



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

Rajesh K. Chandy, Jaideep C. Prabhu, and Kersi D. Antia

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Are dominant firms laggards or leaders at innovation? Research provides conflicting and controversial answers to this important question, with most suggesting that inertia and investments in existing products reduce dominant firms' tendency to innovate.

In this report, authors Chandy, Prabhu, and Antia attempt to resolve contradictory findings on the effect of dominance on radical innovation, and explain why some dominant firms invest aggressively while others don't.

They argue that dominance is a multi-faceted construct, including (1) investments in current technology, (2) market share in current technology, and (3) overall wealth, each generating differing propensities to innovate. In order to identify the overall effects of dominance, it is necessary to consider the combined effects of these facets.

Further, they examine a hitherto ignored, yet potentially significant, driver of innovation: the technology expectations of managers within dominant firms. They show that these managers have widely divergent expectations with regard to 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 non-dominant firms.

Study and Findings

The study combines insights from lab studies with those from field interviews, archival data, and a survey of bricks and mortar banks' responses to Internet banking. Findings include the following:

First, while two facets of firms' dominance—investments and market share in the current technology—tend to decrease the propensity to innovate, one facet—wealth—increases this propensity. Overall, the positive effect of wealth outweighs the negative effects of the other two facets.

Second, technology expectations have potent effects on innovation. In particular, the fear of obsolescence is a more powerful motivator of investment in radical innovation than is the lure of enhancement. Dominant firms that fear obsolescence are much more aggressive in pursuing radical technologies than their less-dominant counterparts with the same expectation.

Implications

For dominant firms, the results suggest that existing research might be overly pessimistic in regard to the firms' propensity to innovate. While it is true that some aspects of dominance—greater investments and stronger market position in the existing product generation—reduce dominant firms' motivation to invest in radical innovation, it is also true that 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.

Further, if managers of dominant firms believe that the new technology is likely to make the existing products obsolete, they are likely to aggressively pursue investments in radically new technologies. Such “paranoia” appears to be a much stronger motivator of investments in radical innovation than the lure of gains from enhancement. Managers who believe a new technology is likely to *increase* sales of their existing products will actually invest *less* aggressively in the new technology than managers who believe otherwise. This result suggests that product champions and change agents trying to steer a dominant firm toward a new technology should use obsolescence rather than enhancement as their rallying cry for the troops.

For non-dominant firms, these findings suggest a careful consideration of the impact of their new product announcements on the investment decisions of dominant firms. While such announcements can provide visibility and legitimacy, claims of inducing obsolescence of the existing technology could alert dominant firms to the danger of inaction, thereby increasing the odds that dominant firms will aggressively pursue the radical innovation. Dominant firms' deep pockets and ability to sustain losses in the short term make them formidable competitors. Non-dominant firms may therefore be better off not emphasizing the issue of obsolescence in their public pronouncements.

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Introduction

The relation between dominance and innovation is one of enduring (and indeed, renewed) interest to scholars in marketing, corporate strategy, economics, and sociology, among others (Cooper and Schendel 1976; Henderson 1993; Miller 1990; Scherer 1992; Schumpeter 1942). For the most part, the prognosis from this research has been a gloomy one, albeit one 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 the preferred mode of action, and dominant firms spurn radical innovations or, at best, leave them to collect dust on laboratory shelves (e.g., Utterback 1994). This reluctance to pursue radically new products eventually leads to the dominant firms' weakening and downfall, as the technological environment turns on the dominant firms. Their very success sows the seeds of these firms' failure. In fact, some 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, plunging him to the earth (Miller 1990).

But reality may not adhere to the script of a Greek tragedy. As Cohen and Levin (1989) state in an extensive review of the literature, the results linking dominance and innovation "are perhaps most accurately described as fragile" (p. 1078). A more recent school of thought notes that dominant firms do enjoy some important advantages. For example, they have greater access to resources—a key advantage when seeking to build and sustain radically new technologies and markets. Some very recent research suggests that large and incumbent firms are often some of the most aggressive radical innovators (Chandy and Tellis 2000; Zucker and Darby 1997). A casual glance at business periodicals reveals that many dominant firms do actively pursue such new technologies, and are relatively successful at it. What explains this performance? We know little about why some dominant firms pursue radical innovations aggressively, while others don't.

Our study attempts to reconcile the opposing views on the relation between dominance and radical innovation. First, we view dominance as a composite of several facets, each with different and countervailing behavioral effects on firms' propensity to innovate. This view is in contrast with existing research which has (a) typically equated dominance with related, though conceptually distinct, proxies such as firm size and incumbency, and (b) rarely integrated the different facets of dominance to assess its overall effect on radical innovation. By elucidating the behavioral consequences of each facet of dominance and by examining the combined effects of these facets, we seek to provide a clearer understanding of the relationship between dominance and innovation, something that has repeatedly been called for by prominent researchers in the field (e.g., Scherer 1992).

Second, we argue that there is another, hitherto-overlooked reason why some dominant firms invest aggressively in radical innovation while others don't: managerial

expectations. When a radically new technology is in its infancy, managers facing the same technology may hold differing expectations about its likely effect on existing products. Specifically, managers may hold at least one of three differing expectations about its likely effect on existing products:

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

For example, articles in the business press and our interviews during the late 1990s with managers making investment decisions on Internet retailing ventures (e.g., banking, books, music) suggest considerable variance in managers' expectations about whether the Internet would enhance bricks and mortar retailing, make it obsolete, or have no effect on it.

We argue that these differing expectations result in significantly different levels of investment in the radical innovation. Moreover, managers with the *same* technology expectations may exhibit very different investment behavior, depending on their level of dominance in the existing product generation. Studying expectations and their interaction with firms' overall dominance allows 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. Though an emerging stream of research focuses on the effects of radically new technologies on existing products (e.g., Anderson and Tushman 1990; Cooper and Schendel 1976; Tushman and O'Reilly 1997), most of this research examines the impact of new technologies in a historical context, *after* they have already taken place. Post hoc, it is possible to categorize specific technologies as having helped, hindered, or had no effect on the existing product category (Geroski, Machin, and van Reenen 1993; Utterback 1994). But managers make investment decisions *before* the effects have taken place. Key decisions are made while the technology is still in its infancy, 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 have noted the importance of a "vision" for the future in promoting radical innovation (cf. Ohmae 1984). By introducing managers' expectations into the analysis, we are able to 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 (see Child 1972). “Paranoid” firms (e.g., Grove 1996), we show, make the most aggressive innovators.

Finally, we use experimental techniques to investigate the causal relationships between dominance, expectations, and radical innovation, as well as field studies to provide real-world context and insight. Very few studies of innovation have employed time-series experimentation to examine causality (Poole, Van de Ven, Dooley, and Holmes 2000; Weick 1967). Our field study allows 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.

The rest of this paper is organized as follows. In the sections below, we present our definitions and conceptual assumptions, and then introduce hypotheses on the effects of dominance and technology expectations on radical product innovation. Next, we describe three studies—two lab-based and one field-based—that test the hypotheses. We end with a discussion of implications for researchers and managers.

Theory

Definitions

Dominance refers to the extent of market power enjoyed by a firm (Bain 1968; Scherer 1980). A *radical innovation* is a product that involves technology and marketing skills that are new to the industry (see Garcia and Calantone 2002). The greater a firm's emphasis on the radically new product, the more *aggressive* it is in radical innovation.¹ By *technology expectations* we mean 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 as well as the ability to invest are likely to be the most aggressive in pursuing the radical innovation. Dominance impacts motivation as well as ability to invest. As we show below, dominant firms are prone to inertia and escalation of commitment, which reduce motivation to invest. As a result, these firms may show a preference for the status quo, i.e., continuing with the existing product generation. But dominant firms are also wealthier, and therefore have greater ability to invest.

