OPTIONS PRICING OF DYNAMIC STRATEGIES

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ABSTRACT

Managers responsible for capital investment decision making need valuation models that can navigate both corporate finance and competitive strategy to generate well-grounded prices. Real options provide the firm with flexibility to adapt to changes in its environment. The dynamic nature of real options in the new economy makes them more difficult to price than stock options. Since real options cannot be modeled by replicating portfolios of traded securities, payoff estimates are not as precise as those for stock options. This paper will analyze the aspects of the new economy that affect the calculation of growth opportunities, and introduce models that can allow managers to better understand how these aspects influence real asset option payoffs.

OPTIONS PRICING OF DYNAMIC STRATEGIES

Introduction

The new economy is changing the way managers think about real options, and traditional pricing models are increasingly challenged to properly price the outcomes possible. The most striking modern examples of firms using real options have seen payoffs generated that do not resemble those from real options in the old economy, let alone stock options. Google's current P/E ratio[1] cannot be justified by even the most optimistic outlooks of current projects. Clearly, technology standards ownership and lock-in effects have produced payoffs that extend beyond those that the old economy could predict. Microsoft recently sold its Xbox 360[2] platform at a loss, expecting to generate profits from the games to be released in the months following. That is an example of an old-economy follow-on option that is not overly difficult to model. But what about the platform as a tool for strengthening Microsoft's standards ownership in the operating system market by linking the television to the computer? The Black-Scholes model, one of the most widely used methods for pricing real options, has little explanatory power in these cases.

Managers responsible for capital investment decision making need valuation models that can navigate both corporate finance and competitive strategy to generate well-grounded prices. This paper will demonstrate how to improve the quality of the assumptions that go into the calculation of real asset options. We believe that in the new economy, the payoffs for different firms' growth opportunities are particularly affected by time, volatility, or isolating mechanisms. Classifying firms according to their sensitivity to these factors allows us to bridge the gap between corporate finance and competitive strategy by looking at the strategic implications of capital investments that ultimately help determine cash flows. We will support our classifications by referencing research on how managers make decisions about capital investments. The emphasis will be placed on estimating payoffs of follow-on options[3].

[1] Trailing Twelve Month PE ratio of 68.61 on March 15, 2006
2 David Kesmodel, Microsoft Places Big Bet on Multiplayer Gaming, Wall Street Journal, December 30, 2005 Page D7
[3] This term is used interchangeably with growth opportunities throughout the paper

Classifying Firm Behavior

A number of authors have attempted to capture firm dynamics and their effects on capital budgeting. Notably, Rappaport[4] sets out Class I, II, and III industries to predict the sustainability of competitive advantage. He then uses these classifications to understand how firms in each class face different forces, and how managers of these firms plan and make decisions accordingly. Grant[5] uses annual industry price change data to predict sustainability in order to support the use of classifications made by those such as Rappaport. The following is a table with price change data for the categories Grant sets out in his work:

[4] Alfred Rappaport, Creating Shareholder Value, The Free Press, 1986.
[5] Robert M. Grant, Contemporary Strategy Analysis 2e, Blackwell, 1995.

Industry	Period	Average Annual Real Change in Producer Price Index (%)
Monopolistic		
Petroleum Refineries	1996-2005	7.26%[6]
Portfolio Management	2003-2005	6.98%
Cigarettes	1996-2005	5.51%
Pharmaceutical Preparation Mfg	1996-2005	1.70%
Dental Equipment and Supplies Mfg	1996-2005	1.68%
Legal Services	1997-2005	1.48%
Burial Caskets	1996-2005	0.91%
Book Publishing	1996-2005	0.65%
General Medical and Surgical Hospitals	1996-2005	0.20%
Offices of Physicians	1996-2005	-1.00%
Scale Driven		
Air Transportation	1996-2005	1.08%
Chemical Mfg	1996-2005	0.01%
Iron and Steel Mills	1996-2005	0.00%
Paint and Coating Mfg	1996-2005	-0.10%
Sheet Metal Work Mfg	1996-2005	-0.70%
Pulp, Paper, and Allied Products	1996-2005	-0.72%
Fruit and Vegetable Canning	1996-2005	-1.74%
Sawmills	1996-2005	-2.03%
Automobiles and Light Duty Motor Vehicle Mfg	1996-2005	-3.14%
Schumpeterian		
Electronic Capacitor Mfg	1996-2005	-1.47%
Optical Instrument and Lens Mfg	1996-2005	-2.11%
Wired Telecommunications Carriers	1996-2005	-4.68%
Electronic Components and Accessories	1996-2005	-5.09%
Telephone Apparatus Mfg	1996-2005	-5.31%
Semiconductor, Related Device Mfg	1996-2005	-8.65%
Computer and Peripheral Equipment Mfg	1996-2005	-11.33%
Computer Storage Device Mfg	1996-2005	-13.80%
Electronic Computer Mfg	1996-2005	-17.85%

