THE ROLE OF ENVIRONMENTAL DYNAMICS IN BUILDING A FIRST MOVER ADVANTAGE THEORY

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We advance first mover advantage (FMA) theory by examining how the pace of market evolution and technology evolution potentially enables or disables FMA. Integrating several streams of literature, we elaborate on the interplay among these two environmental (macro) conditions and the “isolating mechanisms” that underpin FMA. We model these dynamics to help researchers negotiate the current debate, arising from conflicting empirical evidence, on the conditions necessary for FMA to exist.

In the management literature the conceptual appeal of first mover advantages (FMA) is evident. Using “first mover advantage” as keywords, our search for peer-refereed journal articles in the Business Source Premier database yielded a total of 839 articles. The concept has also enjoyed ample diffusion in the practitioner-oriented literature and has fueled aggressive claims and an ongoing debate about whether the advantage actually exists. Consider, for instance, Arthur’s claim that “two maxims are widely accepted in knowledge based markets: it pays to hit the market first and it pays to have superb technology” (1998: 100). This assertion contrasts sharply with Sandberg’s claim that “in most cases . . . being the first mover is no guarantee of success” (2001: 3).

The academic literature has been unable to provide conclusive empirical evidence to support or refute the existence of FMA. Some empirical studies point to a negative relationship between order of entry and such measures of a firm’s performance as market share (Bond & Lean, 1977; Robinson, 1988; Robinson & Fornell, 1985; Whitten, 1979), long-term profitability (Lambkin, 1988), and survival (Robinson & Min, 2002). Other studies show little or no evidence of a relationship between order of entry and a firm’s market share (Golder & Tellis, 1993; Lilien & Yoon, 1990; Schnaars, 1986), higher return on investment (Boulding & Christen, 2001), or failure risk (Shepherd, 1999). Several authors have identified important shortcomings in the existing empirical literature on FMA, which may explain some of the contradictory findings. Among these shortcomings are inconsistencies in the definition of the dependent variables, biased sample selection, and failure to control for entrant capabilities (Anderson & Paine, 1978; Ramanujam & Venkatraman, 1984; Szymansky, Troy, & Bharadwaj, 1995; Vanderwerf & Mahon, 1997). Despite these methodological limitations, Lieberman and Montgomery (1988) and Kalyanaram, Robinson, and Urban (1995) have drawn a few common patterns or “emerging regularities” from empirical research: (1) FMA seems to be associated with specific product categories and industry characteristics (e.g., consumer packaged goods show persistent evidence of FMA), (2) FMA tends to be observed mainly in the form of higher market share, and (3) the longer the lead time to competitive entry, the higher the likelihood of achieving FMA, although this probability dissipates over time.

FMA theory has developed in three conceptual categories. First, the basic “isolating mechanisms” through which first movers’ “entrepreneurial rent” can be protected from imitative competition have been identified and classified (Rumelt, 1987; see Lieberman & Montgomery, 1988, for a review). A second stream of research

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on the “micro” side of FMA theory has explored the firm-level resources and capabilities that allow organizations to exploit FMA (e.g., Robinson, Fornell, & Sullivan, 1992). Finally, a small number of researchers have investigated the theory’s “macro” aspects, or the relationship between environment and competitive advantage based on order of market entry (e.g., Lambkin, 1988). In the following section we extensively review each of these three literature streams. Despite progress so far, existing FMA theory has been unable to sort out the conflicting evidence generated by empirical studies and to provide managers with coherent guidelines for strategy. Lieberman and Montgomery’s recent strong claim that “many of the fundamental conceptual problems that we discussed [in their seminal 1988 paper on the topic] remain unresolved” (1998: 1111) is a stern but realistic assessment of progress with FMA theory to date.

In this paper we tackle the challenge of advancing existing FMA theory by investigating the role of a firm’s environment in enabling or disabling FMA. Our contribution here is threefold. First, we explicitly draw attention to the macro side as a level of analysis that has largely been missing in the literature on FMA.1 We show that a careful articulation of the macro aspects of FMA theory can significantly enhance our understanding of the FMA phenomenon and can help to make sense of today's conflicting empirical findings. We argue that the current inability either to reject or to lend support to the conceptual claims of FMA proponents probably has to do not only with shortcomings in the methods used by empirical researchers—a limitation often acknowledged in the existing literature—but also with shortcomings in existing theory. While the micro side of FMA theory is an important factor in analyzing a firm’s ability to materialize FMA, firm resources and capabilities per se seem to be only one component of a broader set of factors that also include environmental variables and even “luck” (Lieberman & Montgomery, 1988).

Second, integrating arguments from the technology management, marketing, and industrial organization literature, we explain how two components of a firm’s environment—the pace of technological change and the pace of market evolution—interact with FMA isolating mechanisms—for example, resource preemption, technology leadership, and buyer’s switching costs (Lieberman & Montgomery, 1988).