Technology expectations play a critical role in driving investment in radical innovation. Specifically, they alter the manner in which managers frame this investment and, by doing so, amplify (or diminish) managers' motivation to pursue the radical innovation. This effect of expectations on the motivation to pursue the radical innovation results in a corresponding change in how aggressive firms are in investing in it.

Study Scope and Assumptions

For the sake of conceptual and empirical clarity, we restrict our scope to *incumbent firms*. Thus, we do not seek to explain the behavior of firms that have no presence at all in the existing product generation. This is in line with the bulk of past research, which has focused on the behavior of incumbent firms (e.g., Chandy and Tellis 1998; Hannan and Freeman 1989; Scherer 1992). All incumbent firms have a stake in the status quo; that is, they have some investments in the current product generation.

Following Solow (1956), 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). While some dominant firms might appear all-powerful and invincible at a point in time, over the long run few firms control the fate of technologies and industries (Solow 1956).

We also assume that managers (even those of wealthy firms) have *capital constraints*. One consequence of this constraint is that investing in the new product implies less investment in existing products, i.e., there is a trade-off between the existing and the new products. Investing in the new product is likely to make the firm less competitive in the existing product generation (e.g., Blundell, Griffith, and van Reenen 1999; Hall, Griliches, and Hausman 1986). The default course of action is therefore to continue with the existing product generation. The alternate course of action is to invest in the new product.

Hypotheses

In the section that follows, we first introduce hypotheses on the impact of dominance on investment in radical innovation. Next, we present hypotheses on the effect of technology expectations on such investment. We end with hypotheses on the interaction of dominance and technology expectations on investment in radical innovation.

Dominance and Radical Innovation

Are dominant firms more or less likely than non-dominant firms to invest aggressively in a radical innovation? Schumpeter (1942) first highlighted the role of market power on innovation, arguing that dominance favors radical innovation. A steady literature stream has since attempted to empirically test Schumpeter's hypothesis (see Cohen 1995; Scherer 1992). Yet, few researchers have provided a behavioral rationale for the radical innovation behavior of dominant firms (Scherer 1992). Indeed, prominent researchers in the field have criticized the atheoretical nature of work in the field (Cohen 1995). Also, much of the literature has focused on industry-level measures of market concentration, rather than firm-level measures of dominance (cf. Cohen 1995).

We now note the multi-faceted nature of dominance, and provide behavioral explanations for why each facet leads to innovation (or lack thereof) on the part of dominant firms. We also consider how, taken together, these facets influence the overall impact of dominance on investment in radical new technologies.

The Many Faces of Dominance

Consider Microsoft or Intel today. They are well entrenched, and thus have larger investments in their current market than other firms. They also have larger market shares than other firms. Finally, they are wealthier, and have greater access to resources than other firms. These three facets—higher investments, higher market shares, and greater resources—serve to define what it means to be dominant (cf. Bain 1968; Borenstein 1990, 1991). These three facets may also have different impacts on dominant firms' motivation and ability to pursue radical innovation. While there is a substantial literature on some behavioral effects, such as escalation of commitment and inertia which we discuss below, previous research has not linked these effects to the three facets of dominance. Nor has previous research 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 seeks to explain why people continue to pursue courses of action even after it is irrational to do so (Boulding, Morgan, and Staelin 1997; Brockner and Rubin 1985; Staw 1981). According to this theory, managers will frame the decision to invest in the new product relative to continuing with the initial

commitment to the old product. The more committed the manager is to the old course of action, the greater the loss the manager will perceive in the decision to switch to the new course of action (Bazerman 1994). As a consequence of loss aversion (Kahneman and Tversky 1979), the manager is therefore unlikely to switch from the old course of action (Brockner and Ruben 1985) and will place less emphasis on the new course relative to the old course of action.

Recall that all incumbents, by definition, have some investments in the existing product generation. Therefore, all incumbents, dominant and non-dominant, will likely have some commitment to the existing product (cf. Brockner and Ruben 1985; Staw 1981). But since dominant firms have more investments in the existing product than other firms, they are especially prone to escalate their commitment to the existing product relative to the radical innovation (e.g., Chandy and Tellis 1998). Thus,

H_{1a}: The larger the investments by a firm in the existing product generation, the less aggressive its managers will be in their investments 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, are well documented in prior theory (Hannan and Freeman 1989; Nelson and Winter 1982). All incumbents are prone to inertia (Hannan and Freeman 1989) 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 to be, the more it will reinforce its commitment to this course of action. A strong market position signals the validity of the decision-making procedures that the firm currently uses; it legitimizes precedents, and causes these to become normative standards for the future (Hannan and Freeman 1989; Nelson and Winter 1982). The firm subsequently makes decisions about the future based simply on inertia.

Based on this argument, the stronger a firm's market position, the greater the inertial constraints on it. Thus, dominant firms will be less motivated to switch from the status quo, and will therefore invest less aggressively in the radical innovation relative to the existing product than non-dominant firms. Hence,

H_{1b}: The stronger the market position of a firm in the existing product generation, the less aggressive its managers will be in their investments 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 the fact that dominant firms also have more resources than other firms. The greater wealth of dominant firms provides them with greater ability to invest in the radical innovation. Greater wealth also cushions dominant firms from the risk of failure inherent in radical innovation (Nohria and Gulati 1996). Thus the dominant firm has the means to experiment extensively in research and

development and this could result in the dominant firm investing more in the new product.

Managers of dominant firms may also invest heavily in radically new products relative to existing products because they may stand a greater chance of making the new idea a marketplace success than firms with few financial and marketing resources. For example, dominant firms may have larger sales forces, and may be able to ensure greater distribution access for a fledgling product (Galbraith 1956; Schumpeter 1942). Thus:

H_{1c}: The greater the wealth of a firm, the more aggressive its managers will be in their investments in the radical innovation relative to the existing product generation.

Taken together, what are the *overall* effects of dominance on the aggressiveness with which managers invest in radical product innovation? Recent evidence suggests that, overall, dominant firms are likely to be more aggressive than other firms in their investments in a radically new product. Radical innovations are resource intensive, and may be getting increasingly so with time (e.g., Chandy and Tellis 2000; Jelinek and Schoonhoven 1990; Tushman and O'Reilly 1997). Also, 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 large recent literature on the (beneficial as well as 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). In effect, the implication from the above arguments is that any increased inertia and escalation of commitment that comes with dominance may be outweighed by the benefits from greater wealth. In light of the recent findings noted above, we propose the following working hypothesis:

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

While H_{1a}-H_{1d} shed light on the differential effects of dominance on innovation and help clear up some of the conflict in the existing literature, they do not provide a complete picture of factors influencing radical innovation. A critical but overlooked driver of investment in radical innovation is the manager's expectation about the likely effects of this technology on existing products. We now develop hypotheses on the role of technology expectations on firms' radical innovation decisions in general. We then consider how these expectations influence dominant versus non-dominant firms.

Expectations and Radical Innovation

Research on managers' technology expectations is limited, as is research on the impact of these expectations on firms' investments in radical innovation (e.g., Garud, Nayyar, and Shapira 1997; Levinthal and Purohit 1989; Wind and Mahajan 1997). In the absence of directly applicable conceptual and empirical literature,

we develop initial hypotheses on how expectations influence managers' motivation, and therefore, level of investment in radical innovation. We reiterate that managers facing objectively the same new technology often have different expectations about the effects of the new on the old technology. Different expectations will result in very different actions vis-à-vis the new technology.

