence from the new technology on existing products is magnified. Managers of dominant firms therefore expect to be even more successful by maintaining the existing course of action. This perception of renewed (enhanced) success causes dominant firms to be less motivated and more wedded to the status quo when they expect enhancement. Therefore, they invest even less aggressively in radical innovation under this condition. Thus,

H₅: Dominant firm managers who expect the radical innovation to enhance the performance of existing products invest less aggressively in the radical innovation relative to the existing product generation than do nondominant firm managers with the same expectations.

Method

We used two empirical approaches: (1) time-series, cross-sectional analysis in a controlled setting and (2) structured interview-informed survey research combined with archival data in a field setting. The time-series, cross-sectional analysis tests causal links among the key variables being studied. In-depth interviews enabled us to obtain direct, firsthand insights into the actual dynamics of technology expectations and radical innovation. Archival data, together with our survey of managers in an industry confronting radical innovation (i.e., retail banking and the Internet), provide evidence of the applicability of our arguments to a real-world context. By employing multiple methodologies to investigate radical product innovation in a programmatic fashion, we can better ensure the internal and external validity of the research (e.g., Winer 1999). As Jick (1979) notes, multiple and independent methods, such as the ones proposed here, do not share the same weaknesses or potential for bias. Triangulation is particularly appropriate for initial research in an area, because it provides "thick descriptions" of phenomena and facilitates their interpretation.

Lab Studies

Research Context

We used the MARKSTRAT2 simulation (Larrecche and Gatignon 1990) to test our hypotheses in a controlled set-

ting. MARKSTRAT provides an excellent environment for this research for several reasons, which we outline in Appendix A. We tested our hypotheses over two separate studies. Study 1 tests H₁, which describes competing arguments on the role of dominance in decisions on radical innovation. Study 2 tests hypotheses H₂–H₅, which incorporate the effects of technology expectations on radical innovation. The subsequent sections provide the details of each study and descriptions of the results.

Study 1

Subjects and Procedure

In Study 1, we used data from eight MARKSTRAT2 runs (each run involved the creation of one industry), conducted with MBA students at a large public university in California. For each run, we randomly assigned participants to teams of three to four members each and then randomly assigned the teams to 1 of 5 possible firms per industry (in MARKSTRAT there are 5 firms per industry). All participants played the run over seven periods in six of the runs and over ten periods in the other two. Overall, therefore, we gathered data from 40 firms competing across eight runs (industries) over seven to ten periods for a total of 310 observations.

We collected data on each firm's expenditures, market shares, and budgets in each period in the Sonite (existing technology) and Vodite (new technology) markets.¹ We used these variables to test for the relative strength of escalation of commitment, inertia, and wealth, respectively, and the overall effect of dominance on firms' relative expenditure on new technology (H_{1a}–H_{1d}).

Measures

Consistent with our definition, we measured investment aggressiveness in a relative sense: each firm's expenditure in the Vodite market divided by its combined expenditures in the Sonite and Vodite markets. These expenditures include research and development and advertising expenses that are specific to the Sonite and Vodite products.² This measure of

¹The MARKSTRAT manual instructs participants that the existing and new technologies are independent of each other; that is, the growth of the new technology has no effect on the existing technology. As a result, all participants in this study have the same expectation of no effects. We thus control for the effect of expectations on investment behavior.

²In MARKSTRAT2, expenses related to sales force and distribution are not specific to a particular technology. Consequently, we do not expect these expenses to have a systematic impact on the firm's expenses in the new technology relative to the existing technology. Although firms spend money to purchase Sonite and Vodite specific market research, the costs of the market research are low compared with the other expenses. They are also relatively constant across all teams (see, e.g., Glazer and Weiss 1993, p. 516). Consequently, we do not include sales force and market research expenses in calculating technology expenditures. On average, market research expenditures are 5% of total expenditures (standard deviation = 3, range = 0%–18%). To check for robustness, we also estimated Equation 3 using a measure of investment that included market research expenditures. The effects remain robust to this change.

investment in radical innovation thus measures the firm's emphasis on Vodite investments relative to its overall product investments.³ We also measured investment in absolute terms: the firm's total investments in the Vodite market.

Recall that the escalation of commitment effect is based on the firm's level of past investments. To test the escalation of commitment effect, we calculated the average cumulative expenditures by the firm in the existing (Sonite) technology until the previous period. The inertia effect is based on the firm's market position. To test the inertia effect, we used the firm's average market share (in MARKSTRAT dollar sales) in the existing technology until the previous period. The wealth effect is based on the firm's financial resources. To test the wealth effect, we used the average cumulative budget available to the firm until the current period.⁴ (In MARKSTRAT, a firm's budget is a linear function of its net marketing contribution or profit.) We obtained all this data from the output that MARKSTRAT2 provides to the game administrator. MARKSTRAT2 also provides each team with information on its market share, profits, and several other variables each period.

We also tested the overall effect of dominance on investment in the radically new technology. To do so, we first conducted a principal component factor analysis of the previous three variables (past investment, market share, and budget). We used the factor score from this factor analysis as a consolidated measure of firm dominance (Bollen and Lennox 1991).

