Introduction: Strategic Investment as Real Options and Games

I used to think I was indecisive — but now I'm not so sure.
— Anonymous

I.1. About This Book

In this book we present a new perspective on strategic investment, drawing on and synthesizing new valuation methods from finance, such as real options, and basic concepts from industrial organization and game theory. This book on new approaches to strategic valuation aims at both a *professional* and an *academic* audience. We synthesize cutting-edge ideas on strategic valuation, which are communicated in accessible language and illustrated with examples and applications. Our approach will be helpful to professional managers and students of strategy in developing a conceptual framework and choosing the tools for strategic investment decisions. Such an applied orientation provides critical insight into both the opportunities and the potential pitfalls of strategy implementation.

The gap between finance and corporate strategy remains embarrassingly large, as academics and practitioners alike have recognized for some time now. The most important managerial decisions — in terms of both the size of expenditures and their impact on the future of the firm — are strategic decisions, yet they are the least well understood and often are made without the discipline of rigorous analysis. For such strategic decisions, the traditional discounted-cash-flow (DCF) approach is often shortsighted. Strategic thinking and capital budgeting should be combined explicitly when firms make capital investments to gain strategic advantage. Traditional methods of appraising projects do well when valuing bonds, deciding on maintenance or replacement, or determining other passive investments in a stable environment where a stream of cash flows can be well specified. These methods, however, have serious shortcomings in valuing investments when management has the ability to control future cash flows and revise future decisions, particularly when current investment may interact with future investments (growth options), may

Special thanks to Mikhael Shor of Vanderbilt University for identifying some of the quotations appearing in the chapter headings in this book.

confer future strategic advantages, or may affect (and be affected by) actions and reactions of other parties external to the firm (such as competitors and suppliers).

In this book we synthesize the newest developments in corporate finance and related fields, in particular real options and game theory, to help bridge the gap between traditional corporate finance and strategic planning. We use practical examples and references from company experiences to demonstrate the relevance of this approach. The book discusses strategic valuation examples from various industries, such as R & D investment in high-tech industries, joint research ventures, product introductions in consumer electronics, infrastructure and public investment (e.g., airport expansion), and examples from oil exploration investment. Our treatment of "strategic investment" goes far beyond use of standard real-options analysis; we extend the potential of real options by combining it with principles from industrial organization and game theory to capture the competitive dimensions and endogenous interactions of strategic decisions between the firm and its competitors.

We believe that now is the right time to bring these new ideas on strategic valuation to a broader audience. Strategy has been a stagnant field (in terms of concrete quantitative valuation tools) for some time, and the gap between finance and strategy has been apparent. The relatively new fields of game theory and real options have now gained academic credibility and recognition. In 1994 the Central Bank of Sweden awarded the Nobel Prize in economic science to John Nash, John C. Harsanyi, and Reinhard Selten for their contributions to game theory. Box I.1 reveals what's behind the Nash Prize. In 1997 the Nobel Prize was awarded to Myron Scholes and Robert Merton for developing options pricing. In the last several years, all the major consulting firms have attempted to apply these ideas in their practice.

We hope that our book appeals to academics in finance and strategy as well as to high-ranking professionals and a general audience. We are pleased to bring material developed in our work and the work of others to a broader audience and integrate it with other fascinating concepts and approaches from strategy, corporate finance, and related fields. Every attempt was made to make the book accessible to a wide audience, yet at the same time it should be challenging, engaging, and, though not mathematical, compelling to an intellectually rigorous reader.

I.2. Real Options and Games: Linking Corporate Finance and Strategy

In an increasingly uncertain and dynamic global marketplace, strategic adaptability has become essential if firms are to take advantage of favor-

Box I.1 Behind the Nobel Prize Awards

Often the winner of a Nobel Prize is an obscure academic, noticed by few in his community until he is thrust into the spotlight. But when photographs of John Nash appeared in the press last week, a common reaction in and around Princeton, New Jersey, was a shock of recognition: "Oh, my gosh, it's him!" Nash, who shared the Economics Prize with John Harsanyi of the Haas School of Business at the University of California, Berkeley, and Reinhard Selten of the University of Bonn, is a familiar eccentric in the university town — a quiet, detached man who frequently spends his time riding the local "Dinky" train on its short hop between Princeton and Princeton Junction, reading newspapers discarded by other passengers. Some knew him as the author of the enormously complicated mathematical equations that appeared on classroom blackboards from time to time — the product of a splendid but troubled mind working out his thoughts when no one was around.

