First-Mover Advantages

Marvin B. Lieberman, David B. Montgomery

Strategic Management Journal, Volume 9, Issue Special Issue: Strategy Content Research (Summer, 1988), 41-58.

Strategic Management Journal, Vol. 9, 41–58 (1988)

FIRST-MOVER ADVANTAGES

MARVIN B. LIEBERMAN and DAVID B. MONTGOMERY
Graduate School of Business, Stanford University, Stanford, California, U.S.A.

This article surveys the theoretical and empirical literature on mechanisms that confer advantages and disadvantages on first-mover firms. Major conceptual issues are addressed, and recommendations are given for future research. Managerial implications are also discussed.

INTRODUCTION

What, exactly, are first-mover advantages? Under what conditions do they arise, and by what specific mechanisms? Do first-movers make above-average profits? And when is it in a firm's interest to pursue first-mover opportunities, as opposed to allowing rivals to make the pioneering investments?

In this paper we examine these and other related questions. We categorize mechanisms that confer advantages and disadvantages on first-mover firms, and critically assess the relevant theoretical and empirical literature. The recent burgeoning of theoretical work in industrial economics provides a rich set of models that help make understanding of first-mover advantages more precise. There is also a growing body of empirical literature on order-of-entry effects. Our aim is to begin to provide a more detailed mapping of mechanisms and outcomes, to serve as a guide for future research.

We define first-mover advantages in terms of the ability of pioneering firms to earn positive economic profits (i.e. profits in excess of the cost of capital). First-mover advantages arise endogenously within a multi-stage process, as illustrated in Figure 1. In the first stage some asymmetry is generated, enabling one particular firm to gain a head start over rivals. This first-mover opportunity may occur because the firm possesses some unique resources or foresight, or simply because of luck. Once this asymmetry is generated a variety of mechanisms may enable the firm to exploit its position; these mechanisms enhance the magnitude or durability (or both) of first-mover profits.

Our discussion is organized as follows. We first consider theoretical models and empirical evidence on three general categories in which first-mover advantage can be attained: leadership in product and process technology, preemption of assets, and development of buyer switching costs. We then examine potential *disadvantages* of first-mover firms (or conversely, relative advantages enjoyed by late-mover rivals). These include free-rider problems and a tendency toward inertia or sluggish response by established incumbents. The next section addresses a series of basic conceptual issues. These include the endogenous nature of first-mover opportunities, and various definitional and measurement questions. We conclude with an assessment of opportunities for additional research and a discussion of managerial implications.

MECHANISMS LEADING TO FIRST-MOVER ADVANTAGES

First-mover advantages arise from three primary sources: (1) technological leadership, (2) preemp-

0143–2095/88/050041–18$09.00

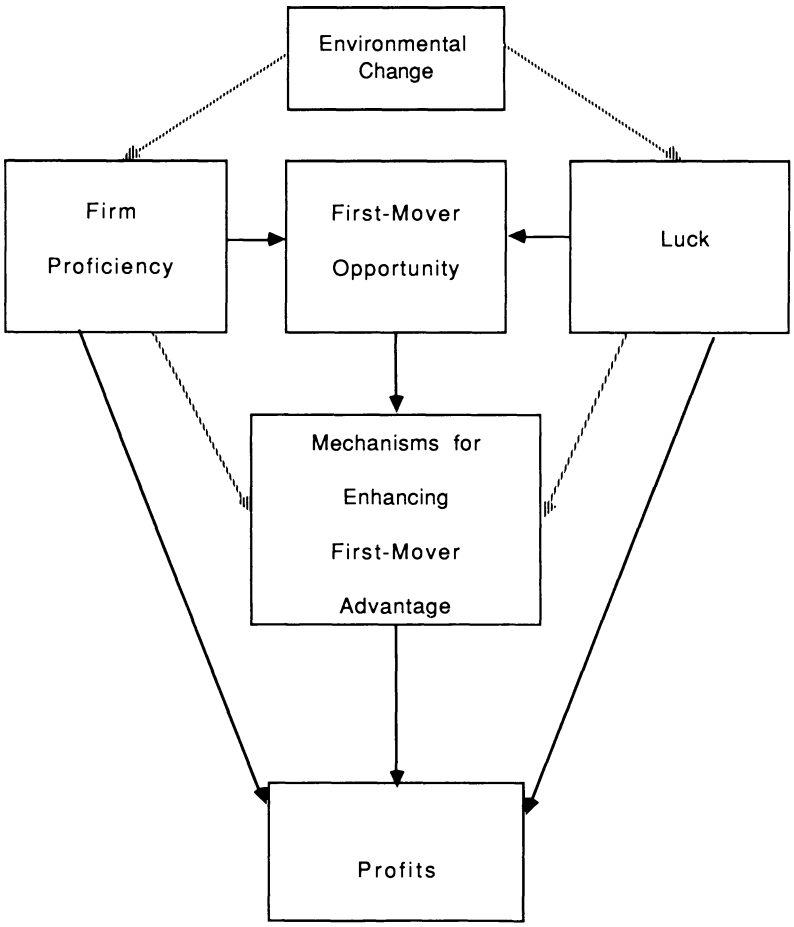

Figure 1. Endogenous generation of first-mover advantages.

tion of assets, and (3) buyer switching costs. Within each category there are a number of specific mechanisms.[1] In this section we survey existing theoretical and empirical literature on these three general categories of first-mover advantages.

The theoretical models surveyed in this section assume the existence of some initial asymmetry among competitors that can be exploited by the first-mover firm. This initial asymmetry is critical; without it, first-mover advantages do not arise. Ways in which this asymmetry may come about are considered later in the paper.

Technological leadership

First-movers can gain advantage through sustainable leadership in technology. Two basic mechanisms are considered in the literature: (1) advantages derived from the 'learning' or 'experience' curve, where costs fall with cumulative output, and (2) success in patent or R&D races, where advances in product or process technology are a function of R&D expenditures.

Learning curve

In the standard learning-curve model, unit production costs fall with cumulative output. This generates a sustainable cost advantage for the early entrant if learning can be kept proprietary and the firm can maintain leadership in market share. This argument was popularized by the Boston Consulting Group during the 1970s and has had a considerable influence on the strategic management field.

In a seminal theoretical paper, Spence (1981) demonstrated that when learning can be kept

[1] Rumelt (1987) refers to these as 'isolating mechanisms', since they protect 'entrepreneurial rents' from imitative competition.

proprietary; the learning curve can generate substantial barriers to entry. Fewer than a handful of firms may be able to compete profitably.[2] Despite high seller concentration, incentives for vigorous competition remain. Firms that do enter may initially sell below cost in an effort to accumulate greater experience, and thereby gain a long-term cost advantage. Such competition sharply reduces profits.

Empirical evidence of learning-based preemption is given by Ghemawat (1984) in the case of DuPont's development of an innovative process for titanium dioxide, and by Porter (1981), who discusses Procter and Gamble's sustained advantage in disposable diapers in the U.S. Similarly, Shaw and Shaw (1984) argue that late entrants into European synthetic fiber markets failed to gain significant market shares or low cost positions, and many ultimately exited. Learning-based advantages are also evident in the case of Lincoln Electric Company (Fast, 1975); the firm's early market entry with superior patented products, coupled with a managerial system promoting continued cost reduction in an evolutionary technological environment, has enabled the company to maintain high profitability for decades.

Inter-firm diffusion of technology, which diminishes first-mover advantages derived from the learning curve, is emphasized in theoretical papers by Ghemawat and Spence (1985) and Lieberman (1987c). It is now generally recognized that diffusion occurs rapidly in most industries, and learning-based advantages are less widespread than was commonly believed in the 1970s. Mechanisms for diffusion include workforce mobility, research publication, informal technical communication, 'reverse engineering', plant tours, etc. For a sample of firms in ten industries, Mansfield (1985) found that process technology leaks more slowly than product technology, but competitors typically gain access to detailed information on both products and processes within a year of development. Lieberman (1982, 1987b) shows that diffusion of process technology enabled late entry into a sample of 40 chemical product industries, despite strong learning curve effects at the industry level.

[2] In a related setting where learning depends on accumulated investment rather than output, Gilbert and Harris (1981) show that a first-mover will preempt in the construction of new plants over multiple generations.

