FOREIGN DIRECT INVESTMENT AND PROCESSED FOOD TRADE

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FOOD MULTINATIONAL ENTERPRISE INVESTMENT STRATEGIES: AN OPTION THEORY APPROACH

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This paper analyzes food firms' internationalization in the late eighties as a strategy process. The entry mode decisions of multinational food firms are conceptualized with a compound option model. The solution of this model provides a decision rule indicating which entry mode firms should choose under alternative investment settings. The option model received substantial support as a behavioral investment model. The existence of vertical synergies between the parent firm and the venture, market size, and market growth, were found to favor ownership of subsidiaries abroad. High host market uncertainty, and investment in non-core businesses were found to favor shared ventures. Strong distribution synergies between the firm and its ventures were found to be negatively associated with investment failure. In addition, the accumulation of horizontal and differentiation synergies was found to be negatively associated with firm's tendency to choose shared ventures.

Introduction

International investment decisions have been analyzed primarily on a project-by-project basis, using the net present value (NPV) approach to capital budgeting (*e.g.*, Contractor). Studies following this approach have two serious shortcomings. First, they have not taken into account the existence of synergies among ventures belonging to the same multinational firm. And second, they have not properly captured management's ability to choose the timing for making irreversible investments under uncertainty (Pindyck).

Unlike the NPV approach, real option-theory explicitly recognizes that many projects are not independent. Rather, projects are interrelated (have compound growth options). Moreover, management's flexibility to adapt its future actions, contingent on future events, introduces an asymmetry in the

distribution of the values of projects. This asymmetry raises an investment opportunity's value relative to the standard NPV, because future management's decisions can improve upside potential, while at the same time limiting downside losses. Projects' interdependence and managerial flexibility require an expanded NPV criterion, one which includes a premium for the flexibility embedded in the projects' operating options. This premium is equivalent to the opportunity cost of either discarding or exercising an investment option. Studies have shown that the required premia are large, which may account for the poor performance of neoclassical models of investment behavior (Dixit and Pindyck).

The analysis of decisions involving the choice of international market entry modes provides interesting insights into the usefulness of real option theory to explain the dynamics of multinational expansion (Kogut). The task of building competitive capabilities and strong market positions requires large resource commitments. It is frequently beyond the resources of a single firm to finance expansion in all potential market opportunities. Partnerships enable the firm to share the risks associated with placing the bet that the opportunity will be realized, and may decrease the total investment cost to an affordable level. If the decision to create a shared venture derives from the prospect of expanding into a new market, which can materialize after additional information reduces environmental uncertainty, then this decision is equivalent to buying a call option. However, the decision to exercise this option is likely to promote the divestiture of the venture by all but one of the partners. This is because the value of the investment includes both the cash flows generated from current assets and those generated from asset redeployment or future expansion (Myers). The latter cash flows are only realized if the business is expanded, and therefore exercising the option requires further commitment of capital and renegotiation among the partners. Since the partners usually place different value on this new capital commitment, according to the levels of synergy between the project and their overall organizations, the expected outcome is that the party placing the higher value on this new capital commitment buys out the others (Kogut). The acquiring partner then positions himself to fully capture the project's value

without being constrained by agreement-bound formulae (*e.g.*, a fixed fee or royalty) or by the divergent objectives of the other partners. When the acquiring partner buys out the other partners' shares in the venture (strikes his call option), he faces internalization costs which are lower than those he faced when he first established the shared venture (or purchased the option). Furthermore, through exercising the option he also reduces transaction costs, which include negotiation and transfer costs, the opportunity costs of foregone direct business, and the risk of creating future competitors.

The purpose of this paper is to describe and test a model of the entry-mode decisions of multinational food firms. We employ a compound option model to capture the strategic internationalization process of multinational enterprises (MNEs) under alternative market environments. The solution of the model is a decision rule that optimizes the choice of a portfolio of wholly owned foreign affiliates or shared ventures. The comparative-static results in turn provide a number of testable hypotheses concerning the roles played by sourcing, distribution, or technological synergies; host-market characteristics; and the degree of oligopolistic rivalry in determining the choice among four investment modes.

A multinomial logit analysis (MNL) was applied to data gathered on 2,465 international ventures located in 66 countries belonging to the world's largest multinational food manufacturing companies. These companies made 1,007 investment decisions during the years 1987-1991. We find that the great majority of our hypotheses are supported by the data.

Model Description

A distinction is made between investment modes involving major and minor resource commitments. Investment modes involving minor resource commitments correspond to shared ventures, whereas those involving major resource commitments correspond to wholly owned subsidiaries. In this paper's model, it is assumed that two critical differences distinguish shared ventures from wholly owned subsidiaries (see Ravara 1994). First, in order to develop a wholly owned subsidiary, the firm has to incur investment costs. When the firm engages in a shared venture, investments are

reversible (no sunk costs). And secondly, only wholly owned subsidiaries generate current incomes which can be appropriated by the parent firm. That is, shared ventures have only option value, which is contingent upon the value of the corresponding wholly owned subsidiaries obtained after development. Shared ventures are temporary investment vehicles, which will either disappear or be converted into wholly owned subsidiaries at some point in time.