Model Formulation

To test our hypotheses, we use a fixed-effects model with a Prais-Winsten regression estimator that accounts for AR(1) serial correlation and computes panel-corrected standard errors (Greene 2000). The fixed-effects specification listed subsequently also enables us to account for unobserved heterogeneity due to team-, firm-, and industry-specific effects. We estimate the following two equations to test hypotheses H_{1a} – H_{1d} , which pertain to the effect of dominance on investment in radically new technology. Equation 1 decomposes the effects of dominance into the escalation of commitment, inertia, and wealth effects. Equation 2 represents the overall effects of dominance (measured with the factor score from the factor analysis described previously) on radical innovation.

$$(1) \text{ Investment}_{it} = \alpha_0 + \alpha_1 (\text{average cumulative expenditures in existing technology})_{i, t-1}$$

³Use of the relative measure results in a dependent variable that lies between zero and one. To avoid the problem of predictions outside this range, we used a logistic transformation, $y = \ln[p/(1-p)]$; this also provides a unit of measurement that is related more linearly to the independent variables (Neter, Wasserman, and Kutner 1985). Our use of generalized least squares estimation for each operationalization of the dependent variable enables us to report R^2 measures. To facilitate the logistic transformation, we replaced data points with zero values with a small fraction (.01) and those with values of 1 with .99.

⁴In this study, and in Studies 2 and 3, we also used single-period measures of each of these components of dominance. The effects remain robust to these alternate formulations.

$$\begin{aligned} &+ \alpha_2 (\text{average market share in existing technology})_{i, t-1} \\ &+ \alpha_3 (\text{average cumulative budget})_{i,t} \\ &+ \phi (\text{industry average expenditure}) \\ &+ \kappa (\text{firm}) + v_i + \varepsilon_{it} \end{aligned}$$

$$(2) \text{ Investment}_{it} = \beta_0 + \beta_1 (\text{dominance})_{i, t-1} + \lambda (\text{industry average expenditure}) + \gamma (\text{firm}) + v_i + \varepsilon_{it}$$

where

investment = (new technology expenditure)/(total expenditure in new and existing technology) for relative measure of investment and new technology expenditure for absolute measure of investment,

industry average

expenditure = a variable that controls for industry-specific effects,

firm = a matrix of dummies that control for firm-specific fixed effects,

$\varepsilon_{it} = \rho\varepsilon_{i, t-1} + \eta_{it}$, $|\rho| < 1$, $\eta_{it} \sim \text{IIN}(0, \sigma_\eta^2)$, and v_i = team-specific errors.

Results

Table 1 presents the estimation results for Study 1. All reported coefficients reflect standardized values (Kim and Ferree 1981). For this and all subsequent analyses, we also computed the White (1980) general test statistic; the tests indicate that heteroskedasticity is not a problem. We use the terms α_{1R} and β_{1R} to refer to the coefficients based on the relative measure, and we use α_{1A} and β_{1A} to refer to the coefficients based on the absolute measure of investment in radical innovation. We account for industry-specific effects by including an industry-level variable that measures the average total expenditure in each period across all firms in the industry. The firm variable controls for heterogeneity due to firm assignment (e.g., differences in starting positions for Firms 1–5). We only include statistically significant fixed effects in the final regression equation.

The escalation of commitment effect (H_{1a}) implies that a firm with many investments in an existing product generation invests less aggressively in the radical innovation. We found a significant, negative effect of past Sonite expenditures on the aggressiveness with which firms invest in the radical innovation ($\alpha_{1R} = -.08$, $p < .10$; $\alpha_{1A} = -.18$, $p < .01$). The inertia effect (H_{1b}) argues that, other things being equal, managers with strong market positions likely continue with the existing product generation at the expense of the radical innovation. We found that firms with high lagged market shares invest less aggressively in new Vodite products than do other firms ($\alpha_{2R} = -.20$, $p < .05$; $\alpha_{2A} = -.17$, $p < .05$). The wealth effect (H_{1c}) suggests that high profits endow dominant firms with resources that enable them to be more aggressive in their investments in radical innovation than are other firms. The results indicate a positive, significant effect of firms' budgets on investment in radical innovation ($\alpha_{3R} = .40$, $p < .01$; $\alpha_{3A} = .24$, $p < .01$).

TABLE 1
Dominance and Its Facets (Study 1)

Independent Variables	Process	Hypothesized Effect	Relative Vodite Investment		Absolute Vodite Investment	
			Model 1	Model 2	Model 1	Model 2
Expenditures in existing technology	Escalation of commitment	–	–.08*		–.18***	
Market share in existing technology	Inertia	–	–.20**		–.17**	
Budget	Wealth	+	.40***		.24***	
Dominance		+		.40***		.15*
Industry average expenditure			.24***	.22***	.68***	.57***
Firm 2			.32***	.26***		
Firm 3			–.27***		–.79***	
R ²			.38	.28	.42	.31

* $p < .10$.

** $p < .05$.

*** $p < .01$.

Notes: Models 1 and 2 present the estimation results of Equations 1 and 2, respectively.

We further test the overall effect of dominance (H_{1d}) by estimating Equation 2. The factor score from the factor analysis of the past investment, market share, and wealth variables has a positive coefficient that is significantly different from zero ($\beta_{IR} = .40, p < .01$; $\beta_{IA} = .15, p < .10$).

Discussion

The Study 1 results suggest that the three facets of dominance—market share, investments, and wealth—affect innovation behavior differently; therefore it is important to account for these differing effects. Overall, dominance has a positive effect on the aggressiveness with which managers pursue radical innovation, but managers might hold different expectations about the likely effects of the new technology on existing products. We manipulate participants' expectations about the effects of the new technology in Study 2.

Study 2: Experiment

In Study 2, we attempt to answer the question, How do expectations about new technology influence managers' product development decisions in dominant and nondominant firms? We used time-series, cross-sectional data to test our causal relationships in a controlled setting.