Third, by focusing on the pace of evolution of both market and technology, we introduce an explicitly dynamic dimension into the macro side of FMA theory. We argue that the enabling or disabling effect of the environment on FMA depends not only on the environmental conditions at the time of entry but on their evolution over time.

In the following section we locate our contribution to the current theoretical debate with a review of existing FMA literature. Next, we provide a theoretical justification for our two proposed environmental dynamics and use those constructs to develop a model of enabling environmental conditions for FMA. We close the paper by discussing ways to integrate our model with existing firm-level research to further understanding of the FMA phenomenon.

**EXISTING FMA THEORY**

The concept of FMA emerged not from theoretical insights but from anecdotal and empirical evidence demonstrating that first movers’ competitive performance tended to be better than that of later entrants. Research funded by the U.S. Federal Trade Commission in the 1970s showed that, in both the prescription drug (Bond & Lean, 1977) and cigarette product categories (Whitten, 1979), first entrants enjoyed enduring performance advantages over later entrants. This “first mover advantage” concept attracted attention from management researchers, who began, in the 1980s, to search for theory-based explanations for why first movers tended to earn “profits in excess of the cost of capital” (Lieberman & Montgomery, 1988: 41), to achieve larger market share, or to survive longer than competitors.

**Isolating Mechanisms**

In the search for rationales behind FMA drivers, researchers borrowed mainly from two independent and unrelated streams: economics literature and consumer behavior literature. These two streams provided rationales for the

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1 Brown and Lattin (1994) suggest that if FMA are to exist, they should be conceptually observable ceteris paribus (i.e., given comparable levels of firm resources and capabilities).
existence of “isolating mechanisms” (Rumelt, 1987) underpinning FMA. Borrowing from economics theory, some researchers argued that first movers could preempt competitors from accessing valuable spaces (Hotelling, 1931; Prescott & Visscher, 1977) or production resources (Bain, 1956; McMillan, 1983), achieve economies of scale from initial investments (Dixit, 1985), benefit from patenting key innovations (Gilbert & Newbery, 1982), achieve cost advantages via learning economies (Lilien & Yoon, 1990; Spence, 1977), and create cost advantages derived from causal ambiguity and imperfectly imitable knowledge and practices (Lippman & Rumelt, 1982; Reed & DeFilippi, 1990). Other researchers, drawing on behavioral and cognitive theories, argued that FMA could result from cognitive switching costs arising from buyers’ habit formation (Schmalensee, 1982), consumer learning and reputation advantages (Carpenter & Nakamoto, 1989), and high buyers’ searching cost (Nelson, 1980).

The identification of these different drivers or isolating mechanisms has been the focus of much of the theory-oriented FMA literature to date. The mechanisms have been polished, classified, and reclassified several times. For instance, Golder and Tellis (1993) proposed producer-based versus consumer-based FMA drivers. Day and Freeman (1990) classified the drivers as resources preemption, proprietary experience effects, and leadership reputation. Mueller (1997) proposed two broad groups: demand-related or “inertial advantages” and supply-related or “efficiency advantages.” And Kerin, Varadarajan, and Peterson (1992) clustered them as economic factors, preemption factors, technological factors, and behavioral factors. Most widely accepted, however, is Lieberman and Montgomery’s (1988) classification of FMA isolating mechanisms into three categories: technology leadership, preemption of scarce assets, and switching costs/buyer choice under uncertainty.

Given the importance of this latter paper in the FMA literature, we use this taxonomy as a building block for our own proposal. FMA in technology leadership include isolating mechanisms, such as learning and experience effects and R&D patenting, that give a firm a technological edge over competitors; preemptive mechanisms encompass cost advantages arising from advanced appropriation of scarce input resources, forestalling bids for product characteristic spaces, and economies of scale created from preemptive investment in the plant and equipment; and switching costs arise from habit formation in buyers or from the installed-base effect in the presence of network effects.

Micro Aspects of FMA Theory

An important group of research studies investigated the effect of firms’ characteristics on competitive advantages based on order of entry into markets. Fueled largely by researchers in the resource-based view of the firm and in industrial economics, this literature stream has identified firms’ assets and strategic maneuvering as the key to capturing possible benefits from early entry. In this view, a firm’s ability to derive FMA should be assessed “with reference to the competence and capabilities which new entrants have, relative to the competitors” (Teece, Pisano, & Shuen, 1997: 529; see also Fuentelsaz, Gomez, & Polo, 2002, and Robinson & Chiang, 2002).