Throughout the section below, we compare the condition in which managers expect the new technology to enhance the existing technology or make it obsolete, with the case in which they expect the new technology to have no impact on the 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 feel less secure about their current course of action (e.g., Jassawala and Shashittal 1998). The new technology, in this case, will have a negative effect on the success of the current course of action, based as it is upon the old, soon to be obsolete, technology. Managers who expect obsolescence will therefore perceive that continuing with the existing technology will lead to a major loss in market position. On the other hand, managers who expect no effect of the new technology on existing products will perceive no such loss (and therefore, no effect on the success of the current course of action) (cf. Clark and Montgomery 1996; Grove 1996). Thus:

H₂: Managers who expect the radically new technology to make the performance of existing products obsolete will invest more aggressively in the radical innovation relative to the existing product generation than managers 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 will invest *less* aggressively in the new technology than managers who expect no effects. The rationale for this hypothesis rests on the absence of a compelling incentive to switch emphasis from an existing technological base that is only expected to be enhanced by the new technology.

Specifically, managers who expect enhancement will not frame investing in the new technology and continuing with the old technology as competing courses of action. Moreover, they will perceive that the existing technology will play a significant, enhanced role in the market (e.g., Jassawala and Shashittal 1998). They will therefore expect the new technology to have a positive effect on the success of the current course of action. Since the new technology is an exogenous shock, this positive outcome will occur regardless of the firm's own investments in the new technology (Solow 1956). The managers' perception of greater success with 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, will experience less inertia and escalation of commitment, because they receive no such reinforcement. Thus:

- H₃: Managers who expect the radically new technology to enhance the performance of existing products will invest less aggressively in the radical innovation relative to the existing product generation than managers who expect the new technology to have no effects on existing products.

Interaction of Dominance and Expectations

As noted earlier, there is considerable empirical evidence that some dominant firms invest very aggressively in radical new technologies while 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 level of investment in radical innovation.

Obsolescence. Under expectations of obsolescence, managers of all firms, dominant and non-dominant, will perceive that staying with the current course of action will cause a loss in market position. However, dominant firms have more to lose from obsolescence relative to their non-dominant competitors. Specifically, dominant firms risk the loss of their strong market position, since their success is based upon the old technology. Thus, managers of dominant firms will perceive the new technology to be a greater threat to their market position than managers of non-dominant firms will. Therefore, they will be even more motivated than non-dominant firms to break out of their inertia, reduce their commitment to the existing product generation, and invest aggressively in the radical innovation. Thus:

- H₄: Dominant firm managers who expect the new technology to make existing products obsolete will invest more aggressively in the radical innovation relative to the existing product generation than non-dominant firms with the same expectations.

Enhancement. We had noted earlier that when managers expect the new technology to enhance the performance of the existing technology, both dominant and non-dominant firms may invest less aggressively than otherwise. However, dominant firms will expect to gain more than non-dominant firms from the positive influence of the new technology. Specifically, given their stronger market position, any positive influence from the new technology on existing products will be magnified in the case of dominant firms. Managers of dominant firms will therefore expect to be even more successful from continuing with the existing course of action. This perception of renewed—indeed, enhanced—success causes dominant firms to be less motivated and more wedded to the status quo when they expect enhancement. Therefore, they will invest even less aggressively in the radical innovation in this condition. Thus:

- H₅: Dominant firm managers who expect the new technology to enhance the performance of existing products will invest less aggressively in the radical innovation relative to the existing product generation than non-dominant firm managers with the same expectations.

Taken together, the preceding hypotheses suggest that relative to their non-dominant counterparts, managers of dominant firms will invest more (less) aggressively in the radical innovation, given expectations of obsolescence (enhancement).

Summary

The different facets of dominance may affect investment in radical innovation differently. Strong market positions and large investments in the existing product generation may cause dominant firms to be less motivated to invest in radical innovation than otherwise, due to inertia and escalation of commitment effects respectively. However, greater wealth may increase dominant firms' ability to invest, and thus outweigh the negative effects of escalation of commitment and inertia. In overall terms, therefore, dominant firms may invest more aggressively in radical innovation than non-dominant firms.

Technology expectations play a key role in explaining innovation. In general, expectations of obsolescence will result in more aggressive investment in the radical innovation relative to the existing product generation, while expectations of enhancement will have the opposite effect. Technology expectations also help explain why similarly dominant firms behave differently with respect to radical innovation. Dominant firms are not necessarily laggards at radical innovation. Those that expect obsolescence will be especially aggressive in pursuing radical innovations. However, those that expect the enhancement of existing products will invest far less aggressively.

Method

To the best of our knowledge, the impact of technology expectations and dominance on innovation investments has not been empirically studied before. In this section, we describe the methods we use to test our hypotheses. Specifically, we use 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 under study. In-depth interviews allow us to obtain direct, first-hand insights into the actual dynamics of technology expectations and radical innovation. Archival data, together with our survey of managers in an industry confronting a 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 (Campbell and Fiske 1959). 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 (Meyer 1982).

Lab Studies

Research Context

We use the MARKSTRAT2 simulation (Larreche and Gatignon 1990) to test the hypotheses presented earlier in a controlled setting. MARKSTRAT provides an excellent environment for this research for several reasons. 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 MARKSTRAT manual describes Vodites as products that come from “a basic technological breakthrough” and which “satisfy an entirely different need than that of the Sonites” (MARKSTRAT2 Student’s Manual, p. 14). Second, MARKSTRAT is considered by managers and academics alike to be a realistic simulation of the real world (Glazer and Weiss 1993; Kinnear and Klammer 1987). Third, the simulation has been used frequently by researchers to study how managers make decisions (e.g., Glazer, Steckel, and Winer 1992; Glazer and Weiss 1993). Hence it provides a well-tested research environment. Fourth, participants make decisions on a variety of business issues, including targeting and positioning, advertising, sales force, pricing, and distribution (Larreche and Gatignon 1990), in addition to technology investment decisions. Since decision makers’ attention is not focused on technology and new product decisions, MARKSTRAT provides a relatively conservative means of testing our research hypotheses. Finally, the MARKSTRAT context allows 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.

We test our hypotheses over two separate studies. Study 1 tests H_{1a-d} , which describe competing arguments on the role of dominance in decisions on radical innovation. Study 2 tests H_2-H_5 , which incorporate the effects of technology expectations on radical innovation. The sections below provide the details of each study, and descriptions of the results.

Study 1: Lab Study

Subjects and Procedure

This study uses data from eight MARKSTRAT2 runs (each run involves 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. We then randomly assigned these teams to 1 of 5 possible firms per industry (in MARKSTRAT there are 5 firms per industry). All participants played the run over 7 periods in six of the runs and 10 periods in the other two. Overall, therefore, we have data from 40 firms competing across eight runs (industries) over 7–10 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. We used these variables to test for the existence and relative strength of escalation of commitment, inertia, and wealth respectively, as well as the overall effect of dominance on firms' relative expenditure on new technology (H_{1a-1d}).

The MARKSTRAT manual instructs participants that the existing and new technologies are independent of each other, i.e., 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.

Measures

Consistent with our definition, we measure *investment aggressiveness* in a relative sense, as each firm's expenditure in the Vodite market divided by its combined expenditures in the Sonite and Vodite markets. These expenditures include R&D and advertising expenses that are specific to the Sonite and Vodite products. This measure of investment in radical innovation thus measures the firm's emphasis on Vodite investments relative to its overall product investments. For the sake of completeness, we also measure investment in absolute terms, as simply the firm's total investments in the Vodite market.

Use of the relative measure results in a dependent variable that lies between zero and one. A simple linear regression model could lead to predictions that are less than zero or greater than one. To avoid this problem, we use a logistic transformation, $y = \ln[p/(1 - p)]$, which causes the predicted values to be between zero and one, and also provides a unit of measurement that is more linearly related to the independent variables (Neter, Wasserman, and Kutner 1985). Our use of GLS estimation for each operationalization of the dependent variable allows us to report R^2 measures. To facilitate the logistic transformation, we replace data points with zero values with a small fraction (.01), and those with values of one with .99.

