

# **Internalization and internationalization under competing real options**

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**Abstract:**

The theories of internalization and internationalization provide general factors of international market entry but are not precise about its timing. A model of waiting and growth options seizes the importance of flexibility to FDI decisions and centers the impact of uncertainty. The results of a panel study using aggregates of 5379 German entries to 22 countries suggest that uncertainty has a U-shaped influence on the probability of entry and a negative effect on the amount of capital whereas it leaves the share in capital unaffected. Investors seem to treat foreign subsidiaries as real options on internationalization but not on internalization.

**Keywords:** Foreign Direct Investment; Market Entry Mode; Real Options; Uncertainty; Timing

**JEL-Classification:** D81, D92, F21, L60

## **Non Technical Summary**

When firms contemplate international market entry by foreign subsidiaries, the option to defer entry (waiting option) interferes with the option to later enlarge the subsidiary (growth option). The values of both options rise with the uncertainty surrounding the investment. The paper analyzes the timing of market entry depending on the uncertainty and tendency of expected returns in the host country. In a panel study of German foreign direct investment in the industrialized countries, the probability of market entry reveals a U-shaped relationship with the course of uncertainty, which can be explained by the model of competing real options. The paper further investigates whether foreign investors use joint ventures as real options on upsizing them to fully-owned subsidiaries. The empirical findings turn out negative. Apparently, they only consider foreign subsidiaries in general as real options whereas they regard joint ventures as conventional investments. In contrast to earlier suggestions, interpreting international market entry as purchasing growth options seems to be more compatible with the view of internationalisation than with the view of internalization. The paper “Investment into new foreign subsidiaries under receding perception of uncertainty”, which also appears in the Bundesbank series, examines the enlargement of foreign subsidiaries as exercises of growth options.

## **Nicht technische Zusammenfassung**

Beim internationalen Markteintritt mit einer Auslandsgesellschaft überlagert sich der Wert der Option, den Markteintritt zu verschieben (Warteoption), mit dem Wert der Option, die Auslandsgesellschaft nach dem Markteintritt vergrößern zu können (Wachstumsoption). Die Werte beider Optionen steigen mit der Unsicherheit der Gewinnerwartung. Der Zeitpunkt des Markteintritts wird in Abhängigkeit der Unsicherheit und der Tendenz der Gewinnerwartung im Gastland untersucht. In einer Panelstudie deutscher Direktinvestitionen in den führenden Industrieländern zeigt die Wahrscheinlichkeit des Markteintritts einen U-förmigen Zusammenhang mit dem Verlauf der Unsicherheit, was sich durch das Modell konkurrierender Realooptionen erklären lässt. Im weiteren richtet sich die Analyse auf die Frage, inwieweit ausländische Investoren Joint Ventures als Realooptionen auf die Erweiterung zu vollbeherrschten Auslandsgesellschaften nutzen. Die diesbezüglichen Befunde sind negativ. Offenbar werden von ihnen nur Auslandsgesellschaften im allgemeinen, nicht aber Joint Ventures im speziellen als Realooptionen betrachtet. Die Interpretation des internationalen Markteintritts als Erwerb einer Realooption beim scheint daher im Widerspruch zu bisherigen Vermutungen eher mit der Perspektive der Internationalisierung als mit der Perspektive der Internalisierung vereinbar zu sein. Die Vergrößerung von Auslandsgesellschaften durch nachfolgende Direktinvestitionen als Ausübung solcher Realooptionen ist Gegenstand des Beitrags „Investment into new foreign subsidiaries under receding perception of uncertainty“, der ebenfalls in dieser Reihe erscheint.



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# **INTERNALIZATION AND INTERNATIONALIZATION UNDER COMPETING REAL OPTIONS**

## **Timing and dimensioning foreign direct investment**

Firms that consider investing abroad need to decide about the time and mode of market entry. Choosing the right moment and volume of international entry is important, as its success is affected by uncertainty. On the one hand, a high degree of uncertainty suggests to wait and postpone the entry, even though cash flows will be lost. On the other hand, uncertainty calls for improving the access to local information and therefore suggests to enter as soon as possible. If so it will be advisable to keep the capital limited since, depending on the current level of uncertainty, there might be better opportunities for large investments. In effect, uncertainty seems to play an ambiguous role in the entry decision. This research sheds some light on its influence on the timing and dimensioning of initial foreign direct investment.