Subjects and Procedure

Similar to Study 1, we used the MARKSTRAT2 simulation to test the hypotheses.⁵ Participants in the simulation were graduate students in business at a public university in

Europe. We conducted the study over one semester and used data from six concurrent runs (industries) of the simulation. We randomly assigned participants to teams of three to four members each. We then randomly assigned these teams to firms in one of the six industries. All participants played the game over eight periods. Therefore, we gathered data from 30 firms competing in six industries over eight periods for a total of 240 observations.

We experimentally manipulated (at the industry level) participants' expectations about the radically new technology.⁶ We assigned ten teams each (two industries each consisting of five firms) to the enhancement and obsolescence conditions. We assigned the teams in the remaining two industries to the no-effect and control conditions, respectively.

H_2 – H_5 , which we test in this study, pertain to the role of technology expectations and their interaction with dominance. Because our interaction hypotheses apply only to overall dominance, we did not decompose the overall measure of dominance in this analysis. We did, however, replicate our test of hypotheses H_{1a} – H_{1c} by reestimating Equation 1 with Study 2 data. We also surveyed each team in each period on its perceived dominance (see Appendix B). The correlation between this measure and our archival measure of dominance is high ($r = .84, p < .01$), which indicates that our measure of dominance reflects participants' own views of their relative market position.

We introduced the technology expectation manipulations at the end of the fourth period, by which point clear patterns of dominance had emerged in each industry. Specif-

⁵All aspects of the game were identical to those in Study 1, with one exception. In Study 2, we made interest-free loans available, subject to a formal application process. We did so because the positive overall effect of dominance in Study 1 could potentially have been due to a MARKSTRAT-specific bias in favor of initially wealthy firms. We wished to rule out this possibility in Study 2. We made the availability of interest-free loans known to all participants in the first period and reminded them of it in every period. Some firms sought and received loans, and others did not. We control for the loan amount in our models.

⁶We chose not to manipulate dominance because Study 1 suggests that this factor varies naturally within the simulation from period to period. Even if we had ensured starting positions that place some firms in a better position than others, this superiority would have washed out because of subjects' use of individual strategies. Therefore, we measured dominance as a continuous function of firms' average cumulative budgets, past investments, and market share by using a factor analysis procedure identical to Study 1.

ically, by the end of the fourth period, the cumulative marketing contribution of firms across industries ranged from \$26 million to \$486 million. None of the participants had made any investments in the new product generation before this time, and they did not have any market research data on the new product generation for much of the time until we introduced the manipulations. Thus, participants made decisions on the new product after we introduced the technology expectation manipulations.

Manipulations

At the end of the fourth decision period, we provided participants with a memo that contained information on prospects for the radically new technology (see Appendix C). We told firms in the enhancement (obsolescence) conditions that the new technology was likely to make products based on the existing technology more effective (obsolete). We instructed firms in the no-effect (no specific expectations) conditions that the new technology was likely to have no effect (unclear effects) on products based on the existing technology.

As we noted previously, the MARKSTRAT student manual actually suggests that there are no interactions between the existing and the new technologies. To allow for varying expectations about the effects of the new technology, the simulation administrator instructed participants at the start of the simulation to ignore this sentence in the student manual. As part of the cover story for the experiment, the administrator told participants that the game parameters had been modified at the start and that the effects of the new technology were unclear. The administrator also noted that a memo with information about the likely effects of the new technology was forthcoming. Manipulation checks indicate that the cover story worked as intended.

Manipulation Checks

To further understand the process underlying participants' investment decisions in each condition, we also surveyed each team on its perceptions of the potential for gains or losses in the industry in the next period (the two items for this perceived loss scale are provided in Appendix B). We collected this perceptual data for each period after the fourth period, when we distributed the memo. The differences in covariance-adjusted means of perceived loss across conditions are as expected. Specifically, the difference between obsolescence and no effect (1.82, $p < .05$) and enhancement and no effect (−6.38, $p < .05$) is statistically significant and in the right direction. The difference between the no-effect and no-specific-expectations conditions is not statistically significant at $p < .05$. These data provided additional evidence for our manipulations.

Model Specification

To test hypotheses H₂–H₅, we again used the Prais-Winsten regression estimator to estimate the following fixed-effects model with AR(1) errors.

$$\begin{aligned} (3) \text{ Investment}_{it} = & \beta_0 + \beta_1 (\text{dominance})_{i,t-1} + \beta_2 (\text{enhancement})_i \\ & + \beta_3 (\text{obsolescence})_i \\ & + \beta_4 (\text{dominance}_{i,t-1} \times \text{enhancement})_i \\ & + \beta_5 (\text{dominance}_{i,t-1} \times \text{obsolescence})_i \\ & + \gamma (\text{loan})_{i,t-1} \\ & + \lambda (\text{industry average expenditure}) \\ & + \tau (\text{firm}) + v_i + \varepsilon_{it}. \end{aligned}$$

Enhancement and obsolescence are represented as dummy variables. Participants in the no-specific-expectations and no-effect conditions behaved similarly on key variables of interest. Therefore, we pooled these two groups into one no-effects condition. The coefficients for the enhancement and obsolescence conditions are therefore estimated relative to this control condition. The loan amount (if any) is represented by the loan variable; other variables are as defined previously. Because the objective of this study is to test the effects of technology expectations on investment behavior, we only used data collected after the period in which the memo with the experimental manipulation had been administered ($n = 120$).

