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RESEARCH NOTES AND COMMENTARIES

OPTION VALUE AND ENTRY TIMING

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When facing uncertainty, firms entering new markets can make initial foothold investments rather than undertake large sunk investments. Such investments are real call option purchases. They offer management flexibility, but also raise questions about whether and when to increase commitments to new markets. We present an entry timing decision criterion and discuss its application to a variety of market entry situations. Optimal timing for exercising real options depends on current dividends, possibilities for preemption, and whether the option is simple or compound, proprietary or shared. Our analysis reveals critical assumptions and new theoretical insights regarding market entry timing. Copyright © 2002 John Wiley & Sons, Ltd.

The timing of market entry decisions is a central concern of business strategists. At the heart of these decisions are trade-offs between commitment and flexibility under uncertainty (Ghemawat, 1991). Entry commitments involve sacrificing flexibility and increasing exposure to the uncertainties of new markets. Research on real options has contributed to our understanding of the considerations surrounding entry timing by elaborating the value of waiting (e.g., Ingersoll and Ross, 1992; McDonald and Siegel, 1986; Trigeorgis, 1991). A fundamental conclusion from this research is that, under uncertainty, deferring sunk commitments can enhance the expected values of investments. If the value of waiting exceeds the benefits from moving quickly, delaying entry enhances firm value.

Here we focus on the decisions of firms holding real options conferring opportunities to enter new product and geographic markets. Table 1 provides some examples of market entry call options. The underlying assets associated with real call options are nonfinancial resources. Throughout this paper, we maintain the conceptual distinction between real options, which are *rights*, and their underlying *resources*. By purchasing a real option, the firm defers resource acquisition until some future time. The subsequent decision to exercise an option involves striking the option by making the sunk investments necessary for resource deployment and full market entry.

This paper has several important objectives. First, we clarify some key underlying assumptions

Key words: real options; entry; timing; preemption; flexibility
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Table 1. Examples of real call options

Investment providing the entry option	Nature of option	Benefits from exercising the option	Exercise price	Factors affecting duration
License to commercialize technology	Right to commercialize technology in a geographic area	• Stream of cash flows from commercialization • Manufacturing experience • Marketing experience • Distribution experience	Cost of manufacturing, marketing, and distribution	• Patent time limit • Availability of substitutes
Equity stake in partner	Right to acquire partner	• Cash flows • Capabilities of partner	Cost of acquiring partner	• Takeover bid by another partner or outside firm
Underutilized foreign capacity	Right to grow the business in country	• Cash flows • Experience in country	Cost of incremental production	• Entry by competitors • Expiration of host country investment incentives
R&D capability	Right to develop and commercialize technology	• Cash flows • Technology	Cost of implementing technology	• Competitors' replication or substitution of R&D capabilities

about real options as applied to strategic management. This is an important contribution because the vast majority of real option research has evolved from finance. Moreover, most related work in strategic management has used real options as a metaphor. This has been an effective way to initiate discussion of real options, but it leaves room for developing models generating refined insights. A second contribution is that we integrate previous real option research into a general framework that expresses the incremental value of moving from flexible positions to sunk investments in new product and geographic markets. Finally, we provide guidance for applying real option reasoning to strategic management practice and identify directions for further research.

The next section provides a precise specification of the entry timing problem for a firm holding an option to enter. This theoretical understanding of the entry timing decision lays the groundwork necessary to explore how key option characteristics affect entry timing. Exercise timing is affected by whether the option to enter is (1) susceptible to preemption, (2) simple or compound, and (3) proprietary or shared. The final section of the paper discusses our findings and their implications.

THE OPTION EXERCISE DECISION

At its core, the real option perspective is like other theories of investment in that it is concerned with identifying the factors that influence the investor's threshold—the point at which investors choose whether to invest or not. What makes the real option perspective distinct is that it seeks to establish this threshold while acknowledging that entry investments are not fully reversible. This assumption is critical because if investors cannot fully recover sunk costs, the initial investment decision depends on expectations about uncertain future cash flows.

This section identifies the parameters for entry decisions by firms holding real options. We introduce a function capturing the incremental value of moving from holding an option to actual entry (the exercise of the option). This function provides a framework for analyzing various kinds of options in the next section of the paper.