R&D and patents

When technological advantage is largely a function of R&D expenditures, pioneers can gain advantage if technology can be patented or maintained as trade secrets. This has been formalized in the theoretical economics literature in the form of R&D or patent-races where advantages are often enjoyed by the first-mover firm. Gilbert and Newbery (1982) were the first to develop a model of preemptive patenting, in which a firm with an early head-start in research exploits its lead to deter rivals from entering the patent-race. Subsequent papers by Reinganum (1983), Fudenberg *et al.* (1983) and others show that successful preemption by the leader depends on assumptions regarding the stochastic nature of the R&D process and on the inability of followers to 'leapfrog' ahead of the incumbent. One general defect of the patent-race literature is the assumption that all returns go exclusively to the winner of the race.

As an empirical matter, such patent-races seem to be important in only a few industries, such as pharmaceuticals. In most industries, patents confer only weak protection, are easy to 'invent around', or have transitory value given the pace of technological change. For a sample of 48 patented product innovations in pharmaceuticals, chemicals and electrical products, Mansfield *et al.* (1981) found that, on average, imitators could duplicate patented innovations for about 65 percent of the innovators cost; imitation was fairly rapid, with 60 percent of the patented innovations limited within 4 years. Imitation appears relatively more costly in the pharmaceutical industry, where imitators must go through the same regulatory approval procedures as the innovating firm. Levin *et al.* (1984) found wide inter-industry variation in the cost and time required for imitation. They also found inter-industry differences in appropriability mechanisms, with lead-time and learning curve advantages relatively important in many industries, and patents important in few. In a study using the PIMS data base, Robinson (1988) found that pioneer firms benefit from patents or trade secrets to a significantly greater extent than followers (29 percent vs. 13 percent). However, he also found that patents accounted for only a small proportion of the perceived quality advantages enjoyed by pioneers.

Several case studies have examined the role of patents in sustaining first-mover advantages. Bresnahan (1985) discusses Xerox's use of patents as an entry barrier. In addition to key patents on the basic Xerography process, Xerox patented a thicket of alternative technologies which defended the firm from entry until challengers used anti-trust actions to force compulsory licensing. Bright (1949) argues that GE's long-term dominance of the electric lamp industry was initially derived from control of the basic Edison patent, and later maintained through the accumulation of hundreds of minor patents on the lamp and associated equipment.

R&D and innovation need not be limited to physical hardware; firms also make improvements in managerial systems and may invent new organizational forms. Organizational innovation is often slow to diffuse, and hence may convey a more durable first-mover advantage than product or process innovation (Teece, 1980). Chandler (1977) describes managerial innovations that enabled producers to exploit newly available scale economies in manufacturing and distribution in the late nineteenth century. Many of these firms—e.g. American Tobacco, Campbell Soup, Quaker Oats, Procter and Gamble—still retain dominant positions in their industries.

Preemption of scarce assets

The first-mover firm may be able to gain advantage by preempting rivals in the acquisition of scarce assets. Here, the first-mover gains advantage by controlling assets that already exist, rather than those created by the firm through development of new technology. Such assets may be physical resources or other process inputs. Alternatively, the assets may relate to positioning in 'space', including geographic space, product space, shelf space, etc.

Preemption of input factors

If the first-mover firm has superior information, it may be able to purchase assets at market prices below those that will prevail later in the evolution of the market. Such assets include natural resource deposits and prime retailing or manufacturing locations. Here, the returns garnered by the first-mover are pure economic rents.[3] A first-mover with superior information can (in principle) collect all such rents earned on non-mobile assets such as resource deposits and real estate.[4] The firm may also be able to appropriate some of the rents that accrue to potentially mobile assets such as employees, suppliers and distributors. The firm can collect such rents if these factors are bound to the firm by switching costs, so that their mobility is restricted.

One empirical study of first-mover advantages in controlling natural resources is Main (1955). Main argues that the concentration of high-grade nickel deposits in a single geographic area made it possible for the first company in the area to secure rights to virtually the entire supply, and thus dominate world production for decades.

Preemption of locations in geographic and product characteristics space

First-movers may also be able to deter entry through strategies of spatial preemption. In many markets there is 'room' for only a limited number of profitable firms; the first-mover can often select the most attractive niches and may be able to take strategic actions that limit the amount of space available for subsequent entrants. Preemptable 'space' can be interpreted broadly to include not only geographic space, but also shelf space and 'product characteristics space' (i.e. niches for product differentiation).

The theory of spatial preemption is developed in papers by Prescott and Visscher (1977), Schmalensee (1978), Rao and Rutenberg (1979) and Eaton and Lipsey (1979, 1981). The basic argument is that the first-mover can establish positions in geographic or product space such that latecomers find it unprofitable to occupy the interstices. If the market is growing, new niches are filled by incumbents before new entry

---

[3] The basic argument is standard economic analysis, and can be traced back to Ricardo's analysis of rents captured by landowners (first-movers) in the market for wheat in nineteenth-century England.

[4] Note that, with complete markets, a first-mover with superior information need not actually own or control such assets to capture economic rents. Hirshleifer (1971) argues that if futures markets exist, the firm can simply assume forward market positions that exploit its superior information.

becomes profitable.[5] Entry is repelled through the threat of price warfare, which is more intense when firms are positioned more closely. Incumbent commitment is provided through sunk investment costs.[6]

Empirical evidence suggests that successful preemption through geographic space packing is rare. In their study of the cement industry, Johnson and Parkman (1983) found no evidence of successful geographic preemption even though structural characteristics of the industry suggest that such strategies would be likely. In a study of local newspaper markets, Glazer (1985) found no difference in survival rates between first- and second-mover firms. One explanation for these findings is that all firms in cement and newspaper markets have similar technologies and entry opportunities, so preemptive competition for preferred sites drives profits to zero. In other words, there were no initial asymmetries in timing or information to be exploited.

One counter-example illustrating effective geographic preemption is a case study of the Wal-Mart discount retailing firm (Ghemawat, 1986b). Wal-Mart targeted small southern towns located in contiguous regions that competitors initially found unprofitable to service. By coupling spatial preemption at the retail level with an extremely efficient distribution network, the firm has been able to defend its position and earn sustained high profits.

Schmalensee's (1978) model of product space preemption was developed in the context of a lawsuit brought by the Federal Trade Commission against the three major U.S. breakfast cereal companies. The FTC alleged that these firms had sustained their high profit rates through a strategy of tacit collusion in preempting supermarket shelf space and product differentiation niches. Although the lawsuit was dismissed, the cereal firms have continued to sustain exceptionally high profit rates.[7]

Robinson and Fornell (1985) found that new consumer product pioneers initially held product quality superiority over imitators and subsequently developed advantages in the form of a broader product line. Thus, there is evidence that pioneers try to reinforce their early lead by filling product differentiation niches.

Preemptive investment in plant and equipment

Another way in which an established first-mover can deter entry is through preemptive investment in plant and equipment. Here, the enlarged capacity of the incumbent serves as a commitment to maintain greater output following entry, with price cuts threatened to make entrants unprofitable. In these models the incumbent may successfully deter new entry, as in Spence (1977), Dixit (1980), Gilbert and Harris (1981) and Eaton and Ware (1987). Alternatively, preemptive investment by the pioneer may simply deter the growth of smaller entrants, as in Spence (1979) and Fudenberg and Tirole (1983).

These investment tactics do not seem to be particularly important in practice. Gilbert (1986) argues that most industries lack the cost structure required for preemptive investment to prove effective. Lieberman (1987a) shows that preemptive investment by incumbents was seldom successful in deterring entry into chemical product industries. One exception was magnesium, where Dow Chemical maintained a near-monopoly position for several decades, based largely on investments (threatened or actual) in plant capacity (Lieberman, 1983).

The role of scale economies is intentionally deemphasized in the above-mentioned models of preemptive investment.[8] When scale economies are large, first-mover advantages are typically enhanced, with the limiting case being that of natural monopoly. However, outside of public utilities, scale economies approaching the natural monopoly level are seldom observed in U.S. manufacturing industries.[9] In a theoretical treat-

[5] Incumbents fill these niches in order to sustain monopoly profits at nearby locations; these profits may be dissipated if new entry occurs.

[6] Judd (1985) argues that sunk costs are not sufficient; exit costs are required as well.

[7] Of course, these profits may be derived from sources other than spatial preemption.

[8] We have also ignored the possibility that network externalities may enhance the position of the first-mover firm. These externalities arise if there are incentives for interconnection or compatibility among users (see, for example, Farrell and Saloner, 1986 and Katz and Shapiro, 1986).

[9] For example, see Weiss (1976). This finding applies to manufacturing operations only; greater scale economies may arise in distribution and advertising. Also, many retailing markets are geographically fragmented, leading to the possibility of spatial preemption of the sort described above. Such preemption requires the presence of some scale economies in the form of fixed costs.

ment, Schmalensee (1981) shows that in most realistic industry settings, scale economies provide only minor entry barriers and hence potential for enhanced profits.

