

# Innovation and Strategic Renewal in Mature Markets: A Study of the Tennis Racket Industry

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This paper presents a study of successive new product introductions in the mature tennis racket industry. The inquiry examines novel design's important role in strategic renewal, under the assumption that innovation includes not only the development, production, and launch of new products, but also communication between firms and market. We explore this industry's transformation through the strategic actions of innovative firms and subsequent competitive contagion. A tennis racket innovation triggers competitors' imitative reactions and sways the market toward a new de facto standard when the new product launch includes marketing such as product endorsement by high-profile professional players and advertising. Our results indicate that innovators should actively manage various industry participants as an integral part of their strategic renewal efforts, especially when facing rivalry with "me-too" peers. We suggest the interface between firms and consumers as a next focus for research on strategic renewal.

*Key words:* innovation; endorsement; advertising; new product design; industry evolution; tennis racket

*History:* Published online in *Articles in Advance* March 6, 2009.

## 1. Introduction

Technological evolution has been an important subject since Schumpeter's pioneering work on firms whose innovative actions trigger "gales of creative destruction." Innovative efforts not only create new markets (e.g., Agarwal and Bayus 2002, Knott and Posen 2009), but also bring existing industries to new states, extend their life cycles, and reshape their competitive landscapes. We focus on the strategic renewal activities of innovative firms and show how these activities influence the conduct of competitors and even produce market transformation and technological evolution throughout their industry. In particular, our study suggests that the marketing activities of innovative firms, including product endorsements by celebrities and targeted or focused advertising, trigger imitative reactions by competing firms and lead to the emergence of a new dominant design. Such marketing diminishes uncertainty about an innovation and is a major trigger for technological evolution around a market-defining artifact.

We explore these issues in the context of the tennis racket industry, which over the last four decades has experienced an ongoing renewal, with innovating firms introducing new products that imitating rivals subsequently match. The contribution of this study is threefold. First, we show that the innovative actions of firms must address not only the supply side of their industry, but also its demand side, most notably by engaging prominent and high-status consumers. Second, we show that

product endorsements by top professionals and advertising largely drive innovation diffusion (imitation by competing firms) when the quality improvement of a new racket design is ambiguous. Third, we avoid "survival bias" (Rogers 1995), which is common in the innovation literature, by including both commercially successful and not-so-successful innovations.

Innovative products often generate controversy and uncertainty in the market (Tushman and Anderson 1986). Initial offerings are often crude, show many shortcomings, and evoke doubts about their potential benefits. In addition to technical uncertainty, there is uncertainty as to whether a market for the innovative products exists and whether users are willing to switch from their current products. In the midst of such uncertainty, competing firms delay their adoption decisions and look for cues confirming the market potential of innovations (Abrahamson and Rosenkopf 1993, DiMaggio and Powell 1983, Coleman et al. 1966). For innovators, such an episode confers an opportunity to sway the market toward their new product design by supporting its introduction with various marketing measures (Van den Bulte and Lilien 2001).

This perspective is in accordance with Robertson (1971), who suggested that innovations are not merely "incremental" or "radical." We also often observe what he calls *continuous innovations*—for example, the history of disk drives reveals ongoing increments in density per square centimeter; digital cameras, increments

in the number of megapixels; and civil aviation, increments in the extent of computerized human factors. In such continuous innovation processes, dominant designs are incessantly subject to quantifiable modifications with dramatic consequences, including exit by major industry participants. The tennis racket industry furnishes still another example of continuous innovation: during the most recent times, this centuries-old competitive arena has witnessed a string of new product design architectures, noticeable and deviant from previous generations, since the phasing out of the wooden racket in the 1970s. A close examination of racket history reveals both commercial failures of technically solid new products and ex post successes, occurring some time after a new product's introduction. This context allows us to examine the factors contributing to the successes and failures of innovations while avoiding survival bias (Rogers 1995). We show that adoption decisions made by competing firms are dependent on an innovating firm's minimizing uncertainty about a new design's benefits. More specifically, our research reveals that the frequency of new racket design replication by competitors depends critically on the endorsements of top professional players and on advertising efforts.

The rest of this paper is organized as follows: We first examine existing approaches to the acceptance of innovations in the market and explore technological change as an occasion for strategic renewal for the firms involved. Next, we describe the empirical setting for the analysis: the evolving tennis racket industry. A brief history of racket development is presented, and the controversy about successive innovations is documented. The main idea of the paper—that supporting an innovative new product introduction with end user endorsements and advertisements results in contagion to other firms—is empirically tested in §4. We conclude by discussing the results and the contribution of the study to the literature on technological changes and strategic renewals.

## 2. Theoretical Development

### 2.1. Literature Review

Successful innovations often change the relative positions of the firms competing in an industry and reshape its competitive landscape. Anderson and Tushman's (1990) cyclical view of technological change captures the essence of such an evolutionary perspective: a stable industry goes through a period of experimentation when technological discontinuities are introduced and then enters a period of incremental change once a new dominant design emerges. Technological discontinuities open up a window of opportunities for firms, newcomers as well as incumbents, to seek alternatives from different knowledge bases. With the emergence of a new dominant design, the industry transforms itself into a new

state, where new rules of the game are in place among a new set of competitors.

One interesting phenomenon during industry transformation is fluctuation in uncertainty. As firms try to take advantage of the opportunities opened up by technological discontinuities, an industry confers a variety of strategic options, some of which have not been tried before, so that uncertainty about technical details significantly increases. Questions are also raised about how the market will respond to the technological developments. The technological alternatives with lower uncertainty might emerge as focal points of innovative efforts and become the industry standards. How proponents of various technological options manage technical and market uncertainty has been of great interest to researchers and managers alike because it is uncommon for an alternative to be outright superior on most product dimensions.

The literature on competing technologies during a transformative period exhibits a consensus that a winning technology emerges through the sociopolitical dynamics among industry stakeholders, in particular those on the supply side of technology (Windrum and Birchenhall 1998, Tschang 2007). In their study of the competition in cochlear implant devices, Van de Ven and Garud (1994) mention the role of regulatory agencies, the National Institutes of Health and the Food and Drug Administration, in selecting the multichannel technology over the single-channel one as the standard, even when the controversy over the technical merits of the two forms had not been settled. When technology is systemic and complex, the importance of managing relationships with other organizations in the technological community becomes more obvious. The research of Rosenkopf and Tushman (1998) on the flight simulator industry illustrates that social and political dynamics among the members of the technological community, including various technical committees and standards bodies as well as component suppliers, determined future technological outcomes. The implication of these studies for the industry renewal process is that managing relationships with key market partners and regulatory agencies, both of which are on the supply side of technology, is the key to the success of an innovation in a mature market.

Several streams of research point out, albeit indirectly, the importance of incorporating factors on the demand side during such periods of technological change. The literature on network externalities (Katz and Shapiro 1985, Arthur 1989) and innovation diffusion (Bass 1969, Coleman et al. 1966) emphasizes the role played by the number of users or adopters of an innovation in shaping the evolutionary path of an industry: the more users adopt a product, the more the product becomes adopted by nonusers because the value of the product increases with its rate of adoption, and the adoption rate itself strongly signals the product's benefits. The underlying mechanism is the positive feedback effect among

users: the sheer number of users reduces uncertainty and pushes the industry in a certain direction. An analogous logic can be found in organization theory, particularly in social contagion or bandwagon theories, which argue that institutional and competitive pressures (DiMaggio and Powell 1983) induce organizations to adopt practices that are increasingly common, legitimate, and obvious, though not necessarily more efficient or beneficial (Abrahamson and Rosenkopf 1993). This literature suggests that whether it is at the individual or the organizational level, nonusers cope with uncertainty by observing what others do.