There is a large body of literature on international market entry but a shortage of studies on its timing. Various studies of international entry treat the timing of investment by relative terms such as early and late (Ursacki/Vertinsky, 1992; Luo, 1998; Delios and Makino, 2003) or first and second (Chang and Rosenzweig, 2001). Only a few studies consider the absolute point in time, i. e., the year of entry. Tan and Vertinsky (1996) draw on the theory of internalization (Buckley and Casson, 1976) and investigate the time by which 262 Japanese electronics companies enter Canada and the US. The study investigates entries by joint ventures vs. wholly-owned subsidiaries and uses numerous independent variables including the current market growth in the host country but does not incorporate the influence of uncertainty. Delios and Henisz (2003) build on the theory of internationalization (Johanson and Vahlne, 1977) and consider the impact of political hazards in the host countries on 3867 international expansions by Japanese firms. The results do not distinguish between different extents of entry but suggest that the influence of political hazards is negative and moderated by the investor's experience. Political hazards, however, may not be as relevant to foreign direct investment decisions as economic turbulences are (Hule, 2000). According to

time series raised by the World Bank (Kaufmann, Kraay and Mastruzzi, 2003), the industrialized countries, which account for a major share of foreign direct investment, show a high and rather constant level of political stability. Furthermore, political hazards represent a downside risk whereas uncertainty may comprise both up- and downturns. Empirical evidence on the impact of the host country's economic volatility on the timing of entry is weak so far.

The existing studies on the timing of foreign direct investment use the established theories of internalization and internationalization as a background but synthesize the models of entry by arguments from other origins. It seems that traditional approaches to international entry need to be enriched for a dynamic analysis. Buckley and Casson (1998) state that early models of the multinational enterprise did not foresee the rising importance of uncertainty in today's foreign direct investment decisions. Therefore, Buckley and Casson propose a new approach, the theory of real options. Through an option lens, the time of entry is the moment by which the internationalizing firm exercises the waiting option to invest. At the same time, the firm acquires a growth option to be exercised by a later investment. The values of both option types rise with uncertainty. Their trade-off is supposed to guide the timing and dimensioning of investment at entry. This paper seeks to develop and test an option model of international entry in order to contribute to the understanding of foreign direct investment.

The remainder of the paper is structured as follows. The next section takes an option view to the known perspectives of internalization and internationalization and raises the question of compatibility. The third section employs a model of competing real options to explain the entry to a foreign market. The data from the German central bank, the measures and the econometric model are explained in the fourth section. Section five presents the results concerning the timing of entry and its volume as measured by the share and amount of capital. The final section discusses the results, reflects the limitations and derives implications for management and future research.

## **AN OPTION VIEW TO INTERNATIONAL ENTRY**

### **Internalization**

According to the “Long-run Theory of the Multinational Enterprise” by Buckley and Casson (1976), firms circumvent the imperfections of international markets by internalizing business processes concerning tacit knowledge, perishable goods, intermediate products and raw materials. However, internalizing markets may lead to reduced economies of scale, problems of cross-border communication and discrimination by host governments. Calvet (1981) tries to reconcile the theory of internalization with the transaction cost view of markets and hierarchies (Williamson, 1975). The theory of transaction costs suggests to internalize transactions that feature a high rate of repetition, are surrounded by uncertainty and require specific investment. Casson (1985) points out that transaction costs are not exactly the same as the costs of internalization but overlap with respect to communication and control. Similar approaches to internalization were presented by Rugman (1980), Teece (1981) and Hennart (1982). Later contributions consider international joint ventures as an intermediate type between markets and hierarchies (Hennart, 1993; Buckley and Casson, 1996). Facing the costs of internalization, firms enter a foreign market by exporting, joint venturing or establishing a fully-owned subsidiary. The mode of market entry is characterized by the degree of control and varies from market over shared to hierarchical coordination.

The notion of transaction costs to determine the degree of control at market entry receives support from several empirical studies (Gatignon and Anderson, 1988; Hennart, 1991; Pak and Park, 2004) but leaves aside the issue of timing. Buckley (1988) recognizes a dynamic deficit of the internalization concept and proposes to integrate ideas from strategic management. However, even studies that enhance the approach by variables of corporate strategy leave the timing of entry unattended (Hennart and Park, 1994; Madhok, 1998; Bradley and Gannon, 2000). The same criticism applies to Dunning’s (1981) eclectic paradigm that adds factors of competitive (Hymer, 1976) and location (Johnson, 1968) advantages but, in spite of further development (Dunning, 2000) and recent support (Tse, Pan and Au, 1997; Mudambi and Mudambi, 2002; Tsai

and Cheng, 2002), stays a static approach (Macharzina and Engelhard, 1991; Kutschker and Schmid, 2005).

Buckley, Casson and Gulamhussen (2002) show that the choice of exporting, joint venturing and establishing a fully-owned subsidiary can indeed be a dynamic one. A firm contemplating entry to a foreign market and facing high uncertainty will seek to stay flexible. To this end, it may completely or partly defer the entry by equity. Exporting preserves full flexibility but impedes gathering local information. Sharing the control of foreign operations with a joint venture partner improves the access to local information and helps to reduce uncertainty while it requires committing resources only to a limited extent. Thus a joint venture can be a useful intermediate step to full ownership.

