The Real Options Solution

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The Real Options Solution

Finding Total Value in a High-Risk World

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To those who gave all in the tragic events
of September 11, 2001

Preface

The Real Options Solution offers a new approach to the valuation of businesses and technologies based on options theory. It provides a *quantifiable* approach to the problem of the strategic premium—the gap between apparent economic value and actual value as determined by the marketplace. *Total value* is the sum of economic value and the strategic premium created by real[1] options.

The wild rise of Internet stocks, which peaked shortly after the millennium opened and the severe correction that followed have made clear to everyone what some have known all along—there is a crisis in how companies, especially technology companies, are valued. Accounting systems based on historical costs can't do it. Discounted cash flow models can't do it when positive cash flow is nowhere in sight. Dubious comparables, such as "price-to-sales ratios" or "eyeballs," lose track of value and beg the question of whether the stocks to which one is comparing are correctly priced.

The gap between market value and economic value has been trending upward for some time as the economy becomes increasingly service- and information-based. The gap reached record proportions at the height of the Internet bubble; it is still very substantial after the correction and is likely to grow again. Dismissing the phenomenon as simply the madness of crowds

wastes the opportunity to analyze the dynamics of how great value is being created and destroyed by innovation in the modern economy.

■ THE VALUATION SOLUTION—PLANS ARE OPTIONS

This book is based on a straightforward central idea: *plans are options*. A plan is unlike the physical or financial asset it is intended to produce because the owner of the plan has freedom to modify the plan as circumstances change. This freedom has value, which can be analyzed quantitatively. The implications of the idea are considerable because options are valued differently than securities. The idea is powerful because it provides a universal valuation method—one that applies equally to the dullest old-economy company and to a wild new Internet start-up. It also creates a framework for the special valuation issues that occur when brilliant innovations are being made within a traditional operating business.

No radical assumptions are required to use this approach. The discounted cash flow (DCF) model is fundamentally sound for operating businesses and is the core first step. And DCF analysis is also the first step in valuing innovative business plans—whether of a new business-to-business (B2B) model, a promising drug in the research pipeline, or a new type of fuel cell. But because these plans are subject to both unique and market risks and because management has considerable flexibility in their execution, such plans are correctly evaluated as real options. The value of such options under the dual conditions of rapid growth and high volatility can be huge—and unquestionably higher than one might intuitively guess.

Plans are certainly not correctly valued by the prevalent, and seriously flawed, notion that they are future cash flow machines to which an arbitrary risk-weighted hurdle rate can be applied.

Why does this insight make a difference? Simply because

DCF analysis alone can lead an investor to pass up a financially attractive opportunity. In the past, executives used the word *strategic* to label intuitively attractive investments that failed to earn the cost of capital. Options theory allows one to *calculate* the strategic premium to obtain total value.

■ WHO SHOULD READ THIS BOOK?

Those who are investing for above-average returns and those who are trying to create these above-average returns should read on. Among the former will be venture investors and those legions of individual investors who are willing to take investment risks to enjoy superior returns. The latter includes executives of New Economy start-ups or of old-economy firms seeking to reinvigorate their companies. The book should be of special interest to those in research and development (R&D).

Potential readers may be frustrated by the mumbo jumbo terminology that aims to justify large premiums based on a "first-mover" principle, impressive intellectual capital, or a supposedly unassailable market position. But just how does one determine what these premiums are worth? If you are willing to think about a new approach, read on.

■ RISK IS MORE PREVALENT THAN WE GENERALLY REALIZE

I am a high-risk investor and have been in the employ of high-risk investors. But I have not thought about myself this way all along, nor has my new perspective developed by conscious choice. After all, I was for most of my career in the employ of solid Fortune 100 industrial companies. I viewed my personal investments as growth oriented, but reasonably safe. These assumptions proved to be illusions.

The lights came on in the 1980s when a misguided news report temporarily destroyed about 25 percent of my paper net worth. The picture became even clearer when modest investments in new technology grew quickly into major investments, while my "value" investments underperformed for a decade. And it became crystal clear when a young relative with an idea created significant personal wealth in the space of one very wild year.

Investors have become inured to massive changes in market valuation triggered by a single business news item, whether it is an announcement about a deal, an earnings warning, or government intervention. It is similarly common to see daily changes in our personal stock portfolios equivalent to months of salaries earned from solid labor. Nonetheless, many of us, old and young alike, have come to prefer being rewarded with equity, especially stock options, rather than with cash.