Source: US Department of Labor, Bureau of Statistics[7]

We support the exercise of classifying firms according to their dynamic behavior because it helps managers to better predict the outcome of their investment decisions. It can also allow them to recapture some of the loss in predicted payoff accuracy brought on by the differences between stock options and real options, and the old and new economy. In this paper, we will use Williams' approach of classifying firms according to their *product half*

[6] All price changes found in the PPI were adjusted for inflation before reproduction.
[7] PPI Detailed Report, US Department of Labor, Bureau of Statistics, April 2006.

life- the amount of time until the per-unit profit margin drops to one half its highest amount. This approach considers the price erosion data above by predicting how managers operating in different product cycles think about their growth opportunities differently.

In the method of economic time, firm behavior during a product cycle is characterized by the dynamics of value creation and product decline. Product half life is time-dependent measurement relevant to option pricing because it provides insight into how cash flows will behave differently throughout the product life cycle, which in turn determines the usefulness of various real options. The broad categories recognized by economic time are as follows:

Economic Time categories

Type of Firm	**Success Factors**	**Product Half Life**	**Examples**
Fast Cycle	Innovation, Capacity Ramping, Strategy Shifting, Preplanned Market Exit	1-2 years	Dell, Nokia, Sony, AMD, Liz Claiborne, Intel
Standard Cycle	Scale Management, Controlled Innovation	5 years	Wal-Mart, McDonalds, Toyota, Citibank, GE, Ikea, Federal Express
Long Cycle	Standards Ownership, Customer Lock-In, Staircase Strategies, Isolating Mechanisms	10 years	Microsoft, Disney, EBay, Honeywell

While classifications are neither exhaustive nor mutually exclusive (there is Multicycle behavior) readers should pay most attention to the behavior that influences option payoff, not just the classification. We hope our classifications contribute to the discussion of the challenges managers face in new economy real option valuation.

Conventional Option Valuation

Black-Scholes Model: In 1973, Fischer Black and Myron Scholes developed a model for pricing European[8] stock options using binomial pricing and put-call parity[9]. A logical extension of their model is to view follow-on projects as call options in the realm of capital investments. If a firm takes on an initial project, it owns a “call” on the follow-on project, where the strike price is the cost of investment and the value of the underlying asset is the present value of the cash flows of the project. This model is among the most frequently used by managers (and is the most commonly cited in MBA corporate finance texts) because it is simple and the inputs are usually known. While the formula was derived specifically for pricing stock options, it provided managers with an estimate of a difficult to model option-like payoff. Old economy options such as those related to the ability to expand capacity or ownership of natural resources were nicely modeled with Black-Scholes or binomial pricing because inputs were known and relatively stable.

Pitfalls of Using the Traditional Models: Real Options are Becoming Increasingly Different From Stock Options:

There are a number of ways that today’s real options differ from stock options that limit the model’s accuracy[10]. Either the Black-Scholes inputs must be measured differently for real options, or there are external factors that have begun to uniquely affect the price of real options. The impact of these factors on option payoffs in the new economy will be explored throughout this paper:

- Execution is not instantaneous: stock options are executed at a distinct point in time and the payoff or loss is incurred immediately. When is the option to launch a follow on project executed? Is it when necessary construction begins, or when the first product line goes to market? Real option values are very sensitive to the time it takes to take actions necessary to capture the option payoff. A firm’s ability to ramp up capacity and shift strategies has considerable impact on the ultimate option payoff, especially when the firm’s products quickly become commoditized[11]. The time variable particularly affects the option payoffs for fast cycle firms.

- Volatility plays a different role: prices of calls and puts on stock options are affected only by the variability in the underlying stock price, and this variability is directly observable. On the other hand, variability of the cash flows in a real

[8] European options can be exercised only upon expiry (in contrast with American options that can be exercised at any point up to expiry. Real options are European type options because they are typically identified with set points in time.