Buckley, Casson and Gulamhussen develop a two-phase decision tree model to explain the choice of market entry by maximizing the expected profit. If success is very unlikely, the expected returns are negative. The firm will refrain from entering by equity to avoid losses. However, it thereby cuts the opportunity to benefit from a rising probability of success in the second phase. When the probability of success is intermediate in the first phase, the firm will choose a joint venture and thereby create an option on full ownership in the second phase, which turns out valuable when the probability happens to increase. If not, the loss is still limited. Under a high probability of success, the expected returns will be greatest when entering right away by a fully-owned subsidiary.

The decision tree model of the market entry mode has the potential to compensate for the dynamic weaknesses of the internalization concept. However, as a decision tree model, it does not exploit all benefits of real options theory. Other authors assign decision tree models to the category of net present value techniques (Trigeorgis, 1996; Hommel and Lehmann, 2001). It will be worthwhile to examine different real option models for their ability to reproduce foreign direct investment decisions. Another problem refers to the quality of international joint ventures as real options. Options theory is directed towards investing capital while choosing an institutional arrangement involves sharing capital with a partner. Control will only rise by additional investment if the joint venture partner agrees to a partial or full buy-out. Buckley, Casson and

Gulamhussen believe that transaction costs are lower between joint venture partners than between ordinary firms, making a deal with equity less difficult. Their second argument is that one partner may be better informed than the other, which is an advantage in negotiations about the purchase of equity. Empirical evidence on the use of joint ventures as real options on international market entry is limited to including buy-out clauses in joint venture contracts. Reuer (2002) reports that a minority of foreign investors use such clauses to ensure a right of takeover. Evidence about domestic joint ventures serving as real options is mixed. In the study by Vassolo, Anand and Folta (2004), the impact of uncertainty on takeover is insignificant even if controlling for buy-out clauses. Kogut (1991) observes the probability of a takeover to rise when positive market signals arrive, though unexpected events may not imply a decline of uncertainty. Folta and Miller (2002) find that uncertainty exerts a negative influence on takeover but makes no significant contribution to its explanation.

### **Internationalization**

Johanson and Wiedersheim-Paul (1975) describe the internationalization processes of four Swedish firms and presume that, in general, firms enter a foreign market by an incremental “establishment chain”. International business starts by exporting occasionally. Later, firms contract intermediaries to sell their products abroad and gain first insights about the foreign market. Then they allocate resources for sales subsidiaries and collect more specific information. The chain is completed by establishing production sites abroad.

Empirical studies show that not only Swedish but also US (Davidson, 1980), Japanese (Johansson and Nonaka, 1983), Turkish (Karafakioglu, 1986) and Spanish companies (Camino and Cazorla, 1998) use an incremental pattern of market entry. The Uppsala model explains this pattern by a self-reinforcing process of learning and investing in the foreign market (Johanson and Vahlne, 1977). Several Finnish firms, however, seem to ignore this rule (Björkman and Eklund, 1996). Neither do empirical studies of internalization or recent findings about “born global” firms support the prevalence of an establishment chain (Bürgel and Murray, 2000; McNaughton, 2000; Moen and Servais, 2002). In this regard, Johanson and Vahlne (1977) mention that a

low level of market risk may require less experience and allow to leapfrog stages of the establishment chain.

In a view of real options, uncertainty is central to the timing and dimensioning of investment at market entry. To stay with the model by Buckley, Casson and Gulamhussen (2002), the investor has the choice between a deferred, a partial, and a full investment. A partial investment creates a real option on up-sizing since it improves the ability to meanwhile gather information and run the investment more successfully than if it was deferred. At a low probability of success, the investor will defer the entry as long as the expected returns are negative. When the probability is intermediate, a partial investment is preferable. It carries the option but not the obligation to invest more at a later stage, depending on how conditions will evolve. At a high probability of success, a full investment promises the highest expected returns.

Apparently, the options view is not only able to mirror the perspective of internalization but also the perspective of internationalization. Exporting corresponds to an omitted investment, joint venturing to a partial investment and establishing a fully-owned subsidiary to a full investment. However, the analogy may depend on buy-out clauses that couple the issues of ownership and investment. The decision tree model considers the size of investment by three steps (no, partial and full investment). Considering such steps is in line with the internalization perspective of market entry by exporting, joint venturing or establishing fully-owned subsidiaries but appears unnecessary in the internationalization perspective of foreign direct investment, as an internationalizing firm is free to choose the size of investment. Also, the firm may continuously change the degree of control by adjusting the share in capital. For an option analysis, discrete entry modes are dispensable.