The work that earned Nash his prize was largely completed by 1950 when, at age 22, he submitted the Princeton Ph.D. thesis that has been described as the rock on which the mathematics of game theory is based. Game theory tries to explain economic behavior by analyzing the strategies "players" in the marketplace use to maximize their winnings. Nash, drawing on the dynamics of such games as poker and chess, introduced the distinction between cooperative games, in which players form binding agreements, and noncooperative ones, in which they don't. His "Nash Equilibrium" has been used by generations of corporate and military strategists to help decide when to hold 'em and when to fold 'em.

Source: Excerpts from "Bittersweet Honors," *Time*, October 24, 1994. © 1994 Time Inc., reprinted by permission.

able future investment opportunities, respond appropriately to threatening competitive moves, and limit losses from adverse market developments. The conceptual approach to strategic decision-making developed in this book considers a firm's growth opportunities as a package of corporate real options that is actively managed by the firm and that may influence and be affected by competitive actions. In this way, strategic considerations of importance to practicing managers can be brought into the analysis in a rigorous fashion that is consistent with the tenets of both industrial organization and modern finance theory.

A combination of real-options analysis and game theory, such as the one presented in this book, can help answer many strategic questions that

are important for corporate success. Thinking in terms of options, games, and adaptive strategies may help managers address strategic questions, such as these: What is the value of growth opportunities in our business? When is it appropriate to speed up investment in order to capture a larger market share or preempt entry by competitors? When is it better to maintain a "wait and see" approach to benefit from resolution of market uncertainty? When should the firm proceed in stages? Should the firm compete in R & D, or take an accommodating stance via a joint research venture? Is another form of strategic alliance more appropriate?

In an ever-changing technological and competitive landscape, precisely these strategic decisions determine the firm's competitive success and market value—and sometimes its very survival. Yet managers often have to make these decisions using intuition and experience alone, with little guidance from structured, quantitative analysis.

We provide quantitative guidance by integrating two complementary fields: strategy and finance. In strategic management theory, the resource-based view and core-competence arguments explain why firms should invest in resources or competencies to acquire a distinctive advantage in pursuing market opportunities in a dynamic environment. Valuation techniques from finance help quantify those resources that enable the firm to adjust and redeploy assets, develop and exploit synergies, and generate new opportunities (e.g., time-to-market and first- or second-mover advantages).

Investment decisions that have a major *strategic* impact on the firm's future path have been more difficult to analyze than standard discounted cash flow (DCF) techniques would suggest. Rapid technological changes and intensified competition necessitate an analysis of the project's strategic growth potential that is more dynamic than just a forecast of expected cash flows. Thinking of future investment opportunities in terms of "real options" has provided powerful new insights and has already enabled substantial progress in modern corporate decisions on allocation of resources.

Real-options theory utilizes the insights and techniques derived from financial option pricing to quantify the thus far elusive elements of strategic adaptability to capitalize on better-than-expected developments (e.g., expand into new growth markets) or retreat to limit losses from market setbacks. Real options stresses the importance of wait-and-see flexibility, suggesting that managers should wait until major uncertainties are resolved and the project is more clearly beneficial, requiring a positive premium over the zero-NPV (net present value) threshold. During postponement, new information can be revealed that might affect the future desirability of the project; if future prospects turn sober, the firm has implicit insurance cushioning it against downside losses by choosing not to proceed with (subsequent stages of) the project.

Since it recognizes that investments tend to be sequentially related over time, real-options analysis is particularly suitable to valuing strategy instead of isolated projects. In this framework, strategic projects are not considered as stand-alone investments, but rather as links in a chain of interrelated investment decisions, the earlier of which set the path for the ones to follow.