And despite our anxiety about this irrational and high-risk world, on the whole we are more prosperous than ever. It seems we must live with risk; and if we must, it's best to enjoy the ride.

■ ORIGINS OF THE BOOK

This book is an outgrowth of two major influences. The first was my earlier book,[2] *The Valuation of Technology*, which was conceived in 1997 and published in 1999. Broadly speaking, that work aimed to bridge the communications gap between scientists and engineers and the business and financial community through the concept of valuation. More narrowly, the book linked the familiar algorithms used by the R&D community, where I spent much of my professional career, with the algorithms used by those more directly concerned with shareholder value: investors, senior executives, and board members.

The Valuation of Technology is a quantitative book, replete with graphs, tables, equations, and detailed examples. It is aimed

at practitioners of and investors in technology. I came away from the task of writing it with the conviction that some of its key concepts had broad usefulness and could eventually be the core of a book aimed at a wider audience. In particular, I recognized that the techniques used to manage the extraordinarily high-risk world of R&D were applicable to other important problems in the business world.

The second influence for this book has been my exploration of the concept of real options. I have been exposed to the general concept of R&D as a form of real option[3] for over a decade. My initial reaction as a practitioner was that the idea had conceptual merit but was too abstract to use as an effective communications tool in a real company (and I was a senior executive of a real company at the time). Nevertheless, I included the basics of options analysis in my original book, included a number of quantitative cases to show why the idea could be important, and referenced some of the current thinking in the field.

The epiphany about the consequences of options thinking came in a classroom situation, when, in the role of a professor, I was trying to explain the value of embedded options in a business proposal, using a case taken from a corporate finance textbook. The example described a proposal to make a new computer product, which implied the further option to introduce a second-generation computer three years later. Coincidentally, the talk of the business community at the time was about the extraordinary and seemingly irrational valuations being placed on Internet stocks. The fact that my young relative was deeply involved in a dot-com compounded my interest. I decided to plug typical Internet growth rates and volatilities into the textbook case. These new conditions produced some extraordinarily high valuations,[4] yet the results all were derived using standard financial theory.

While these results demonstrated a very plausible linkage of market valuation to embedded options, the most important message was that the options *were visible to some and invisible to*

others. In the original textbook case, the chief executive officer (CEO) had rejected a proposal to make the new computer because it failed to meet his hurdle rate. But an analyst pointed out that making a first-generation machine carried with it an option to build a second-generation machine a few years later. In other words, she had identified and valued a strategic premium that reversed a flawed decision derived from economic value alone. How to identify, structure, and exploit such hidden options is one of the ambitions of this book.

■ FIVE KEYS TO A LOCK

The immediately following paragraphs offer a crisp summary of the book's five premises and how they can unlock the mystery of value. The book will explore a wide range of cases that illustrate the consequences of these ideas.

The first key to the lock is the concept of value, that new capital is created in direct proportion to the degree to which returns on capital exceed the cost of capital. This idea is widely accepted today, but hardly universally understood. It needs development.

The second key is that value creation cannot occur in the absence of risk and, indeed, is dependent on the assumption of risk and its intelligent management. These general ideas are not really original, but the actual algorithms linking risk and value for the innovation process may be novel and are central elements in *The Valuation of Technology*.

The third key is that human capital and intellectual capital are important, and sometimes dominant, parts of the valuation of modern companies. The idea of intangible capital assets has a reasonably long history, and its extension as "intellectual capital" to explain the gap between accounting and marketplace values has gained adherents during the past decade. Nevertheless, there is considerable confusion about just how intel-

lectual capital is converted into shareholder value. This book outlines a solution.

The fourth key is that strategic capital resides in an organization's plans and options for future actions. The implications of this fact are largely unexplored. Previous approaches tended to look at intellectual capital as an extension of quantifiable intellectual property, such as patents, trademarks, and copyrights. To these were added more subjective forms of intellectual capital, such as learning and knowledge, business processes, and technical know-how. However, the weakness of this approach is that it is not intellectual capital itself but the ability to translate it into business plans that creates value in the marketplace. There is no other way to determine which patent, which ad campaign, or which employee will add the most value.

The fifth key—perhaps the missing key—is that plans begin as real options and are transformed into tangible capital when the options are exercised. This idea is new, particularly in the context of the fourth premise, and is a promising approach to the valuation of strategic capital.