Although this body of work hints at a strong demand-side role, the mechanism by which the contagion or bandwagon phenomenon is initiated has not been fully explored. The literature in marketing and consumer behavior, however, has been more explicit in framing and analyzing the mechanism and process of innovation acceptance at the micro level. Research on consumer behavior has identified major factors that influence end users' decisions to adopt an innovation. Sujan and Bettman (1987) suggest that adoption of new products hinges on which strategy—differentiation or niche—innovators pursue in their external communication. Consumers express their expectations for branded products and either “assimilate” a novel product that fits an existing schemata or “accommodate” a novel product that requires creation of a new schema. Moreau et al. (2001a) examine consumer responses to digital cameras replacing mechanical ones and categorize responses to what they call continuous versus discontinuous innovations. It appears that sophisticated consumers face higher mental thresholds when accommodating a novel product with nonconventional features—a finding consistent with the claim of Hoch and Deighton (1989) that the strategic tools of innovative firms should be anchored by the assumption that consumers need to unlearn some ingrained routines before new products are integrated into their lives. Hoch and Deighton (1989) provide compelling evidence that firms proactively shape consumer experiences when products are surrounded by ambiguity and do so even more when they are new. These insights from consumer behavior research suggest that innovative firms trigger bandwagon effects if they complement the development and launch of new products with marketing efforts that reduce consumers' cognitive and emotive adoption barriers.

This study is an attempt to complement the recent work on producers of new products by considering demand aspects. The point of difference is that this study presents a new perspective on strategic renewal by treating technological evolution as a learning process, one in which producers learn about demand conditions. As we will argue, firms should integrate consumers into the innovation process and recognize the cognitive and hedonic hurdles they experience when exposed to new

products. If firms alleviate consumer uncertainty about new products, they are more likely to emerge as market innovators (Agarwal and Bayus 2002). An innovator's actions to alleviate consumer skepticism clearly indicate to competing firms that technical and market uncertainty has been significantly removed. Therefore, the innovator stands to provoke quick and aggressive responses from competing firms in the form of mimicking the innovation. In other words, competitive contagion is anticipated when innovators bundle customer concerns into their new product launches. We will show that such actions render innovators more successful by the magnitude of competitive contagion. The product as physical artifact becomes the medium around which populations of producers interact with consumers, setting the stage for a race among innovators and their peers to stay ahead of their competitors (Knott and Posen 2009). Strategic renewal refers then to firms initiating a new stage in their established market through both new product development and attentive commitment to customers.

## 2.2. Strategic Renewal and Hypotheses

Economists and sociologists argue that consumer experience with innovations should be viewed as a learning process rather than a rational choice process in which consumers choose the option that maximizes expected utility based on fixed preferences (Payne et al. 1992, Frenzen et al. 1994). The mechanism by which such learning occurs has been most extensively investigated by marketing scientists. In their classic research, Carpenter and Nakamoto (1989) showed that the firm pioneering a new product category enjoys an enduring advantage because consumers begin to form preferences around the firm's product attributes. In the absence of well-defined preferences, consumers learn to value the attributes offered by the pioneering firm through trial and error and subsequently update their preferences. This learning perspective is particularly useful for the analysis of salient qualitative changes. Innovations with pronounced new characteristics promising new benefits demand consumers' assimilation, if not outright accommodation (Moreau et al. 2001b). Being boundedly rational, consumers gradually acquire new and alternative preferences for new products and their architecture (March 1978). We hold such views and findings to have important implications for firms attempting to build market segments for their new products. Therefore, innovators need to integrate the needs of potential consumers into their strategic renewal process.

As explained earlier, advertising and other marketing efforts are crucial in shaping the learning process of consumers, who in many cases resist switching to a new product because early products embodying new technologies are often crude and primitive (Agarwal and Bayus 2002, Sujan and Bettman 1987) and require consumers to invest in learning new skills to take full

advantage of them (David 1985). Generating demand promptly and successfully is also critical because innovators often lack the resources to survive a long period of slow demand growth (Golder and Tellis 2004). Once an innovator successfully attracts consumers' attention and motivates them to experiment with the new product, it asserts the product's technical feasibility and market acceptance. Market feedback gains in strength when demand for the new product swells, providing additional impetus for contagion and putting further pressure on those who continue to hedge. This contagion process is discernable not only in emergent, but also in mature stages of markets, as Malerba (2006) and Rosa et al. (1999) demonstrate. As markets mature, a virtuous circle is likely to take effect, so that rival firms' replication of an innovation pushes the demand as well as the supply outward (Agarwal and Bayus 2002).

From these observations, we predict the propensity for firms' attention to demand-side aspects of innovation to lead to strategic renewal, as measured by their ability to trigger bandwagon effects among competing firms. We start with the presumption that innovators contend with uncertainty among consumers who contemplate the purchase of their new products. Although we do not have access to the information processed by market participants, the aforementioned literature indicates that firms' communication to the demand side might alleviate the ambiguity that surrounds new products, especially those in established markets where consumers have abundant familiarity with existing products. The ambiguity applies all the more to competing firms and other market participants who are confronted with discontinuities in product offerings.

Technology diffusion exhibits a typical "social lag": information about a new product spreads much faster than the product itself (Rogers 1995). Geroski (2000) therefore argues that innovation diffusion bifurcates through divergent channels. Verbal and articulated product knowledge spreads through documentation, trade shows, product presentations and announcements, etc., whereas more implicit, experiential knowledge travels directly through practice with the product and other means of tacit knowledge dissemination such as socialization and face-to-face contact. Gavetti and Levinthal (2000) frame these channels as "forward-looking" and "backward-looking." We depict them not in horizontal but in vertical terms as "top-down" and "bottom-up" and present two hypotheses to spell out their roles in the successes and failures of new product diffusion.

In the present paper these two scenarios take the specific forms of product endorsement and advertising. Endorsement can be interpreted as vicarious experience or indirect learning by doing; advertising, as explicit persuasion or education. Disseminating product information through these modalities eliminates ambiguity about a new product, enticing other market participants

to follow suit—an institutional phenomenon that is now commonly known as "mimetic isomorphism" (DiMaggio and Powell 1983). According to DeBruyne and Reibstein (2005), such mimicry paradoxically amounts to incumbent entry, in which "competitor see, competitor do." Mimicry or contagion mitigates uncertainty and is central to the tenets of institutional theory. It serves to avoid a worst-case scenario in which nonadopters are confronted with the false negative, an evasive scenario in which firms did not, but should have, mimicked the innovator. Endorsement and advertising are powerful signals about an innovation's commercial viability that strip the product of uncertainty. Consequently, a new product supported by such bottom-up and top-down communication is much more likely to trigger a bandwagon effect among peer firms.