Most previous real option models assumed that each investor owned a single undeveloped asset, which could become a developed asset by paying a strike price or development cost (Titman; Clarke and Reed; Brennan and Schwartz; Padock and Siegel). Departures from this assumption have been scarce (*e.g.*, Williams; Dixit and Pindyck), but are critical to incorporate the effects of strategic interaction among firms into the analysis of their investment decisions. Our model also departs from the proprietary/single asset perspective. First, it assumes that firms compete to accumulate capacity and fulfill demand within each market. Second, it assumes that firms may have simultaneous access to multiple shared ventures within a market, and ultimately decide to develop only a sub-set of these ventures into wholly owned subsidiaries.

In the model, each firm has initial access to a portfolio of shared ventures within the market for those ventures' output. Market size is assumed to grow stochastically over time. Engaging in shared ventures is analogous to selling short a given amount of output from those ventures (buying a call option). At some point in time, the firm may decide to select a subset of its shared ventures within the market and acquire the shares of its partners in those ventures, thereby converting them into wholly owned subsidiaries. The firm will then use these subsidiaries as vehicles to expand its activities within the market. In subsequent periods, the firm will further develop internally these subsidiaries, trying to catch up with market growth. The remaining shared ventures will loose strategic importance to the firm and will be divested. As long as the market keeps growing over time, the firm can always marginally increase its market presence. Thus the option to expand in the market never expires, and each new round of financing corresponds to exercising an additional stage in a compound option with infinite stages.

Each firm is a player in a Cournot game with conjectural variations specific to each of its ventures' output markets. A firm's current market sales is derived from an expression for the optimal output from aggregate subsidiaries' sales in that market. In order to attain its optimum output goal in a market, the firm develops an optimal number of wholly owned subsidiaries; the optimum is derived as the Cournot solution to a capital accumulation game involving all the multinational firms in the market.

Three stylized facts of multinational firms' growth are explicitly incorporated in the options model. (i) When a multinational firm behaves as an oligopolist, its actions can affect output market prices, and thereby the sales of all firms' subsidiaries in the market. How each firm responds in equilibrium depends partly on the degree of rivalry among firms. (ii) If firms face increasing marginal costs of subsidiary development, then the aggregate cost of subsidiary development depends on the aggregate demand for subsidiary development, which is a function of the untapped demand for the aggregate output from developed subsidiaries. The resulting equilibrium affects each firm's optimum exercising policy and imposes restrictions on the number of shared ventures that are actually developed into wholly owned subsidiaries. (iii) The model permits firms to hold a portfolio of shared ventures within each market. The development of wholly owned subsidiaries causes the upside potential value of the remaining shared ventures belonging to the firm's portfolio to fall. Therefore, the calculation of the net capital gain from developing subsidiaries takes into account the expected negative impact of development upon the value of the firm's undeveloped shared venture portfolio, as well as the impact of possible retaliation by the firm's partners in such ventures.

The model is setup in three stages (Ravara 1994, 42-49). First, from Cournot first-order profit-maximization conditions an expression for each project's current income is derived. Second, the issue of change in project's income over time is addressed. This implies determining expressions for market growth and for the dynamics of wholly owned subsidiary supply. And finally, the results from the first two stages are incorporated into two option

valuation expressions to determine the market values of the portfolios of shared ventures and wholly owned subsidiaries.

Model solution

Following Williams (1992), the model is solved in five steps. First, it is temporarily assumed that there is a finite and non-negative level of current income $y = y^*$ from each wholly owned position, above which MNE *i* is willing to convert a shared position *j* into the corresponding wholly owned position *j*. Second, we solve for F, the asset value of wholly-owned subsidiaries. Third, the expression for F is used to derive an expression for G, the value of shared ventures. Fourth, the values of F and G are used to find the switching point y^*. And fifth, the switching point y^* is shown to verify the temporary assumption in the first step above. The detailed steps of this problem's solution can be found in Ravara (1994, 50-56).

Let π represent a generic parameter. Investment mode decisions are determined by the values assumed by the function $H(y|\pi)$, which is defined as follows:

[1] $H(y|\pi) = F\text{-}G\text{-}\omega\ y\ G'\text{-}K_i$, where ω is, G' is, and K_i is .

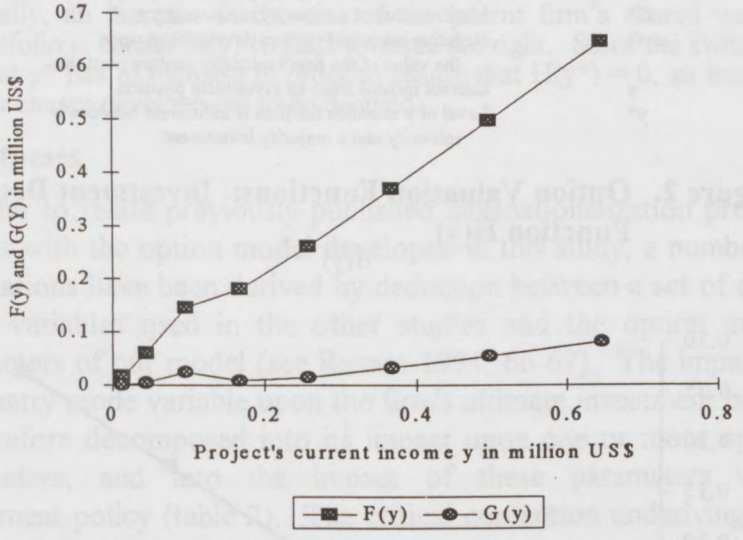
It can be proved (Williams 1992; Ravara 1994) that the unique root of equation (1), or the solution to $y = y^*$ of $H(y|\pi) = 0$, is the current income level at which the MNE is indifferent between keeping a shared or a wholly-owned position on market-segment *s* over time period *t*. Moreover, this root satisfies the condition $H'(y^*|\pi) > 0$. Under these conditions, it can be concluded that a sufficient condition for development to be delayed when the value of parameter π increases is that $H(y^*|\pi)$ be decreasing in π. $H(y|\pi)$ is decreasing on a parameter π when F is small compared to G and $\omega y G'$ (the impact of developing a wholly-owned position upon the value of the remaining shared ventures in the parent firm's portfolio). With financial options, the first term in (1) is independent from all parameters, and the third term is zero. Therefore, a larger value of a parameter π increases the switching point y^* and thereby defers optimal exercise of the option if and only if it also increases the value of the option at y^*, $G(y^*|\pi)$. On the other hand, with real options and either perfectly competitive