An important consequence is that to value the opportunity (and therefore the strategic premium), the analyst must carefully separate unique risk from systematic risk. This technique for evaluating options is not new to options theorists, but it is only just beginning to be understood and applied in the world of real business and investment.

■ PLAN OF THE BOOK

Part One of the book provides a new perspective on value by developing the concepts on which an integrated value model is built. The introductory chapter retells a high-seas adventure story from the viewpoint of a high-risk investor and recapitulates the enormous prosperity (the Total Value) triggered by that investment.

A foundation for a new approach is built in Chapter 2, where the crisis in valuation noted earlier is reviewed, and the differences between book capital, economic capital, and strategic capital are reviewed. This structure is more useful than the notion that the difference between market value and book value is accounted for by "intellectual capital." Why? Because those intangibles that support the current economic processes of the firm must be distinguished from those other intangibles that create a strategic premium. Without that distinction, valuation of a strategic premium is hopeless. Some recent business cases are used to illustrate the point.

Chapter 3 has two purposes. The first is to review the methods and the limitations of conventional (DCF) economic valuation, which is the foundation on which the Total Value approach is built. The second purpose is to imprint a fundamental understanding of the powerful link between sustainable growth and value creation. Yet, it is easy to go badly astray with DCF analysis, leading to serious undervaluation or, almost as easily, to overvaluation.

The Real Options Solution comes together in Chapter 4. Here, an ambitious, integrated valuation model combines *economic* valuation based on forecast cash flows with *strategic* valuation based on option theory. The chapter also discusses how strategic capital can be converted into economic capital, and vice versa. The model has the advantage of universality: It does not require separate yardsticks for established operating companies and innovative new businesses; it can smoothly accommodate a mix of the two—a common situation. And it holds true for both microeconomic and macroeconomic conditions. Chapter 4 reduces the concepts just introduced to a practical, six-step method for determining total value. It begins with a brief summary of the method. It then defines and discusses the underlying concepts in each step, beginning with the core concept of economic value and its relationship to growth rates. To complement theory with a concrete example, the economic value of a very straight-

forward business is calculated. This business model then becomes a platform to which a single strategic option is added. The value of the option is calculated, the sum of economic capital and strategic capital is added, and a total value for the business is obtained.

Options are an extremely useful way to manage risk, the subject of Chapter 5. This chapter reviews the basics of financial options and shows why they are closely analogous to business situations that contain what are called *real options.* (The term *real* is coming into increasing use, in the titles of books, articles, and management conferences, to distinguish those options that arise in ordinary business from financial options relating to securities or commodities.) It demonstrates why, in situations characterized by a combination of high growth and high volatility, options can take on extraordinary values. Investors need to understand the dynamics by which this remarkable phenomenon occurs. But financial options are risky—they can expire with the full loss of the premiums paid for them—and the wild ride of Nasdaq stocks in 1998 and 2001 amply demonstrates a corresponding risk for real options.

Chapter 6 explores the proposition that strategic capital resides in an organization's plans and options for future actions. This assertion is the foundation for a quantitative approach to the valuation of strategic capital. However, to make the equation *Plans = Options* useable, it is important to recognize *that plans are neither forecasts nor dreams*. In a nutshell, one must realize that *Position* is a necessary although not sufficient condition for plans to be actionable.

Part Two of the book describes how *diminishing returns, risk,* and *innovation* affect the integrated value model introduced in Part One and in particular outlines why the management of risk and innovation is the foundation of modern prosperity.

Chapter 7 deals with the law of diminishing returns and shows how its consequences have driven organizations to stagnation and devolution through value destruction. Investors and

executives can be slow to accept the inevitable deterioration of once-successful business models, which leads to serious misallocation of scarce resources.

The acceleration of economic growth and widely spreading prosperity have been the most extraordinary of modern phenomena. Chapter 8 explores the causes. What is different today from the stagnation typical of past eras? I argue that one difference is a far superior understanding of risk, which has led to a new balance between innovation and diminishing returns.

Risk is the subject of Chapters 9 and 10. Traditional risk management (think of a bank or an insurance company) does not translate easily to the high-risk environment of breakthrough innovation. So what is it that we have learned about risk management? We are beginning to understand that the management of systematic (market) risk requires different techniques (and provides different profit opportunities) than the management of unique (private) risk. And we have developed new value-creating management techniques pioneered for a high-risk environment, such as the aggressive use of the option to abandon troubled projects. We are also learning to apply what financial experts have called the "last free lunch," diversification, to technology and other high-risk portfolios.