By way of analogy, mature markets that enter a period of product upheaval resemble other settings or sectors where high levels of uncertainty motivate incumbents to mimic decisions removing that uncertainty. Mimicry substitutes for securing confidence in the choices to be made and provides a rich scenario for observing institutionalization and its attendant bandwagon behaviors. Perhaps such settings are best illustrated by capital markets in which investors, analysts, and traders grope for reasons to justify their choices. Their collective behavior amounts to what Rao et al. (2001) refer to as "social proof" for chosen alternatives, whose existence is interpreted as still another indication of mimetic isomorphism. The mimetic behavior might follow after a certain firm (i.e., one of its star analysts) initiates coverage of some stock, bond, or other instrument, inspiring others to join the bandwagon, including other banks and naturally also their clients, but perhaps also creating opportunities for hedge fund managers who are not fooled by randomness and recognize a black swan when they see one (Taleb 2007). Rao et al. (2001) show that herd behavior might also exhibit a negative tipping point at which some participants in the market reverse their course, thus shielding them from survival bias. Either way, the ongoing or continuous revision during the random walk provides social proof about an investment's value and echoes our perspective about product markets that exhibit discontinuity and confer advantage on those who can engineer a tipping point toward a new demand. That engineering critically involves not only the introduction of a new choice alternative but also an entourage for that alternative consisting of communication such as advertising, newsletters, blogs, road shows, and third-party endorsements by lead users or large and ostentatious clients such as Warren Buffet and other institutional investors, who practice what innovative analysts preach. Similarly, Stuart et al. (1999) have shown that underwriting by venture capital firms greatly alleviates the perceived uncertainty surrounding the hazards of entrepreneurship and conceivably sets the stage for still another California

“gold rush.” In short, uncertainty requires the proponent of a novelty to embellish it by managing its demand side through top-down and bottom-up persuasion.

Let us first look at the innovative firm’s communication that fosters what might be called bottom-up cognition. An innovation is bound to benefit from reliance on well known or high-profile consumers whose visibility and product use have a “halo effect” on the innovator’s product design. Hoch and Deighton (1989) imply that when someone observes use of an innovative product, “vicarious usage,” a bottom-up process related to experiential learning, occurs. Popular wisdom suggests that most car buyers like to test-drive a car and kick its tires. Producers of novel cars and other new products entice potential buyers by having them experience use. Likewise, Apple recently opened numerous retail outlets where consumers can play with and adopt iPods, iPhones, and Macs, causing consumers to abandon competing architectures such as Wintel. Such experience might be direct or vicarious. Experience diminishes uncertainty about a new product’s benefits or required practices, not only for consumers but also for incumbent firms (Windrum and Birchenhall 1998). Nocera (2007) presents an example close to the focus of this study, speculating that an obese pentagonarian who plays with Babolat’s Aeropro racket fancies himself to be Nadal, who has reached stardom with the very same implement. By using and thus sanctioning the Babolat racket, the hard-hitting contemporary Spanish tennis star furnishes vivid and tacit evidence of his familiarity with that artifact from the leading French sporting equipment manufacturer. An additional reason for stressing product endorsement as distinct from other marketing efforts might be timing. Perhaps experience, as Moreau et al. (2001a) show, is more paramount when a new product differs from existing products; its endorsement by prominent, high-status consumers could be construed as experience by proxy, particularly when the new product is as yet untested and surrounded by a good deal of causal ambiguity. That endorsement reduces uncertainty about the emergent niche’s viability, furnishes social proof about the artifact’s quality, and powerfully induces market incumbents not to remain on the sidelines, but rather to reenter their own market. In short, through ostentatious product usage, tennis celebrities give innovations a piggyback by allowing them to leverage their status or reputation. Endorsement by highly visible consumers should therefore heighten the viability of a new product’s arrival over and beyond its sheer novelty. It follows that

*HYPOTHESIS 1A (H1A). An innovative firm’s obtaining an endorsement from a top professional player increases the likelihood of its competitors’ launch of products imitating the innovation.*

By contrast, other marketing tools, such as advertising, represent “learning by education,” a top-down process. Hoch and Deighton (1989) develop a persuasive

argument about the impact that advertising might have when product uncertainty is high and consumers look for evidence in support of their purchase decision. Through advertisements and other media coverage, consumers form a tentative hypothesis or a top-down belief about product quality and other features (Hoch and Ha 1986, Kempf and Smith 1998). A long tradition in the marketing literature supports the assumption that advertising accelerates the diffusion of new products, especially during the early stages of the product life cycle (e.g., Hursky and Simon 1983). Interestingly, in their study on innovation and advertising, Golder and Tellis (2004) speculate that advertising might have delayed significance, or significance that is gained after the word-of-mouth process—what Rao et al. (2001) identify as the creation of “social proof,” with its attendant opportunities for direct and vicarious product experience—has taken its course. Unfortunately, they do not provide empirical evidence on how the timing of advertising relates to the age of an innovation. In line with this marketing research, we expect advertising also to trigger bandwagon effects among an innovator’s competitors. It is particularly plausible to impute mimetic isomorphism to competitors when advertising involves “core media” in the marketplace. Use of media suspends product uncertainty and motivates peer firms to imitate an innovation. We hypothesize that advertising has a positive effect on an innovation’s success as indicated by the frequency with which peer firms replicate the innovating firm’s product design architecture:

*HYPOTHESIS 1B (H1B). Advertising by an innovating firm increases the likelihood of competitors’ launch of products imitating the innovation.*

### 3. Empirical Setting: The Tennis Racket Industry

The tennis racket industry provides an interesting opportunity to study strategic renewal among innovators and imitators alike. The industry is conservative and not known for innovation, yet it has experienced a series of product renewals since the late 1960s. Its evolution is commonly believed to have been significantly shaped by three seemingly incremental major racket design innovations (American Tennis Industry Federation 1991, Collins and Hollander 1994, Patterson 1999). These successive innovations could be mapped as “continuous” rather than “incremental” or “discontinuous” (Robertson 1971). As will be discussed, these racket innovations have entailed much more than change in the artifact. As they have provoked controversy in public opinion and collective practices, the technical improvement they represent does not readily translate into a market judgment. Robertson (1971) emphasizes the need to shore up the introduction of these types of innovations with advertising, product demonstrations, and other commercial communication vehicles.

The first major innovation is the oversize design, introduced in 1976. Its surface area is 110 square inches (or 784 square centimeters), whereas the traditional racket's face is only 70 square inches (or 460 square centimeters). The second is the widebody design, introduced in 1987. Whereas the traditional racket is 19 millimeters thick across the frame, the thickness of the widebody racket varies across the frame, and the thickest part in the middle of the frame can be up to 39 millimeters. The latest important innovation is the extra-long racket, introduced in the late 1990s. It is between 28 inches (or 68 centimeters) and 32 inches (or 71 centimeters) long, whereas the traditional racket is 27 inches long.

A closer look at the history, however, reveals other numerous novel product designs that are at best briefly mentioned as footnotes to the history of racket technology development. For example, several competitors have tried unique string patterns: the Davis company Top-Spin, with a diagonal pattern, and the Mad Raq rackets, with strings going in three directions (two diagonal and one perpendicular), rather than two. Furthermore, the Snauwaert Company introduced an ergonomics-inspired racket whose face is attached to the throat 43 degrees tilted, and other companies commercialized rackets equipped with bent grips.

Tracing racket development *ex post* suggests that the industry evolved through a series of trendsetting product introductions and that consumers seamlessly migrated from one major innovation to another. In reality, however, consumers had to contend with firms' claims about new products, both *ex post* unsuccessful and successful ones. In fact, it is quite a challenge for consumers to evaluate claims when assessing the technical merits of products is difficult and their use requires subtle adjustments in tacit skills. Although a scrutiny of successful innovations illuminates distinct patterns of evolution in the industry, it is not appropriate for grasping the challenges that consumers face in dealing with the ambiguity and uncertainty surrounding new products. By including both successful and failed product innovations, we seek to better access the process through which such uncertainty is reduced (Rogers 1995).

