THE TIMING AND PROBABILITY OF FDI:

An Application to the United States Multinational Enterprises*

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ABSTRACT

An 'option-pricing' model is employed to analyse when a firm should expand its production capabilities abroad. In a framework where the firm's profits are determined by some average of the attractiveness of the home and foreign countries, and attractiveness in each country follows differentiated Brownian motions, this paper derives an optimal trigger value for FDI. The model shows that, contrary to the NPV rule, FDI entry should be optimally delayed the greater the uncertainty surrounding the future path of attractiveness in both locations. The second part of the paper is devoted to empirically test the results of the model. Drawing on data of FDI from the US into a panel of developed and developing countries and using labour costs as a proxy for (the reciprocal of) attractiveness, our estimation overwhelmingly confirms the results of the model, namely that FDI entry events are negatively related to the uncertainty surrounding attractiveness.

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INTRODUCTION

The surge of globalisation has presented multinational firms with new opportunities but also tougher challenges. In an ever faster changing market environment, the optimal timing for expanding abroad becomes of utmost relevance for firms considering engaging in FDI. In that regard, this paper sets up a stochastic model that provides an optimal rule for the timing of FDI-entry and tests empirically the appropriateness of such optimal rule.

The analysis of the timing of FDI has traditionally relied on the *cost-benefit analysis*, according to which the firm should engage in FDI whenever the net present value (NPV) of the investment is non-negative. However, since the NPV rule is oblivious of the irreversibility of most FDI projects and also of the uncertain nature of the payoff of such ventures, it is likely to provide flawed guidance as to the optimal timing of FDI-entry. In the real world, exchange rate volatility, price fluctuations, productivity changes, political instability, among others, render the outcome of any investment uncertain, so that a firm might have to wait for more information before optimally engaging in FDI, especially when investment costs cannot be fully recovered later on. Since in most cases the firm is not compelled to engage in FDI at any specific moment, it holds an option to invest abroad that should only be exercised when it is optimal to do so. The point is that in an context of uncertainty there is an opportunity cost associated with committing resources rather than waiting for new information so that the present value of the investment payoffs must exceed the investment costs by the value of keeping the firm's option to invest unexercised (Pindyck, 1988).

Taking on board the high degree of irreversibility associated with most FDI ventures and also the uncertainty attached to the success of such ventures, this paper develops an ‘option-pricing’ model[1] with the intent of investigating when should a firm expand its production capabilities abroad. The firm is assumed to continuously maximise intertemporal utility, which depends on the level of capital invested and also on the attractiveness of the locations where the firm is installed. The attractiveness of the home and foreign countries, which is here understood to measure the location’s potential in generating profits, are assumed to follow differentiated Brownian motions. Letting the overall attractiveness to be determined by a geometric average of the attractiveness of the home and foreign countries weighted by the shares of capital committed to each location, the model sets out to derive the value of keeping the option of FDI alive. The main output of the model consists of a threshold that bisects the firm’s decision-making space into a zone where it is optimal to exercise the FDI option and a zone where the firm maximises its value by leaving the option unexercised, so that it becomes apparent when exactly should the firm engage in FDI. The results of the model suggest, among other things, that FDI-entry should take longer the higher the uncertainty regarding the future path of attractiveness in both locations. Moreover, we show that the theoretical results are empirically substantiated by our empirical results of United States MNEs’ FDI into a panel of developed and developing countries.

The results derived in this paper are tuned in with the bulk of the empirical research undertaken recently on the role of uncertainty and irreversibility on the timing and extent of FDI. In fact, the recent FDI literature reveals that overall, empirical evidence points to a general negative relation between entry events and uncertainty. Rivoli and Solario (1996) argue that ownership and internalisation advantages, which make FDI more irreversible, may be negatively related with entry events, as firms become more sceptical about the overall success of the venture. Erramilli and D’Souza (1995) examined

1 This model applies the methodology developed by Dixit and Pindyck (1994) to investment decisions under uncertainty and follows Strobel’s (1999) application of this particular methodology.

empirically the effects of uncertainty on the firms' decision to engage in FDI instead of exporting or licensing to identify two contradictory effects of uncertainty on FDI. On one side, and as expected, uncertainty about the functioning of the firm's specific market in the host country discourages FDI in detriment of alternative modes of market-penetration. On the other side, uncertainty makes the physical presence of the firm in the foreign market more valuable as it allows the firm to get a better grasp of the market's characteristics and so improve its overall risk management. Campa (1993) tests the effects that real exchange rate fluctuations had on FDI into the United States during the 1980's. The results point to exchange rate volatility being negatively related to the number of foreign firms entering the market. This negative effect is evident in industries with relatively high sunk investment costs in tangible and intangible assets. Goldberg (1990) finds a strong negative relation between long term exchange rate volatility and entry events during both the 1970s and the 1980s in the United States, which he attributes to high risk-aversion and rising costs. However, short-term exchange rate volatility is found to coincide with investment expansion, possibly reflecting increased short-term expected profits (Goldberg, 1990; Goldberg and Kolststad, 1994).

In the context of the literature on the effects of uncertainty and irreversibility on FDI, this present paper not only develops an analytical framework based on the option-pricing theory that formalises the main empirical results in a rather general fashion, but also provides new empirical evidence. The use of 'option-pricing' models that capture the role of uncertainty in international economics issues is not novel as it has been extensively applied to international trade theory since the mid-1980s. Some of the most influential contributions focused on providing a theoretical argument to explain the hysteretic effect that the large exchange rate swings of the 1980s had on trade prices and quantities. Foreign firms that entered the United States market during the first half of the

1980s, when the real value of the United States dollar was appreciating, could not exit when the United States dollar returned to its original level due to the sunk costs incurred. The exchange rate would have had to decline strictly below the level that triggered entry in order to induce firms to exit (Baldwin, 1988; Baldwin and Krugman, 1989; Dixit, 1989a; 1989b). This particular episode illustrates once again the inappropriateness of the NPV rule in explaining events dominated by the uncertainty of the underlying variables.

A crucial implication of the theoretical and empirical results established in this paper is that the NPV rule is blatantly misguiding in any context other than the unrealistic setting where sunk costs are negligible and there is certainty regarding the determinants of the profitability of the project to be undertaken. Under more realistic assumptions it becomes immediately apparent that a positive NPV does not necessarily render investment optimal since an unexpected turn of events may bring the NPV into negative territory in which case the firm has to choose between staying in business and sustaining negative profits or pulling-out of the market without fully making up for the sunk costs incurred. In other words, the higher the uncertainty regarding the profitability of the FDI initiative, that is, the more likely is a favourable situation to turn into an unfavourable one and vice-versa, the more the firm gains from waiting for more information before committing itself to investment (or dis-investment) whenever there are significant sunk costs. This result, which is a prediction of the "option-pricing" approach to the analysis of irreversible investment under uncertainty (Dixit, 1989a; 1989b; Dixit and Pindyck, 1994) is formally derived in the present paper.

The structure of this paper is as follows. In the first part, a stochastic option-pricing model of FDI-entry is set up and solved and its results analysed. In the second part, the data and the estimation method are described and the empirical results discussed.

MODEL

Consider the problem of a firm whose production is located exclusively at home but is contemplating expanding its production capabilities abroad. The firm will engage in FDI only if such a move is deemed beneficial in the medium and long run. That in turn, will depend on the perceived evolution of the relative attractiveness as production sites and selling grounds of foreign countries candidates to host the foreign subsidiary of the home country's firm. In that particular context, attractiveness is seen as a broad measure of return for the medium/long term, comprising indicators such as output growth, market size, costs of production and macroeconomic and political stability, as seen by the firm. This attractiveness concept applies to both domestic and foreign economies.

Unlike other models of investment under uncertainty, such as that of Caballero and Pindyck (1992), the type of competition and other market functioning features need not to be specified here, since prices and other relevant information pertaining to the particular market setting are encapsulated in the attractiveness indicator. It follows that this model's results are not hostage to a specific market setting. The attractiveness variable can be built such as to allow a measure of total profits ($\tilde{\Pi}$), highly correlated with actual total profits, to be given by[2]:

$$\tilde{\Pi}(t) = K(t) \cdot A(t)$$

Where K and A denote the firm's stock of capital and level of overall attractiveness as seen by the firm, respectively. In this model, the capital stock is determined optimally

2 Even though in reality the firm may consider factors other than profit, from the modelling standing point it seems fair to introduce the simplification according to which attractiveness is regarded as the foreign location's potential in generating profits per unit of capital invested by the firm. In this context, attractiveness can be formalised as follows. Actual total profits are given by: $\Pi = R - C = r(x_1, \ldots, x_n) - c(y_1, \ldots, y_n)$, where R denotes the total revenues function and C, the total costs function. The profit per unit of capital invested is, $\pi = (R - C)/K = p(x_1, \ldots, x_n, y_1, \ldots, y_n)$. By defining the attractiveness of one location as: $A_i = \tilde{\pi}_i = a_i(x_1, \cdots, x_n, y_1, \cdots, y_m)$, where i indexes the country, it follows that, since the function $a_i(\cdot)$ depends on the same variables as $p(\cdot)$, it can be chosen so that Π and $\tilde{\Pi}$ are highly correlated.

through the maximisation of the firm's utility function, whereas attractiveness is stochastic and follows a geometric Brownian motion:

$dA = \alpha A dt + \sigma A dz$, where $dz = \varepsilon_t \sqrt{dt}$ is the increment of a Wiener process and $\varepsilon_t \sim iid\, N(0,1)$, $E(\varepsilon_t \varepsilon_s) = 0$ for $t \neq s$.

Due to the uncertain nature of the outcome of any investment venture, the firm takes into consideration the fact that it can sustain losses at any time, which like profits, are increasing in the stock of capital, the only variable the firm has control over. Assuming that the firm is risk-averse[3], its instantaneous utility function can be written as:

$$u(K, A) = A(t)K(t) - \frac{1}{2} r\left[K(t)\right]^2 \tag{1}$$

where r measures the relative weight of the downside risk of investment and must be positive if the firm is risk-averse, as assumed.

The first term on the RHS of equation (1) is a measure of profit, whereas the second term is a measure of risk. The fact that the second term is quadratic so that the utility function is concave in this second term just reflects the firm's risk aversion attitude in the sense that the more capital the firm commits to the venture, the higher becomes the scope for losses. Hence, the bigger r, or the more risk-averse investors are, the lower becomes the instantaneous utility derived by the firm from overall investment, including FDI.