A recent study based on PIMS (Profit Impact of Market Strategy) data shows that first movers, early followers, and late entrants tend to deploy different skills and resources (Robinson et al., 1992). Some studies outline the substantial effect of a firm’s history on the relationship between order of entry and market performance (Carroll, Bigelow, Seidel, & Tsai, 1996; Klepper, 2002). For example, Klepper and Simons (2000), studying the U.S. receiver industry, found that firms with experience in radio technology are most likely to enter TV manufacturing, to have higher innovation rates, and to capture higher market share and survive longer. Schoenecker and Cooper found that “firms with large R&D intensities, that possess a direct sales force, and that have greater internal financial resources will be earlier entrants in industries with significant opportunities to build first mover advantages” (1998: 1132). Murthi, Srinivasan, and Kalyanaram (1996), analyzing 236 business units over a period of three years, found that pioneering advantages are significant when managerial skills are factored in. Rosenbloom and Cusumano (1987) discussed how firms’ R&D capabilities and their strategy with respect to “technology pioneering” played an important role in the competitive outcome of the VCR industry. Mitchell (1991) outlined the role of specialized assets
in the strategies of new entrants and incumbents entering new technical subfields of the diagnostic imaging industry.

**Macro Aspects of FMA Theory**

The role of the environment in organizational dynamics has long been studied in the various streams of organizational theory (e.g., Barnett & Carroll, 1995; Hannan & Freeman, 1988; Lawrence & Lorsch, 1967; Perrow, 1979; Pfeffer & Salancik, 1978; Scott, 1992). In a seminal work, Dess and Beard (1984) summarized previous literature by proposing three environmental attributes that affect organizational performance: munificence, dynamism/instability, and complexity. McArthur and Nystrom (1987) and Covin and Slevin (1989) found environmental munificence to be a significant predictor of the strategy-performance relationship, and Lambkin (1988) predicted the order of entry strategies most likely to succeed under three environmental dimensions: variability, grain of the variability, and uncertainty.

Using game theory tools, stylizing the FMA issue as an allocation problem given a certain market structure, and assuming rationally competing agents, the industrial organization literature outlines the conditions under which a firm deliberately decides whether to be a first mover or a later entrant. According to this literature, FMA are affected by such variables as degree of competition (Farrell & Saloner, 1985; Gal-or, 1985; Jensen, 1982; Reinganum, 1981), market structure (Katz & Shapiro, 1986, 1992), and time elapsed between first and second mover entry (Glazer, 1985).

The strategy literature addresses the relationship between the environment and FMA. For example, contingency theorists propose that firm performance results from coalignment of the environment and a firm’s resources, structure, and processes (Andrews, 1971; Lawrence & Lorsch, 1967; see Aragon-Correa & Sharma, 2003, for a review). Porter (1985) argues that advantages derived from entry timing are conditioned to industry characteristics, and he proposes a taxonomy of entry strategies vis-à-vis technological change in products and processes. Teece (1986) relates a firm’s ability to profit from technological innovation to the specific appropriability regime that surrounds the innovation, the emergence of a dominant design, and the firm’s possession of complementary assets. He argues that “when imitation is easy, markets do not work well and the profits from innovation may accrue to the owner of some complementary assets, rather than to the developers of the intellectual property” (1986: 285). Nehrt (1998) has studied the impact of government regulation on the sustainability of FMA.

We identify two main shortcomings in existing macro FMA theory. First, it is not sufficiently coupled to the core constructs of FMA theory. The environmental elements considered are, for the most part, independent and unrelated, and the link between them and FMA isolating mechanisms is weakly explored. Second, most of the variables identified in the literature are concerned with the existence/nonexistence of specific environmental characteristics only at the time the first mover enters the market (e.g., regulation, appropriability regime), and not with these characteristics’ temporal development.

**TOWARD AN FMA THEORY INCLUDING ENVIRONMENTAL DYNAMICS**

We argue that for FMA theory to be advanced in its macro aspects, the interplay between the environment and the FMA isolating mechanisms must be addressed much more formally. Consequently, our first task is to identify the environmental dimensions that have the strongest influence on the effectiveness of the FMA isolating mechanisms. Integrating several arguments from industrial economics, consumer behavior, strategy, and technology management, we isolate two environmental components that can help capture the essence of this interplay: the pace of technology evolution and the pace of market evolution. By introducing these explicitly dynamic components and by explaining why and how these dynamics play an important role as enablers or disablers of the isolating mechanisms that give rise to FMA, we advance the macro side of FMA theory and, thus, contribute to a richer, more integrated FMA theory overall. We assume that these two environmental components evolve independently, but we expect the implications of our framework to hold even when there is endogeneity between market and technology dynamics, as we explain in the last section of the paper.

In Figure 1 we place our proposed theoretical contribution (dotted-line boxes) beside the exist-
ing constructs, suggesting an avenue through which to integrate the existing components of FMA theory into a more comprehensive framework. Figure 1 shows that the isolating mechanisms’ effectiveness in generating FMA for a firm in a given situation depends on both firm-level (micro) and environment-level (macro) enabling conditions. The micro side of the theory relates to firm-level resources and capabilities that allow organizations to exploit FMA. The macro side of the theory relates to the characteristics of a firm’s environment that influence FMA. Each set of FMA enablers in the figure (central boxes) is connected by an arrow to its corresponding theoretical foundations (upper boxes). The isolating mechanisms are drawn as a class of their own, consistent with Lieberman and Montgomery (1988).