Consider the decision managers face after purchasing a call option conferring the right to buy the resources needed to enter a market. Let C represent the value of the call option. If the firm chooses to exercise the option, it pays an exercise price and gains a series of cash flows. Let X represent the option exercise price necessary for entry. We can categorize the potential cash flows resulting from exercising the option according to two time periods: (1) cash flows over the remaining option duration period and (2) cash flows after the option expiration date. Corresponding to the first time period, let D designate the present value of foregone dividends. Dividends are cash flows that are realized *only* if the option is exercised prior to its expiration date. Corresponding to the latter period, R_T indicates the discounted resource value at the option expiration date (T).[1] The incremental value associated with moving from holding the option to exercising the option is $V = D + R_T - X - C$.[2] Subtracting the value of the call option, C, acknowledges the opportunity cost associated with striking the option. A firm that overlooks this opportunity cost would have a much lower threshold value of cash flows (D and R_T) needed to motivate market entry.

V is the *incremental value* associated with moving from the option position to the sunk investment. For simplicity, we refer to V as the 'value function,' although it might be more descriptive to call it the 'incremental value,' 'commitment value,' or 'exercise value' equation. The value function is a precise mathematical identity reflecting the change in firm value associated with moving from a flexible call option position to sunk commitment to a market.

A firm holding a call option also faces an opportunity cost for delaying entry. This opportunity cost is reflected directly in the value function as dividends (D), i.e., cash flows that the organization realizes only if the firm enters the market by exercising its option prior to the expiration date. Assessing the potential to generate dividends has been the primary focus of strategy research on entry timing. Dividends may reflect competitive advantages gained from moving early (Lieberman and Montgomery, 1998). Over time, an organization's ability to learn about a technology or a market enhances dividends (Roberts and Weitzman, 1981).

In the absence of dividends, the value function simplifies to $V = R_T - X - C$. Under uncertainty, the value of the call option will always exceed the net value of exercising the option, i.e., $C > R_T - X$. Only as the option is about to expire do the call option value and the value of exercising the option converge, i.e., $C = \max[R_T - X, 0]$. As such, in the absence of dividends, it is optimal to delay exercising the call option as long as possible. This contention corresponds to Merton's (1973) proof that one should never exercise an American option prior to its expiration date. Without dividends, uncertainty unequivocally increases the value of the option relative to an irreversible investment. If we make the alternative assumption that holding the option requires forgoing current dividends associated with the underlying asset, then the conclusion that waiting is preferable to exercising the option no longer holds universally. In this case, it is quite possible that $D + R_T - X > C$, and exercising the option becomes reasonable.

Dividends enter the value function at two points. They appear (1) directly in the dividend term, D, and (2) indirectly through the value of the underlying resource associated with the call option. The relationship between dividends and the value of the call option's underlying resource is best understood by direct comparison with financial options. The holder of a call option on a financial asset, such as a stock, receives dividend payments only after exercising the option. If a dividend payment occurs while the option remains unexercised, the dividend is permanently lost (from the standpoint of the option holder). Furthermore, the value of the call option's underlying stock falls by an amount equal to the dividend. The ex-dividend stock value fully reflects the dividend payout. The call option value also drops by the full amount of the dividend payout.

When is the optimal time to exercise the option to enter a new market? The optimal exercise date is when the present value of V reaches a maximum. If we make the simplifying assumption that the value function is strictly concave, there is a unique solution to the optimal exercise timing problem. This occurs when the rate of appreciation of the value function equals the appropriate risk-adjusted interest rate ($\mathrm{d}V/\mathrm{d}t = r$).[3]

[1] The appropriate discount rate for determining the present value of D and R_T is the risk-adjusted rate specific to the cash flows associated with the resource.

[2] To simplify notation, we have not included time subscripts, yet the reader should recognize that the value of each of these variables varies over time.

[3] The terms in the first-order condition $\mathrm{d}V/\mathrm{d}t = \mathrm{d}D/\mathrm{d}t + \mathrm{d}R_T/\mathrm{d}t - \mathrm{d}X/\mathrm{d}t - \mathrm{d}C/\mathrm{d}t = r$, can be rearranged as $(\mathrm{d}D/\mathrm{d}t +$

The value function, V, could take a variety of paths over time. Its path may be concave or convex. V may suddenly jump or fall. Discontinuities in the path of V may be due to events such as the exit or entry of a competitor, a technological breakthrough, or a change in government policy. Regardless of the nature of the path, managers can add the greatest value to their firms by planning entry for the time that maximizes the present value of V.