Since the firm can adjust its stock of capital according to the present realisation and future expectations of attractiveness (the state variable), it will do so in order to maximise the following intertemporal utility function:

$$U(A) = E_t \int_t^{\infty} \left\{ A(\tau)K(\tau) - \frac{1}{2} r\left[K(\tau)\right]^2 \right\} e^{-\mu(\tau - t)} d\tau \tag{2}$$

where μ is the time-discount rate.

3 In this context, risk-aversion means that the firm is more concerned with the downside than the upside risks of profits.

It turns out that the firm is an expected utility maximiser. However, notice that the measure of risk used is given by the square of capital rather than the variance of profits, as it usually appears in expected utility maximising problems. By doing this, we are deliberately assuming that the 'risk of profit' is a function of the scale of capital[4], since in effect it is the size of the project that determines the 'size' of risk.

The solution to this Max problem requires solving the following Bellman equation:

$$\mu U(A) = \underset{K}{Max}\left[u(K, A) + \frac{1}{dt}E_t(dU)\right] \tag{3}$$

Applying Ito's lemma, we can write equation (3) as:

$$\mu U(A) = \underset{K}{Max}\left[u(K, A) + \alpha A\frac{\partial U}{\partial A} + \frac{1}{2}\sigma^2 A^2 \frac{\partial^2 U}{\partial A^2}\right] \tag{3a}$$

Maximisation of the right-hand side of the above expression involves setting the stock of capital according to the following optimal rule:

$$K^*(t) = \frac{A(t)}{r} \tag{4}$$

Equation (4) implies that the optimal stock of capital varies positively with the level of contemporaneous attractiveness in a proportion inversely related to the degree of risk-aversion. Intuitively, the optimal level of capital increases with $A(t)$ because more capital boosts instantaneous total profits and decreases with r, since additional capital raises the costs associated with the risk of future losses. Substituting (4) into (2) we get the intertemporal utility function when the firm is constantly optimising over time:

$$U(A) = E_t\int_t^\infty \frac{1}{2r}\left[A(\tau)\right]^2 e^{-\mu(\tau - t)}d\tau \tag{5}$$

4 Since K is being determined endogenously and so is constant at any period τ, $[K(\tau)]^2$ is a measure of the scale of capital, not of its variance.

Bearing in mind that $A(t)$ follows a geometric Brownian motion, we can use the properties of the lognormal distribution[5] to transform equation (5) into:

$$U(A) = \frac{[A(t)]^2}{2r(\mu - 2\alpha - \sigma^2)} \qquad (6)$$

provided that $\mu - 2\alpha - \sigma^2 > 0$, which will be assumed here to ensure the convergence of the integral in (5). Intuitively, this condition forces intertemporal utility to be bounded by imposing the time preference to be higher than the rate at which the square of attractiveness is expected to increase.

Utility Before and After FDI

Because the variables that determine the level of attractiveness behave differently from country to country, we must characterise attractiveness in the home country and in the potential host countries differently. Since there is no *a priori* reason to believe that the attractiveness of any given country drifts away in a specific direction, we assume that irrespective of the country in question, attractiveness always follows a driftless stochastic process[6]. In particular we assume that:

$$dA_h = \sigma_h A_h dz_h \qquad (7)$$

$$dA_f = \sigma_f A_f dz_f \qquad (8)$$

where the subscripts h and f denote home and foreign, respectively, with $\sigma_h, \sigma_f \geq 0$, $E_t\left(dz_h dz_f\right) = \rho dt$ and ρ is the correlation coefficient between the random shocks affecting attractiveness in the home and foreign countries.

The utility of the firm prior to engaging in FDI can be derived by combining equations (6) and (7):

5 See e.g. Aitchison and Brown (1957).
6The fact that we have eliminated the possibility that attractiveness contains a deterministic trend does not preclude attractiveness of a particular country from drifting persistently away from its unconditional mean via a stochastic trend.

$$U_h(A_h) = \frac{[A_h(t)]^2}{2r(\mu - \sigma_h^2)} \tag{9}$$

provided that $\mu - \sigma_h^2 > 0$, which will be assumed here.

Applying Ito's lemma to $U_h(A_h)$ and ignoring the terms of order $(dt)^{3/2}$ and higher, gives:

$$dU_h = \sigma_h^2 U_h dt + 2\sigma_h U_h dz_h \tag{10}$$

which means that U_h also follows a geometric Brownian motion.

However, once the firm expands its production to a foreign country, overall attractiveness, as seen by the firm, must be an average of both locations weighted by the share of capital assigned to each location:

$$A_o(t) = A_h(t)^{s_h} A_f(t)^{s_f} \tag{11}$$

where A_o denotes the overall attractiveness, s_h and s_f are the shares of capital employed at home and at the host country, respectively, with $s_h + s_f = 1$.

Using Ito's lemma it can be shown that the stochastic process followed by overall attractiveness, $A_o(t)$ is also a geometric Brownian motion:

$$dA_o = s_h s_f \left[-\frac{(\sigma_h^2 + \sigma_f^2)}{2} + \rho\sigma_h\sigma_f \right] A_o dt + A_o (s_h\sigma_h dz_h + s_f\sigma_f dz_f) \tag{12}$$

Combining equations (6), (11) and (12) we can determine that the firm's utility after it has invested abroad as:

$$U_o = \frac{A_h(t)^{2s_h} A_f(t)^{2s_f}}{2r\left\{\mu + s_h s_f\left[2(\sigma_h^2 + \sigma_f^2) - 4\rho\sigma_h\sigma_f\right] - s_h\sigma_h^2 - s_f\sigma_f^2\right\}} \tag{13}$$

provided $\mu + s_h s_f\left[2(\sigma_h^2 + \sigma_f^2) - 4\rho\sigma_h\sigma_f\right] - s_h\sigma_h^2 - s_f\sigma_f^2 > 0$, which will be assumed.

Using Ito's lemma, we can confirm that $U_o(t)$ also follows a geometric Brownian motion:

$$dU_o = \left[\left(s_h - s_f\right)\left(s_h\sigma_h^2 - s_f\sigma_f^2\right) + 4\rho s_h s_f \sigma_h \sigma_f\right] U_o dt + 2\left(s_h\sigma_h dz_h + s_f\sigma_f dz_f\right) U_o \qquad (14)$$

Optimal Stopping Problem

When the firm is producing exclusively in the home country its decision of whether or not to engage in FDI constitutes an optimal stopping problem for which the relevant Bellman equation is:

$$I(U_h, U_o) = Max\left\{U_o - U_h, \frac{1}{\mu dt} E_t\left[dI(U_h, U_o)\right]\right\} \qquad (15)$$

where $I(U_h, U_o)$ is the value of the option to invest in a foreign country, $U_o - U_h$ accounts for the expected discounted utility gain that results from opting for FDI and the second term in the curly brackets yields the time-discounted expected increment in the value of the option that ensues from keeping the option unexercised for an additional lapse of time, dt. The range of values for which the second term in the curly brackets is greater than the first defines the continuation region, where it is optimal not to exercise the option. In this region the Bellman equation is given by:

$$I(U_h, U_o) = \frac{1}{\mu dt} E_t\left[dI(U_h, U_o)\right] \qquad (16)$$

Applying Ito's lemma to (16) yields the partial differential equation that the function $I(U_h, U_o)$ must satisfy in the continuation region:

$$(17)$$

$$2\sigma_h^2 U_h^2 \frac{\partial^2 I}{\partial U_h^2} + 2\left(s_h^2\sigma_h^2 + s_f^2\sigma_h^2 + 2\rho s_h s_f \sigma_h\sigma_f\right) U_o^2 \frac{\partial^2 I}{\partial U_o^2} + 4\left(s_h\sigma_h^2 + \rho s_f\sigma_h\sigma_f\right) U_h U_o \frac{\partial^2 I}{\partial U_h \partial U_o} +$$
$$+\sigma_h^2 U_h \frac{\partial I}{\partial U_h} + \left[s_h\left(1 - 2s_f\right)\sigma_h^2 + s_f\left(1 - 2s_h\right)\sigma_f^2 + 4\rho s_h s_f\sigma_h\sigma_f\right] U_o \frac{\partial I}{\partial U_o} - \mu I(U_h, U_o) = 0$$

The set of boundary conditions that applies to this optimal stopping problem is composed of a value-matching condition,

$$I(U_h^*, U_o^*) = U_o^* - U_h^*$$

and of two smooth-pasting conditions,

$$\frac{\partial I\left(U_h^*,U_o^*\right)}{\partial U_o}=1 \text{ and } \frac{\partial I\left(U_h^*,U_o^*\right)}{\partial U_h}=-1$$

The vector $\left(U_h^*,U_o^*\right)$ defines the boundary line that separates the $\left(U_h,U_o\right)$ space into a stopping region, where it is optimal to engage in FDI and a continuation region, where it is optimal to refrain from investing abroad. The derivation of the option value function $I\left(U_h,U_o\right)$ from the partial differential equation (16) and the corresponding boundary conditions although possible[7] is unnecessary. Since the optimal choice regarding FDI depends exclusively on the relative value of the utility attained before and after FDI has been undertaken, that is, on the ratio $u=\frac{U_0}{U_h}$ we can impose homogeneity of degree one of $I\left(U_h,U_0\right)$ in $\left(U_h,U_0\right)$[8], such that:

$$I\left(U_h,U_0\right)=U_h i\left(\frac{U_0}{U_h}\right)=U_h i(u) \tag{18}$$

Such transformation allows us to re-write (16) as a function of u rather than $\left(U_h,U_0\right)$:

$$2s_f^2\left(\sigma_h^2+\sigma_f^2-2\rho\sigma_h\sigma_f\right)u^2\frac{d^2 i}{du^2}+\left[s_h\left(1-2s_f\right)\sigma_h^2+s_f\left(1-2s_h\right)\sigma_f^2+4\rho s_h s_f\sigma_h\sigma_f\right]u\frac{di}{du}+$$
$$+\left(\sigma_h^2-\mu\right)i=0 \tag{19}$$

which turns out to be an ordinary differential equation. The corresponding boundary conditions becomes:

$$i\left(u^*\right)=u^*-1$$

$$\frac{di\left(u^*\right)}{du}=1;\ i\left(u^*\right)-u^*\frac{di\left(u^*\right)}{du}=-1$$

Notice that equation (19) imposes a supplementary boundary condition: $i(0)=0$

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7 See Dixit and Pindyck (1994, p.209-10).
8 This solution strategy borrows from Dixit and Pindyck (1994, p.210).