Results

Replication tests of H_{1a}–H_{1c}. Because hypotheses H_{1a}–H_{1c} apply to investment behavior in the absence of obsolescence or enhancement expectations, we estimated Equation 1 only for those teams that fell into the control condition. This analysis is a conceptual replication of the corresponding analysis in Study 1. The results in Table 2 are consistent with our hypotheses (with the exception of the escalation of commitment effect on absolute investment) and provide further support for hypotheses H_{1a}–H_{1c}.

Main effects of expectations. H₂ suggests that managers who expect a new technology to make existing products obsolete invest more aggressively in radical innovation than do managers who expect the new technology to have no effect on existing products. The results support this hypothesis (see Table 3). Specifically, obsolescence has a positive, statistically significant main effect on investment in radical innovation ($\beta_{3R} = .24, p < .01$; $\beta_{3A} = .24, p < .05$).

For the enhancement versus no-expectation condition, H₃ proposes that managers invest less aggressively in a radical innovation than do managers who expect no effect. In support of H₃, the coefficient of enhancement is negative and statistically significant ($\beta_{2R} = -.52, p < .01$; $\beta_{2A} = -.41, p < .05$).

Interactions of dominance and expectations. H₄ predicts that, given expectations of obsolescence, managers of dominant firms likely invest more aggressively in radical innovation than do managers of nondominant firms. As predicted, the coefficient for the interaction of dominance and obsolescence is positive and significant ($\beta_{5R} = .21, p < .05$; $\beta_{5A} = .34, p < .05$), in support of H₃.

H₅ predicts that, given expectations of enhancement, managers of dominant firms likely invest less aggressively

TABLE 2
Facets of Dominance (Study 2 Control Condition)

Independent Variables	Hypothesized Effect	Relative Vodite Investment	Absolute Vodite Investment
Expenditures in existing technology	–	–.17*	.06
Market share in existing technology	–	–1.04***	–.75**
Budget	+	1.24***	.96***
Industry average expenditure		1.13*	.56
Firm 3			.76***
Loan		.45**	.38*
R ²		.41	.60

* $p < .10$.

** $p < .05$.

*** $p < .01$.

TABLE 3
Dominance and Expectations (Study 2)

Independent Variables	Hypothesized Effect	Relative Vodite Investment	Absolute Vodite Investment
Dominance	+	.18**	.55**
Obsolescence	+	.24**	.24*
Enhancement	–	–.52**	–.41*
Dominance × obsolescence	+	.21*	.34*
Dominance × enhancement	–	.06	.01
Industry average expenditure		.62**	.43*
Firm 3		.35**	.37**
Firm 5		.37**	.22*
Loan		–.04	.36**
R ²		.57	.42

* $p < .05$.

** $p < .01$.

in the new technology than do managers of nondominant firms. This hypothesis is not supported: The coefficient for the interaction of dominance and enhancement is not significantly different from zero ($\beta_{4R} = .06$, $p = .26$; $\beta_{4A} = .01$, $p = .28$).

Main effect of dominance. The results in Table 3 indicate that the main effect of dominance is positive and significant ($\beta_{1R} = .18$, $p < .01$; $\beta_{1A} = .55$, $p < .01$). The results support H_{1d} : Managers of dominant firms tend to invest more aggressively in radical innovation than do managers of nondominant firms.⁷

Discussion

Overall, the results indicate that technology expectations play a complex role in driving investments in radical innovations. An expectation of obsolescence causes both dominant and nondominant firms to invest significantly greater

proportions of their resources toward radical innovations than do firms in industries in which expectations of no effect are prevalent. The situation is different in an industry in which the enhancement expectation is prevalent. Both dominant and nondominant firms invest significantly lower proportions toward radical innovation in such industries, compared with industries facing expectations of obsolescence or no effect. Moreover, regardless of whether the expectation is one of obsolescence or enhancement, expectations have a greater effect on investment behavior for dominant firms than for nondominant firms.

Given its longitudinal and experimental design, the MARKSTRAT-based study helps ensure internal validity. Study 3 presents insights from a real industry and practicing managers involved in making actual financial decisions.

Study 3: Field Study of Retail Banking

The U.S. retail banking industry during 1999 and 2000 proved an excellent setting for our field study (see Schotema 2001). We provide details in Appendix D. The following sections describe the full-scale field study, in which we attempt to quantify the effects of expectations and dominance on bricks-and-mortar banks' investments in Internet

⁷Some scholars (e.g., Ettlie and Rubenstein 1987) have suggested a nonlinear (U-shaped or inverted U-shaped) relationship between dominance and innovation. To test for possible nonlinearity in the effects of dominance, we also tested an alternate model that included a squared dominance term in Equation 1. The coefficient for this term was not significantly different from zero; therefore, we do not include the results in Table 3.

banking. (Additional details on the methodological aspects of the study are available in Chandy, Prabhu, and Antia's [2003] work.)

Unit of Analysis and Sampling

Our unit of analysis is the U.S. retail banking division for each bank (the key informant was the officer in charge of U.S. retail banking or the equivalent). We used a frequently updated and detailed database published by Thomson/Polk to construct our sample frame, which consisted of 550 U.S. retail banks, chosen randomly from the population of U.S. retail banks. Our data collection efforts yielded a total of 189 usable questionnaires, representing a 39.4% response rate. The mean number of employees at responding institutions was 428 (standard deviation = 2933) and the mean number of bricks-and-mortar branches was 27 (standard deviation = 147). Of the 189 usable questionnaire responses, 129 were from publicly held retail banks. We also checked for nonresponse bias; results indicate that such bias is unlikely.⁸

Measures

The final measures for each construct appear in Appendix B. Table 4 reports the correlation matrix and descriptive statistics for these measures.⁹ The scale of relative investment comprises three items with an α of .88, and the scale of absolute investment comprises four items with an α of .86. To further test the convergent validity of our measure, we also included a third, nonperceptual measure of investment in the survey (see Appendix B). The correlations between this measure and our dependent measures of relative and absolute investment are .67 ($p < .01$) and .63 ($p < .01$), respectively.