We introduced the value function in order to precisely frame the challenging problem of optimal entry timing for firms holding real call options. In the remainder of this paper, we apply this framework to generate new theoretical insights and guidance for managers.

OPTION CHARACTERISTICS AND ENTRY TIMING

Although the variables in the value function are financial values, the factors determining these values are strategic in nature. This section highlights three general categories of strategic considerations affecting exercise timing: (1) the threat of preemption, (2) whether the option is simple or compound, and (3) whether the option is shared or proprietary. Each of these factors bears directly on the value function components and, as such, entry timing. We explain the nature of these effects. Our analysis reveals unstated assumptions in previous work linking strategic management and real option research. We also derive some novel contentions.

Preemption

Preemption generally refers to strategic investments that reduce the value of competitors' dividends. When viewed from an option perspective, we must add that preemption also includes strategic investments that reduce the value of competitors' real options. Rivals may act preemptively in ways that increase the cost of subsequent entry (i.e., increase the exercise price) or preclude further investment, causing other firms' call options to expire. If managers are able to predict such investments by rivals, they can choose whether to exercise an option in anticipation of rivals' actions.

Under the threat of preemption, the decision rule for optimal exercise timing remains the same as that derived earlier for dividend paying assets, namely, enter at the time that maximizes the present value of $V = D + R_T - X - C$. Any or all of the components of the value function may change due to rivals' preemptive actions. In this section, we explain some subtle, but important, implications of preemption for firms' incentives to exercise their options to enter.

Smit and Ankum (1993) considered the valuation of real options under alternative assumptions regarding market structure. A call option on a monopoly position is analogous to a call on a stock with a constant dividend payout ratio. Under competition, the dividend payout erodes as rivals enter the market. Optimal timing requires waiting until just prior to a rival's investment to exercise the option. This timing keeps the option alive for the longest possible time, yet avoids the loss of dividend and call option value associated with the rival's entry. Because the entries of various rivals will have differential effects on project value, it makes sense to key timing decisions to the entries of those firms that will have the greatest effect on total project value.

Treatments of preemption in the real options literature assume individual firms seek to time entry investments in ways that maximize their own value. It may also be insightful to consider two alternative decision rules: (1) entry timed to maximize own-firm value relative to that of a rival firm and (2) collusion to maximize total industry value. To illustrate the implications of maximizing relative value, consider a firm i that seeks to maximize total project value relative to rival firm j. Firm i's value function is as before, $V_i = D_i + R_{Ti} - X_i - C_i$, and that of firm j is similar. Firm i seeks to maximize $V_i - V_j$. If we assume that the two firms face equivalent resource values at the option expiration date and also face the same exercise prices (i.e., $R_{Ti} = R_{Tj}$ and $X_i = X_j$ in each period t), then the objective function simplifies to $\max[(D_i - D_j) - (C_i - C_j)]$. That firms

$dR_T/dt - dX/dt) = r + dC/dt$. The left-hand expression indicates the marginal increase in firm value from making the sunk resource commitment. The option will be exercised if this is at least equal to the risk-adjusted discount rate plus the marginal change in call option value.

For simplicity, we assume that a common risk-adjusted rate applies to the resource cash flows (D and R_T), exercise price, and call option. Alternatively, we could allow for different discount rates for each of these components of the value function. Allowing for different discount rates for each component, we can still compare the present values of $V = D + R_T - X - C$ over the time horizon of the option to determine the optimal exercise date.

would seek to time entry based on their current dividends relative to those of rivals is not novel. What is unique to this formulation is the incorporation of own-firm and rival's call option values. Under this decision rule, early exercising of an option may occur in order to reduce rivals' option values. This is a novel motivation for preemptive investment that has not been explored previously.

Firms that do not hold options and have no intention of entering a market may, nevertheless, signal their intent to enter as a way to force premature exercising of options by rivals. Although such signaling does not directly enhance own-firm value, competitors responding to this signal by exercising their options forfeit option value. Hence, signaling the intent to preemptively enter enhances relative competitive position by reducing the value of competitors' options.

It is possible that payments could occur among rivals to avoid preemption. If firm i sought to maximize its relative value at some time t, firm j may be willing to buy out firm i's option. Firm j would do so if its optimal timing at some future period t^+ would result in greater value than firm i's investment in t. That is, if $\{[D_i(t) - D_j(t)] - [C_i(t) - C_j(t)]\}$ is less than the present value at t of $\{[D_j(t^+) - D_i(t^+)] - [C_j(t^+) - C_i(t^+)]\}$, then firm j would be willing to pay firm i as much as the difference between these amounts to induce firm i not to preemptively exercise its option at t. If this increase in value is greater than the loss of relative value to i between t and t^+, there would be a mutually beneficial trading opportunity to delay exercising options until t^+.