Solution to the Optimal Stopping Problem

To solve the optimal stopping problem given by equation (19) and the respective boundary conditions, we must search for a solution and test its validity by substituting it into equation (19). Considering $i(u) = Bu^{\beta}$, we find out that it constitutes a solution to (19) if and only if β is a root of the following quadratic equation:

$$Q(\beta) = 2s_f^2\left(\sigma_h^2 + \sigma_f^2 - 2\rho\sigma_h\sigma_f\right)\beta^2 + \left\{\sigma_h^2\left[s_h\left(1-2s_f\right) - 1 - 2s_f^2\right] - \sigma_f^2\left(s_h s_f + s_f^2\right) + 4\rho s_f \sigma_h \sigma_f\right\}\beta - \\ -\left(\mu - \sigma_h^2\right) = 0 \quad (20)$$

The roots of $Q(\beta)$ can be shown to be equal to:

$$\beta_1, \beta_2 = \frac{-b \pm \sqrt{b^2 + 8s_f^2\left(\sigma_h^2 + \sigma_f^2 - 2\rho\sigma_h\sigma_f\right)\left(\mu - \sigma_h^2\right)}}{4s_f^2\left(\sigma_h^2 + \sigma_f^2 - 2\rho\sigma_h\sigma_f\right)}$$

where $b = \sigma_h^2\left[s_h\left(1-2s_f\right) - 1 - 2s_f^2\right] - \sigma_f^2\left(s_h s_f + s_f^2\right) + 4\rho s_f \sigma_h \sigma_f$. Since for $-1 < \rho < 1$ the coefficient of β^2 in (20) is positive, $Q(\beta)$ is an upward-pointing parabola. Moreover, since $Q(1) = s_h\left(1-2s_f\right)\sigma_h^2 + s_f\left(1-2s_h\right)\sigma_f^2 + 4\rho s_h s_f \sigma_h \sigma_f - \mu$ and $Q(0) = \sigma_h^2 - \mu$ are both negative by previous assumptions[9], it follows that $\beta_1 > 1$ and $\beta_2 < 0$.

The general solution for equation (20) is then, $i(u) = B_1 u^{\beta_1} + B_2 u^{\beta_2}$, which simplifies to $i(u) = B_1 u^{\beta_1}$, since $B_2 = 0$ in order to satisfy the boundary condition, $i(0) = 0$.

Making use of the value-matching and smooth-pasting conditions, we get the expression for the critical utility ratio and likewise for the constant B_1 as:

$$u^* = \frac{\beta_1}{\beta_1 - 1} \quad (21)$$

$$B_1 = \frac{(\beta_1 - 1)^{\beta_1 - 1}}{\beta_1^{\beta_1}} \quad (22)$$

Now, since $\beta_1 > 1$, equation (21) implies that $u^* > 1$, meaning that the firm will only engage in FDI if the expected utility after investing abroad exceeds that attained when

9 See assumptions concerning equations (13) and (9).

production is exclusively carried out domestically. Put differently, contrary to what the NPV principle would suggest the set of parameters' values for which the firm is indifferent between engaging in, and abstaining from, FDI yields a utility after FDI strictly greater than that associated with utility before FDI. In other words, when the outcome of the FDI venture is uncertain the firm is willing to take the risk associated with FDI if it expects to be strictly better-off than before.

In order to obtain the critical value as a function of the ratio of the model's state variables, i.e. the attractiveness before and after FDI, we use equations (9) and (13) to get:

$$u = \frac{\mu - \sigma_h^2}{\mu + s_h s_f\left[2\left(\sigma_h^2 + \sigma_f^2\right) - 4\rho\sigma_h\sigma_f\right] - s_h\sigma_h^2 - s_f\sigma_f^2}\left(\frac{A_f}{A_h}\right)^{2s_f} \tag{23}$$

With equation (21) and (23) we are now in position to derive the expression in terms of the ratio of the expected attractiveness after and before FDI that optimally triggers FDI:

$$\frac{A_f^*}{A_h^*} = \left\{\frac{\mu + s_h s_f\left[2\left(\sigma_h^2 + \sigma_f^2\right) - 4\rho\sigma_h\sigma_f\right] - s_h\sigma_h^2 - s_f\sigma_f^2}{\mu - \sigma_h^2}\frac{\beta_1}{\beta_1 - 1}\right\}^{\frac{1}{2s_f}} \tag{24}$$

For values of the ratio $\frac{A_f}{A_h}$ lower than $\frac{A_f^*}{A_h^*}$ it is optimal not to engage in FDI, conversely, if the value of the ratio is greater than the critical value, the firm should invest abroad. It follows that equation (24) defines the line that divides the $\left(A_h, A_f\right)$ space into two regions: one where it is optimal to exercise the FDI option and another where it is not.

In order to do some comparative statics we will simplify the original setup and consider that $\sigma_h = \sigma_f = \sigma$, which allows us to write equation (24) as:

$$\frac{A_f^*}{A_h^*} = \left\{\left[1 + \frac{4s_h s_f\sigma^2(1-\rho)}{\mu - \sigma^2}\right]\left[\frac{(1-\rho)\sigma + \sqrt{(1-\rho)\left(\mu - \rho\sigma^2\right)}}{(1-\rho)\sigma\left(1 - 2s_f\right) + \sqrt{(1-\rho)\left(\mu - \rho\sigma^2\right)}}\right]\right\}^{\frac{1}{2s_f}} \tag{25}$$

It follows from the above equation and the assumptions $\mu - \sigma^2 > 0$, that both bracketed terms are greater than one, implying that the value of the ratio $\frac{A_f^*}{A_h^*}$ above which the firm should optimally engage in FDI is greater than one. This means that the firm will only invest abroad if the attractiveness associated with FDI strictly exceeds that of a situation of exclusive home production and that is due to uncertainty of the future path of attractiveness.

Moreover, since $\partial \frac{A_f^*}{A_h^*} \Big/ \partial \sigma > 0$[10] and $\lim_{\sigma \to \infty} \frac{A_f^*}{A_h^*} = \infty$, the greater the volatility (i.e. the higher σ) the higher must be the foreign attractiveness relatively to the home country's to make it optimal for the firm to invest abroad. The more correlated are the shocks affecting the attractiveness both at home and abroad, the less the FDI option is worth and so the lower is the value of the relative attractiveness that triggers FDI-entry, i.e. $\partial \frac{A_f^*}{A_h^*} \Big/ \partial \rho < 0$[11]. The reason is that the more correlated shocks are, the more closely both attractivenesses move and so the lower the uncertainty that results from the switch from a situation where production is exclusively carried out at home to one where the firm extends its production facilities abroad.

In regard to the discount rate, the greater is the firm's time discount, the lower it values the FDI option and so the lower will be the value $\frac{A_f^*}{A_h^*}$ that triggers optimal entry, that is $\partial \frac{A_f^*}{A_h^*} \Big/ \partial \mu < 0$[11]. This result stems from the fact that a higher time preference increases the firm's opportunity cost of not immediately investing abroad. In the extreme case where the firm cares only about the present moment, so that $\mu \to \infty$, then

10 Because the expression for the derivative is too long it is shown in Appendix.

$\lim_{\mu \to \infty} \beta_1 = 0$ and $\frac{A_f^*}{A_h^*} = 1$, so that uncertainty is disregarded and the value of the FDI option collapses to zero.

Lastly, the higher the foreign share of the firm's production, the higher must be the foreign attractiveness relative to the home country's, i.e. $\partial \frac{A_f^*}{A_h^*} \Big/ \partial s_f > 0$[11] and this ensues from the fact that investment expenditures always exhibit some degree of irreversibility such that an increase in FDI raises the firm's overall risk exposure.

These results are extended for equation (24) using simulations (see figures 1-6 in Appendix). The simulations are performed against a benchmark case (see Appendix for description of the benchmark case). Figures 1-6 provide a sensitivity analysis of the trigger value $\frac{A_f^*}{A_h^*}$ with respect to the parameters of the model: σ_h, σ_f, ρ, μ, s_h and s_f. The simulations carried out on the critical values of relative attractiveness confirm the results of the comparative statics discussed above. Figure 1 reveals that the trigger value is much more sensitive to σ_f than to σ_h. This is due to the fact that the higher the uncertainty in foreign locations, the higher the risk of foreign investments' returns and so the higher must relative attractiveness be in order to trigger FDI-entry. Figure 2 shows that the trigger value rises when σ_f is high and ρ moves toward minus 1, since such combinations entail the highest increase in uncertainty following FDI-entry. In figures 2 and 5 note that the dampening influence of higher ρ and μ on the critical ratio strengthens as σ_f increases. Figure 3 confirms that the more the firm has been investing abroad, the more exposed to foreign volatility it is, making the trigger value to increase. The accentuated curvature of the surface graphed in figure 4, in which the critical value of relative attractiveness rises very fast as both σ_f and s_f increase, indicates that the higher is the firm's exposure abroad the more dominant becomes the uncertainty pertaining to the foreign location to the FDI decision. Finally, figure 6 shows that if home operations are subject to high uncertainty, the firm will invest abroad for high trigger values. When the firm already faces a considerable amount of uncertainty it needs to be compensated for engaging on yet another uncertain venture.

Before proceeding to the empirical application, it would be interesting to ascertain, from any point within the continuation region, the likelihood that FDI-entry will become optimal in the future. In addition, under the circumstances in which future financial liberalisation is a certainty, it is important for the firm to know the expected time that will take until the decision of FDI-entry becomes optimal.

Using standard properties of the Brownian motion and the lognormal distribution[11], closed-form solutions for the probability $Q\left(\frac{A_f}{A_h}\right)$ and expected time $T\left(\frac{A_f}{A_h}\right)$ for the process $\frac{A_f}{A_h}$ to hit the barrier $\frac{A_f^*}{A_h^*}$ from any point inside the continuation region can be shown to be given by:

$$Q\left(\frac{A_f}{A_h}\right)=\begin{cases} 1 & if\ \sigma_h^2 \geq \sigma_f^2 \\ \exp\left[\dfrac{\left[\ln\left(\frac{A_f^*}{A_h^*}\right)-\ln\left(\frac{A_f}{A_h}\right)\right]\left(\sigma_h^2-\sigma_f^2\right)}{\sigma_h^2+\sigma_f^2-2\rho\sigma_h\sigma_f}\right] & if\ \sigma_h^2 < \sigma_f^2 \end{cases} \tag{26}$$

$$T\left(\frac{F_{AL}}{F_{BL}}\right)=\begin{cases} \infty & if\ \sigma_h^2 > \sigma_f^2 \\ \dfrac{\ln\left(\frac{A_f^*}{A_h^*}\right)-\ln\left(\frac{A_f}{A_h}\right)}{\frac{1}{2}\left(\sigma_h^2-\sigma_f^2\right)} & if\ \sigma_h^2 \leq \sigma_f^2 \end{cases} \tag{27}$$

[11] See Dixit (1993, ch.6).

where $\left[1/2\left(\sigma_h^2 - \sigma_f^2\right)\right]$ and $\left(\sigma_h^2 + \sigma_f^2 - 2\rho\sigma_h\sigma_f\right)$ are respectively, the drift and variance parameters of the process $\frac{A_f}{A_h}$.

