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Investment in new foreign subsidiaries under receding perception of uncertainty

Jan Hendrik Fisch

Lehrstuhl fuer Technologie- und Innovationsmanagement, Zeppelin University, Friedrichshafen, Germany

Correspondence:
J H Fisch, Lehrstuhl fuer Technologie- und Innovationsmanagement, Zeppelin University, Am Seemooser Horn 20, D-88045 Friedrichshafen, Germany.
Tel: +49 (0)7541 6009 1261;
Fax: +49 (0)7541 6009 1199;
E-mail: jfisch@zeppelin-university.de

Abstract
Research on foreign direct investment has focused considerable attention on the moment of market entry, but less on the dynamics of investment in the post-entry phase. This paper centres the influence of uncertainty on investment, and develops a growth options model to explain the sequence of investment in new foreign subsidiaries. In a learning process that starts at entry, investors perceive receding levels of uncertainty and shift their reason for investment from option values towards net present values. The findings of a panel study of 634 German subsidiaries support the propositions and reveal the potential of the real options approach to improve the understanding of internationalisation processes.
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INTRODUCTION

Foreign investors must meet the challenge of establishing subsidiaries under high levels of uncertainty. A common procedure is to start a foreign subsidiary with little capital and enlarge it later by way of subsequent investment. In spite of the large body of literature about foreign direct investment, these sequences have not yet been subject to true dynamic study.

Some analyses of international investment recognise the need to investigate the time dimension, but postpone it to future research (Agarwal & Ramaswami, 1992; Gatignon & Anderson, 1988; Mudambi & Mudambi, 2002). Other studies observe sequences of investment but do not intend to explain their timing (Camino & Cazorla, 1998; Erramilli, Srivastava, & Kim, 1999). Studies on the timing of investment are limited to international entries (Chang & Rosenzweig, 2001; Delios & Henisz, 2003; Tan & Vertinsky, 1996). Work on the development of foreign subsidiaries has mainly examined their failures, that is, the causes of international divestment (Benito, 1997; Mata & Portugal, 2000; McCloughan & Stone, 1998). Uhlenbruck (2004) is an exception, but considers the development of subsidiaries as the growth in sales in a single year rather than a sequence of investment over several years. All in all, previous studies of market entries and internationalisation processes do not address the question of investment sequences in the establishment of foreign subsidiaries. Research on multinational enterprises begins with the premise that the foreign affiliates have

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already been built up (Bartlett & Ghoshal, 1989; Doz & Prahalad, 1991; Hedlund, 1986).

The knowledge gap between the initial set-up and final operation of foreign subsidiaries may result from a dynamic deficit of the established theories of internationalisation. Many approaches are static in nature, such as the theories of Hymer (1976), Buckley and Casson (1976) and Dunning (1981). By contrast, Johanson and Vahlne (1977) propose a dynamic approach (similarly, Bilkey & Tesar, 1977; Luostarinen, 1979). The Uppsala model hypothesises a self-reinforcing relationship of international experience and investment. This mechanism is well known. However, the model also assumes that the interplay of experience and investment is controlled by the market risk in the host country. As soon as the market risk exceeds a certain level of tolerance, foreign investors are likely to continue investing only when their experience has grown or the market risk has declined, conditional upon the expectation of positive returns. Low market risk may allow the investors to leapfrog phases of the establishment chain, as less international experience is required. Subsequent research has largely ignored this part of the model, possibly because it was not thoroughly developed. In later publications, the authors admit that their model considers just one influencing factor of investment: the investor's international experience (Andersson, Johanson, & Vahlne, 1997; Vahlne & Nordström, 1993).

Buckley and Casson (1998) state that a correct conceptualisation of the dynamics of foreign direct investment must account for the predominant role of uncertainty. In their ''modern research agenda'' they plead for enriching the research on internationalisation by a new approach, the theory of real options. This line of thought might be especially suitable, as it emphasises the value of flexibility in volatile environments, as host countries are. Considering flexibility gives an interesting clue to investment behaviour. Investors seeking to retain flexibility in the face of uncertainty do not schedule investment in a foreign subsidiary along with a predefined establishment chain. They would rather try to hold their options open for later investment decisions. Initial empirical studies show the potential of real options theory to gain new insights into international investment activities (Hurry, Miller, & Bowman, 1992; Reuer, 2002). First conceptual models analyse the decision of international entry (Buckley, Casson, & Gulamhussen, 2002; Hule, 2000; Rivoli & Salorio, 1996).

This paper attempts, theoretically and empirically, to bridge the research gap about investment in foreign subsidiaries in the establishment phase between set-up and operation. Its aim is to examine the ability of an intuitive real options model to explain the investment rate after international entry. The model analyses the balance of option and net present values. This balance should guide investment decisions after entry: the growth option value retards whereas the net present value accelerates the allocation of further capital. However, the foreign affiliate's value depends on factors that are moderated by a learning process. The investor's receding perception of uncertainty makes the balance shift dynamically from option to net present values. The paper provides an empirical test of the model using data on the establishment of foreign subsidiaries owned by German manufacturing firms. The results support the view of real options reasoning in foreign direct investment decisions and allow for a derivation of important theoretical and practical implications.

The paper proceeds with a review of relevant real option models and empirical findings on corporate investment rates, as explained by the progression of uncertainty. The third section devises a model of international growth options and derives a set of propositions. Exogenous and endogenous factors of the uncertainty and tendency of future profits should have an influence on the investment rate in new foreign subsidiaries. Furthermore, their relevance is hypothesised to change over time. The panel of foreign subsidiaries, the measures, and the econometric model are described in the fourth section. The fifth section shows the results of panel analyses incorporating the dynamics of investment in different ways. This is followed by a discussion of the results. The last section provides a concluding summary.

A REAL OPTIONS PERSPECTIVE TO SEQUENCES OF INVESTMENT

Models of Growth Options and Learning under Uncertainty

As Pindyck (1988) shows, there is a mathematical solution to finding an optimal strategy of incremental investment under uncertainty. Let K be the capital invested and θ the demand for a good that is produced using K. The value of the investment object

$$W = C(K, \theta) + V(K, \theta) \quad (1)$$

consists of two parts: the value C of the capital already invested, and the value V of the growth

option to invest more capital. Deconstructing the capital into marginal units of investment, the equation reads

$$W = \int_0^K \Delta C(\nu, \theta)\mathrm{d}\nu + \int_K^\infty \Delta V(\nu, \theta)\mathrm{d}\nu \qquad (2)$$

The investor raises the stock of capital until the value of a marginal unit of capital invested equals its cost s plus the opportunity cost of the irreversible decision to exercise the related growth option:

$$\Delta C(K^*, \theta) = s + \Delta V(K^*, \theta) \qquad (3)$$

Assuming a quadratic production function and a stochastically evolving demand, contingent claims analysis or dynamic programming lead to a system of equations that can be solved numerically to find the optimal stock of capital K^*. Simulations suggest that even moderate levels of uncertainty make investors wait for demand to triple before they decide to add capital.

