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ENTRY IN THE PRESENCE OF DUELING OPTIONS

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This paper investigates the influence of industry uncertainty on the decision by established firms to enter a new industry. Specifically, we examine the tension between the option to defer, which discourages entry in the presence of uncertainty, and the option to grow, which may encourage entry in the presence of uncertainty when there are early mover advantages. Empirical analysis on data from a broad array of industries revealed that the effect of uncertainty on entry is not monotonic. Our findings are the first to find support for the nonmonotonic effect of uncertainty that has only recently emerged in theoretical treatments of real options theory, and amplify the importance of considering both the option to defer and the option to grow when contemplating entry. Furthermore, we found evidence that the relationship between uncertainty and entry is moderated by: (a) irreversibility, which influences the value of the option to defer; (b) the total value of growth opportunities; and (c) early mover advantages, which magnify the value of growth options.

This paper explores how exogenous industry uncertainty influences the decision by established firms to enter a new industry. Although prior studies have implicitly assumed that uncertainty is not pertinent to the entry decision by established firms (Montgomery and Hariharan, 1991; Silverman, 1999), the real options perspective argues that uncertainty will be a critical factor whenever an investment decision is characterized by some degree of irreversibility and there is potential for the future exercise of managerial discretion (Kogut and Kulatilaka, 2001). However, even within the real options literature, debate continues about the influence of uncertainty on the entry/investment decision. The conflict between the *option to defer* and the *option to grow* plays a central role in this debate.

The option to defer obtains its value from the potential for a manager to defer the entry decision, which allows a firm to 'keep its options open' and avoid the opportunity costs associated with making an irreversible investment (McDonald and Siegel, 1986). Factors that increase the value of the option to defer, such as greater sunk costs associated with the investment, make entry less likely. Alternatively, the option to grow gains its value from the possibility that early investment will help the firm to develop a 'capability' that will allow it to take better advantage of future growth opportunities in the industry (Kulatilaka and Perotti, 1998). Accordingly, more valuable growth options encourage investment and make entry more likely.

Since these two types of real options have opposite effects on entry, and both increase in value with increasing uncertainty, predicting the

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net impact of uncertainty on entry is problematic. However, recent theoretical work by Kulatilaka and Perotti (1998) suggests that different options will dominate the entry decision at different levels of uncertainty, thus leading to a nonmonotonic effect of uncertainty on entry. In investigating whether insights from real options theory enlighten firm entry decisions, we seek to make two important contributions to the literature. First, we test whether uncertainty has a nonmonotonic effect across a broad sample of industries. Second, we theoretically and empirically examine how the influence of uncertainty on entry is moderated by factors that influence the value of the growth and deferment options.

BACKGROUND

Since a real option is the right, but not the obligation, to take some action in the future (Amram and Kulatilaka, 1999), the option will be valuable whenever an investment decision entails significant uncertainty and cannot be costlessly reversed.[1] The traditional approach to examining firm investment behavior, neoclassical investment theory, is based on the reasoning that investments should be made when the simple net present value (NPV_S) of the opportunity equals or exceeds zero, the investment threshold. In the context of market entry, this suggests the following decision rule:

$$\text{Enter if}: NPV_S \geq 0 \tag{1}$$

However, this reasoning does not accurately describe the influence of uncertainty on entry because it fails to consider the two crucial factors that are tenets of real options theory. First, most investments are at least partially irreversible since they cannot be fully recovered and costlessly redeployed in the event of a negative shock. Second, managers can adapt and revise their strategies in response to unexpected market developments that cause cash flows to deviate from their original expectations. Real options theory provides a theoretical basis for considering why firms set investment thresholds at any point other than that suggested by neoclassical investment theory (i.e., at NPV_S equals zero).

Even though it is rare for real managers to explicitly employ real options models when making investment decisions (Copeland and Keenan, 1998), evidence suggests that managers are often willing to overrule traditional investment criteria in the interest of strategic flexibility (Hayes and Garvin, 1982; Donaldson and Lorsch, 1983). One such form of strategic flexibility is the flexibility to defer an investment decision when substantial uncertainty exists about the future conditions in the targeted industry. The 'option to defer' is intended to describe just this type of flexibility. The basic intuition is that a firm sacrifices its option to defer when it makes an irreversible investment, losing the potential to make a different decision should new information arrive that affects the desirability or timing of the investment. Thus, when a firm makes an irreversible investment, it incurs an opportunity cost, D, that is equal in value to the option to defer. A focus on the option to defer suggests that the investment threshold should be raised (i.e., should be increased above zero) by the value of these opportunity costs. The key insight from this perspective is that entry is discouraged with greater uncertainty because D escalates with uncertainty. In previous research, evidence that uncertainty has a depressive effect on investment has been interpreted as support for the explanatory power of real options theory.[2]

To date, most of the empirical research on real options theory has focused on this option to defer. Although there is relatively strong support for the prediction that macroeconomic uncertainty discourages economy-wide investment levels (e.g., Pindyck, 1986; Episcopos, 1995), research examining firm investment levels has produced mixed results.[3] The latter is curious since real options approaches to investment specifically attend to firm-level thresholds, and thus it is at this level of analysis that the influence of uncertainty should be most evident (Carruth *et al.*, 2000). Research that examines whether or not investment occurs, rather than investment levels, may be more amenable to

[1] Consistent with Amram and Kulatilaka (1999), we define uncertainty as the randomness of the external environment that cannot be altered by the actions of individual firms or managers.

[2] See Carruth, Dickerson, and Henley (2000) for a review of these arguments and the associated empirical work. A focus on *total* uncertainty distinguishes real options analysis from traditional investment theory, which argues that NPV is influenced only by the systematic component of uncertainty.

[3] Several studies report the expected negative relationship between uncertainty and firm investment levels (Huizinga, 1993; Guiso and Parigi, 1999), while others report weakly negative or no relationship (Campa and Goldberg, 1995; Driver, Yip, and Dakhil, 1996; Leahy and Whited, 1996).

real option analysis because, as Dixit and Pindyck (1994) note, the theory does not determine the level of investment per se, but rather it identifies factors that may affect the *threshold* at which investment should occur. Accordingly, it is noteworthy that studies focusing on the probability of investment have linked increased uncertainty with both a decreased likelihood of foreign entry (Campa, 1993), and a decreased likelihood of acquiring an alliance partner (Folta and Miller, 2002).

Although previous studies have indicated that real options analysis is helpful in describing investment patterns, there remain significant opportunities for further study. For example, the empirical focus has been almost exclusively on how uncertainty *deters* investment, thus ignoring that investment may provide valuable growth options. Since the value of growth options increases with uncertainty, higher uncertainty may lower investment thresholds for projects with significant growth options, thus inducing a positive relationship between uncertainty and investment. Kester (1984) was perhaps the first to recognize that traditional investment thresholds are too high when growth opportunities are embedded in investments. In recent years, growth options have been used by management scholars to justify investment in a number of contexts, such as the acquisition of new firm capabilities (Kogut and Kulatilaka, 2001), and patterns of sequential investment in new ventures (Hurry, Miller, and Bowman, 1992), industry segments (Kim and Kogut, 1996), international markets (Chang, 1995), and technology (McGrath, 1997). Although this work has served as a useful bridge between strategy and finance, it has failed to empirically consider how uncertainty influences the choice between waiting and immediate entry.

