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ISBM Report 01-2009

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ABSTRACT

This research considers an interfirm mechanism that affects long-term firm performance: interfirm difference in innovation. We investigate innovation strategies that minimize negative interfirm differences and enhance positive interfirm differences in innovation across high-tech firms with different levels of competitive rivalries. Using longitudinal data over more than six years from 247 companies and surveying 212 senior managers, we show that interfirm differences in innovation, not the absolute level of innovation, influence a firm's long-term stock return. Moreover, the long-term stock market rewards are greater for minimizing negative interfirm difference in innovation than for enlarging positive interfirm differences. Finally, competitive rivalry within the industry influences the effectiveness of innovation strategies on interfirm differences in innovation. We discuss the implications for these findings for the management of innovation strategies.

Keywords: Interfirm difference in innovation, Innovation strategies, Long-term stock returns

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Two backpackers see a bear begin to charge them, so one backpacker takes off his hiking boots and puts on running shoes.

His companion says, "You'll never outrun the bear; why are you putting those on?"

The guy with the running shoes replies, "I don't have to outrun the bear, I just have to outrun you." —Folk Story

Considerable research addresses the question of how innovation relates to performance (e.g., Drucker 1973; Hauser, Tellis, and Griffin 2006), generally by considering the effect of the absolute level of innovation activities within a firm. But as the opening story suggests, the ultimate winner of the race depends on the competition. Well-known competitors, such as Procter & Gamble versus Colgate, Microsoft versus Google, and Lowe's versus Home Depot, constantly examine how well both they and their competitors perform with regard to innovation (cf. Porter 1998), because competition in innovation affects their market returns differently. For example, both Airbus and Boeing are innovative, yet Boeing's stock price rose 26% when it announced the launch of its new 787 Dreamliner project (Adams 2007), whereas Airbus's stock ~~dropped~~dropped when it announced its superjumbo A380 -in 2006 (Airbus Press Room 2007). The relative level of innovation between the competing firms apparently matters a great deal.

We define the difference between the innovation outcomes of a focal firm and that of its major competitor as the *interfirm difference in innovation* (IFDI): A positive term when the focal firm leads its major competitor in innovation outcomes, whereas the term is negative when it lags its competitor. We contend that firms should acknowledge the importance of IFDI and develop strategies to decrease or increase IFDI to deal with the competitive landscape of their markets. For example, Toyota experienced a negative IFDI upon entering the automotive industry but eventually outstripped its competitors in its "velocity of discovery"—the speed with which the

company has innovated in comparison with its rivals in the past 25 years (Spear 2008, p. 156). The strategies that Toyota has used to outpace the competition mostly rely on experimental innovations, such as successfully introducing previously technologically or financially impossible products, such as the Prius or computer-aided front-loaded processes (Spear 2008).

With regard to IFDI, we also consider whether markets reward leaders' accomplishments, such as when leaders enlarge innovation gaps (increase positive IFDI) in the same way as followers when followers decrease innovation gaps (decrease negative IFDI). If the rewards differ, leaders and followers may experience dissimilar incentives to engage in their innovation activities. In the years that Airbus led the aircraft industry, its innovations, such as leading cabin technologies and the fuel-efficient A350, helped it widen its innovation gap with its competitors and even enabled its stock prices to rise 18% in 2005—a record high (BBC News 2006). However, when Boeing introduced its Dreamliner jet in 2006, Boeing surpassed Airbus for the first time in about five years, marking a stunning turnabout in stock market returns in which Boeing's stock price shot up nearly 15%, compared with a 33% decline for the majority owner of Airbus (Lagorce 2006).

The managerial implications of IFDI also may seem apparent, yet no systematic understanding exists of the strategies most conducive to decreasing or increasing IFDI. In particular, it remains unclear whether leaders and followers should follow similar or different strategies. For example, both Google and Toyota are industry leaders, but Google benchmarks Microsoft closely in the area of online search engines (Helft 2008), whereas Toyota has been conducting experimental innovations for years to outdistance its competitors (Spear 2008). Airbus and General Motors both lag behind their respective industry leaders, yet Airbus increased its experimental innovations to accelerate wing production (Lawrence et al. 2008), whereas General Motors decided to benchmark Toyota, Honda, Audi, and others (Vasilash 2003).

We develop a theoretical framework to explore the concept of IFDI, along with its strategic antecedents and consequences, specifically the firm's long-term stock returns. Specifically, we address the following three research questions:

(1) Does IFDI influence a firm's long-term stock return? If so,

(2) Does the market reward increasing positive IFDI and decreasing negative IFDI equally?

And,

(3) Which strategies are most conducive to increasing positive IFDI and decreasing negative IFDI?

To answer these questions, we conduct an empirical study with longitudinal data collected from 247 companies in high-tech industries. To validate key aspects of our findings, we further surveyed more than 200 senior managers in these high-tech industries.

Our empirical results address these questions as follows. First, we find that IFDI, rather than the absolute level of innovation outcomes, influences a firm's performance, reflected in its long-term stock returns. Second, increasing positive and decreasing negative IFDIs have asymmetric effects on the firm's long-term stock return; closing a negative innovation gap has a greater positive effect on stock returns than does enlarging a positive innovation gap. Third, both benchmarking and experimental strategies may help enlarge positive IFDI or minimize negative IFDI, depending on the level of competitive rivalry within the industry.

We structure the remainder of the paper as follows: In the next section, we introduce the notion of IFDI, following our descriptions of long-term stock returns as a critical performance variable. Then we formulate hypotheses for the differential effects of positive and negative IFDIs on a firm's long-term stock returns and the effect of two important innovation strategies (i.e., benchmarking and experimental) on the size and direction of IFDI, contingent on the level of

competitive rivalry. We test these hypotheses with longitudinal secondary data and senior managers' observations in high-tech industries. We then conclude with a discussion of the results, limitations, and implications for management and further research.

CONCEPTUAL FRAMEWORK AND HYPOTHESES

In Figure 1, we present our conceptual framework for how a firm's choice of innovation strategy, as regulated by competitive rivalry within the industry, influences IFDI, which ultimately drives firm performance. Two innovation strategies—benchmarking (an imitative process) and experimental (a trial-and-error process, where little existing knowledge exists)—should increase positive IFDI or decrease negative IFDI, as moderated by the competitive rivalry in the industry. In addition, we expect that greater positive IFDI has a smaller impact on enhancing a firm's long-term stock returns than lesser negative IFDI.