## **MODELS OF INTERNATIONAL REAL OPTIONS**

### **Creating a Growth Option by Killing the Waiting Option to Invest**

A real waiting option is similar to a European call option at financial markets. As the models by Black and Scholes (1973) and Cox, Ross and Rubinstein (1979) show, its value increases with the volatility of the stock price. Unlike financial options, real

options do not cease after a fixed period. A model to determine the optimal time of a real investment under uncertainty is devised by McDonald and Siegel (1986) and further developed by Pindyck (1991). The investor triggers the investment if the discounted cash flows are greater than a threshold which rises with uncertainty. Simulations make clear that even under moderate levels of uncertainty, this threshold can be twice the amount of the investment. Under higher uncertainty, the threshold rises quickly to ten or even more times the amount to be invested, indicating a high opportunity cost of giving up the flexibility to invest later.

Managers do not seem to use quantitative option models for foreign direct investment decisions (Becker 2005) but may implicitly account for the value of flexibility (Howell and Jägle, 1997; Miller and Shapira, 2004). To mirror real options reasoning (McGrath and Nerkar, 2004), a simple model of option values will be sufficient. Thus we expect that a foreign investor exercises the option to defer entry as soon as the value of the waiting option  $D$ , which increases with uncertainty  $\sigma$ , falls below the net present value  $C$ , which shall be a function of the economic prospects  $\mu$ .

$$C(\mu) \geq D(\sigma). \quad (1)$$

By deciding to trigger the investment, the internationalizing firm acquires a growth option to further build up the foreign subsidiary. Just as the value of the waiting option does, its value rises with uncertainty. In competitive markets, the growth option will be the more valuable the earlier it is available to the firm considering entry, which can be reflected by a multiplier  $\alpha \geq 1$  (Lieberman and Montgomery, 1998). Including the earlier growth option  $\alpha G(\sigma)$  in the case of immediate entry and the later growth option  $G(\sigma)$  in the case of deferral, the model reads

$$C(\mu) + \alpha G(\sigma) \geq D(\sigma) + G(\sigma) \quad (2)$$

(Folta and O'Brien, 2004). Bowman and Hurry (1993) argue that investors perceive very high uncertainty when objects are new to them. Therefore, they assign a high value to holding options. Later, in a process of learning, the perception of uncertainty may lessen and let the value of cash flows gain importance. The view that the option value is more relevant to entry decisions than the net present value is empirically supported by Schatzki (2003). An implication is that foreign investors will

align the timing of entry to the course of uncertainty rather than to the contemporary economic prospects. Consequently, the model may be simplified by setting the total value  $W$  equal to the net option value  $V$

$$W(\mu, \sigma) \approx V(\sigma) = 0 + \alpha G(\sigma) - D(\sigma) - G(\sigma). \quad (3)$$

Provided that an internationalizing firm is waiting for the right moment to place the investment, we expect that

*Hypothesis 1. The economic trend in the host country has no significant impact on the probability of entry.*

To determine the time of entry, the foreign investor will rather balance the value of two dueling options, a waiting and a growth option. The growth option competes with the waiting option since, with increasing uncertainty, it suggests to invest whereas the waiting option advises not yet to invest. Entry will occur if the net option value is positive

$$V(\sigma) = (\alpha - 1) G(\sigma) - D(\sigma) \geq 0. \quad (4)$$

The shape of the net option value function depends on the way by which the growth and the waiting option values rise with uncertainty. If both rose by the same rate, the net effect would cancel out. Folta and O'Brien (2004) propose two arguments why the growth option may be more sensitive to uncertainty than the waiting option. One is that immediate entry is likely to effect a larger market share and higher profits than delaying the entry. The second is that the value of the option to grow is unbounded while the option to defer is limited to the amount of capital that may be lost. To put it in mathematical terms, the second derivative of the revalued growth option exceeds the second derivative of the waiting option

$$(\alpha - 1) \frac{dG}{d\sigma^2} > \frac{dD}{d\sigma^2}. \quad (5)$$

If so, the net option value is U-shaped: When uncertainty is comparably low, the influence of the waiting option prevails and keeps the foreign investor from entry. High uncertainty, by contrast, allows the influence of the growth option to outweigh the waiting option's effect, which leads to a positive net impact of uncertainty.



*Hypothesis 2. At low levels, the economic uncertainty of a host country has a negative impact on the probability of international entry whereas at high levels, it has a positive impact.*

### **Dimensioning the Growth Option by the Share and Amount of Capital**

Pindyck (1988) devises a model of incremental investment to calculate the optimal stock of capital for an investment project under uncertain demand. The total value of the project is maximized by considering two components. One is the net present value of the capital already invested and the other is the value of the growth option to invest additional capital

$$W(\mu, \sigma) = C(\mu) + G(\sigma). \quad (6)$$

A numerical solution to the problem reveals that even intermediate levels of uncertainty require demand to triple before investing the first unit of capital becomes efficient. Low uncertainty suggests to invest less than a fourth of the amount that should be invested under certainty. In qualitative terms, the model expresses that the value of the growth option rises quickly with uncertainty and can be very high as compared to the net present value. The higher the uncertainty at entry, the smaller is the optimal stock of capital to start with.