The choice between waiting and immediate entry has strong implications for business- and corporate-level strategy. Entering earlier may better position the firm to build a technological advantage, develop brand recognition, or accrue any number of resources that may lower costs or increase revenues relative to later movers (Lieberman and Montgomery, 1988). Whether entry should be undertaken immediately to take better advantage of growth opportunities, or delayed until the environment becomes less uncertain, depends on the nature and the size of the deferment and growth options, which may depend critically on the total uncertainty in the target industry. The next section elaborates on the relative impact of the options underlying these alternatives.

THEORY AND HYPOTHESES

Both the option to defer and growth options are potentially valuable whenever there is uncertainty about the underlying asset. In the context of new market entry, we are concerned with uncertainty as it relates to the potential cash flows associated with entering the target industry. Below, we explain how the option to grow is embedded in entry decisions, how it may conflict with the option to defer, and highlight the factors that influence the relative value of both options.

Option influences on the entry decision

No prior investment is necessary to initiate the option to defer since any firm can choose to 'not invest' and every firm incurs opportunity costs, D, when it makes an irreversible commitment (Trigeorgis, 2000). As mentioned earlier, this logic alters the decision rule (1), since the simple net present value of immediate entry must not only be greater than zero, but also greater than D. However, since D will always be greater than or equal to zero, the modified decision rule can be simply stated as

$$\text{Enter if}: NPV_S + CF \geq D \tag{2}$$

where NPV_S represents the simple net present value of the opportunity with deferred entry, and CF represents the cash flows forgone if entry is delayed one period. This equation implies that a decision to 'not enter' may be attributed to either an elevated entry threshold due to a valuable option to defer (D), or to the possibility the firm is not a viable candidate for entry because the present value of all future cash flows ($NPV_S + CF$) is less than zero.

Unlike the option to defer, which all firms have, growth options must be initiated at some extra cost from the outset (Trigeorgis, 2000: 4). For example, entry gives a firm the right, but not the obligation, to expand operations in the future if industry conditions turn out favorable. Since managers have discretion over the exercise of growth options, their value, G, escalates with uncertainty due to the asymmetry in their pay-off distribution: if unexercised, their lowest value is zero, while their upper value is virtually unbounded. Thus, even if the simple NPV for entry is negative, it may be worthwhile to enter the industry if there is a significant potential for the industry conditions to far exceed the expected values that were used in calculating NPV_S.

It is important to recognize that the incremental cash flows, CF, may be more valuable if entry occurs earlier. This is the primary focus of the strategic management research on entry timing. However, the value of growth options, G, may also be enhanced by some multiplier, α, if moving early gives the firm an increased future ability to expand beyond initial expectations (Lieberman and Montgomery, 1988), where $G \geq 0$ and $\alpha \geq 1$. Therefore, in competitive markets, the entry decision should reflect the potential to enhance the value of the growth option with immediate entry compared to deferred entry:

$$\text{Enter if}: (NPV_S + CF + \alpha G) \geq (D + G) \quad (3)$$

There are several key insights that can be gleaned from this model with respect to the firm's probability of entering a new market:

(a) Entry is more likely when α is larger (i.e., when there are competitive advantages to moving early). If $\alpha = 1$, there is no competitive advantage to early entry, so the entry decision is reduced to decision rule (2).
(b) Entry is more likely when CF is large. CF may be a function of early mover advantages, or it may represent forgone cash flow under monopoly conditions.
(c) Entry is more likely as the option premium grows, where the option premium is defined as the net value of the options (i.e., $\alpha G - (D + G) = [\alpha - 1]G - D$).

These first two points are consistent with prior research. The last point, (c), is relatively unexplored and is the focus of this paper because it illuminates the relationship between uncertainty and entry (and investment more generally). The implication is that, in the absence of competition (i.e., $\alpha = 1$) uncertainty should negatively influence the entry decision. However, when there are competitive advantages to earlier entry (i.e., $\alpha > 1$) the total effect of uncertainty becomes ambiguous because both G and D increase with uncertainty. Predicting how uncertainty impacts entry requires assumptions about the relative magnitudes of each option and how their valuations grow with respect to uncertainty.

The conflict between growth and deferment options

Figure 1 illustrates how G and D may vary with uncertainty, and how their interplay may affect the incentive to enter immediately, holding NPV_S constant. In this figure, G, D, and α combine to create the option premium, which determines the total effect of uncertainty on entry. Panel A demonstrates that, with $\alpha = 2$, increases in uncertainty have a negative effect on entry when the slope of D exceeds the slope of G, and a positive effect on entry when the slope of G exceeds the slope of D.[4] Although the figure is stylized, the basic intuition remains: when there are competitive advantages to early entry, increasing uncertainty may not categorically dissuade entry through a monotonic decrease in the option premium (Amram and Kulatilaka, 1999; Kulatilaka and Perotti, 1998).

There are two reasons why the value of an option to grow may be more sensitive to uncertainty than the option to defer. Relative to delayed entry, immediate entry may result in a larger market share and higher profits because the firm benefits from first mover advantages, creating greater upside potential (Kulatilaka and Perotti, 1998). The second reason is that the value of the option to defer is bounded, while the value of the growth option is not. Option pricing theory informs us that the maximum value of a call option is bounded by the current price of the underlying stock. Intuitively, the maximum value of a call option is the maximum amount that an investor could lose by simply purchasing the underlying asset now. In the case of entry, the value of the option to defer, D, cannot exceed the total irreversible commitment required to enter the industry. Thus, although D is monotonically increasing in uncertainty, it is also asymptotic to the total sunk costs required to enter the industry, which occurs only at very high levels of uncertainty. In contrast, growth options have no such upper bound on their value. As the uncertainty about future industry conditions increases,

[4] More generally, increasing uncertainty, U, will positively influence entry when $(\alpha - 1)[dG/dU] > dD/dU$.

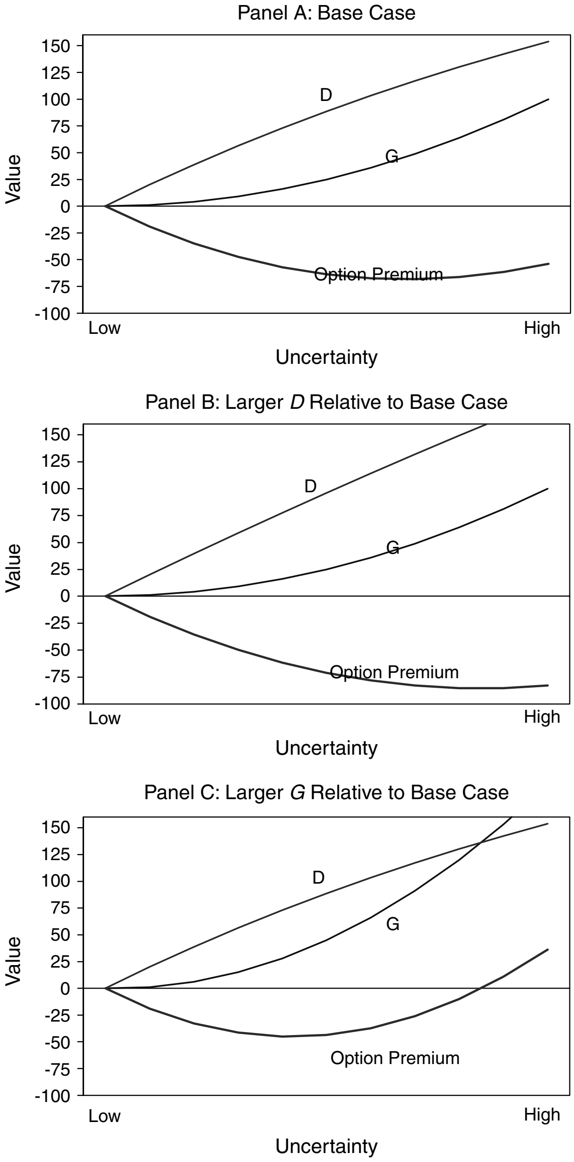

Figure 1. The value of the option to defer (D) and the option to grow, (G) with respect to uncertainty

so does the potential economic value of gaining a competitive advantage in that industry. Since the upside of the growth option is not bounded, the value of the growth option may be substantially greater than the value of the deferment option at extreme levels of uncertainty.