Pindyck's (1988) approach was improved to allow for surges in investment (Dixit, 1995) and lower degrees of irreversibility (Dixit & Pindyck, 2000). Nevertheless, foreign investors appear to refrain from real option models in their investment decisions (Becker, 2005). Other surveys show in general that only a few managers are aware of the blessings of real option models; even fewer put them to use (Busby & Pitts, 1997; Peemöller, Beckmann, & Kronmüller, 2002; Vollrath, 2003). However, laboratory studies suggest that economists intuitively consider option values in investment decisions under uncertainty (Howell & Jägle, 1997; Miller & Shapira, 2004). Rules of thumb lead to results that are very similar results to those of correct option valuations (McDonald, 2000). Therefore it seems reasonable to suggest that practitioners apply real options reasoning (McGrath & Nerkar, 2004). As long as managers do not rely on precise option techniques, behavioural option models may be sufficient to provide insights into foreign investors' decisions.

In this study, uncertainty will denote the unpredictability of a foreign affiliate's financial success. Uncertainty may originate from different sources and appear in various shapes. Using a straightforward concept of uncertainty puts a boundary on the analysis, but facilitates a structured approach. In order to examine the influence of uncertainty on investment decisions, Roberts and Weitzman (1981) consider two types of uncertainty. Exogenous uncertainty is largely unaffected by the investor's actions, whereas endogenous uncertainty can be reduced by learning. The study by Cuypers and Martin (2006) draws on the analysis of exogenous *vs* endogenous uncertainty by Folta (1998) and shows that, in contrast to exogenous uncertainty, endogenous uncertainty does not create a waiting option value prior to investment. Under endogenous uncertainty, firms may rather have an incentive to trigger the initial investment, since investing is the only way to start reducing it. However, in the learning phase right after the investment, endogenous uncertainty will still be effective and keep a growth option value alive, just as the exogenous uncertainty does (Chi, 2000). Chi further suggests that the effects not only of endogenous but also of exogenous uncertainty on the option valuation decay over time as the investor learns to cope with both types of uncertainty. Chi's notion is supported by the literature on perceived environmental uncertainty. This stream of research distinguishes between an objective uncertainty and the uncertainty that a manager perceives (Duncan, 1972; Lorenzi, Sims, & Slocum, 1981). The investor may learn to predict future states of the environment, to foresee their effects on the organisation, and to estimate the consequences of organisational responses (Milliken, 1987). As a consequence, perceived uncertainty declines. The impact of learning on the perception of environmental uncertainty has been asserted by several studies (Downey, Hellriegel, & Slocum, 1977; Downey & Slocum, 1975; Perkins & Rao, 1990). Furthermore, the investor may achieve control over the environment and thereby directly influence the environmental uncertainty (Bowman & Hurry, 1993). We therefore use the source of uncertainty rather than the degree to which it is affected by the investor's actions or perceptions in order to differentiate between exogenous and endogenous uncertainty. According to this understanding, we assume that both exogenous and endogenous uncertainty can be reduced by learning.

Studies on the Impact of Uncertainty on Incremental Investment

The review by Carruth, Dickerson, and Henley (2000) suggests that empirical studies have mostly supported the view that uncertainty negatively influences investment. In recent years, panel studies have generated additional findings on the dynamics of investment under uncertainty. Ogawa

and Suzuki (2000) investigate the investment rate of 389 Japanese manufacturing firms between 1984 and 1993. Different measures of the concurrent uncertainty of demand show a negative impact on the investment rate. Ghosal and Loungani (2000) consider the influence of uncertain returns on the aggregate investment rate of 91 industries being dominated by small and 239 industries being dominated by large companies between 1965 and 1991. Using several measures of uncertainty and time lags, they find a negative influence on investment. Small companies seem to react more strongly to uncertainty than large ones. Bloom, Bond, and van Reenen (2003) study the investment rate of 672 companies quoted in Britain between 1972 and 1991. The contemporary uncertainty of stock price gains is negatively associated with investment, whereas the precedent year's uncertainty is not. Kalckreuth (2003) examines the influence of uncertainty in sales on the investment rate of 4234 West German companies between 1987 and 1997. The coefficients are significantly negative for various measures and time lags. Obviously, investors hold back investments in phases of high uncertainty and launch them in more predictable ones. The studies' results are fairly robust against different measures of uncertainty, and suggest that investment decisions reflect the course of uncertainty with little delay.

Findings about investment decisions on the corporate level cannot be directly transferred to establishing new foreign subsidiaries. The overall investment rate is subject to a variety of options, including waiting options and growth options. Folta and O'Brien (2004) argue that they induce investment effects in opposing directions. Surveys on the general rate of investment can only observe their balance. In the case of new foreign subsidiaries, by contrast, waiting options (Huisman, Kort, Pawlina, & Thijssen, 2004) have already been exercised by the decision to enter the host country. International switching options (Kogut & Kulatilaka, 1994; Rangan, 1998) gain importance mainly after the build-up phase. Modelling investment behaviour to build up new subsidiaries may concentrate on one option type: growth options.

Investigating new subsidiaries carries another analytical advantage. The learning processes, by which uncertainty is perceived less intensely over time, start with every object that is new to the investor. The general investment rate, however, refers to spending for new objects as well as for enhancing and replacing existing ones. The learning processes commence at different points in time and overlie each other; their effects are difficult to differentiate at an aggregate level. On the other hand, the investment rates and the learning processes to establish new foreign subsidiaries can be studied more independently of other investment objects. Therefore it appears feasible to observe learning effects that were neglected by studies on aggregate investment.

A DYNAMIC MODEL OF INVESTMENT IN NEW FOREIGN SUBSIDIARIES

Option Evaluation

Let us assume that a local company was recently founded or acquired by a foreign investor. As a consequence of their unfamiliarity with the host country, the investor perceives a significantly higher degree of uncertainty than in a domestic environment (Rob & Vettas, 2003). It is likely but not necessary that the investor consciously reacted to uncertainty by limiting the capital at entry (''shadow option''; Bowman & Hurry, 1993). Assume that the initial and following investments are at least partly irreversible because the subsidiary's activities require specific assets such as service tools or production facilities. The investor's opportunity to build up the subsidiary further by a sequence of investment is regarded as a growth option that is ready to be exercised over time.