The relatively simple nature of the tennis racket allows us to track technical changes in detail and reveal the confusion around a user's experience of an innovation.<sup>1</sup> Consider the controversy about the Prince oversize racket, today hailed as the most innovative racket design. The simple idea behind the Prince's innovation was not immediately recognized, and a flood of negative comments had to be fended off. Two years after its launch, a well known industry expert still wrote, "The Prince [i.e., the company's oversize racket] is more of a gimmick, not a true step forward in high performance racket technology" and "is best used by beginners or novices" (Fiott 1978, p. 66). This skeptical commentary, however, turns out to be a response made without proper

understanding of the innovation, as a later technical paper (Brody 1979) documents the advantages the oversize racket has over traditional rackets because of its larger "sweet spot." This paper acknowledges that players require retraining to get maximum performance from an oversize racket, because its sweet spot is located closer to the handle than is that of the traditional racket. Comparing the innovation in terms of new technology versus new usage routines, Brody (1979) points out that a change in highly tacit tennis-playing skills is only attainable through repetitive practice. In the absence of such implicit knowledge of oversize rackets, skeptical users might not compromise their playing styles; as a result, those styles strongly anchored to legacy equipment render the new design rather problematic. The implication is that tennis players at various skill levels should overcome barriers to appreciate the advantages of an innovation, and an innovator needs to manage this learning and institutionalization.<sup>2</sup>

Although various factors affect the acceptance of innovations and influence the direction of industry development, the explanatory power of these factors seems quite limited in this context. For example, network effects (Katz and Shapiro 1985) do not affect the fate of racket innovations because the choice of racket resides with an individual player, as long as the racket design remains within the parameters set by the International Tennis Federation (ITF). A dominant coalition of industry participants seeking to impose or negotiate a *de facto* standard, as in the Cusumano et al. (1992) VCR example, is absent here, and there is little evidence that racket manufacturers share critical knowledge to influence the market (Baugh 1998). In this context, oversight by the governing body (Van de Ven and Garud 1994), the ITF, is limited, as it only sets design parameters and thus levels the playing field for incumbents and potential entrants.

Under these circumstances, an innovative firm's efforts to familiarize consumers with its innovation seem critical to success not only in the market, but also in relation to its predecessors, as tennis emphasizes preservation of traditions. A premium is put on physical proficiency and skill, to such an extent that reliance on novel cutting-edge equipment is deemed a sign of weakness, if not dishonesty. These market attributes increase resistance to any performance-enhancing innovation, and surmounting such resistance is thus all the more important for producers of new equipment.

Experimental evidence on behavioral decision making shows that when feedback is largely ambiguous—as in the case of novel tennis rackets—consumers interpret the experience as confirming their tentative hypothesis (Hoch and Ha 1986, Kempf and Smith 1998). An innovator might condition consumer choices by sending a strong message through the endorsements of professional tennis players. Being highly visible and

respected in the tennis community, such players might greatly enhance the legitimacy and perceived quality of a new design. If those players perform well with the new product, they actually reduce ambiguity about its performance.

The use of celebrities as spokespersons for a new product increases a communication's credibility. Three factors make celebrities a credible source of information: expertise, trustworthiness, and attractiveness (Ohanian 1991, Kahle and Homer 1985). In the case of the tennis racket, expertise carries more weight than the other two, rendering professional players optimal product spokespersons (Kahle and Homer 1985), so it is not surprising that firms recruit and pay top professional players to use their rackets (Meadow 1983). Recent enthusiasm about the extra-long racket illustrates the effect of endorsement by celebrities: the racket received wide recognition after Michael Chang, a top professional player, climbed up the rankings while using it, even though earlier versions going back as early as 1979 had failed to capture any attention.<sup>3</sup> Similar arguments could be applied to advertising. As numerous sectors have their own unique set of media, tennis racket manufacturers can create stronger signaling effects if they transmit information about their products through specialized outlets, in this case magazines such as *Tennis* and *World Tennis*. Promotion through such media carries more weight and should provide more mimetic pressure than promotion through general media.

This section has provided a brief overview of the tennis racket industry and its most important constituencies. The major implication is the role of nontechnical aspects of product design changes: this mature industry is subject to "continuous innovation" (Robertson 1971) that has triggered collective changes in a multitude of behaviors, beliefs, and attitudes. Manufacturers with their product launches, advertisements, and endorsements; the tennis-playing public; journalists; regulators; and the scientists and engineers involved in changes to the artifact engage in a discourse through which a number of product designs become widely dispersed while other designs disappear into oblivion. The strategic renewal of the industry's incumbents occurs when innovations' technical virtues are reinforced by activities that reduce uncertainty in the marketplace and shape consumer preferences in their favor.

#### 4. Data and Analysis

We are interested in the process that reduces the controversy and confusion around novel products and causes industry participants to accept or reject products. A critical concern is unbiased, objective selection of design innovations to avoid survival bias and to capture the viewpoint of a consumer pondering the value of the designs and making purchase decisions in real time

(Rogers 1995). Therefore, we included new designs that claim to be very different. When seemingly incremental innovations have the potential to break away from tradition, they are described with positive words like "revolutionary," "breakthrough," and "radical" in product reviews and advertisements. At the same time, their unfamiliarity may generate negative words such as "weird," "funny," "unusual," and "controversial." Hence, we selected new product designs whose product reviews and advertisements contained positive, negative, or both positive and negative terminology in the two most popular magazines in the industry, *Tennis* and *World Tennis* (see Table 1 for their description).<sup>4</sup>

We initially examined the 1,463 tennis rackets introduced to the U.S. market between 1976 and 1992. Design-related innovations significantly increased after 1976, when Prince introduced its oversize racket. This introduction sparked the race for better tennis racket designs. (Earlier innovations tended to be in materials.) We then ended our study period in 1992 because data for our performance measure are not available after 1991, when *World Tennis*, which contained needed information, stopped publishing.

##### 4.1. Sources

Content analysis of *Tennis* and *World Tennis* allowed us to identify newly introduced tennis rackets and their unique features. Both magazines ran sections reporting the latest developments and reviewing new equipment. In particular, they regularly featured sections with detailed information on rackets to help their readers make informed choices ("Racket Survey" in *World Tennis* and "Racket Review" in *Tennis*). The advertisements in these magazines contained useful information as well. As racket manufacturers attempt to persuade consumers to purchase their newly introduced rackets, they often provide descriptions and highlight unique features of the products.

We decided to focus on the rackets launched between 1980 and 1992. A key variable of the study is tennis racket quality. Although *World Tennis* published articles using our key quality measure, "playability," from 1983 to 1991, it also published material about racket design innovations that were introduced before 1983 and covered innovations from 1980 onward. Therefore, the 1,244 tennis rackets introduced between 1980 and 1992 (the dependent variable was lagged by one year) were examined for their unique features and design innovations.

We also collected data for other variables in the study, such as the characteristics of the companies and the number of firms in the industry, from various issues of the *Sporting Goods Directory*, published by the Sporting Goods Dealers Association. Data on the size of the U.S. tennis-playing population were collected from the sporting goods market research database compiled

**Table 1 Racket Designs Included in the Empirical Analysis**

Design	Year	Innovator	Description
Oversize	1976	Prince	—Enlargement of the sweet spot —110 square inches of the racket head (traditional rackets had a face of 70 square inches)
Adjustable string tension	1976	Fischer	—Equipped with tension adjusting device
Extra long	1979	Head	—Longer than the traditional 27 inch racket
Perimeter weighting system	1981	Wilson	—Put more weights at 3 o'clock and 9 o'clock positions on the frame to increase the stability of the racket
Ergonomic design	1983	Sentra	—13 degree bent grip for lessening stress on the muscles of the arm and wrist when players hit the ball with the racket
Convex throat	1984	Chris	—Wide throat design for increased stability
Three string pattern	1986	Mad Raq	—Strings woven in three directions for increased stiffness
Widebody	1987	Wilson	—Different frame width throughout the frame —Thin at the tip and bottom of the frame, thick in the middle for increased stiffness

by the Sports Business Research Network in Princeton, New Jersey.