Alternatively, if firms sought to maximize the collective value of their holdings, the optimal timing would maximize the present value of $\Sigma_i V_i$ over all firms $i = 1, \ldots, n$. If we make the simplifying assumption that resource values at the end of the option term, R_{Ti}, are fixed and exercise prices, X_i, appreciate at a rate equal to the discount rate, the critical issue becomes the trade-off between aggregate current dividends and option value. Compared with a competitive environment in which the first firm to reach their maximum individual value $(D_i - C_i)$ would determine the entry time for all investors, a collusive arrangement delays entry. Hence, real option reasoning motivates analysis of delayed entry as collusion to optimize aggregate value, including option value.

Our observations shift strategy discussions of preemption from their exclusive focus on dividends to considering dividends and option values together. Under joint consideration of dividends and option values, several possible objectives may be reasonable: (1) entry may be timed to maximize the firm's own value by preempting rivals; (2) entry may be timed to maximize own-firm value relative to a competitor's value; or (3) entry may be timed to maximize the aggregate value of the industry. The latter two cases present possibilities for side payments to induce rivals not to move preemptively.

Compound options

Real options commonly have other options, rather than dividend-generating resources, as their immediate underlying assets. Compound options involve complex series of nested investments. Often strategic investments in new products and geographic markets are of this sort. Initial foothold investments confer privileged access to information and opportunities for future investments. These investments may take the form of further product development stages or investments toward product commercialization. The term 'compound option' distinguishes such multistage investments from 'simple options' on resources. Portraying multistage investments as options within options is a way to conceptualize the interdependencies associated with strategic decisions regarding path-dependent resources. For example, Kim and Kogut (1996) addressed situations in which entry into one technological subfield provides a platform into another subfield. In their model, firms must follow a specific sequence of investments in order to gain access to future growth opportunities. Firms lacking these platforms fail in their attempts to enter new markets.

The multistage nature of many real options affects exercise timing. However, the nature of these effects is not all that apparent. A critical question to ask is: if maintaining maximum flexibility adds to the value of compound options, why do we observe firms making successive investments in uncertain technologies and markets over time? Although it is true that the firm will eventually reach the point of deploying the underlying resource, it is not apparent why they would extend these successive exercise decisions over time rather than making them as rapidly as possible once they are ready to begin generating dividends. Either the firm should realize *none* or *all* of the compound option investments. There does not seem to be a compelling argument for partially exercising a compound option. Here we explain the key assumptions that lead to sequential exercise decisions for compound options.

The value of a compound option is, in part, a function of the value of the embedded option. Holding other relevant variables constant, we can represent the value of a two-stage compound call option as $C = f(G)$, where the value of the first-stage option (C) is an increasing function of the value (G) of an embedded option. We use the notation G to indicate a common type of embedded option, namely, a growth option; however, G could be interpreted as any type of real option.[4]

If the exercise price is fixed, an option on an option is always at least as valuable as exercising the option and holding the underlying simple option.[5] If the exercise price is not fixed, an option on an option is still more valuable than exercising the option and holding the simple option if movements in the exercise price do not fully reflect movements in the value of the embedded option, e.g., when $X_C = \alpha G$ where the parameter α is less than 1. This could occur if the firm has unique knowledge about how to combine inputs to form the growth option. In such a case, movements in the exercise price (X_C) and the growth option price (G) are largely independent. If $\alpha = 1$, management would be indifferent between holding the compound option and the simple option. If $\alpha > 1$, management would prefer to exercise the first-stage option and hold the underlying option.

We argued earlier that for a simple option, exercise timing is accelerated by potential dividends. However, forgone dividends are not a relevant consideration if exercising an option simply leads to holding an embedded option paying no dividends. Therefore, the potential to enhance option value, or avoid the loss of option value, by preempting rivals must be the *sole* motivation for exercising compound options. Preemptively exercising a compound option may lock in access to scarce information or resources relevant to the next investment stage.

There are many examples where preemption explains sequential investments in compound options with no possibilities to realize positive current dividends. Consider, for example, the willingness of firms to make foothold investments in uncertain developing country markets where early commitment confers privileged investment terms relative to later entrants. Another example is a firm that makes sequential R&D investments in pursuit of a technology that is patentable, but may have no current commercial application.