In MARKSTRAT2, sales force and distribution-related expenses are not specific to a particular technology. Hence 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. While firms do spend money to purchase Sonite and Vodite specific market research, the costs of the market research are small compared to the other expenses. They are also relatively constant across all teams (e.g., see Glazer and Weiss 1993, p. 516). Hence we do not include sales force and market research expenses in calculating technology expenditures.²

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 calculate the average cumulative expenditures by the firm in the existing (Sonite) technology until the previous period. The inertia effect is based on its market position. To test the inertia effect, we use 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 use the average cumulative budget available to the firm until the current period.³ (In MARKSTRAT, a firm's budget is a linear function of its net marketing contribution or profit.) We obtain 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 a variety of other variables each period.

We also test the overall effect of dominance on investment in the radically new technology. To do so, we first conduct a principal component factor analysis of the above three variables (past investment, market share, and budget). The variables load on to a single factor, suggesting that a composite index of dominance comprising the three facets is appropriate (Bollen and Lennox 1991). We thus use the factor score from this factor analysis as a consolidated measure of firm dominance (Gorsuch 1974; Lastovicka and Thamodaran 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 below also allows 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-d}, which relate to the effect of dominance on investment in the 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 using the factor score from the factor analysis described above) on radical innovation.

$$\text{Investment}_{it} = \alpha_0 + \alpha_1 (\text{Average Cumulative Expenditures in Existing Technology})_{i,t-1} + \alpha_2 (\text{Average Market Share in Existing Technology})_{i,t-1} + \alpha_3 (\text{Average Cumulative Budget})_{i,t} + \phi (\text{Industry Avg. Expenditure}) + \kappa(\text{Firm}) + v_i + \varepsilon_{it} \quad (1)$$

$$\text{Investment}_{it} = \beta_0 + \beta_1 (\text{Dominance})_{i,t-1} + \lambda(\text{Industry Avg. Expenditure}) + \gamma(\text{Firm}) + v_i + \varepsilon_{it} \quad (2)$$

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

$$\varepsilon_{it} = \rho\varepsilon_{i, t-1} + \eta_{it},$$

$$|\rho| < 1 \text{ and } \eta_{it} \sim \text{IIN}(0, \sigma_{\eta}^2)$$

v_i = team-specific errors

Industry Average Expenditure is a variable that controls for industry-specific effects,

and

Firm is a matrix of dummies that control for firm-specific fixed effects.

Results

Table 1 presents the estimation results for Study 1. All reported coefficients reflect standardized values (Kim and Ferree 1981). The results for directional hypotheses reflect one-tailed significance levels. Here and throughout the paper, we use the terms α_{iR} and β_{iR} to refer to the coefficients based on the relative measure, and α_{iA} and β_{iA} 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., due to differences in starting positions for firms 1–5). We only include statistically significant fixed effects in the final regression equation.

Table 1. Dominance and Its Facets (Study 1)

Independent Variables	Process	Hypothesized Effect	Relative Vodite Investment		Absolute Vodite Investment	
			Model 1 ^a	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

^a Models 1 and 2 present the estimation results of equations 1 and 2 respectively.

* $p < .10$; ** $p < .05$; *** $p < .01$

The escalation of commitment effect (H_{1a}) implies that a firm with many investments in an existing product generation would invest less aggressively in radical innovation. The results in Table 1 reveal a significant, negative effect of past Sonite Expenditures on the aggressiveness with which firms invest in the radical innovation ($\alpha_{1R} = -.08, p < .10$; $\alpha_{1A} = -.18, p < .01$). Thus the decision makers remain committed to their investments in the existing product generation, causing them to invest less aggressively in the radical innovation. This result supports recent findings by Boulding, Morgan, and Staelin (1997) that indicate that escalation of commitment is quite a pervasive phenomenon among managers involved in new product development activities. Further, these results suggest that the escalation of commitment effects are powerful enough to appear even in situations where product investment decisions are but one of many decisions that managers make. Most studies so far on escalation of commitment involve situations where the technology investment decision is the only (or the primary) decision made by subjects.

The inertia effect (H_{1b}) argues that, other things being equal, managers with strong market positions are likely to continue with the existing product generation at the expense of the radical innovation. We find that firms with high lagged market shares are likely to invest less aggressively in the new Vodite product than other firms ($\alpha_{2R} = -.20, p < .05$; $\alpha_{2A} = -.17, p < .05$). This result provides evidence to indicate the presence of inertia on the part of decision makers in dominant firms.

The wealth effect (H_{1c}) suggests that high profits endow dominant firms with resources that allow them to be more aggressive in their investments in the radical innovation than other firms. The results indicate a positive and significant effect of firms' budgets on investment in radical innovation ($\alpha_{3R} = .40, p < .01$; $\alpha_{3A} = .24, p < .01$). This result confirms the presence of a wealth effect in the data.

We further test the overall effect of dominance (H_{1d}) by estimating Equation 2 noted earlier. 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 ($\beta_{1R} = .40, p < .01$; $\beta_{1A} = .15, p < .10$). This result suggests that other things being equal, dominant firms invest more aggressively in radical innovation than other firms.

Discussion

Study 1 clarifies some important conceptual issues. The results suggest that the different facets of dominance—market share, investments, and wealth—affect innovation behavior differently, and that it is therefore important to account for these differing effects. The results remain robust across relative and absolute levels of investment in new technology, and help us integrate the many faces of dominance. After accounting for unobserved heterogeneity, we find that dominance, overall, has a positive effect on the aggressiveness with which managers pursue radical innovation.

But managers may hold differing expectations about the likely effects of the new technology on existing products. The data from Study 1 do not allow us to test if these expectations have systematic effects on innovation decisions, as hypotheses H_{2-5} predict. We manipulate participants' expectations about the effects of the new technology in a second study, which we describe below.

Study 2: Experiment

Researchers studying organizational innovation rarely employ the experimental approach to empirical research (cf. Poole et al. 2000). Weick's (1967) criticism of the field for its neglect of the experimental method continues, by and large, to hold. An unfortunate consequence of this situation may be that the internal validity of many studies in the area may be open to question. In this section, we describe a study that uses time-series, cross-sectional data to test our causal relationships in a controlled setting.

This study seeks to answer the question: How do expectations about new technology influence managers' product development decisions in dominant and non-dominant firms? As in Study 1, we used the MARKSTRAT2 simulation to test the hypotheses.

Subjects and Procedure

Participants in the simulation were graduate students in business at a public university in Europe. The study was conducted over one semester and used data from six concurrent runs (industries) of the simulation. The MARKSTRAT2 simulation had not been used previously at the university; so the possibility of feedback and the creation of "folk norms" from experiences of previous MARKSTRAT2 participants are remote.

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. Overall, therefore, we have data from 30 firms competing in six industries over eight periods for a total of 240 observations.

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

We kept the game parameters identical for all industries in the study. Further, in the initial periods all aspects of the game structure were identical to those in Study 1, with one exception. In Study 2, we made interest-free loans available (subject to a formal application to the administrator) to all firms in the study. 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 firms in all industries in the first period, and reminded them of it in every subsequent period.⁴

We chose not to manipulate dominance since Study 1 suggests that this factor varies naturally within the context of the simulation from period to period. Even if

we had ensured starting positions that place some firms in a much better position than others, this superiority would likely have washed out because of subjects' creation and use of individual strategies. Therefore, we measured dominance as a continuous function of subjects' average cumulative budgets, past investments, and market share, using a factor analysis procedure identical to that used in Study 1.