For the purposes of this analysis, we define “first mover” as the first firm—or the first few firms when the market lead time that separates them is insignificant—to enter a new product.
category. This definition is consistent with most of the existing literature and allows the terms first mover, market pioneer, or early entrant to be used interchangeably. We define “first mover advantage” as the performance gain that a firm attains from being first to market in a new product category, once other effects (namely, firm resources, lead time) have been controlled for. Empirical evidence suggests that first mover performance gains are typically reflected in economic profit or market share (Lieberman & Montgomery, 1998).

Theoretically, investigation of FMA should concentrate on the time period during which the isolating mechanisms have maximum potential to affect first movers’ competitive performance. There is broad agreement that the drivers of competitive advantage change over time (Utterback & Abernathy, 1975). For instance, Agarwal, Sarkar, and Echambadi, reviewing the evolutionary economics, population ecology, and technology management literature, conclude that “there appears to be convergence on the notion that at a particular point in time in an industry’s history, a structural change occurs that changes the resource conditions associated with competitive advantage” (2002: 976); the authors call this dividing point the “onset of maturity phase.” Consistent with these theoretical observations, we argue that FMA isolating mechanisms should be investigated in the period spanning from first product introduction to the onset of maturity (OM) in an industry. After OM, other competitive mechanisms are likely to influence a first mover’s competitive performance (e.g., commoditization, modularization, consolidation; see Porter [1980] for an extensive review of competitive mechanisms in mature industries). Our argument here is consistent with the empirical regularity, identified by Lieberman and Montgomery (1988: 1121), that FMA “dissipates over time.”

Operationally, OM can be defined as the inflection point in the industry’s cumulative sales curve (the inflection point is the time at which sales per year peak). Alternatively, OM can be identified using discriminant analysis, as in Agarwal et al. (2002). As these authors show, OM can vary considerably across product categories. For example, cathode ray tubes and freon compressors, both launched in 1935, reached the OM phase in 1967 and 1980, respectively.

In the analysis that follows, we define pace of market evolution and pace of technology evolution with reference to the period spanning from first product introduction to OM. In particular, pace of market evolution is defined as the average market change up to OM. Similarly, pace of technology evolution is defined as the average change in the level of technology performance up to OM. We now show why and how the pace of technology evolution and the pace of market evolution affect the three FMA isolating mechanisms: technology leadership, preemption of scarce assets, and switching costs.

**Pace of Technology Evolution and Isolating Mechanisms**

Once a new product category emerges, its core technology may evolve along a number of trajectories (Abernathy & Utterback, 1978; Anderson & Tushman, 1990; Nelson & Winter, 1982; Suarez & Utterback, 1995; Tushman & Anderson, 1986) and design hierarchies (Clark, 1985; Dosi, 1982). Different product categories may experience very different paces of technology evolution up to OM. For example, the degree of efficiency improvements for vacuum cleaners over the early phase of that industry (Agarwal & Bayus, 2002) was marginal when compared to the improvements in CPU clock speed in the early PC industry. The pace of technology evolution can be captured through the technology “S curve” (Cooper & Schendel, 1976; Foster, 1986; Sahal, 1982) that represents—in technical terms—the evolution of a technology along a particular performance parameter as more “development effort” is poured in. The technology S-curve framework has been extended to analyze cases of technological “discontinuities” or “disruptive” technologies (Utterback & Kim, 1986). For instance, Christensen (1997) has used an S-curve framework to illustrate how different generations of computer disk drives improved not only along the technology performance parameters of previous generations but also along new performance parameters.

The pace at which technology evolves directly affects the possibility of deriving FMA through technology leadership. For instance, the advantage derived from entering first into a market can be linked to a firm’s ability to keep up with the evolution of knowledge within the industry. Technology evolution may render a firm’s
knowledge obsolete, destroy existing competences (Henderson & Clark, 1990; Leonard, 1992; Schilling, 2002; Tushman & Anderson, 1986), and negate possible “experience curve” advantages (Lieberman, 1989). Bohmann, Goldner, and Mitra (2002) provide theoretical and empirical evidence that FMA are difficult to sustain in product categories with high “vintage effects”—that is, where product quality significantly improves over time. Christensen, Suarez, and Utterback found that, in the fast-changing rigid disk drive industry, “the notion of first mover advantage is not applicable” (1998: S207). Similarly, Christensen (1997) shows how technological change allowed for a new breed of late entrants in the steel and disk drive industries.

Rapid technology evolution also influences the effectiveness of patents and other forms of intellectual property protection. The economics literature on patenting has shown that a firm’s ability to protect its underlying product technology varies across industries (Levin, Klevecz, Nelson, & Winter, 1987). Empirical evidence suggests that about 60 percent of successful innovations are initiated within four years (Mansfield, Schwartz, & Wagner, 1991). A fast pace of technology evolution may give latecomers plenty of opportunities to “invent around” a patent and come up with improved products that do not necessarily infringe on patent rights. These technology-driven options or gateways (Bain, 1956) to the market reduce the effectiveness of intellectual protection and provide more opportunities for later entrants to challenge first movers’ technology leadership.