A key assumption related to the preemption motive for sequential investment is that uncertainty must, at least in part, be subject to managerial control. This is quite distinct from the assumption in financial option pricing models that the option holder does not influence uncertainty. Managers often perceive themselves as controlling key variables determining the risk of their investments (MacCrimmon and Wehrung, 1986; March and Shapira, 1987). In his discussion of real option reasoning, Folta (1998) applied the terms 'endogenous' and 'exogenous' to distinguish the dimensions of uncertainty managers can control from those they cannot. The possibility of preempting rivals presupposes that some aspects of the uncertainty surrounding compound options are subject to managerial control. To the extent that uncertainty can be reduced and uncertainty reduction enhances value through preempting rivals, managers should accelerate their multistage investments relative to when uncertainty is beyond managerial control. This motivation is distinct from the rationale for exercising simple options discussed earlier (i.e., seeking current dividends and enhanced resource values).

A related motivation for accelerating investments in multistage compound options is preservation of option value, as contrasted with the value enhancement motivation just discussed.[6] This occurs in industry contexts where early exercise of compound options does not confer any particular advantage, but moving late places a firm at a competitive disadvantage, or may preclude entry entirely. Such is the case when failure to make critical investments in a timely manner results in technology lockout (Ghemawat, 1991). For example, consider the multistage competition associated

[4] Geske (1979) provided solution techniques for deriving the values of two-stage compound options.

[5] This is a logical extension of Merton's (1973) earlier cited conclusion regarding simple options.

[6] We thank an anonymous reviewer for this insight.

with the emergence of a new industry. The first stage investment involves product research and development investments. As competitors begin to move toward investments designed to establish their product technology as the industry standard (through alliance formation or lobbying activities), it may be essential to move to this second stage investment to preserve the value of the future growth opportunity. Similarly, competitors' moves to production technology development may necessitate investment in this area by others in order to be prepared to enter the market in a timely manner. In each stage, preserving growth options, rather than enhancing their value, motivates subsequent stage investments.

This discussion of compound options has yielded several important insights relevant to strategy, and specific to entry timing. We identified the conditions when embedded options with variable exercise prices increase in value with uncertainty. We established that the potential to preempt, or avoid being preempted, is essential to motivate sequential investments under uncertainty. Furthermore, the feasibility of preemption presupposes uncertainty is, at least in part, subject to managers' control.

Proprietariness

Kester (1984, 1993) highlighted the contrasting nature of financial options, which are proprietary, and real options, which are often shared. Proprietariness refers to the degree of exclusivity of a holder's claim to an option. 'Shared real options can be seen as jointly held opportunities of a number of competing firms or of a whole industry, and can be exercised by any one of their collective owners' (Trigeorgis, 1996: 143). Strategic alliances may produce shared growth options. Technologies generated by the alliance provide the bases for future business opportunities.

Proprietariness and preemption are distinct. Proprietariness deals with conflicting rights to a particular option. By contrast, preemption reduces option values, but not option rights. When we speak of nonproprietary (shared) options, there is an implicit notion that some firms have inside positions relative to outsiders who hold no option claims. Hence, even shared options have some degree of exclusivity—but it is exclusivity in terms of a set of firms. Privileged access to information and defined property rights limit the set of firms sharing a real option.

The key issue of interest to strategists—and unaddressed in the existing real options literature—is whether shared real options can enhance the value of any given firm. Here we address this issue.

A shared option is a local public good, equally available to all who share joint ownership. A shared option has the potential to add value to the set of owners *vis-à-vis* outsiders but no individual firm among those sharing ownership can fully appropriate this value. Consider the growth option associated with technology shared among firms in an industry. Acting collectively, the joint owners of the option should follow the optimal timing guidelines derived in the previous subsection to maximize the value of the technology for the collective. However, divergent interests among industry rivals would speed up exercising the option relative to the optimal timing under collusion. Competitive firms, seeking to optimize the values of their own holdings, incorporate expectations about preemptive moves by other firms into exercise timing decisions. If we were to assume that firms sharing the option are homogeneous, competition would result in exercising options as soon as the present value of expected cash flows exceeds the call option value, i.e., $D_i + R_{Ti} - X_i > C_i$ for all firms i. Here, each of the valuation parameters is a function of the interdependent strategic moves of industry rivals. Simultaneous moves to exercise the shared option eliminate potential added value for the industry.