According to Pindyck (1988) the total value W of the subsidiary consists of the net present value C of the capital invested and the option value V of the capital to be invested (Eq. (1)). By previous investment decisions, the investor has determined the stock of capital K from which growth options can be exercised. Findings about the use of real option models in practice do not allow for the presumption that the investor employs contingent claims analysis or dynamic programming to calculate the optimal stock of capital. However, the investor may strive for an improvement of the current stock of capital and balance the value of binding more capital against the value of losing flexibility. To analyse the direction in which the investor will adjust the stock of capital, it is sufficient to develop a simple deterministic model instead of a stochastic real option model. The rate of investment I/K will depend on the difference between the marginal net present value $c=\mathrm{d}C/\mathrm{d}K$

and the marginal option value v=dV/dK of adding a unit of capital

$$\frac{I}{K} = (c - v) + I^* \tag{4}$$

I^* denotes the propensity to invest for other reasons than exercising options. Let the marginal net present value in period k be

$$c(k) = \sum_t \frac{c_t[\mu(k)]}{\{1 + r + i[\sigma(k)]\}^t} \tag{5}$$

and, owing to the prognosis of cash flows, increase with a rising tendency of expected returns $\mu(k)$. The denominator includes the risk-free interest rate r and a risk premium i, which rises with uncertainty $\sigma(k)$. In effect, the marginal net present value $c(k)$ decreases as uncertainty $\sigma(k)$ increases.

Similar to the option pricing model by Black and Scholes (1973) suppose that the marginal value of the growth option $v(k)$ increases with the uncertainty of expected returns $\sigma(k)$ but is independent of their concurrent tendency $\mu(k)$. The investment rate of Eq. (4) becomes

$$\frac{I(k)}{K(k)} = \sum_t \frac{c_t[\mu(k)]}{\{1 + r + i[\sigma(k)]\}^t} - v[\sigma(k)] + I^* \tag{6}$$

Investors make their decisions with respect to the uncertainty that they perceive. The perceived uncertainty will decline over time by a learning function $l(k)$ and affect both exogenous and endogenous uncertainty:

$$\sigma(k) = l(k)[\sigma_{ex}(k) + \sigma_{en}(k)] \tag{7}$$

Exogenous uncertainty $\sigma_{ex}(k)$ reflects the time-variant volatility of the host country environment. Endogenous uncertainty $\sigma_{en}(k)$ is caused by a disability of the investor to control the subsidiary (Brouthers, 1995). By analogy, the tendency of expected returns $\mu(k)$ has an exogenous and an endogenous part:

$$\mu(k) = \mu_{ex}(k) + \mu_{en}(k) \tag{8}$$

Exogenous tendency $\mu_{ex}(k)$ refers to the prospects of the host country environment to develop. Endogenous tendency $\mu_{en}(k)$ addresses the subsidiary's promise to operate successfully. Introducing the factors $c^*(k)$ and $v^*(k)$, the investment rate of Eq. (6) can be linearised:

$$\frac{I(k)}{K(k)} \approx \sum_t \frac{c_t^*}{\{1 + r + i[\sigma(k)]\}^t}\mu(k) - v^*(k)\sigma(k) + I^* \tag{9}$$

The option value factor $v^*(k)$ will incorporate the learning function $l(k)$ and therefore decrease with time k: see Figure 1.

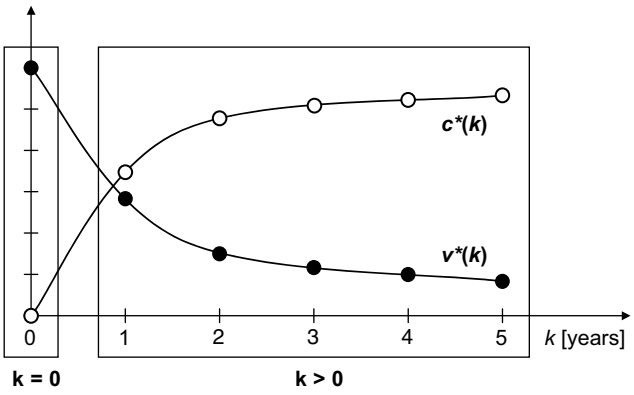

Figure 1 Marginal net present value and option factors evolving over time.

The more complicated factor preceding $\mu(k)$ in Eq. (9) happens to depend on $\sigma(k)$ owing to the risk adjustment i of the interest rate, so there is an interaction of $\mu(k)$ and $\sigma(k)$. Analysing the limits for extremely high and low uncertainty shows that this interaction is asymmetric. While the tendency of expected returns overlies the uncertainty for the entire range of $\mu(k)$, the uncertainty does not. If the uncertainty is extremely high, the denominator may become very large and let the factor reach

$$\lim_{\sigma \to \infty} \sum_t \frac{c_t^*}{\{1 + r + i[\sigma(k)]\}^t} = 0 \tag{10}$$

which suppresses the influence of $\mu(k)$. Uncertainty is most likely to be very high at the moment of entry. If uncertainty is extremely low, however, the risk-free interest rate prevents the denominator from declining to zero and leads to a factor of

$$\lim_{\sigma \to 0} \sum_t \frac{c_t^*}{\{1 + r + i[\sigma(k)]\}^t} = \sum_t \frac{c_t^*}{(1 + r)^t} \tag{11}$$

The influence of $\mu(k)$ is not remarkably affected by changes in uncertainty, which is perceived low by the investor, most probably in the years after entry. Hence there is an asymmetric interaction under the dominance of $\mu(k)$. It makes deriving and testing hypotheses difficult, and is accompanied by the circumstance that the factor concerned represents a series of rational functions.

We make the assumption that the reduction of uncertainty perception through learning occurs quickly after entry (Figure 1) and is significant when compared with the yearly change in objective uncertainty. Such dynamics can be approximated by introducing a factor $c^*(k)$ rapidly increasing with time (see Figure 1), and neglecting the asymmetric interaction in the years after entry. Inserting

the exogenous and endogenous elements of uncertainty (Eq. (7)) and tendency (Eq. (8)), the investment rate reads

$$\frac{I(k)}{K(k)} \approx -v^*(k)[\sigma_{ex}(k) + \sigma_{en}(k)] + c^*(k)[\mu_{ex}(k) + \mu_{en}(k)] + I^* \quad (12)$$

Hypotheses

Uncertainty boosts the growth option value of the foreign subsidiary and keeps the investor from exercising the option by a subsequent investment. The investor waits for the exogenous uncertainty $\sigma_{ex}(k)$ of the host country environment to resolve. Thus exogenous uncertainty such as the economic volatility, *vola*, of the host country has a detrimental impact on the investment rate, which is indicated by the negative sign of the marginal option value factor $v^*(k)$ in Eq. (12). As a downside risk, country risk emerged as a negative factor of foreign direct investment in numerous studies (Enders & Sandler, 1996; Hall, 2004; Mudambi & Navarra, 2003). Corresponding to the findings of the real option-based studies by Bloom et al. (2003) and Kalckreuth (2003) it seems likely that

Hypothesis 1a: The economic volatility in the host country has a negative impact on the investment rate to build up new foreign subsidiaries.