Switching costs and buyer choice under uncertainty

Switching costs

First-mover advantages may also arise from buyer switching costs. With switching costs, late entrants must invest extra resources to attract customers away from the first-mover firm. Several types of switching costs can arise. First, switching costs can stem from initial transactions costs or investments that the buyer makes in adapting to the seller's product. These include the time and resources spent in qualifying a new supplier, the cost of ancillary products such as software for a new computer, and the time, disruption, and financial burdens of training employees. A second category of switching costs arises due to supplier-specific learning by the buyer. Over time, the buyer adapts to characteristics of the product and its supplier and thus finds it costly to change over to another brand (Wernerfelt, 1985). For example, nurses become accustomed to the intravenous solution delivery systems of a given supplier and are reluctant to switch (Porter, 1980). A third type of switching cost is contractural switching cost that may be intentionally created by the seller. Airline frequent-flyer programs fit in this category (Klemperer, 1986).

Theoretical models of market equilibrium with buyer switching costs include Klemperer (1986) and Wernerfelt (1986, 1988). Switching costs typically enhance the value of market share obtained early in the evolution of a new market. Thus they provide a rationale for pursuit of market share. However, first-movers with large market shares do not necessarily earn high profits; early competition for share can dissipate profits; and under some conditions the inertia of an incumbent with a large customer base can make the firm vulnerable to late entrants, who prove to be relatively more profitable (Klemperer, 1986).

Buyer choice under uncertainty

A related theoretical literature (e.g. Schmalensee, 1982) deals with the imperfect information of buyers regarding product quality. In such a context, buyers may rationally stick with the first brand they encounter that performs the job satisfactorily. Brand loyalty of this sort may be particularly strong for low-cost 'convenience goods' where the benefits of finding a superior brand are seldom great enough to justify the additional search costs that must be incurred (Porter, 1976). In such an environment, early-mover firms may be able to establish a reputation for quality that can be transferred to additional products through umbrella branding and other tactics (Wernerfelt, 1987).

Similar arguments derived from the psychology literature suggest that the first product introduced received disproportionate attention in the consumer's mind. Late entrants must have a truly superior product, or else advertise more frequently (or more creatively) than the incumbent in order to be noticed by the consumer. In a laboratory study using consumer products, Carpenter and Nakamoto (1986) found that the order-of-entry influences the formation of consumer preferences. If the pioneer is able to achieve significant consumer trial, it can define the attributes that are perceived as important within a product category. Pioneers such as Coca-Cola and Kleenex have become prototypical, occupying a unique position in the consumer's mind. Their large market shares tend to persist because perceptions and preferences, once formed, are difficult to alter.

More traditional marketing studies confirm the existence of such perceptual effects. In a study of two types of prescription pharmaceuticals—oral diuretics and antianginals—Bond and Lean (1977) found that physicians ignored 'me-too' products, even if offered at lower prices and with substantial marketing support.[10] Montgomery (1975) found that a product's newness was one of the two key variables necessary to gain acceptance onto supermarket shelves.

These imperfect information effects should be greater for individual consumers than corporate buyers, since the latter's larger purchase volume justifies greater investment in information acquisition activities.[11] Using the PIMS data base,

[10] One explanation of these findings is that physicians are price-insensitive because they do not actually pay the prescription costs. However, the Carpenter and Nakamoto (1986) experiments found that more typical consumers are also unwilling to switch to objectively similar 'me-too' brands, even at subtantially lower prices.

[11] Moreover, switching costs in industrial markets often dissipate over time as buyers become more knowledgeable about competing products (Cady, 1985).

Robinson (1988) and Robinson and Fornell (1985) found that pioneers had larger market shares than followers in both consumer and industrial markets, but the effect was much greater for consumer goods—order of entry explained 18 percent of the variance in market share in consumer goods markets, but only 8 percent in industrial markets. For a sample of 129 consumer packaged goods, Urban *et al.* (1986) found a strong inverse relation between order-of-entry and market share.

Brand positions remain remarkably durable in many consumer markets. Ries and Trout (1986) noted that of 25 leading brands in 1923, 20 were still in first place some 60 years later. Davidson (1976) found that two-thirds of the pioneers in 18 United Kingdom grocery product categories developed since 1945 retained their market leadership through the mid-1970s.

FIRST-MOVER DISADVANTAGES

The mechanisms that benefit the first-mover may be counterbalanced by various disadvantages. These first-mover disadvantages are, in effect, advantages enjoyed by late-mover firms. Late-movers may benefit from: (1) the ability to 'free-ride' on first-mover investments, (2) resolution of technological and market uncertainty, (3) technological discontinuities that provide 'gateways' for new entry, and (4) various types of 'incumbent inertia' that make it difficult for the incumbent to adapt to environmental change. These phenomena can reduce, or even completely negate, the net advantage of the incumbent derived from mechanisms considered previously.

Free-rider effects

Late-movers may be able to 'free-ride' on a pioneering firm's investments in a number of areas including R&D, buyer education, and infrastructure development. As mentioned previously, imitation costs are lower than innovation costs in most industries. However, innovators enjoy an initial period of monopoly that is not available to imitator firms. The ability of follower firms to free-ride reduces the magnitude and durability of the pioneer's profits, and hence its incentive to make early investments.

The theoretical literature has focused largely on the implications of free-rider effects in the form of information spillovers in R&D (Spence, 1984; Baldwin and Childs, 1969), and learning-based productivity improvement (Ghemawat and Spence, 1985; Lieberman, 1987c). As mentioned previously, empirical studies document a high rate of inter-firm diffusion of technology in most industries.

Guasch and Weiss (1980) assess free-rider effects operating in the labor market. They give a theoretical argument that late-mover firms may be able to exploit employee screening performed by early entrants, and thus acquire skilled labor at lower cost. This is in addition to the fact that early entrants may invest in employee training, with benefits enjoyed by later entrants who may be able to hire away the trained personnel.

Teece (1986a,b) argues that the magnitude of free-rider effects depends in part on ownership of assets that are complementary or 'co-specialized' with the underlying innovation. For example, EMI developed the first CT scanner but lost in the marketplace because the firm lacked a technology infrastructure and marketing base in the medical field. Pilkington, by comparison, was able to profit handsomely from its pioneering float glass process due to its assets and experience in the glass industry. In other instances late-mover firms have been successful largely because they were able to exploit existing assets in areas such as marketing, distribution, and customer reputation—e.g. IBM in personal computers and Matsushita in VCRs (Schnaars, 1986).

Resolution of technological or market uncertainty

Late-movers can gain an edge through resolution of market or technological uncertainty.[12] Wernerfelt and Karnani (1987) consider the effects of uncertainty on the desirability of early versus late market entry. Entry in an uncertain market obviously involves a high degree of risk. They argue that early entry is more attractive when the firm can influence the way that uncertainty is resolved. For example, the firm may be able to set industry standards in its favor. Firm size

[12] A related point is that a late-mover may be able to take advantage of the first-mover's mistakes. For example, when Toyota was first planning to enter the U.S. market it interviewed owners of Volkswagens, the leading small car at that time. Information on what owners liked and disliked about the Volkswagen was incorporated in the design process for the new Toyota.

may also be important—large firms may be better equipped to wait for resolution of uncertainty, or to hedge by maintaining a more flexible investment portfolio.

In many new product markets, uncertainty is resolved through the emergence of a 'dominant design'. The Model T Ford and the DC-3 are examples of dominant designs in the automotive and aircraft industries. After emergence of such a design, competition often shifts to price, thereby conveying greater advantage over firms possessing skills in low-cost manufacturing (Teece, 1986b).

Shifts in technology or customer needs

Schumpeter (1961) conceived of technological progress as a process of 'creative destruction' in which existing products are superseded by the innovations of new firms. New entrants exploit technological discontinuities to displace existing incumbents. Empirical studies which consider these technological discontinuities or 'gateways' for new entry include Yip (1982) and Bevan (1974). Foster (1986) gives practical advice on how such discontinuities can be exploited by entrants, who might be defined as 'first-movers' into the next technological phase. Scherer (1980) provides a list of innovative entrants who revolutionized existing industries with new products and processes. He also cites numerous examples of dominant incumbents that proved slow innovators but aggressive followers.