---Insert Figure 1 about here---

IFDI and Long-Term Stock Returns

Despite widespread acceptance of innovation as a key contributor to a firm's superior performance (Drucker 1973), formal evidence about its relative effect on competing firms' performance remains quite limited. In particular, little information exists linking IFDI and the financial well-being of the firm. We use long-term stock returns to measure firm performance for several reasons. First, stock returns not only provide a forward-looking measure of changes in firm value but also incorporate traditional short-term performance measures, such as sales and profits (Sorescu, Chandy, and Prabhu 2003). Second, long-term stock returns are already adjusted for risk premiums (Fama 1998), unlike traditional performance measures, such as sales and profits, that do not incorporate risk components. Third, stock returns reflect market responses to firm management efforts, controlling for macroeconomic conditions such as economic recessions and inflation (Ang

et al. 2006). Fourth, Porter (1998) points out that, compared to short-term stock returns, long-term stock returns provide a superior yardstick for measuring sustainable competitive advantage.

(1998). Lastly, long-term stock returns have important managerial implications, since managers experience constant pressure to justify the relevance of their marketing efforts using stock market values (Mizik and Jacobson 2003).

As derived from the classic capital asset pricing model (CAPM; Sharpe 1964; see also Fama 1998), long-term stock returns refer to differences between a firm's realized stock market returns and its expected market returns, based on its risk premium, over a relatively long period of time (e.g., a year versus a day). Srinivasan and colleagues (2004) suggest that the investor community rewards innovative firms by its willingness to pay a premium in its valuation, which depends on the innovations of the firms relative to those of their competition. Such interfirm differences in innovation are more likely to influence a firm's performance than the absolute level in innovation in the long run partly because investors view such interfirm difference as key to the successful introduction and adoption of new products relative to the competition, leading to competitive advantage (Srinivasan et al. 2004) and -long-term financial gain (see Moorman and Miner 1997).

Therefore, we hypothesize:

H₁: A firm's IFDI, rather than the absolute level of its innovation outcomes, positively influences its long-term stock returns.

Asymmetrical Effects Associated with IFDI and Long-Term Stock Returns

Consider the asymmetrical positions of a leader and a follower in an innovation race. The Resource Based View (RBV, Wernerfelt, 1984) suggests that the capabilities and endowment of the leader explain the leader's position; the follower is the follower because of lower capabilities, lower resources or both. Now consider the challenge facing the follower attempting to close the gap or surpass the leader--the follower will have to invest very heavily to overcome its positional

and resource disadvantages. Hence, a firm that closes the (innovation) gap with a leader will need to have invested heavily in capabilities and related innovation programs. In contrast, the leader needs merely to continue (or invest a bit more) in the capabilities that lead to its leading position to maintain or increase its lead. Hence, the efficient market hypothesis suggests that the stock market will reward the more challenging (and far heavier) investment needed to close the IDFI gap than it will the investment needed to expand that gap (Shim and Siegel 2000), giving us:

H₂: The decrease of negative IFDI has a greater effect on long-term stock returns than does the increase of positive IFDI.

Innovation Strategies and IFDI

The focal firm's innovation strategy depends on the sign of IFDI, i.e., its goal is to catch up with an industry rival if IFDI is negative and its goal is to enlarge the positive gap if IFDI is positive. The focal firm also has a different knowledge/resource position than its industry rivals in conditions of positive and negative IFDI. When IFDI is positive, the leading firm generally has a broader innovation portfolio from which to draw for future innovation activities, as well as more experience and knowledge about managing innovation activities. In contrast, lagging firms with negative IFDI generally have a weaker existing innovation portfolio, and less experience and knowledge about managing innovation activities.

Firms tend to use two types of innovation strategies to deal with industry rivals: benchmarking (e.g., Camp 1989; Vorhies and Morgan 2005) and experimental (Schilling et al. 2003).ⁱ A benchmarking innovation strategy involves promoting a structured process, by which the firm seeks to follow its competitors and generate similar “best practices” to influence IFDI (e.g., Camp 1995). In contrast, an experimental strategy requires strategic actions to leapfrog competitors through trial-and-error processes to gain insights into emerging technological opportunities with no or little existing knowledge (e.g., Smith and Eppinger 1997). The major difference between these

innovation strategies lies in the specific mechanisms: benchmarking strategies keep firms on existing paths while experimental strategies take firms into uncharted territory (cf. Huber 1991). Firms may also blend the two types of innovation strategies. (e.g., Grewal, Comer, and Mehta 2001; Huber 1991).

Conventional wisdom suggests that, when a firm lags its competitors (negative IFDI), the appropriate strategy is to benchmark to discover areas in need of development (cf. Camp 1989). When the firm is leading its competitors (positive IFDI), it should instead adopt a higher level of innovation experimentation to maintain and enlarge the positive difference (cf. Zollo and Winter 2002). However, as Deshpandé and Gatingon (1994) show, in practice, perhaps because of the effects of boundary conditions, including competitive rivalry and intensity in marketplace, firms often deviate from this conventional wisdom. For example, direct observations of a market structure (for example who compete with whom in the marketplace) and competitors' actions (such as how competitors make their decisions) will influence a firm's strategic decisions.

Decreasing negative IFDI: Catch-up strategies. Competitive rivalry tends to be closely associated with the possibility and severity of competitor retaliation (e.g., Grewal, Comer, and Mehta 2001; Srinivasan et al. 2004), which also may be critical for the effectiveness of the benchmarking strategy in reducing negative IFDI. First, intense competition makes it difficult to seek and evaluate knowledge and ideas from competitors, who tend to protect their knowledge through a variety of mechanisms (Dierickx and Cool 1989). Second, intense competition makes it harder for a laggard firm to translate benchmarked ideas into innovation outcomes (cf. Vorhies and Morgan 2005) because doing so may provoke retaliation, and leading competitors have more experience handling innovation activities (cf. McGee and Thomas 1986). In highly competitive

markets, benchmarking innovation strategies that assimilate best practices thus may not provide optimal results for firms that hope to close the gaps with leading industry rivals (cf. Ohinata 1994).

In a market with less competition though, a leading firm may provide a relatively stable and credible source of best practices that the laggard firm can benchmark (cf. Vorhies and Morgan 2003). The lower level of competition also makes the leading industry rival less likely to retaliate against a laggard firm's benchmarking (cf. Chen and Miller 1994), partly because the extent to which a laggard firm's innovation practices pertain to the market may be less significant to rivals that already dominate the marketplace in terms of innovation. Hence,

H₃: When IFDI is negative, the effect of a benchmarking strategy on decreasing negative IFDI is greater when competitive rivalry is low.