Chapter 11 returns to the subject of human and intellectual capital—the key to value creation in a modern economy. It explores the mechanics by which human and intellectual capital are translated into economic capital on the one hand and into strategic capital on the other. After reviewing traditional intellectual property, including patents and copyrights, the chapter turns to the more complex issues of valuing R&D and new business opportunities. The situational nature of intellectual capital valuation is emphasized throughout.

Innovation is our weapon for overcoming the law of diminishing returns and is tied to the ability to frame real options. Innovation is the subject of Chapter 12. The technological S-

curve and the appearance of disruptive technologies are two critical features of how innovators create value for themselves and destroy value for others. Innovation itself appears to be in a stage of exponential growth based on the accelerating number of combinatorial possibilities generated by the increasingly frequent emergence of new technologies. One of the most promising investment strategies is to place chips where such combinatorial possibilities are greatest.

Governments have an important role in creating or in destroying prosperity. We examine their role in Chapter 13. Strong governments have historically provided important contributions by enhancing security and reducing risk. Governments also provide services, sometimes efficiently and sometimes less so. They invest in education, infrastructure, health, and technology. But while governments may adopt policies that favor value-creating investments, they are perfectly capable of misguided policies that systematically destroy value. Some examples will be presented.

The Epilogue deals with three of the central issues of our time. The first is the Keynesian nightmare—that we will run out of attractive investment opportunities. The second is the notion that the planet itself imposes serious limits on our future prosperity. The third is that the complexity of modern-day decision making will overwhelm human intellectual limits. However, there is ample reason to believe that our age of prosperity is far from over.

■ STYLE OF THE BOOK

This book is appearing at what will one day be viewed as the denouement of the Internet gold rush, a very unique time in U.S. economic history. There is an obvious peril in dispensing business wisdom that is the product of a unique era—it may fit the

times, but times soon change. So I will mix contemporary examples with historic examples to test whether the central premises are useful in a broader context.

For the contemporary examples, I did not have the full advantage of hindsight. But I did have the advantage of abundant stores of financial and economic data, plus my own direct experience. The historic examples are just the opposite—we know how the story turned out; but there may never be enough data, especially regarding profit margins, to confirm, or possibly disprove, the arguments. Given my seemingly safe position in the latter cases, I can still hope that the readers will gain new insight into the economic forces that have shaped our past and amusement from how classic examples translate into modern business jargon!

To increase the readability of this book, I have also chosen to minimize tables, formulas, and charts.

■ ACKNOWLEDGMENTS

The development of this book owes much to conversations I have held with members of my classes at the Yale School of Management and with many professional colleagues with whom I have discussed the implications of options theory.

Three people deserve special thanks. Ranch Kimball, formerly a partner at Boston Consulting Group (BCG) and a managing director of Tiger Scientific, Inc., made many contributions to the book in terms of its organization and provided several specific case studies based on his extensive consulting experience. Ranch in particular helped me articulate the notion that position is a prerequisite for plans and was a major contributor to Chapter 6.

Andrew Boer, through our many discussions of real-world situations, deserves the credit for my introduction to the special dynamics of high technology during the Internet bubble. An-

drew, after founding in 1997 the Internet nonprofit TRUSTe, which dealt with issues of Internet privacy, moved on to found the distinctly for-profit corporation Emptor in 1998. Emptor was funded by two prominent Silicon Valley venture capital firms, changed its name to Accept.com in 1999, and was sold to Amazon.com for $180 million.

Louis Hegedus of Atofina, a veteran R&D practitioner and my former associate, was kind enough to read the draft in full and provided highly useful critical tests of its assertions and assumptions.

I also wish to thank Richard Luecke for skillful professional assistance in reviewing the book and arranging for its publication. The unstinting support of Jeanne Glasser and the splendid Wiley team, Judy Cardanha, and Jamie Temple is gratefully appreciated. May Adams, my assistant for two decades, has been an invaluable helper, not only in the preparation of some of the materials used in this book, but also in organizing my many activities to ensure that the book stayed on track.

Finally, my wife, Ellen, has undoubtedly wondered why, after one book was completed, I still felt that there was enough left unsaid to justify the time spent on yet another. Surely, I neglected to tell her that, having done one, I might go for another. Her continued support and enthusiasm, and her conversion to the cause, are deeply appreciated. Even more important, since Ellen is an inveterate high-risk investor, I hope she concludes that reading the final version will be another winning investment.

F. PETER BOER

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