Equations (26) and (27) indicate that the probability and expected time for FDI-entry to become optimal depend on the relative variability of attractiveness in the foreign location and at home. The higher is the variability of the home country's attractiveness relative to that of the foreign, the higher is the likelihood that $\frac{A_f}{A_h}$ diverges away from the threshold that triggers optimal FDI-entry, and so the lower the probability that FDI will ever become optimal. Similarly, the higher the differential between σ_f^2 and σ_h^2 the more likely long excursions of $\frac{A_f}{A_h}$ away from the critical ratio become, and so, the more time is the system expected to take until hitting the threshold beyond which FDI-entry is optimal.

FDI-entry will become optimal with certainty provided that $\sigma_h^2 > \sigma_f^2$ and it is expected to occur sooner the higher $\frac{A_f}{A_h}$ and the lower σ_f^2. For the limiting case where $\sigma_h^2 = \sigma_f^2$, even though the probability that the firm will engage in FDI in the future is one, the expected time for it to occur is infinite. The intuition behind these apparently contradictory result is that if the drift of $\frac{A_f}{A_h}$ is zero, long diversions away from the barrier $\frac{A_f^*}{A_h^*}$ might occur. Thus, since the probabilities for successfully longer hitting times do not fall sufficiently fast, and the expectation, which is the average of the possible hitting times weighted by their respective probabilities, diverges[12].

For the set of parameters for which $\frac{A_f}{A_h}$ has a negative drift, i.e. when $\sigma_h^2 < \sigma_f^2$, there is still a positive probability that FDI-entry will become optimal sometime in the future, as given by equation (26). This is because, in spite of $\frac{A_f}{A_h}$ being drifting away from the critical ratio, there is the possibility that a combination of positive shocks might just bring the system towards the threshold barrier. However, the expected time for this event is infinite, given that there is a positive probability that $\frac{A_f}{A_h}$ never reaches $\frac{A_f^*}{A_h^*}$ that drives the expectation into diverging. When $\sigma_h^2 < \sigma_f^2$, the probability that $\frac{A_f^*}{A_h^*}$ will be hit in the future is decreasing in σ_f^2. This is because the lower σ_f^2 the closer is the drift of the process $\frac{A_f}{A_h}$ to zero, in which case the probability of the barrier being hit converges to one.

In summary, the higher the relative volatility of attractiveness at home and in the foreign location, the more likely FDI-entry is to become optimal and the sooner it is expected to occur. Moreover, FDI activities become likelier and are expected sooner, the closer is the system to the critical threshold, that is the closer is $\frac{A_f}{A_h}$ to $\frac{A_f^*}{A_h^*}$.

[12] This argument is presented in Dixit (1993, p.56).

EMPIRICAL APPLICATION

The model presented gives clear indications to the effects of the uncertainty of the attractiveness of foreign locations on FDI. It predicts that the higher the volatility in foreign locations, σ_f, and the share of foreign capital invested in a specific location, shf, the more valuable the option to enter will be and so the fewer entry events we will observe. Conversely, the higher the attractiveness of the foreign relative to the home location, atf, the higher the discount factor and the higher the correlation between the foreign and home attractiveness, the more entry events we would expect to observe. Thus, for empirical testing purposes the reduced form of the model can be written as follows: $FDI_{ijt}^{US} = f\begin{pmatrix} shf & \mu & atf & \sigma_f & \rho \\ - & + & + & - & + \end{pmatrix}$. However, since the proxy used here for the attractiveness of the foreign location is labour cost (lc), we expect to observe that as the attractiveness variable rises or as labour costs go up, the fewer FDI-entry events will occur[13]. So, the reduced form to be estimated becomes, $FDI_{ijt}^{US} = f\begin{pmatrix} shf & \mu & lc & \sigma_f & \rho \\ - & + & - & - & + \end{pmatrix}$.

DATA

The data consists of a firm-level panel of United States FDI into 13 different industries of 12 different countries for the period 1988-1996[14]. The countries in the panel are Canada and Mexico, six countries of the European Union (France, Germany, Italy, Netherlands, Spain and the United Kingdom) and the Southeast Asian New Tigers (Indonesia, Malaysia, Philippines and Thailand). The host countries were selected so as to produce a mix of the world's three main economic regions and also to highlight the duality between developed and developing countries. In addition to accounting for around 60 percent of the total United States FDI, this sample of countries also

13 In fact, labour costs proxy 'unattractiveness' rather than attractiveness.

14 The data appendix includes a full explanation of each variable and its source.

accommodates a wide variety of cultures, income levels, organisation and infrastructures and degrees of economic and political stability.

The attractiveness of foreign locations depends on several factors, such as prices, operating and fixed costs, culture, language, legal framework, among others. However, it seems to be the case that MNEs pay particular attention to operating costs, of which wage and non-wage labour costs are a crucial item. Moreover, labour costs also account for a significant part of the uncertainty inherent to any FDI venture, since from the parent company's stand point, labour costs not only vary in response to changes in the local labour market but are also affected by other sources of uncertainty such as exchange rate fluctuations. Consequently, in this application wages per employee of foreign affiliate industry are used to proxy for the attractiveness of foreign locations. The data are desegregated into 13 different industries[15]. Table 1 in the data appendix details the industry classifications.

Note that the need to choose a proxy for attractiveness implies ignoring many of the factors that affect attractiveness, but that is a limitation one must be ready to endure in any empirical application. Moreover, whilst labour costs have scarcely received attention in the related literature, the importance of other variables deemed relevant for the decision to engage in FDI under uncertainty has been tested in previous contributions. In particular, the linkage between exchange rate volatility and FDI has been the focus of many studies, of which Blonigen (1997), Campa (1993), Froot and Stein (1991), Goldberg (1990) and Goldberg and Kolststad (1994) are good examples.

The next step consists of finding a suitable measure for the United States MNEs'

15 The classification is based on the Standard Industrial Classification (SIC), Revision 2 (Standard Industrial Classification Manual, 1987).

engagement in foreign direct investment, that is, for FDI[16] entry. Ideally we would be using the difference between the number of enterprises that entered into and exited from foreign locations, but such information is not available for the panel under analysis. However, by recognising that a positive capital outflow implies that total entries surpass total exits, we choose to use positive capital outflows as a measure of net entry events. In addition, for each such entry event, we analyse whether the number of employees in the foreign affiliate increased relatively to the previous year. This leads to three ordered categories: no entry ($FDI = 0$); entry with no increase in the number of employees in the foreign affiliate ($FDI = 1$); and entry with increased employment in the foreign affiliate ($FDI = 2$). The introduction of the additional entry category, ($FDI = 2$), reflects the need to accommodate two separate issues. First, capital outflows do not necessarily have a one-to-one correspondence with real activities as they include all sorts of financial flows. Thus, the supplementary criterion enhances the accuracy of the proxy for FDI-entry used here. Second, since attractiveness has been chosen to be proxied by labour costs, the additional employment criterion increases the robustness of the results.

The variables σ and ρ embody the firms' expectations of the future behaviour of the level of attractiveness of foreign locations candidates to host United States FDI. The variable σ measures the idiosyncratic shocks to labour costs, i.e. industry-specific volatility, while ρ stands for the industry-specific correlation between the United States' labour costs and the respective level in the foreign location. The need to quantify expectational variables raises the difficult issue of specifying the assumption according to which expectations are formed. In the present framework, static expectations seems a

16 United States' direct investment abroad is typically defined as the ownership or control, directly or indirectly, by one United States' person of 10 percent or more of the voting securities of an incorporated foreign business enterprise or an equivalent interest in an unincorporated foreign business enterprise. Any United States investment abroad that is not direct investment by this definition was not covered by the BEA benchmark survey.

more appropriate hypothesis as it turns out to be more coherent with the theoretical treatment given to the dynamic behaviour of the attractiveness of foreign locations in the first part of the paper. On the other hand, forward-looking expectations, by implying that agents are able to successfully guess future shocks to their business ventures are somewhat unrealistic. Nevertheless, in order to enhance the generality of our empirical application, we test for two distinct models of expectations formation, namely, static expectations and forward-looking expectations.

In respect to the former, it is assumed that United States MNEs base their expectations on the past three-year performance of the attractiveness' level of the foreign location. Therefore, for each period, σ and ρ are defined as the moving average of the standard deviation and correlation, respectively, of the logarithm of labour costs at industry level of the previous three years (excluding the year under observation)[17]. The latter consists of assuming that firms form their expectation according to the observed level of attractiveness of the foreign location three years ahead. In this case, σ and ρ are defined as the moving average of the standard deviation and correlation, respectively, of the logarithm of labour costs at industry level three years ahead. Consequently, under static expectations we will analyse the period between 1991 and 1996, whereas under the perfect foresight assumption the period under analysis is between 1989 and 1993.

Ideally, the share of capital invested abroad would be proxied by the foreign affiliates' assets held by United States parent companies. However, since data constraints preclude us from isolating the affiliates' assets owned by United States parent companies, the share of total assets of United States foreign affiliates, industry of foreign affiliate relative to the total assets of the United States parent company, industry of United States parent, is used to proxy for the share of capital invested in the foreign

17 Note that the moving average (MA) was chosen in order to smooth those series as they were found to be quite irregular. For the relative labour costs of each country, the MA is not applied since it has already been standardised to the United States attractiveness.

countries. Finally, for the discount factor we use the United States' Treasury 5-year bond yield.