Technological evolution also affects key antecedents of buyers’ switching costs, such as domain expertise (Wernerfelt, 1984) and consumer preference formation (Carpenter & Nakamoto, 1989). Again, rapid technological evolution tends to result in a succession of different technology generations or “vintages,” each of which renders the previous one obsolete. When buyers perceive this “technological uncertainty,” they tend not to commit themselves to product-specific learning (Carpenter & Nakamoto, 1989; Schmalensee, 1982). This phenomenon is particularly relevant for experience goods that can be evaluated only after purchase (Nelson, 1980) and for standards-war situations in which producers of two or more incompatible technologies compete for market dominance (Suarez, 2004). First movers who risk introducing an “underdevel-

Pace of Market Evolution and Isolating Mechanisms

The market evolution of consumer and industrial product innovations is generally characterized by an initial period of slow growth immediately after first product commercialization; this phase is eventually followed by a sharp increase or “sales takeoff” (Golder & Tellis, 1993; Klepper, 2002; Mahajan, Muller, & Bass, 1990; Rogers, 1995) and, as discussed above, a later phase of market maturity and decline (e.g., Mahajan et al., 1990). Empirical evidence (Agarwal & Bayus, 2002) shows that the time from initial product commercialization to sales takeoff and industry maturity can vary considerably across product innovations. Some product categories show very high sales growth from the start (e.g., compact disc players and cellular phones), whereas others languish for many years with slow sales (e.g., dishwashers).

Market evolution in a given product category, often measured in sales, household penetration, or number of adopters, is influenced by several market-related dynamics. These can include changes in consumer tastes or preferences (Moore, 1999), emergence of new regulations, degree of market fragmentation, and consumer learning (Agarwal & Bayus, 2002). Our core construct—pace of market evolution—reflects the combined effect of these market-related dynamics within a product category.

Several researchers have studied the impact of market evolution on the relationship between order of entry and performance. In a study of thirty-three product innovations, Agarwal et al. (2002) found that an industry’s growth pattern has a significant “conditioning effect” on the relationship between entry timing and firm survival; Bohmann et al. (2002) suggest that FMA are more sustainable in markets where horizontal (as opposed to quality-based) product differentiation predominates, a situation more common in slow-growing (mature) markets (Utterback, 1994).

The pace of market growth has important implications for the effectiveness of buyer preemption mechanisms. The ability of a firm to
preempt scarce market resources has been shown to depend on the pace at which an industry is growing. A situation of high market growth implies that, at any point in time, there will always be sufficient market resources (e.g., enough buyers) for new entrants. This is consistent with theoretical models of industrial organization, which show that a fast-growing market in the presence of network effects is crucial to overcoming a new product’s entry timing advantage (Katz & Shapiro, 1992). Organizational theorists have shown that environmental munificence—that is, the scarcity or abundance of critical resources needed by firms operating within an environment—effectively determines the rate at which new competitors can be added to the population (Pfeffer & Salancik, 1978).

A further aid to understanding the role played by the pace of market evolution in the effectiveness of competitive mechanisms appears in Figure 2. Let us call M the cumulative level of market-related resources in a given product category (e.g., cumulative buyers or cumulative sales) and \( M_{OM} \) the level of market-related resources at the industry’s OM. Let us further consider two reference scenarios for the pace of market evolution: an abrupt pace (curve B in Figure 2) and a smooth pace (curve A). For any fixed \( \bar{V}_T \), firms operating in an environment with a higher pace of market evolution will benefit from a greater level of available market resources. In fact, the segment “ab,” representing market resources deployed in \( \bar{V}_T \) in scenario B, is longer than the corresponding segment, “bc,” for scenario A. Unlike the slow pace scenario, when market growth occurs at a fast pace, other things being equal, a larger amount of consumer resources becomes available to the existing companies in the market for any given \( \bar{V}_M \); this process undermines early entry inertial advantages (Katz & Shapiro, 1992). Alternatively, for any given fixed \( \bar{V}_M \), there is a longer \( \bar{V}_t \) in reference scenario A (\( \bar{V}_t, A \)), slow-paced market growth, than in reference scenario B (\( \bar{V}_t, B \)), fast-paced market growth. That is, a fixed amount of resources will have to “feed” all active firms for a longer period of time in scenario A than in scenario B, assuming a given distribution of en-

FIGURE 2
Two Scenarios for Pace of Market Evolution

![Diagram showing two scenarios for pace of market evolution: curve B (fast-paced) and curve A (slow-paced). The diagram illustrates the cumulative level of market-related resources (M) and the level of resources at the industry’s OM (M_{OM}). The figure highlights the difference in available market resources between the two scenarios, with scenario B showing a longer segment for available resources compared to scenario A.]
try and exit into the market over time (the longer the time, the greater the number of entrants). Researchers have found that the scarcity of environmental resources tends to enable order of entry-based advantages (Dierickx & Cool, 1989; Lambkin, 1988).