In contrast, greater competitive intensity inspires laggard firms to take more risks to survive in the marketplace (e.g., Bowman and Faulkner 1994). Such risk-taking attitudes can facilitate an experimental strategy to close the gap with industry competitors. In addition, greater competitive rivalry requires the firm to take flexible approaches to its innovation activities (Moorman and Miner 1998); this flexibility can contribute significantly to the potential effectiveness of a firm's experimental strategy. In particular, when the laggard firm uses experimental innovations to build its advantage in emerging areas, the lower level of competition in such areas generates less retaliation (Chen and Miller 1994). In a low competitive rivalry situation though, using experimental innovation strategies may be not as efficient or effective for decreasing negative IFDI, because the laggard firms are less motivated to take risks, discouraging them from adopting experimental innovation (e.g., Zott 2003). Thus, we expect

H₄: When IFDI is negative, the effect of an experimental strategy on decreasing negative IFDI is greater when competitive rivalry is high.

Increasing positive IFDI: Outdistancing innovation strategies. Even if a firm already outperforms its competitors, ignoring what those competitors are doing might not be wise if the

firm wants to increase its positive IFDI. When competition is high, the innovation gap between the leader and follower is likely to be small and perhaps unstable. For example, Utterback and Suarez (1990) report that three dominant firms in the 1950s—General Electric, Philco Ford, and RCA—lost their leading positions to new firms—Texas Instruments, Motorola, and Fairchild—by 1966, mainly because of competition in innovation.

To maintain and expand its lead over competitors, a firm may closely monitor and even benchmark what laggard competitors are doing in terms of innovation, since the laggard's innovation activities may threaten its leadership position. (cf. Vorhies and Morgan 2005). In addition, a leading firm may be able to execute such best practices and ideas better than the laggard. Furthermore, closely monitoring and benchmarking competitors' innovation activities may help minimize innovation inertia, which tends to affect leading firms (Dickson 1992). This effect is more pronounced with greater competitive rivalry, because the need for appropriate responses to competitors increases in highly competitive environments (Jaworski and Kohli 1993). When competition is less fierce, the leading firm gains little from benchmarking; benchmarking laggard firms in stable market environments may even hurt a leading firm's advantageous position (Camp 1989; Francis and Holloway 2007). Therefore, we expect that

H₅: When IFDI is positive, the effect of a benchmarking strategy on increasing positive IFDI is greater when competitive rivalry is high.

The effectiveness of an experimental innovation strategy should diminish as competitive rivalry increases for several reasons. First, a leading firm must monitor what its competitors innovate in a highly competitive environment, which may make it more risk averse. Yet risk averseness is not conducive to the positive effect of an experimental strategy on IFDI (cf. Nohria and Gulati 1996). For example, IBM's Howard Wilson notes that increased competitive pressures reduce the effectiveness of innovation experimentation in leading innovative companies (Biesada

1991). Second, increased competitive rivalry should generate higher levels of internal control within the leading firm as it attempts to maintain its position (Moorman and Miner 1998), which can cause reduced organizational flexibility, critical to the success of an experimentation strategy. If industry competition is not as strong, the relatively stable market environment encourages the leading firm to take its innovation portfolio, as well as its accumulated knowledge and experience, to a higher level of innovation experimentation. Therefore,

H₆: When IFDI is positive, the effect of an experimental strategy on increasing positive IFDI is greater when competitive rivalry is low.

Methodology

Research Setting

We considered several issues in selecting our research setting. First, innovation must be one of the key drivers of firm performance. Second, the set of firms must adopt both experimental and benchmarking innovation strategies to varying degrees. Third, competitive rivalry had to vary across the industries selected for study. On the basis of these criteria, we selected several high-tech industries, including computers and related products (standard industrial classification [SIC] codes 3571–3577), electronic equipment (SIC 3600), semiconductors (SIC 3672), software development (SIC 7374), and pharmaceuticals (SIC 2834). The time frame is from 2001 to 2007. We collected data from several sources, including primary surveys to senior managers and secondary data sources such as COMPUSTAT, CRSP, and firm patents. In Table 1, we provide our measures and data sources for those measures.

---Insert Table 1 about here---

Measures

IFDI. Our definition of IFDI refers to the difference in innovation outcomes between a firm and its major competitor; therefore, before measuring IFDI, we must identify the major

competitor. Since senior managers are probably the best source of such information (see Francis and Holloway 2007), we surveyed senior managers of publicly traded firms in the selected industries (firms with stock market and financial data, as we discuss subsequently). We obtained 750 senior managers' names and contact information from two commercial mailing lists and company Web sites. We then conducted telephone interviews with these managers, of whom 282 agreed to participate. During the telephone survey, we explained the purpose of the study, assured the respondent of anonymity and confidentiality, and asked each respondent to report his or her firm's major competitor in the firm's primary industry from 2001 to 2007.

After identifying one major competitor for each firm, we measured the innovation outcomes for the selected firms and their respective competitors. Firms in these high-tech industries normally codify their innovation output in the form of patents, to prevent infringement on their intellectual property (Prabhu, Chandy, and Ellis 2005), so patents serve as viable proxies for firm's innovation outputs (Jaffe and Trajtenberg 2002). In addition, patents provide an important source of firm revenue through licensing and other forms of interfirm agreement, and many firms rely predominantly on them as revenue sources (i.e., Qualcomm). Consistent with prior studies (e.g., Prabhu, Chandy, and Ellis 2005), we used the number of filed patents as a proxy for innovation outcomes and gathered filed patent data for both focal firms and their major competitors from the Thompson Scientific Delphion database, a comprehensive database that includes all U.S. patents since 1964. We also deleted firms that possessed too few patents between 2001 and 2007 (i.e., <10). Sorescu, Chandy, and Prabhu (2003) use both citation-weighted and equal-weighted measures of the patents as a firm's innovation outcomes and find consistent results. Because the patents in our study were relatively recent (after 2001) and many (76%) had not received any citations, we used equal-weighted measures. To measure IFDI, we

used the difference between the number of patents in year t filed by the focal firm and the competitor firm. To achieve a common baseline for cross-sectional comparison, we adjusted the difference based on the total number of patents filed by the focal firm and its competitor in year t .

Benchmarking and experimental innovation strategies. A patent filing produces a public document that contains extensive information, including backward citations to previous patents. Because backward citations represent an important means to protect firms from intellectual property infringement allegations, they represent the previous patents on which a firm's filed patents build, as well as the extent to which they build on those previous patents (Jaffe and Trajtenberg 2002).