Since the replacement technology often appears while the old technology is still growing, it may be difficult for an incumbent to perceive the threat and take adequate preventative steps. Cooper and Schendel (1976) provide several examples, such as the failure of steam locomotive manufacturers to respond to the invention of diesel. Foster (1986) cites American Viscose's failure to recognize the potential of polyester as a replacement for rayon, and Transitron's inattention to silicon as a substitute for germanium in semiconductor fabrication. This perceptual failure is closely related to 'incumbent inertia' considered below.

Customer needs are also dynamic, creating opportunities for later entrants unless the first-mover is alert and able to respond. Docutel, as the pioneer, supplied virtually all of the automatic teller machine market up to late 1974. Over the next 4 years its market share declined to less than 10 percent under the onslaught of Honeywell, IBM and Burroughs, all of whom offered computer systems to meet the emerging need for electronic funds transfer (Abell, 1978).

Incumbent inertia

Vulnerability of the first-mover is often enhanced by 'incumbent inertia'. Such inertia can have several root causes: (1) the firm may be locked-in to a specific set of fixed assets, (2) the firm may be reluctant to cannibalize existing product lines, or (3) the firm may become organizationally inflexible. These factors inhibit the ability of the firm to respond to environmental change or competitive threats.

Incumbent inertia is often a rational, profit-maximizing response, even though it may lead to organizational decline. For example, Tang (1988) presents a model that rationalizes the decisions of most U.S. steel producers to continue investing in open-hearth furnace technology even after it had become clear that basic oxygen furnaces were superior. A firm with heavy sunk costs in fixed plant or marketing channels that ultimately prove sub-optimal may find it rational to 'harvest' these investments rather than attempt to transform itself radically.[13] MacMillan (1983) suggests that in the rapidly changing environment of health care, old health care systems may currently be harvesting from their initial investments in locations and personnel. The appropriate choice between adaptation and harvesting depends on how costly it is to convert the firm's existing assets to alternative uses. And, as we discuss below, organizational inertia has often led firms to continue investing in their existing asset base well beyond the point where such investments are economically justified.

Much of the literature on cannibalization-avoidance refers to R&D. Arrow (1962) was the first to lay out the theoretical argument that an incumbent monopolist is less likely to innovate than a new entrant, since innovation destroys rents on the firm's existing products. More recent theoretical studies along these lines include Reinganum (1983) and Ghemawat (1986a). Bresnahan (1985) argues that Xerox exhibited such behavior following the expiration of its patent-enforced monopoly—Xerox lagged in certain types of innovations and was sluggish to cut

[13] For first-movers, sunk costs are a two-edged sword: they lock the firm into a particular course of action but also provide commitment value that can help deter entry.

prices on account of its large fleet of rental machines in the field. Brock (1975) and Ghemawat (1986a) make similar arguments regarding the innovative responses of IBM in computers and AT&T in PBX's. However, Conner (1988) shows that under a broad range of conditions the incumbent's optimal strategy is to develop an improved product but delay market introduction until challenged by the appearance of a rival product.

From an organizational theory perspective, Hannan and Freeman (1984) outline factors that limit adaptive response by incumbents. These include the development of organizational routines and standards, internal political dynamics and the development of stable exchange relations with other organizations.[14]

While Hannan and Freeman argue that organizational inertia is often a positive outcome of selection processes, numerous dysfunctional examples of such inertia can be cited. Abernathy and Wayne (1974) assess Henry Ford's decision to persist in production of the Model T, long after changes in the competitive environment had made it clear that new products were required. Bevan (1974) cites organizational blinders as a key factor contributing to the decline of the major potato chip producer in the U.K. Historically, the vast majority of chips were consumed by men in pubs. It took the incumbent five years to realize that the challenger had invented a whole new market segment—supermarket sales to women and children. Similarly, Jacobson and Hillkirk (1986) discuss Xerox's inability to perceive the growing threat of Japanese competition in the 1970s. Cooper and Schendel (1976) note that even when an incumbent makes a commitment to change, organizational factors often sabotage the effort; in their sample, 15 incumbents made major commitments to the new technologies but only two of them ultimately proved successful.

GENERAL CONCEPTUAL ISSUES

Endogeneity of first-mover opportunities

A given firm cannot simply choose whether or not to pioneer; pioneering opportunities arise endogenously, through the process illustrated in Figure 1. A firm gains first-mover opportunities through some combination of proficiency and luck. Various types of proficiency may be involved, including technological foresight, perceptive market research, or skillful product or process development. For example, Procter and Gamble's initial lead in disposable diapers can be attributed to most of these proficiency factors.

In addition to generating first-mover opportunities, proficiency and luck also influence the firm's success in exploiting the specific mechanisms discussed earlier. In the case of disposable diapers, Procter and Gamble's initial lead was enhanced by its skill in maintaining a proprietary learning curve in manufacturing, and in preempting supermarket shelf space.

Proficiency and luck also affect profits in ways that are unrelated to first-mover advantages. For instance, some component of Procter and Gamble's disposable diaper profits can be traced to the firm's economies of shared distribution channels and general manufacturing proficiency. The recent increase in the U.S. birth rate has augmented industry profits, representing the direct effect of luck.

In the endogenous process illustrated in Figure 1, profits earned by first-movers are fundamentally attributable to proficiency and luck, rather than 'pioneering' *per se*. But as a practical matter, it is often exceedingly difficult to distinguish between proficiency and luck, particularly at the stage where first-mover opportunities are generated. Entrepreneurs often perceive 'great opportunities', many of which ultimately prove disappointing. Investors face the problem of distinguishing between 'true' and 'false' entrepreneurial vision. Even after success or failure is observed, disentangling the contribution of exceptional foresight or skill from that of mere luck is no easier.[15] We leave this difficult problem to venture capitalists, and extremely ambitious empirical researchers.

Nevertheless, in a purely conceptual way one can usefully distinguish between these two sources. Profits linked to first-mover opportunities arising from exceptional skill or foresight can be viewed as returns to superior entrepreneurship.

[14] One example of the latter is Timex's introduction of the disposable watch. Timex introduced the disposable watch in drug stores and other mass channels, but the Swiss watch industry was unable to follow, for fear of offending the jewelry stores that were their prime mode of distribution (Porter, 1980).

[15] One complication is that skill affects luck, and vice-versa. For instance, greater skill in research increases the probability of success in performing risky R&D. With repeated observation the proficiency level of the firm may be revealed by its mean success rate.

Figure 1 shows that skill can also affect profits more directly, as in situations where the firm possesses know-how that enables it to manufacture products at lower costs than its competitors. These returns may not always be visible as company profits, as they may be captured, in part, by the employees responsible for their generation.

Similarly, luck can affect profits directly (e.g. a factory damaged by fire) and indirectly by influencing the quality of first-mover opportunities available to the firm.[16] This effect of luck on first-mover opportunities has important implications for empirical research, since it leads to sample selection biases that have sometimes been overlooked.

Sample selection bias

When first-mover opportunities are generated by processes of chance, firms that draw less attractive opportunities may choose not to enter, or they may exit quickly and thus not be observed. Pioneers that survive this screening process would be expected to earn above-average returns.[17]

The role of luck is illustrated by the following simple example. Assume that a given firm (having no exceptional proficiency in research) faces an opportunity to engage in risky R&D on a pioneering new product, with a 50 percent probability of technical success. Expected profits are the average of two components: a gain of $\pi + \epsilon$ if the research succeeds, versus a loss of π if the project fails. The firm enters the market only if the project proves technically successful. Significant profits will thus be observed contingent on entry, even though expected profits ($\epsilon/2$) may be barely sufficient for the firm to be induced to undertake the project. With free entry, competition among R&D-performing firms should drive these expected profits to near zero.

Thus, first-mover advantages may enable successful pioneers to earn high returns even though an unbiased sample earns zero economic profits. One extension is that as the 'riskiness' of R&D increases, the average profit rate observed for successful firms increases as well.[18]

Failure is a common occurrence in practice. For example, Mansfield (1968) found that more than one-fourth of corporate R&D projects fail to achieve their technical objectives. Davidson (1976) observed that about 70 percent of test market brands are not expanded nationally and hence can be considered failures. In an empirical study that considered the endogenous nature of first-mover opportunities, Boulding and Moore (1987) found that pioneering firms were marginally unprofitable on average.

The fact that luck- or skill-based asymmetries are required to generate above-normal profits is confirmed by the results of theoretical models where such initial asymmetries are absent, e.g. Glazer (1985), Fudenberg and Tirole (1985), and Gilbert and Harris (1984). Firms in these models face an investment timing decision—e.g., when to enter an emerging market that is initially too small to support even a single entrant. If all firms have identical information and investment opportunities, the initial entrant fails to earn excess returns; competition for the first-mover position drives the associated profits to zero. Preemptive investment occurs at the earliest point in time that the initial entrant can earn a non-negative present value of profits.