MICROECONOMETRIC ESTIMATION TECHNIQUE

In this study, the dependent variable is discrete and represented by a three-ordered category variable (FDI_{ijt}^{us}). When it takes the value one it indicates that the United States MNEs have invested in industry *j* of country *i* at time *t* and no employment increase has occurred; when it takes the value two it indicates that the United States MNEs have invested in industry *j* of country *i* at time *t* and employment has increased, and zero otherwise:

$$\begin{cases} FDI_{ijt}^{US} = 0, \text{ if } KF_{ijt}^{US} \leq 0 \\ FDI_{ijt}^{US} = 1, \text{ if } KF_{ijt}^{US} > 0 \text{ and } E\text{M}_{ijt}^{US} \leq EM_{ijt-1}^{US} \\ FDI_{ijt}^{US} = 2, \text{ if } KF_{ijt}^{US} > 0 \text{ and } E\text{M}_{ijt}^{US} > EM_{ijt-1}^{US} \end{cases} \tag{28}$$

The dependent variable, FDI_{ijt}^{US}, is an ordered variable characterising the United States FDI into industry *j* of country *i* at time *t*, as described above. KF_{ijt}^{US} is the direct investment capital outflows from United States into industry *j* of country *i*, at time *t*. EM_{ijt}^{US} is the number of employees of the United States affiliates in industry *j* of country *i*, at time *t*.

Let the underlying response model be:

$$fdi_{ijt}^{US} = \beta_o + \beta_1 shf_{ijt}^{US} + \beta_2 \mu_t^{US} + \beta_3 lc_{ijt}^{US} + \beta_4 \sigma_{ijt} + \beta_5 \rho_{ijt}^{US} + \varepsilon_{ijt} = W\beta + \varepsilon_{ijt} \tag{29}$$

Where, $\begin{cases} i = 1,2,\cdots,12 \text{ denotes countries.} \\ j = 1,2,\cdots,13 \text{ denotes industries.} \\ t = 1,\cdots,T \text{ denotes time periods (years).} \end{cases}$ and, $\varepsilon_{ijt} \sim iid(0, \sigma_\varepsilon^2)$

shf_{ijt}^{US} is the share of United States' capital invested in industry *j* of country *i*, at time *t*. μ_t^{US} is the United States' discount rate, at time *t*. lc_{ijt}^{US} is the foreign affiliates' labour costs in industry j of country i relative to United State's. σ_{ijt} and ρ_{ijt}^{US} are the volatility and correlation, respectively, of the labour cost in industry j of country i, at time t.

Let W be the matrix of explanatory variables and β the vector of coefficients, such that:

$W = [\ 1 \ \ | \ \ shf \ \ | \ \ \mu \ \ | \ \ lc \ \ | \ \ \sigma \ \ | \ \ \rho\ ]$ and $\beta^T = [\beta_0 \quad \beta_1 \quad \beta_2 \quad \beta_3 \quad \beta_4 \quad \beta_5]$.

The number of observations is given by: $N = \sum_{i=1}^{12}\sum_{j=1}^{13}(T_{ij}) = 936$ under the static expectations' scenario and $N = \sum_{i=1}^{12}\sum_{j=1}^{13}(T_{ij}) = 780$ under forward-looking expectations' scenario. Since we have balanced panel data, T_{ij} is six (1991-1996) for the former scenario and five (1989-1993) for the latter, for all i and j.

The variable fdi_{ijt}^{US} is not observable, but we know which of the three categories it belongs to. So, the set of ordinal variables may be defined so that:

$E_{ijt}^{US} = 1$ if fdi_{ijt}^{US} falls in category k, with $k = 1,2$.

$E_{ijt}^{US} = 0$ otherwise.

Thus, $\text{Prob}\left[E_{ijt}^{US} = 1\right] = F\left(c_k - \beta^T w_{ijt}\right) - F\left(c_{k-1} - \beta^T w_{ijt}\right)$

and $\text{Prob}\left[E_{ijt}^{US} = 0\right] = 1 - F\left[\beta^T w_{ijt}\right]$

where c_k is a constant such that $c_0 = 0$, $c_1 = c$ and $c_2 = +\infty$; w_{ijt} is the vector of explanatory variables; and $F(\cdot)$ is the cumulative distribution of ε_{ijt}. Generally the logistic and normal distributions are adopted[18]. The logistic distribution is similar to the normal distribution, except for the tails, which are considerably heavier (see Cox, 1970). Contrary to the binary case, the similarity[19] between probit and logit no longer holds under the present specification, leading to very distinct inference (see Hsiao, 1986).

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18 Under the logit and probit models $F(W\beta) = \dfrac{e^{W\beta}}{1 + e^{W\beta}}$ and $F(W\beta) = \Phi(W\beta) = \int_{-\infty}^{W\beta} \frac{1}{\sqrt{2\pi}} e^{-\frac{\varepsilon^2}{2}} d\varepsilon$, respectively.

19 For the similarity between binomial logit and probit models see Amenina (1981).

Moreover, the answer to the question of which distribution to use is very difficult to justify on theoretical grounds (Greene, 1993; Baltagi, 1995; Hsiao, 1986; Maddala, 1983). In this application, we present the results for the ordered probit and logit. Since we have panel data, we need to control for unobserved characteristics of the individuals, μ_{ij}, in order to get a consistent estimator.

ESTIMATION RESULTS

The results are presented for two separate cases. In the general case, it is only analysed whether entry occurs or not (see Table 1). The results for this case are presented for the fixed effects logit model and random effects probit model, in which the dependent variable is binary[20] under both the static expectations and forward-looking expectations' hypotheses. A more specific case where entry is broken down into two different categories, entry without employment and entry with employment is then analysed using an ordered probit model. For the ordered probit model we also report the results under the static expectations' hypothesis and forward-looking expectations' hypothesis (see Table 2).

Before describing the results, it must be noted that since we cannot assume that under the static-looking expectations' hypothesis MNEs observe the current value of labour costs, we used the value of relative labour costs lagged one period, implying as it should in a context of static-looking expectations, that firms expect relative labour costs not to change from the last period. On the other hand, under forward-looking expectations, MNEs are assumed to accurately forecast relative labour costs so that entry decisions are based on current values.

20 When it takes the value one it indicates that the United States' MNE has invested in industry j of country i at time t, and zero otherwise, such as: $FDI_{ijt}^{US^*} = 1 \text{ if } KF_{ijt}^{US} > 0$ and $FDI_{ijt}^{US^*} = 0 \text{ otherwise}$. In this case, positive capital outflows (KF_{ijt}^{us}) are used to signal overall entry events.

The results of the binary dependent variable model are presented in Table 1. Table 1 is arranged into two main sections, the first is composed of columns (1)-(5), which correspond to the model under static-looking expectations' hypothesis and the other composed of columns (6)-(10), which correspond to the model under the forward-looking expectations' hypothesis. In the first column of each section, the maximum likelihood estimation's (MLE) results for the standard logit model are presented whilst the second column reports the fixed effects logit model's results. The null hypothesis of the Hausman's (1978) test is not rejected, hence both the standard maximum likelihood logit estimator and the Chamberlain's (1980) estimator are consistent, but the Chamberlain's estimator is inefficient, under both expectations' hypotheses. Finally, in the third and fourth columns of each section, the results of the binomial probit model and the random effects probit model[21] are presented. The marginal effects[22] of the random effects probit model are given in last columns of each section.

As we may observe in Table 1, for both standard logit and probit models, the overall significance[23] of the regressors is not rejected at 1 percent significance level, under both expectations' hypotheses. The random effects specification is also not rejected at 6 percent under the static expectations' hypothesis and 8 percent under the forward-looking expectations' hypothesis. The coefficient estimates all have the correct signs, with the exception of the share of FDI (*shf*) variable. The best-fit model, as suggested by the measures of goodness of fit[24], appears to be the random effects probit model, under

21 See Buttler and Mofit, 1982, Hsiao, 1986 and Baltagi, 1995.
22 The partial derivatives of probabilities with respect to the vector of characteristics are computed at the means of the exogenous variables using all observations.
23 For testing the joint hypothesis that k slopes in the regression equal to zero we have the likelihood ratio statistic (LR), which follows a chi-square with k degrees of freedom (see Greene, 1993).
24 As Maddala (1992) and Greene (1993) suggest we may think of the goodness fit of the model in terms of the proportion of the corrected predictions, resulting in the Pseudo and Naïve R-squares.

both expectations' hypothesis with the highest likelihood ratio index (LRI)[25] and pseudo Zavoina and McKelvey (ZM) R-square[26] relatively to the standard specification.

TABLE 1 - BINOMIAL LOGIT AND PROBIT MODELS										
Dependent variable is FDI*		**Static Expectations**					**Forward-Looking Expectations**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Logit	**Logit Fixed Effects**	**Probit**	**Probit Random Effects**	**Marginal Effects**	**Logit**	**Logit Fixed Effects**	**Probit**	**Probit Random Effects**	**Marginal Effects**
Constant	0.495		0.335	0.343	0.088	0.473		0.345	0.361	0.094
p-value	(0.542)		(0.463)	(0.468)	(0.467)	(0.367)		(0.252)	(0.227)	(0.221)
Share of FDI	0.056	0.017	0.033	0.036	0.009	0.020	0.169	0.011	0.013	0.003
p-value	(0.148)	(0.918)	(0.130)	(0.151)	(0.153)	(0.621)	(0.318)	(0.631)	(0.627)	(0.627)
Discount Rate	0.230	0.233	0.132	0.137	0.035	0.161	0.174	0.089	0.093	0.024
p-value	(0.068)	(0.072)	(0.063)	(0.064)	(0.063)	(0.024)	(0.019)	(0.028)	(0.022)	(0.022)
Relative Labour Costs	-0.622	0.320	-0.367	-0.377	-0.097	-0.406	0.663	-0.242	-0.251	-0.066
p-value	(0.002)	(0.673)	(0.002)	(0.002)	(0.002)	(0.060)	(0.473)	(0.056)	(0.063)	(0.060)
Volatility	-1.047	-0.851	-0.614	-0.609	-0.157	-0.810	-1.360	-0.509	-0.535	-0.140
p-value	(0.054)	(0.317)	(0.050)	(0.091)	(0.091)	(0.216)	(0.230)	(0.179)	(0.179)	(0.174)
Correlation	0.034	-0.103	0.019	0.013	0.003	0.505	0.496	0.291	0.297	0.078
p-value	(0.788)	(0.513)	(0.787)	(0.858)	(0.858)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)
Rho				0.076					0.083	
p-value				(0.175)					(0.190)	
No. Observations	936	936	936	936	936	780	780	780	780	780
Log likelihood function	-446.1	-233.6	-445.9	-444.1		-373.6	-175.1	-373.5	-372.0	
Restricted log likelihood	-453.9		-453.9	-445.9		-387.5		-387.5	-373.5	
LR (Chi-square)	15.493		15.958	3.658		27.915		27.960	3.056	
Degrees of Freedom	5		5	1		5		5	1	
Significance	(0.008)		(0.007)	(0.056)		(0.000)		(0.000)	(0.080)	
LRI	0.017		0.018	0.022		0.036		0.036	0.040	
Pseudo R-SQR	0.810		0.810	0.810		0.801		0.801	0.801	
NAÏVE R-SQR	0.811		0.811	0.811		0.803		0.803	0.803	
Pseudo ZM R-SQR			0.335	0.339				0.352	0.357	
Hausman Test		3.226					3.478			
Degrees of Freedom		5					5			
Significance		0.665					0.627			

i) P-values corresponding to Maximum Likelihood Estimation are reported in parentheses.

ii) The Restricted log likelihood for the random effects probit model is for Rho=0

The results of the random effects probit model under the static expectations' hypothesis (column 4) suggest a positive and significant coefficient at 6 percent for the United States' discount rate and a positive but not significant coefficient for the correlation between the labour cost of United States and the foreign location were obtained. A negative and highly significant coefficient for the relative labour costs and a negative and significant at 9 percent coefficient for the volatility that the United States' investors face in the foreign location. However the coefficient estimate for the share of capital already invested in a specific industry of a specific country has not the expected

25 The LRI results from MacFadden (1974).
26 See Zavoina and McKelvey (1975)

sign but it is not significantly different from zero.