The benchmarking innovation strategy involves heavy reliance on prior knowledge embedded in the innovation outcomes produced by competitors. Therefore, the strategy should be reflected in the extent to which the focal firm's filed patents cite patents filed by the competitor (Jaffe and Trajtenberg 2002). When backward citations of patents by the competitor increase, the focal firm apparently benchmarks innovation outcomes by this competitor. Therefore, we measure the benchmarking innovation strategy as the percentage of a firm's overall backward citations that refer to the identified competitor. In contrast, an experimental innovation strategy describes the extent to which the focal firm exceeds its identified competitors in innovation activities, with no or little prior knowledge. With few or no backward citations (Jaffe and Trajtenberg 2002), the patent relies more on experimentation than on existing innovation knowledge; hence, the fewer the backward citations, the more pronounced is the experimental innovation strategy. We obtained the focal firm's and competitor's average number of backward citations and calculated the difference as a reverse-coded measure of experimental innovation strategy. To test the effects of the

benchmarking and experimental strategies on IFDI in year t , we examined the firm's filed patents in year $t - 1$.

Competitive rivalry. Consistent with previous studies (e.g., Fang et al. 2008), we posit that competitive rivalry is reflected in the industry's Herfindahl index. In the focal firm's primary industry, we squared each firm's market share and took the sum over all firms. Because we are interested in industry competition, not its concentration, we subtracted this sum from 1. We obtained the data for these measures from the COMPUSTAT Industry Annual database.

Long-term stock return. We measured long-term stock return using the cumulative abnormal return (CAR) (Aaker and Jacobson 2001), which captures the difference between a firm's realized stock market return in year t and its expected stock market return; it has received support from previous studies because it derives directly from the CAPM (Fama 1998). Specifically, it can be modeled as:

$$(1) \quad \text{Cumulative abnormal return} = \sum_{m=1}^{12} (ret_{im} - \text{expRet}_{im})$$

where ret_{im} refers to the realized market return of firm i in month m during year t , according to data collected from the University of Chicago's Center for Research in Security Prices (CRSP) database, and expRet_{im} refers to the expected rate of return of firm i in month m during year t .

According to the CAPM framework, expRet_{im} can be computed as:

$$(2) \quad \text{expRet}_{im} = \text{Ret}_{\text{risk free},m} + \beta_i * (\text{Ret}_m - \text{Ret}_{\text{risk free},m}),$$

where $\text{Ret}_{\text{risk free},t}$ is the risk-free rate of return in month m , Ret_m is the market return in month m , β_i is $\text{cov}(\text{Ret}_{im}, \text{Ret}_m) / \text{var}(\text{Ret}_m)$, and $\beta_i * (\text{Ret}_m - \text{Ret}_{\text{risk free},m})$ is the risk premium for firm i of month m at year t . Using Sorescu, Shankar, and Kushwaha's (2007) method, we obtained the monthly values of Ret_m , $\text{Ret}_{\text{risk free},t}$, from the Kenneth French data library (posted at

<http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/>). We provide descriptive statistics and the associated correlation matrix in Table 2.

---Insert Table 2 about here---

Analysis and Results

After dropping observations due to missing data or because competitors identified by the focal firms are private firms without available financial data, we retained (n=) 247 firms with t=6 (we take a one-year lag between the innovation strategies and IFDI, we lose one year in the analysis) or 1,158 observations. We next estimate our hypotheses in two separate models: one that examines the effects of IFDI on long-term stock returns, and another that investigates the effects of innovation strategies, together with competitive rivalry, on IFDI.

Effects of IFDI on long-term stock returns. In estimating the model, we included the focal firm's absolute level of innovation outcomes, measured as the number of patents in year t. Thus, we can test whether the interfirm innovation difference or the focal firm's absolute level of innovation outcomes drives abnormal stock return. Consistent with previous studies (Aaker and Jacobson 2001), we also included the firm's financial performance (return on assets, or ROA) to control for the effect of financial performance on stock returns.

The CAR captures abnormal returns, that is, only new, unanticipated information. In other words, as Aaker and Jacobson (1994) suggest, if the financial market expects that a firm has performed well and will continue to do so, the market will immediately incorporate this information in the firm's stock price. Therefore, the firm's expected abnormal return will be zero until new and unexpected information becomes available. In this case, IFDI leads to positive cumulative abnormal stock returns only if (1) IFDI relates positively to firm value and (2) there is an unexpected positive change in the firm's IFDI. Consistent with Mizik and Jacobson (2003) and

Sorescu and Spanjol (2008), we estimate the unanticipated components of IFDI, focal and competitor firms' innovation outcomes, and ROA as residuals of first-order autoregressive models:

$$(3a) \text{IFDI}_{i,t} = a_0 + a_1 \text{IFDI}_{i,t-1} + e_{i,t};$$

$$(3b) \text{Focal firm's innovation outcome}_{i,t} = a_0 + a_1 \text{Focal firm's innovation outcome}_{i,t-1} + e_{i,t}; \text{ and}$$

$$(3c) \text{ROA}_{i,t} = a_0 + a_1 \text{ROA}_{i,t-1} + e_{i,t}.$$

We then estimate the following model using least squares regression and provide the results in Table 3:

$$(4) \text{Cumulative Abnormal Stock Return}_{i,t} = a_0 + a_1 \text{unanticipated change IFDI}_{i,t} + a_2 \text{unanticipated change of ROA}_{i,t} + a_3 \text{unanticipated change of focal firm's innovation}_{i,t} + e_{i,t}.$$

---Insert Table 3 about here---

As we show in Table 3, an unexpected change in IFDI has a significant and positive effect on performance in the abnormal stock return ($\beta = .387, p < .01$), whereas an unexpected change in the focal firm's innovation outcome ($\beta = .004, n.s.$) has no significant effect on performance with regard to the cumulative abnormal stock returnⁱⁱ. In Model 1 of Table 3, we include the interaction between IFDI direction (1 if positive, 0 if negative) and an unexpected change in IFDI. The interaction term is negative and significant ($\beta = -.170, p < .05$), which suggests that an unexpected change in IFDI when IFDI is negative has a greater effect on long-term abnormal stock returns than when IFDI is positive. Thus when IFDI is negative, the positive unexpected change of IFDI has positive effect on abnormal stock return ($\beta = .387, p < .01$), while when IFDI is positive, the positive unexpected change of IFDI has a positive but a lesser effect on abnormal stock return ($\beta = .387 \text{ less } 0.170 = .217, p < .05$). These results provide support for H₁ and H₂.