#### 4.2. Variables

The *dependent variable* in this study is the number of new rackets with a particular design introduced by competitors of an innovating company: for example, in counting the number of oversized rackets introduced in 1985, we exclude those launched by Prince, the innovator. By excluding the innovator itself, we tease out imitation and thus capture an innovation's success as measured by competitors' replication. We want to ascertain producers' propensity to launch a product that is endowed with architectural or "extrabrand" attributes (Bearden and Shimp 1982, Boyd and Mason 1999).

To measure the *quality* of a racket design innovation, we use performance data collected from reviews published in *World Tennis*. The magazine published a series of articles on racket quality based on extensive tests—both technical and behavioral. One of the measures, "playability," was based on the judgment of test panelists who played with a racket for at least an hour and provided a score ranging from one to ten to indicate intrinsic quality. These records reveal an intriguing phenomenon: some innovative rackets identified as failures *ex post* received fairly high playability scores when they were launched. For example, even though the ergonomic design of Snauwaert was awarded the highest playability score in 1984 and the rackets made by Mad Raq with three-way strings also received very high marks, both racket designs failed commercially. We therefore took the quality variable into consideration to check whether racket design adoption by competitors primarily resulted from a racket's superior quality.

To capture the quality of each innovation, we used the highest playability score received by a racket embodying that innovation. For instance, the extra-long racket by MatchMate received an eight in playability, the highest

score among all the rackets introduced in 1984, whereas Yonex's was given a seven in 1985, and Sentra's, a five in 1986. Although the extra-long rackets in the later years received lower playability scores, we used the higher score achieved by MatchMate as the quality frontier for all extra-long rackets in 1985 and 1986 because the MatchMate racket demonstrated that it was possible for extra-long rackets to obtain a high level of quality.

Moreover, two additional product-related characteristics were measured: advertising and endorsement by top professional players. As a proxy for *advertising*, we counted the number of advertisement pages in *Tennis*. When a full one-page advertisement was dedicated to one tennis racket, we counted it as one. When multiple rackets appeared on a single page advertisement, we gave each racket the count of one over the number of all rackets advertised on the page. Then, we calculated the total number of pages containing advertisements promoting a specific racket design. A new technology appears not only in the innovator's advertisement, but also in the competitors' advertisements as they promote their own brand of the racket incorporating the particular technology. For example, the oversize technology was featured in the advertisements placed by the competitors of the original innovator, Prince, because they were attempting to attract consumers to their version of the product. Because the advertising by competitors contributes to familiarity and acceptability of a product design as well, we constructed three advertising variables: one for the innovator's, another for the competitors', and a third for aggregate advertising in the entire industry.

Measuring *endorsement* by highly visible and prestigious users also involved a count. The number of top professional players using a racket incorporating one of the eight new racket designs was constructed from *Tennis*, *World Tennis*, and other publications on tennis. We defined visible and prestigious users as those included in the "top ten players of the year" lists published by the Association of Tennis Professionals (ATP)



for male players and the Women's Tennis Association (WTA) for female players, both available from Collins and Hollander (1994). In addition to these ranked players, we also included athletes who reached the semifinals at four Grand Slam tournaments—Wimbledon, the U.S. Open, the French Open, and the Australian Open—because they attract a significant amount of attention from the tennis community and because the semifinals are often televised on a national network. We considered these classifications as an appropriate proxy for visibility, credibility, and vicarious experience.

Finally, we included a racket's *age*, measured as the number of years since the first racket with the new design entered the market. We transformed this variable logarithmically. A great deal of research has been conducted on the effect of advertising and other marketing support that accompanies products during different stages in their life cycles (e.g., Van den Bulte and Lilien 2001).

Three variables descriptive of firms in this sector were included. We classified companies into three categories: first, as an incumbent or a new entrant; second, as concentrating in tennis equipment exclusively or as diversifying into other lines of business; and third, as an American or foreign company. Finally, we included several market indicators each year, such as the size of the tennis-playing population, the number of tennis racket manufacturers, and the number of rackets available in the market. Some of these variables have received a considerable amount of interest in the research on innovation and strategic renewal. For example, incumbents are afflicted with technological legacies that restrain their capacity to innovate (Morison 1942), diversified firms enjoy the benefit of diversity (Tushman and O'Reilly 1996), and ecological studies show market density induces competition and strategic renewal (Hannan and Freeman 1989).

#### 4.3. Count Data Analysis with Negative Binomial Regression

Negative binomial regression was used to analyze the data. This procedure should be used to estimate count models when the Poisson estimation is not appropriate because of the problem of overdispersion (Allison 1999). We used the GENMOD procedure in SAS.

The dependent variable is the number of products matching the design introduced by a focal firm in one year.  $\mathbf{X}_1$ ,  $\mathbf{X}_2$ , and  $\mathbf{X}_3$  are vectors of variables described in Table 2.  $\mathbf{X}_1$  denotes a vector of variables representing environmental conditions at time  $(t - 1)$ : the size of the tennis-playing population, the number of tennis racket manufacturers and its squared term, and the number of rackets on the market and its square. We lag all three variables by one year to capture their effects on new tennis racket introduction in the following year. The second group of variables,  $\mathbf{X}_2$ , is a vector of innovator

characteristics: binary variables measuring whether an innovator is (1) a new entrant or an incumbent, (2) a part of a multidivisional firm or a tennis racket-only business, and (3) an American or a foreign company. The last vector in the equation,  $\mathbf{X}_3$ , represents variables capturing the characteristics of the product embodying a focal racket design: the age of the innovation, the quality of the racket incorporating the innovation, advertisement pages for the innovation, and the number of top professional players using a racket with the innovation. We center these variables to reduce the level of correlation between the variables and their interaction terms (Aiken and West 1991) and also lag them by one year.

## 5. Results

Table 2 reports means, standard deviations, and a correlation matrix for the variables in the models.

Table 3 reports the results of a negative binomial regression analysis for replication of racket design innovations by competitors. Examining the effect of advertising on racket design replication by competitors, Model 1 supports H1B, as advertising exerts a positive and significant influence on racket design replication by competitors. Following Van den Bulte and Lilien (2001), we disaggregated the advertising variable into advertising by the innovator and advertising by the imitator. Model 2 indicates the positive effect of advertising on new racket introduction with a particular racket design is mainly because of the advertising done by competitors rather than that done by the innovator. This effect suggests that innovators rely on means other than advertising to legitimize their innovative racket designs. It also implies herd behavior by imitators, because the advertising of a particular racket design by imitators increases the number of new rackets with the same design produced by competitors in the period that follows the introductory phase. The positive coefficient for professional endorsement in Model 3 supports our H1A, stating that the greater the number of endorsements by top professional players, the greater the chance of adoption of that particular racket design by competitors.