To the best of our knowledge, Campa (1993) is the only study to test for a nonmonotonic effect of uncertainty. His results imply that the effect of exchange rate uncertainty on entry into wholesale markets is negative and monotonic. It should be noted, however, that his industry context may lack growth opportunities, and exchange rate uncertainty represents only one form of potential uncertainty. Further work is needed to verify whether uncertainty has a nonmonotonic effect on entry. If growth options are present in a reasonable number of industries, we expect that the overall net impact of uncertainty on the probability of entry will be nonmonotonic.

Hypothesis 1a: The impact of uncertainty on entry is nonmonotonic.

Hypothesis 1b: Uncertainty will negatively influence entry when uncertainty is low and positively influence entry when uncertainty is high.

Factors influencing the relative value of growth and deferment options

The remaining hypotheses relate to factors that may systematically alter the relative value of growth options and deferment options, and thereby shift the critical point at which the relationship between uncertainty and entry changes from negative to positive. Relative to the base case (Panel A) provided in Figure 1, Panel B alters the slope of D to illustrate how more valuable deferment options influence the option premium. We see that the uncertainty has a negative effect on the option premium over a larger proportion of its range. If D were steep enough (i.e., valuable deferment options), uncertainty would have a monotonically decreasing effect on the option premium.

The value of the option to defer is influenced by the degree of irreversibility of the investment required for entry. If the investments required for entry are completely reversible, then the deferment option has no value and there is no point in delaying entry, since those investments can be fully recouped in the event that the firm decides to exit the industry at some point in the future. However, as those investments become more irreversible, there is a higher opportunity cost associated with entering. Thus, higher irreversibility should be associated with more valuable deferment options, making entry less likely.

Hypothesis 2: More valuable options to defer (i.e., greater irreversibility) will attenuate the U-shaped effect of uncertainty on entry.

The curvilinear effect described in Hypotheses 1a and 1b should also be affected by the size of growth options. Relative to the base case (Panel A) provided in Figure 1, Panel C alters the slope of G to illustrate how the option premium varies in uncertainty with larger growth options. It shows that, relative to the base case, the option premium becomes positively related to uncertainty at lower levels of uncertainty. This suggests that the effect of uncertainty on entry will switch from negative to positive at lower levels of uncertainty. Similarly, if G were flat enough (suggesting the growth option is small), uncertainty would have a monotonically decreasing effect on the option premium.

> *Hypothesis 3: More valuable growth options will accentuate the U-shaped effect of uncertainty on entry.*

The same result illustrated in Panel C of Figure 1 can be obtained if we hold the value of G constant relative to the base case (assuming $G > 0$), but increase the importance of early mover advantages, such that $\alpha > 2$. Thus, when early entry conveys an increased ability to benefit from future growth opportunities (perhaps due to learning or experience curve advantages), there are added incentives to move early in highly uncertain environments. In some industries, growth opportunities may be secured through competitive preemption. If there is only space for n firms in an industry, then entry by firm $n + 1$ will not be economical because it will reduce profits below the threshold level (Schmalensee, 1978).[5] This may lead to an incentive for early entry to secure growth options before the competitive space is filled. Therefore, in contexts where early mover advantages are more pronounced, the value of growth options will be magnified and the effect of uncertainty will switch from negative to positive at lower levels of uncertainty.

> *Hypothesis 4: When early entry enhances the value of growth options, the U-shaped effect of uncertainty on entry is accentuated.*

[5] Of course, firms may sometimes make dramatic errors in forecasting either the market size or the number of other entrants (Sahlman and Stevenson, 1985).

METHODS

Data sources

Most of the variables used in this study were derived from the Compustat Industrial and Business Segments databases. Compustat I contains detailed financial information at the level of the firm, and is the source for most of our firm-level variables. Compustat II, which provides financial data for each of the firm's lines of business, was used to develop most of the industry-level variables and to detect instances of entry into new industries. Since Compustat II was not available for years prior to 1980, our analysis encompassed the 17,897 firms and 144,947 firm/year observations that were listed in Compustat II between 1980 and 1999. The only variable not constructed from Compustat data was our measure of uncertainty, which was derived from GDP data taken from the Bureau of Economic Analysis at the U.S. Department of Commerce.

Dependent variable: entry

In Compustat II, firms may report up to 10 individual business segments, with each segment having up to two primary segment SIC codes and four product SIC codes.[6] Thus, for any given year, a firm may report up to 60 SIC codes. We defined *Entry* as activity by an existing firm in an industry in which the firm had not reported involvement in the previous 2 years. To detect entry, we looked for instances where a firm listed a primary segment SIC code that did not match any of the possible 60 SIC codes reported by the firm in each of the 2 previous years. If such activity in a new industry was found, and the firm was in Compustat II in the prior year, that new primary segment SIC code was coded as an entry. Using this approach, we identified 19,354 instances of entry between 1981 and 1999. In some instances, firms have multiple entries in a given year.[7]

The primary advantage of using the Compustat data to identify entry by established firms into new industries concerns generalizability. Unlike alternative databases, such as Trinet or the FTC dataset,

[6] Approximately 46 percent of observations report a single segment, and less than 0.5 percent report 10 segments.

[7] The data do not distinguish between direct entry and entry by acquisition. However, the motives for entry outlined above should apply to both modes of entry.

Compustat data cover a significant period of time and several phases of the business cycle.[8] Furthermore, the Compustat data capture a large portion of activity in all sectors of the American economy, whereas Trinet and FTC data focus on the manufacturing sector. Thus, the Compustat data are not only more generalizable across industries and across time, but also help ensure that our sample will contain considerable variation in uncertainty and in the value of deferment and growth options.

There are also some disadvantages to using Compustat data to identify entry into new industries. Probably the greatest concern is that industry segment SIC codes may be inconsistently assigned. In order to attenuate this concern, all SIC codes in Compustat were recoded from 4-digit level of analysis to the 3-digit level.[9] An additional concern is that firms have some discretion in how they group business activities in a single segment, leading to the potential agglomeration of diverse business activities into the same segment. However, Davis and Duhaime (1992) argue that the problem should not be substantive because of FASB reporting requirements. Again, by moving to a higher level of aggregation (3-digit SIC), we attenuate this possibility.

Independent variables

All of the independent variables were computed for each year and lagged 1 year to avoid potential problems of endogeneity with the instances of entry. Descriptive statistics and correlations are illustrated in Table 1.[10]

Uncertainty

There are at least two key challenges to measuring the uncertainty that is pertinent to the decision to enter a new industry. The first challenge involves choosing among the multiplicity of sources that account for the randomness in the external environment. We focus on the randomness of demand because demand impacts prices, which in turn largely determines profitability. Moreover, the strategic advantage of growth options should be particularly valuable in high states of demand, where profits per unit of output are higher (Kulatilaka and Perotti, 1998). Finally, there is strong precedent for operationalizing uncertainty using demand (Episcopos, 1995; Price, 1995), including Kulatilaka and Perotti (1998), the study from which this study builds most directly.[11]

Testing our hypotheses necessitates the development of time-varying measures of industry-specific uncertainty. All prior real options studies have measured macroeconomic uncertainty, except Kogut (1991), Folta (1998), and Folta and Miller (2002), who measured industry-specific uncertainty. However, all three of these studies calculated the variance of some output or indicator (e.g., stock price, GDP, sales) over time, an approach that has two critical shortcomings. First, it fails to account for the trends in the data, which will increase the measured variance although they may not constitute an element of uncertainty if they are predictable. Second, this approach does not allow for the possibility that the variance may be heteroskedastic (i.e., not constant over time), a characteristic that is typical of many economic time series (Campa, 1993).