Real-options analysis also gives new insight into the effect of uncertainty on an investment opportunity's value, insight that runs counter to traditional thinking. If management is asymmetrically positioned to capitalize on upside opportunities but can cut losses on the downside, more uncertainty can actually be beneficial when it comes to option value. Gains can be made in highly uncertain or volatile markets by staging the investment because of the exceptional upside potential and limited downside losses, since management can default on planned investments or simply not proceed to the next stage.

Of course, it may not always be advisable to follow a flexible wait-and-see strategy from a competitive perspective. When a competitor's investment decisions are contingent upon others' moves, a more rigorous *game-theoretic* treatment becomes necessary. The optimal investment timing under uncertainty and competition often involves a trade-off between wait-and-see flexibility and the "strategic value" of early commitment. Early commitment generates value when it can influence how competing firms assess their options in the market in a way favorable for the incumbent. Consider a pioneer firm that makes an aggressive, large-scale investment in a new geographical market. The firm's competitors may view this entry as a threat, inducing them to enter the market later on a reduced scale to avoid a battle over market share. By reducing the likelihood of competitive intrusion, the project can produce higher profits for the pioneer. Such aspects of competition and flexibility are essential in strategic analysis, but they are not properly captured in the standard tools for evaluating projects.

Appropriate competitive strategies can henceforth be analyzed using a combination of option valuation and game-theoretic principles. To bring the flexibility and competitive aspects together in a holistic framework, we adopt an expanded (or strategic) NPV criterion. This expanded NPV criterion can capture the strategic commitment value of competitive interactions, as well as the value of managerial flexibility to alter planned investment decisions within the firm's overall strategy. Strategic commitment can have significant value. For example, by making an early strategic R & D investment, a firm may develop more cost-efficient or higher-quality products or processes that can result in a sustainable cost or other competitive advantage and a higher market share down the road. A firm anticipating competitive entry may commit to excess production capacity early on to preempt competitors. The "strategic value" of early investment

can sometimes be negative. This may be the case when the realized value of the strategic investment is vulnerable to the firm's ability to appropriate for itself the resulting benefits. Competitors can often benefit from the commercial results created by another firm's R & D, while competition or rivalry later in the commercialization stage can erode the value of strategic investments for the pioneer. Besides the proprietary or shared nature of the investment, the competitor's expected reaction to counter or reinforce the pioneer's strategic investment action can also affect the value and desirability of the strategic investment.

The options and games approach in this book provides a novel framework that enables valuing various competitive strategies in different circumstances under uncertainty. The valuation explicitly allows capturing important strategic aspects and views the option chain of investments within a broader competitive environment. Proper strategy valuation and design, in this view, requires careful consideration of the capabilities for growth created by strategic investments, of the effect of competitive moves and the type of competitive reactions, of the value of commitment and deterrent strategies, as well as of the development of successful commercial investment opportunities. Box I.2 shows that even Bill Gates could benefit from game theory.

I.3. An Overview of the Book

The book is organized in three parts. Part I (chaps. 1–4), "Approaches to Strategic Investment," provides an overview and develops step by step the conceptual frameworks and principles useful for strategic investment analysis. It reviews modern approaches to strategic management and introduces new valuation principles for strategic investment. The rationale for this part of the book can be seen by referring to figure I.1 (discussed in more detail in chapter 1), which brings out the connection between corporate strategic planning and the market value of the firm. Chapter 1 provides a motivation by linking strategy to the market value of investment opportunities (via the expanded NPV criterion), taking a first step toward closing the gap between traditional corporate finance and strategic planning. Discounted cash flow (DCF), real-options theory, game theory, and strategic planning are brought together in a comprehensive framework capable of incorporating management's flexibility to respond to market opportunities and competitive moves or threats in an uncertain and evolving environment. We view an expanded or strategic NPV as the sum of standard NPV plus flexibility value and strategic value. We discuss the value drivers of standard NPV, as well as of flexibility and strategic value. In the subsequent chapters we review the basic concepts and foundations of these three building blocks: strategic manage-

Box I.2 Reciprocity: Bill Gates Could Gain a Lot from a Little Game Theory

It's too bad that Bill Gates, chairman and founder of Microsoft Corp., decided to drop out of college and become a billionaire. He might have learned from game theory that in the long run the best competitive strategy is to be nice, or at the very least to do unto others as they do unto you. If others are nice and play fair, do likewise. And if not, treat them accordingly: reciprocity, as the social scientists say, and tit-for-tat, as the game theorists put it. What you don't do is grind them into dust on the assumption that the best competition is no competition. Game theory says that is not a good strategy for long-term survival. With no competition, why innovate?