conditions among MNEs or an infinite proportion of independent ventures relative to MNE's subsidiaries, larger parameter values increase the switching point y* if and only if they also increase the difference between the values of the shared and wholly-owned positions at y*, $G(y^*|\pi)-F(y^*|\pi)$. Finally, with real options, and either imperfect competition among MNEs, or a non-zero proportion of MNE's ventures relative to independent ventures, larger values of π defer the option exercise if and only if they decrease the value of the difference $F(y^*)-G(y^*) -\omega yG'(y^*)$.

Comparative-static results

The geometry of the functions F(y), and G(y) is presented in figure 1. For a given y, F(y)-G(y) is always non-negative.

Figure 1. Option Valuation Functions: Value of F(y) and G(y)



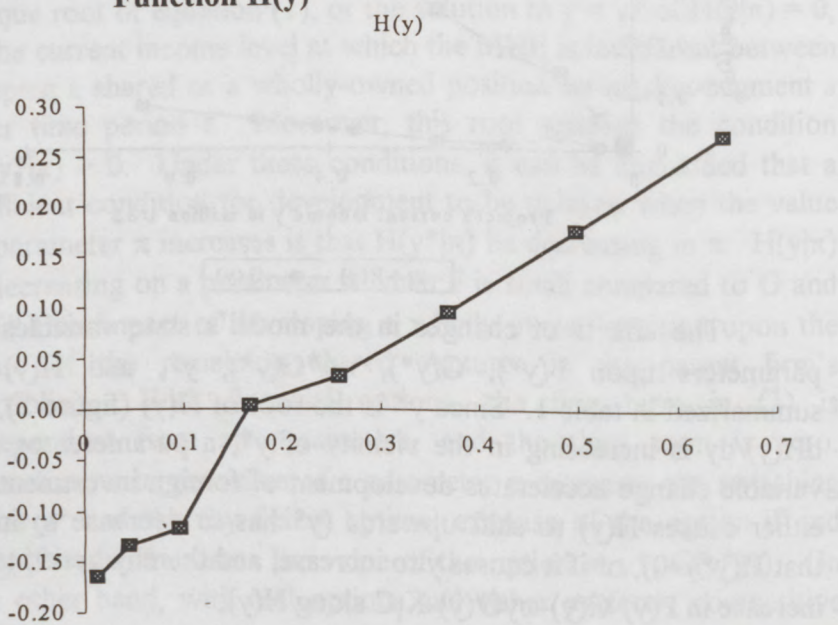
The effects of changes in the model's state variables and parameters upon $F(y^*)$, $G(y^*)$, $\omega y^*G(y^*)$, y^*, and H(y) are summarized in table 1. Since y* is the root of H(y) (figure 2), and dH(y)/dy is increasing in the vicinity of y*, a parameter or state variable change accelerates development of foreign investment if it either causes H(y) to shift upwards (y* has to decrease to insure that $H(y^*)=0$), or if it causes y to increase, and thereby generates an increase in $F(y)-G(y)-\omega yG'(y)-K_iC$ along H(y).

Table 1. Option Model of MNE Investment: Summary Comparative-static Results

	Parameter	κ	s	e	β	C	μ	σ	λ	ω	ι	x	q
	subscripts	*si*	*si*	*s*	*s*	*si*	*s*	*s*	*si*	*i*	*s*	*s*	*s*
Variable	F*	0	0	0	-	+	+	-	-	0	-	0	0
	G*	0	0	0	-	-	+	-	-	-	-	0	0
	ωyG	0	0	0	-	+	+	-	-	+	-	0	0
	y*	0	0	0	+	+	-	+	+	+	+	0	0
	y	-	+	-	0	0	0	0	0	0	0	+	-

	s	Market segment subscript
	i	Parent firm subscript
κ	si	Slope of firm i's marginal cost function in market s
s	si	Market share of firm i in market s
C	si	Investment cost disadvantage of firm i in market s
μ	s	Annual growth rate of market s
σ	si	Annual sales variance faced by firm i in market s
λ	si	Firm i's risk aversion coefficient in market s
ω	i	Number of undeveloped ventures in firm i's portfolio
ι	s	Risk-free interest rate in market s
x	s	Size of market s in dollars
q	s	Number of MNEs' developed ventures in market s
F*		Market value of a majority position at y = y*
G*		Market value of a minority position at y = y*
ωyG		Negative impact of venture development upon the value of the firm's minority venture portfolio
y		Current income from an investment position
y*		Level of y at which the firm is indifferent between a minority and a majority investment

Figure 2. Option Valuation Functions: Investment Decision Function H(y)



