What really drives the relevance of real options?
– a conceptual analysis on the basis of neo-institutional economics

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1 INTRODUCTION

In the recent past, the research area of real options theory (ROT), in which researchers and practioners together are trying to seize and measure the construct of managerial flexibility, has gained increased importance (Stark (2000), p. 313). Although already known for a notable time in finance (Kester (1984); McDonald/Siegel (1986), Trigeorgis (1990)), ROT roused the attention of more and more researchers from other business disciplines such as strategy (Amram/Kulatilaka (1999a); Amram/Kulatilaka (1999b)) or marketing (Hommel/Ludwig (1999); Kühn/Fuhrer (2001)).

However, neither the theoretical nor the more practice oriented publications in the field of real options theory attach much value to the preliminary decision whether or not to apply real options theory in principal to a specific context. Most often it is assumed that action flexibility is indeed of great importance for a setting and that therefore corporations have already voted for the implementation of real option theory. As a consequence most of the contributions focus on the detailed execution of the real options approach. Only a minority of authors comprises the preliminary decision, but mostoften remains on a very abtract level, stating that the relevance of action flexibility and therefore the principal application potential of real options theory is the higher, the higher an investment context's uncertainty is.

Only a few publications show that the categorical relevance of action flexibility can be approached through the awareness that the investment decision is trivial in two cases (Meise 1998, pp. 6-11). Firstly, it is if the decision maker is perfectly informed with respect to all of the relevant data, because in this case the decision can be reduced to the simple calculation of the best alternative. Supplementary changes are not necessary. Secondly, the investment decision is trouble-free if the focal decision is completely reversible, that means if the decision can be revised without any costs. In those two scenarios action flexibility is of no specific use and could be neglected. The reverse means that the relevance of action flexibility for a decision context is determined by the combination of the degree of uncertainty and irreversibility.

Nevertheless, it remains unclear, which of the two factors is of what relevance. Even more important are the questions, if the impact of the two constructs for the relevance of the different categories of real options is equally strong and what factors actually drive an investment's uncertainty and irreversibility. Research towards those questions seems especially indicated as the different forms of real options demand for differentiated approaches and in addition literature has given loose hints that in different industries and different investment phases, different categories of real options are of different importance (Micalizzi/Trigeorgis, 1999, p. 18).

The objectives of our paper originate from those problem areas and are important from both a theoretical as well as a practitioner's point of view. The first objective of our research is to deepen the analysis concerning the two determinants of the relevance of action flexibility in principal and thereby identify their underlying driving forces on the basis of a closed theoretical concept, neo-institutional economics. The second objective is to analyse the impact of the two determinants on the individual relevance of the different categories of real options.

The paper's further proceeding is consistent with these objectives and divided into four parts. In the first section (chapter 2) we will outline the theoretical foundations of our paper by elucidating our categorisation of real options and sketching the basics of neo-institutional economics. In the second section (chapter 3) we will answer our first resarch objective by subtantiating the abstract constructs of uncertainty and irreversibility. In the third section (chapter 4) we will answer our second research objective and therefore focus on the driving forces for the relevance of the different categories of real options. The fourth section (chapter 5) closes our analysis by offering the paper's conclusion and a discussion concerning future research.

2 THEORETICAL FOUNDATIONS: REAL OPTIONS THEORY AND NEO-INSTITUTIONAL ECONOMICS

In this section we will introduce the paper's theoretical foundations. Therefore we will explain the categorisation of real options used in this paper and the concept of neo-institutional economics.