Under the hypothesis of static expectations the data predicts that, at the sample means (see column 5), the negative effect of variations in labour costs' volatility, σ, on the probability of United States' entry is 0.157 whereas the positive effect of correlation, ρ, on the probability of entry is 0.003. Changes in relative labour costs, lc, affect negatively the probability of entry by 0.097, and the discount rate, μ, affects positively the probability of entry by 0.035. Though not supported by the model's predictions, in this econometric application the share of United States' capital already invested in a specific country's industry, shf, affects positively the probability by 0.009.

The results of the random effects probit model, under the forward-looking expectations' hypothesis (columns 9 and 10) suggest a positive and significant coefficient at 2 percent for the United States' discount rate and a positive and highly significant coefficient for the correlation between the labour cost of United States and the foreign location. The changes in these variables affect the probability of entry by 0.024 and by 0.078, respectively. A negative and significant at 6 percent coefficient for the relative labour costs and a negative and significant at 17 percent coefficient for the volatility that the United States' investors face in the foreign location are found. The probability of entry is affected negatively by variations in relative labour costs and volatility in the foreign location by 0.06 and 0.14, respectively. However, the coefficient estimate for the share of capital already invested in a specific industry of a specific country has not the expected sign but it is not significantly different from zero.

Though statistically quite robust, the random effects probit model under the static-looking and forward-looking expectations' hypotheses does not suit very well the predictions of the model as far as the share of capital invested is concerned. This could be due to the fact that the proxy for the attractiveness of the foreign location used in this application is the labour cost per employee whilst entry is, in this case, solely defined by net capital outflows. Thus, it seems to be more sensible to define FDI-entry also in terms of employment. Therefore, in what follows, the data are analysed using a second criterion for entry, the United States affiliates number of employees (EM). This results in three-ordered categories for the entry events of the United States MNEs.

TABLE 2 - ORDERED PROBIT MODEL								
Dependent variable is FDI	Static Expectations				Forward-Looking Expectations			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Ordered Probit LD-MLE	Marginal Effects (FDI=0)	Marginal Effects (FDI=1)	Marginal Effects (FDI=2)	Ordered Probit LD-MLE	Marginal Effects (FDI=0)	Marginal Effects (FDI=1)	Marginal Effects (FDI=2)
Constant	0.463	-0.0680	-0.0455	0.1134	0.236	-0.0346	-0.0235	0.0581
p-value	(0.435)				(0.573)			
Share of FDI	-0.001	0.0002	0.0001	-0.0004	-0.002	0.0004	0.0002	-0.0006
p-value	(0.956)				(0.946)			
Discount Rate	0.236	-0.0346	-0.0231	0.0577	0.221	-0.0324	-0.0220	0.0544
p-value	(0.009)				(0.000)			
Relative Labour Costs	-0.414	0.0609	0.0407	-0.1016	-0.443	0.0650	0.0441	-0.1091
p-value	(0.010)				(0.043)			
Volatility	-1.070	0.1572	0.1051	-0.2624	-0.939	0.1379	0.0935	-0.2315
p-value	(0.028)				(0.134)			
Correlation	0.048	-0.0071	-0.0048	0.0119	0.388	-0.0569	-0.0386	0.0955
p-value	(0.597)				(0.000)			
Mu(01)	1.803				1.764			
p-value	(0.000)				(0.000)			
Rho	0.393				0.451			
p-value	(0.004)				(0.002)			
No. Observations	936	936	936	936	780	780	780	780
Log likelihood function	-966.5				-793.6			
Restricted log likelihood (Rho=0)	-968.7				-796.0			
Wald test (DF=5)	21.02				39.90			
Significance	(0.001)				(0.000)			
LR (Chi-square, DF=1)	4.44				4.85			
Significance	(0.035)				(0.028)			
LRI	0.012				0.029			
Pseudo ZM R-SQR	0.727				0.758			

i) P-values corresponding to Maximum Likelihood Estimation are reported in parentheses.

Table 2 presents the ML results concerning the ordered probit model with a logistic distribution (LD) of the original model under the static-looking expectations hypothesis (columns 1 to 4) and under the forward-looking expectations’ hypothesis (columns 5 to 8). Under both hypotheses we do not reject the overall significance of the regressors with the Wald test and we do not reject the random effects specification with the LR test at 5 percent significance. The pseudo ZM R-square is of 0.727 and 0.758 for the model under static and forward-looking expectations’ hypotheses, respectively. Comparing these values with those given in Table 1, the measure of goodness of fit improves considerably, being twice that in the binomial model, which underscores the superiority of the ordered specification relative to binary one.

The ML estimates of the ordered probit model under both expectations' hypotheses suggest, as expected, a negative though not significant coefficient for the share of capital already invested in a specific country's industry, a positive and significant coefficient for the United States' discount rate, a positive and significant coefficient for the correlation between the labour cost of United States and the foreign location, under the forward-looking expectations' hypothesis but not significant under the static-looking expectations' hypothesis. We also found a negative and significant coefficient for the relative labour costs and a negative and significant coefficient for the volatility that the United States' investors face in the foreign location, under static-looking expectations, but not significant under the forward-looking expectations' hypothesis.

In regard to the marginal effects displayed in the second to fourth columns of each section, notice that a constant had to be included in the regression to ensure that the marginal effects sum up to zero[27]. Under both hypotheses we obtain similar marginal effects for the United States' share of FDI, discount rate and relative labour costs' variables. The probability of entry with employment (FDI=2) is affected negatively by the change in the share of FDI by around 0.0005, positively by variations in the discount rate by 0.05 and negatively by the relative labour costs by 0.1. On the other hand, the probability of no entry events (FDI=0) is affected positively by the share of FDI and the relative labour productivity and negatively by the discount rate by around 0.0003, 0.06 and 0.03, respectively.

27 Note that, since the interpretation of the marginal effects concerning entry without employment, the third column of each section in Table 2, are ambiguous (see Greene, 1993), we concentrate the discussion on the signs of the changes in the probability of FDI=0 and FDI=2.

With respect to the variables that make up for the uncertainty in the model, namely volatility and correlation of labour costs, the results vary with the two expectations' assumptions. Under static expectations' hypothesis, the volatility of labour costs affects negatively the probability of entry with employment (FDI=2) by 0.26, and positively the probability of no entry (FDI=0) by 0.16. These estimated marginal effects are higher than under the forward-looking expectations' hypothesis, which stand at 0.23 and 0.14, respectively. On the other hand, the effect of the correlation between the foreign location and United States' labour costs appears to be higher under the forward-looking than the static expectations' hypothesis. The correlation affects positively the probability of entry with employment (FDI=2) by 0.09 under forward-looking expectations and by 0.01 under static looking expectations' hypothesis. On the other hand, it affects negatively the probability of no entry (FDI=0) by 0.05 under forward-looking expectations and by 0.007 under the static hypothesis.

It is worth noting that although the qualitative response of entry to the different explanatory variables is similar, the quantitative impact differs among the two different expectations' formation assumptions. Such discrepancy is explained not only by differences in the specification of the respective equation, but also because the small period spanned by the data implies that the effective sample differs quite dramatically for the two alternative expectations' models. Therefore, the quantitative results obtained for each specification do not lend themselves to comparison. Moreover, due to the quite contrasting underlying assumptions of both expectations' hypotheses, the results must be interpreted in a different fashion. In fact, as opposed to the forward-looking hypothesis, volatility and correlation in the static expectations' hypothesis translate into uncertainty. This follows from the fact that, first, the higher the underlying volatility of labour costs abroad, the more volatile that variable becomes and so the higher the uncertainty associated with FDI-entry. Second, the lower the correlation between home and foreign labour costs the more volatile relative labour cost turns out to be and consequently the more uncertainty is faced by prospective foreign investors. Conversely, since under the forward-looking expectations' hypothesis firms are assumed to accurately predict future movements of all variables, volatility and correlation do amount to variability but not uncertainty. It follows that uncertainty does not have any bearing on the decision-making of firms endowed with perfect foresight, but irreversibility still does. What can be drawn from the similarity of the qualitative results is that the predictions of the analytical model developed earlier are robust to both specifications.

Although the data do not reject the forward-looking behaviour of the United States' investors, the assumption of perfect foresight is at odds with the uncertain environment in which any investment decisions are taken. As a result, for the purpose of analysing the overall results (see Table 3), we will concentrate on the static expectations' model.