The predicted relationships seem intuitively credible. For example:

1. Increases in s and x cause $F(y)-G(y)-\omega yG'(y)-K_iC$ to increase along H(y), whereas increases in κ, |e|, and q have the opposite effect. None of these five state variables and parameters has any direct impact upon y^*. Everything else being equal, the model predicts that firms with low marginal production costs κ and firms with large market shares *s* operating within markets with small |e|, are expected to prefer high commitment investment modes.
2. An increase in the potential aggregate development rate β causes investing MNEs to be less constrained. With an increase in β, F decreases by proportionately more than $G + \omega yG'$ and therefore H(y) shifts towards the right, y^* increases, and development is delayed.
3. The net effect of an increase in C is a backward shift in H(y), which in turn causes y^* to decrease, and thereby accelerates development.
4. Similarly to what occurs with financial options, an increase in the market growth rate μ tends to accelerate development, whereas increases in market variance σ, the risk-free interest rate i, or the risk aversion coefficient λ, tend to delay development.
5. Finally, an increase in the size of the parent firm's shared venture portfolio ω causes H(y) to shift towards the right. Since the switching point y^* has to increase in order to ensure that $H(y^*) = 0$, an increase in ω causes development to be delayed.

Hypotheses

In order to relate previously published internationalization process studies with the option model developed in this study, a number of associations have been derived by deduction between a set of entry mode variables used in the other studies and the option model parameters of our model (see Ravara 1994, 66-67). The impact of each entry mode variable upon the firm's ultimate investment policy is therefore decomposed into its impact upon one or more option parameters, and into the impact of these parameters upon investment policy (table 2). The critical contention underlying this procedure is that the levels of the option model parameters included in this study are the key drivers of managers' investment decisions and that most entry mode variables which have been previously identified in the literature can therefore be related directly to these parameters.

The (+) and (-) signs correspond to hypothesized relationships between specific model parameters and entry mode variables.

Table 2. Model Variables and Comparative-static Results

	Parameters and state variables											Endogenous variables				
Independent variables	κ	s/|e|	β	C	μ	σ	λ	ω	ι	x	q	F*	G*	ωy*G'*	y*	y
A - Synergies MNE / venture																
X1 brand synergies		+		-								-	+	-	-	+
X2 sourcing synergies	-			-								-	+	-	-	+
X3 horizontal synergies	-			-								-	+	-	-	+
X4 distribution synergies	-	+		-								-	+	-	-	+
X5 R&D synergies	-											0	0	0	0	+
B - Macro environment variables																
X6 Host market size			+							+		-	-	-	+	+
X7 Host market demand growth			+		+							+	+	+	-	0
X8 Host market demand uncertainty						+						-	-	-	+	0
C - Competitive interaction																
X9 current rivalry				+							+	+	-	+	+	-
X10 Risk of opportunity expiration			+		-					-		-	-	-	+	-
X11 Strategic alliance factor								+				0	-	+	+	0
D - Investment option (focus/diversif.)																
X12 Focus	-	+		-	-							-	+	-	-	+

Note: For definitions of parameters and endogenous variables, see table 1. For construction of the independent variables see (Ravara, 1994 or Ravara, 1995)

The last five columns on the right side of table 2 include the expected impacts of the entry mode explanatory variables upon F(y*), G(y*), ωyG'(y*), y*, and y. These columns were built through combining (1) the relationships between the explanatory variables and the model parameters, with (2) the impacts of the parameters upon F(y*), G(y*), ωyG'(y*), y*, and y. Generally, the existence of synergies between the parent MNE and the venture, and large host market size and growth are expected to favor high commitment entry modes. On the other hand, high host country risk, large cultural distance between the parent firm home and host countries, high demand uncertainty in the host market, and investments in non-core businesses are expected to be associated with low commitment investment modes.

The signs presented in table 2 suggest eight testable hypotheses. These hypotheses are verified by two regression analyses reported in the following sections. The reasoning supporting the hypotheses is more fully explained in Ravara (1994, 68-78).

H1: Brand and distribution synergies reflect product differentiation capabilities, and are therefore associated with increased s/|e| (table 2). In addition, horizontal, sourcing, distribution, and technology synergies are associated with decreased operating costs κ. Finally, brand, horizontal, sourcing and distribution synergies are associated with decrease in the internalization cost C that the investing firm faces when it starts operating a new venture.

H2: Investment in large rapidly growing markets is associated with high commitment / high control investment modes.

H3: Investment in markets with great uncertainty created by variation in demand, host country-home country cultural distance, or political-social risk is associated with low commitment/low control investment modes.

H4: Investment in market segments characterized by high levels of current rivalry among competing MNEs is associated with low commitment / low control investment modes. The competitive environment was evaluated along three dimensions: (1) level of current rivalry among MNEs, (2) risk of investment opportunity expiration, and (3) existence of shared positions between MNEs within a market segment.

H5: When a MNE faces the prospect of a drop in the value of its investment opportunity within a market caused by the entry of other firms, it tends to either delay its investment decision (if it cannot preëmpt its rivals from entering the market) or to invest aggressively (if it can preëmpt its rivals). Specifically, the number and strategic importance of shared ventures that an MNE holds within a market-segment tends to inhibit aggressive investment by that MNE within the region of influence of its shared ventures.

H7: Investments leading to consolidation of market positions which were previously held by an investing MNE tend to be characterized by high commitment investment modes, whereas investments leading to diversification and purchase of new growth opportunities tend to be characterized by low commitment investment modes[1].