[9] Call Price = $(S) \times N(d_1) - Xe^{-rT} \times N(d_2)$

[10] Aswath Damodaran, The Promise and Peril of Real Options, pg 20-22, http://pages.stern.nyu.edu/~adamodar/pdfiles/papers/realopt.pdf

[11] Real Options Reasoning and a New Look at the R&D Investment Strategies of Pharmaceutical Firms- R.G. McGrath, A. Nerkar, Strategic Management Journal, January 2004

project is not observable because the project is not traded on an exchange. Furthermore, real option values are affected by multiple forms of risk without a single one being sufficient an input to price the option. Take the case of the owner of a mine with substantial mineral deposits who wants to delay extraction because he expects prices to rise. Not only is the value of the wait option affected by mineral price changes, but also variability in his estimate of the size of the mineral deposit, and the variability of the public's usage of the particular mineral. His mineral may become the most popular substitute for natural gas when oil prices rise, or end up being banned by the EPA if there are complications with disposal. Also, the Black-Scholes model assumes the variance of the value of the underlying asset is constant. This may be a reasonable assumption for stock prices, but real projects face competitive and regulatory forces that can cause cash flows to have uneven variance. The volatility variable particularly affects the option payoffs for standard cycle firms.

- No payoff entitlement upon execution: owners of stock options have the legal right to an arbitrage payoff. Depending on the strength of the firm's isolating mechanisms[12], it may find the payoffs they expected from taking on an initial investment vaporize by competitive convergence, technological obsolescence, or inopportune market position. The concept of shared options[13] applies here. Ideally, growth opportunities are not shared and closely relate to the firm's competitive advantage[14]. This is because real options cannot be securitized, so the firm is not able to subsequently sell the project in the financial markets to extract the value it cannot capture itself. The isolating mechanism variable particularly affects the option payoffs for long cycle firms.

- Real option holders are not risk neutral: binomial option pricing models should not always be used for real options. Real options executors have their own set of risk preferences that reflect their incentives, work environment, and industry of their firm. Managers must possess the flexibility and will to execute real options. In some cases, executing options with positive option payoffs may entail eliminating a product line with a small but loyal client base, closing plants and laying off workers, and taking risks outside the norm for the firm. Not only can these actions disrupt operations and create shutdown costs, they can also cause harm to the company's reputation and its other products. Furthermore, investment decisions have implications that can alter the work environment within the firm. Resources and attention are shifted from one area of the organization to another, creating a new equilibrium with winners and losers. Miller and Shapira find[15] that managers' risk preferences may lead them to price

[12] Richard P. Rumelt, Toward a Theory of the Firm, Competitive Strategic Management, Ballinger, 1984.
[13] Firm and Industry Influences on the Value of Growth Options, Tony W. Tong, Jeffrey J. Reuer, Strategic Organization volume 4(1):71-95
[14] Strategic Investment, Smit & Trigeorgis, Princeton University Press, 2004
[15] K.D. Miller and Z. Shapira- An Empirical Test of Heuristics and Biases Affecting Real Option Valuation, Strategic Management Journal, March 2004.

options at premiums or discounts, and we will rely on this assumption in predicting investment decisions.

Real Options for Fast Cycle Firms

Consider a typical fast cycle firms such as Intel that uses real options to manage the challenges that surface most often in short product cycles. Since the nature and magnitude of these challenges is defined by timing, real option value is highly sensitive to option time horizon. The marketplace these firms operate in is best characterized as Schumpeterian[16].

Accelerated Competitive Convergence, Ramping, and Forces of Uncertainty

First movers with innovative products like the Pentium usually lack the advantage of market exposure that builds brand loyalty and awareness. Without intellectual property protection (essentially isolating mechanisms) fast followers will enter and steal market share by offering similar products with lower prices or modified features. The fast cycle product fades into a commodity status, accelerating the erosion of the value of the first mover's profits. If competitive entry is well timed, it can also threaten the first mover's growth opportunities as well. This happened to Intel when AMD came along. Follow-on projects planned for launch beyond a point in the product cycle become worthless because the firm can't combat competitive convergence with its vanishing first-mover momentum.

Fast followers like AMD face equally pressing timing forces. The firm takes a gamble by trading off early learning and market share for information it believes will prove critical to its ability to seize the market. The payoff of this gamble depends on its ability to quickly shift strategies and ramp up capacity to act on the information it has gained. This could involve redesigning products, acquiring additional capacity, or changing marketing approach. If the product is of a highly innovative nature, significant effort will be made to educate consumers and create demand for their products. In the case of AMD, this involves working closely with software and video game producers to create content that runs on faster computer chips. These principles can apply to the first mover as well- the firm has to react effectively to information and competitive threat.