Because preemptive exercising of shared options reduces potential returns, one of the holders of a shared option may seek to purchase the option rights of the others. Turning a shared option into a proprietary option requires a competitive bidding process. Following Barney's (1988) logic, if such bidding processes are efficient, returns from internalizing shared options should be reduced to the normal (risk-adjusted) rate. The only difference between internalizing a shared option and acquisitions in general is that in the case of shared options there is a set of bidders with inside information about the acquisition candidate. This limits the set of potential bidders for shared options, but may do little to reduce the competitiveness of the bidding.

An alternative approach to assigning proprietary rights to shared options is buyout options among firms sharing options. Partner buyout clauses in alliance agreements clarify property rights for shared options, effectively embedding the shared option in a proprietary compound option (i.e., an option on the shared growth option). Some joint venture partners have taken this approach by defining the terms for partner buyouts in their venture contracts (Kogut, 1991). A necessary condition for partners to enter into buyout option agreements is that they expect partners' valuations of the shared option may diverge at some point in the future (Chi and McGuire, 1996).

Because explicit buyout terms for shared options are rare in partnerships and nonexistent among industry rivals, it is worthwhile considering whether there may, nevertheless, exist implicit buyout options among partners. Hurry, Miller, and Bowman (1992) and Hurry (1993) contended such implicit buyout options exist and have strategic implications; that is, they have the potential to add value to the buyout option holders. However, in the absence of explicit buyout terms, the exercise price and duration are determined endogenously by the firms holding the shared option. This raises the question of whether implicit buyout options exist and have value. Chi (2000) recently addressed this issue by providing a real option analysis of joint venture partner buyouts considering both the case when an exercise price is specified *ex ante* and the case when it is determined through *ex post* bargaining.

Among heterogeneous firms sharing an option, the firm willing to outbid all other option holders possesses an implicit buyout option. Such a firm must have inside information or complementary resources that cause it to assign a value to the shared option that exceeds the value to other bidders. Because the valuation of the shared option by other option holders varies over time, the high bidder faces a moving exercise price for making the option proprietary. Let C_C and X_C designate the buyout option value and exercise price. C is the value of the call option when converted from shared to proprietary. The optimal timing for buying out the other option holders is when the rate of appreciation of the function $C - X_C - C_C$ equals the risk-adjusted interest rate (and $C - X_C - C_C > 0$).[7] Once a buyout has taken place, the optimal timing problem reverts to that of a proprietary simple option.

In this discussion of proprietariness, we considered three strategies firms may consider when seeking to capture economic value from shared options: (1) early exercise to preempt the exercise decisions of other option holders, (2) converting the option from shared to proprietary by buying out the other option holders, and (3) holding an implicit buyout option. Our evaluation indicates limited potential for adding value through such strategies due to competitive responses and bidding processes among the option claimants. Firm-specific complementary resources, rather than the shared options themselves, are the sources of enhanced firm value.

DISCUSSION

This study formulated the market entry problem in terms of call option exercise timing. In doing so, we highlighted some critical assumptions regarding the determinants of the time-paths of the values of strategic commitments. Dividend payouts, preemption opportunities and threats, the presence of embedded options, and whether the options are shared or proprietary are key determinants of optimal exercise timing. We showed how all of these disparate considerations could be analyzed in terms of the incremental value associated with exercising entry options. Our parsimonious decision rule—maximize the present value of $V = D + R_T - X - C$—encompasses the complexities associated with market entry investment timing considerations. This decision rule draws attention to the opportunity cost (i.e., the loss of call option value) associated with moving from positions of flexibility to sunk commitments. Our approach to the option timing problem encompasses a broad set of considerations raised in previous strategic management and real option discussions.

Table 2 provides a summary of key entry timing considerations relevant to firms holding real call options. High current dividends, residual resource value, and interest rate increase the likelihood of entry. High exercise price and call option value deter entry. Of course, 'high' is a relative term. In this case, we refer to comparisons relative to discounted expected future values of these variables. The table summarizes factors that are positively and negatively related to each of the

[7] As before, we assume this is a strictly concave function so that there is either a unique time at which $\mathrm{d}(C - X_C - C_C)/\mathrm{d}t = r$ or a 'corner solution' at the time of expiration of the first stage of the compound option.