2.1 Real Options Theory

Real options refer to different forms of action flexibility (Kulatilaka, 1995b, pp. 99-104), whereat we define the latter as "(…) the ability to change or react with little penalty in time, effort, cost or performance" (Upton, 1994, p. 73). In this paper we categorise the different forms of action flexibility as learn options, expansion options, assurance options and growth options.[1]

Learn options allow a firm to tie its resource allocation to the solution of project-related risk and are associated to a point of time before the actual investment takes place, respectively is completed. Lern options can be subdivided into options to wait and options to stage investments. Options to wait allow a company to postpone the actual investment decision as the potential investment opportunity sustains for a certain period. During this time period new information can arise, reduce the project-related uncertainty and therefore change the economic feasibility of an investment. Waiting options result from the timely acquisition of licences or patents, which exclude the competitors temporarily or permanently from the investment opportunity. Options to wait can be understood as call options. Options to stage investments refer to the fact that most investments don't necessarily have to be financed by a single up-front outlay, but can be financed by a sequence of smaller amounts. In this sense companies have the possibility to refrain the further investments, if the costs for the next investment stage surmount the value of the continuing project. As a consequence options to stage investments can be interpreted as compound options (options on options). In this context each partial amount corresponds to the exercise price for acquiring the sequential option.

Expansion options and assurance options refer to forms of action flexibility, that exist during and after the actual investment phase and are related to an existing project. Expansion options empower a company to increase its economic activity, i.e. to expand production or distribution, depending on a positive development of the relevant economic parameter. Expansion options can be viewed as call options.

Contrarily, assurance options permit management to react to a negative development of the economic parameter with a reduction or modification (switching options) of its economic activity. Concerning the reduction, depending on its magnitude we distinguish between options to contract, options to shut down and restart as well as

options to abandon. The mentioned options can be interpreted as put options. Within the switching options, we further differentiate between options that allow a switch of the input factor and those options that enable management to produce alternative products. Switching options can also be viewed as put options.

Growth options refer to a time frame after the investment phase and refer to qualitatively innovative products. Growth options are of enormous strategic importance as a project might not appear profitable as a stand alone project, but may enable profitable future investments. The main value of growth options is therefore not related to the project's own cash flows, but to those of the potential future projects. Growth options can be viewed as call (compound) options.

2.2 Neo-institutional economics

The term "neo-institutional economics (NIE)" (Coase, 1998, p.72) denotes a collection of theoretical concepts, whose common core is the treatment of organisational questions (in a broad sense) on an economic basis (Fischer, 1992, p. 40). The central objective of NIE is thereby the analysis of socio-economical exchange relationships (also in a broad sense) in political economies, which are characterised by a division of labour and therefore need strong coordination institutions (Kaas, 1992, p.3). In this context institutions are perceived as a system of norms that are adapted towards a specific goal bundle and which purpose it is to steer individual behaviour in a specified direction (North, 1989, p. 239). With this wide definition of the term institution, NIE disengages itself from the neoclassical paradigm which proclaims the sole and gratitous coordination of all dispositions through price mechanism via the market as the sole institution (Currie/Messori, 1998, p. 171). The basic set of assumptions of any analysis in the context of NIE consists of the propositions of methodological individualism (Richter, 1994, p. 4), the recognition of individual rationality (Richter/Bindseil, 1995, p. 132) and the attention of transaction costs (Coase, 1937, pp. 386-405).

In the proceeding we will now sketch three selected theories within NIE which will subsequently be used in section three to substantiate the constructs of uncertainty and irreversibility. In this context we briefly introduce information economics, principal-agent theory and transaction cost economics.

2.2.1 Information economics

NIE not only takes into account the pluralism of institutions in economies, but also secedes itself from the out of touch with reality assumptions of complete information and indefinitely fast reaction processes (Helm, 1997, p. 4). On the basis of information economics as a partial approach, NIE expounds the problems of bounded rationality (Simon, 1997, p. 88), opportunism (Williamson, 1990, p. 54) and the resulting uncertainties which can be viewed as the original reason for the problems of exchanges. Information economics assumes that because of the bounded rationality of market participants information asymmetries occur and because of potential opportunism result in uncertainties.

Depending on the considered variables one can distinguish between exogenous and endogenous uncertainties (Hirshleifer/Riley, 1979, p. 1376). Exogenous uncertainties result from information asymmetries concerning variables outside a concrete exchange relationship. Endogenous uncertainties are due to information asymmetries with respect to variables within a concrete exchange relationship.