To see whether the effects of our variables of interest change over time, we added the interactions between the age of a racket design innovation and the two promotion variables, advertising and professional endorsement (Models 4 and 5). In both models, the coefficients of the interaction between age of innovation and innovation quality are positive and significant. These coefficients suggest that the effect that a racket's quality has on a competitor's launch of a new racket with a focal design might increase as the design matures. This suggestion is consistent with our observation of the industry. When a new racket design innovation is introduced, the first rackets embodying it may be crude and in need of improvement to render them more playable (Agarwal

**Table 2 Descriptive Statistics of the Variables**

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11
1. Number of rackets with focal innovation	4.93	10.29											
2. Tennis playing population (millions)	21.51	5.19	-0.07										
3. Number of manufacturers	32.46	4.39	-0.04	-0.74***									
4. Number of rackets	186.95	58.22	0.00	-0.57***	0.83***								
5. Year 1981	0.85	0.36	0.14	-0.77***	0.40***	0.33**							
6. New entrant (yes = 1; no = 0)	0.41	0.50	0.37***	-0.14	0.03	-0.02	0.14						
7. Diversified (yes = 1; no = 0)	0.73	0.45	0.25*	0.31**	-0.18	-0.16	-0.26*	-0.56***					
8. U.S. firm (yes = 1; no = 0)	0.79	0.41	0.22 <sup>†</sup>	-0.04	-0.00	-0.05	0.04	0.37***	-0.14				
9. Log (age of innovation)	0.88	3.30	0.33**	-0.17	-0.01	0.05	0.28*	-0.18	0.45***	-0.27*			
10. Innovation quality	1.30	2.41	0.15	-0.18	0.08	0.08	0.16	-0.08	0.14	0.39***	0.25*		
11. Advertisement	28.68	76.13	0.05	-0.11	0.06	0.00	0.10	-0.23*	0.23**	0.20 <sup>†</sup>	0.27*	0.79***	
12. Professional endorsement	1.16	2.19	0.82***	-0.14	0.01	0.06	0.17	0.18	0.33**	0.27*	0.42***	0.41***	0.42***

<sup>†</sup> $p < 0.10$ ; \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

and Bayus 2002). As innovators refine their designs, the quality of the rackets improves, in turn attracting more competitors with matching designs. The coefficient of professional endorsement still remains positive and significant, as predicted in H1A (Model 5), and the effect of advertising by imitators dissipates with the interaction term (Model 4).

Models 6, 7, and 8 include both advertising and professional endorsement. Although the high pairwise correlation between professional endorsement and advertising by imitators (0.87,  $p < 0.001$ ) is a concern, it is not sufficient evidence for the existence of multicollinearity. To check for a potential multicollinearity problem with the two variables in the model, we conducted diagnostic tests. The PROC GENMOD procedure in SAS does not provide popular diagnostic options such as tolerance and variance inflation factors (VIFs), so we assessed multicollinearity with PROC REG, as the issue of multicollinearity concerns the property of explanatory variables, not the dependent variable (Allison 1999). No strict criteria for determining the existence of multicollinearity exist, but a widely used rule of thumb is that a tolerance level below 0.1 and a VIF above 10.0 (Kleinbaum et al. 1988) indicate multicollinearity. The test diagnostics indicated that advertisements by imitators had a tolerance level of 0.12 and a VIF of 8.69, and professional endorsement, a tolerance level of 0.18 and a VIF of 5.41.<sup>5</sup> The test statistics therefore suggest that the two variables do not create a serious multicollinearity problem. Nevertheless, caution should be exercised in interpreting the results.

Model 6 has advertising by an innovator and imitators and professional endorsement. The effect of advertising by imitators, which is significant in Model 2, disappears in Model 6, whereas the coefficient of professional endorsement still stays positive and significant when both advertising and professional endorsement are included (Model 6). To examine the interaction between

the variables of interest, we include the age interaction terms in Model 7 and the interaction between advertising and professional endorsement in Model 8. When we introduce the interaction term with age of innovation (Model 7), the effect of professional endorsement still remains significant, and the interaction between age and quality turns out to be positive and significant, as in Model 5. In Model 8, the interaction between advertising and professional endorsement is introduced. In keeping with previous models, the main effect of professional endorsement and the age and quality interaction are positive and significant.

A few more interaction terms turn out to be significant.<sup>6</sup> The age variable's interaction with advertising by innovator is positive, and its interaction with professional endorsement is negative. This fact suggests that as a racket design matures, the effect of advertising by its innovator increases while that of professional endorsement decreases. In other words, the legitimacy of a new racket design improves with professional endorsement in its earlier period, and the influence of advertising by the innovator on the introduction of new rackets with the design becomes more significant in the later period. The negative interaction between professional endorsement and the two advertising variables is consistent with the pattern exhibited by the interaction between the age of the racket and advertising and professional endorsement: the influence of advertising is larger when the level of professional endorsement is relatively low. In short, a new racket design gets replicated by competitors when endorsed by top professionals in its early days, and advertising further increases the chance of replication in its later days. Perhaps the effects of word-of-mouth—such as praise from previous adopters—become more pronounced and supplant the effects of endorsement. Also interesting to note is the differential effect of advertising and endorsement for innovators versus imitators, suggestive of divergent implications resulting from

**Table 3** Negative Binomial Regression on Racket Design Replication by Competitors

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Intercept	−50.183* (22.001)	−48.810* (21.352)	−33.550* (17.112)	−47.360* (21.510)	−36.397* (18.206)	−38.721† (21.192)	−29.423 (21.844)	−32.758† (19.257)
Environment characteristics								
Tennis playing population	−0.061 (0.086)	−0.060 (0.087)	−0.001 (0.090)	0.064 (0.104)	0.052 (0.093)	−0.001 (0.090)	0.101 (0.105)	0.033 (0.091)
Number of firms	3.087* (1.402)	2.969* (1.358)	1.828† (1.065)	2.532† (1.312)	1.949† (1.128)	2.175 (1.364)	1.298 (1.368)	1.826 (1.232)
Number of firms <sup>2</sup>	−0.046* (0.020)	−0.044* (0.020)	−0.026† (0.015)	−0.036† (0.019)	−0.027† (0.016)	−0.031 (0.020)	−0.017 (0.020)	−0.026 (0.018)
Number of rackets	−0.031 (0.023)	−0.026 (0.025)	−0.017 (0.020)	−0.014 (0.025)	−0.024 (0.021)	−0.020 (0.024)	−0.006 (0.024)	−0.018 (0.022)
Number of rackets <sup>2</sup>	−0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Innovator characteristics								
New entrant (1 = yes; 0 = no)	−0.531 (1.105)	−0.499 (1.104)	1.177* (0.462)	1.227 (1.051)	1.609*** (0.465)	0.710 (1.159)	2.531* (1.210)	1.340 (1.152)
Diversified (1 = yes; 0 = no)	1.906 (1.415)	1.914 (1.428)	3.632*** (1.021)	3.908* (1.650)	4.572*** (1.282)	3.112* (1.531)	5.155** (1.804)	4.333** (1.627)
U.S. firm (1 = yes; 0 = no)	2.060† (1.086)	2.094† (1.089)	0.828 (1.113)	−0.029 (1.537)	−0.478 (1.429)	1.014 (1.168)	−0.907 (1.642)	−0.805 (1.488)
Innovation characteristics								
Log (age)	0.352 (0.322)	0.378 (0.328)	−0.358 (0.308)	0.077 (0.444)	−0.599† (0.318)	−0.234 (0.414)	−0.575 (0.534)	−0.061 (0.526)
Quality	−0.179 (0.369)	−0.192 (0.372)	0.004 (0.369)	0.842 (0.516)	0.763 (0.482)	−0.043 (0.374)	0.895† (0.537)	0.755 (0.459)
Advertising (overall)	0.169* (0.068)							
Advertising by innovator		0.117 (0.120)		−0.228 (0.239)		0.018 (0.125)	−0.282 (0.239)	−0.270 (0.227)
Advertising by imitator		0.178* (0.076)		0.147† (0.082)		0.041 (0.090)	−0.014 (0.110)	0.068 (0.101)
Professional endorsement			0.396** (0.133)		0.363* (0.158)	0.354* (0.163)	0.446† (0.232)	0.520* (0.206)
Interaction								
Log (age) × quality				0.849** (0.263)	0.731** (0.235)		0.844** (0.266)	0.698** (0.250)
Log (age) × advertising by innovator				0.354 (0.321)			0.320 (0.321)	1.181* (0.528)
Log (age) × advertising by imitator				−0.134 (0.089)			−0.102 (0.094)	0.086 (0.126)
Log (age) × professional endorsement					−0.190 (0.153)		−0.203 (0.254)	−0.424† (0.224)
Professional endorsement × advertising by innovator								−0.140* (0.061)
Professional endorsement × advertising by imitator								−0.031* (0.016)
Pearson chi-square	98.76	102.80	107.03	70.84	78.22	85.48	80.33	56.54
Degrees of freedom	55	54	55	51	53	53	49	47

† $p < 0.1$ ; \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

the marketing strategies for the two classes of firms and their strategic renewal efforts.