Several studies have shown that the perception of environmental uncertainty recedes by learning (Downey & Slocum, 1975; Downey et al., 1977; Perkins & Rao, 1990). The investor learns to predict changes of the environment and how these changes might affect the subsidiary's success. As the uncertainty perception recedes, the growth option value of the foreign subsidiary abates. The diminishing option value factor $v^*(k)$ (cf. Figure 1) in Eq. (12) suggests that the impact of uncertainty *vola* on the investment rate will recede over time.

Hypothesis 1b: The impact of economic volatility on the investment rate is stronger in the first years after entry than in later years.

The endogenous uncertainty $\sigma_{en}(k)$ of a foreign subsidiary's success creates a value of holding a growth option in favour of investing right away. It is caused by the disability of the investor to control the subsidiary. The more experience from previous international entries, the better can the investor assess the subsidiary's operations and predict its success. According to the negative sign of the marginal option value factor $v^*(k)$ in Eq. (12), endogenous uncertainty retards the investment rate. International experience, *intexp*, is likely to effectuate the opposite, as previous studies on foreign direct investment suggest (Camino & Cazorla, 1998; Erramilli et al., 1999; Hadley & Wilson, 2003).

Hypothesis 2a: The previous international experience of the investor has a positive impact on the investment rate to build up new foreign subsidiaries.

The endogenous uncertainty $\sigma_{en}(k)$ that is caused by the investor's deficit of controlling the foreign subsidiary decays by the learning effect of Eq. (7), as is expressed by the declining option value factor $v^*(k)$ in the investment model (Eq. (12)) and outlined in Figure 1. In the moment of entry, the level of endogenous uncertainty depends on the international experience from previous entries, *intexp*. As time goes by, the investor acquires new knowledge about controlling the subsidiary at hand and thereby further reduces the endogenous uncertainty; the general international experience that was gained before entry becomes less relevant.

Hypothesis 2b: The impact of previous international experience on the investment rate is stronger in the first years after entry than in later years.

When the prospects of the host country environment develop favourably, the subsidiary will generate higher cash flows. The expected returns of the subsidiary increase the net present value factor $c^*(k)$ in Eq. (12). Therefore an upward economic *trend* of the host country as an exogenous tendency of expected returns, $\mu_{ex}(k)$ will have a positive impact on the investment rate. Previous studies have shown that foreign subsidiaries are less likely to be shut down under economic growth (Benito, 1997; Li, 1995).

Hypothesis 3a: An upward economic trend in the host country has a positive impact on the investment rate to build up new foreign subsidiaries.

To determine the net present value of the subsidiary, the investor discounts the expected cash flows by a risk premium that depends on the

uncertainty surrounding the foreign subsidiary (Eq. (5)). As the perception of uncertainty reduces through learning, the net present value factor $c^*(k)$ increases as shown in Figure 1. Consequently, learning strengthens the impact of the economic *trend* on the investment rate to build up a foreign subsidiary (Eq. (12)).

Hypothesis 3b: The impact of the economic trend on the investment rate is weaker in the first years after entry than in later years.

Observing a rising performance of a foreign subsidiary as an endogenous tendency of expected returns $\mu_{en}(k)$, the investor will extrapolate this progression and expect higher cash flows in the future as well. Increasing cash flows result in a higher net present value and provide an incentive for further investment. The role of foreign subsidiary performance has rarely been investigated by previous studies; Uhlenbruck (2004) considers performance as a dependent variable. In the dynamic investment model of Eq. (12), the net present value factor $c^*(k)$ is positively signed and indicates a positive effect of a rising performance, *riperf*, on the investment rate.

Hypothesis 4a: Rising performance of new foreign subsidiaries has a positive impact on the investment rate to build them up.

The investor discounts the expected cash flows by a risk premium that peaks off during the learning process. The net present value factor $c^*(k)$ rises over time (Figure 1) and intensifies the influence of the endogenous tendency of expected returns $\mu_{en}(k)$ on the investment rate (Eq. (12)). The receding perception of uncertainty puts a higher weight on the rising performance *riperf* when the investor decides on enlarging the subsidiary.

Hypothesis 4b: The impact of rising performance on the investment rate is weaker in the first years after entry than in later years.

METHOD

Data

German law requires investors to report balance sheets, figures of revenue and employees as well as local and sectoral information about their foreign direct investment objects to the central bank (Deutsche Bundesbank). Public access to these data is in principle denied, but provided to visiting researchers of the Bundesbank Economic Research Centre. The data assigns not only direct subsidiaries but also subsidiaries of subsidiaries etc. to the German investors. However, all investors and investment objects are anonymous. Anonymity makes collecting supplementary company information and matching this with other databases difficult. Nevertheless, it is possible to link data on the country and industry level. From 1996 on, the objects hold the same identification numbers from year to year, which leads to time series for nearly all German-owned foreign subsidiaries. This research uses final figures for the years 1996 to 2000 and preliminary data for 2001.

The study was restricted to certain countries and industries in order to avoid excess heterogeneity among the panel objects. The OECD 23 countries accounted for 87% of the stock of German foreign direct investment in 2001 (Deutsche Bundesbank, 2003), which is the last year of observation. Limiting the observation to these 22 countries (OECD 23–1, which is Germany) ensures a set of comparably industrialised locations. Manufacturing is the most important German industry sector and was chosen for the study, since more than 50% of foreign direct investment is related to these 23 industries. The Bundesbank database attaches pure sales subsidiaries to the retail sector; they are excluded from the manufacturing panel under observation. This is important, because sales subsidiaries require less specific investment and might violate the real option theory's assumption of irreversibility.

New entrants were distinguished from former objects by comparing reports of subsequent years. Since the time series start in 1996, new entrants could be tracked from 1997 on. Investment objects with a balance sheet total below €5 million were dropped in order to prevent misinterpretations of entries and exits near the reporting limit, which was repeatedly modified during that period. Data were considered not usable when investors failed to report on a subsidiary annually, or when subsidiaries had no employees, zero revenue or non-positive equity. Subsidiaries featuring a profitability outside a range of −200 and 600% and a capital growth rate outside −100 and 700% were cut off. The outliers were distributed nearly symmetrically around these limits and account for 2.2 and 3.8% of the observations, respectively.