Definitional and measurement issues

What constitutes a 'first-mover'?

Perhaps the most fundamental problem with the concept of 'first-mover' is that of definition. If a firm enters an established market, but exploits some technological discontinuity or appeals to new demand segment, should it be classified as a first-mover? In general, how large a discontinuity from existing practice is required to cross the threshold for definition as a pioneer?

---

[16] Rumelt (1987) calls profits generated by luck 'entrepreneurial rents'. His characterization differs slightly from our approach, since he ignores the potential for first-mover profits linked to proficiency.

[17] Compounding this selection bias is the fact that if all potential entrants perceive net disadvantages to early entry, no entry will occur, and hence no pioneer will be observed. When this arises there may be an argument for public provision, as in the case of government funding of basic research projects.

[18] Assume that R&D projects are drawn from some random distribution with a mean return of approximately zero, and that only successful projects with positive returns are introduced to the market. The average profit earned contingent on success rises with mean-preserving increases in risk. For a formal analysis along these lines, see Lippman and Rumelt (1982).

We offer no good answers to these questions; available data and expedience have been the criteria used in most empirical studies. Clearly, adopting a loose definition causes a large fraction of entrants to be classified as pioneers.[19] In the PIMS data, for example, more than half of all business units are 'pioneers', including multiple competitors within the same market segment (Buzzell and Gale, 1987).

There is also the question of whether the criterion for first-movership is actual market entry, or the initiation of preliminary work such as R&D. The standard definition is based on market entry, which we agree is the appropriate criterion.

Assuming some reasonable definition of what constitutes a pioneer, for empirical work there remains the problem of distinguishing among later entrants. Such entrants can be classified by (1) their numerical order in the sequence of entry, (2) elapsed time since entry of the pioneer, or (3) general categories such as early follower, late follower, differentiated follower, 'me-too' follower, etc. These categories are not, in general, consistent or comparable across markets. For example, a firm that is third in the order of entry is likely to have been an early follower in a market with 20 firms, but a late follower in a market with four.

Alternative measures of 'first-mover advantage': profits vs. market share vs. probability of survival

Earlier we argued that economic profits are the appropriate measure of first-mover advantage. Profit maximization is the sole objective of stockholders in all modern theories of the firm. First-mover advantages exist when the pioneering firm earns positive present value of profits as the consequence of its early entry (i.e. positive profits net of those attributable to more general types of firm proficiency).

A serious problem confonting those engaged in empirical work is the fact that disaggregate profit data are seldom obtainable.[20] Hence, market shares and rates of company survival are typically used as surrogate measures. Market share and survival have both been shown to be correlated with profits and thus have some validity as proxies. But the correlation of these measures with profits is not always strong and causality is often ambiguous. For example, managers can often increase share at the expense of profits, e.g. by drastically cutting price, or increasing promotional activity. Moreover, measures of market share can vary greatly depending on whether markets have been broadly or narrowly defined.

Market share and survival also have some spurious correlations with first-movership and are thus inherently biased. Consider, as a stylized example, a market with two identical firms, A and B, that grow at identical rates, say 20 percent per year. Assume that both firms earn zero economic profits. A enters 1 year ahead of B, making A the 'first-mover'. In this case firm A will always maintain a market share 20 percent greater than B, even though by our definition there are no 'first-mover advantages'. While this example is extreme, our point is that early entrants have natural advantages in market share that do not necessarily translate into higher profits.

Survival rates suffer from similar biases. For example, first-movers may be intrinsically 'stronger' or more proficient than later entrants. Consider first-mover advantages generated through firm proficiency, as illustrated in Figure 1. First-movers may exhibit higher survival rates, but it may be exceedingly difficult to ascertain whether this stems from pioneering, *per se*, or whether it reflects some more basic characteristic of the firm.

Magnitude and duration of first-mover advantages

The term 'first-mover advantage' suggests that the pioneer remains more profitable than later entrants, but careful reflection reveals that this need not be the case. Pioneering firms can enjoy significant first-mover advantages but be less

[19] In this article we use the terms 'first-mover' and 'pioneer' interchangeably to refer to a unique firm within a given market. However, a broader definition of 'pioneer' is often applied, as in the PIMS questionnaire which asks whether the business unit was 'one of the pioneers' at the time it entered the market. In the extreme, if market niches are defined narrowly enough, virtually all firms can be classified as 'pioneers'.

[20] The only general source of such data is the PIMS data base, which has numerous limitations. For an assessment, see Anderson and Paine (1978).

profitable than later entrants when viewed over an extended period.

Consider, for example, a pioneer with patent protection, whose economic profits fall to near-zero after the patent expiration date. This pioneer has clearly gained a first-mover advantage, even though after expiration of the patent the pioneer may be less profitable and hold a smaller market share than other firms. Indeed, many pioneers exploit their initial advantages, then exit or sell out to others.[21]

Note that this raises the possibility that there may be both first-mover and late-mover advantages in a given market. For example, the pioneering firm described above may earn high initial profits based on its patent, but ultimately be overshadowed by a larger firm with unique marketing skills that yield above-average returns. In this case, first-mover advantages accrue to the pioneer, and late-mover advantages to the marketing firm. Whether the first-mover or late-mover has greater relative advantage depends on the point in time that the market is observed.

Moreover, for any given firm, the question of whether early or late entry is more advantageous depends on the firm's particular characteristics. In the above example, if one firm has unique R&D capabilities while the other has strong marketing skills, it is in the interest of the first firm to pioneer and the second firm to enter at a later date. Both may earn significant profits entering in this sequence, but neither would gain if the (attempted) order of entry were reversed.

ISSUES FOR FUTURE RESEARCH

Given the problems discussed in the previous section, is 'first-mover advantage' a useful research concept? Clearly, it does provide a unifying framework for a broad class of phenomena. But as a focus for empirical research, the concept of first-mover advantage may be too general and definitionally elusive to be useful. In recent years a number of cross-section empirical studies have attempted to detect and categorize a wide range of 'pioneering advantages'. While these studies provide useful groundwork, we feel that future empirical research needs to be more precise in elucidating specific first-mover mechanisms. Theoretical work in the area has often suffered from the opposite problem: models have been designed to articulate one piece of the first-mover puzzle but have failed to embed it within a suitably endogenous system.

Below, we develop these points further and offer some specific suggestions for future research. We propose several directions that we regard as interesting, even though we doubt that all our suggestions are truly feasible.

Theoretical and conceptual issues

In this survey we have stressed the endogenous nature of first-mover advantages. Most theoretical studies have begun by assuming some initial asymmetry, thereby sidestepping the endogeneity issue. The fundamental (and in our view most interesting) question of how first-mover opportunities arise and are pursued by specific firms remains almost completely unexplored. An important theoretical challenge is to flesh out this dynamic process, and distinguish the impact of firm proficiency from that of luck.

A related need is for more theoretical work linking individual firm characteristics to optimal timing strategy. For example, what types of firms are best suited to pioneer, and what types are best suited to follow? Models from the economics literature typically make only the most rudimentary distinctions among firms—indeed, firms are usually assumed identical along all dimensions except timing and size. The strategic management field has traditionally emphasized a wider set of inter-firm differences. The implications of these differences in the context of mechanisms for first-mover advantage needs to be explored in greater depth. Work by Teece (1986a,b) and Wernerfelt and Karnani (1987) provides a useful start, but many opportunities remain.

Despite its deficiencies, theoretical work on first-mover *advantages* remains far ahead of our understanding of mechanisms that assist late-movers. There has, for example, been little conceptual work on resolution of technological and market uncertainty, even though this is often the major factor affecting the timing of entry in practice. Similarly, incumbent inertia is one area where our understanding remains weak. For

[21] For example, DuPont was the world's first commercial producer of cyclohexane, but exited when the firm was no longer able to compete with oil companies using refinery-based processes (Stobaugh, 1988).

example, we have few frameworks (with the exception of population ecology, and the model by Tang, 1988) that enable us to determine when inertia is desirable, and when it is dysfunctional (Lambkin, 1988).

Empirical issues

In our view, an important priority for empirical research is to focus more precisely on the evaluation of specific first-mover mechanisms, rather than on general investigations of the merits of pioneer versus follower strategies. Researchers should aim to test specific models and carefully distinguish among mechanisms. For example, additional empirical research is needed on the topic of switching costs, where first-mover advantages seem to be significant. Here it may be possible to distinguish empirically between risk-based models (such as Schmalensee, 1982) and those based on psychological framing effects (e.g. Carpenter and Nakamoto, 1986). The initial efforts of Carpenter and Nakamoto suggest that experimental methods may prove fruitful for disentangling the fundamentals of such first-mover mechanisms.