Estimation of innovation strategies on IFDI. To estimate the effect of innovation strategy on IFDI, we must consider several estimation issues. First, IFDI may be nonstationary, which could bias the estimates (Cuthbertson and Gasparro 1995). However, a significant panel unit root test (chi-squared = -24.35; $p < .01$) indicates that IFDI is stationary (Cameron and Trivedi 2005; Levin, Lin, and Chu 2002). Second, in estimating the time-series cross-sectional model, we must control for unobserved firm-specific effects (Jacobson 1990), because failing to do so leads to biased parameter estimates. Including firm-specific effects also reduces serial correlation in the errors (Cameron and Trivedi 2005). Therefore, we conducted Hausman's (1976) test to determine whether the unobserved effects can be best modeled as fixed or random. The Hausman test is significant ($p < .05$), so we adopt a fixed-effects model. Third, because we hypothesized different effects of benchmarking and experimental innovation strategies on IFDI in positive and negative IFDI situations, we created a dummy variable for direction of IFDI (1 if positive; 0 if negative).

We also controlled for several industry and firm-level variables that might affect IFDI. At the industry level, we control for industry growth and industry dynamism, using measures from previous research (e.g., Finkelstein and Boyd 1998). For industry growth, we regressed the sales revenues in the firm's primary industry (four-digit SIC) against time for the five preceding years. We then divided the slope coefficient obtained from this regression by the mean value of industry sales for those years (to adjust for absolute industry size) to get the growth score for each industry (Dess and Beard 1984). For industry turbulence, we first calculated the standard deviation of sales in the firm's primary industry across the preceding five years and then divided it by the mean value of industry sales for those years (Fang et al. 2008). At the firm level, we control for both the focal firm's and the competitor firm's R&D investment, measured as the log-transformation of

their R&D expenditures. We obtained these data from the COMPUSTAT industry annual databases.

We estimated the following fixed effect model with least square estimation; we present the results in Table 4:

$$(5) \quad \text{IFDI}_{it} = \nu + \alpha_i + \gamma_t + \beta_1 \text{ Experimental Strategy}_{it-1} + \beta_2 \text{ Benchmarking Strategy}_{it-1} + \beta_3 \text{ Experimental Strategy}_{it-1} * \text{Competitive Rivalry}_{it-1} + \beta_4 \text{ Benchmarking Strategy}_{it-1} * \text{Competitive Rivalry}_{it-1} + \beta_5 \text{ Experimental Strategy}_{it-1} * \text{Competitive Rivalry}_{it-1} * \text{Direction of IFDI}_{it-1} + \beta_6 \text{ Benchmarking Strategy}_{it-1} * \text{Competitive Rivalry}_{it-1} * \text{Direction of IFDI}_{it-1} + \beta_7 \text{ Industry Growth}_{it} + \beta_8 \text{ Industry Dynamism}_{it} + \beta_9 \text{ Focal Firm R\&D Intensity}_{it} + \beta_{10} \text{ Competitor R\&D Intensity}_{it} + \varepsilon_{it},$$

where

ν = the overall constant,

α_i = firm-specific constant,

γ_t = time-specific constant, and

ε_{it} = the error term, such that $E(\varepsilon_{it}) = 0$ and $E(\varepsilon_{it}^2) = \sigma_e$.

---Insert Table 4 about here---

In order to identify the effects of experimental and benchmarking strategies on IFDI differ under high and low levels of competitive rivalry for positive and negative IFDI, we used the simple slope analysis, a regression of the outcome on the predictor at a specific value of a moderator (Darlington 1990). Aiken and colleagues (1991) show that simple slope analysis overcomes the need to create subgroups of continuous independent variables and thus increases analysis power. Hence, we included variables representing high and low competitive rivalry conditions (defined as two standard deviations above and below the mean) in the model to assess

the overall effect of experimental and benchmarking strategies on IFDI for positive and negative IFDIs. We present the results in Table 5.

--Insert Table 5 about here--

As indicated in Table 4, the three-way interaction term among benchmarking strategy, competitive rivalry, and direction of IFDI is significant and positive; that is, the moderating effect of competitive rivalry on the effect of benchmarking strategy differs for positive and negative IFDI. Further, the results of simple slope analysis reported in Table 5 imply that in negative IFDI conditions, the effect of a benchmarking strategy on IFDI does not differ significantly between high and low competitive rivalry situations ($\beta = .597, p < .05$); therefore, we do not find support for H₃. In contrast, with positive IFDI, the effect of the benchmarking strategy on IFDI is significantly higher when competitive rivalry is high ($\beta = 1.762, p < .01$) compared with when competitive rivalry is low ($\beta = .476, n.s.$), in support of H₄.

Additionally, Table 4 shows that the three-way interaction among experimental strategy, competitive rivalry, and the direction of IFDI is significant and negative, which suggests a different moderating effect of competitive rivalry on the relationship between experimental strategy and IFDI with positive and negative IFDI. The simple slope analysis results in Table 5 show that when the IFDI is negative, experimental strategy has a significantly greater effect on IFDI when competitive rivalry is high ($\beta = .0170, p < .01$) than when it is low ($\beta = .0062, p < .05$), in support of H₅. Finally, when IFDI is positive, experimental strategy has a significantly greater effect on IFDI when competitive rivalry is low ($\beta = .0054, p < .05$) than when it is high ($\beta = .0011, n.s.$), providing support for H₆.

Model Validation and Robustness Analysis

As with most empirical analyses, we made a number of assumptions and choices related to the measurement of our constructs, analysis and model. In this section, we discuss these assumptions and provide additional validation and robustness analysis.

Alternative measure of abnormal stock returns. To assess the robustness of our results to our choice of dependent variable are not dependent on the specific CAR calibration, we employed buy-and-hold abnormal returns (BHAR) (e.g., Barber and Lyon 1997) as an alternative measure of long-term stock returns. BHAR describes the return achieved by an investor holding the security for the duration of the period, minus the expected return for this security during this period, as used in previous marketing studies (Sorescu, Shankar, and Kushwaha 2007; Sorescu and Spanjol 2008). In the following formula, ret_{im} refers to the realized market return of firm i in month m during year t , and $expRet_{im}$ refers to expected rate of return of firm i in month m during year t (as in Equation 2):

$$(6) \text{BHAR}_{i,y} = \prod_{t=1}^{t=12} (1 + ret_{im}) - \prod_{t=1}^{t=12} (1 + expRet_{im})$$

The results using BHAR, as shown in Table 3, are consistent with those using CAR; namely, the unexpected change of IFDI has a positive effect on BHAR, but neither the unexpected change of the focal firm's absolute level of innovation outcomes nor that of the competitor's absolute level of innovation outcomes has significant effects

Alternative measure of firm innovation outcomes. To validate our use of patents as a valid measure of firm innovation outcomes, we obtained the list of *Fortune* magazine's America's Most Admired company survey (FAMA) between 2001 and 2007, which is a reliable indicator of firm innovativeness (e.g., Houston and Johnson 2000). The correlation between the number of patents filed by the firm and its innovativeness scale from FMA survey is significant and high ($r = .479, p < .05$), supporting our use of firm filed patents as a proxy for innovation outcomes.