With respect to the underlying reasons for information asymmetries one can distinguish between complexity and dynamics. Complexity is point of time related and refers to the fact that the great number of relevant endogenous and exogenous variables can assume different states and that their interdependencies change on the basis of those individual state configurations (Duncan, 1972, pp. 313-327). Dynamics results from the instance, that the states of the variables and the latters' interrelations are instabile over time. It can therefore be interpreted as a complexity over time. The dynamics of a specific context is mainly influenced by the frequency, the intensity and the irregularity of the variable changes (Kieser/Kubicek, 1983, p. 319).

As a consequence information economics analyses the reasons for information asymmetries and –problems, the resulting implications for the market developments as well as possibilities for their overcoming. In this context it is assumed that a subject's amount of information is model endogenous and therefore behaviour dependent (Adler, 1996, p. 12). With respect to the overcoming of information, especially the activities of screening and signaling are of relevance. Within screening (Stiglitz, 1974, pp. 28-44), in which the less informed exchange party takes the initiative, one can distinguish between two versions. The activity of examination refers to a detailed analysis of the relevant

variables through the less informed party, although it has to be mentioned that not all goods are equally accessible for such an inquiry. The activity of self selection aims on getting the better informed party to classify itself and in this context reveal the desired information. Signaling (Spence, 1973, p. 357) also refers to information transfers from the better to the less informed party, but this time the initiative stems from the better informed exchange party. Signaling can be based on exogenous expensive signals or contingency contracts.

2.2.2 Prinicpal-Agent Theory

A principal-agent-relationship refers to a collaboration between an ordering party (principal) and a representative (agent), in which both are acting selfish and the agent has an information headstart (Richter/Furubotn, 1996, p. 163). The problems and uncertainties arising from this relationship can be classified on the basis of the temporal positioning of the underlying information asymmetries.

In the case of *hidden information* the agent utilises his information headstart based on endogenous uncertainties and withholds relevant information for the principal. In this context one can further distinguish between hidden characteristics and hidden intentions. *Hidden characteristics* denote those characteristics of an agent or product that the principal can't observe before the actual conclusion of the contract. They constitute the danger of an *adverse selection* as an inefficient selection of an agent or product (Akerlof, 1970, pp. 488-500). In contrast *hidden intentions* refer to those intentions of the agent that the principal can't observe when concluding the contract. They establish the opportunity for the agent to commit a *hold-up*, which refers to the opportunistic utilisation of gaps in contracts (Holmström/Roberts, 1998, p. 74). Protection mechanisms therefore have to make an impact already in the run-up to the conclusion of the contract, although the principal will have access to the relevant information after the conclusion of the contract anyway.

The phenomenon of *hidden action* refers to an agency problem, in which the principal can't observe the actions of the agent (Bergen/DuttaWalker, 1992, p. 3-6). This is due to the fact that the performance results are not only influenced by the activity level of the agent, but also from the changing states of the environment.. As a consequence hidden actions are based on endogenous as well as exogenous uncertainties. As the design of

those two factors can't be observed by the principal they constitute the danger of a moral hazard.

2.2.3 Transaction cost economics

The purpose of transaction cost economics is a comparative analysis of institutional patterns, with the goal of assigning specific transactions as the level of analysis to its most efficient coordination form (Fischer, 1992, S.4). In this context the term transaction costs embraces only those costs that result from the winding-up of a transaction in the sense of a process of agreement and execution of an exchange between subjects (Arrow, 1969, p. 20). As the direct measurement of transaction costs seems difficult research focuses on the indirect measurement. The latter is based on the theoretical thought that the amount of transaction costs is reflected in the parameter value of specific transaction dimensions and can be measured through proxy variables. The transaction dimensions are usually represented by the amount of transaction-specific investments as well as the uncertainty and the frequency of the transactions under observance (Williamson, 1990, pp. 59-69).