If growth projects are to be successful, they should be executed early enough to capitalize on the information the firm has gained and late enough to properly adapt operations to use this information. Options with horizons that can strike the right balance between these dynamic forces can payoff much more than those with slightly different horizons. This discrepancy demonstrates two fundamental differences between real options and stock options.

First, stock option payoffs are protected by the legal ownership of the security; real option payoffs can be taken away through competitive convergence or wither away from the firm's own rigidity. Second, unlike stock options, real options do not increase in value in the same manner by longer time horizons.

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[16] Joseph Schumpeter, The Theory of Economic Development, Harvard University Press, 1934.

The cash flows from real options are influenced by several related forms of uncertainty. New products are highly vulnerable to shifting industry standards (think Beta vs. VHS), ramping capabilities (the availability of capacity and inputs), and end-product prices. While end-product price changes are the easiest to measure, the former still play a major role in determining project cash flows, and ultimately option payoffs. This may be the case for standard and long cycle firms as well, but accelerated convergence and the act of capacity ramping make the difficult-to-measure sources of uncertainty most worthwhile and relevant to consider for fast cycle firms. This helps explain why high growth startups that have yet to earn a profit trade at high P/E ratios and investors demand high rates of return to compensate for risk.

Black-Scholes Approach for Fast Cycle Firms

In the 1990's, Intel faced the possibility of developing the Pentium II at a low cost and with trial experience if it decides to first develop Pentium. In this case Pentium II is the follow-on project for Pentium, the platform. Suppose that the Pentium II has expected cash flows of $200 million and the cost of the investment is $175 million. Intel believes its operating costs are certain, but knows the Pentium II revenues are not. It assesses a 50% volatility to the cash flows because it believes that represents the distribution of future chip prices.

With a thirty month time horizon, the follow-on option is a call worth $79.973 million. If the projects had time horizons of three months or eighteen months, the call options are priced at $35.185 million and $64.817 million respectively[17]. The Black-Scholes model predicts misleading prospects here because it doesn't capture the highly competitive nature of the computer chip business. The model *can* predict the price erosion in that estimating the underlying cash flows involves incorporating expected market rates for chips. What the model is not aware of is that the price erosion is a side effect of commoditization that prevents Intel from capitalizing on its own growth opportunities. Intel and its competitors were releasing faster chips every year and a half, turning their product into a commodity where chip price was determined by speed.

Furthermore, the effectiveness of Pentium chips of the intermediate future was highly uncertain, especially when it can only be forecasted with information managers had in the then-present. Intel's growth opportunities resembled a series of Pentium follow-ons, not a single follow-on to be executed 30 months down the road.

At the same time, the company had to be adept at adopting new technologies and ramping capacity in order to defend market position. The company would likely not possess the flexibility and agility to launch a phase II within three months time. Nor would the software exist that would generate demand for such a fast processor.

[17] See Appendix

Economic Time Approach: Scaling Factors

Black-Scholes option values can be scaled up or down based on the firm's product cycle to account for the dynamic competitive forces faced by the firm. An analogy can be made that scaling factors allow us to compare the life cycles of fast and long cycle firms in the same way "dog years" allows us to compare the life cycles of dogs and humans.

The factors presented in the Intel case imply that the peak option payoff occurs somewhere between three and thirty months. One way of modeling this is through applying a convex multiplier function[18] to the Black-Scholes value that uses time as a simple scaling factor. When this scaling factor is multiplied by Intel's Black-Scholes call value, we arrive at option price estimates more in line with the implications of economic time than the Black-Scholes estimate[19]:

Thirty month horizon: $45 million
Three month horizon: $10 million
Eighteen month horizon: $65 million

Applying a convex multiplier assumes that options are worthless when the horizon is beyond the product cycle- a notion that can be reasonably applied to a case such as Intel's where growth opportunities come as a series of options.

Economic Time Approach: Leakage in Value

When fast-cycle firms are more concerned with convergence than ramping or creating demand, managers can use a modified version of the Black-Scholes that employs a "dividend yield[20]" to decrease option value as time passes. The dividend yield measures how much value disappears as each period passes[21].

$$C_t = Se^{-d(T-t)}N(d_1) - Xe^{-r(T-t)}N(d_2)$$

A dividend yield of 25% yields a 30 month option price of approximately $45 million for the thirty month option and approximately $7 million for the three month option. These figures happen to be in line with what the scaling factors predict- this is not intentional. Managers can determine the dividend yield that deteriorates option value according to competitive dynamics and price erosion.