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[1] Previous studies have suggested that investments in projects which can serve the purpose of acquiring options on environmental opportunities tend to be associated with low initial commitment of resources (*e.g.* Kogut, 1983, 1991; Hurry, Miller and Bowman, 1992; Hurry, 1991). On the other hand, projects that serve as vehicles to explore opportunities (or call options) which have been previously recognized by the firm, generally involve stronger commitment of resources. In this study, investments oriented towards the consolidation of market positions previously held by the MNEs are assumed to be associated with some form of cost advantage (reduced κ or C) relative to investments leading to diversification and exploration of new options by the MNE.

Multinomial Logit Model

The dependent variables in the logit model are the logarithms of the odds that a particular investment mode will be chosen, and the independent variables are the synergy, environmental, and investment type variables listed in the leftmost column of table 2. In particular, four institutional investment mode choices were considered (divestiture, minority shared investment, majority shared investment, and acquisition), with respective probabilities P_1, P_2, P_3, P_4. The general model is specified as follows (Schmidt and Strauss):

$$[2] \qquad \log_e\left(\frac{P_{ij}}{P_{ir}}\right) = \beta'_j X_i,$$

where

P_{ij} = probability that the investment *i* is of the institutional mode *j* = 1, 2, 3, and r is the reference mode (numeraire), X_i = a vector (1∗ 12) of the independent variables for the i^{th} entry observation, and $\beta'j$ = a vector (12 ∗ 1) of parameters of the independent variables for the j^{th} institutional mode.

In order to compare all possible pairs of choices concerning firm's investment mode, three specifications of the model are considered. In these three specifications, the estimated parameters are successively interpreted in reference to acquisitions, minority investment positions, and majority shared investment positions. The left hand-side of each equation (2) is the logarithm of the ratio of the probabilities with the denominator being associated with acquisitions in specification 1, minority investment positions in specification 2, and majority shared positions in specification 3. The three equations in (2), plus the requirement that the probabilities for every *i* sum to one, determine the probabilities uniquely. Explicitly, the solution for each specification is as follows:

$$P_{ir} = \frac{1}{1 + \sum_{j=1}^{3} e^{X_i \beta_j}}, \text{ and}$$

$$[3] \qquad P_{ij} = \frac{e^{X_i \beta_j}}{1 + \sum_{j=1}^{3} e^{X_i \beta_j}} \text{, with } j = 1,2,3.$$

This model was estimated by maximum likelihood, with the likelihood function being specified as follows:

$$[4] \qquad L = \prod_{i \in \theta_r} P_{ir} \cdots \prod_{i \in \theta_j} P_{ij},$$

where $\theta_l = \{ i \mid j^{th}$ institutional investment mode is observed.

By differentiating (3), the marginal effects of the regressors on the probabilities were:

$$[5] \qquad \frac{\partial P_j}{\partial X} = P_j * [\beta_j - \sum_{k \neq j} P_k \beta_k].$$

The likelihhod ratio test is adopted to assess the model's overall fit. The hypothesis that all of the slope coefficients are zero can be tested if the regressor vector includes a constant term (Greene 1990). Then, the restricted log likelihhod function is then defined as follows:

$$[6] \qquad \ln L_0 = \sum_{j=0}^{4} n_j \ln P_j .$$

where P_j is the sample proportion of observations that make choice j. The associated likelihood ratio[2] is:

$$[7] \qquad LRI = 1 - \frac{\ln \hat{L}}{\ln L_0}.$$

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[2] The likelihood ratio is bounded by zero and one. If all of the slope coefficients are zero, it equals zero; it increases as the fit of the model improves, and it approaches one asymptotically as the model approaches perfect fit. The measure above presents some limitations, including that (1) values between zero and one have no natural interpretation; and (2) the maximum likelihood estimator is chosen to maximize the joint density of the observed dependent variables, and not specifically a fitting criterion based on prediction of y (as is the maximization of R^2 in classical regression). In order to complement the likelihhod ratio as a measure of overall model fit, a table listing the model's hits and misses was developed.

The multinomial logit model is specified from equation (2) as follows, with complete definitions given in (Ravara 1994, 82-96, and Ravara 1995) and short definitions in table 2:

$$[8] \quad \ln_e [P(OPER_{jitcap}= j)/P(OPER_{jitcap}) = \alpha + \beta_1*X_1+ \beta_2*X_2 + \beta_3*X_3 + \beta_4*X_4 + \beta_5*X_5 + \beta_6*X_6 + \beta_7*X_7 + \beta_8*X_8 + \beta_9*X_9 + \beta_{10}*X_{10} + \beta_{11}*X_{11} + \beta_{12}* X_{12}$$

where:
j = 4-digit N.A.C.E industry code (Statistical Office of the European Community, 1985),
i = product category within each industry *j*, (each combination of *j* and *i* defines a product at the 6-digit N.A.C.E industry code level)
t = year,
c = country,
a = geographic region, and
p = parent firm.

Sample

The sample includes 1004 structural operations involving food manufacturing activities over the period 1987-1991. Only large multinational food groups were considered, each of which realized more than one billion dollars in food sales in 1988. Three large food subsidiaries were also included in the sample. These were BP-Nutrition (subsidiary of British Petroleum), Provendor (subsidiary of Volvo), and SME (subsidiary of IRI).