The internationalizing firm has decided to enter a foreign market at a degree of uncertainty which makes the growth option just more valuable than the waiting option and, on any account, provides it with a much higher value than the net present value. By limiting the stock of capital, the investor will focus on the capacity of an initial investment to create a growth option on a later investment and pay less attention to the expected returns, which are driven by the economic prospects  $\mu$ .

$$W(\mu, \sigma) = C(\mu) + G(\sigma) \approx 0 + G(\sigma). \quad (7)$$

In the perspective of internalization, the entry mode is described by the extent to which the investor exerts control over foreign operations. The option value of an international joint venture is independent of the expected profits in the short run. Therefore, we expect that

*Hypothesis 3a. The economic trend in the host country has no significant impact on the share in capital at international entry.*

In the perspective of internationalization, the extent of entry is characterized by the size of investment. The new foreign subsidiary will include a growth option regardless of its current returns.

*Hypothesis 3b. The economic trend in the host country has no significant impact on the amount of capital at international entry.*

Pindyck's (1988) model of incremental investment suggests that the value of the option to grow increase with uncertainty. In the face of uncertainty, the investor will limit the capital at entry. In terms of internalization, uncertainty will have a negative influence on the degree of control. The investor may upgrade the engagement as soon as uncertainty lessens.

*Hypothesis 4a. The economic uncertainty in the host country has a negative impact on the share in capital at international entry.*

With respect to internationalization, uncertainty suggests to limit the size of investment at entry and hold the option of enlarging it in the event that uncertainty abates.

*Hypothesis 4b. The economic uncertainty in the host country has a negative impact on the amount of capital at international entry.*

## **PANEL STUDY OF FOREIGN DIRECT INVESTMENT IN THE OECD 23 COUNTRIES**

### **Deutsche Bundesbank FDI Statistics**

For the purpose of official statistics on foreign direct investment, German investors are legally obligated to report their investment objects to the Deutsche Bundesbank (central bank). The reports include simplified balance sheets, figures of revenue and employees as well as local and sectoral information. The Bundesbank Economic Research Center stores these data in the MiDi database. In principle, public access is denied but, under strict confidentiality, provided to visiting researchers. The

data are organized in a way that allows for tracking chains of indirect investment. Thereby not only direct subsidiaries, but also subsidiaries of subsidiaries etc. are assigned to the German investors. The project uses final figures of the years 1996 to 2000 and preliminary data of 2001.

In order to gain a set of comparable investment objects, the study was restricted to certain countries and industries. The industrialized OECD 23 (-1, which is Germany) countries accounted for 87 % of the stock of German foreign direct investment in the last year of observation, which is 2001 (Deutsche Bundesbank, 2003). Manufacturing is the most important German industry sector and was chosen for the study, since more than 50 % of foreign direct investment are related to these industries. Reports of precedent years served as references to distinguish new entrants from former objects. Because data series start in 1996, new entrants could be identified from 1997 on. Investment objects with a balance sheet total below € 5 mill. were cut off in order to prevent artifacts of entry near the exemption limit. The resulting data comprise 5379 entries by 2282 German investors in 22 countries over a period of five years.

### **Measures and Econometric Model**

The timing of international entry may be tracked by a panel of potential investors. The MiDi database, however, reports only on those firms that have actually entered a foreign country. For that reason it is necessary to switch the point of view and examine a panel of host countries that receive entries from an unknown set of foreign firms contemplating entry. The Bundesbank data cover the share of entries made by German investors.

The first dependent variable, the probability of *entry* between the waiting and the growth option, was approximated by the number of entries within a country and year. The second dependent variable refers to the use of growth options on internalization. The *share* in capital can be measured easily on a scale ranging from 0 to 100 %. To investigate entries under uncertainty on the country level, it is sufficient to calculate averages of all entries within a country and year as reported to the Bundesbank. The extent to which an investor uses a growth option on internationalization is difficult to measure on a scale of 0 to 100 %. The investment at entry can be observed whereas the desired final size of the subsidiary cannot. Expecting an error compensation among the

investors' strategies, the third dependent variable was measured by the average *amount* of foreign direct investment for all entries within a country and year. The log of investment was used since most investments were small compared to very few large investments. The Bundesbank calculates foreign direct investment as the total of attributable shares in the registered capital minus owing contributions, 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.