To address both of these concerns, we measure uncertainty with the conditional variance generated from generalized autoregressive conditional heteroskedasticity (GARCH) models (Bollerslev, 1986). To approximate unique time-varying estimates of uncertainty for each industry requires time series data that correspond to (a) our sample period (1981–99), (b) our full vector of industries, and (c) an adequate number of data points prior to our sample period. Although we could not satisfy these requirements at the 3-digit level, we obtained data from the Bureau of Economic Analysis at the U.S. Department of Commerce on Gross Domestic Product (GDP) for 51 industries that largely overlap the full array of 3-digit SICs in Compustat.

[8] Our data cover 19 years, while FTC and Trinet cover only 4. Also, the FTC dataset covers an unusual period in economic history immediately subsequent to the first oil shock and Nixon's wage and price controls.

[9] For example, while a segment may be coded as manufacturing either disk drives (SIC 3684) or computer peripheral parts (SIC 3688), it will likely always be classified inside of the more general 3-digit SIC of 368.

[10] Despite high correlations for several variables, analysis revealed that multicollinearity should not be a problem since (a) all tolerances were well above the most conservative commonly used cut-off of 0.01 (Neter *et al*., 1996); and (b) reduced models excluding variables that were highly correlated with our variables of interest produced substantively similar results.

[11] Other ways in which uncertainty has been represented in empirical studies include volatility in stock market index returns (Pindyck, 1986; Episcopos, 1995; Folta and Miller, 2002), exchange rates (Campa, 1993), inflation (Huizinga, 1993), and output prices (Huizinga, 1993).

Table 1. Descriptive statistics and Pearson correlations

Variable	Mean	S.D.	Min.	Max.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Relatedness	0.03	0.07	0.00	0.97																			
Diversification	0.14	0.23	0.00	0.90	0.21																		
F-Size	4.28	2.48	−0.69	13.09	0.13	0.40																	
F-Capital Intensity	7.93	335.04	0.00	85,352.00	0.00	−0.01	−0.01																
F-R&D	0.05	0.33	0.00	40.00	−0.01	−0.06	−0.12	0.00															
F-Sell	0.02	0.24	0.00	43.95	−0.01	−0.01	−0.02	0.00	0.00														
Beta	1.12	0.35	−2.58	2.49	0.03	0.02	−0.02	0.00	−0.01	0.00													
Concentration	0.19	0.17	0.01	1.00	−0.20	−0.03	0.00	0.00	0.01	0.00	−0.04												
I-Size	8.90	2.11	0.39	16.18	0.20	−0.02	0.04	0.00	0.01	−0.01	−0.08	−0.40											
I-ROS	0.06	2.86	−230.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00	−0.02	−0.02	0.05										
I-Capital Intensity	16.41	1041.00	0.19	85,352.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.01	−0.03	−0.99									
I-R&D	0.01	0.04	0.00	0.79	0.13	−0.01	0.00	0.00	0.02	0.00	0.05	−0.10	0.18	−0.01	0.00								
I-Advertising	0.01	0.02	0.00	0.92	−0.05	0.00	−0.02	0.00	0.00	0.00	0.04	0.02	−0.16	−0.02	0.00	−0.04							
I-GDP	758.57	199.78	279.18	1629.00	−0.09	−0.05	0.03	0.00	0.01	0.00	−0.15	0.06	−0.03	−0.06	0.05	−0.02	−0.05						
Intangibles	0.02	0.04	0.00	0.44	−0.09	−0.04	0.03	0.00	0.01	0.00	−0.09	0.10	−0.07	0.01	−0.01	−0.06	0.01	0.06					
Inverse Leverage	0.83	0.12	0.22	1.00	0.09	0.00	−0.01	0.00	0.01	0.00	0.05	−0.03	−0.04	−0.02	0.00	0.20	0.04	−0.07	−0.11				
Market-to-Book	1.04	0.80	0.04	46.20	0.03	−0.02	0.01	0.00	0.01	0.00	−0.01	0.07	−0.09	−0.02	0.01	0.20	0.13	−0.01	0.10	0.12			
Growth	0.03	0.12	−0.45	0.88	−0.03	0.04	−0.02	0.00	−0.02	0.00	0.00	0.02	−0.09	0.03	−0.03	−0.05	0.03	−0.22	−0.07	0.00	−0.07		
Scale Advantages	0.06	0.15	0.00	1.00	−0.12	−0.01	0.00	0.00	0.00	0.00	−0.03	0.43	−0.49	−0.04	0.02	−0.05	0.20	0.08	0.12	−0.13	0.09	0.06	
Uncertainty	86.84	75.43	11.28	543.34	0.03	−0.01	0.00	0.00	0.00	0.00	−0.02	0.01	0.00	−0.07	0.07	−0.06	−0.06	0.41	−0.01	0.02	0.00	−0.09	0.10

With $n = 74,915$, correlations with an absolute value of 0.01 or more are significant at $p < 0.05$.

GDP by industry, which represents an industry's contribution to overall GDP, provides an excellent measure of total industry demand. See the Appendix for a description of these 51 industries.

After obtaining annual measures of GDP for 51 broad industries for the period 1947–2000, we fit GARCH models to each of the individual time series. This enabled us to approximate unique time-varying estimates of demand uncertainty for 51 broad industries. The GARCH model produces an estimate of the conditional variance, which captures the uncertainty that is not predictable about any trend that might exist for each period in the time series. Specifically, we employ the GARCH-in-mean, or GARCH-M model, which is parameterized by two values that specify the number of lags for the squared error terms and the number of past variances to be included in the computation of the current variance. In general, a one-period lag on both parameters (i.e., a GARCH-M[1,1] model) provides excellent fit for modeling a wide variety of asset returns (Solnik, 1996). Diagnostic checks of our data indicate that the parsimonious GARCH-M(1,1) model provides excellent fit.[12] We used the square root of the annual conditional variance generated from this model as our estimate of industry-specific *Uncertainty.*

Variables representing the irreversibility of the entry decision

While it is impossible to measure irreversibility directly, theory suggests several approximations. For example, Arrow (1968) suggests that intangible assets may have very little use outside their current application because they are likely to suffer from market failure, making trade on the open market difficult relative to physical assets (Long and Malitz, 1985). Thus, the irreversibility of an investment decision is negatively related to the tangibility of the assets in which a firm invests. Following precedent, including Friend and Lang (1988), Titman and Wessels (1988), Gompers (1995), and Rajan and Zingales (1995), we measure *Intangible* for each industry by the median value of the ratio of intangible assets to total assets for all firms in that industry in the previous year. We generate a second measure of irreversibility because, while intangible assets are expected to be highly irreversible, the salvage value of tangible assets may also vary across industries. Tangible or intangible assets that have high salvage value (i.e., are less irreversible) can support a high level of debt, while assets that have low salvage value will have to rely on equity financing (Williamson, 1988). Thus, the investments required to enter high-leverage industries should be more reversible than the investments required to enter low-leverage industries (Titman and Wessels, 1988; Shleifer and Vishny, 1992; Gompers, 1995). The variable *Inverse Leverage* is computed by taking, for all firms competing in an industry, the median value of one minus the ratio of long-term debt to total book value of assets.