This study spans 16 food related industries and seven geographic regions including a total of 66 countries (Ravara 1994, table 4.2). Although structural operations involving the sampled firms occurred in only 42 of these countries, the measurement of both the regional market variables and the regional firm's synergy variables was based on information concerning 2465 ventures dispersed throughout 7 world regions. Three geographic regions (Africa, South-Central Asia, and the Middle East) were excluded from the sample because the number of MNE's structural operations which took place in those regions between 1987 and 1991 was very small (less than 2% of the universe in each region).

Data Sources

The dependent variable $OPER_{jitcap}$ was measured using information extracted from the database Agrodata (1990). The other variables were measured using information extracted from various sources, including Agrodata (1990), the OECD 1979-91 detailed National Accounts tables (OECD 1993); the United Nations Statistical Yearbook (United Nations 1980-91); the World Bank Social Indicators of Development 1993 (World Bank 1993); and the Bureau of Labor Statistics' United States input-output tables (Bureau of Labor Statistics 1980). For a description of the variable measurement procedure see Ravara (1994).

Results for Investment Behavior

Since the goodness-of-fit statistics (the residual chi-squares) are insignificant, it can be concluded that the data fits the model. The estimated model's coefficients, standard deviations and p-values are presented in table 3.

Table 3. Logit Model Coefficients (b), Standard Deviations (s), and Prob. t>t*, /1

Dep. variable	Result	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
log(P1/P4)	b	-0.0377	-0.0022	-0.0013	-0.0393	0.0024	0.0007	-11.4269	-0.3338	-0.7150	0.2251	-0.0475	-0.7060
	s	0.0103	0.0070	0.0014	0.0343	0.0013	0.0007	6.8159	0.1236	0.3878	0.0443	0.3652	0.1570
	P(t>t*)	0.0002*	0.7515	0.3426	0.2516	0.0724	0.2884	0.0936	0.0069*	0.0652	0.0000*	0.8965	0.0000*
log(P2/P4)	b	0.0010	-0.0699	-0.0020	-0.2185	-0.0006	-0.0015	-37.0237	0.3397	-1.5333	-0.0951	0.7502	-0.5702
	s	0.0141	0.0314	0.0018	0.0659	0.0042	0.0016	9.8599	0.1146	0.9948	0.0691	0.4113	0.2120
	P(t>t*)	0.9454	0.0260*	0.2714	0.0009*	0.8814	0.3434	0.0002*	0.0030*	0.1233	0.1685	0.0682	0.0072*
log(P3/P4)	b	-0.0095	-0.0368	-0.0014	-0.1965	0.0018	-0.0032	-19.7960	0.4262	-0.5620	-0.0980	0.8145	-0.0989
	s	0.0117	0.0148	0.0014	0.0486	0.0014	0.0014	6.3155	0.0916	0.4378	0.0546	0.3334	0.1730
	P(t>t*)	0.4152	0.0128*	0.3002	0.0001*	0.2087	0.0223*	0.0017*	0.0000*	0.1993	0.073	0.0146*	0.5675
log(P1/P2)	b	-0.0389	0.0677	0.0007	0.1782	0.0023	0.7410	25.1726	-0.6736	0.0035	0.3396	-0.6282	-0.1531
	s	0.0157	0.0316	0.0021	0.0693	0.0017	1.0034	10.9816	0.1480	0.0048	0.0731	0.4785	0.2322
	P(t>t*)	0.0134*	0.0322*	0.7317	0.0102*	0.1776	0.4602	0.0219*	0.0000*	0.4570	0.0000*	0.1892	0.5097
log(P3/P2)	b	-0.0108	0.0332	0.0006	0.0198	-0.0017	0.9069	16.9035	0.0815	0.0029	0.0110	0.1704	0.4577
	s	0.0160	0.0336	0.0020	0.0757	0.0020	1.0011	10.3004	0.1077	0.0048	0.0761	0.4261	0.2299
	P(t>t*)	0.4998	0.3228	0.7542	0.7935	0.3825	0.3650	0.1008	0.4490	0.5417	0.8852	0.6892	0.0465*
log(P1/P3)	b	-0.0275	0.0345	-0.0000	0.1583	0.0040	-0.1446	8.7023	-0.7577	0.0006	0.3096	-0.9715	-0.5853
	s	0.0136	0.0154	0.0017	0.0537	0.0015	0.5264	8.1963	0.1326	0.0014	0.0595	0.3940	0.1989
	P(t>t*)	0.0440*	0.0256*	0.9743	0.0032*	0.0074*	0.7836	0.2884	0.0000*	0.6689	0.0000*	0.0137*	0.0033*

1/
P1 = Probability that a divestiture is chosen
P2 = Probability that a minority shared agreement is chosen
P3 = Probability that a majority shared agreement is chosen
P4 = Probability that an acquisition or greenfield investment is chosen
* $P(t > t^*) < 0.05$

Hypothesis H1 is only partially supported, because no significant association was found between firm's brand power

within a host market (X_1) and its preference for wholly owned subsidiaries over shared majority and minority ventures in that market. However, the ability of the parent company to leverage brand synergies to its ventures has a negative impact upon the probability that the company divests its ventures relative to choosing any other type of structural operation, (including the creation of both minority and majority shared ventures, and the development of wholly owned subsidiaries). Moreover, the ability of the parent firm to transfer manufacturing technology and know-how to its core-business ventures does not have the expected relationship with firm's choice of investment mode. The coefficient of X_5 associated with the probability that the investing firm chooses a divestiture over a majority shared venture is positive. Food MNEs tended to sell their positions in high R&D ventures during the period of analysis. Finally, the ability of a parent firm to leverage horizontal synergies (X_3) to its new ventures has no impact upon the firm's choice of investment mode.