John von Neumann, who made fundamental contributions to computer science and quantum theory, called game theory a mathematical analysis for modeling competition and cooperation in living things, from simple organisms to human beings. Game theory has become useful in helping scientists determine how entities cooperate and compete and which strategies are most successful.

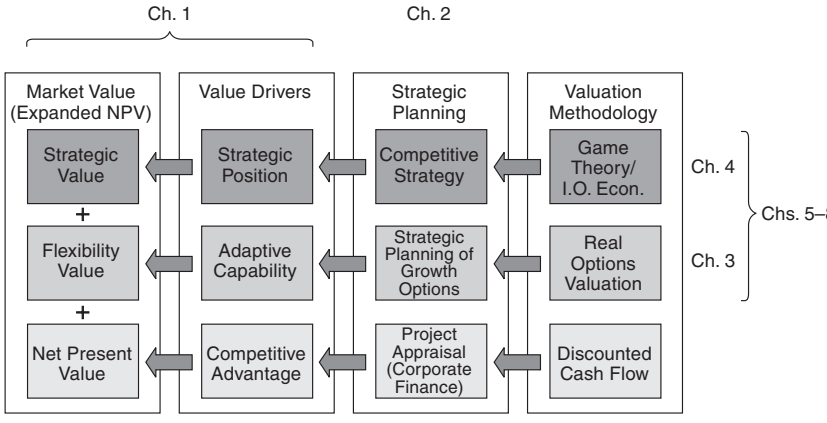
Source: Excerpts from "Bill Gates Could Gain a Lot from a Little Game Theory," by Bernard Cole, *EE Times,* June 19, 2000. Reprinted by permission.

ment and portfolio planning, corporate real options, and economics of strategy (industrial organization game theory).

Chapter 2, "Strategic Management: Competitive Advantage and Value Creation," reviews various strategic paradigms that analyze the underlying sources of value creation for the firm, focusing on industry and competitive analysis, firms' internal resources and dynamic capabilities, and portfolio planning of growth options. Industry analysis, competitive forces, and portfolio approaches each approach the problem from an external perspective. Internal approaches, such as the resource-based view or the dynamic capabilities framework, approach this issue of the sources of value creation from within the firm. Value creation is seen as resting on distinctive resources and capabilities, as well as on the ability to adapt to a changing environment.

Chapter 3, "Corporate Real Options," reviews the basic concepts and valuation principles of real options within a framework that views investment opportunities as collections of corporate options on real assets. Examples include valuing a license or patent giving a firm an option to invest in commercial production of a new product, valuing R & D and other growth opportunities as multistage growth options, and analyzing a mine concession with options to shut down and reopen. Chapter 4,

Figure I.1 Impact of Corporate Strategic Planning on the Market Value of the Firm



The broader strategy framework recognizes three levels of planning that have an effect on the market value (expanded NPV) of investment opportunities. First (bottom row), project appraisal from corporate finance aims at determining the effect on the net present value of the projected cash flows resulting from establishing a competitive advantage. Second, strategic planning of growth opportunities aims at capturing the flexibility value resulting from the firm's adaptive capabilities through real-options valuation. Third, competitive strategy aims at capturing the strategic value from establishing, enhancing, or defending a strategic position vis-à-vis competitors based on game theory analysis and industrial organization economics.

"Games and Strategic Decisions," provides an overview of basic principles of game theory and industrial organization/strategy that are essential for our understanding of strategic decisions. Strategic investment decisions are often made in a context where decision makers must take into account the deliberate (re)actions of other players and firms. Practical examples from consumer electronics, such as the development of CD technology, and from other industries illustrate the potential use of combined options concepts and game theory principles in developing a better understanding of competitive behavior under uncertainty in oligopolistic markets.