Hypotheses 2–5, which we seek to test in this study, refer to the role of technology expectations and their interaction with dominance. Technology expectations are of three types: enhancement, obsolescence, and no effect. Since our interaction hypotheses apply only to overall dominance, we do not decompose the overall measure of dominance in this analysis. A factor analysis of the three components of dominance shows that these components load on a single factor. We do, however, also replicate our test of H_{1a-c} by re-estimating Equation 1 using Study 2 data. For this analysis, we test the effect of the three individual components of dominance on firms' relative and absolute investment in radical innovation.

To ensure that the composite measure of dominance reflects participants' own perceptions of dominance, we also surveyed each team in each period on their perceived market position. The teams responded on a seven-point “Strongly agree” to “Strongly disagree” scale to the following items: (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, and (3) we have led the market from the start. We then summed the responses to these items, and correlated this measure with our measure of dominance. The correlation between these two measures is high ($\rho = .84, p < .01$), indicating that our measure of dominance does reflect 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. Specifically, by the end of the fourth period, the cumulative marketing contribution of firms across industries ranged from a minimum of \$26 million to a maximum of \$486 million. None of the participants had made any investments in the new product generation before this time. The participants also did not have any market research data available on the new product generation for much of the time until the manipulations were introduced. Thus, participants made decisions on the new product after the technology expectation manipulations had been introduced. We describe these manipulations below. To better understand the decision-making process used by each team, we asked each team to provide strategy reports in each period after the fourth period. These strategy reports (which we discuss later) contained responses by each team to questions on a number of decision-making dimensions.

Manipulations

At the end of the fourth decision period, participants were provided a memo that contained information on prospects for the radically new technology. The memo was addressed from a (fictitious) consulting company named “Technology Marketing Consultants, Inc.” The information in the memo corresponded to the experimental

condition to which the industry had been assigned. Appendix 1 provides the contents of the memo for each experimental condition.

We took care to ensure that participants found the memo credible and used it as a source of their technology expectations. The memo was written on official-looking company letterhead and was professional in format and tone. The information in the memo indicated that the consulting firm's recommendations were based on fairly extensive market research. At the same time, it left room for uncertainty about the eventual effects of the new technology. We also included an additional "control" condition in which participants were told that each of the three other conditions was equally likely. The paragraphs below describe the specific information that served as the experimental manipulation in each condition.

Enhancement Condition. Firms in the enhancement condition were instructed that the new technology is quite likely to make products based on the existing technology *more effective* than before. The memo noted that products based on the new technology (Vodite) fulfill similar needs, and serve similar customers relative to products based on the existing technology (Sonite). Moreover, the performance characteristics of the Vodite products are likely to *complement* those of the Sonite products. The new technology is also projected to offer greater opportunities for performance improvement in the existing product category. Thus Sonite sales will probably increase substantially as the Vodite technology is developed and introduced to the market.

Obsolescence Condition. Firms in this condition were instructed that the new technology is quite likely to make products based on the existing technology *obsolete*. As in the enhancement memo, this memo noted that products based on the new (Vodite) technology fulfill similar needs, and serve similar customers relative to products based on the existing (Sonite) technology. But unlike in the enhancement condition, this memo noted that the performance characteristics of the Vodite products are likely to be *superior* to those of the Sonite products. The memo also noted that new technology is projected to offer greater opportunities for performance improvement relative to the existing product category. Thus Sonite sales will probably decrease substantially as the Vodite technology is developed and introduced to the market.

No-effect Condition. Firms in the no-effect condition were instructed that the new technology is quite likely to have *no effect* on products based on the existing technology. Unlike the enhancement and obsolescence memos, this memo indicated that products based on the new (Vodite) technology fulfill somewhat different needs relative to products based on the existing (Sonite) technology. Also, the performance characteristics of the Vodite products are likely to be *different* from those of the Sonite products. The memo also noted that performance improvement in the new technology is projected to be independent of any performance improvements in the existing product category. Thus Sonite sales will probably be unaffected as the Vodite technology is developed and introduced to the market.

No-specific-expectations Condition. In this condition, firms were told that there is little consensus among experts and consumers on how the new (Vodite) technology

will affect the existing (Sonite) products. Specifically, the memo indicated, three different scenarios are possible. The Vodite technology may make Sonite products obsolete, leading to a decrease in Sonite sales. Alternately, the Vodite technology may make Sonite products more effective, leading to an increase in Sonite sales. Yet another possibility is that Vodite technology could have no effect on Sonite products. Given the uncertainty in the market at the present time, the consulting firm noted that it could not provide any definitive forecasts on which of these three scenarios is most likely to come true.

Manipulation Checks

Participants in the study were informed that each industry had a different underlying structure, and therefore information from one industry would not be applicable to other industries. Participants were also instructed not to discuss particulars of the simulation with persons outside their team. They were asked to address any questions regarding the game to the administrator. These instructions served to reduce cross-talk across conditions and to restrict the information in the manipulations to the intended firms.

As we noted earlier, the MARKSTRAT student manual actually suggests that there will be 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 not clear. The administrator also noted that a memo with further information about the likely effects of the new technology would be forthcoming in a future period. Manipulation checks (discussed below) indicate that the cover story worked as intended.

We periodically asked participants to answer a series of questions regarding their strategy in the Sonite and Vodite markets. Participants generally indicated that they did incorporate the information from the memo in their decision making. To further understand the process underlying participants' investment decisions in each condition, we also surveyed each team on their perceptions of the potential for gains versus losses in the industry in the next period. The two items for this perceived loss scale are provided in Appendix 2. We collected this perceptual data for each period after the fourth period, when the memo was distributed. The differences in covariance-adjusted means of perceived loss across conditions are as expected. Specifically, the differences between the obsolescence and no-effect conditions (1.82, $p < .05$) and the enhancement and no-effect conditions (-6.38 , $p < .05$) are 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 that our manipulations worked as intended.

Model Specification

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

$$\begin{aligned} \text{Investment}_{it} = & \beta_0 + \beta_1 (\text{Dominance}_{i,t-1}) + \beta_2 (\text{Enhancement}_i) + \beta_3 (\text{Obsolescence}_i) \quad (3) \\ & + \beta_4 (\text{Dominance}_{i,t-1} * \text{Enhancement}_i) + \beta_5 (\text{Dominance}_{i,t-1} * \text{Obsolescence}_i) \\ & + \gamma (\text{Loan}_{i,t-1}) + \lambda (\text{Industry Avg. Expenditure}) + \tau(\text{Firm}) + \nu_i + \varepsilon_{it} \end{aligned}$$

Enhancement and Obsolescence are represented as dummy variables. For example, the Enhancement variable is set to one if the industry that corresponds to a particular data point was given the memo containing the enhancement manipulation, and zero otherwise. Participants in the No-specific-expectations condition and No-Effect conditions behaved very similarly on key variables of interest. Therefore, we pooled these two groups into one No-effect condition. The coefficients for the Enhancement and Obsolescence conditions are thus estimated relative to this control condition. The loan amount (if any) provided to each team prior to each period is represented by the Loan variable. Other variables are as defined previously. Since the objective of this study is to test the effects of technology expectations on investment behavior, we only use data collected *after* the period in which the memo with the experimental manipulation had been administered ($N = 120$).

Table 2. 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
* $p < .10$; ** $p < .05$; *** $p < .01$			

Results

Table 2 presents the parameter estimates for the coefficients in Equation 3. In the paragraphs below, we describe the results pertaining to each of the hypotheses.