Robustness of findings to choice of lag time. In our model, we used a one-year time lag between innovation strategy_{t-1} and IFDI_t. As a robustness check, we also estimated the model with a two-year lag. Using data from years t – 2 to t – 1 (two-year span), we examined the effect of innovation strategies on IFDI in year t and found consistent results (see Table 4).

Alternative measures of IFDI and Innovation Strategy. Our results rely on secondary data sources such as firm filed patents to measure IFDI and experimental and benchmarking innovation strategies, and COMPUSTAT for firm-level R&D, and industry-level competitive rivalry, dynamism, and growth. To assess the appropriateness of these measures, we conducted a survey to measure the constructs above directly. We surveyed 750 senior managers from high-tech industries, including computers and related products ([SIC] codes 3571–3577), electronic equipment (SIC 3600), semiconductors (SIC 3672), software development (SIC 7374), and pharmaceuticals (SIC 2834) through telephone calls; among those contacted, 282 provided the names of their major competitor in the firm’s primary industry and 264 senior managers agreed to answer additional questions about their innovation strategies related to this competitor. We obtained 212 usable responses from this process. . (See Appendix for details of the survey.)

Hierarchical moderated regression analysis provides the results that corroborate with what we have found using secondary data approachesⁱⁱⁱ. Specifically, we found that experimental innovation strategy helps to minimize negative IFDI if competitive rivalry is high ($\beta = .278, p < .05$) or to enlarge positive IFDI if competitive rivalry is low ($\beta = -.175, p < .10$). We also found that benchmarking innovation strategy enlarges positive IFDI when competitive rivalry is high ($\beta = .254, p < .05$). These results, using a far more granular measure of IFDI and Innovation strategy provide support for our analysis using alternative indicators from our secondary data analysis.

DISCUSSION

In this research, we introduce the notion of IFDI to examine how innovation strategies that reduce the negative or enlarge the positive innovation with competitors affect firm financial performance. The results of our study support previous research that points to the need to maintain higher levels of innovation than competitors (Day 1994). We show that benchmarking and experimental innovation strategies can increase positive or decrease negative IFDI, depending on the level of competitive rivalry in the industry.

Theoretical Implications

Our study contributes to the literature on innovation and interfirm competition. First, we show that changing the absolute level of innovation outcomes has little effect on a firm's long-term performance. Rather, changes in IFDI, such as decreasing its negative or increasing its positive IFDI, have much more influence on a firm's long-term performance. This finding supports prior literature that indicates that the financial impact of a firm's innovation activities on a firm's stock return is based not solely on its own merits, but rather on how much better or worse the firm manages its innovation activities than its major competitors (e.g., Srinivasan et al. 2004). In other words, the impact of innovation should be assessed in a relative, interfirm context and not at an absolute level.

Second, we find asymmetrical effects between catching up with competitors in innovation and outdistancing those competitors on a firm's performance. This striking finding suggests that the same innovation strategy will have different effects depending on the position of the firm in the market (leading or lagging). This findings supports what Alfred Sloan, founder of General Motors, when he said "it was not necessary to lead in technical design or run the risk of untried experiments, provided that our cars were at least equal in design to the best of our competitors' in a grade" (Johnson 1996, p. 8).

Third, our results show the importance of adopting appropriate innovation strategies to minimize and/or enlarge IFDI. This result confirms some prior findings; for example, after analyzing the 1996–2002 automobile industry, Srinivasan and colleagues (2004) find that, although innovations have a positive impact on firm value, the impact may turn negative if the firm fails to manage its innovation strategies appropriately. We find that the effects of innovation strategies are subject to industry-level factors, such as the level of competitive rivalry. When competitive rivalry is high, the industry leader should use benchmarking strategies to enlarge its positive IFDI, but a laggard firm should use experimental strategies to close the negative IFDI gap. When competitive rivalry is low, experimentation strategies work well for the industry leader, but benchmarking strategies work better for the laggard firm. This finding helps explain why, for example, Google may use benchmarking strategies but Toyota may use experimental strategies to outdistance their competitors, even though both of them are leaders in their respective industries.

Managerial Implications

This research has several implications for managers. First, focusing solely on the firm's own innovation actions, without monitoring competitors' innovation, is possibly damaging for firm performance. Rather, interfirm differences in innovation performance provide the most appropriate yardstick for the firm to evaluate and predict its performance.

Second, catching up to and outdistancing competitors have asymmetrical implications for firm performance. A firm's efforts to emulate industry leaders' innovations will likely receive more reward than industry leaders' efforts to outdistance their laggard competitors.

Third, benchmarking and experimental strategies can be helpful to both industry leaders and lagging firms. Yet before adopting these strategies, firms should examine the characteristics of their industries, particularly the level of competitive rivalry. For example, for a firm who is

leading in innovation in its industry (IFDI positive), it should expect that the effect of an experimental strategy on increasing that positive IFDI is greater if competitive rivalry is low than if it is high.

Limitations and Further Research

We have investigated the roles of benchmarking and experimental innovation strategies in shaping IFDI but have not examined the effects of other types of strategies, such as outsourcing innovations (DiRomualdo and Gurbaxani 1998). The factors contributing to IFDI might be complex, so a more complete picture of its strategic antecedents would be helpful.

Further, organizational capabilities, such as organizational design and operation, problem solving and improvement, and knowledge sharing, may contribute to changes in IFDI (cf. Spear 2008). A firm may adopt certain strategies, but, following the philosophy of the resource-based view of the firm, the firm must have sufficient resources to fulfill its tasks. In addition, it would be useful to investigate alternative ways to operationalize and refine IFDI, such as separating radical versus incremental innovations, looking at IFDI across multiple competitors and the like.

Finally, as Paul H. O'Neill, the former CEO and Chairperson of Alcoa, argues, the concept of "chasing the rabbit contains ideas that form the basis for structured continuous learning and improvement in every aspect of our lives" (Spear 2008, back cover page). It is important to revisit other conventional marketing concepts, such as product positioning, and incorporate the concept of IFDI therein. We hope our work will help firms better understand what it takes to attain an industry leadership position and maintain that position profitably.

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FOOTNOTES

ⁱ While there are other strategies to manage interfirm innovation activities such as make-vs.-buy or cooperation between the firms to deal with technical and market uncertainty (Veugelers and Cassiman 1999; Whitley 2000), we focus on two of the most common strategies to provide focus and at least preliminary insights for this research.