The quality of the panel analysis is likely to rise both with the sample size and with the observation

Table 1 Panel objects by country and industry

Country	*No. of FDI objects*	*Industry*	*No. of FDI objects*
Australia	10	Food	21
Austria	42	Tobacco	x
Belgium	19	Textile	15
Canada	11	Clothing	5
Denmark	14	Leather	x
Finland	7	Wood	11
France	101	Paper	23
Greece	8	Publishing, printing	19
Ireland	8	Fuels	8
Italy	55	Chemicals	83
Japan	14	Rubber, plastics	62
Luxembourg	x	Glass, ceramics	31
Mexico	14	Extraction of metals	17
Netherlands	37	Metal products	70
Norway	x	Mechanical engineering	100
Portugal	18	Office, computing	x
Spain	55	Electrical engineering	31
Sweden	11	Communications	17
Switzerland	49	Medical, measurement, control	33
Turkey	12	Automobile	60
United Kingdom	50	Other vehicles	6
United States	93	Furniture, jewellery, sports	12
		Recycling	6
Total	634	Total	634

duration. However, the later the entries added to the panel, the shorter the observation period until 2001. Subsequent investment in the subsidiaries that entered in 1997 can be observed for 4 years. The 1997 entrants total 254, which was regarded as unsatisfactory. The 1998 entrants deliver investment rates for 3 years until 2001. Including them allows for a more useful panel size of 634 objects. The resulting panel of 1997 and 1998 entrants is unbalanced, with observations commencing in the year of entry, respectively, and jointly closing in 2001. Table 1 displays the number of panel objects by host country and industry. Counts below 3 must be suppressed for confidentiality, and are indicated by an ''x''.

Measures

Dependent variable. According to the Deutsche Bundesbank's definition, the stock of foreign direct investment is the total of attributable shares in the registered capital minus contributions owing, capital and surplus reserves, profit or loss brought forward, net profit or loss minus deficits uncovered by equity, loans from the investor, and those from associated companies. The database provides an investment figure that reaches through the chains of indirect investment and indicates the imputable stock of foreign direct investment for every foreign subsidiary. The rate of additional investment I/K_{ik} in a foreign subsidiary i in year k was measured by the increase of that investment figure as compared with the previous year, divided by the amount of the previous year.

Independent variables. For the variable *vola* it is necessary to measure volatility. There are firm-specific or aggregate and narrow or broadband approaches to measure uncertainty. Many sources of data fall short of providing information with a high time resolution. A firm-specific broadband measure such as the stock price of the related company (Bloom et al., 2003) seems ideal, as it examines directly relevant information and captures more factors of performance than a narrowband measure such as profit or sales. However, the companies in the Bundesbank database are anonymous and largely not listed. Stock indices of comparable companies as used by Folta and Miller (2002) are an aggregate alternative; production values are another. Miller (1993) suggests that managers' perceptions of environmental uncertainty do not differ significantly between industries but do differ between countries. Therefore it will be sufficient to use a measure of economic uncertainty on the country level. Every month, the OECD publishes a composite leading indicator (CLI) predicting the cyclical differences of economic development in the member countries from the long-term trend. Further, the OECD provides tables of the CLI's 6-month rate of change (6mC). This figure denotes the direction and intensity of the expected economic development, and can therefore be interpreted more easily. The CLI is more country-related than a stock index for two reasons. First, the movements of stock prices in the industrialised countries are closely interrelated under the lead of the New York Stock Exchange. Second, stock indices are calculated from large companies that operate internationally and thereby refer to the range of countries entered by these companies rather than to their home countries. This study uses the standard deviation of the monthly CLI 6mC within a country j and year k as a proxy of host country volatility $vola_{jk}$. It cannot be avoided that

$vola_{jk}$ is the same for all subsidiaries i in country j. Providing a time lag is unnecessary as the CLI indicates a forecast rather than an actual economic development.

The variable *intexp* calls for measuring the international experience of the German investors. Conducting a survey like Eriksson, Majkgard, and Sharma (2000) and Hadley and Wilson (2003) is impossible since the Bundesbank data are anonymous. Studies with secondary data use proxies such as the time since the year of entry (Luo, 1999; Mudambi & Mudambi, 2002) or the number of previous entries (Barkema, Bell, & Pennings, 1996; Tan & Vertinsky, 1996) or both (Delios & Makino, 2003). The Bundesbank data allow for tracking former entries back to 1996 only because, in the years before, the identification numbers were not assigned consistently. Therefore the international experience $intexp_i$ had to be operationalised by the quantity of foreign subsidiaries held by the investor of subsidiary i prior to entry. It indicates the level of endogenous uncertainty at the moment of entry, from when on its relevance declines by learning.

The variable *trend* denotes the economic trend in the host country. Previous studies used market growth to measure similar variables (Benito, 1997; Li, 1995). Data from various sources come into question, since calculating a trend within a year does not necessitate high-resolution information as volatility does. Employing the same data from the OECD, however, provides the advantage of consistency. For that reason, $trend_{jk}$ was measured by the mean of the CLI 6mC in country j and year k. Again, it is the same for all subsidiaries within one country.

Rising financial performance of a foreign subsidiary may explain part of the investment rate. Because most studies of internationalisation focus on entry, however, a variable like *riperf* has rarely been measured. Real option studies of domestic investment consider the revenue or the cash flow or their rate of change (Bloom et al., 2003; Kalckreuth, 2003). The Bundesbank database allows for measuring the return on equity, which is particularly interesting to investors. The increase in profitability by percentage points as compared with the previous year was assigned to the variable $riperf_{ik}$ for subsidiary i in year k.

Control variables. A suitable panel model is able to control for all constant influences concerning the individual panel objects, including properties of the foreign subsidiary such as the growth potential of a greenfield investment or an acquisition as well as attributes on higher levels such as the competitive advantage of the investor or the cultural distance to the host country. Time dummies are able to capture overall time-dependent factors. The irreversibility of investment is guaranteed by excluding pure sales subsidiaries. The degree to which investment is irreversible, though, might change and influence the investor's propensity to keep options alive. The variable $turnov_{ik}$, calculated by the natural logarithm of the turnover rate of the subsidiary i in year k relative to the industry turnover rate (source: Statistisches Bundesamt), controls for the importance of sales within the subsidiary's activities.

Econometric Model

The standard method for cross-sectional time-series analyses of proprietary investment rates under changing levels of uncertainty are panel models using ''within'' estimation (Bloom et al., 2003; Kalckreuth, 2003; Ogawa & Suzuki, 2000). These models extract all unobserved influences $\mathbf{z}_i'\boldsymbol{\alpha}$ in

$$y_{it} = \mathbf{x}'_{it}\boldsymbol{\beta}_x + \mathbf{z}'_i\boldsymbol{\alpha} + \varepsilon_{it} \tag{13}$$

from the data. If $\mathbf{z}_i'$ is correlated with $\mathbf{x}_{it}'$, and if $\mathbf{z}_i'\boldsymbol{\alpha}$ can be expressed by a term α_i, a fixed effects model

$$y_{it} = \mathbf{x}'_{it}\boldsymbol{\beta}_x + \alpha_i + \varepsilon_{it} \tag{14}$$

may be used to control for object-related influences. Just as a dummy variable could do, the constant α_i catches the unobserved characteristics of each panel object i. Apart from the fixed effects in α_i, the analysis considers only time-dependent variables, and takes no notice of all variables that are constant over time. As a consequence, a fixed effects model would be suitable for studying the influence of the time series variables $vola_{jk}$, $trend_{jk}$, and $riperf_{ik}$. The international experience of the investor $intexp_i$, though, is measured only at the moment of entry. Its initial level remains constant, whereas its effect recedes over time. As a consequence, the variable $intexp_i$ drops out unless dynamic learning effects are included in the model.