TABLE 3 - SUMMARY RESULTS

	Static Expectations			Forward-Looking Expectations		
	(1)	(2)	(3)	(4)	(5)	(6)
	Logit Fixed Effects	Probit Random Effects	Ordered Probit LD-MLE	Logit Fixed Effects	Probit Random Effects	Ordered Probit LD-MLE
Constant		+	+		+	+
Share of FDI	+	+	-	+	+	-
Discount Rate	+ (*)	+ (*)	+ (***)	+ (**)	+ (**)	+ (***)
Relative Labour Costs	+	- (***)	- (***)	+	- (*)	- (**)
Volatility	-	- (*)	- (**)	-	-	-
Correlation	-	+	+	+ (***)	+ (***)	+ (***)

Note: The symbol (***) denotes significance at 1% level, (**) at 5% and (*) at 10%

The estimated negative effect of the share of FDI on entry, although not significantly different from zero, reflects the fact that the more capital a firm commits to its foreign operations, the more vulnerable it becomes to the uncertainty pertaining to the labour costs of the foreign locations. The result by which the discount rate affects entry positively is in line with the stochastic model presented before, and is explained by the fact that a higher time-preference raises the opportunity cost of not starting reaping immediately the proceeds of investment. The estimated negative relation between FDI-entry and relative labour costs is a trivial outcome, however, the remarkable feature of the present results is the fact that the bearing of attractiveness on the probability of entry comes second to the impact of volatility. The relevance of such a result in the present context is that, by highlighting the importance of uncertainty on FDI decisions, it lends overwhelming support to the analytical framework proposed in the first part of the paper. Indeed, the estimated strong negative effect of volatility on FDI suggests that in the presence of a positive degree of irreversibility of investment and uncertainty regarding future events, firms worry that gains may turn into losses, in which scenario pulling-out their investment could entail considerable costs. The fact that, in spite of having the correct sign the estimated correlation coefficient is statistically not significant suggests that, even though firms take uncertainty seriously, they do not care whether its coming from their domestic ventures or foreign ones.

CONCLUSION

This paper presents an "option-pricing" model with the aim of analysing the optimal timing and probability of FDI-entry in a context of uncertainty and irreversibility concerning FDI ventures. The results of our model reveal that optimal FDI-entry should take longer the higher the uncertainty regarding the future path of attractiveness in both locations and the higher the share of capital committed by the firm to the foreign location. Conversely, the higher the level of foreign attractiveness relative to that at home, the higher the discount rate and correlation between attractiveness in both locations, the relatively sooner should the option of FDI be exercised.

With the aim of empirically testing the 'option-pricing' model, a discrete-variable econometric model that uses labour cost as the proxy for (the reciprocal) of attractiveness is estimated for a 1990s sample of United States MNEs' FDI into a panel of developed and developing countries, under both static and forward-looking expectations hypotheses. The results of the econometric estimation suggest that the model can explain the entry events of United States FDI under the hypotheses of static and forward expectations. Indeed, as predicted by the analytical model, FDI-entry depends negatively on the volatility of foreign locations' attractiveness, on relative labour costs and on the share of capital already invested in that location. The entry of firms depends positively on the discount rate and on the correlation between the attractiveness of home and host countries. Thus, the overall empirical results, by suggesting that FDI-entry depends not only on the relative attractiveness but crucially on the uncertainty surrounding the future path of attractiveness, corroborate the implications of our analytical model.

APPENDIX

A. Comparative Statics

In this appendix the derivatives referred to in the main text are presented. The derivatives of the critical ratio with respect to the various parameters are computed taking into consideration the assumptions made in the main text, which will prove instrumental in ascertaining the signs of some of the derivatives. To these assumptions, it is added for ease of calculations, that $\sigma_h = \sigma_f = \sigma$, which allows us to write equation (24) in the main text as:

$$\frac{A_f^*}{A_h^*} = \left\{ \left[1 + \frac{4 s_h s_f \sigma^2 (1-\rho)}{\mu - \sigma^2} \right] \left[\frac{(1-\rho)\sigma + \sqrt{(1-\rho)\left(\mu - \rho\sigma^2\right)}}{(1-\rho)\sigma\left(1 - 2s_f\right) + \sqrt{(1-\rho)\left(\mu - \rho\sigma^2\right)}} \right] \right\}^{\frac{1}{2s_f}}$$

a) Derivation of the sign of $\dfrac{\partial\left(\dfrac{A_f^*}{A_h^*}\right)}{\partial\sigma}$.

To get the sign of $\dfrac{\partial\left(\dfrac{A_f^*}{A_h^*}\right)}{\partial\sigma}$, we decompose the derivation of the derivative expression into several steps:

1st: $\left[1 + \dfrac{4 s_h s_f \sigma^2 (1-\rho)}{\mu - \sigma^2} \right]_\sigma^{|} = \dfrac{8 s_h s_f \sigma \mu (1-\rho)}{\left(\mu - \sigma^2\right)^2} \geq 0$, under the assumption $\left(\mu - \sigma^2\right) > 0$

2nd: $\dfrac{\partial \beta_1}{\partial\sigma} = -\dfrac{\mu}{2 s_f \sigma^2 \sqrt{\left[(1-\rho)\left(\mu - \rho\sigma^2\right)\right]}} < 0$

3rd: $\dfrac{\partial\left(\dfrac{\beta_1}{\beta_1 - 1}\right)}{\partial \beta_1} < 0$ and so $\dfrac{\partial\left(\dfrac{\beta_1}{\beta_1 - 1}\right)}{\partial \sigma} > 0$

4th: Since the 1st and 3rd step yield positive derivatives, it follows that $\dfrac{\partial\left(\dfrac{A_h^*}{A_f^*}\right)}{\partial \sigma} > 0$

b) Derivation of the sign of $\dfrac{\partial\left(\dfrac{A_f^*}{A_h^*}\right)}{\partial\mu}$.

As before, we decompose the derivation of the derivative expression into several steps:

1st: $\left[1+\dfrac{4s_h s_f\sigma^2(1-\rho)}{\mu-\sigma^2}\right]'_{\mu}=-\dfrac{4s_h s_f\sigma^2(1-\rho)}{\left(\mu-\sigma^2\right)^2}<0$, under the assumption $\left(\mu-\sigma^2\right)>0$

2nd: $\dfrac{\partial\beta_1}{\partial\mu}=\dfrac{1}{4s_f\sigma\sqrt{(1-\rho)\left(\mu-\rho\sigma^2\right)}}>0$

3rd: $\dfrac{\partial\left(\dfrac{\beta_1}{\beta_1-1}\right)}{\partial\beta_1}<0$ and so $\dfrac{\partial\left(\dfrac{\beta_1}{\beta_1-1}\right)}{\partial\mu}<0$

4th: From the 1st and the 3rd steps it follows that $\dfrac{\partial\left(\dfrac{A_h^*}{A_f^*}\right)}{\partial\mu}<0$.

c) Derivation of the sign of $\dfrac{\partial\left(\dfrac{A_f^*}{A_h^*}\right)}{\partial\rho}$:

1st: $\left[1+\dfrac{4s_h s_f\sigma^2(1-\rho)}{\mu-\sigma^2}\right]'_{\rho}=-\dfrac{4s_h s_f\sigma^2}{\left(\mu-\sigma^2\right)}<0$, under the assumption $\left(\mu-\sigma^2\right)>0$

2nd: $\dfrac{\partial\beta_1}{\partial\rho}=\dfrac{\mu-\sigma^2}{4s_f\sigma(1-\rho)\sqrt{(1-\rho)\left(\mu-\rho\sigma^2\right)}}>0$

3rd: $\dfrac{\partial\left(\dfrac{\beta_1}{\beta_1-1}\right)}{\partial\beta_1}<0$ and so $\dfrac{\partial\left(\dfrac{\beta_1}{\beta_1-1}\right)}{\partial\rho}<0$

4th: From the 1st and 3rd steps, it follows that $\dfrac{\partial\left(\dfrac{A_h^*}{A_f^*}\right)}{\partial\rho}<0$

d) Derivation of the sign of $\dfrac{\partial\left(\dfrac{A_f^*}{A_h^*}\right)}{\partial s_f}$:

1[st]: $\left[1+\frac{4s_h s_f \sigma^2(1-\rho)}{\mu-\sigma^2}\right]^1_{s_f} = \frac{4s_h\sigma^2(1-\rho)}{\left(\mu-\sigma^2\right)} > 0$; under the assumption $\left(\mu-\sigma^2\right) > 0$

2[nd]: $\frac{\partial \beta_1}{\partial s_f} = -\frac{\sigma(1-\rho)+\sqrt{(1-\rho)\left(\mu-\rho\sigma^2\right)}}{2s_f{}^2\sigma(1-\rho)} < 0$

3[rd]: $\frac{\partial\left(\frac{\beta_1}{\beta_1-1}\right)}{\partial \beta_1} < 0$ and so $\frac{\partial\left(\frac{\beta_1}{\beta_1-1}\right)}{\partial s_f} > 0$

4[th]: From the 1[st] and 3[rd] steps, it follows that $\frac{\partial\left(\frac{A_h^*}{A_f^*}\right)}{\partial s_f} > 0$

B. Simulations

The simulations relate to the critical ratio obtained in equation (24). These simulations are conducted with reference to a benchmark case.

The values of the parameters considered in the Benchmark case, as well as the ranges used in the simulations of the critical ratio, were drawn from a panel data set of United States' MNEs investing into some European Union Countries (France, Germany, Italy, Netherlands, Spain and UK), the Southeast Asian "New Tiger Countries" (Indonesia, Malaysia, Thailand and Philippines) and into Canada and Mexico, during the period 1992-1996. The attractiveness of the foreign country is proxied by the labour productivity (GDP per employee per hour, US$), from the World Competitiveness Yearbook (WCY) for the period. Thus, the parameters pertaining to the equations of the critical ratio are defined as:

Sigma Volatility of Labour Productivity, is the standard deviation of the logarithm of labour productivity of the threes years prior to entry.

Rho Correlation is the correlation between the logarithm of labour productivity of the foreign country relative to the United States of the threes years prior to entry.

Mu The Discount Rate is the United States' Treasury 5-year bond yield, from the Statistical Abstract of the United States.

Share Since the data on the share of capital invested is not available, the benchmark value and the range of variation for both shares were picked arbitrarily according to what seems to be reasonably faithful to the underlying reality.

The table below presents the range as well as the mean for each parameter according to the data set specification above. The mean values are used to define the benchmark case while the maximum and the minimum values bound the range used for the simulations of the critical ratio.