The arguments presented in this section suggest that the pace of technological and market evolution plays an important role in enabling or disabling FMA isolating mechanisms. Therefore, we offer the following proposition.

**Proposition 1:** The pace of technological evolution and the pace of market evolution will affect the effectiveness of FMA isolating mechanisms.

**IMPLICATIONS FOR FMA STRATEGIES**

Building on the two environmental dynamics described above, we develop a theoretical model to shed further light on FMA theory and describe implications for FMA strategies. To provide a parsimonious representation of our model, we outline two scenarios—smooth and abrupt—for the pace at which technology and the market may evolve. We use the S-curve framework to illustrate our points. Recall that we define pace of market and technology evolution with reference to the OM phase, and assume that other variables relevant for FMA theory (e.g., firm resources, lead time) are constant across the resulting scenarios.

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We use the S-curve framework to operationalize and intuitively understand our two core constructs, pace of technology evolution and pace of market evolution. Although the S-curve framework does not capture the entire granularity in technology and market evolution that is reflected in the resulting pace of evolution from product introduction to OM, it does help to illustrate alternative scenarios.
Our model is illustrated in Figure 3 as a matrix with four quadrants, each of which represents a different combination of environmental dynamics. The implications for each quadrant are discussed below.

**Smooth Market Growth and Smooth Technology Improvement (Quadrant I)**

When both market growth and technology development move at a smooth pace, early entrants have the best chance of benefiting from FMA. By making it easier for first movers to grab a significant share of market resources and harder for later entrants to find space to grow and survive, a smooth pace of market evolution reduces the likelihood that later entrants will be able to break the first mover’s “inertial” advantages (Katz & Shapiro, 1992). Because first movers are able to control a larger share of the market, customers are less likely to engage in the “hold-up” and “wait and see” attitudes they typically adopt when no clear industry leader is perceived (Carpenter & Nakamoto, 1990). In a classic reinforcing loop, lower customer hold-up tends to favor the market pioneers. The cognitive literature suggests that learning occurs more effectively when the environment is stable (e.g., Polanyi, 1983) and that more effective learning is associated with higher cognitive switching costs that favor first movers.

Where the advantage is based on technology leadership, a smooth pattern of technology and market growth also tends to work in favor of first movers, since later entrants will be less able to challenge first movers by using improvements in technological performance to differentiate their products. Even if the challengers were to succeed, first movers would be able to catch up rapidly by improving on their own products, exploiting their experience curve, and carefully selecting the most valuable technologies and skills (e.g., Tushman & Anderson, 1986). Unable to rely on technology, later entrants will have trouble differentiating their offerings from those of first movers. Lane (1980) and Prescott and Vischer (1977) show that when product differentiation in the market is unlikely to occur, later entrants incur greater costs in their efforts to gain market share. Similarly, Bohmann et al. (2002) show strong evidence of FMA when differentiation or “horizontal variety” is the main driver of competition, a situation that occurs more often in the mature industries in their sample. Because it simplifies sound technical and commercial decision making, a predictable environment benefits first movers (e.g., Weick 1993); smooth technological evolution may also increase the effectiveness of a firm’s R&D patenting. Levin et al. (1987) show that R&D patent protection is more effective in the inorganic and organic chemicals industries and the traditional drugs industry, all of which are characterized by a relatively slow pace of technology evolution.

Current empirical evidence supporting the existence of FMA comes mostly from new product categories in mature industries. For instance, Robinson and Fornell (1985) analyzed 371 mature consumer products and found that pioneers have substantially higher market share than followers; Robinson (1988) found a similar pattern for industrial goods. Bond and Lean (1977) and Whitten (1979) found first entry brand advantages for two prescription drugs and seven cigarette product categories, respectively, while Urban, Carter, Gaskin, and Mucha (1986) found that pioneers outperformed later entrants in twenty-four frequently purchased consumer products. Mature industries such as those described in the cited studies tend to show a smooth pace of market and technology evolution, because the underlying technology has already reached a phase characterized by decreasing returns and because new product introductions often relate to the simple extension of existing products (e.g., a new cereal flavor).

As Figure 3 and the above discussion suggest, environmental elements are aligned to favor FMA when both technological and market evolution are smooth. Thus, Proposition 2 follows.

**Proposition 2:** When the pace of market evolution and the pace of technology evolution are both smooth, the enabling effect of environmental elements on isolating mechanisms will be strongest.

**Proposition 2a:** In this situation—controlling for firm-level differences—FMA will likely occur.

**Abrupt Market Growth and Abrupt Technology Improvement (Quadrant III)**

We argue that, in a scenario exactly opposite that above, when market growth and technology
improvement both proceed abruptly, early entrants are least likely to benefit from FMA. Because abrupt market and technology dynamics have a high potential to undermine the effectiveness of isolating mechanisms, early entrants find FMA based on technology leadership more difficult to achieve; conversely, later entrants find that higher-quality products, or innovative solutions that can enable powerful vintage effects, are easier to develop (Bohlmann et al., 2002).