We measured expectations (obsolescence, enhancement, and no effect) by asking respondents to allocate 100 points

⁸The first wave of responses included 139 of the 189 usable responses. We first tested for differences between early and late respondents (Armstrong and Overton 1977), using the focal variables of the study as dependent variables. The analysis of variance yielded no significant differences on any of the variables ($F = 0.4$; $p = .52$). We further compared the two groups on the mean number of employees, assets, deposits, net equity, and ownership pattern. We did not find any significant differences between the two groups on any of these measures.

⁹The overall fit of the mixed-measurement model consisting of the three reflective scales and the composite index of dominance is high ($\chi^2_{70} = 104.7$, $p = .005$; Cmin/degrees of freedom = 1.49; root mean square error of approximation = .05; Akaike information criterion = 202.71; comparative fit index = .99; normed fit index = .98; and Tucker-Lewis index = .99), suggesting unidimensionality of the reflective scales. All items loaded on their prespecified constructs and had t-values significant at .05, which provides evidence of convergent validity. Appendix B presents the item parameter values for the factor structure matrix and Cronbach's alpha estimates for all reflective scales. All reliability estimates exceed .70. An alternate model with cross-loadings specified failed to converge, which supports the discriminant validity of the constructs. Discriminant validity of the scales is further supported by the Lagrange-multiplier tests: None of the possible cross-loadings exceeds the critical value of the χ^2 with one degree of freedom (Speier and Venkatesh 2002).

to reflect their beliefs about the likely impact of the Internet on bricks-and-mortar banking, both in the short term (next two years) and in the long term (next ten years). Recall that our hypotheses compare the behavior of firms that expect obsolescence and enhancement with that of firms that expect no effect. To ensure consistency with our hypotheses and comparability between the experimental and the field studies, we averaged the short- and long-term variables and created two dummy variables (enhancement and obsolescence) to represent the three conditions. We categorize a firm as expecting enhancement (or obsolescence) if it allocates more points to that condition relative to the median number of points allocated to that condition across all firms.¹⁰

Consistent with the in-depth interviews we conducted and the measure of dominance adopted in Studies 1 and 2, we measured dominance as a composite of three accounting variables. We used the average dollar value of bricks-and-mortar assets (net of depreciation) as a measure of investment in the existing product, average dollar value of deposits as a measure of market share,¹¹ and average net equity (total equity capital net of preferred and common stock, surplus, and undivided profits from bricks-and-mortar operations) as a measure of cumulative earnings. These averages are over a six-year period before the survey (using five- and four-year averages produces consistent results). To minimize common method bias, we collected archival data on the preceding variables from the Federal Deposit Insurance Corporation. We controlled for individual firms' willingness to cannibalize with a three-item, seven-point scale adapted from Chandy and Tellis (1998). In addition, we controlled for banks' ownership with a dummy variable coded as 1 for publicly owned banks and as 0 otherwise.

Analysis

We regressed firms' investments on the hypothesized explanatory variables, including the moderators and control variables, as depicted in Equation 4. We used Lance's (1988) residual centering approach to reduce multicollinearity in the interaction terms.

$$\begin{aligned} (4) \quad \text{Investment} = & \beta_0 + \beta_1 (\text{dominance}) + \beta_2 (\text{obsolescence}) \\ & + \beta_3 (\text{enhancement}) \\ & + \beta_4 (\text{dominance} \times \text{obsolescence}) \\ & + \beta_5 (\text{dominance} \times \text{enhancement}) \\ & + \beta_6 (\text{willingness to cannibalize}) \\ & + \beta_7 (\text{public ownership}) + \epsilon. \end{aligned}$$

¹⁰In 14 cases, the previous procedure assigns firms to more than one condition. In these cases, to maintain the mutually exclusive nature of the dummy variables, we assigned the firm to the condition with the higher average score. The parameter estimates remain robust to dropping these 14 cases.

¹¹The market share for any firm is simply that firm's sales divided by industry sales. In our case, the denominator term (industry sales) is constant across all firms because our data comes from a single industry. As such, a firm sales measure is equivalent to a market share measure.

TABLE 4
Descriptive Statistics and Correlation Matrix (Field Survey)

	Mean	Standard Deviation	Relative Internet Investment	Absolute Internet Investment	Dominance	Enhancement	Obsolescence	No Effect	Willingness to Cannibalize
Relative Internet investment	12.09	5.84							
Absolute Internet investment	13.49	5.85	.84***						
Dominance	0	1	.12*	.11*					
Enhancement	.58	.49	-.01	.00	.06				
Obsolescence	.10	.29	.07	.08	-.03	-.38***			
No effect	.32	.46	-.04	-.06	-.04	-.81***	-.22***		
Willingness to cannibalize	12.42	3.41	.24***	.22***	-.08	.00	-.04	.02	
Public ownership	1.66	.47	-.23***	-.22***	-.15**	-.11*	.10*	.07	-.08

* $p < .10$.

** $p < .05$.

*** $p < .01$.

Results

Table 5 presents regression coefficients for Equation 4. The models are statistically significant ($F = 11.74, p < .01$; $F = 26.62, p < .01$, for relative and absolute measures, respectively) and explain a significant percentage of variation in Internet banking investments ($R^2 = .14$ and $.12$, respectively).