Main Effects of Expectations

Obsolescence versus No Expectations. Hypothesis 2 suggests that managers who expect a new technology to make existing products obsolete will invest more aggressively in radical innovation than managers who expect the new technology to have no effect on existing products. The results support this hypothesis. Specifically, Obsolescence has a positive and statistically significant main effect on investment in radical innovation ($\beta_{3R} = .24, p < .01$; $\beta_{3A} = .24, p < .05$). Thus, regardless of whether they are dominant or non-dominant, firms are likely to invest aggressively in radical innovation when they believe the new technology will make existing products obsolete. The threat of obsolescence appears to jolt incumbent firms out of their inertia and commitment to the existing product generation.

Enhancement versus No Expectations. What happens when managers expect the new technology to enhance the effectiveness of existing products? Hypothesis 3 argues that in such situations managers will invest less aggressively in the radical innovation than managers who expect no effect. Our results support this hypothesis. Specifically, the coefficient of Enhancement is negative and statistically significant ($\beta_{2R} = -.52, p < .01$; $B_{2A} = -.41, p < .05$).

Interactions of Dominance and Expectations

Obsolescence. Hypothesis 4 predicts that, given expectations of obsolescence, managers of dominant firms are likely to invest more aggressively in radical innovation than managers of non-dominant firms. As predicted, the coefficient for the interaction of Dominance and Obsolescence is positive and significant ($\beta_{5R} = .21, p < .05$; $\beta_{5A} = .34, p < .05$), providing support for H_3 . Thus dominant firms are more aggressive in investing in radical innovation than non-dominant firms when they believe that the new technology will make existing products obsolete.

Enhancement. Hypothesis 5 predicts that, given expectations of enhancement, managers of dominant firms are likely to invest more aggressively in the new technology than managers of non-dominant 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 2 indicate that the main effect of dominance is positive and significant ($\beta_{1R} = .18, p < .01$; $\beta_{1A} = .55, p < .01$). The results thus support H_{1d} , and suggest that managers of dominant firms tend to invest more aggressively in radical innovation than managers of non-dominant firms.⁵

Overall, these results indicate that technology expectations play a complex role in driving investments in radical innovations. An obsolescence expectation causes industry participants—both dominant and non-dominant—to invest substantially

higher proportions of their resources toward radical innovations than participants in industries where no-effect expectations are prevalent. The situation is different in an industry where the enhancement expectation is prevalent. Both dominant and non-dominant firms invest substantially *lower* proportions of their resources toward radical innovations in such industries, relative to industries where firms expect 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 non-dominant firms.

Replication Tests of Hypotheses 1a-1c

Table 3 presents the parameter estimates for the replication tests of H_{1a-c} using Equation 1 above. Because H_{1a-c} apply to investment behavior in the absence of obsolescence or enhancement expectations, we estimate Equation 1 only for those banks that fall in the control condition. This analysis is a conceptual replication of the corresponding analysis in Study 1. The results in Table 3 are generally consistent with our hypotheses (with the single exception of the escalation of commitment effect on absolute investment) and thus provide additional support for H_{1a-c} .

Table 3. 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
* $p < .10$; ** $p < .05$; *** $p < .01$			

Discussion

The MARKSTRAT-based study reported above provides evidence for the internal validity of the relationships that we hypothesize in this research. Given the time-series nature of the data, and the experimental control available as a result of the manipulations, these studies provide a good test of the causal relationships hypothesized in the research. However, as with many experimental studies of marketing phenomena, the research also suffers from a number of weaknesses, mostly related to external validity (see Winer 1999). In particular: (1) the studies employ MBA student participants, not practicing managers, and (2) the participants make financial decisions in a simulated, not real, market environment.

To overcome these limitations, and to provide additional insights on the effects of technology expectations, we undertook a test of our hypotheses in a real industry with practicing managers and real financial decisions.

Study 3: Field Study of Retail Banking

Empirical Context and Insights from In-depth Interviews

An assessment of articles in trade publications indicated that during the 1999–2000 period, the U.S. retail banking industry met three key criteria for selection as our empirical context (see Bank Technologies Group 2001; Schotema 2001). First, Internet banking fits our definition of radical innovation. In the banking context, the World Wide Web is widely seen as an innovation that caused discontinuities both in the technology embedded in new products that employed it, as well as in the marketing skills needed to market these products (Schotema 2001; also see Garcia and Calantone 2002 for a more general discussion of the World Wide Web and radical innovation). Internet banking was, especially at the time of the study, very 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 1999–2000. Specifically, according to the Online Banking Report (www.onlinebankingreport.com) only 319 (3.12 percent) of the 10,239 banks in operation in the U.S. in 1999 had Internet transaction capability by the end of that year, and only 462 (4.62 percent) of the 10,006 banks in operation in the U.S. 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. Finally, firms in the U.S. banking industry vary considerably in market positions, assets, and resources, thus allowing us to test the effects of dominance on innovation.

Structured interviews with 14 industry executives with diverse designations (CIO, CTO, 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. We conducted the interviews using a semi-structured protocol; the time taken for each interview ranged from 26 minutes to 1 hour 40 minutes. From the interviews, it became clear that some managers expected that Internet banking would make bricks and mortar banking obsolete in the not-too-distant future, while 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. Our interviews also yielded insights on the appropriate measures of dominance in the retail banking context. Taken together, the interviews significantly sharpened our focus on the retail banking industry, and helped in the preparation of a larger-scale study in this empirical context. The following sections describe the full-scale field study, which seeks to quantify the effects of expectations and dominance on banks' investments in Internet banking.

Unit of Analysis and Sampling

Our unit of analysis is the U.S. retail banking division for each bank. We also specified upfront, and throughout the survey, that the term “bank” refers to the respondent bank’s U.S. retail banking division. We used a frequently updated and detailed database published by Thomson/Polk to construct our sample frame, consisting of 550 U.S. retail banks, chosen randomly from the population of U.S. retail banks.

Our key informant in each bank was the officer in charge of U.S. retail banking, or equivalent. Since the Thomson/Polk directory also provides data on the job responsibilities and titles of managers included in their list, we were able to pre-screen the managers in the sample frame to ensure that they were involved in strategic decision making for the firm. Pre-survey phone calls further ensured that the surveys were targeted to the appropriate key informants. In addition to carefully screening potential respondents by telephone, we administered a post-hoc check on informant quality as part of the questionnaire. Specifically, we included two questions at the end of the questionnaire, asking “How involved are you personally in the Internet banking initiative at your bank?” and “How knowledgeable are you in general about your bank’s Internet banking initiative?” On seven-point scales, the mean responses to the involvement and knowledge questions were 5.75 (SD = 1.72) and 5.97 (SD = 1.32) respectively, providing evidence of the quality of our key informants.

Survey Administration

We took several steps to maximize measurement validity and response rates for the survey, beginning with a pilot test of the survey instrument across 110 randomly chosen retail banks from the sampling frame. With the 42 responses thus obtained, we were able to conduct preliminary analyses of the psychometric validity of our measures, clarify item wording as needed, and modify our survey solicitation approach as necessary. Our full-scale survey rollout began with a letter to each of the 550 randomly chosen firms in our sampling frame, explaining the purpose of the study, and informing potential respondents to expect further communication from us. A week later, we contacted each firm by telephone, in order to introduce ourselves, ascertain willingness to participate, and identify suitably qualified key respondents (John and Reve 1982). Of the 550 firms called, we were unable to contact 31, 35 expressed their unwillingness or inability to participate, and another 8 had Internet-only operations, leaving us with a final sample of 476 potential respondents.

We then sent out a survey packet by mail to the identified key respondents at the remaining 476 banks. Our personalized, iterative data collection efforts yielded a total of 189 usable questionnaires, representing a 39.4 percent response rate. The mean number of employees at responding institutions was 428 (SD = 2933); mean number of bricks and mortar branches was 27 (SD = 147); of the 189 usable responses, 129 were from publicly held retail banks.