Parenthetically, it should also be pointed out that some of the control variables are significant. The density, or the number of competitors, in the industry has a positive

effect on the replication of innovation. An innovation is more likely to be successful when an innovator is a new entrant into this sport equipment market and a multipoint competitor, active in a number of other lines of business. The size of the market—the number of rackets and

the size of the tennis-playing population—has no effect on the innovation race being played out by firms and consumers.

## 6. Discussion

The results presented in this study support our hypotheses about the role of top professionals' endorsements and advertising on the adoption of new racket designs by an innovator's competitors, a mechanism of strategic renewal through new product introductions. When firms bundle the introduction of new products with opportunities for consumers to experience the products vicariously, they are much more likely to create contagious effects in their industry. Contagion is particularly strong when an innovator recruits celebrities to legitimize its new product design and create social proof about its viability. Top-down cognitive predisposition, induced by advertising or "education" that allows consumers to upgrade their tentative hunches about new products, also fosters contagion among competing firms. Firms that implement strategic renewal along these lines can sway the market away from an old and toward a new product architecture, and these firms are more likely to forge a tipping point or a technological evolution, setting off a process commonly known as institutionalization (compare Rao et al. 2001). In other words, through their strategic renewal efforts, some firms emerge as agents of a market's transformation and push that market toward a new era.

When product innovations are introduced, their technical merits are not obvious. Industry participants, both consumers and competing firms, tend to continue with the existing solutions that have served them well (Hoch 1984), especially in the tennis industry, where tradition is highly valued and reliance on novel equipment is discouraged. Therefore, innovators' engagement of top professional players as endorsers substantially reduces technical and market uncertainty. In other words, professional endorsement is one way to significantly increase consumer confidence in novel products and alleviate uncertainty and confusion about performance. Advertising likewise is conducive to the acceptance of innovation through the creation of greater awareness. This is consistent with Tripsas (2009) who highlights the importance of communication to various stakeholders: the process of strategic renewal from a digital photography company to a flash memory card company required the firm to convince security analysts who cover semiconductor producers to classify the company in their coverage of the market. Similarly, Stuart et al. (1999) have amply demonstrated that the financial underwriting by venture capital firms constitutes a crucial endorsement for business start-ups, which need to dispel the uncertainty surrounding the initial phases of their organizational life cycle. Following such an endorsement the venture enjoys

much better survival prospects. We have mentioned institutional theory to frame contagion as collective conformity to a trend-setting innovator to alleviate uncertainty. Firms thus converge toward a common standard—a phenomenon that has been observed in both the marketing (e.g., DeBruyne and Reibstein 2005) and sociology literatures (e.g., DiMaggio and Powell 1983).

The empirical findings also offer some interesting insights into the role of endorsement and advertising across innovators and imitators over time. For instance, the effects of product endorsement and advertising appear to be dependent on the duration of a new design in the market, hinting that word-of-mouth becomes more powerful and might in fact supersede the effects of endorsement. Another interesting finding involves the differential effect of endorsement and advertising for these two kinds of firms. As we have already noted, the multiplicative effect of endorsement and advertising is much stronger for innovators than for their "me-too" competitors, suggesting the great need for these marketing tools to be bundled with the new product launch.

### 6.1. Implications for Further Research

More data involving other sectors are called for to fully clarify the interesting interactions we found between several strategic renewal efforts among innovators and imitators. These findings also have important marketwide implications, concerning both the approach that first and second movers undertake in the pursuit of strategic renewal and the bundles of supportive actions that accompany such renewal efforts. These implications call for new research and theory of innovation encompassing marketing, sociological, and technological issues.

This study examined both ex post failed and successful innovations. Previous studies of technological innovation have mostly focused on successful innovations; in many cases, innovations that created new categories. Therefore, technological evolution is deemed to consist of triumphant launches of new products, as if an industry seamlessly transitions from one major technology to another. The theory and research on technological evolution have been pushed forward, yet a grasp of less than successful innovations is still beyond our reach. At least two reasons dictate such an extension of our inquiry. First, we should investigate further the nature of technological innovation without sampling on the dependent variable. Only a small fraction of new ideas finds its way into products, of which only a minor proportion becomes successful. More important, the presence of less successful product launches helps us realize that product innovation is a very complex process involving technical issues as well as organizational, marketing, social, and political regulatory factors. Perhaps unsuccessful innovations can be included as control cases to test the validity of claims based solely on successful outcomes and to circumvent

the so-called survival bias that characterizes much of the literature to date. In contrast to the typical description of the tennis racket industry as having “experienced major changes” (American Tennis Industry Federation 1991), this research has demonstrated that the tennis racket industry has evolved through both *ex post* successful and not-so-successful innovations. These innovations are not necessarily radical technological innovations, nor do they seem to always have unambiguously positive effects on players’ performance, but they do often evoke new mental dispositions and behavioral practices that have provoked much controversy. Here we have construed an innovation’s success in terms of the frequency with which the new design has been competitively replicated.

An important aspect of the research reported here involves the quality of new products. Quality is a multidimensional concept, and its attributes are not always correlated. It is commonly assumed that innovations represent quality advances over prior products. The failed innovations in this study did not always involve products that were inferior. Other conceivably better products failed initially and were blocked from obtaining rapid market acceptance. Playability was the dominant measure of the quality of tennis racket innovations. Yet this somewhat ambiguous assessment of the quality of an innovation, whether it is a “gimmick” or otherwise, does not fully explain the success or failure of new rackets. Technological improvements are ambiguous or inconsistent, as indicated by a racket’s stiffness, hitting accuracy, or sweet spot size. New benefits for some innovations also seem dubious on other accounts. For example, bigger racket bodies hardly allow players to hit the tennis ball harder than did their smaller predecessors. Ironically, some failed new designs conferred benefits such as ergonomic ones, yet the diminished risk of tendon injuries did not sway consumers toward those designs. Future research should consider how quality enters into the probability that a new product or service becomes the dominant design, particularly when quality is contrasted with other factors such as those subsumed under the earlier mentioned social proof and other socially constructed aspects of new products that enter established markets.

It would then also be desirable to consider the various communication mechanisms that firms invoke in assuring the success of their new products. Although we considered product endorsement and advertising and noted their differential benefits depending on the stage or timing of their entry into the market, we should consider other nontechnical behaviors as well—for example, product demonstrations and alternative product placements such as online marketing and demonstrations. The research reported here suggests that such nonproduct aspects figure prominently in the success and failure of innovations.