In support of H_{1d} , the results suggest that, in general, managers of dominant firms invest more aggressively in radical innovation than do managers of nondominant firms ($\beta_{1R} = .12, p < .01$; $\beta_{1A} = .11, p < .01$). We also find significant support for H_2 ($\beta_{2R} = .12, p < .05$; $\beta_{2A} = .13, p < .05$). However, we do not find support for H_3 , which involves the main effect of expectations of enhancement ($\beta_{3R} = -.00$; $\beta_{3A} = .02$).

H_4 is supported ($\beta_{4R} = .07, p < .01$; $\beta_{4A} = .04, p < .05$), indicating that dominant firm managers who expect the new technology to make existing products obsolete invest more aggressively in radical innovation than do managers of nondominant firms with the same expectations. We also find support for H_5 , which posits that dominant firm managers who expect the new technology to enhance the performance of existing products invest less aggressively in radical innovation than do managers of nondominant firms with the same expectations ($\beta_{5R} = -.09, p < .05$; $\beta_{5A} = -.07, p < .05$). As we expected, banks with greater willingness to cannibalize ($\beta_{6R} = .24, p < .01$; $\beta_{6A} = .21, p < .01$) invest more in radical innovation, though public banks invest less in Internet banking ($\beta_{7R} = -.19, p < .01$; $\beta_{7A} = -.19, p < .01$).

Finally, Table 6 presents the parameter estimates for the replication tests of hypotheses H_{1a} – H_{1c} using Equation 1.

These results suffer from multicollinearity and should be interpreted with caution. The results in Table 6 are mostly consistent with our hypotheses (with the exception of the effect of deposits on investment, which is positive instead of negative). Thus, we find some additional support for H_{1a} and H_{1c} in the Internet banking context.

Discussion

Contributions to Research

This article makes three main contributions to the research on radical innovation (for a summary of results across measures and contexts, see Tables 7 and 8). First, we reconcile the opposing views in the literature on the relationship between dominance and radical innovation. Existing research typically equates dominance with related though conceptually distinct proxies, such as firm size, and rarely integrates the three facets of dominance to assess its overall effects on radical innovation. We show that relying solely on individual proxies leads only to an incomplete picture and, more significant, to misleading conclusions. Dominance is a rich composite of all three facets. Only when these facets are examined in a composite manner can the overall effects of dominance on radical innovation be properly identified.

Second, we help explain why some dominant firms invest aggressively in radical innovation and others do not. We examine the role of expectations; in particular, we examine how different expectations increase or decrease managers' motivation to maintain the status quo rather than

TABLE 5
Dominance and Expectations (Field Survey)

Independent Variables	Hypothesized Effect	Relative Internet Investment	Absolute Internet Investment
Dominance	+	.12**	.11**
Obsolescence	+	.12*	.13*
Enhancement	–	–.00	.02
Dominance $\times$ obsolescence	+	.07**	.04*
Dominance $\times$ enhancement	–	–.09*	–.07*
Willingness to cannibalize		.24**	.21**
Public ownership		–.19**	–.19**
R^2		.14	.12

* $p < .05$.

** $p < .01$.

TABLE 6
Facets of Dominance (Field Survey, Control Condition)

Independent Variables	Hypothesized Effect	Relative Investment	Absolute Investment
Assets in existing technology	–	–3.37**	–3.01**
Deposits in existing technology	–	3.38**	2.95**
Net equity	+	.22*	.26*
Willingness to cannibalize		.29*	.27*
Public ownership		–.13	–.10
R^2		.19	.16

* $p < .05$.

** $p < .01$.

TABLE 7
Summary of Hypotheses and Results on Facets of Dominance

Independent Variables	Hypothesis	Predicted Effect	Studies and Measures of Radical Innovation					
			Study 1		Study 2		Study 3	
			Relative Investment	Absolute Investment	Relative Investment	Absolute Investment	Relative Investment	Absolute Investment
Expenditures in existing technology	H _{1a}	-	Supported	Supported	Supported	Not supported	Supported	Supported
Market share in existing technology	H _{1b}	-	Supported	Supported	Supported	Supported	Not supported	Not supported
Wealth	H _{1c}	+	Supported	Supported	Supported	Supported	Supported	Supported
Dominance	H _{1d}	+	Supported	Supported	Supported	Supported	Supported	Supported

TABLE 8
Summary of Hypotheses and Results on Expectations and Dominance

Independent Variables	Hypothesis	Predicted Effect	Studies and Measures of Radical Innovation			
			Study 2		Study 3	
			Relative Investment	Absolute Investment	Relative Investment	Absolute Investment
Obsolescence	H ₂	+	Supported	Supported	Supported	Supported
Enhancement	H ₃	–	Supported	Supported	Not supported	Not supported
Dominance × obsolescence	H ₄	+	Supported	Supported	Supported	Supported
Dominance × enhancement	H ₅	–	Not supported	Not supported	Supported	Supported

invest in radical innovation. Research so far has not accounted for the effect of expectations on investment in radical innovation. Most research has instead focused on evaluating the impact of the new technology in hindsight, that is, after it has been introduced. Yet, as we argue and show, managers form expectations and make investments in radical innovation before the eventual effects are evident. Managers' a priori expectations strongly affect their investment decisions. To the best of our knowledge, our study is the first to incorporate the important role such expectations play. Our findings suggest that the fear of obsolescence is a greater incentive to invest in new technologies than is the lure of enhancement. Our findings also suggest that current research is overly pessimistic in portraying dominant firms as laggards in pursuing radically new technologies.