The first wave of responses consisted of 139 of the 189 usable responses. To assess the possibility of non-response bias, we tested for differences between early and late respondents (Armstrong and Overton 1977), using the focal variables of the study as dependent variables. The ANOVA conducted yielded no significant differences on any of the variables ($F = .4, p = .52$). We further compared the 189 responding banks with non-responding counterparts on various demographic variables and measures of dominance (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. Non-response bias therefore appears unlikely.

Measures

In developing our measures, we were guided by conceptual definitions and prior research, coupled with feedback received during the in-depth interviews we conducted. In order to facilitate inter-study comparison, we also attempted to remain as close as possible to the measures used in our laboratory-based studies. The final measures for each construct appear in Appendix 2, while Table 4 reports the correlation matrix and descriptive statistics for the final measures.

Table 4. Descriptive Statistics and Correlation Matrix (Field Survey)

	Mean	SD	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

$p < .10$; ** $p < .05$; *** $p < .01$

As in studies 1 and 2, we measured firms' investments in radical innovation using relative as well as absolute measures. Our measure validation approach follows the prescriptions of classical psychometric theory (Churchill 1979). We first examine the intercorrelations among the items designed to measure each reflective scale, removing items that exhibit low correlations. The scale of relative investment consists of three items with an α of .88, and the scale of absolute investment consists of four items with an α of .86. We also included a third, non-perceptual measure of investment in the survey (see Appendix 2). Respondents were asked to indicate their bank's development expenditures on Internet banking in the last year, relative to total development expenditure. The correlations between this measure and the measures of relative and absolute investment we use as dependent variables are .67 ($p < .01$) and .63 ($p < .01$) respectively. This result offers additional evidence of the convergent validity of our measures.

We measure expectations (obsolescence, enhancement, and no effect) by asking respondents to allocate 100 points to reflect their beliefs regarding the likely impact of the Internet on bricks and mortar banking, both in the short term (next 2 years), as well as long term (next 10 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 field studies, we average the short- and long-term variables, and create two dummy variables (Enhancement and Obsolescence) to represent the three conditions. We classify 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 in the sample.⁶

Consistent with the in-depth interviews we conducted, and the measure of dominance adopted in studies 1 and 2, we measure dominance as a composite of three accounting variables. We use 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,⁷ 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 wealth. These averages are over a six-year period prior to the survey (using five-year and four-year averages produces consistent results). In order to minimize common method bias, we collected archival data on the preceding variables from the Federal Deposit Insurance Corporation (FDIC). As in studies 1 and 2, we use a principal component factor analysis on the three facets to arrive at a summary factor score of dominance. As in Study 2, however, we also replicate our test of H_{1a-c} by re-estimating Equation 1 using Study 3 data. For this analysis, we test the effect of the three individual components of dominance on firms' relative and absolute investment in Internet banking.

Prior research on radical innovation in general (Chandy and Tellis 1998) and Internet banking in particular (Mols 2001) suggests that willingness to cannibalize is an important predictor of radical innovation. Accordingly, we control for individual firms' willingness to cannibalize with a four-item, seven-point scale adapted from Chandy and Tellis (1998). In addition, we control for banks' ownership with a dummy variable coded as one for publicly owned banks, and zero otherwise.

Analysis

We regress firms' investments on the hypothesized explanatory variables, including the moderators and control variables, as depicted in Equation 4 below. We model the moderators as multiplicative interaction terms. Following Singh (2000) and Ramaswami (1996), we use Lance's (1988) residual centering approach to reduce multicollinearity in the interaction terms.

$$\begin{aligned} \text{Investment} = & \beta_0 + \beta_1(\text{Dominance}) + \beta_2 (\text{Obsolescence}) + \beta_3 (\text{Enhancement}) \\ & + \beta_4 (\text{Dominance*Obsolescence}) + \beta_5 (\text{Dominance*Enhancement}) \\ & + \beta_6 (\text{Willingness to Cannibalize}) + \beta_7 (\text{Public Ownership}) + \epsilon \end{aligned} \quad (4)$$

Overall Results

Table 4 provides the descriptive statistics and correlation matrix for the variables in Study 3, and Table 5 presents regression coefficients for Equation 4. The models are statistically significant ($F = 11.74, p < .01$ and $F = 26.62, p < .01$ for relative and absolute measures, respectively), and explain a significant percentage of the variation in banks' investments in internet banking ($R^2 = .14$ and $.12$ for relative and absolute measures, respectively).

In support of H_{1d} the results suggest that, in general, managers of dominant firms invest more aggressively in radical innovation than managers of non-dominant firms ($\beta_{1R} = .12, p < .01$; $\beta_{1A} = .11, p < .01$). We also find significant support for H_2 ($\beta_{2R} = .12, p < .05$; $\beta_{2A} = .13, p < .05$). Managers who expect the radically new

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 * Obsolescence	+	.07***	.04**
Dominance* Enhancement	-	-.09**	-.07**
Willingness to Cannibalize		.24***	.21***
Public Ownership		-.19***	-.19***
R^2		.14	.12

* $p < .10$; ** $p < .05$; *** $p < .01$

technology to make the performance of existing products obsolete invest more aggressively in radical innovation relative to managers who expect the new technology to have no effects on existing products. However, we do not find support for H₃, involving the main effect of expectations of enhancement ($\beta_{3R} = .00$; $\beta_{3A} = .02$). The survey data seem to suggest no statistically significant difference in investment behavior between managers expecting the radically new technology to enhance the performance of existing products, and those who expect the new technology to have no effect on existing products.

H₄ is supported ($\beta_{4R} = .07, p < .01$; $B_{4A} = .04, p < .05$), indicating that dominant firm managers who expect the new technology to make existing products obsolete will invest *more aggressively* in radical innovation relative to non-dominant firms with the same expectations. We also find support for H₅, which posits that dominant firm managers who expect the new technology to enhance the performance of existing products will invest less aggressively in radical innovation relative to non-dominant firms with the same expectations ($\beta_{5R} = -.09, p < .05$; $\beta_{5A} = -.07, p < .05$). As expected, banks with higher willingness to cannibalize ($\beta_{6R} = .24, p < .01$; $\beta_{6A} = .21, p < .01$) invest more in radical innovation, although 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 H_{1a-c} using Equation 1 above. These results suffer from multicollinearity, and should be interpreted with caution. As in Study 2, because H_{1a-c} apply to investment behavior in the absence of obsolescence or enhancement expectations, we estimate Equation 1 only for those banks that fall in the control (no-effect) condition. 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.

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
* $p < .10$; ** $p < .05$; *** $p < .01$			

Discussion

Are dominant firms more or less aggressive in investing in radical innovation than non-dominant firms? We address this question by arguing that dominance has three facets, each with different effects on investment in radical innovation. While two of these facets, investments and market position in the existing product generation, tend to decrease firms' motivation to invest in radical innovation by increasing their escalation of commitment and their inertia, the third facet, wealth, increases firms' ability to invest in the radical innovation. Overall, we find that the positive effect of wealth outweighs the negative effects of escalation of commitment and inertia and therefore, *ceteris paribus*, dominant firms invest more aggressively in radical innovation.

Why then are some dominant firms highly aggressive in pursuing radical innovations, while others lag behind? This paper points to one possibility: the nature of their managers' technology expectations. We argue, and demonstrate in the context of bricks and mortar banks facing Internet banking, that technology expectations vary considerably—even within the same industry and with regard to the same new technology. These differing technology expectations have powerful effects on the aggressiveness with which managers pursue radical innovations. Moreover, managers with the same expectations also invest differently in the new technology depending on whether their firms are dominant or non-dominant. In the section that follows, we elaborate on the contribution of these findings to academic research and managerial practice. Tables 7a and 7b offer a summary of results across measures and contexts.