	MEAN	MAXIMUM	MINIMUM
Share H	0.9	0.99	0.51
Share F	0.1	0.49	0.01
Mu	6.116	6.690	5.140
Sigma H	0.044	0.07	0.02
Sigma F	0.123	0.959	0.01
Rho	0.374	1	-1

Figure 1: Share-H=0.9; Share-F=0.1; Rho=0.374; Mu=0.061

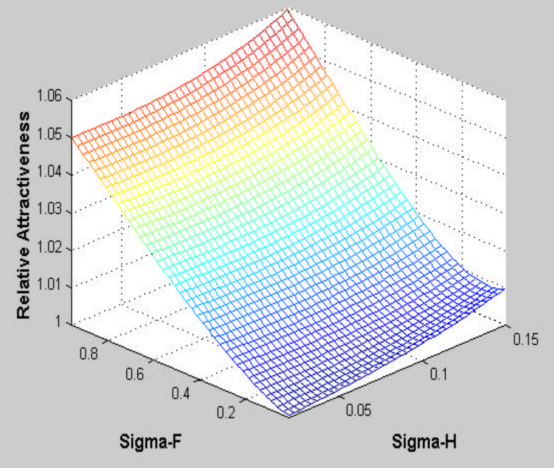


Figure 2: Share-H=0.9; Share-F=0.1; Sigma-H=0.044; Mu=0.061

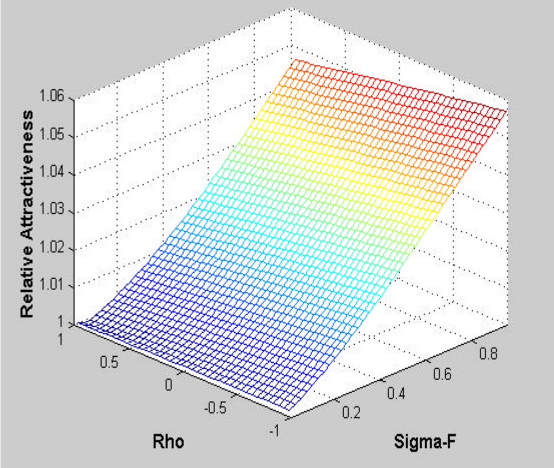


Figure 3: Sigma-H=0.044; Rho=0.374; Mu=0.061

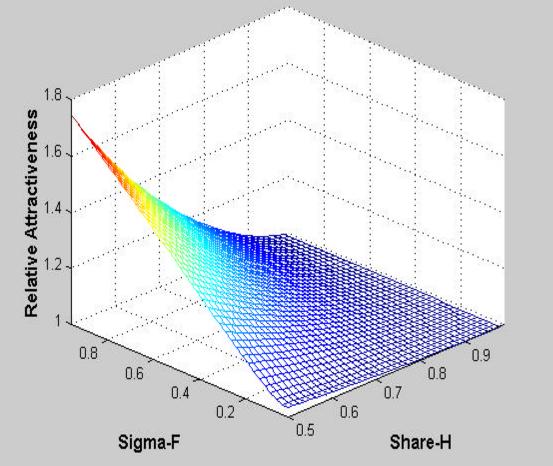


Figure 4: Sigma-H=0.044; Rho=0.374; Mu=0.061

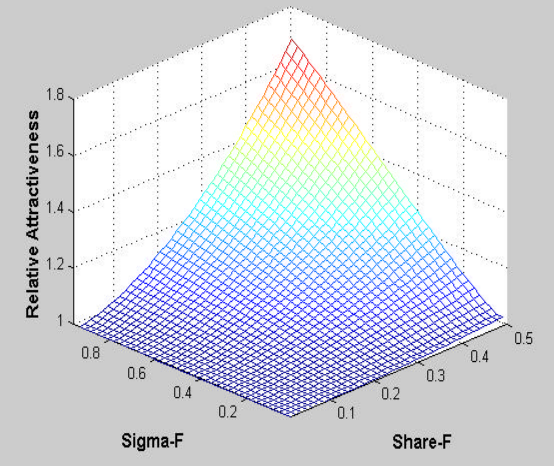


Figure 5: Share-H=0.9; Share-F=0.1; Sigma-H=0.044; Rho=0.374

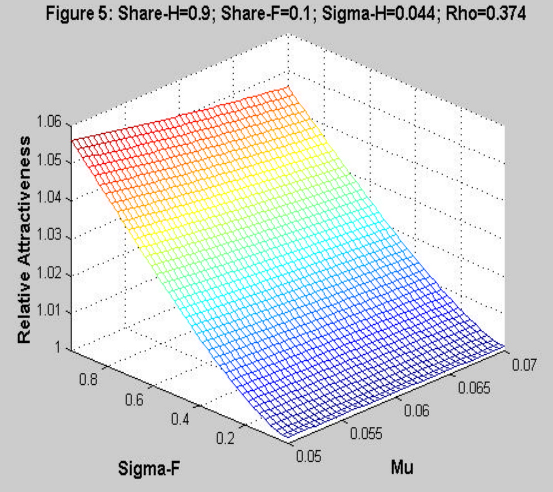
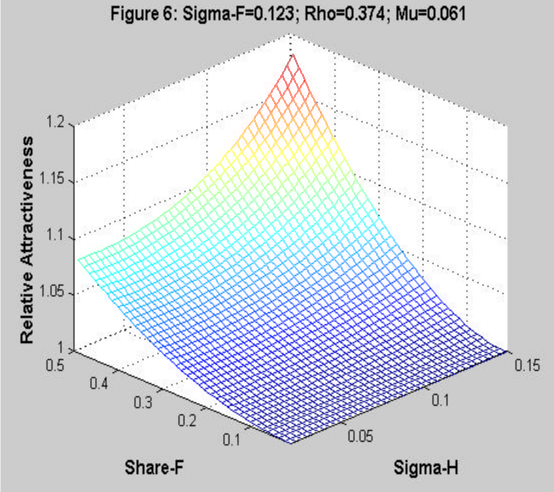


Figure 6: Sigma-F=0.123; Rho=0.374; Mu=0.061



C. Data Appendix

TABLE 1 I1 - All Industries

I2 - PETROLEUM

Oil and gas extraction
Crude petroleum extraction (no refining) and natural gas
Oil and gas field services
Petroleum and coal products
Integrated petroleum refining and extraction
Petroleum refining without extraction
Petroleum and coal products, nec
Petroleum wholesale trade
Other

I3 - MANUFACTURING

I4 - Food and kindred products

Grain mill and bakery products
Beverages
Other

I5 - Chemicals and allied products

Industrial chemicals and synthetics
Drugs
Soap, cleaners, and toilet goods
Agricultural chemicals
Chemical products, nec

I6 - Primary and fabricated metals

Primary metal industries
Ferrous
Nonferrous
Fabricated metal products

I7 - Machinery, except electrical

Farm and garden machinery
Construction, mining, and materials handling machinery
Office and computing machines
Other

I8 - Electric and electronic equipment

Household appliances
Radio, television, and communication equipment
Electronic components and accessories
Electrical machinery, nec

I9 - Other manufacturing

Transport equipment (Motor vehicles and equipment and Others)
Tobacco products
Textile products and apparel
Lumber, wood, furniture, and fixtures
Paper and allied products
Printing and publishing
Rubber products
Miscellaneous plastics products
Glass products
Stone, clay, and other nonmetallic mineral products
Instruments and related products
Other

I10 - WHOLESALE TRADE

Durable goods
Nondurable goods

I11 - FINANCE (EXCEPT BANKING), INSURANCE, AND REAL ESTATE

Finance, except banking
Insurance
Real estate
Holding companies

I12 - SERVICES

Hotels and other lodging places
Business services
Advertising
Equipment rental (ex automotive and computers)
Computer and data processing services
Business services, nec
Automotive rental and leasing
Motion pictures, including television tape and film
Health services
Engineering, architectural, and surveying services
Management and public relations services
Other

I13 - OTHER INDUSTRIES

Agriculture, forestry, and fishing
Mining
Metal mining
Nonmetallic minerals
Construction
Transport
Communication and public utilities
Retail trade

Data Sources

Capital Outflows: The source for the FDI capital outflows is the BEA. The direct investment capital outflows consist of equity capital outflows[28], reinvested earnings[29], and intercompany debt outflows[30].

Direct investment capital outflows exclude transactions between two U.S. persons, because transactions between U.S. persons are not considered international, even if cross-border transactions are involved. Thus, if one U.S. person purchases a direct investment interest in a foreign affiliate from another U.S. person, the new owner will establish or increase its ownership interest in the foreign affiliate, but no equity capital outflow is recorded, because the transaction occurs entirely within the United States. In addition, there is no net increase in U.S. claims on foreign countries; instead, one U.S. person's claims have merely been substituted for those of another.

Employment: The number of employees is defined as the full-time and part-time employees on the payroll at the end of fiscal year[31], extracted from the Bureau of economic Analysis (BEA) of the United States' Commerce Department.

Share of FDI: The share of total assets of United States' foreign affiliates[32], industry of foreign affiliate relative to the total assets of the United States' parent company[33],

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28 Equity capital outflows are net increases in U.S. parents' equity in their foreign affiliates. Equity capital inflows (decreases in equity) are netted against equity capital outflows (increases in equity) to derive the net outflow.

29 Reinvested earnings of foreign affiliates are earnings less distributed earnings. Earnings are U.S. parents' shares in the net income of their foreign affiliates after the provision for foreign income taxes. Note that, because reinvested earnings are not actually transferred to the U.S. parent, they increase the parent's investment in its affiliate. Thus, an entry equal to the value of reinvested earnings is made in the direct investment income account, and a similar entry, but with the opposite sign, is made in the direct investment capital account.

30 Intercompany debt outflows consist of the increase in U.S. parents' net intercompany debt receivables from their foreign affiliates during the year, as they are recorded in the financial records of the U.S. parents.

31 An affiliate's fiscal year is defined as the financial reporting year that ended in that calendar year.

32 The foreign affiliates' total assets are equal to the sum of total owners' equity in affiliates held by both U.S. parents and all other persons and total liabilities owed by affiliates to both U.S. parents and all other persons.

33 A U.S. parent is a U.S. person who has direct investment, that is, a 10 percent or more direct or indirect ownership interest in a foreign business enterprise.

industry of U.S. parent, from the Bureau of economic Analysis (BEA) of the United States' Commerce Department.

Discount Rate: United States' Treasury 5-year bond yield extracted from the Statistical Abstract of the United States.

Relative Labour Costs: Labour costs of the countries in the panel relatively to the United States[34], during the period 1988 to 1996

The affiliates' wages per employee are extracted from the ratio of employment compensation to the number of employees in industry of foreign affiliate, from the Bureau of economic Analysis (BEA) of the United States' Commerce Department. The employment compensation (wages and salaries per employee) data cover the full year.

Volatility: There are two assumptions on the calculation of this variable. (1) Static expectations: calculated as the moving average of the standard deviation of the logarithm of host country's labour costs, at industry level, from the three years (excluding the year under observation) prior to the date of entry. (2) Forward-looking expectations: defined as before but using the data for the three years (excluding the year under observation) after the entry occurred.

Correlation: defined as the moving average of the correlation between the logarithm of host country and United Sates' labour costs, at industry level, following the criteria explained for volatility above.

34 The United States' labour costs are proxied by the ratio of employment compensation to number of employees of U.S. parent companies, industry of parent.

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