Variables representing growth options or early mover advantages

One broad proxy for the presence of growth options is the market-to-book ratio. Myers (1977) argued that firms with a high market-to-book ratio should be associated with a higher proportion of unexercised growth opportunities. Thus, industries with higher average market-to-book ratios should generally have more valuable growth options. The variable Market-to-Book is the median industry market-to-book ratio, and is intended to capture expected future industry growth opportunities.

Industry growth rates should also increase the importance of growth options relative to deferment options. When an industry grows quickly, a firm must invest in order to exercise the option to grow with the market. Having a strategic advantage is particularly valuable in states of high demand when profits per unit of output are higher (Kulatilaka and Perotti, 1998). Thus, firms targeting higher growth industries should have more valuable growth options. The variable *Growth* is intended to capture expectations about the future growth rate of the industry. The GARCH model that was used to produce our measure of uncertainty also produces an estimate of the predicted value of industry GDP for each year and each of the industries where uncertainty was estimated. To capture expected industry growth, we computed *Growth* as the predicted value of industry GDP for the year that entry occurred, less the actual value of industry GDP in the previous year, all divided by the actual value of industry GDP in the previous year.

[12] We evaluated model fit based on evidence that the residuals were distributed as white noise, the statistical significance of the model's hyperparameters, and comparison of the model with alternative lag structures.

Preemption is a way in which firms can secure competitive advantages when the industry is only able to support a limited number of players. If firms delay entry too long, they may get locked out and find it infeasible to enter at a later date because they cannot reach minimum efficient scale. Access to scale economies can provide firms an enduring advantage (Lieberman and Montgomery, 1988). Thus, target industries defined by larger scale economies should be stronger candidates for early entry. An estimate of each industry's minimum efficient scale (MES) was constructed by the median value of assets for all business segments that compete in each industry.[13] Since it is the MES relative to total industry size that influences the advantages of early entry, we develop a measure of relative scale, *Scale Advantages*, by dividing the estimated MES by total industry assets.

Control variables

In addition to the variables specified above, proper specification of the theoretical model requires the inclusion of variables correlated with the expected NPV of the entry opportunity. Several industry-level variables should influence the attractiveness of entering a given industry. *I-Profit* is defined as the industry median operating profit to sales ratio. *Concentration* is the industry's Herfindahl concentration index. *I-Size* is the natural log of the total assets of all business segments competing in each industry. *Beta* controls for the systematic risk of each industry, and is calculated as the covariance between the returns on each industry's stock index and the market return over the previous 60 months. The intensity of investment in capital, *I-Capital Intensity*, is measured by the industry median ratio of assets to total sales. The intensity of R&D and advertising is approximated by *I-R&D* and *I-Advertising*, respectively, and is measured by the median industry ratios of R&D and advertising, respectively, to assets.[14]

Several firm-level factors could also impact the static NPV of the entry decision. The degree of relatedness between the industry entered and the portfolio of industries in which the firm already competes should greatly influence the expected value from entry. Thus, we include a measure of industry relatedness similar to that proposed by Teece *et al*. (1994), which measures the likelihood that a firm operating in industry j will also operate in industry m, corrected for the expected degree of relatedness under the null hypothesis that diversification is random. This measure was calculated at the 3-digit industry level and allowed to vary over time. *Relatedness* was the distance between the target industry and nearest industry that was already in the firm's portfolio.

Diversification controls for how diversified the firm was prior to the new entry by measuring the sum of squared shares of each of the firm's business segments. *F-Size* controls for the size of each firm by taking the natural log of total firm assets. The variables firm-level capital intensity (*F-Capital Intensity*), firm-level advertising intensity (*F-Advertising*), and firm-level R&D intensity (*F-R&D*) were computed in a similar fashion as their industry-level counterparts, but for each individual firm.

Analysis

Similar to Montgomery and Hariharan (1991), we use state-based sampling (Manski and McFadden, 1981) to model the dichotomous entry decision with a series of multivariate binomial logit models that compare instances of entry with a random sample of all the nonentries.[15] The sample of nonentries was created by randomly selecting (with replacement) 60,000 firm–year observations, and then randomly assigning to each observation an industry in which the firm had not competed in at least the previous 2 years. After eliminating observations with missing data, the final sample includes 14,915 instances of entry and 60,000 instances of nonentry.

Since our hypotheses predict that *Uncertainty* may have a nonmonotonic (i.e., a U-shaped) effect on the probability of entry, we include both *Uncertainty* and *Uncertainty*^{2} as predictor variables in our model. We expect that the sign of the coefficient on *Uncertainty* will be negative and the coefficient on *Uncertainty*^{2} will be positive, which

[13] Results are substantively identical if the minimum value of assets, the 10th percentile, or the 25th percentile is used instead of the median.

[14] *I-Advertising* was calculated based on firm-level data, while *I-Capital Intensity* and *I-R&D* were based on segment-level data.

[15] State-based sampling yields unbiased and consistent coefficients for all variables except the constant term, which can be corrected by subtracting from it the log(proportion of all entries in sample/proportion of all nonentries in the sample), where the numerator is 1, and the denominator is [60,000/(144,947 * 51–313,247)].

is consistent with a relationship that is generally negative but turns positive at high levels of uncertainty. As stated in Hypotheses 2–4, this relationship will be moderated by the presence of deferment or growth options. Decisions to enter into target industries with larger deferment options will lead to *Uncertainty* having a negative effect over a larger range of the sample. Alternatively, decisions to enter target industries with larger growth options and strong first mover advantages will lead to *Uncertainty* having a positive effect over a larger proportion of its range. Accordingly, we test these hypotheses by interacting the variables approximating deferment options, growth options, and first mover advantages with both *Uncertainty* and *Uncertainty*^{2}. These interactions represent the unique contribution of real options theory relative to other theories pertinent to entry (such as industrial organization) which emphasize only main effects.

RESULTS

The logit models presented in Table 2 test whether the independent variables significantly improve our ability to explain the choice between entry and nonentry. Model 1 presents the base model, Model 2 includes *Uncertainty*^{2}, and Models 3–7 include the interactions for the moderating effects on uncertainty. Firm- and industry-level variables are included to control for the NPV_S of the entry opportunity. Also included in each of these models, although not reported, are year fixed effects. The significance of individual coefficients is interpreted using two-tailed Wald chi-square tests. However, since our hypotheses are concerned with interaction effects, the relevant test is a likelihood ratio test comparing a model including interaction terms with a base model excluding interactions.

The effect of uncertainty

Consistent with much of the prior research on the relationship between uncertainty and investment, Model 1 indicates that *Uncertainty* has a significant negative effect ($p < 0.001$) on the probability of entry. Our point of departure from these previous studies, however, is that we hypothesize a curvilinear (i.e., a U-shaped) effect for uncertainty. A likelihood ratio test indicates that the addition of *Uncertainty*^{2} in Model 2 significantly improves model fit relative to Model 1 ($p < 0.001$). Moreover, the coefficient for *Uncertainty*^{2} is positive, while the coefficient for *Uncertainty* is negative, indicating that the effect of uncertainty is nonmonotonic—greater uncertainty decreases the likelihood of entry, but after some critical level it increases the likelihood of entry. While this finding is consistent with the expectations stated in Hypothesis 1, it is important to determine whether the effect of uncertainty is truly nonmonotonic within the sample's range of uncertainty. By taking the first derivative of the logistic regression equation with respect to *Uncertainty*, we determined that the critical point where the relationship switches from negative to positive (henceforth, the turning point) occurs at about the 94th percentile of *Uncertainty* ($\approx$199).[16] Thus, the effect of *Uncertainty* is nonmonotonic and U-shaped, as predicted in Hypotheses 1a and 1b.