In the event that $\mathbf{z}_i'$ and $\mathbf{x}_{it}'$ are uncorrelated, a random effects model according to

$$y_{it} = \mathbf{x}'_{it}\boldsymbol{\beta}_x + \alpha + u_i + \varepsilon_{it} \tag{15}$$

is preferable to the fixed effects model. The term u_i, which is specific to the panel object i, is a random variable estimated by generalised least squares

(Greene, 2003). Hausman (1978) devised a test for orthogonal u_i and $\mathbf{x}_{it}'$. If the null hypothesis can be rejected, the precondition of random effects is violated; it is advisable to use a fixed effects model (Eq. (14)).

There are further tests that help in deciding which method to use. After a provisional calculation of random effects, the Lagrangian multiplier test by Breusch and Pagan (1980) may examine whether $\mathrm{Var}(u_i)=0$. If the null hypotheses can be rejected, the assumption of random effects is supported. After a provisional calculation of fixed effects, an *F*-test may examine whether the fixed effects are zero. Rejecting the null hypothesis indicates support for the assumption of fixed effects. If none of these tests suggests that ''within'' estimation methods should be applied, an alternative is including a lagged dependent variable as a control for unobserved effects (Wooldridge, 2003).

RESULTS

Descriptive statistics, a correlation matrix and the variance inflation factors (VIF) are presented in Table 2. The correlation coefficients show no close relationships between the independent variables; nor do the VIF indicate multicollinearity.

We proceed with three sets of models. First, the relevance (not the evolution) of the uncertainty and tendency of expected returns are assumed to stay the same over time to test Hypotheses *x*a, which merely propose the directions of influence. The level of international experience that the investor has accumulated prior to entry is a constant variable and drops out in a common fixed effects model. Therefore Hypothesis 2a cannot be tested by this means. Second, the panel is split into an early and a late phase after entry. Comparing the coefficients of the early phase with those of the late phase suggests an increasing or decreasing relevance of the independent variables, and enables testing of Hypotheses *x*b. Again, $intexp_i$ drops out, which makes testing Hypothesis 2b impossible. Third, the relevance of the independent variables is assumed to increase or decrease continuously by a learning function. Since the declining relevance makes the uncertainty effect of (lacking) international experience a time-variant variable, Hypotheses 2a and 2b can then be tested.

Constant Relevance

In a Hausman test, the null hypothesis of orthogonality must be rejected at 1%. Furthermore, the random effects are insignificant in a Breusch/Pagan test. Both tests suggest using a fixed effects model. Table 3 reports the results of five fixed effects models. All models were estimated with time dummies.

The base Model 1 contains the control variable $turnov_{ik}$ and the time dummies. Model 2 considers the influence of the host country's volatility on the investment rate. According to Hypothesis 1a it is supposed to be negative. The related coefficient is negatively signed and significant at the 1% level; including *vola* increases R^2. As volatility seems to impede the exercise of growth options, Hypothesis 1a receives support. The positive effect of an upward economic trend in the host country on the investment rate, as suggested by Hypothesis 3a, is tested by Model 3. The coefficient is significantly positive (10%) and causes a small increase in R^2, which indicates a moderate support for Hypothesis 3a. Still we may assume that expecting an upturn in the host country's economy prompts investors to exercise growth options. Model 4 introduces the rise in performance of the subsidiary. As presumed by Hypothesis 4a, its influence is significantly positive and causes a remarkable jump in R^2. Investors seem to exercise their growth options according to the development of the subsidiary's performance. In Model 5, all variables are tested for their joint influence on the investment rate. Just as in the individual tests, they show the expected signs and are significant. The R^2 is tripled as

Table 2 Descriptive statistics, correlation matrix and variance inflation factors

Variable	*Obs.*	*Mean*	*s.d.*	*Min*	*Max*	*1*	*2*	*3*	*4*	*5*	*VIF*
I/K_{ik}	2156	0.2433	0.7194	−0.9959	6.9444						
1. $vola_{jk}$	2156	2.3887	1.7071	0.2631	12.4487	1.000					1.02
2. $intexp_i$	2156	8.5881	24.4604	0	209	−0.042	1.000				1.00
3. $trend_{jk}$	2156	1.9432	3.8220	−11.1700	20.6150	0.111	−0.022	1.000			1.02
4. $riperf_{ik}$	2156	−0.0226	0.6026	−5.8949	6.2885	0.002	0.011	0.052	1.000		1.00
5. $turnov_{ik}$	2156	1.1013	1.2452	−4.6052	8.2258	−0.057	0.017	0.052	0.022	1.000	1.01

Table 3 Growth option exercises to enlarge foreign subsidiaries

Hypothesis Exp. sign	*Variable*	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
H1a	$vola_{jk}$		−0.0515***			−0.0563***
–			(0.0166)			(0.0163)
H3a	$trend_{jk}$			0.0155*		0.0153*
+				(0.0081)		(0.0079)
H4a	$riperf_{ik}$				0.2234***	0.2232***
+					(0.0268)	(0.0267)
	$turnov_{ik}$	−0.0781**	−0.0817**	−0.0729**	−0.1000***	−0.0987***
		(0.0341)	(0.0340)	(0.0342)	(0.0335)	(0.0335)
	R^2	0.024	0.030	0.026	0.066	0.075
	Observations	2156				
	Objects	634				
	Obs./Object	3.4				

Estimation with time dummies; ***p<0.01; **p<0.05; *p<0.1; standard errors in parentheses.

compared with the baseline model. Judging its absolute amount needs to consider that the share of the variance explained by the significant fixed effects is not included in this figure. When using fixed effects, R^2 is generally small, and may not be compared to using dummy variables for each object. Individual dummies explain a major share of the variance, and boost R^2 (Wooldridge, 2003).

Relevance in Early and Late Phases

The hypotheses indexed ''b'' predict that the relevance of the independent variables will change over time. For a test, the panel is split into an early and a late phase, as was done by Chang and Rosenzweig (2001). The early phase comprises the first 2 years after entry in 1997 or 1998; the late phase covers the last 2 years until the end of observation in 2001. For the 1998 entrants the phases overlap by 1 year. Fixed effects models were estimated for either phase. The results are displayed axisymmetrically in Table 4. Comparing the coefficients of the left-hand-side models (Models 6 and 7) with the right-hand-side models (Models 8 and 9) demonstrates an increasing or decreasing relevance from the early to the late phase. Models 6 and 9 omit $vola_{jk}$ and serve as a R^2 reference for the adjacent Models 7 and 8, respectively.