A rapidly changing technology also increases the risk of first movers’ knowledge inertia or obsolescence. Not only does this condition make it more difficult for first movers to catch up with the products introduced by later entrants (Henderson & Clark, 1990; Tushman & Anderson, 1986), but a weak appropriability context also seems to characterize fast-paced industries (e.g., computers and semiconductors). Levin et al. (1987) found that patenting is largely ineffective in these industries.

Abrupt technology and market evolution, by creating uncertainty for firms and consumers, makes sound decision making more difficult for all agents and, thus, also makes it very difficult for firms to preempt technological and consumer resources. Approaching the problem from different theoretical angles, Porter (1985), Wernerfelt and Karnani (1987), and Weick (1993) suggest that erroneous organizational decisions are likely to be made in high-uncertainty situations. Gal-or (1985) argues that the higher the uncertainty, the more reluctant firms are to commit to long-term contracts to secure key factor inputs. Abrupt technology and market evolution can even disable switching costs, which often favor first movers, since negative word of mouth effects can develop the perception that later entrants’ products are superior (Kalish & Lilien, 1986). An abrupt market evolution also will ease later entrants’ efforts to find market spaces that have not yet been exploited by incumbents (Christensen, 1997). Katz and Shapiro (1992) have shown that “excess inertia”—a bias toward the competitive advantage achieved by an earlier entrant—can be overcome under the assumption of fast market growth.

Current empirical evidence that refutes the existence of FMA seems to support our hypotheses. Bohlmann et al. (2002), analyzing data from thirty-six product categories, found that FMA cannot be achieved in the presence of strong, technology-driven vintage effects. Christensen et al., studying the fast-changing disk drive industry and finding that first movers are superseded by later entrants, posit the existence of an “entry window tightly linked to the emergence of the product dominant design” (1998: S208). Tegarden, Hatfield, and Echols (1999), analyzing the rapidly evolving personal computer industry, found that not only can later entrants succeed and enjoy high survival rates but can even make a “wrong” initial technology choice—say, opting for a design that is later deselected—and still manage to switch successfully to the winning design. Empirical data have been collected in several case studies of product categories in fast-growing environments. Among these, studies of the PC industry (e.g., Schnaars, 1986), cellular telephones (Agarwal & Bayus, 2002), VCRs (Rosenbloom & Cusumano, 1987), and microwaves (Agarwal & Bayus, 2002) have found no evidence of FMA.

In Quadrant III, both environmental elements are aligned in an abrupt evolutionary pace. Unlike in Quadrant I, where smooth technology and market evolution enable the effect of FMA drivers, in Quadrant III abrupt alignment pace disables FMA drivers. From this reasoning, Proposition 3 then follows.

**Proposition 3:** Where the pace of market evolution and the pace of technology evolution are both abrupt, the disabling effect of environmental elements on isolating mechanisms will be strongest.

**Proposition 3a:** In this situation—controlling for firm-level differences—FMA will be unlikely to occur.

**Abrupt Market Growth and Smooth Technology Improvement (Quadrant II) and Smooth Market Growth and Abrupt Technology Improvement (Quadrant IV)**

Figure 3 illustrates the two remaining quadrants, II and IV, where market and technology evolution are not aligned. Unlike the two cases described above, in these situations, one environmental dynamic tends to favor FMA, while the other has an opposite effect. For example, in Quadrant II, a slow pace of technology evolution favors early entrants by enabling FMA isolating mechanisms (as extensively argued in the pre-
vious sections), but a fast pace of market evolution tends to disable the effect of FMA isolating mechanisms and to favor later entrants. The environmental dynamics exert a similarly conflicting effect on the isolating mechanisms in Quadrant IV: an abrupt pace of technological evolution tends to disable the isolating mechanisms, while a smooth pace of market evolution tends to enable them. Therefore, we propose the following.

**Proposition 4:** Where the pace of market evolution is abrupt and the pace of technology evolution smooth, or where the pace of market evolution is smooth and the pace of technology evolution abrupt, the net effect of environmental elements on isolating mechanisms will be weaker than in cases where both environmental elements are aligned.

**CONCLUDING REMARKS AND AVENUES FOR FUTURE RESEARCH**

In this paper we have advanced FMA theory by exploring the impact of environmental dynamics on the effectiveness of the isolating mechanisms that drive FMA. Integrating insights from the technology management, industrial organization, and marketing literature, we have provided a rationale for incorporating two hitherto missing environmental elements—the pace of technology evolution and the pace of market evolution—into FMA theory. In doing so, we have advanced the “macro side” of FMA theory by adding an explicitly dynamic element and by elaborating on the interplay between the environment and FMA isolating mechanisms. Our proposed environmental dynamics complement and integrate the existing FMA literature that has, to date, largely been focused at the micro or firm level. Taken together with our macro, environment-level elements, these theoretical components open an avenue for building a more comprehensive FMA theory, according to which firm-level variables and environment-level dynamics jointly determine the effectiveness of FMA isolating mechanisms with neither able to explain independently why a particular firm enjoys FMA in a given situation.