However, a firm's ability to leverage *vertical* synergies to its ventures, including both sourcing and distribution synergies, are significant and consistent with the option model's predictions. The coefficients of the variables for sourcing and distribution synergies (X_2 and X_4) are negative and significant for subsidiaries. These results are particularly significant for distribution synergies. On the other hand, vertical synergies are also associated with a tendency of firms to give preference to divestitures over shared ventures, which probably reflects a tendency towards increasing specialization after a period of intense merger activity in the 1980s.

Hypothesis H2 receives support. The results suggested that firms investing in large markets (X_6) prefer to engage in high commitment investment modes. Moreover, firms investing in a growth market prefer high commitment investment modes. The results indicated that firms investing in high-growth markets prefer acquisitions over any form of shared venture, and prefer to engage in majority rather than minority shared ventures.

Hypothesis H3 receives strong support. Although firms do not avoid investing in markets which present high uncertainty (X_8), they clearly prefer to engage in shared ventures rather than develop

wholly owned subsidiaries in those markets. Uncertainty places a premium on the reversibility of investments.

Hypothesis H4 is not supported. High current rivalry is associated with an increased probability that the firm chooses acquisitions or greenfield investments over divestitures. In other words, we find evidence of followership in multinational investing, a pattern first noted by knickerbocker.

Hypothesis H5 is partially supported. The coefficient relating risk of opportunity expiration (X12) to firm's preference for majority shared ventures over wholly owned subsidiaries is negative and significant. However, the coefficients in the case of a firm's preference for divestitures over shared ventures are positive and significant. Overall, the results suggested that a firm facing high risk of investment opportunity expiration avoids shared ventures.

Hypothesis H6 receives support. The coefficient relating a firm's engagement in shared ventures with other MNEs (X_{13}) to the probability that it chooses a shared agreement over a wholly owned subsidiary is positive and significant. This result suggests that firms which engage in shared ventures with other MNEs tend to restrain from investing aggressively in wholly owned subsidiaries within the same regions where they have those shared ventures in effect.

Hypothesis H7 receives strong support. The coefficients relating the investment focus dummy variable (X_{14}) to the probability that the investing firm chooses either a divestiture or a minority shared venture over a wholly owned subsidiary are both negative and significant. Furthermore, the relationship between FOCUS and the probability that the investing firm chooses a divestiture over a minority shared agreement is also negative and significant, and the coefficient relating FOCUS to the probability that the investing firm chooses a majority shared over a minority shared venture is positive and significant.

The assessment of the model's performance is completed by analyzing its predictive power. The model's numbers of hits and misses are reported in table 4. The model's hit ratio is 48.23%. This is almost double the hit ratio of a naive model which assumed that the four alternative investment modes are equally likely to be chosen. It is clear that both the large number of acquisitions relative to other operation types, and the number of subsidiary sales

between sampled firms tend to bias the model towards over-predicting acquisitions and greenfield investments, and particularly towards misclassifying divestitures as acquisitions. Since this results primarily from the intense restructuring activity which took place in the industry between 1987 and 1990, it is likely that the model structure will change and its predictive power will increase if fitted to data from more stable periods.

Table 4. Number of Hits and Misses for Mixed Model /1

		Observed				
		Divest.	Minor	Major	Acquis.	Total
Estimated	Divest.	27	6	7	56	96
	Minor	0	1	0	0	1
	Major	8	10	30	23	71
	Acquis.	148	61	106	338	653
	Total	183	78	143	417	821

Hit ratio = 48.23%

Above chance = 23.23%

/1 Divest. = Divestiture
Minor = Minority shared investment position
Major = 50/50 joint venture or majority shared investment position
Acquis. = Acquisition or greenfield investment

Summary and Conclusions

Overall, the empirical results provide strong support for an investment-choice model derived from real options theory. Goodness of fit and predictive power are both satisfactory. Of the eight hypotheses (proxied by 14 variables), seven were fully or partially supported by 1987-1991 data on more than 2000 overseas ventures of the world's largest multinational food manufacturers.

An active market for ventures during 1987-91 was reflected in a powerful wave of divestitures and acquisitions which introduced some difficulty in the interpretation of the model's results. However, the evidence suggests that the existence of vertical synergies between a firm and its ventures influences the firm's investment behavior in accordance with the option model's predictions. Strong synergies between a firm and its ventures was expected to provide management with an incentive to accelerate the development of its ventures, which, according to the logit model's

results, is what happens in practice. Horizontal and product differentiation synergies are apparently much less critical than vertical synergies in determining a firm's investment mode. However, the results generally suggested that brand synergies have some commitment value, in the sense that their presence restrains firms from divesting those ventures which benefit from brand synergies.