Since investors are believed to perceive uncertainty less intensely over time k by an option value factor $v^*(k)$, Hypothesis 1b presumes that the negative impact of volatility will be stronger in the first years after entry than in later years. In Model 7 the $vola_{jk}$ coefficient's absolute value amounts to 0.0588 and is significant at the 5% level. Omitting the variable (Model 6) reduces R^2 by 0.006, which indicates an explanatory power of uncertainty. In the late phase (Model 8), the absolute value falls to 0.0227 and is not significantly different from zero. Omitting the variable (Model 9) does not change the share of variance explained. The findings suggest that the relevance of volatility has decreased, and support Hypothesis 1b.

The net present value factor $c^*(k)$ makes the positive impact of the economic trend become stronger over time, as was expressed by Hypothesis 3b. Model 8 features a significant regression coefficient of 0.0205 in the late phase. In the early phase (Model 7) it used to be 0.0094 and insignificant. The relevance of the economic trend has grown, providing support for Hypothesis 3b. Similarly, $c^*(k)$ strengthens the impact of the subsidiary's rise in performance (Hypothesis 4b). We observe the related coefficient increasing from 0.2286 in the early (Model 7) to 0.2429 in the late phase (Model 8). Hypothesis 4b cannot be rejected, and receives additional support from the fact that R^2 increases considerably. As time goes by, the development of the subsidiary's performance becomes more relevant for investment decisions.

Relevance under a Continuously Receding Perception of Uncertainty

Modelling the receding perception of uncertainty by a time-dependent function allows for testing Hypothesis 2a and 2b, which relate to the international experience of the investor, and sheds further light on the relationships considered before. The investment Eq. (12) includes an option value factor $v^*(k)$ and a net present value factor $c^*(k)$. They

Table 4 Option exercises in early and late phases after entry

Hypothesis increasing/decreasing influence	*Variable*	*Model 6*	*Model 7*	*Model 8*	*Model 9*
H1b	$vola_{jk}$		−0.0588**	−0.0227	
|Model 7|>|Model 8|			(0.0289)	(0.0335)	
H3b	$trend_{jk}$	0.0131	0.0094	0.0205*	0.0175*
|Model 7|<|Model 8|		(0.0147)	(0.0148)	(0.0109)	(0.0099)
H4b	$riperf_{ik}$	0.2286***	0.2299***	0.2429***	0.2430***
|Model 7|<|Model 8|		(0.0435)	(0.0434)	(0.0322)	(0.0322)
	$turnov_{ik}$	−0.1439**	−0.1483**	−0.0789	−0.0784
		(0.0596)	(0.0595)	(0.0500)	(0.0500)
	R^2	0.053	0.059	0.121	0.121
	Phase	Early	Late		
	Observations	1268	1268		
	Objects	634	634		
	Obs./Object	2	2		

Estimation with time dummies; *** p<0.01; ** p<0.05; * p<0.1; standard errors in parentheses.

Table 5 Option exercises under the effect of proportional and exponential time weights

Hypothesis variable	*Model 10*	*Model 11*	*Model 12*	*Model 13*	*Model 14*	*Model 15*
H1a, H1b	−0.0638***		−0.0609**	−0.0855***		−0.0799***
$vola_{jk}$	(0.0241)		(0.0240)	(0.0275)		(0.0273)
H2a, H2b		0.0095***	0.0094***		0.0212***	0.0204***
$intexp_i$		(0.0022)	(0.0021)		(0.0045)	(0.0044)
H3a, H3b	0.0054*		0.0059**	0.0367**		0.0379**
$trend_{jk}$	(0.0030)		(0.0029)	(0.0173)		(0.0172)
H4a, H4b	0.1051***		0.1045***	0.5721***		0.5685***
$riperf_{ik}$	(0.0121)		(0.0120)	(0.0655)		(0.0651)
$turnov_{ik}$	−0.1061***	−0.0768**	−0.1044***	−0.1048***	−0.0762**	−0.1024***
	(0.0334)	(0.0339)	(0.0332)	(0.0334)	(0.0339)	(0.0332)
R^2	0.076	0.036	0.088	0.078	0.038	0.091
Time weight	Proportional			Exponential		
Observations	2156			2156		
Objects	634			634		
Obs./Object	3.4			3.4		

Estimation with time dummies; *** p<0.01; ** p<0.05; * p<0.1; standard errors in parentheses.

change over time, as shown by Figure 1. A simple means of implementing them in the econometric model is to use a proportionally decreasing option value time weight ($1/k$) and a proportionally increasing net present value weight (k). An exponential approach as proposed by Chi (2000) provides diminishing rates for both factors. For a rapid decline of uncertainty perception, we assume Euler functions with a time factor of 4 years:

$$v^*_{\exp}(k) = e^{-k/4} \quad (16)$$

$$c^*_{\exp}(k) = 1 - e^{-k/4} \quad (17)$$

The estimations in Table 5 were run with independent variables that were multiplied by proportional (Models 10–12) and exponential time weights (Models 13–15). Models 10 and 13 contain the same variables as Model 5 in Table 3. Models 11 and 14 test the individual impact of international experience. Models 12 and 15 examine the joint influence of all variables when modified by time weights.

The proportional weights in Model 10 improve R^2, as compared with Model 5, by 0.001. The exponential weights in Model 13 cause a more noticeable increase of 0.003, suggesting that learning effects are present and can be better described

by an exponential function. Hypothesis 3a expects that the investor's international experience will have a positive impact on the investment rate. Hypothesis 3b predicts that this impact will become less relevant in the course of time. Applying proportionally (Model 11) and exponentially (Model 14) decreasing time weights to the variable $intexp_i$ results in significantly positive coefficients. The share of variance explained rises from 0.024 (Model 1) to 0.036 (Model 11) and 0.038 (Model 14), indicating an explanatory power and giving support to both hypotheses. Testing the influence of international experience in the complete Models 12 and 15 provides additional support. All coefficients have the expected signs and are significant. Comparing R^2 (0.091) with Model 5 (0.075) confirms that modelling the dynamics of uncertainty perception makes a contribution to explaining the investment rate in new foreign subsidiaries.

DISCUSSION

The option model of investment in new foreign subsidiaries proposes that investors acquire a growth option by entering the host country. Later, the investors may exercise the growth option by investing at a rate that depends on the uncertainty and tendency of expected returns. The higher the tendency, the higher the net present value attracting subsequent investment. The higher the uncertainty, the higher the option value of retaining it. Balancing the marginal net present and growth option values of an additional unit of capital helps to reproduce these decisions and explain the sequence of investment in new foreign subsidiaries. Traditional models of internationalisation, for example, the Uppsala approach, have considered such investment sequences in general, but have not explained them in chronological detail.