We have elaborated on our proposed environmental dynamics to present a model of FMA-enabling (or -disabling) environmental contexts and have analyzed two reference scenarios—the smooth and the abrupt pace of technology and market evolution—to deduce the implications for FMA theory and entry timing strategies. We conclude that environmental dynamics either impose restrictions or create opportunities for the exploitation of FMA. For example, in environments characterized by a smooth pace of market and technology evolution (Figure 3, Quadrant I), the environmental dynamics are aligned to strongly enable FMA and, other things being equal, present the greatest challenge for later entrants to overtake the first movers. Conversely, in an environment characterized by an abrupt pace of technology and market evolution (Figure 3, Quadrant III), the environmental dynamics are aligned to strongly disable FMA and facilitate late entry, other things being equal. Quadrants II and IV represent cases in which the two environmental forces oppose each other and make the net effect of the environment on the FMA isolating mechanisms weaker than in the previous cases.

Our model also has important implications for management practice, the most straightforward of which concerns entry timing strategy. For a given level of firm resources and capabilities, the success of a specific entry timing strategy will be affected by the particular dynamics of market and technology evolution; first mover strategies are most likely to be successful when the pace of both market and technology evolution is smooth. Conversely, firms need to be extra careful when attempting to implement first mover strategies in environments characterized by an abrupt pace of market and technology evolution, because, in these situations, the abrupt pace of environmental evolution is likely to create windows of opportunity for successful later entry strategies.

Another managerial implication of our model relates to the level and typology of resources and capabilities required to enable successful first mover strategies in different environmental conditions. We argue that environmental dynamics have an enabling/disabling effect on isolating mechanisms, all other things (including resources and capabilities) being equal. From this conclusion it follows that a given set of resources and capabilities will be more or less “useful” (in terms of helping a firm to obtain FMA), depending on the existing environmental conditions.
dynamics in a given situation, as illustrated by the four quadrants in our model. All other things being equal, we would expect a given level of resources and capabilities to be "less useful" in Quadrant III (abrupt–abrupt) than, say, in Quadrant I (smooth–smooth). To predict the scenario of environmental dynamics that a first mover may face in a particular case, managers could use market forecasting techniques such as those outlined in Bass (1969) and technology forecasting methods such as those outlined in Sahal (1982).

The environmental dynamics introduced in this paper represent building blocks that have the potential to substantially increase the predictive power of current FMA theory and to open several research avenues that could enhance our knowledge of the FMA phenomenon. We have shown that our proposed theory can help make sense of the empirical FMA literature; however, as with all theory papers, more formal tests of our propositions are needed.

Further theoretical and empirical research is needed to gain a better understanding of the relative importance of market versus technology dynamics as enablers/disablers of the isolating mechanisms. This could help, for instance, to sort out more formally the role of each environmental element in situations such as those depicted in Quadrants II and IV of our model (Figure 3). Additional theoretical and empirical research on the macro side of FMA theory may allow each isolating mechanism’s relative weight to be determined more precisely in contexts such as those outlined in Figure 3. In addition, further research could shed light on the potential interactions between the pace of market and technology evolution, which we have assumed here to evolve independently. We expect the main claims of our model to hold even in the presence of endogeneity between market and technology evolution. Were the correlation between technology evolution and market evolution always perfect, the parsimonious expression of our model would be reduced to one axis instead of two: abrupt or smooth (which now would imply abrupt or smooth in both dimensions simultaneously). Our model would then be reduced to two quadrants (I and III), instead of four. We would expect all the reasoning and implications we develop for these two quadrants to remain the same. That is, other things being equal, FMA would be less likely in the abrupt quadrant and more likely in the smooth quadrant.

Most of the constructs in this article can be easily operationalized for empirical testing. FMA can be captured with respect to different firms’ performance measures, most significantly market share and profitability. The pace of market evolution, as well as the pace of technology evolution, can be measured by focusing on specific properties relevant to a particular product category. For instance, market evolution in most product categories can be measured by tracing total sales or household penetration from first product introduction to the point of OM (the latter can be operationalized as the point of inflection in the cumulative sales curve). Similarly, technology evolution can be calculated by tracing the performance changes of a core underlying technology (e.g., million of instructions per second in the case of microprocessors) from first product introduction to OM. Consistent with existing literature, the operationalization of constructs should take into account other variables, such as wars or economic depression, that have the potential to affect a firm’s market entry performance (Agarwal & Bayus, 2002), lead time between entrants (Lieberman & Montgomery, 1998), and firm resources and capabilities (Penrose, 1956; Peteraf, 1993).

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