## 6.2. Managerial Implications

Practically speaking, this study also hints at the importance of behaviors that are complementary to new

products and their introduction into the marketplace. We tend to focus on the success of new products *per se*, wondering how they satisfy user needs or confer other benefits. We are oblivious to the role firms play in promoting the new products, such as the active involvement of leading players mentioned above. Innovation success clearly does not hinge solely on the quality of an innovation or its putative benefits for consumers. We should ask what other supportive actions managers execute to increase the success of their strategic renewal. Their challenge appears to depend very much on whether their firms are the initiators of a bandwagon or are me-too competitors. Compared to endorsement, advertising appears to be more critical for imitators than innovators when it comes to strategic renewal and the transformation of their market. Advertising and endorsement as tools for strategic renewal vary with the age of an innovation; our findings imply that innovative firms’ managers should use endorsement, and imitating firms ought to use advertising to successfully join the bandwagon. A potential implication is for a firm’s new product development people to focus on product endorsements early (along with advertising) and rely more progressively on advertising as the product becomes the beneficiary of bandwagon effects.

Consider a scenario in which managers mold the word-of-mouth grapevine that Golder and Tellis (2004) proclaim to be critical during the very early stages of a new product in the market. In the present context, we could inquire about tennis pros in local tennis clubs as opinion leaders who can persuade the market toward a new tipping point (Nocera 2007). Other aspects might range from medical, orthopedic, and fitness recommendations to the creation of a proprietary website inviting bloggers to voice their experiences. Eventually, more mass communication efforts can be added, including advertising. Such ideas could also pave the way for new research efforts that focus on intangible aspects of innovation other than mere physical product attributes. How firms build, accumulate, and understand multiple forms of social capital around the institutionalization of their new products would be one of the most compelling avenues for future research on innovation. The research reported here is strongly suggestive of the leverage they could muster when propagating their new product introductions.

On the other hand, reflections on customer involvement also point to firms’ need to become boundaryless—both within as well as across firms. Some firms studied here are diversified, and as such they could leverage their multipoint competition by developing multiple avenues for developing and legitimizing their new products. The French tennis racket manufacturer Babolat owned legacy capabilities in musical strings and transferred them to tennis racket strings. Diversified firms might exploit economies of such scope that knowledge from one line of business can be replicated elsewhere. In the present study, information on more specific

firm attributes is absent. Perhaps diversified firms leverage their multipoint competitive capabilities and create multiple avenues in recruiting market constituencies for commercializing their new products. As we have explained repeatedly, strategic renewal through product innovations is most likely to succeed when firms involve customers in the innovation process—a managerial practice that is known currently as “open innovation.” (Huston and Sakkab 2006, Chesbrough 2003, von Hippel 1988). Salvato (2009) might frame such environmental triggers as seemingly mundane events or conditions.

### 6.3. Conclusion

The research reported here opens up new lines of inquiry on the relationships between firms and on the convergent relationships among them in realizing a market transformation. Strategic renewal by a single firm might inject new vigor into established markets, provoking a flurry of creative activity, entrepreneurship, and other competitive disruptions. Transformations have occurred in mature markets such as photography, telephones, and watches in which the physical implements remained largely unaltered in appearance, but their functions, architectures or ecosystems, and underlying knowledge bases changed drastically. Sometimes it might even be problematic to label such established but invigorated markets as mature.

The arrival of new technologies may also disrupt producer-consumer relationships. It is perhaps more appropriate to view the arrival of a technology and accompanying products as a transient event in which continuous innovation (Robertson 1971) is collectively constructed and modified. Consumers integrate the products into their activity and accumulate experience in usage as a technology becomes more widely diffused. Producers also travel along technological trajectories, locking them into established market equilibria, until a new technology triggers the emergence of a new platform of practices and institutions. What has been left out of such framing is the interplay between producers and consumers, as if they represent separate and nonoverlapping groups, status systems, or “institutional fields.” Often the consumer is a passive bystander as producers move through cycles of reorientations and adjustments. We should view both as players on a stage often labeled the “market” but traditionally limited to the supply side.

Whether innovations are incremental, continuous, or discontinuous depends critically on the social construction that comprises a product or service but is much more comprehensive in its totality than the mere product attributes that we identified to map the events in the window of study. Although the tennis racket is tangible and visible, its evolving properties are merely one of the many guideposts (Sahal 1985) that inform us about stages in technological evolution that should also include transformations in putative benefits and collective practices. The process of refashioning the relationships between a firm and consumers around an artifact

in the market remains to be examined; nevertheless, the findings presented here invite new lines of inquiry.

### Endnotes

<sup>1</sup>The technology management literature often brushes aside performance issues of simple products because “straightforward measures such as price/performance ratio” are readily available (Tushman and Rosenkopf 1992). Yet numerous studies in the history and sociology of technology suggest otherwise and demonstrate that controversy about innovations often abounds even with such simple products as bicycles (Pinch and Bijker 1987).

<sup>2</sup>The significance of the way in which innovations are introduced to users is highlighted in the Morison (1942) narrative on the U.S. Navy’s reluctant adoption of “continuous aim firing” developed by the British Navy. The arduous adoption process of a simple and seemingly trivial innovation, a change in the turret’s gear ratio on deck, revealed that bombarding the decision makers with the objective data on technical improvement, a 3,000 times improvement in firing accuracy, was not effective at all in changing their attitudes toward this new technique. Unstated reasons for the resistance include the not-invented-here mentality and the possibility to alter the spatial arrangement of naval warfare and eventually produce a power shift in the Navy command structure from navigators to gunners because of much improved firing accuracy. Morison’s study implies that the spread of an innovation is conditional on surmounting barriers among adopters as well as sectorwide practices and conventions. Strategic renewal seems to require innovators to carefully address these issues and not to relegate them to the status of passive bystander—a presumption that is common in the current innovation literature.

<sup>3</sup>The extra-long racket experienced a closure (Pinch and Bijker 1987) with the true benefit of the innovation misunderstood by the authority as well as the public. The innovation was commonly believed to increase the power of serves (Felcyn 1996), and the rule change on the length of the racket by the ITF in response to the extra-long racket was also based on the same perception (Doherty 1997). However, a simple experiment organized by one of the industry magazines, after the ITF decision had been made, illustrated that the extra-long racket improves serve accuracy, not serve power or speed (Doherty 1997).

<sup>4</sup>Relying on the subjective judgment by a group of panels to select innovations with big technical potential suffers from the following issues because of the historical nature of this study. On the one hand, those who are knowledgeable about the tennis racket industry would easily pick design innovations that are successful in hindsight, such as the oversize racket. On the other hand, if casual tennis players who do not know much about the technology are consulted, it is possible that hugely successful technologies like the oversize racket might not get selected because they have already achieved the taken-for-granted status.

To avoid these issues, we conducted a content analysis to select the innovations in this study. Two graduate students were retained as judges: one with limited knowledge of tennis has played tennis for about five years on a casual and infrequent basis; a second judge, a serious tennis player for more than fifteen years, including participation in the local United States Tennis Association (USTA) tournaments, has a

keen interest in the development of racket technology. Without knowing the purpose or hypotheses of this study, they were instructed to review the advertisements and product reviews and to flag the products with the positive and negative descriptions as explained above. Despite the difference in their knowledge of tennis, they expressed a high level of agreement about the eight innovations described in Table 1 that satisfy the instruction given to them.

<sup>5</sup>The test was conducted with the raw data because mean-centering could distort the outcome (Belsley 1984). The authors appreciate an anonymous reviewer for bringing this issue to their attention.

<sup>6</sup>The authors thank an anonymous reviewer for suggesting this interpretation of the results.

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