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[18] This is an arbitrary function multiplier derived to maximize option values at the mid-point of the product cycle, in this case 18 months. Managers can create their own multiplier to fit option payoffs throughout the product cycles of their firm. We expect that for fast cycle firms, scaling factors resemble concave functions such that before and after a certain point, option values are lower because of the challenges of ramping and convergence, respectively. In this case, the multiplier is $(-4/9T_2+4/3T)$.

[19] See Appendix

[20] Martha Amram and Nalin Kulatilaka, Real Options: Managing Strategic Investment in an Uncertain World (131-134), Harvard Business School Press, 1999.

[21] See Appendix

Economic Time Approach: Combined Volatility

Another way to estimate the option payoffs of Intel's growth opportunities is to account for the various forms of volatility that affect cash flows. This approach is appropriate in scenarios where these forms of volatility are important to measure and competitive convergence is not as pressing.

In the example above, Intel's managers only used the volatility of chip prices as an input to the Black-Scholes formula. Yet other forms of uncertainty exist that can be estimated. The demand for personal computers, the relative popularity of Intel chips, and the availability of capacity all play a role in determining the cash flow volatility of Pentium II. The variability of these factors can be combined to arrive at a single volatility input to be used in the Black-Scholes:

$$\sigma^2_{\text{cash flows}} = \sigma^2_{\text{chip prices}} + \sigma^2_{\text{PC demand}} + \sigma^2_{\text{Intel popularity}} + \sigma^2_{\text{capacity}}$$

The applied volatility approach refines the assumptions of the inputs that go into the Black-Scholes model, but does not adjust for the effect of time as the previous two models do.

Real Options for Standard Cycle Firms

Contrast the dynamics of a fast cycle firm like Intel with those of more traditional firms like McDonalds. Scale is basis on which standard cycle firms tend to compete, and rivalry is over extended periods of time. In these traditional, mass markets, and throughout the product cycle, the firm focuses on standards setting and control to help achieve success. Whereas fast cycle management is concerned with innovation, reaction, and flexibility, profits for McDonalds are increased through scalability, productivity improvements, and better scale management. This sort of standard cycle behavior renders real options less valuable.

Options derive their value from the variability of possible outcomes, so the complex scale orchestration driving the competitiveness of a standard cycle company overrides the possibility of making a move with a highly uncertain outcome. Remember that the firm needs to possess the flexibility to capture the real option payoffs. The standard cycle firm is rarely agile enough to make impulsive moves, even upon receiving highly favorable information. It instead concerns itself with extended planning for projects that can be highly profitable only with enough scale.

A critical insight is that scale orchestration constraints increase the perceived risk of real options. Whereas the holder of a stock option can choose not to execute it if it is out of the money, the real option holder may not have the same flexibility. In the same sense a standard cycle firm may not be agile enough to take on profitable growth opportunities, it may also be unable to abandon ones that turn sour. This serves to limit the effectiveness of real options as hedging instruments and decreases attractiveness of options where a high degree of commitment is necessary[22]. We expect this problem to be most prevalent in standard cycle industries.

Furthermore, the managers at standard cycle firms often lack the will or ability to take the risks that come with real option execution and abandonment. Investment and new product development can involve a highly bureaucratic and time consuming decision process. Conflict is certain to arise when resources or attention is diverted from one area of the firm to another. In this sense growth opportunities can be a sort of zero sum game- where one division of the company wins at the expense of another.

This sort of behavior is discouraged in fast and long cycle firms because of intense time pressures and companywide benefits of network effects respectively. Additionally, the organizational cultures that resist change and risk tend to be prominent in standard cycle firms. This prevents the firm from entering new markets or adopting innovative processes in favor of pursuing the stable and predictable strategy of scale management. Think about how the autos and airlines have adapted over the past 20 years compared to the Apples and Nokias. The most notable innovations for standard cycle firms relate to

[22] Pankaj Ghemawat, Commitment- The Dynamic of Strategy, The Free Press, New York, New York, 1991.

new pricing tactics, supply chain management, and investment in productivity increasing capital.

Black-Scholes Approach for Standard Cycle Firms

McDonald's, as the world's largest fast food restaurant, has the option (given its customer base, distribution network, and sites) to introduce new items to its menus. Suppose McDonald's approached its franchisees with the idea of selling pizza, and they overwhelmingly reject it, given the failure of the product in the restaurant during the 1990's. McDonald's is currently considering the repurchase of some of its franchises so that they can be centrally managed and new items can be added to the menu. How should the option to sell pizza in these restaurants be evaluated?