ⁱⁱ We also ran the model separately with unexpected change of IFDI and that of the focal firm's innovation outcomes, with results consistent with those presented here.

ⁱⁱⁱ First, we examined the unidimensionality and convergent validity of the constructs with confirmatory factor analysis (CFA) using LISREL. All items load on their respective constructs, and each loading is significant at the .01 level, showing satisfactory convergent validity (Anderson and Gerbing 1988). All pairs of constructs also pass Fornell and Larcker's (1981) test of discriminant validity. Second, because both the dependent and independent variables come from the same respondent, common method bias might become an issue. We therefore conducted Harman's one-factor test, (e.g., Mithas, Krishnan, and Fornell 2005). Because no single factor emerges as a dominant factor that can account for most of the variance, common method bias is unlikely to be a serious problem for our data. In addition, because the focus of our analysis is the interaction effect between experimental/benchmarking innovation and competitive rivalry on interfirm difference in innovation, we consider common method bias not to be a serious concern (cf. Rindfleisch et al. 2008).

TABLE 1
Constructs, Measurements, and Data Sources

Constructs	Measurements	Data Source
Long-Term Abnormal Stock Return	The focal firm's realized stock market return in year t minus a firm's expected stock market return at year t	CRSP and Kenneth French data library
Inter-Firm Difference in Innovation	The difference between focal firm and its identified major competitor's filed patents in year t (adjusted by total number of filed patents by the focal firm and its identified competitor at year t).	Delphion Patent Database Primary Survey
Benchmarking Innovation Strategy	The percentage of citations for the focal firm's filed patents at year t-1 that belong to its identified competitor.	Delphion Patent Database
Experimental Innovation Strategy (reverse coded)	The difference between focal firm and competitor's average number of backward citations for their filed patents at year t-1	Delphion Patent Database
Focal firm's R&D	Log-transformation of focal firm's R&D expenditure	COMPUSTAT
Competitor's R&D	Log-transformation of competitor firm's R&D expenditure	COMPUSTAT
Competitive Rivalry	1-Herfindahl Index of the focal firm's primary industry at year t	COMPUSTAT
Industry dynamism	Standard deviation of focal firm's primary industry sales revenue from t-5 to t-1 (adjusted by overall industry sales revenue)	COMPUSTAT
Industry growth	Regression slope of focal firm's primary industry sales revenue from t-5 to t-1 (adjusted by overall industry sales revenue)	COMPUSTAT

TABLE 2
Descriptive Statistics and Correlations

Construct	Mean	Standard Deviation	Correlations									
			1	2	3	4	5	6	7	8	9	
1 Long-term stock return	0.030	0.260	1.000									
2 Interfirm difference in innovation (IFDI)	-0.190	0.640	.091	1.000								
3 Benchmarking innovation strategy	0.020	0.050	-.036	.109	1.000							
4 Experimental innovation strategy	-2.560	10.530	.049	-.128	-.176	1.000						
5 Focal firm's R&D	1.789	0.752	.005	.356	-.076	.106	1.000					
6 Competitor's R&D	1.548	0.673	.021	-.243	.187	.076	.463	1.000				
7 Competitive rivalry	0.412	0.197	-.107	.087	.153	.134	.007	.035	1.000			
8 Industry dynamism	0.052	0.032	.067	-.076	-.109	.074	.139	.157	.123	1.000		
9 Industry growth	0.132	0.110	.088	.032	-.022	.090	.099	.101	-.045	.056	1.000	

Notes: $p < .05$ if $r > .048$ or $r < -.048$

TABLE 3:
Regression Analysis for Long-Term Stock Return with Alternative Dependent Variables

Variables	(1) Long-Term Abnormal Stock Return as DV	(2) Buy-and-Hold Abnormal Stock Return as DV
Constant	0.043 (0.002)**	0.067 (0.003)**
<i>Independent Variables</i>		
Unexpected change in inter-firm difference in innovation (Hypothesis 1)	0.387 (0.153)**	0.261 (0.111)**
Direction of inter-firm difference in innovation (positive=1, otherwise 0)	0.006 (0.040)	0.008 (0.061)
Unexpected change in interfirm difference in innovation *Direction of inter-firm difference in innovation (positive=1, otherwise 0) (Hypothesis 2)	-0.170 (0.089)*	-0.221 (0.121)*
Unexpected change in focal firm's innovation	0.004 (0.012)	-0.005 (0.034)
<i>Control Variables</i>		
Unexpected ROE change	1.434 (0.421)**	0.832 (0.341)**
R ²	0.114	0.093

*Notes: ** p < .01; * p < .05*

TABLE 4
Two-Way Fixed Effect Model for Inter-Firm Difference in Innovation

Variables	(1) Inter-Firm Difference in Innovation (One Year Span)	(2) Inter-Firm Difference in Innovation (Two-Year Span)
Constant	- 1.133 (0.036)**	- 1.345 (0.046)**
<i>Independent Variables</i>		
Benchmarking innovation strategy	0.410 (0.254)	0.388 (0.242)
Experimental innovation strategy	0.006 (0.004)	0.004 (0.004)
Direction of Inter-Firm Difference in Innovation(positive=1, otherwise 0)	1.458 (0.287)**	1.420 (0.244)**
Competitive rivalry	0.056 (0.107)	0.051 (0.103)
<i>Two-Way Interaction Effects</i>		
Benchmarking innovation strategy * Competitive rivalry	0.445 (0.320)	0.411 (0.312)
Experimental innovation strategy * Competitive rivalry	0.014 (0.006)**	0.016 (0.007)**
<i>Three-Way Interaction Effects</i>		
Benchmarking innovation strategy * Competitive rivalry *Direction of interfirm difference in innovation (Hypotheses 3 and 5)	1.224 (0.534)*	1.152 (0.501)*
Experimental innovation strategy * Competitive rivalry *Direction of IFDI (Hypotheses 4 and 6)	-0.022 (0.012)*	-0.025 (0.009)**
<i>Control Variables</i>		
Focal firm's R&D	0.345 (0.114)**	0.412 (0.143)**
Competitor's R&D	-0.278 (0.097)**	-0.290 (0.088)**
Industry dynamism	0.067 (1.231)	0.055 (1.012)
Industry growth	0.245 (0.176)	0.210 (0.146)
R^2	0.178	0.157