New data are required in order to broaden and deepen understanding of first-mover advantages and disadvantages and the mechanisms that generate them. Researchers need to wean themselves from convenient but much-used data bases (e.g. PIMS). Wherever possible, data should be collected on non-survivors, as well as surviving firms, to alleviate the censored sample problem. More difficult to obtain, but even more important, would be appropriate measures of profit, in order to reduce the dependence of empirical knowledge on market share effects.

The endogeneity issue has been ignored in most empirical studies as well as in theoretical work. Recent research by Boulding and Moore (1987) suggests some possible empirical approaches. Models with endogenous structure are necessary for exploring the linkage between firm characteristics, first-mover opportunities, and performance. Potentially, such research might be able to disentangle the relative importance of proficiency versus luck in generating first-mover advantage.

While we are skeptical about the value of more broad-brush empirical efforts, we do think there are a number of interesting but unanswered questions regarding the relative importance of first-mover advantages. Such assessments might be made across several dimensions. First, it would be interesting to assess the magnitude of first-mover advantages relative to profits derived from more general forms of firm proficiency, such as superior manufacturing or marketing skills. How much of the inter-firm variance in profit rates can be attributed to first-mover effects, as opposed to more general proficiency differentials? And to what extent should managerial effort be allocated toward searching out preemption opportunities, as opposed to building more general organizational capabilities? We are intrigued with the possibility of obtaining some rough quantitative evidence on this score, despite the obvious difficulties.

Similar comparisons might be made among specific first-mover mechanisms and the industries in which they operate. It would be useful to know which of the various mechanisms are most important in practice, and in what industries they operate most strongly. Some empirical first-mover studies (e.g. Robinson, 1988 and Robinson and Fornell, 1985) have highlighted inter-industry differences; their results suggest that first-mover effects are more powerful in consumer-goods industries than in producer-goods. It would be interesting to extend such comparisons to service industries where casual observation suggests that imitation occurs rapidly. Still, this producer/consumer/service industry trichotomy is rudimentary; a more precise mapping between industry characteristics and first-mover mechanisms would be useful.

Another set of comparisons relates to the duration of first-mover advantages. Under what conditions are they ephemeral versus long-lived? How does this vary by mechanisms and by industry? And what steps can management take to enhance sustainability? The existing empirical literature provides some evidence on these issues, but our knowledge is still quite limited.

IMPLICATIONS FOR MANAGERS

Although our focus has been primarily on research issues, we conclude with a brief discussion of managerial implications.

One of the first lessons of the first-mover literature is that pioneering carries both

advantages and disadvantages. The net impact may well be negative, as illustrated by the demise of Bomar and Osborne, pioneers in electronic calculators and portable computers respectively. In a cross-sectional study, Boulding and Moore (1987) found pioneering to be marginally unprofitable on average. On the other hand, numerous studies have found enduring market share advantages for surviving pioneers (Bond and Lean, 1977; Carpenter and Nakamoto, 1986; Urban *et al.* 1986; Robinson, 1988; Robinson and Fornell, 1985). Thus, pioneering may prove advantageous to some firms in some circumstances, but it is not necessarily a superior strategy for all entrants.

In order for a firm to become a first-mover or pioneer, a feasible opportunity must present itself. The occurrence of such an opportunity depends on the firm's own foresight, skill and luck, and that of competitors. These factors are interdependent—or as MacMillan (1983) has put it, 'Good generals make their luck by shaping the odds in their favor'. The likelihood of being a first-mover may be enhanced, often substantially, by managements' actions, but opportunities for first-movership are by no means controlled by the firm alone.

Firms must decide whether to invest resources in search of first-mover opportunities. Moreover, when a specific first-mover opportunity arises, managers must decide whether and how to exploit it. Sony, for example, aggressively pursues first-mover advantages from new product innovation. Its rival, Matsushita (whose nickname in Japanese, *maneshita denki* translates as 'electronics that have been copied'), generally lets Sony and others innovate; Matsushita then takes a position based on its manufacturing and marketing capabilities. Matsushita invests in R&D to be ready to enter the market when it begins rapid growth, but the firm will not launch new products until others have proven the market. Choice between these two alternative approaches depends on the firm's specific characteristics and skills. Firms whose entrepreneurial vision and new-product R&D are excellent will tend to find first-movership attractive, whereas firms having relative skill bases in manufacturing and marketing may not. Then too, firms having a strategy of first-movership may often be forced to follow in related product areas in order to provide a more complete product line.

Managers who have chosen to emphasize pioneering must address a number of issues. First, how can the pioneer protect itself from imitation, to prevent later entrants from 'free-riding' on the pioneer's efforts? Patents are one obvious way to achieve this; designs that are deliberately difficult to reverse engineer are another. Pioneers can sometimes preempt key resources, such as the most desirable retailing locations or distribution networks. If the product is one where consumer switching costs will be important, it may be essential that the pioneer induce trial by the majority of potential customers before rivals have an opportunity to do so.

First-movers must also guard against incumbent inertia, which may result from complacency, arrogance, or inattention to shifts in technology or customer needs. Changes in the environment can give potential competitors a window of opportunity. Pioneers may want to consider broadening the product line, thereby thickening their relationship with customers and blocking opportunities for competitors to enter.

First-movers must recognize that initial success does not automatically confer a franchise for permanent competitive advantage. Rather, first-mover advantages must be sustained by careful nurturing. Even companies with long-established leadership positions, based in part on pioneering, can dissipate their advantages. In the late 1970s, for example, Kleenex tissues, which had established the industry standard, lost significant market share (Carpenter, 1988). Subsequent research indicated that consumers' preferences had shifted to competing brands that were perceived as being softer. This preference shift was the result of Kleenex's production economy choices that had gradually increased the level of recycled wood pulp in the tissues. Once Kleenex restored and enhanced the level of softness, it regained and even surpassed its previous market share (*Wall Street Journal*, 1987).

Alert pioneers take proactive steps to protect their pioneering advantages. Pioneers need to increase capacity sufficiently, especially in high-growth markets, to avoid being overtaken by aggressive followers. Tohatsu, the leading Japanese motorcycle producer in the late 1950s, failed to do so and was overtaken by Honda (Abegglen and Stalk, 1985). Continual product innovation is another key to retaining competitive advantage. Caterpillar, by neglecting to re-

engineer their low-end models in the early 1970s, gave John Deere an opportunity to enter the over-100 horsepower bulldozer market using an innovative transmission as a differentiating feature (HBS, 1977). Finally, quality and breadth of product line may also be used to sustain pioneer advantage. Robinson (1988) found that pioneer quality advantages tend to diminish over time, but product line breadth advantages are more sustainable. In general, pioneers that build adequate capacity, innovate to meet changing technologies and customer requirements, and fill up available market niches, are formidable opponents and exceedingly difficult to overcome.

For firms with a follower strategy (whether by design or inevitable) the major issue is whether to attack the pioneer directly, or seek a less confrontational, differentiated position. If the pioneer is small, lacks resources, or has not yet achieved much market penetration or recognition, he may be vulnerable to aggressive attack by a follower. Urban *et al.* (1986) found that followers in consumer packaged goods were able to overcome the pioneer's market share advantage by substantially out-spending the pioneer on advertising. However, a number of studies have found that 'me-too' strategies tend to be unsuccessful (Bond and Lean, 1977; Montgomery, 1975; Davidson, 1976; Carpenter and Nakamoto, 1986). Even substantial price cuts may fail to wrest significant market share (Bond and Lean, 1977; Carpenter and Nakamoto, 1986). In general, 'me-too' strategies seem to be effective only when the innovator has not done its marketing properly or intensely enough.[22]

Followers may find it preferable to avoid direct confrontation with a strong pioneer, at least initially. Golden Wonder developed a totally new market segment and distribution channel in the U.K. potato chip market, thereby distinguishing itself from the dominant incumbent (Bevan, 1974). Urban *et al.* (1986) found that superior positioning of a follower brand with respect to consumer needs was the single most important predictor of a follower's share relative to a first-mover. Foster (1986) cites numerous examples of followers that were able to successfully differentiate themselves by exploiting technological discontinuities. Once the follower has gained a strong foothold, direct challenge of the pioneer often becomes feasible.