Suppose that the option to add pizza to the menu has expected cash flows of $200 million and the cost of additional investment is $175 million. It assesses a 50% volatility to the cash flows of the 18 month horizon option. The Black-Scholes call price is $64.817 M.[23]

The Black-Scholes model is unable to incorporate the effects of scale orchestration on the ability to execute the option. Pizza takes at least 5-6 minutes to make, while all of McDonalds' other marquee meals can be served in a minute or less. This alienates and confuses the die-hard customer and creates problems with congestion in the restaurant. McDonald's employees are trained to handle a limited range of duties in serving a limited menu. The addition of pizza to the menu adds dimensions of complexity that would increase the time and expense for training significantly.

McDonald's restaurants operate efficiency-engineered processes with the target being predictability. The company derives these processes by aligning demand for various products with the time it takes to serve them. Investing in products with cyclical cash flows is highly interruptive to such standards-driven processes. This problem becomes more obvious when the question is posed: *Is it possible for McDonald's to redesign its kitchens and serving procedures to make it profitable under both conditions of high and low demand for pizza?*

McDonald's restaurants are designed and operated to serve a certain capacity level. Customers frequent the restaurant expecting a very specific level of service. An unexpected shift in demand from the introduction of pizza would throw off serving times, alienating the die-hard customer. Furthermore, McDonalds' suppliers plan their operations with the expectation of certain levels of demand, and would grow agitated with high variability in orders. Thus, the implications to a standard cycle firm of variability in their investment reveals why standard cycle firms are better off avoiding the combination of risky investments with their other products that require extensive scale orchestration.

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[23] See Appendix note 17b

Economic Time Approach: DCF for Premeditated Moves

Rather than model growth opportunities as options, they can be evaluated as strict choices when there is a high degree of uncertainty surrounding occurrence. The DCF of the opportunity is simply the excess of the present value of the cash flows over the cost of the investment. The cost of the investment is certain, so it can be discounted at a risk free rate. This excess equals $37.35 million[24].

This approach does not imply that the standard cycle firm does not consider the possibility of follow-on investments, project abandonment, or launch delays. Nor does it suggest that the cash flows of these real options come with a higher degree of certainty than those of fast and long cycle firms. Rather, these opportunities are seen as *premeditated strategic moves* around which there is reasonable certainty of execution, regardless of information surfacing during the vesting period. Whereas additional variability in the underlying increases the value of the stock option, it often decreases the value of the growth opportunity for the standard cycle firm because of risk-averse preferences. Thus, in the absence of chance execution and diminished cash flow volatility, payoffs from growth opportunities resemble those of normal projects, not stock options, and should be valued using DCF methods.

Economic Time Approach: Cost of Commitment using Binomial Lattices

A second method of incorporating the element of real option commitment is to price the investment as a stock option where the investor does not have the flexibility to not execute an out of the money option (or to execute an in the money option) beyond a certain point. This constraint is congruent with that faced by a standard cycle firm that has a limited time to incorporate new information before commitment is necessary if the investment is to be undertaken.

Consider a simple three-stage binomial model. Between today and the first stage, the firm receives some information about the prospects of its investment. It can act on this information at stage one by deciding whether or not to invest at stage three, the option expiration. Between stage one and three, the firm receives further information about the prospects of its investment but cannot reverse its stage one decision. Applying this approach to the McDonalds case where each stage represents 6 months, the cost of commitment is the decrease in option value, or $51.15-$40.70= $10.45M. Part of the reason the firm incurs this cost is that by committing, it sacrifices the right to act when the option out of the money at stage one ends up being in the money at stage three, or when the option in the money at stage one ends up out of the money at stage three. Losing the right to act on new information is costly.

[24] See Appendix

So	200.000
u	1.250
d	0.800
X	175.000
Pr(u)	0.500
Pr(d)	0.500
Rf	0.025

Exercise	In the Money
Don't Exercise	Out of Money

NORMAL

			390.63
			215.63
		312.50	
		141.77	
	250.00		250.00
	87.00		75.00
200.00		200.00	
51.15		36.59	
	160.00		160.00
	17.85		0.00
		128.00	
		0.00	
			102.40
			0.00

COMMIT

			390.63
			215.63
		312.50	
		141.77	
	250.00		250.00
	83.43		75.00
200.00		200.00	
40.70		29.27	
	160.00		160.00
	-6.57		-15.00
		128.00	
		-42.73	
			102.40
			-72.60

Real Options for Long Cycle Firms

Like all firms, long cycle firms can evaluate real options closely when making capital budgeting decisions. However, the special time dependencies of a long cycle firm like Microsoft or Disney leads to dynamic distinctions that can thwart time decay and foster tie-in with other products.