Investors make decisions depending on the uncertainty they perceive. As the MiDi database is anonymous, the *volatility* of the host country could not be measured in a questionnaire survey but had to be estimated by a correlative. Every month, the OECD publishes the six-month rate of change (6mC) of the composite leading indicator (CLI) in the member countries. The CLI forecasts the direction and intensity of cyclical differences of the economic development from the long-term trend. An alternative would be using stock indices. However, the CLI is more country-specific. Firstly, the movements of stock prices in the industrialized countries are closely interrelated under the lead of the New York Stock Exchange. Secondly, stock indices are usually calculated from large companies that operate internationally and thereby refer to the whole range of countries entered by these companies rather than to their home countries only. The study uses the standard deviation of the monthly CLI 6mC within a country and year as a proxy of volatility. Calculating the mean of the 6mC delivers a related measure for the second independent variable *trend*, which is to indicate the economic prospects of the host country.

The timing of entry to a particular host country may not only depend on its economic uncertainty and trend but also on other factors of attractiveness to foreign direct investment that are subject to change. The country's technological position was measured by the number of *patents* claimed by foreign companies in the year of observation. The country's buying power was included by yearly data on GDP per capita (*gdppc*). Both time series were taken from the World Development Indicators CD-ROM 2005 (World Bank). Time dummies control for overall influences that vary

with time. Controlling for constant properties of the host countries such as size, location and culture is unnecessary when using a cross-sectional time-series model.

Various studies employ panel techniques to investigate investment behavior in the light of real options (Ogawa and Suzuki, 2000; Bloom, Bond and van Reenen, 2003; Kalckreuth, 2003). The standard methods are fixed and random effects models using “within” estimation. To capture constant influences on the object level, fixed effects models introduce a constant whereas random effects models include a random variable for each object. The estimators of these methods, however, are inefficient, if the data are heteroscedastic. In a model

$$y_{it} = x'_{it} \beta_x + \varepsilon_{it} \quad (8)$$

heteroscedasticity occurs if the variances  $\sigma_{jt}^2$  of the error terms  $\varepsilon_{jt}$  are not the same for all objects. Feasible generalized least squares (FGLS) models are able to estimate the heteroscedasticity function (Wooldridge, 2003). A modified Wald test examines the null hypothesis that all variances are equal. For the data at hand, the null hypothesis had to be rejected, which suggests to estimate the regression coefficients by a FGLS model.

## GERMAN ENTRIES BETWEEN 1997 AND 2001

Descriptive statistics are given in Table 1. The 110 observations are aggregates of the entries in 22 countries over five years. The dependent variables are listed above the independent and control variables. To interpret the values of the variables *share* and *amount*, note that they reflect averages on the country level.

**Table 1: Descriptive statistics and correlation matrix**

<i>Variable</i>	<i>Obs.</i>	<i>Mean</i>	<i>Std.Dev.</i>	<i>Min.</i>	<i>Max.</i>	<i>volatility</i>	<i>trend</i>	<i>patent</i>	<i>gdppc</i>	<i>VIF</i>
<i>entry</i>	110	48.900	48.614	3.000	243.000					
<i>share</i>	110	0.835	0.098	0.445	1.000					
<i>amount</i>	110	9.142	1.056	5.426	11.688					
<i>volatility</i>	110	2.784	2.247	0.263	12.449	1.000				1.02
<i>trend</i>	110	2.895	5.247	-11.170	21.402	0.055	1.000			1.11
<i>patent</i>	110	126552	54108	27985	230729	0.064	-0.303	1.000		1.21
<i>gdppc</i>	110	26885	12508	2873	56381	-0.089	-0.039	0.274	1.000	1.10

The matrix in the right part of Table 1 shows that most variables are independent of each other but *patent* is correlated to *trend* and *gdppc*. The respective variance inflation factor (VIF) suggests that it is affected by some multicollinearity. Still it was included in the following models; dropping *patent* as a control variable does not change the results remarkably.

### Number of Entries

The results about the uncertainty to influence the timing of international entry are presented in Table 2. Model 1 is the base model and comprises only the control variables and time dummies (concealed). Model 2 includes the economic trend. As predicted by *Hypothesis 1*, its influence on the probability of entry is insignificant. The log likelihood test with respect to the base model shows that *trend* does not contribute to explaining *entry*. Comparing the log likelihood and considering the standard errors in Model 3 and Model 4 deliver the same result. Foreign investors seem to choose the time of entry regardless of the contemporary economic prospects in the host country.