The option model's predictions concerning the impact of macro-environmental variables upon firm's investment decisions are strongly supported. Large host markets and boyant growth motivate MNE's to develop wholly owned subsidiaries, whereas increased market uncertainty tends to inhibit such development. According to the option model, the impact of market size upon venture development can be seen as static, in the sense that it affects the net value of a developed project through its impact on the project's current income, which is an increasing function of market size. On the other hand, market growth and uncertainty are also dynamic factors, in the sense that they affect the relative time values of the options associated with holding on to shared ventures and subsidiaries. Through their differential impact upon these time values, changes in project uncertainty and growth cause the project value function H(y) to shift, thereby moving the switching point y* in order to ensure that $H(y^*) = 0$. The fact that the relationships between both market growth and uncertainty and the firm's choice of investment mode are highly significant provides an additional strong argument in support of the option model, since these dynamic factors are highly associated with the model's core idea that firms implicitly take into account the time value embedded in their investment options.

The results concerning competitive interaction (risk of opportunity expiration and strategic alliances) also provide strong support for the option model. Unlike the other investment decision variables analyzed in this study, which proxy the intensity of signals revealing an upcoming investment opportunity, opportunity expiration measures the intensity of a signal in the opposite direction, associated with the disappearance of an investment opportunity. Since managers typically react more strongly to threats than opportunities (Hurry, Miller and Bowman), an increase

in this variable was expected to be strongly associated with a tendency of firms to either divest, or assume full control of their ventures. The results strongly support this hypothesis. We also found that current rivalry encourages high commitment investments, whereas firms in strategic alliances avoid such investments in the same areas as the alliances.

The hypothesis that firms value the upside value of their portfolios of undeveloped ventures is central to the argument that their internationalization process is the outcome of rationally managing portfolios of options. The negative impact $wy^*G'^*$ of developing wholly owned subsidiaries within a market-segment upon the value of the firm's undeveloped venture portfolio is probably enhanced if the firm is engaged in shared ventures with other large firms within that market-segment. The reason is that, in this case, development by one partner can be seen as opportunistic behavior or lack of commitment to the shared ventures by the other partners. The results in table 4 strongly support this hypothesis, and therefore provide additional support to the option model.

Finally, we find that firms tend to choose higher commitment investment modes when they invest in ventures that substantially increase their horizontal synergies within a market-segment. One interpretation of this result is that firms view investment in new industries or regions as the acquisition of growth options on environmental opportunities, whereas they view follow-up investments as the exercise of previously acquired options.

References

Agrodata. *Les 100 Premiers Groupes Agro-Alimentaires Mondiaux.* Reseau Agropolis Strategies. Montpellier, France (1990).

Brennan, M., and E. Schwartz. "Evaluating Natural Resource Investments Under Uncertainty." *Journal of Business* 58 (1985): 135-57.

Bureau of Labor Statistics. "Historical and Projected Input-Output Tables of the Economic Growth Project." Vol. 1. *Direct Requirements Tables*. US Department of Labor. Washington, D.C. (1980).

Clarke, H., and W. Reed. "A Stochastic Analysis of Land Development Timing and Property Valuation." *Regional Science and Urban Economics* 18 (1988): 367-82.

Contractor, F. "Contractual and Cooperative Forms of International Business: Towards a Unified Theory of Modal Choice." *Management International Review* 30 (1990): 31-54.

Dixit, A. and R.S. Pindyck. *Investment Under Uncertainty*. Princeton University Press, New Jersey (1994).

Euromoney. *Country Risk Ratings*. Euromoney Publications, London (September 1986-September 1992).

Greene, W.H. *Econometric Analysis*. Macmillan Publishing Co., New York (1990).

Hurry, D., A.T. Miller, and E.H Bowman. "Calls on High-Technology: Japanese Exploration of Venture Capital Investments in the United States." *Strategic Management Journal* 13 (1992): 85-101.

Kogut, B. "Foreign Direct Investment as a Sequential Process." *The Multinational Corporation in the 1980s*, ed. Kindleberger and Audretsch. Boston M.I.T. Press (1983).

Kogut, B., and H. Singh. "The Effect of National Culture on the Choice of Entry Mode." *Journal of International Business Studies* 19 (1988): 411-432.

Myers, S.C. "Determinants of Corporate Borrowing." *Journal of Financial Economics* 5 (1977): 147-75.

OECD-Department of Economics and Statistics. *National Accounts. Detailed Tables*. Vol. 2. Paris (1993).

Padock, J.L, D.R. Siegel. "Option Valuation of Claims on Real Assests: The Case of Offshore Petroleum Leases." *The Quarterly Journal of Economics* (August 1988): 479-508.

Pindyck, R. "Irreversibility, Uncertainty, and Investment." *Journal of Economic Literature* 29 (1991): 1110-1148.

Ravara, F.A. *Food Multinational Enterprises Investment Strategies: an Option Theory Perspective*. Ph.D. thesis, Department of Agricultural Economics, Purdue University, West Lafayette, IN (1994).

Ravara, F.A. *Food Multinationals' Investment: an Option Theory Approach*. Working paper series, Universidade Nova de Lisboa (1995).

Schmidt, P., and R.P. Strauss. "The Prediction of Occupation Using Multiple Logit Models." *International Economic Review* 16 (2) (June 1975).

Statistical Office of the European Community. *N.A.C.E.: General Industrial Classification of Economic Activities Within the European Community*. Luxembourg (1985).

Titman, S. "Urban Land Prices Under Uncertainty." *American Economic Review* 75(1985): 505-14.

United Nations. *Statistical Yearbook*. United Nations. New York (1990-1992).

Williams, J.T. "Equilibrium and Options on Real Assests." *Working paper, Faculty of Commerce and Business Administration, University of British Columbia* (1992).

World Bank. *Social Indicators of Development*. The John Hopkins University Press. Washington, D.C (1991-1993).