Isolating Mechanisms, Network Effects, and Tipping:

When the long cycle firm possesses patents, standards ownership, or brand power its growth opportunities are primarily influenced by the strength of these isolating mechanisms. Time is not as pressing a factor as it is for fast cycle firms because convergence can be blocked for extended periods of time. Customers are highly loyal because the lock-in to the platform product makes the costs of switching to competitors' products prohibitive. Even if a competitor releases a superior product at a better price, customers prefer to wait until the follow-on to the platform is released. This leads to "market tipping" to the long cycle firm's platform, while competitors are pressured to pursue other markets and competencies. The importance of isolating mechanisms, network effects, and tipping to the value of growth opportunities is demonstrated in the case of the Microsoft Windows operating system.

Growth Opportunities with Strong Isolating Mechanisms: Microsoft

Microsoft leveraged its standards ownership in the operating system market to lock in customers by employing a staircase strategy. The bundling of spreadsheet software, presentation programs, and personal organizers with Windows served to extend Microsoft's market ownership to new areas and simultaneously increase the value of the operating system platform. In other words, these add-ons formed a link between past and future products that created a lock-in effect for users of Windows. Excel, PowerPoint, and Outlook- all part of Microsoft Office- enhanced the customer experience because of the integration between these programs and others Microsoft includes in its operating systems. Savings or functionality cannot compensate a long time Windows user for the inconvenience of having to switch to Macintosh or Linux programs.

Firms with Strong Isolating Mechanisms Can Fail

Long cycle firms need not possess the same level of market ownership as Microsoft in order to have successful follow-on projects. It is the strength of the relationship between the isolating mechanism- be it a patent, monopoly, or other intangible- and the growth opportunity that delivers the option payoff. Firms with strong isolating mechanisms can produce money losing projects if the project doesn't align with the firm's power.

In the 1980's Disney's shareholder value increased significantly following the success of follow-on projects to popular movies such as video releases, merchandise, and character rights. Yet one particular investment in 1992 was not so successful. EuroDisney opened to disappointing crowds near Paris- 500,000 visitors were expected on the first day and barely 50,000 people showed up. The park recorded major losses throughout the past decade, and it has become apparent that the magic of Disney in America does not carry similar weight in France.

One isolating mechanism Disney projects possess is the special magic of its characters and theme parks has that been driven into the minds of Western youth for the past half century. The peak of American childhood is often cited to be the trip to Disney. Only in the past decade or so has Disney made a substantial effort to reach foreign audiences, so Disney's magic has yet to manifest. In fact, the opening of Euro Disney was marked by protests from French citizens concerned that the new park was imposing upon their unique way of life.

The lesson here is that isolating mechanisms, especially abstract ones tied to culture and identity, take a considerable time to develop and are not quickly transferred across borders and markets. While Disney has successfully launched follow-on projects that extend from merchandise to home video releases to Broadway musicals, each of these options have a strong uniting quality: they existed in a context that allowed for the aura and extension of Disney's magic from a movie to a new venue.

Black-Scholes Approach for Long Cycle Firms

Let's take a look at how Disney can evaluate real options to make better capital investment decisions in the future. At one point Disney faced the decision of whether to commence production of the Lion King movie. If the movie is released, a Lion King franchise will develop that includes a Broadway musical follow-on with cash flows of $200 million, investment of $175 million, variability 50%, and release date 18 months from today. This implies a Black-Scholes call value of $64.817 million[25]. Under the traditional option pricing method, Disney may or may not take on the investment depending on the NPV for the film and the value of other options embedded.

Black-Scholes is inappropriate here to the extent that it leads managers to stop once the follow-on payoff is calculated, when, in fact, significant other payoffs may exist. It also suggests that the long cycle firm is entitled to option payoffs when competition may collect the profits because the firm is employing a poorly aligned strategy. Recall the case of EuroDisney- where the company owned all aspects of the Disney franchise but chose an unsuitable market for expansion. The growth opportunities of long cycle firms are largely determined by tie-in to marquee platforms.