**Table 2: FGLS models of the number of entries to a host country**

<i>Hyp.</i> <i>Exp. sign</i>	<i>entry</i>	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>	<i>Model 5</i>
2 +	<i>volatility</i> <sup>2</sup>					0.5345*** (0.2079)
2 -	<i>volatility</i>			-4.5899*** (0.9304)	-4.6163*** (0.9522)	-9.8639*** (2.4543)
1 ∅	<i>trend</i>		0.3908 (0.5680)		0.3371 (0.5590)	0.6182 (0.5087)
	<i>patent</i>	3.46e-4*** (4.10e-5)	3.46e-4*** (4.16e-5)	3.33e-4*** (4.24e-5)	3.36e-4*** (4.21e-5)	2.93e-4*** (4.27e-5)
	<i>gdppc</i>	-2.97e-4** (1.27e-4)	-2.81e-4** (1.32e-4)	-3.66e-4*** (1.42e-4)	-3.61e-4*** (1.40e-4)	-2.86e-4** (1.37e-4)
	<i>log likelh.</i>	-510.58	-510.73	-506.55	-506.11	-503.20
	<i>l/r test</i>	Base model	-0.30	8.07***	8.94**	14.76***

Estimation with time dummies; \*\*\* p < 0.01; \*\* p < 0.05; \* p < 0.1, std. errors in parentheses

The model of dueling real options suggests that the uncertainty have a significant impact on the timing of entry. As the likelihood ratio test reveals, adding *volatility* in Model 3 significantly increases the log likelihood as compared to the base model.

Including *volatility*<sup>2</sup> in Model 5 causes another jump in log likelihood. Both coefficients are significant with the expected sign, supporting the view of a U-shaped influence of uncertainty on the probability of entry as presumed by *Hypothesis 2*. In the range of low uncertainty, foreign investors seem to refrain from entry as uncertainty rises. At high levels of uncertainty, they tend to enter the host country with rising uncertainty as the value of the growth option overrides the value of the waiting option.

### Capital at Entry

The growth option model states that the smaller the investment at international entry, the larger is the option to grow by a later investment. The influence of the uncertainty and trend of the economic development on the dimensioning of growth options was investigated with respect to both the perspectives of internalization and internationalization. Table 3 reports the results concerning the share, Table 4 regarding the amount of capital. Models 6 and 10 are the base models, respectively.

Model 7 in Table 3 examines the impact of the economic trend on the share in capital. Contrary to *Hypothesis 3a*, the variable *trend* exerts a significantly positive influence on the degree of control over new foreign subsidiaries and significantly increases the log likelihood as compared to the base model. The impact of *trend* is also significant in the complete Model 9.

**Table 3: FGLS models of the share in capital at entry**

<i>Hyp.</i> <i>Exp. sign</i>	<i>share</i>	<i>Model 6</i>	<i>Model 7</i>	<i>Model 8</i>	<i>Model 9</i>
4a -	<i>volatility</i>			0.0021 (0.0038)	0.0012 (0.0036)
3a ∅	<i>trend</i>		0.0058*** (0.0017)		0.0056*** (0.0018)
	<i>patent</i>	-4.24e-8 (1.11e-7)	-2.26e-8 (1.33e-7)	-2.87e-8 (1.10e-7)	3.47e-9 (1.29e-7)
	<i>gdppc</i>	5.78e-7 (5.31e-7)	6.99e-7 (5.18e-7)	6.16e-7 (5.42e-7)	7.44e-7 (5.36e-7)
	<i>log likelh.</i>	138.79	140.50	138.77	140.50
	<i>l/r test</i>	Base model	3.42*	-0.04	3.42

Estimation with time dummies; \*\*\* p < 0.01; \*\* p < 0.05; \* p < 0.1, std. errors in parentheses

Model 11 in Table 4 tests for the influence of the economic trend on the *amount* of capital at entry. As expected by *Hypothesis 3b*, the related coefficient is insignificantly different from 0. Probably due to correlations (Table 1), including *trend* deteriorates the log likelihood; the variable makes no contribution to explaining the amount of capital. It seems that a rising economic trend induces a higher share but is irrelevant to the amount of capital.

**Table 4: FGLS models of the amount of capital at entry**

<i>Hyp.</i> <i>Exp. sign</i>	<i>amount</i>	<i>Model 10</i>	<i>Model 11</i>	<i>Model 12</i>	<i>Model 13</i>
4b -	<i>volatility</i>			-0.0741** (0.0336)	-0.0789** (0.0345)
3b ∅	<i>trend</i>		-0.0016 (0.0137)		0.0098 (0.0147)
	<i>patent</i>	-7.56e-7 (1.84e-6)	-8.12e-7 (1.86e-6)	-6.98e-7 (1.81e-6)	-6.85e-7 (1.83e-6)
	<i>gdppc</i>	9.68e-6 (6.90e-6)	9.81e-6 (6.95e-6)	9.39e-6 (6.51e-6)	9.04e-6 (6.55e-6)
	<i>log likelh.</i>	-134.86	-135.02	-132.81	-132.88
	<i>l/r test</i>	Base model	-0.32	4.10**	3.96