Table 2. Determinants of entry speed

Accelerators	Decelerators
Current dividends (D)	*Exercise price (X)*
+ Market size	− Proprietariness
+ First-mover advantages	− Partner buyout options
+ Learning opportunities	
Residual resource value (R_T)	*Call option value (C)*
+ Uniqueness of resource	+ Exogenous uncertainty
+ Durability of resource	− Threat of preemption
+ Transferability to other markets	+ Unique complementary resources
Discount rate (r)	
+ Risk-free rate	
+ Risk premium	

value function variables and the interest rate. For example, exogenous uncertainty and unique complementary resources are positively related to call option value, while the threat of preemption is negatively related to call option value. The factors highlighted here provide guidance for structuring qualitative and quantitative analyses of market entry timing decisions. They are also testable propositions for future research on market entry timing.

In our discussion of preemption, we argued that firms seeking to maximize their own value relative to competitors may do so by forcing competitors to exercise options prematurely. Entry or simply the credible threat to enter may be sufficient to cause rivals to exercise their options, thereby forfeiting option value. This is a novel explanation for signaling intended entries that are never completed. Of particular interest in this regard would be instances when intentions to enter through greenfield investment are signaled to competitors and then not implemented, or when unsuccessful bids are made for acquisition candidates resulting in competitors acquiring the candidates. Such actions cause competitors to kill their options to wait to acquire. Another intriguing idea is the possibility that delayed entry may evidence collusion to increase collective option value.

Recognizing the value of holding options motivated the question: why do we observe races to exercise compound options? Do such investments express blatant disregard for the value of flexibility? We argued that they do not. Rather, value enhancement through preemption in multistage investments may overshadow the loss of flexibility with each successive investment. For first- or early-movers enhanced option value arises from preemptive advances through path-dependent sequential investments. Early movers may control both the uncertainty they face (through their capabilities to learn), and the pay-offs associated with alternative outcomes (through their abilities to determine industry standards and technological trajectories).

We were careful to distinguish shared options from buyout options. Applying option reasoning to partner buyouts requires careful specification of which partner holds the call option. Whether an explicit exercise price is prespecified is critical to buyout option value (Chi, 2000). Although buyout options are sometimes assumed to exist among partners with shared options, we argued that an implicit buyout option can only have value when partners are heterogeneous. Furthermore, an implicit buyout option can only have positive value for the firm with the *highest* value-adding complementary resources. Partner buyout options are most valuable in contexts where explicit contractual agreements limit the exercise prices (Kogut, 1991), partners are heterogeneous (Chi and McGuire, 1996), and there are few partners (resulting in limited competition to bid up the exercise price).

It follows that real options explanations for alliance formation and dissolution (e.g., Hurry, Miller, and Bowman, 1992; Kogut, 1991) may be less compelling than applications of real options in contexts that are proprietary, such as internal R&D. For an internal venture, the firm faces an exercise price that is determined by the technical characteristics of the project itself. By contrast, in the context of alliances, implicit buyout options are exercised at prices that result from bargaining processes involving two or more partners. Just as firms may want to move away from alliances in their search to capture option value, strategy researchers may do well to move away from their focus on alliances to test real option propositions.

The extent to which managers explicitly or implicitly make entry decisions consistent with the guidelines offered here remains an open issue for future research. If managers are going to make timing decisions, they must have some basis for formulating expectations of the time paths of the four value function components and the option