Contributions to Practice

Our results have implications for managers of both dominant and nondominant firms. For dominant firms, the results suggest that they have less to worry about than some of the existing research might lead them to believe. Although some aspects of dominance—greater investments and stronger market position in the existing product generation—reduce dominant firms' motivation to invest in radical innovation, dominant firms' greater wealth compensates for this reduction. Across three studies—two in the lab and one in the real-world context of Internet banking—dominance, as an overall composite of its various facets, has a positive impact on investment in radical innovation.

Our findings also point to an important way that dominant firms can overcome the negative effects of inertia and escalation of commitment. When managers of dominant firms believe that the new technology is likely to make the existing products obsolete, their behavior hardly suggests sloth or inertia. This finding may partly explain the energetically innovative behavior of firms such as Intel and Microsoft, where such fear of obsolescence is a strong part of the corporate mind-set (Gates, Myrvold, and Rinearson 1995; Grove 1996). The results suggest that such "paranoia" causes firms to pursue investments aggressively in radically new technologies.

Our results also show that dominant firm managers who believe that the new technology is likely to increase sales of their existing products actually invest less aggressively in the new technology than do managers who believe other-

wise. Consequently, the fear of loss as a result of obsolescence appears to be a much stronger motivator of investments in radical innovation among such firms than is the lure of gains from enhancement. This result has important implications for product champions and change agents trying to steer a dominant firm toward a new technology. Such persons should use obsolescence rather than enhancement as the rallying cry for their troops.

Appendix A **Suitability of MARKSTRAT Context**

First, decisions on new technology are intrinsic in the MARKSTRAT decision environment. Participants make decisions about the adoption of a new technology and develop radically new products (Vodite) even as they manage portfolios of products based on an existing technology (Sonite). More specifically, the Vodite fits our definition of a radical innovation as a product that involves technology and marketing skills that are new to the industry (see Garcia and Calantone 2002). For example, the MARKSTRAT2 student's manual describes Vodites as products that come from "a basic technological breakthrough" and that "satisfy an entirely different need than that of the Sonites" (Larrecche and Gatignon 1990). Second, managers and academics alike consider MARKSTRAT a realistic simulation of the real world (Glazer and Weiss 1993; Kinnear and Klammer 1987). Third, researchers have frequently used the simulation to study how managers make decisions (e.g., Glazer, Steckel, and Winer 1992; Glazer and Weiss 1993). Therefore, MARKSTRAT provides a well-tested research environment. Fourth, participants make decisions on various business issues, including targeting and positioning, advertising, sales force, pricing, and distribution (Larrecche and Gatignon 1990) in addition to technology investment decisions. Because decision makers' attention is not focused on technology and new product decisions, MARKSTRAT provides a relatively conservative means of testing our research hypotheses. Fifth, the MARKSTRAT context enables us to collect data on (1) the decision-making processes used by participants over time and (2) the actual decisions they made during this period. This longitudinal information is extremely difficult to obtain in the field.

Appendix B Measures

Items marked with an asterisk are reverse coded. All Likert-type items are seven-item, "strongly agree" to "strongly disagree," and have Cronbach's alpha and item parameter values for the factor structure matrix reported.

Measures of Constructs Used in Study 2

Perceived Dominance

1. Our performance so far has been better than that of everyone else in our industry.
2. We have had few serious threats to our position as industry leaders so far.
3. We have led the market from the start.

Perceived Loss

How would you characterize the situation you face in the MARKSTRAT industry in the next period?

- | | | | | | | | |
|----|-----------|---|---|---|---|---|-----------|
| a) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | Potential | | | | | | Potential |
| | for loss | | | | | | for gain* |
| b) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | Positive | | | | | | Negative |
| | Situation | | | | | | situation |

Measures of Constructs Used in Study 3

Investment in Internet Banking

Listed below are statements regarding your Internet-related investments:

- (A) in general
- (B) relative to bricks-and-mortar operations
- (C) relative to total development expenditures

Please indicate the extent to which you agree or disagree with the following statements.

Measure of Absolute Investments in Internet Banking ($\alpha = .86$)

(A) Our Internet related investments in general:

1. We have done very little with respect to Internet banking at our bank.* .92
2. Our bank has only a token Web presence.* .74
3. We haven't done much yet to develop our Internet banking capabilities.* .93
4. Most of our development expenditures are targeted toward Internet banking efforts. .57

Measure of Relative Investments in Internet Banking ($\alpha = .88$)

(B) Relative to our bricks-and-mortar operations:

1. We have not invested aggressively in Internet banking.* .96
2. Our bank is yet to make significant investments in Internet banking.* .94
3. We have earmarked few managerial resources to Internet banking in the short term.* .71

Nonperceptual Measure of Investments in Internet Banking

(C) Relative to total development expenditures:

Please indicate the percentage of your bank's development expenditures on Internet banking in the last year, relative to total development expenditures: _____ %

Willingness to Cannibalize ($\alpha = .70$)

1. Our bank's investments in bricks-and-mortar branches make switching to Internet banking difficult.* .74
2. We rely too much on our bricks-and-mortar branches to switch focus to Internet banking.* .78
3. We are reluctant to cannibalize our investments in bricks-and-mortar branches.* .63

Technology Expectations

Please indicate your expectations about the likely effects of the Internet on bricks-and-mortar banking IN GENERAL (i.e., across all retail banks), by allocating 100 points across the following three alternative scenarios.