The theory of real options is originally directed to optimal investment decisions. Modelling real investment behaviour, however, must take into account that investors make their decisions regarding the uncertainty they subjectively perceive rather than the uncertainty we can objectively measure. The perception of uncertainty is likely to be very high in the beginning and peak off in the following years. Internationalisation is characterised by even more uncertainty than domestic investment decisions. The receding effect of uncertainty perception may be stronger than in domestic environments as well. The model of investment in new foreign subsidiaries operates with dynamic option and net present value factors that mimic the decline of uncertainty perception. Previous option models have mainly analysed overall corporate investment, and paid less attention to the perception of uncertainty.

The empirical findings support the hypotheses derived from the real option model. The investment rate in new foreign subsidiaries depends negatively on the economic volatility of the host country. This finding is consistent with real option studies in domestic environments (Bloom et al., 2003; Kalckreuth, 2003; Ogawa & Suzuki, 2000). With respect to internationalisation processes, the finding is new. The study replicates the influence of international experience on foreign direct investment known from other studies (Hennart & Park, 1993; Luo, 1999; Madhok, 1998) but conceptualises it as a factor of endogenous uncertainty, which is new in real option studies. As proposed by the related hypotheses, the predicted trend of the host country's economy and the development of the subsidiary's performance show a positive influence on the investment rate. Domestic studies of real options employ similar indicators of anticipated returns. As expected, their impact is positive throughout (Bloom et al., 2003; Kalckreuth, 2003).

Furthermore, the empirical findings support the view that the receding perception of uncertainty plays an important role for later investment decisions (Bowman & Hurry, 1993; Chi, 2000). In the course of time, the relevance of the option value decreases while the relevance of the net present value increases. The effected investment behaviour becomes apparent when comparing the early with the late phase after international entry. In the first years, uncertainty has a significant effect on the investment rate. In later years, the effect disappears. The tendency of expected returns shows the opposite: it gains importance. Mapping the recession of uncertainty perception to a monotonously declining function produces a result that can be interpreted to the same end: the explanatory power of the model rises when including decreasing time weights for the uncertainty and increasing weights for the tendency of expected returns.

Both the theoretical model and the empirical findings are subject to a number of limitations. The model is extremely simple as compared with stochastic real option models. The aim of the model was to mirror a real options reasoning that, according to empirical evidence, works without calculus at all. Taken as this, the model is no more accurate than necessary, and may be mathematically improved in multiple ways. A conceptual

improvement would be to feed back the degree to which the subsidiary has already reached the desired size, which requires information about the investor's intention. The model of growth options comprises only the exogenous and endogenous uncertainty and tendency of expected returns. Other types of real options and factors beyond real options remain unattended. The fixed effects model and time dummies control for most of the unobserved effects. Nevertheless, the share of variance explained indicates that the model makes a contribution but does not explain the whole of investment. This shortcoming could also be a consequence of the methods employed. In Germany, a legal obligation requires investors to report on their subsidiaries completely and correctly, which ensures a comprehensive and reliable data set. It also guarantees anonymity to the investors and prevents enhancing the data by company information. Consequently, the exogenous uncertainty and tendency of expected returns had to be linked to the company data on an aggregate level. Measuring the endogenous variables was restricted to the information given by the database. Future work must challenge the findings by surveys that allow for a more valid measurement and, in particular, for deeper insights into the perception of uncertainty.

Even though the study is affected by such weaknesses, it may provide interesting implications for international business studies. It seems that the theory of real options enables a clearer dynamic analysis of the establishment of subsidiaries than traditional theories of foreign direct investment. The Uppsala model recognises the role of international experience and uncertainty, but comes to less precise conclusions about their interplay and effects on the investment behaviour. The point made by Buckley and Casson (1998) that uncertainty is a predominant variable to explain foreign direct investment holds, at first, true. The findings about investment decisions in the early phase of a subsidiary's development suggest that not only the theory of internationalisation but also the general theory of investment deserve a revision with respect to the value of flexibility. Later on, the relevance of the option value is replaced by the net present value. Investors no longer deviate from the advice of traditional investment theory, and align their decisions to the expected profits. Managers seem to resolve the conflict between the ideas of real option and net present value theory (Dixit & Pindyck, 1994; Trigeorgis, 1996) in the time dimension, as their perception of uncertainty recedes.

The study is directed to explaining investment behaviour rather than recommending successful investment strategies, but it carries some managerial implications. First, the results highlight the empirical relevance of uncertainty to investment decisions after international entry. Managers who have kept to the net present value rule so far may consider including option values in their future decisions. Second, the study had to assume that those managers who already incorporate option values in their decisions mostly do so in an intuitive way. They may further improve their investment decisions by applying more precise, quantitative option models. Third, the research hypothesises and supports the view that learning leads to a receding perception of uncertainty and weakens the impact of option values, whereas it strengthens the impact of net present values on the investment rate. In fact, the empirical findings reveal this effect more clearly than expected: the influence of volatility on investment completely disappears within a few years after entry. Managers should trust their receding perception of uncertainty only if it is based on a growing ability to predict the success of investment. However, recent studies show that a weak perception of uncertainty and a strong focus on cash flows are associated with managerial overconfidence (Dittrich, Güth, & Maciejovsky, 2005; Malmendier & Tate, 2005).

CONCLUSION

The research into foreign direct investment features a gap between the initial entry and final operation of foreign subsidiaries. The theory of real options offers a novel framework to study the sequence of investment to build up foreign subsidiaries. Based on a balance of the marginal net present and option values of adding capital to a subsidiary, the paper has developed a growth options model that accounts for the receding perception of uncertainty in the post-entry phase. The results from a panel study of 634 new foreign subsidiaries of German manufacturing firms in the OECD 23 countries reveal that uncertainty has a negative impact and the tendency of expected returns a positive impact on the investment rate over the subsequent years, supporting the notion of real options reasoning in international investment decisions. After a validation by studies in different settings, future work can build on this finding, and may find the option lens

more useful than traditional approaches to explain internationalisation processes.

Comparing an early and a late phase after entry, however, suggests that the influence of uncertainty on the investment rate fades away. Decrescent time weights lead to an analogical result. At the same time, the trend of expected returns gains importance. As the perception of uncertainty recedes, internationalising firms seem to change their reason for investment from option values towards common net present values. Understanding that real options reasoning can be a transient phenomenon may prevent future option studies from obtaining insignificant results. Practitioners may consider that their investment decisions are more likely to succeed when adhering to the logic of real options, even if the host country environment has become familiar. International business research will be able to provide more information about the profit impact of using quantitative real option models as soon as they receive acceptance in practice.

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ABOUT THE AUTHOR

Jan Hendrik Fisch (jfisch@zeppelin-university.de) is Professor of Technology and Innovation Management at Zeppelin University, Friedrichshafen, Germany. He holds a combined degree in electronics and economics from Technical University Darmstadt, Germany, and a doctoral degree in economics from Hohenheim University, Stuttgart, Germany. His research interests include foreign direct investment and the globalisation process. He is a native of Germany.

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