Part II (chaps. 5–7), "Competitive Strategy and Games," brings out in more detail the interaction and integration of the real-options approach with game theory and industrial organization concepts to capture the competitive aspects of investment strategy. Again, competitive investment strategy is based on the strategic or expanded NPV criterion that incorporates not only the direct cash-flow value (NPV) and the flexibility

or option value, but also the strategic commitment value from competitive interaction.

Chapter 5, "Simple Strategic Investment Games," provides a simplified overview of many of the ideas that follow. The reader can take part in a thought experiment involving a series of strategic investment problems of increasing complexity. Questions addressed include the following: What is the impact of exogenous competitive entry (substitute products) on a firm holding a license giving it an option to invest in commercial production of a new product? What if an early strategic investment can preempt competitive entry altogether? What is the impact on the firm's first-stage R & D strategy of exogenous competition in production (in a later stage) that can influence asymmetrically the production decisions and profits of competing firms? Can the optimal R & D strategy differ depending on whether it generates proprietary or shared benefits? Does it differ according to the type of industry? What happens in innovation races where the first mover can achieve an advantage that may preempt its competitor and "win all"? What if both competitors invest early (overinvest), hurting both? What are the benefits of cooperating via a joint research venture (while preserving the right to compete in commercialization and sales)? The reader is guided through such stylized problems supported by practical examples of the strategies of leading companies.

Chapter 6, "Flexibility and Commitment," focuses on the trade-off between the value of timing flexibility and early strategic commitment, revisiting previous ideas in a more rigorous framework that accounts for proper modeling of different competitive equilibrium games. The focus here is on second-stage competition in product markets. This analysis provides guidelines for the circumstances in which strategic investment may be advantageous or disadvantageous. The key factors influencing the optimal competitive strategy are (1) whether the firm's strategic investment makes the firm "tough" or "vulnerable" (related to whether the resulting strategic benefits are exclusive or shared with competition); and (2) how the competitor is expected to respond when it is hurt or benefits from the pioneer's investment. According to the anticipated reaction of competitors, we distinguish various exercise games and determine appropriate investment strategies in different settings, such as investments in R & D and goodwill (advertising).

Chapter 7, "Value Dynamics in Competitive R & D Strategies," extends the preceeding analysis to a broader range of issues in the case of strategic R & D investments. The chapter discusses extensions accounting for an uncertain outcome of the R & D effort and considers the benefit of cooperation in a joint research venture.

Part III (chaps. 8–10), "Applications and Implications," discusses various applications, continuous-time analytic models, and the implications

of the approach presented here. Chapter 8 provides case applications illustrating the powerful potential of a combined options and games approach. In general, real options and competitive games have complex structures. Thus, it is difficult to provide credible analysis without using realistic examples. An in-depth analysis of typical situations is important in validating the framework described in the first two parts of the book. We first discuss examples of actual situations facing competing firms in a particular industry (consumer electronics), to show the real-life flavor of typical problems. Subsequently we discuss an acquisition strategy known as "buy and build," in which an investor initially undertakes a "platform" acquisition in an industry and then leverages core competencies onto follow-on acquisitions in a broadened geographical base. Important questions for a successful acquisition strategy are these: How valuable are the growth opportunities created by the acquisition? When is it appropriate to grow organically or through strategic acquisitions? Finally, the chapter discusses in depth the case of an infrastructure investment for expansion of a European airport. Airports in Europe face a changing competitive environment. We analyze the flexibility and strategic characteristics of infrastructure investments that generate other investment opportunities, and in so doing change the strategic position of the enterprise.

In chapter 9, "Continuous-Time Analytic Models and Applications," we review various analytic models in continuous time that have made a significant contribution to the literature and provide interesting applications. We also extend our own framework (discussed in chapters 6 and 7) in continuous time. The chapter reviews related literature in terms of continuous-time analytic models and discusses more applications. It also supplements the rest of the book, which follows a discrete-time analysis for expositional simplicity and accessibility to a broader audience.

The last chapter, "Overview and Implications," pulls things together. It reviews the strategic framework integrating options and competitive games, and recaps the main conclusions and implications (including empirically testable hypotheses). The chapter ends with suggestions for implementation and ideas for future work.