Contributions to Research

This paper makes three main contributions to the research on radical innovation. First, we reconcile the opposing views in the literature on the relation between dominance and radical innovation. Existing research has typically equated dominance with related though conceptually distinct proxies such as firm size, and has rarely integrated the different facets of dominance to assess its overall effects on radical innovation. We show that relying solely on individual proxies only leads to an incomplete picture and, more significantly, to misleading conclusions as well.

For instance, conceptualizing dominance solely in terms of cumulative investment in an existing technology might lead to the conclusion that dominance discourages investment in radical innovation. So too equating dominance with market position only: success in the marketplace results in a decreased propensity to innovate. In contrast, were we to think of dominance only in terms of wealth, there is strong evidence of a positive relationship between dominance and innovation. Because different measures of dominance reflect different facets of the concept, each with countervailing effects on radical innovation, using only one measure (say, market share) would lead to the opposite conclusion as using another (such as profits). Yet, each facet has enough face validity to warrant its inclusion as a measure of

Table 7a. 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 7b. 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

dominance. How are we to decide then which aspect of dominance is most representative of the construct? Equally important, which of the results relating individual facets to innovation should we set store by? We contend that dominance is a rich composite of all three facets. Only when we examine these facets in a composite manner can we properly identify the overall effects of dominance on radical innovation.

A second contribution we make is to provide an explanation for why some dominant firms invest aggressively in radical innovation while others do not. We do so by examining the role of expectations; in particular, by examining how different expectations increase or decrease managers' motivation to stick to the status quo versus investing in the 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, i.e., *after* the fact. 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 impact their investment decisions. To the best of our knowledge our study is the first to incorporate the important role played by such expectations. Our findings suggest that the fear of obsolescence acts as a greater incentive to invest in new technologies than does the lure of enhancement. Our findings also suggest that current research is overly pessimistic in suggesting that dominant firms are laggards at pursuing radically new technologies. By ignoring the role of expectations, the research does not do justice to the managers who have successfully taken their organizations through successive waves of radical innovation. When managers' expectations are included in the picture, we find that dominant firms with obsolescence expectations actually display the most aggressive investment behavior. Further research on the role of firm leader characteristics on radical innovation would be valuable.

Our third major contribution lies in the effort we have undertaken to verify the robustness of our findings across a triangulation of methods (experiments, field interviews, survey, and archival data). Triangulation exploits the strengths of each method but alleviates its weaknesses (Jick 1979; Meyer 1982). Previous studies have mostly been restricted to survey or archival methods, and have rarely combined these approaches in the same study. More significantly, past research on innovation has rarely used the experimental method, and has thus been unable to establish the causality of relationships. Our paper seeks to combine the control of laboratory experiments with the richness of in-depth interviews and the external validity of survey and archival research. The strength of the experimental approach lies in its control and its ability to trace the links between expectations, dominance, and investment. The field research provides external validity and grounding in the phenomenon as it unfolds in a real-world context. The robustness of the results across these methods lends support to the important, yet so far ignored, role of managers' expectations in determining firms' investments in innovation.

Although we find evidence for the role of expectations and dominance in two different operating contexts (MARKSTRAT2 as well as the real-world retail banking context), the generalizability of our findings to other contexts is yet to be established. In particular, it would be useful to examine these effects in understudied areas such as packaged good and services. Also, the notion of aggressive investment could be more comprehensively tapped. Clearly, more work remains to be done on these fronts.

Managerial Contributions

Our results have implications for managers of both dominant and non-dominant 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. Specifically, while it is true that some aspects of dominance—greater investments and stronger market position in the existing product generation—reduce dominant firms' motivation to invest in radical innovation, it is also true that dominant firms' greater wealth compensates them for this. In all our studies—two in the lab and one in the real-world context of Internet banking—dominance, as an overall composite of its various facets, had a positive impact on investment in radical innovation.

But our findings offer still more good news for dominant firms. Our findings suggest that there is an important way in which 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 is hardly suggestive of sloth and 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 mindset (Gates, Myrvhold, and Rinearson 1995; Grove 1996). Indeed, results from our controlled experiment and field research suggest that such “paranoia” causes firms to aggressively pursue investments in radically new technologies.

Our results also show that dominant firm managers who believe a new technology is likely to *increase* sales of their existing products will actually invest *less* aggressively in the new technology than managers who believe otherwise. Thus, the fear of loss due to obsolescence appears to be a much stronger motivator of investments in radical innovation among such firms than 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 their rallying cry for the troops.

For non-dominant firms, on the other hand, our findings suggest a careful consideration of the dual impact of their new product announcements on the investment decisions of dominant firms. Doubtless, pre-announcements of radically new technologies aid non-dominant firms in gaining legitimacy, funding, and media attention. By the same token, however, strident claims of inducing obsolescence of the existing technology would also alert dominant firms to the danger of inaction in the face of this innovation, thereby increasing the odds that dominant firms will aggressively invest in the radical innovation (see also Miller and Chen 1994). Moreover, dominant firms’ deep pockets and ability to undergo losses in the short term could scoop the market from under the feet of non-dominant firms. Non-dominant firms may therefore be better off not emphasizing the issue of obsolescence in their public pronouncements.

Appendix 1. Experimental Manipulations

To: XXX Industry Participants
From: Technology Marketing Consultants, Inc.
CC: MARKSTRAT Administrator
Date: XX/XX/XX
Subj: 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 sales of VCRs. 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 sales of VCRs.
- 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 2. Measures

Items marked with an * are reverse coded. All Likert-type items are 7-item: “Strongly Agree” to “Strongly Disagree”.

Measures of Constructs used in Study 2

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 for loss						Potential for gain*
B.	1	2	3	4	5	6	7
	Positive Situation						Negative 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.*
 - 2. Our bank has only a token Web presence.*
 - 3. We haven't done much yet to develop our Internet banking capabilities.*
 - 4. Most of our development expenditures are targeted toward Internet banking efforts.

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.*
 - 2. Our bank is yet to make significant investments in Internet banking.*
 - 3. We have earmarked few managerial resources to Internet banking in the short term.*

Non-perceptual 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 is highly committed to its bricks and mortar branches.*
2. Our bank's investments in bricks and mortar branches make switching to Internet banking difficult.*
3. We rely too much on our bricks and mortar branches to switch focus to Internet banking.*
4. We are reluctant to cannibalize our investments in bricks and mortar branches.*

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 2 years	In the next 10 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.		

Notes

1. In this paper, we focus on product innovations rather than process or organizational innovations.
2. Market research expenditures are on average 5 percent of total expenditures (s.d. = 3, range = 0 – 18%). To check for robustness, we also estimated Equation 3 below using a measure of investment that included market research expenditures as well. The effects remain robust to this change.
3. In this study as well as in studies 2 and 3 described later, we also used single period, in addition to cumulative, measures of each of these components of dominance. The effects remain robust to these alternate formulations.
4. We control for the loan amount in our models below (see tables 4 and 5).
5. Some scholars (e.g., Ettlie and Rubenstein 1987) have suggested a non-linear (U-shaped or inverted U-shaped) relation between dominance and innovation. To test for possible non-linearity 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; so we do not include these results in Table 2.
6. In 14 cases, the above procedure assigns firms to more than one condition. In these cases, to maintain the mutually exclusive nature of the dummy variables, we assign the firm to the condition with the higher average score. The parameter estimates remain robust to dropping these 14 cases from the sample.
7. The market share for any firm is simply that firm's sales, divided by the sales of the industry as a whole. In our case, the denominator term (industry sales) is constant across all firms, since our data come from a single industry. As such, a firm sales measure is operationally equivalent to a market share measure.

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