Estimation with time dummies; \*\*\* p < 0.01; \*\* p < 0.05; \* p < 0.1, std. errors in parentheses

The growth option model expects uncertainty to discourage investment at international entry. Therefore, *Hypothesis 4a* predicts a negative influence of uncertainty on the *share* in capital. The findings of Models 8 and 9 in Table 3, however, contradict this proposition. In both models, the variable *volatility* has no significant impact and does not improve the log likelihood. Model 12 in Table 4 examines the influence of uncertainty on the *amount* of capital. The coefficient of *volatility* is negatively signed and significant. There is also a significant increase in log likelihood, supporting *Hypothesis 4b*. The significance of uncertainty is further supported by the complete Model 13. Apparently, uncertainty does not prevent foreign investors from choosing a high mode of control but it does keep them from binding a high volume of capital.



## **DISCUSSION**

A real options view to international entry enables analyzing the timing and dimensioning of foreign direct investment in a way that may be compatible with the perspectives of internalization and internationalization but is more precise about the influence of uncertainty. Traditional theories of foreign direct investment conceive uncertainty as a downside risk that suggests being careful at international entry. The theory of real options recognizes uncertainty as a chance as well as a risk, since the returns of an investment can also be greater than expected. Waiting may still be worthwhile as it carries the possibility of uncertainty to become less for exogenous reasons or be decreased by collecting additional information. However, collecting information is easier after launching the investment. Investing to a limited extent provides this advantage but preserves the flexibility to invest the major part at a later point in time. Enforced by early mover advantages, the value of the option to grow may be greater than the value of the option to defer and, on balance, plead for entry. The study of German investment in the OECD 23 countries suggests that the uncertainty of a host country have a nonlinear effect on the probability of entry. When uncertainty is low, rising uncertainty prevents entry, whereas when uncertainty is high, rising uncertainty attracts entry. This observation is consistent with the finding that Folta and O'Brien (2004) produce in a domestic context and supplements the empirical knowledge about the timing of international entry. The theory of real options proves to be useful as it provides an explanation for the ambivalent role of uncertainty. As an implication for management it asserts that entering a foreign market in the face of high uncertainty can be rational even though traditional theories advise not to invest.

The influence of host country uncertainty on the dimensioning of foreign direct investment can be studied both by the perspectives of internalization and internationalization. Interpreting international entry as creating a growth option, uncertainty is supposed to have a negative impact on investment either way. The empirical results are contradictory though. Economic uncertainty has a negative influence on the amount of capital whilst it has no influence on the share in capital. The economic prospects, by contrast, exert no influence on the amount whereas they have a positive influence on the share. Since the value of growth options is driven by uncertainty, this observation suggests that investors use the amount but not the share in

capital as a growth option. There is no support for the notion of Buckley, Casson and Gulamhussen (2002) that reduced transaction costs and asymmetric information are sufficient to provide the investor with the option to take over a joint venture. It seems that foreign subsidiaries, in general, are real options but international joint ventures, in particular, are not. Joint ventures rather serve as regular investments. Regarding the option-related problems of joint venture partnership (Chi, 2000) and the effort to negotiate buy-out clauses in order to prevent these problems (Reuer, 2002), this finding may not be surprising. Nevertheless, it can help directing future research to the perspective of internationalization, since studying joint ventures as growth options appears difficult. Even if shared or full ownership seem to reflect decisions about investment, they actually measure decisions about control. As the theory of real options is a theory of investment, it fits the perspective of internationalization better than the perspective of internalization. Feeding this result back into practice, the consequence for management would be straightforward. In order to stay flexible after entry, internationalizing firms may rather limit their stake than engage in a joint venture.

Further research is needed to validate these findings since the study is subject to a number of limitations. Surveys and laboratory experiments suggest that economists abandon traditional net present value rules to stay flexible for future investment decisions. For the time being, though, it is no more than an assumption that foreign investors apply real options reasoning to their decisions. The model of waiting and growth options tries to reproduce basic reasoning and is kept simple to this end but might be a quasi theory rather than an true theory of investment behavior. Taken as a plausible model, it gives an explanation why German investors choose the timing and dimensioning of international entry synchronized to uncertainty. The empirical findings brought forward, however, could partly be the consequence of methodological shortcomings. The Deutsche Bundesbank database is anonymous and does not allow for studying a panel of potential investors that differ by certain properties. The data require observing international entries to a country as they occur. In an aggregate figure, we do not know whether the unobserved influences on the firm level even out or produce artifacts. Factors on the country level are eliminated by the econometric model but may be as important to entry decisions as the impact of uncertainty. The measurement of uncertainty relies on the presumption that the investors' expectations are correlated to

the economic forecasts collected by the OECD. The study should be followed by a survey that may provide a smaller coverage but enable investigating the decision makers' real intentions about using options.

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