[22] The Carpenter and Nakamoto (1986) experiments suggest an elaboration of the 'me-too' product question. They found that 'me-too' brands tend to fail when positioned close to the pioneer but are often successful when positioned close to differentiated later entrants. A brand that mimics an entrenched pioneer usually finds it difficult to generate trial purchases, due to the dominant perceptual position of the pioneer. However, a brand positioned near a differentiated later entrant can make it easier for both to generate trial in competition with the pioneer. Thus, some 'me-too' positions may be superior to others (Carpenter, 1988).

SUMMARY

This article has surveyed theoretical and empirical research on mechanisms that confer advantages and disadvantages on first-mover firms. Mechanisms that promote first-mover advantages include proprietary learning effects, patents, preemption of input factors and locations, and development of buyer switching costs. Conversely, first-mover disadvantages may result from free-rider problems, delayed resolution of uncertainty, shifts in technology or customer needs, and various types of organizational inertia.

We have discussed key conceptual issues and research priorities. Future research should consider the endogenous nature of first-mover opportunities and the potential for sample selection bias. Greater emphasis should be given in empirical analysis to economic profits as a criterion. Perhaps most important, basic questions still need to be addressed on how 'first-movers' are defined and identified in practice.

Finally, managers must decide whether a strong emphasis on pioneering is appropriate, given their firm's resource base. In specific situations where skill and good fortune have generated a first-mover opportunity, managers must decide whether the firm should pursue it, and if so, how best to enhance its value. And managers of follower firms must determine whether and how the first-mover advantages of the pioneer can be subverted.

ACKNOWLEDGEMENTS

We thank Piet Vanden Abeele, Rajiv Lal, Mark Satterthwaite and Birger Wernerfelt for helpful discussions on earlier drafts. The Strategic Management Program at Stanford Business School provided financial support.

REFERENCES

Abegglen, J. C. and G. Stalk. *Kaisha, the Japanese Corporation*, Basic Books, New York, 1985.

Abell, D. F. 'Strategic windows', *Journal of Marketing*, **42**, July 1978, pp. 21–26.

Abernathy, W. J. and K. Wayne. 'Limits of the learning curve', *Harvard Business Review*, **52**, 1974, pp. 109–119.

Anderson, C. R. and F. T. Paine, 'PIMS: a reexamination', *Academy of Management Review*, **3**, July 1978, pp. 602–612.

Arrow, K. 'Economic welfare and the allocation of resources to innovation'. In R. Nelson (ed.), *The Rate and Direction of Inventive Activity*. Universities-National Bureau Conference Series, No. 14, Arno Press, New York, 1962.

Baldwin, W. L. and G. L. Childs. 'The fast second and rivalry in research and development', *Southern Economic Journal*, **36**, 1969, pp. 18–24.

Bevan, A. 'The U.K. potato crisp industry, 1960–72: a study of new entry competition', *Journal of Industrial Economics*, **XXII**, June 1974, pp. 281–297.

Bond, R. S. and D. F. Lean. *Sales, Promotion and Product Differentiation in Two Prescription Drug Markets*. U.S. Federal Trade Commission, Washington, DC, 1977.

Boulding, W. and M. J. Moore. 'Pioneering and profitability: structural estimates from a nonlinear simultaneous equations model with endogenous pioneering'. Research Paper, Fuqua School of Business, Duke University, May 1987.

Bresnahan, T. F. 'Post-entry competition in the plain paper copier market', *American Economic Review*, **75**, May 1985, pp. 15–19.

Bright, A. A. *The Electric Lamp Industry*, Macmillan, New York, 1949.

Brock, G. W. *The U.S. Computer Industry: A Study of Market Power*, Ballinger Publishing Company, Cambridge, MA, 1975.

Buzzell, R. D. and B. T. Gale. *The PIMS Principles: Linking Strategy to Performance*, Free Press, New York, 1987.

Cady, J. F. 'Marketing strategies in the information industry'. In R. D. Buzzell (ed.), *Marketing in an Electronic Age*. Harvard Business School Press, Boston, 1985.

Carpenter, G. S. 'Market pioneering and competitive positioning strategy', *Annales de Telecommunications* (forthcoming 1988).

Carpenter, G. S. and K. Nakamoto. 'Market pioneers, consumer learning, and product perceptions: a theory of persistent competitive advantage'. Research Paper, Columbia University and University of California, November, 1986.

Chandler, A. D., Jr. *The Visible Hand: The Managerial Revolution in American Business*. Belknap Press of Harvard University Press, Cambridge, MA, 1977.

Conner, K. R. 'Strategies for product cannibalism', *Strategic Management Journal*, **9** (Special Issue), 1988, pp. 9–26.

Cooper, A. C. and D. Schendel. 'Strategic responses to technological threats', *Business Horizons*, **19**, February 1976, pp. 61–69.

Davidson, J. H. 'Why most new consumer brands fail', *Harvard Business Review*, **54**, March–April 1976, pp. 117–122.

Dixit, A. 'The role of investment in entry deterrence', *Economic Journal*, **90**, 1980, pp. 95–106.

Eaton, B. C. and R. Lipsey. 'The theory of market pre-emption: the persistence of excess capacity and monopoly in growing spatial markets', *Economica*, **46**, 1979, pp. 149–58.

Eaton, B. C. and R. Lipsey. 'Capital, commitment and entry equilibrium', *Bell Journal of Economics*, **12**, 1981, pp. 593–604.

Eaton, B. C. and R. Ware. 'A theory of market structure with sequential entry', *Rand Journal of Economics*, **18**, Spring 1987, pp. 1–16.

Farrell, J. and G. Saloner. 'Installed base and compatibility: innovation, product preannouncements and predation', *American Economic Review*, **76**, December 1986, pp. 940–955.

Fast, N. 'Lincoln Electric Company'. Working Paper Case No. 376–028, Harvard Business School, 1975.

Foster, R. N. *Innovation: The Attacker's Advantage*. Summit Books, New York, 1986.

Fudenberg, D., R. Gilbert, J. Stiglitz and J. Tirole. 'Preemption, leapfrogging, and competition in patent races', *European Economic Review*, **22**, June 1983, pp. 3–31.

Fundenberg, D. and J. Tirole. 'Capital as a commitment: strategic investment to deter mobility'. *Journal of Economic Theory*, **31**, December 1983, pp. 227–250.

Fudenberg, D. and J. Tirole. 'The fat-cat effect, the puppy-dog ploy, and the lean and hungry look', *American Economic Review*, **74**, May 1984, pp. 361–366.

Fundenberg, D. and J. Tirole. 'Preemption and rent equalization in the adoption of new technology', *Review of Economic Studies*, **LII**, 1985, pp. 383–401.

Gal-Or, E. 'First mover and second mover advantages', *International Economic Review*, **26**, October 1985, pp. 649–653.

Ghemawat, P. 'Capacity expansion in the titanium dioxide industry', *Journal of Industrial Economics*, **XXXIII**, December 1984, pp. 145–163.

Ghemawat, P. 'Drastic product innovations under uncertainty'. Working paper, Harvard Business School, 1986a.

Ghemawat, P. 'Wal-Mart Stores' discount operations'. Working Paper Case No. 0–387–018, Harvard Business School, 1986b.

Ghemawat, P. and A. M. Spence. 'Learning curve spillovers and market performance', *Quarterly Journal of Economics*, **100**, 1985, pp. 839–852.

Gilbert, R. J. 'Pre-emptive competition'. In J. E. Stiglitz and G. F. Mathewson (eds), *New Developments in the Analysis of Market Structure*. MIT Press, Cambridge, MA, 1986.