Economic Time Approach: Payoffs Triggered by Tipping

The most distinctive feature of long cycle management is the absence of competition upon the market tipping in the firm's favor. Once that occurs, the firm focuses on employing staircase strategies to capture as much profit as it can with its isolating mechanisms in place. This factor helps drive two key differences between stock and real options that help us identify models for pricing long cycle options. First, volatility is not

[25] See Appendix

constant. Before tipping, investment payoffs are much more uncertain than after tipping. Second, changes in the underlying are not continuous. At the tipping point, the value of future growth opportunities is likely to incur a discrete rise or decline. This makes far out of the money options more likely to revert to producing payoffs than they would have otherwise.

Disney can estimate payoffs from the Lion King by breaking its growth opportunities into pre and post tipping periods and reconsider Black-Scholes inputs accordingly. Before the tipping point, expected cash flows may be low but volatility is likely to be quite high. After the tipping point, the cash flows (high if the market tips in the firms favor and low otherwise) are much less volatile because isolating mechanisms will be strong. Suppose post-tipping point Disney's cash flows will be $400 million in the favorable scenario and $125 million otherwise, with 15% volatility. This implies the $64.817 million pre-tipping estimate should be revised to approximately $240 million if the market tips in Disney's favor and $1 million if it does not[26].

Economic Time Approach: Decision Trees

A related approach that can be applied when tipping causes significant network effects is modeling option payoffs with decision trees. The payoff of a staircase strategy is conditional on the performance of the platform. This is consistent with the assumption Disney's staircase strategy (movie sequels, merchandise, and Broadway musicals) are follow on projects of a highly successful Lion King film. If the original film is a flop, these projects have very little chance of making money. It is also likely that if the firm has strong isolating mechanisms and the film is a success, expected cash flows of growth opportunities will be easier to predict than before the tipping point. The manager can replicate these outcomes using a decision tree with real world probabilities and expected payoffs that are conditional on the success of the original film.

Summary

What we have sketched here are modifications to option valuation procedures that can navigate corporate finance and competitive strategy. In modern competitive markets the goal is to assist in generating robust valuation estimates in complex dynamic settings. While real options provide the firm with flexibility to adapt to changes in its environment, we have suggested how real options can be more fully realized by dynamically-sensitive approaches that complement traditional payoff estimates.

This paper reviewed commonly used methods for valuing real options against the method of economic time. Although somewhat rudimentary and speculative, recognizing broad dynamic distinctions in competitive strategy payoffs as suggested here are a step toward augmenting traditional options approaches so as to better evaluate increasingly diverse, dynamic competitive outcomes.

[26] See Appendix

OPTIONS PRICING OF DYNAMIC STRATEGIES
APPENDIX

Note 17:

With S= \$200M
X= \$175M
r= 5%
σ= 50%

T= .25 years (a) 1.5 years (b) 2.5 years (c)

Call Price = (S) x $N(d_1)$ - Xe^{-rT} x $N(d_2)$

a) \$35.185 M
b) \$64.817 M
c) \$79.973 M

Note 19:

With T= .25 years (a) 1.5 years (b) 2.5 years (c)

Scaling Factor = $(-4/9T^2+4/3T)$

a) .305555
b) 1
c) .555555

Note 21:

Suppose Intel knows that Pentium II will be unaffected by convergence for X periods. The cost of delay is 1/X per period.

Value of call = Se^{-yt} N(d1) - Xe^{-rt} N(d2)

Where
y = dividend yield = dividends/current value of assets or 1/X periods of "protection"

Note 22:

With S= \$200M
X= \$175M
r= 5%
σ= 20%
T= 2 years

Call Price = (S) x $N(d_1)$ - Xe^{-rT} x $N(d_2)$
= \$72.889 million

Note 21:
$C_t = Se^{-d(T-t)}N(d_1) - Xe^{-r(T-t)}N(d_2)$

Assume a $50 dividend paid on a $200 option, or a 25% dividend yield. For the thirty month option, we priced the call assuming that the dividend would be paid in the third month of the year. For the three month option, we assumed the dividend would be paid immediately before expiry.

Note 24:
$200 million- $175 million/$(1+.05)^{1.5}$ million= $37.35 million

Note 26:

With T= 1.5 years
X= $175M
r= 5%
σ= 15%
S= a) $400 million b) $125 million

Call Price = (S) x $N(d_1)$ - Xe^{-rT} x $N(d_2)$
a) $237.645 million
b) $.909 million