Hypotheses 2–4 suggest that if target industries differ in the magnitude of deferment and growth options, the effect of uncertainty will shift to reflect these differences. Models 3–7 introduce interaction effects to test our hypotheses regarding the moderating role of deferment and growth options. As indicated in the table, likelihood ratio tests confirm that all of the interaction terms improve fit ($p < 0.001$) relative to Model 2. Since the interpretation of multiple moderating effects is difficult, we provide illustrations of each of these effects in Figure 2, which demonstrates the effect of *Uncertainty* over the moderating variable's range at three different levels: the 5th percentile of the moderating variable's range; the median; and the 95th percentile.

The moderating effect of irreversibility on uncertainty

Models 3 and 4 incrementally introduce interaction terms involving our two measures of irreversibility: *Intangible* and *Inverse Leverage*. Since the option to defer is expected to have greater relative importance when *Intangible* and *Inverse Leverage* are higher, we expect that *Uncertainty* will have a negative effect on entry over a larger portion of its range when either of these two variables is large. Panel A, which is derived from Model 3,

[16] Approximately the same turning point was found when conducting the analysis where all industries were defined at the 2-digit level.

Table 2. Maximum likelihood estimates for the determinants of entry[a]

Variables	1	2	3	4	5	6	7
Intercept	−2.176***	−1.835***	−1.802***	−3.181***	−1.885***	−1.743***	−1.769***
Relatedness	20.974***	20.820***	20.807***	20.787***	20.749***	20.810***	20.782***
Diversification	0.974***	0.982***	0.982***	0.984***	0.986***	0.986***	0.982***
F-Size	−0.050***	−0.049***	−0.049***	−0.048***	−0.048***	−0.049***	−0.049***
F-Capital Intensity	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F-R&D	−0.261***	−0.258***	−0.260***	−0.266***	−0.260***	−0.265***	−0.262***
F-Sell	−0.365	−0.366	−0.366	−0.367	−0.371	−0.360	−0.368
Beta	0.146***	0.151***	0.153***	0.122***	0.169***	0.158***	0.150***
Concentration	−0.602***	−0.618***	−0.629***	−0.636***	−0.623***	−0.620***	−0.600***
I-Size	−0.012	−0.010	−0.010	−0.003	0.007	−0.011	−0.014
I-ROS	0.304**	0.302**	0.294**	0.221*	0.164	0.275**	0.376***
I-Capital Intensity	0.001**	0.001**	0.001**	0.001*	0.000	0.001*	0.001***
I-R&D	−0.102	−0.020	−0.065	−0.239	−0.546	−0.052	−0.095
I-Advertising	−9.782***	−9.980***	−10.029***	−10.072***	−10.267***	−9.674***	−10.241***
I-GDP	−0.001***	−0.002***	−0.002***	−0.002***	−0.002***	−0.002***	−0.002***
Intangibles	−3.332***	−3.249***	−2.858**	−2.904***	−3.331***	−3.234***	−3.362***
Inverse Leverage	1.474***	1.455***	1.448***	3.104***	1.433***	1.447***	1.464***
Market-to-Book	0.127***	0.119***	0.121***	0.114***	−0.031	0.121***	0.142***
Growth	−1.022***	−0.918***	−0.940***	−0.909***	−0.837***	−3.468***	−0.899***
Scale Advantages	−3.150***	−2.972***	−3.078***	−2.957***	−2.775***	−2.986***	−4.529***
Uncertainty	−7.20E-04***	−4.16E-03***	−4.38E-03***	1.66E-02***	−7.60E-03***	−5.16E-03***	−4.67E-03***
Uncertainty^2		1.00E-05***	1.00E-05***	−2.00E-05*	1.50E-05***	1.30E-05***	1.00E-05***
Uncertainty × Intangibles			−3.05E-02				
Uncertainty^2 × Intangibles			2.30E-04***				
Uncertainty × Inverse Leverage				−2.45E-02***			
Uncertainty^2 × Inverse Leverage				3.90E-05***			
Uncertainty × Market-to-Book					3.53E-03***		
Uncertainty^2 × Market-to-Book					−5.58E-06***		
Uncertainty × Growth						2.35E-02***	
Uncertainty^2 × Growth						−3.00E-05***	
Uncertainty × Scale Advantages							9.69E-03***
Uncertainty^2 × Scale Advantages							1.60E-05***
Likelihood Ratio	22,702.611	22,768.665	22,794.526	22,818.496	22,844.191	22,824.101	22,860.250
Likelihood Ratio Test (vs. Model 2)			51.723***	99.662***	151.052***	110.873***	183.171***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$
[a] Year fixed effects included in models, but not reported.