Gilbert, R. J. and R. G. Harris. 'Investment decisions with economies of scale and learning', *American*

Economic Review, **71**, May 1981, pp. 172–177.
Gilbert, R. J. and R. G. Harris. 'Competition with lumpy investment', *Rand Journal of Economics,* **15**, Summer 1984, pp. 197–212.
Gilbert, R. J. and D. M. G. Newbery. 'Preemptive patenting and the persistence of monopoly', *American Economic Review,* **72**, June 1982, pp. 514–526.
Glazer, A. 'The advantages of being first', *American Economic Review,* **75**, June 1985, pp. 473–480.
Guasch, J. L. and A. Weiss. 'Adverse selection of markets and the advantages of being late', *Quarterly Journal of Economics*, May 1980, pp. 453–466.
Hannan, M. T. and J. Freeman. 'Structural inertia and organizational change', *American Sociological Review,* **49**, April 1984, pp. 149–164.
Harvard Business School. 'Deere & Company: industrial equipment operations', case no. 577–112, 1977.
Hirshleifer, J. 'The private and social value of information and the reward to inventive activity', *American Economic Review,* **61**, 1971, pp. 561–574.
Jacobson, G. and J. Hillkirk. *Xerox: An American Samurai*, Macmillan, New York, 1986.
Johnson, R. N. and A. Parkman. 'Spatial monopoly, non-zero profits and entry deterrence: the case of cement', *Review of Economics and Statistics,* **65**, August 1983, pp. 431–438.
Judd, K. L. 'Credible spatial preemption', *Rand Journal of Economics,* **16**, Summer 1985, pp. 153–166.
Katz, M. L. and C. Shapiro. 'Technology adoption in the presence of network externalities', *Journal of Political Economy,* **94**, August 1986, pp. 822–841.
Klemperer, P. 'Markets with consumer switching costs'. PhD thesis, Graduate School of Business, Stanford University, 1986.
Lambkin, M. 'Order of entry and performance in new markets', *Strategic Management Journal,* **9** (Special Issue) 1988, pp. 127–140.
Levin, R., A. Klevorick, R. Nelson and S. G. Winter. 'Survey research on R&D appropriability and technical opportunity—Part I: Appropriability'. Working Paper, Yale University, July 1984.
Lieberman, M. 'The learning curve, pricing and market structure in the chemical processing industries', PhD thesis, Harvard University, 1982.
Lieberman, M. 'The U.S. magnesium industry'. Standford University Business Case No. S-BP-231, 1983.
Lieberman, M. 'Excess capacity as a barrier to entry: an empirical appraisal', *Journal of Industrial Economics,* **35**, June 1987a, pp. 607–627.
Lieberman, M. 'The learning curve, barriers to entry, and competitive survival in the chemical processing industries'. Unpublished, Graduate School of Business, Stanford University, March 1987b.
Lieberman, M. 'The learning curve, diffusion and competitive strategy', *Strategic Management Journal,* **8**, September-October 1987c, pp. 441–452.
Lippman, S. A. and Rumelt, R. P. 'Uncertain imitability: an analysis of interfirm differences in efficiency under competition', *Bell Journal of Economics,* **13**, Autumn 1982, pp. 418–438.
MacMillan, I. C. 'Preemptive strategies', *Journal of Business Strategy,* **4**, Fall 1983, pp. 16–26.
MacMillan, I. C. 'Preemptive strategies'. In W. Guth (ed.), *Handbook of Business Strategy*, Warren, Gorham & Lamont, New York, 1984.
Main, O. W. *The Canadian Nickel Industry*. University of Toronto Press, Toronto, 1955.
Mansfield, E. *Industrial Research and Technological Innovation: An Econometric Analysis*, W. W. Norton Company, New York, 1968.
Mansfield, E. 'How rapidly does new industrial technology leak out?', *Journal of Industrial Economics,* **XXXIV**, December 1985, pp. 217–223.
Mansfield, E., M. Schwartz, and S. Wagner. 'Imitation costs and patents: an empirical study', *Economic Journal,* **91**, December 1981, pp. 907–918.
Montgomery, D. B. 'New product distribution: an analysis of supermarket buyer decsions', *Journal of Marketing Research,* **12**, August 1975, pp. 255–264.
Porter, M. *Interbrand Choice, Strategy and Bilateral Market Power*. Harvard University Press, Cambridge, MA, 1976.
Porter, M. *Competitive Strategy*. Free Press, New York, 1980.
Porter, M. 'Strategic interaction: some lessons from industry histories for theory and anti-trust policy'. In S. Salop (ed.), *Strategy, Predation and Anti-trust Analysis*. Washington: FTC, 1981.
Prescott, E. and M. Visscher. 'Sequential location among firms with foresight', *Bell Journal of Economics,* **8**, 1977, pp. 378–393.
Rao, R. and D. Rutenberg. 'Pre-empting an alert rival: strategic timing of the first plant by analysis of sophisticated rivalry', *Bell Journal of Economics,* **10**, 1979, pp. 412–428.
Reinganum, J. F. 'Uncertain innovation and the persistence of monopoly', *American Economic Review,* **73**, September 1983, pp. 741–748.
Ries, A. and J. Trout. *Marketing Warfare*, McGraw-Hill, New York, 1986.
Robinson, W. T. 'Sources of market pioneer advantages: the case of industrial goods industries', *Journal of Marketing Research*, (forthcoming, September 1988).
Robinson, W. T. and C. Fornell. 'The sources of market pioneer advantages in consumer goods industries', *Journal of Marketing Research,* **22**, August 1985, pp. 297–304.
Rumelt, R. 'Theory, strategy and entrepreneurship'. In D. Teece (ed.), *Strategy & Organization for Industrial Innovation and Renewal*. Ballinger, Cambridge, MA, 1987.
Scherer, F. M. *Industrial Market Structure and Economic Performance*. Rand McNally, Chicago, 1980, pp. 431, 438.
Schmalensee, R. 'Entry deterrence in the ready to eat breakfast cereal industry', *Bell Journal of Economics,* **9**, Autumn 1978, pp. 305–327.
Schmalensee, R. 'On the use of economic models in antitrust: the Realemon case', *University of Pennsylvania Law Review,* **127**, April 1979, pp. 345–365.

Schmalensee, R. 'Economies of scale and barriers to entry', *Journal of Political Economy,* **89**, 1981, pp. 1228–1238.

Schmalensee, R. 'Product differentiation advantages of pioneering brands', *American Economic Review,* **72**, June 1982, pp. 349–365.

Schnaars, S. P. 'When entering growth markets, are pioneers better than poachers?', *Business Horizons,* **29**, March-April 1986, pp. 27–36.

Schumpeter, J. A. *The Theory of Economic Development.* Oxford University Press, New York, 1961.

Shaw, R. W. and S. A. Shaw. 'Late entry, market shares and competitive survival: the case of synthetic fibers', *Managerial and Decision Economics,* **5**, 1984, pp. 72–79.

Spence, M. 'Entry, capacity, investment and oligopolistic pricing', *Bell Journal of Economics,* **8**, 1977, pp. 534–544.

Spence, M. 'Investment strategy and growth in a new market', *Bell Journal of Economics,* **10**, 1979, pp. 1–19.

Spence, M. 'The learning curve and competition', *Bell Journal of Economics,* **12**, 1981, pp. 49–70.

Spence, M. 'Cost reduction, competition, and industry performance', *Econometrica,* **52**, January 1984, pp. 101–121.

Stobaugh, R. *Monopolies Aren't Forever: The Case of Petrochemicals.* Harvard Business School Press, Boston, 1988.

Tang, M. 'An economic perspective on escalating commitment', *Strategic Management Journal,* **9** (Special Issue), 1988, pp. 79–92.

Teece, D. J. 'The diffusion of an administrative innovation', *Management Science,* **26**, May 1980, pp. 464–470.

Teece, D. J. 'Firm boundaries, technological innovation, and strategic management'. In L. G. Thomas (ed.), *The Economics of Strategic Planning.* Lexington Books, Lexington, MA, 1986a.

Teece, D. J. 'Profiting from technological innovation: implications for integration, collaboration, licensing and public policy', *Research Policy,* **15**, 1986b, pp. 285–305.

Urban, G. L., R. Carter, S. Gaskin and Z. Mucha. 'Market share rewards to pioneering brands: an empirical analysis and strategic implications', *Management Science,* **6**, June 1986, pp. 645–659.

Wall Street Journal. 'Paper tiger: how Kimberly-Clark wraps its bottom line in disposable huggies', 23 July 1987.

Weiss, L. W. 'Optimal plant size and the extent of sub-optimal capacity'. In R. T. Masson and P. D. Qualls (eds), *Essays in Industrial Organization in Honor of Joe S. Bain.* Ballinger Press, Cambridge, MA, 1976.

Wernerfelt, B. 'Brand loyalty and user skills', *Journal of Economic Behavior and Organization,* **6**, 1985, pp. 381–385.

Wernerfelt, B. 'A special case of dynamic pricing policy', *Management Science,* **32**, December 1986, pp. 1562–1566.

Wernerfelt, B. 'Umbrella branding as a signal of new product quality: an example of signalling by posting a bond'. Unpublished, Kellogg Graduate School of Management, Northwestern University, September 1987.

Wernerfelt, B. 'General equilibrium with real time search in labor and product markets', *Journal of Political Economy,* **96**, forthcoming June 1988.

Wernerfelt, B. and A. Karnani. 'Competitive strategy under uncertainty', *Strategic Management Journal,* **8**, March–April 1987, pp. 187–194.

Yip, G. S. *Barriers to Entry.* Lexington Books, D. C. Heath and Company, Lexington, MA, 1982.