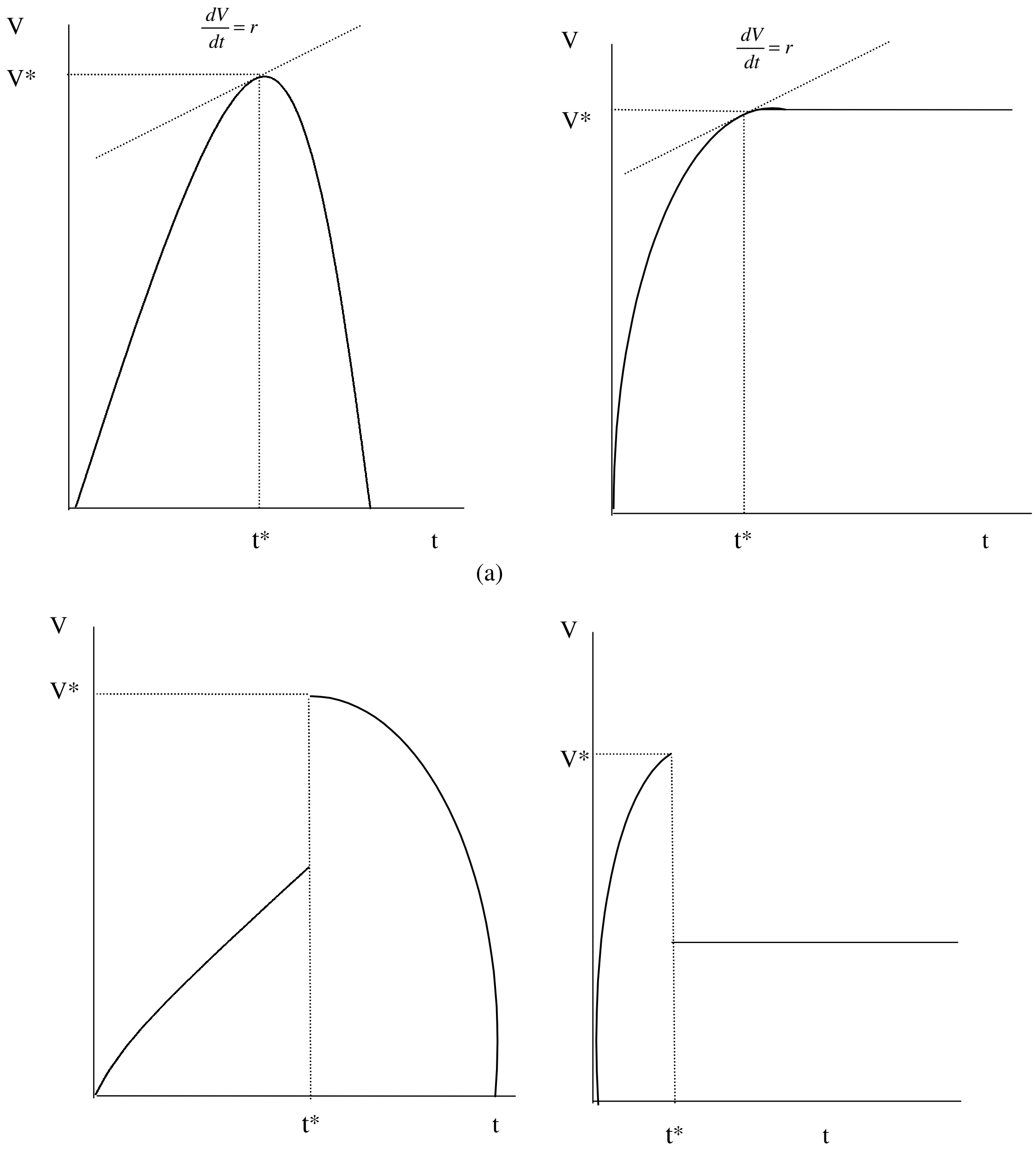

Figure 1. Value functions resulting in robust timing decisions

duration. Uncertainty around these expectations makes the use of risk-adjusted interest rates appropriate for comparing the present values of exercising the option at different points in time.[8] If managers are unable to quantify the components of the value function, this function may, nevertheless, serve as a general framework for qualitative analysis of the factors contributing to the relative value of committing vs. maintaining a flexible real option investment position. Table 2 could serve to structure such a qualitative analysis.

The sensitivity of timing decisions depends on the shape of the value function over time—in particular, its slope and whether the function is continuous or discontinuous. The first case in which

[8] If managers could perfectly predict the time path of V, the risk-free rate would be used for determining the exercise date.

we will have robust timing conclusions is the case of the 'steep' value function that suddenly plateaus or begins to decline. Here the value function slope exceeds the discount rate ($dV/dt > r$) up to the optimal entry point, then it soon drops to less than the discount rate. Two possible cases fulfilling these conditions are portrayed in the upper portion of Figure 1. The optimal time to exercise the option is at t^*, when committing to the market will add V^* to the value of the firm.

The two cases shown in the lower portion of Figure 1 illustrate how discontinuities can affect optimal entry timing. The possibility for discontinuities in the value function points out how qualitative assessment of future scenarios informs entry timing decisions. In many instances the choice of the discount rate may be less crucial than the identification of investment 'trigger events.'

Finally, in order to narrow the scope of this study, we focused on call options. Subsequent research may examine the timing of put (abandonment or shutdown) options. Strategy researchers have yet to undertake any systematic theoretical treatment of real put options or empirical research on this topic.

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