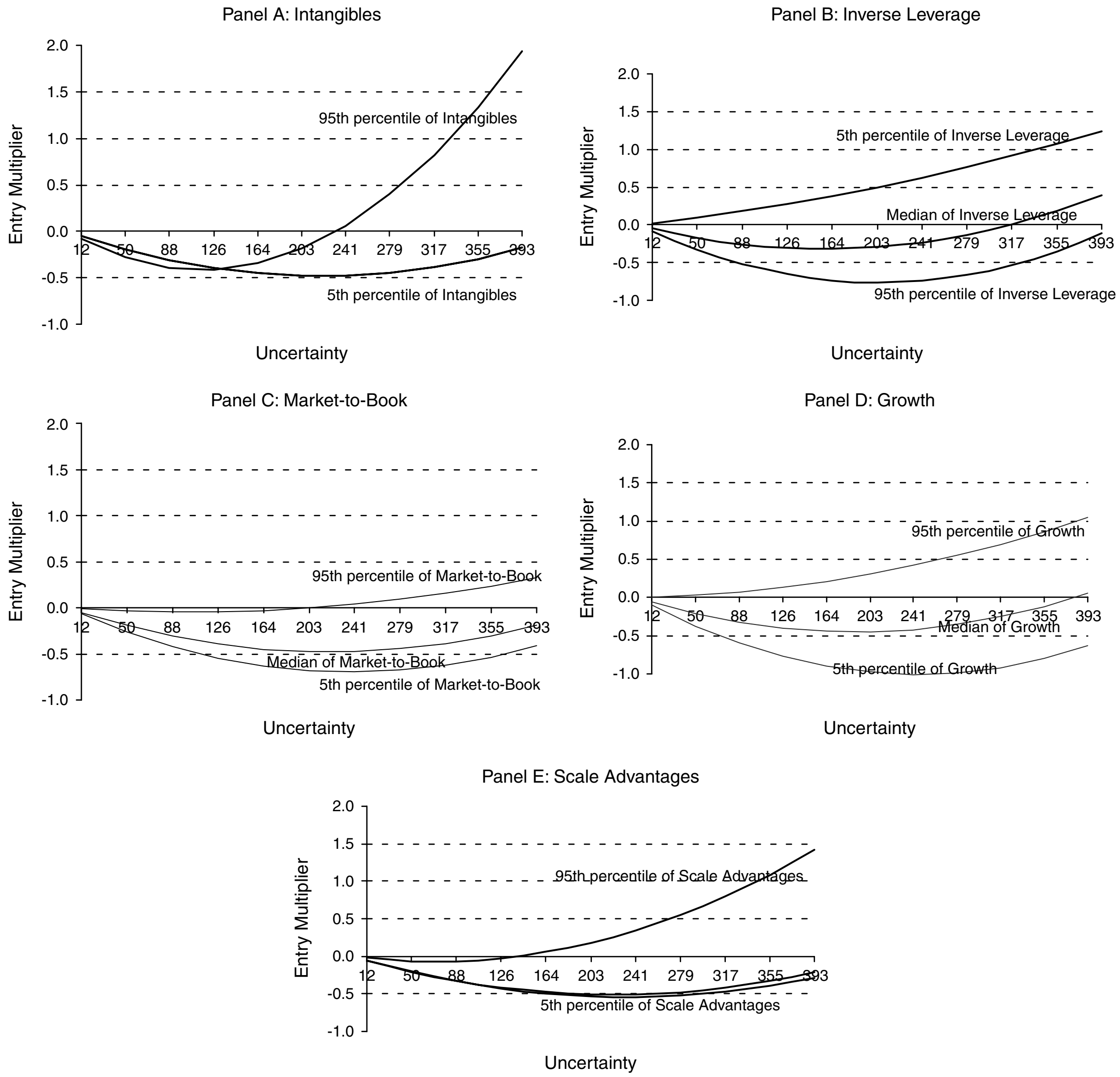

Figure 2. The effect of uncertainty at different percentiles of the moderating variables. Each figure was produced by taking the derivative of the relevant logistic regression equation (with respect to *Uncertainty*) at each of three different levels (i.e., 5th, median, and 95th percentiles) of the relevant moderating variable. The vertical axes in these figures represent the computed multiplier of entry, while the horizontal axes depict *Uncertainty* plotted from the 1st to the 99th percentile. In Panel A both the 5th percentile and median of *Intangibles* equal zero

reveals that the moderating effect of *Intangible* on *Uncertainty* is not consistent with Hypothesis 2. The figure suggests that when firms target industries requiring more investment in intangible assets, *Uncertainty* has a negative effect on entry over a smaller portion of its range. Panel B depicts the predictions derived from Model 4, which introduces the interaction terms involving *Inverse Leverage*. In contrast to Panel A, Panel B is consistent with Hypothesis 2. Interestingly, *Uncertainty* has a monotonically positive effect on entry into industries that require investments that are highly reversible (i.e., *Inverse Leverage* at 5th percentile). Conversely, in industries where investments are more irreversible, (i.e., *Inverse Leverage* at 95th percentile), *Uncertainty* has a negative effect on entry over 94 percent of its range. In sum, we found mixed results for the expectation that uncertainty will have a negative effect over a larger portion of its range when

Table 3. Economic significance of uncertainty on entry

Quantile of *Uncertainty*	Value of *Uncertainty*	Probability of entry[a]	% of 3-digit Industries with *Uncertainty* exceeding quantile	Market-to-Book		Growth		Scale Advantages	
				5th quantile	95th quantile	5th quantile	95th quantile	5th quantile	95th quantile
10th	23.7	1.22%	97.4%	1.15%	1.28%	1.95%	0.68%	1.52%	0.48%
20th	34.0	1.18%	97.0%	1.08%	1.27%	1.81%	0.69%	1.46%	0.47%
30th	42.7	1.15%	90.6%	1.02%	1.27%	1.71%	0.69%	1.41%	0.47%
40th	55.4	1.10%	88.0%	0.95%	1.26%	1.57%	0.70%	1.34%	0.46%
50th	67.2	1.06%	87.1%	0.89%	1.26%	1.46%	0.71%	1.29%	0.46%
60th	82.1	1.02%	57.7%	0.82%	1.25%	1.34%	0.72%	1.23%	0.46%
70th	99.4	0.98%	44.0%	0.75%	1.25%	1.23%	0.74%	1.17%	0.47%
80th	114.5	0.95%	29.9%	0.71%	1.25%	1.15%	0.75%	1.13%	0.48%
90th	163.3	0.89%	15.4%	0.60%	1.27%	0.97%	0.83%	1.03%	0.52%
95th	268.8	0.91%	6.0%	0.54%	1.41%	0.88%	1.12%	1.00%	0.81%
99th	392.6	1.22%	2.1%	0.71%	1.80%	1.26%	1.89%	1.26%	2.01%

[a] Calculated at the mean values of all variables except *Uncertainty*.

firms target industries requiring investments that are more irreversible.

The moderating effects of growth options and early mover advantages

Models 5–7 incrementally introduce interaction terms involving the three measures of the total value of growth options: *Market-to-Book, Growth*, and *Scale Advantages*. The interactions involving *Market-to-Book* are entered in Model 5, and Panel C depicts the moderating effect of this variable on uncertainty. This figure illustrates that when growth options are valuable (i.e., *Market-to-Book* is at the 95th percentile), the effect of *Uncertainty* on entry turns positive at the 67th percentile of *Uncertainty*. However, when growth options are less valuable (i.e., *Market-to-Book* at 5th percentile), the effect of uncertainty on entry does not turn positive until about the 94th percentile of *Uncertainty*. Thus, Model 5 indicates that when firms target industries with larger market-to-book ratios, entry is encouraged over a wider range of *Uncertainty*.

Model 6 introduces the interactions involving *Growth*. Panel D in Figure 2 demonstrates that for high-growth target industries (i.e., *Growth* at 95th percentile, expected growth of 23% or higher), the effect of *Uncertainty* on entry is monotonically positive. In contrast, sharply declining industries (i.e., *Growth* at 5th percentile, expected decline of at least 13%), the effect of *Uncertainty* does not become positive until its 96th percentile. Overall, the results for the variables *Market-to-Book* and *Growth* indicate strong support for Hypothesis 3.

Finally, Model 7 tests whether early mover advantages enhance the value of growth options. Consistent with expectations, Panel E illustrates that in contexts where there are potentially strong early mover advantages (i.e., *Scale Advantages* at 95th percentile), the effect of *Uncertainty* on entry turns positive at about the 54th percentile of *Uncertainty*. In contrast, the effect of *Uncertainty* does not turn positive until around its 94th percentile for most industries (as illustrated by both the median and 5th percentile of *Scale Advantages*).

Economic significance of uncertainty

To interpret the economic significance of uncertainty and the variables approximating growth potential, it is necessary to convert the estimated log odds ratios to actual probabilities of entry.[17] Table 3 illustrates how changes in *Uncertainty* affect the probability of entry. Holding all other variables constant at their mean values, the probability of entry declines from 1.22 percent to 0.89 percent as *Uncertainty* increases from its 10th percentile (23.7) to its 90th percentile (163.3). This represents a 27 percent decrease in the probability of entry due to changes in *Uncertainty*. The

[17] We used Model 2 in Table 2 to estimate the probabilities. The estimated probabilities are calculated after having adjusted the constant term for state-based sampling.

table also illustrates the U-shaped influence of *Uncertainty* on the probability of entry, because as *Uncertainty* increases beyond its 90th percentile to the 99th percentile (392.6), the probability of entry increases from 0.89 back up to 1.22 percent. These findings clearly suggest that changes in *Uncertainty* have an economically significant impact on entry.