Notes: ** $p < .01$; * $p < .05$

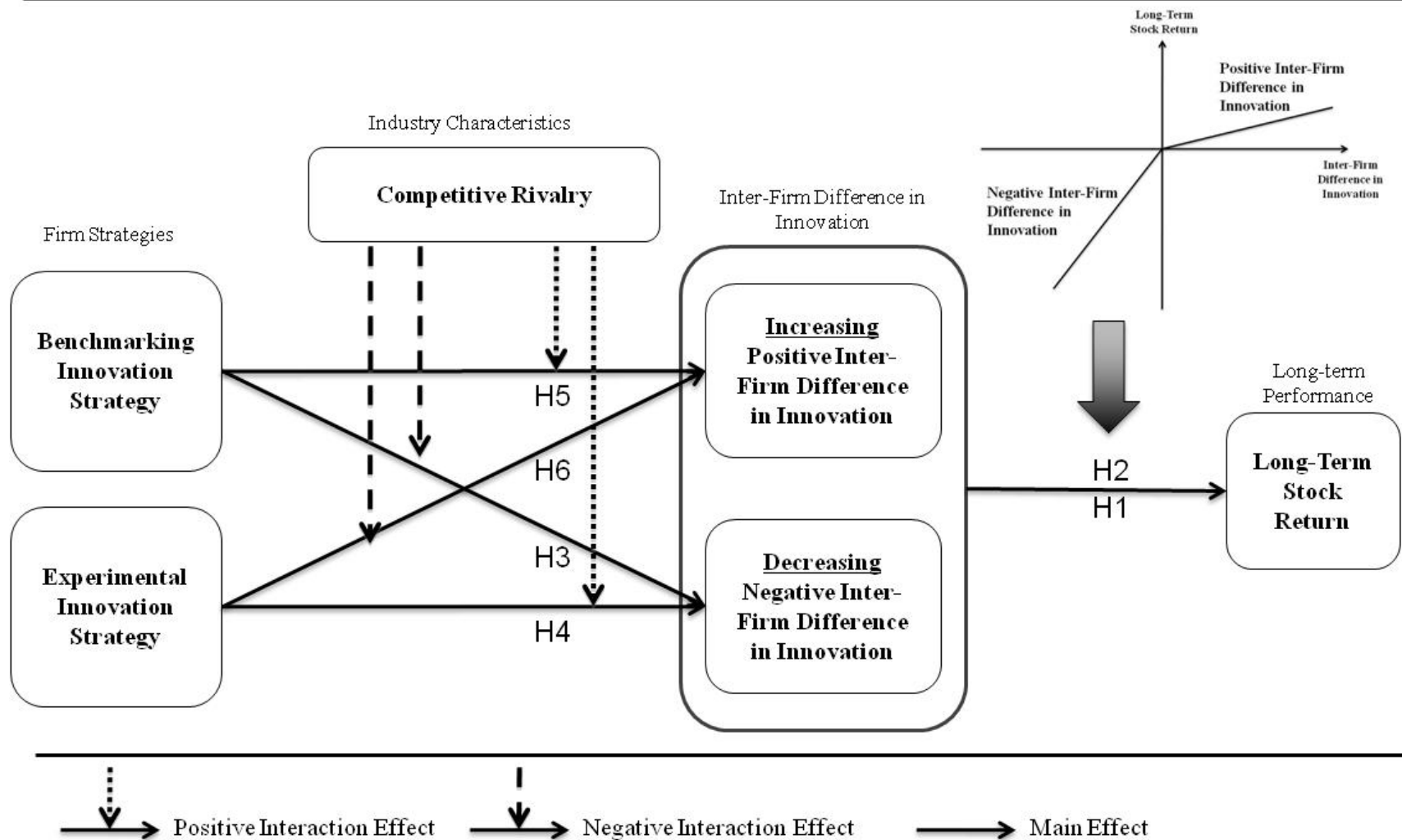
TABLE 5
RESULTS OF SIMPLE SLOPE ANALYSIS[&]

Decreasing Negative Interfirm Difference in Innovation		
	High Competitive Rivalry	Low Competitive Rivalry
Experimental strategy (Hypothesis 4)	.017**	.006*
Increasing Positive Interfirm Difference in Innovation		
	High Competitive Rivalry	Low Competitive Rivalry
Benchmarking strategy (Hypothesis 5)	1.762**	.476
Experimental strategy (Hypothesis 6)	.001	.005*

** $p < .01$. * $p < .05$.

[&] Note: This table shows the overall effect of experimental and benchmarking strategies on IFDI for positive and negative IFDIs, under high and low competitive rivalry, proving support for hypotheses 4, 5 and 6.

FIGURE 1
Antecedents And Consequences Of Inter-firm Difference In Innovation



Appendix: Items and Constructs

Interfirm Difference in Innovation:

Three years ago, your firm (a) lagged behind or (b) occupied the lead over this competitor in the area of generating innovative ideas and developing high-impact new products/services.

a. *If your firm lagged behind this competitor three years ago*

During the last three years, this lagging position has:

(anchored from “significantly enlarged= -3” to “significantly shrank =3”)

Significantly enlargedAbout the same.....Significantly shrank

b. *If your firm occupied the lead over this competitor three years ago*

During the last three years, this leading position has:

(anchored from “significantly shrank = -3” to “significantly enlarged =3”)

Significantly shrankAbout the same.....Significantly enlarged

All the following measures are based on 7-point Likert scale and anchored from strongly disagree=1 to strongly agree=7.

Experimental Innovation Strategy (newly developed, coefficient alpha: 0.87)

During the last three year, as compared with the competitor you identified above, we have:

1. Stressed the importance of learning from R&D experimentation without any prior knowledge base.
2. Have often experimented with different development approaches and methods to enhance R&D knowledge.
3. Have encouraged employees to try different development methods to enhance R&D knowledge, even though the outcomes of these methods are uncertain.
4. Have regarded failures from R&D experimentation activities as learning experiences, rather than development costs.
5. Have gained a great deal of knowledge through repeated trial-and-error R&D processes.

Benchmarking Innovation Strategy (newly developed, coefficient alpha: 0.88)

1. Our firm has emphasized the importance of tracking the R&D activities by industry competitors.
2. Our firm has encouraged researchers and developers to adjust their skills and knowledge to catch up with industry competitors.
3. We have adapted our R&D approaches to follow technological opportunities pursued by industry competitors.
4. Our firm has continuously improved our innovation knowledge to face industry competitors .
5. We have consistently kept track of the differences we have with industry competitors.
6. We have constantly assessed our effort to benchmark with industry competitors.

Competitive Rivalry (adapted from Jaworski and Kohli 1993, coefficient alpha: 0.79)

1. Competition in our industry is cutthroat.
 2. There are many “promotion wars” in our industry.
 3. Anything that one competitor can offer, others can match readily.
 4. One hears of a new competitor move almost every day.
 5. Our competitors are relatively weak.
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