For example, if you strongly believe that Internet banking is very likely to have **no effect** on bricks-and-mortar banking in the next two years, you could allocate the 100 points above as follows: (a) 0 points, (b) 0 points, and (c) 100 points. If you believe all three scenarios are equally likely, you could allocate the 100 points above as follows: (a) 33.3 points, (b) 33.3 points, and (c) 33.3 points.

Scenario	Points Awarded	
	In the Next Two Years	In the Next Ten Years
1. Internet banking is likely to make bricks-and-mortar banking <i>obsolete</i> .		
2. Internet banking is likely to <i>enhance</i> bricks-and-mortar banking.		
3. Internet banking is likely to have <i>no effect</i> on bricks-and-mortar banking.		

Appendix C Experimental Manipulations

To: XXX Industry Participants
From: Technology Marketing Consultants, Inc.
CC: MARKSTRAT Administrator
Date: XX/XX/XX
Subject: How will Vodite technology affect the Sonite industry?

Per your request, we conducted an extensive study of the likely effects of the Vodite technology on the Sonite industry. This study involved analysis of multiple sources of data, including the following:

- In-depth interviews with 78 leading technology and market experts
- A survey of 2132 likely Vodite buyers
- An observational study of product usage patterns in 165 selected households in a representative test market
- Historical data on sales and adoption patterns of other (comparable) consumer durable goods

[Obsolescence Manipulation, emphases in original]

Based on the results of this analysis, it is our opinion that products based on the Vodite technology are *quite likely* to make Sonite products *obsolete*. Vodites fulfill similar needs relative to Sonites and serve similar customers. Yet the performance of Vodite-based products is likely to be superior to Sonite products. For example, the introduction of tape recorders decreased the sales of gramophones. The Vodite technology is also projected to offer greater opportunities for performance improvement relative to the Sonite product category. Thus, our analysis indicates that Sonite sales will probably drop substantially as the Vodite technology is developed and introduced to the market.

[Enhancement Manipulation, emphases in original]

Based on the results of this analysis, it is our opinion that products based on the Vodite technology are *quite likely* to make Sonite products *more effective* than before. Vodites fulfill similar needs relative to Sonites and serve similar customers. Moreover, their performance characteristics are likely to *complement* those of the Sonite products. For example, the introduction of camcorders led to an increase in the sale of videocassette recorders. The Vodite technology is also projected to offer greater opportunities for performance improvement in the Sonite product category. Thus, our analysis indicates that Sonite sales will probably increase substantially as the Vodite technology is developed and introduced to the market.

[No-Effect Manipulation, emphases in original]

Based on the results of this analysis, it is our opinion that products based on the Vodite technology are *quite likely* to have *no effect* on Sonite products. Vodites fulfill somewhat different needs relative to Sonites. The performance characteristics of Vodite-based products are likely to be *different* from Sonite products. For example, the introduction of microwave ovens had no effect on the sales of conventional ovens. Performance improvement in the Vodite technology is also projected to be independent of any improvements in the Sonite product category. Thus, our analysis indicates that Sonite sales will probably be unaffected as the Vodite technology is developed and introduced to the market.

[Control Condition]

Our analysis indicates little consensus among experts and consumers on how the Vodite technology will affect Sonite products. Three different scenarios are possible.

- The Vodite technology may make Sonite products obsolete, leading to a decrease in Sonite sales. For example the introduction of tape recorders decreased the sales of gramophones.
- The Vodite technology may make Sonite products more effective, leading to an increase in Sonite sales. For example, the introduction of camcorders led to an increase in the sale of videocassette recorders.
- The Vodite technology may have no effect on Sonite products. For example, the introduction of microwave ovens had no effect on the sales of conventional ovens.

Given the uncertainty in the market at the present time, we are unable to provide any definitive forecasts on which of these three scenarios is most likely to come true.

Appendix D Suitability of Internet Banking Context

First, Internet banking fits our definition of radical innovation. In the banking context, the World Wide Web is widely considered an innovation that caused discontinuities both in the technology embedded in new products that employed it and in the marketing skills needed to market the products (Schotema 2001; for a more general discussion of the World Wide Web and radical innovation, see also Garcia and Calantone 2002). Internet banking was, especially at the time of the study, salient in the minds of banking executives (Fraser 1996). Yet only a handful of banks had achieved the ability to conduct transactions over the Internet during 1999 and 2000. Specifically, according to data from the Online Banking Report, only 319 (3.12%) of the 10,239 banks operating in the United States in 1999 had Internet transaction capability by the end of that year, and only 462 (4.62%) of the 10,006 banks operating in the United States in 2000 had Internet transaction capability by the end of that year. The banks' actions with respect to Internet banking were considered likely to have considerable impact on their competitive positions going forward. Second, our research also revealed considerable variance in opinions about the likely effects of the Internet on bricks-and-mortar banking. Third, U.S. banking firms vary considerably in market positions, assets, and resources, which thereby enabled us to test the effects of dominance on innovation.

Structured interviews with 14 industry executives with diverse designations (chief information officer, chief technology officer, e-commerce director, head of retail banking, president) provided further confirmation of the suitability of the Internet banking context for our research on radical innovation. From the interviews, it became clear that some managers expected Internet banking to make bricks-and-mortar banking obsolete in the not-too-distant future, but others expected Internet banking to enhance bricks-and-mortar banking. These two expectations closely fit the two key conditions that are of theoretical interest to us: obsolescence and enhancement.

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Joost M.E. Pennings
University of Illinois at Urbana-Champaign
Department of Ag & Consumer Economics
Marketing/Decision Sciences Group
326 Mumford Hall
1301 W. Gregory Drive
Urbana, IL 61801
United States of America