Table 3 also reveals that the moderating influence of growth options is strong and economically significant. For example, when *Uncertainty* moves from its 10th percentile to the 90th, the probability of entry declines by 48 percent, 50 percent, and 32 percent, respectively, when targeting industries where growth options are small (*Market-to-Book, Growth*, and *Scale Advantages* at their 5th percentile, respectively). However, when focusing on target industries where growth options are large (*Market-to-Book, Growth*, and *Scale Advantages* each at their 95th percentile) the probability of entry actually increases by 11 percent, 35 percent, and 56 percent, respectively, as *Uncertainty* moves from its 90th percentile to its 95th percentile. These findings suggest that properly accounting for growth options can lead to substantial improvement in our ability to predict entry.

Control variables

Since our sample constitutes a wide range of industries, results for control variables may not be directly comparable to studies that focused only on manufacturing industries, such as Montgomery and Hariharan (1991) and Silverman (1999).[18] Nevertheless, the control variables generally have the expected effect. Among the variables unique to this study, *Relatedness* had a positive effect, which suggests that firms are more likely to enter industries that are highly related to an industry in which they already compete. This finding is consistent with predictions from the resource-based view.

DISCUSSION

Assumptions about a negative relationship between uncertainty and investment have dominated empirical attempts to validate the explanatory power of real options theory in the last 10 years. Such a focus assumes that firm decision-making is dominated by the option to defer investment in the face of uncertainty and ignores the possibility that growth opportunities are also enhanced with greater uncertainty. We empirically demonstrate that the relationship of uncertainty to entry is not monotonic, as previous research had theorized. We find that throughout 93 percent of the range of uncertainty, uncertainty has a negative effect on entry, implying that the option to defer dominates growth options in most contexts. However, the value of growth options outweighs the value of deferment options at high levels of uncertainty (i.e., beyond the 93rd percentile) and induces a positive effect of uncertainty on entry. Furthermore, the turning points may be much lower when firms target industries offering larger growth options. Our findings are the first to find support for the nonmonotonic effect of uncertainty that has only recently emerged in theoretical treatments of real options theory, and amplify the importance of considering both the option to defer and the option to grow when contemplating entry.

Some discussion of our findings pertaining to intangible assets is warranted. While we postulated that an industry's ratio of intangible assets to total assets approximated irreversibility, we found that more intangible assets accentuate the U-shaped relationship of uncertainty on entry. One possible explanation is that greater levels of investment in intangible assets may actually be associated with greater growth options, in addition to greater irreversibility. Myers (1977) actually postulated that the proportion of intangible assets to tangible assets represents the proportion of growth options to assets in-place. It may also be that early entry may be more important when competing on R&D or brand equity. Thus, while there is some empirical and theoretical precedent for using intangibles to approximate irreversibility, our results suggest that its effect on growth options dominates concerns about irreversibility.

Our findings should be particularly interesting to scholars of strategic management, who have long recognized that certain projects should be undertaken because they have 'strategic' value. Although managers seldom use real options theory in capital budgeting, our empirical evidence suggests that they recognize subtle factors that alter the value of growth opportunities. This is encouraging for scholars who believe that real

[18] An unreported model concentrating only on the manufacturing industry produced results for our control variables that correspond closely to these previous findings.

options theory is an economic explanation for certain aspects of managerial intuition. Our evidence suggests that real options theory enriches the study of entry from the perspective of industrial organization. While the structural conditions of industries clearly influence expected performance in those industries, our results also suggest that managers are constantly factoring uncertainty into their entry decisions. Moreover, many of the factors that have been traditionally related to industry structure (and hence expected performance) also seem to have important threshold effects, as evidenced by their significant interaction with uncertainty. It is possible that industrial organization research has overemphasized the performance effects of structural attributes. Our real options approach suggests that much of the influence that such attributes have on entry may be due to their threshold effects. Researchers should consider the threshold effects induced by structural attributes, to the extent that they correlate with irreversibility or growth opportunities.

We have also demonstrated that real options theory enriches the study of entry from the perspective of resource-based theory. Uncertainty has a potent effect on entry even after controlling for firm resource profiles, including the relatedness to the target industry. Previous applications of the resource-based view have focused on performance effects and ignored the possibility that firm-specific thresholds for investment may either induce or restrict entry. There remain many fruitful opportunities for further work in this realm. For example, while we have controlled for firm-level factors, our work emphasizes how industry-level factors influence option value. Resource-based and knowledge-based views will help in deducing how firm-level differences influence option value. For example, firms with higher absorptive capacity may have lower investment thresholds because they are better suited to capitalize on growth options. We can also conjecture that differences in firm reputation or managerial capability may also affect investment thresholds due to their impact on growth opportunities. Thus, firm-level factors may help to explain why some firms enter and others do not in the face of similar industry characteristics, an issue that has not been satisfactorily resolved in either the real options literature (Carruth *et al*., 2000) or in work on early mover advantages (Lieberman and Montgomery, 1998).

We believe that this research provides a generalizable statement on the importance of growth options for entry decisions by diversified firms. The need for such an approach should not be underemphasized. Nevertheless, we may be underemphasizing the importance of growth options because we lack data that may allow for a more precise evaluation of the various factors that influence the value of growth options. For example, if we were better able to discern the precise submarket that firms were entering, we would have a better sense for the structural forces that might enable a first mover advantage for growth opportunities. Another factor that may inhibit our ability to observe growth option effects is that we are focusing on existing industries with incumbents. It is likely that the effect of uncertainty turns positive at lower levels of uncertainty in new industries, where first mover advantages are more likely to be pertinent. Future research should examine our hypotheses in the context of new industries.

Despite the noted shortcomings and the broad research agenda ahead, we feel that this research provides an important first step in empirically examining the dueling options present in entry decisions. In general, these results suggest that, consciously or not, managers consider the value of real options and generally recognize the factors that influence their value. We have demonstrated that the effect of uncertainty is not monotonic, on average, and that turning points are influenced by factors that should theoretically influence options to grow and options to defer. Since growth options may lie at the heart of strategic investment decisions, this first step is significant.

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APPENDIX: INDUSTRY CODING SCHEME

Industry	Name	SICs	Industry	Name	SICs
1	Agriculture, Forestry & Fishing	1–10	27	Local Passenger Transit	41
2	Metal and Coal Mining	10–12	28	Trucking/Warehousing	42
3	Oil & Gas Extraction	13	29	Water Transport	44
4	Other Mining	14	30	Air Transport	45
5	Construction	15–17	31	Pipelines	46
6	Lumber & Wood	24	32	Transportation Services	47
7	Furniture & Fixtures	25	33	Communications	48
8	Stone, Clay & Glass Prod.	32	34	Electric, Gas, & Sanitary Serv.	49
9	Primary Metal Indus.	33	35	Wholesale	50–51
10	Fabricated Metal Prod.	34	36	Retail	52–59
11	Machinery	35	37	Banking & Credit Agencies	60, 61
12	Electric, Electronic & Instruments	36, 38	38	Security & Commodity Brokers	62
13	Autos & Equipment	371	39	Insurance Carriers	63
14	Other Transp. Equip.	372–379	40	Insurance Agents & Brokers	64
15	Misc. Manufacturing Indus.	39	41	Real Estate & Holding	65–67
16	Food Products	20	42	Hotels/Lodging	70
17	Tobacco	21	43	Personal Services	72
18	Textile	22	44	Business & Misc Professional Serv.	73, 84, 87
19	Apparel	23	45	Auto Repair, Services & Parking	75
20	Paper	26	46	Misc. Repair Services	76
21	Printing	27	47	Motion Pictures	78
22	Chemicals	28	48	Amusement/Recreation	79
23	Petroleum & Coal Products	29	49	Health Services	80
24	Rubber & Plastic Products	30	50	Educational Services	82
25	Leather Products	31	51	Social Services	83
26	Railroad Transportation	40			