Transaction specific investments "… result when capital is specifically designed or located for a particular use or user…" (Masten, 1986, p. 494). They are often a prerequisite for the accomplishment of a transaction and allow the transaction partners to realise economies of scale and learn effects. However, they also constitute the danger of a hold-up on the "quasi-rent". The latter labels the difference between the return of the invested ressources in the considered transaction relationship and the return in the best utilisation opportunity outside the focal relationship (Klein/Crawford/Alchian, p. 298).

With respect to transaction uncertainty, which has also a very strong influence on the amount of transaction costs, transaction cost economics mainly refers to the insights of information economics already stated before. The frequency of transactions has a smaller relevance and beyond this is of only limited relevance for our further proceeding.

3 DETERMINANTS OF THE RELEVANCE OF ACTION FLEXIBILITY

In this section we substantiate the abstract determinants of the relevance of action flexibility, namely uncertainty and irreversibility. In this context the relevance of action

flexibility is interpreted as management's ex ante perception of the ratio between the expanded net present value (NPV), respectively the NPV including the consideration of action flexibility and the traditional NPV, respectively the NPV without the consideration of action flexibility. In this sense the relevance of action flexibility is high if the relevant decision makers estimate the investment to have a high option value compontent and that therefore the disregard of the inherent action flexibility could lead to grave misinvestment. In the proceeding we will use the before described three theories of neo-institutional economics as a guiding line and will treat the two determinants separately despite existing interdependencies (e.g. adverse selection).

3.1 Uncertainty

If a company wants to analyse the parameter value of a specific investment context's complexity and dynamics as a whole it first of all has to identify the different textual sources of uncertainty. Against this backdrop it is advisable in a first step to use the classification of information economics and distinguish between endogenous and exogenous uncertainties.

Endogenous uncertainties are certainly most important as it is the primary goal of every company to interact with and sell their goods to their customers. In this context it has to be mentioned that both parties possess information advantages with respect to their perceptions and benefits. Examples for endogenous variables to look at are qualities, prices, costs or preferences. From the perspective of a good producing company the amount of endogenous uncertainty is therefore on the one hand mostly due to uncertainties regarding the static and dynamic variability of the consumer preferences and needs, which determine the volatility of the consumer's demand for the company's product. In this context it can be mentioned that most companies have to some extent the possibility to reduce this uncertainty, e.g. by the measure of self-selection in the insurance business. On the other hand the mentioned volatility of demand is also affected by the endogenous uncertainties from the side of the consumer. In this context companies can influence the consumer's uncertainties regarding the qualities and prices of their goods through the different measures described in section 2.2.1 and therefore reduce the overall endogenous uncertainty. As a consequence companies that want to assess the complexity and dynamics of the relevant endogenous uncertainties of their business certainly have to focus on the (intertemporal) variability of preferences and

needs, but in this context have to take into account which measures the company (and its consumers) have to reduce the overall uncertainties, once the actual production has started. Hence, the amount of endogenous uncertainty is highest in those industries, where the consumer preferences and needs are statically very heterogenous and dynamically very volatil and where the goods produced give companies (and consumers) only very limited room for reducing the endogenous uncertainties through the measures of screening and signaling.

The second compontent of the overall uncertainty is the amount of exogenous uncertainty. In this respect the most important textual sources are uncertainties with respect to the actions of competitors, technological developments, interest and exchange rates and the political sphere (Micalizzi/Trigeorgis, 1999, pp. 2-5). Uncertainties concerning the competitors result from the instance that strategic or tactical moves like e.g. aggressive price competition, introduction of innovative products or merger's and acquisisition can have a huge effect on the market demand for a company's product, especially in oligopolistic industries. The second source of exogenous uncertainty, the further development of the existing and the occurrence of new technologies, is closely related to the competitive uncertainty as the combination of the technological factors can lead to a loss in competitive advantage. In this context is has to be mentioned that especially the process of technological innovation is per definitionem uncertain and that therefore one challenge for companies refers to the optimal timing of investment decisions in the innovation process. In contrast uncertainties concerning the interest rates result from discrepancies between the active and the passive rates and in the consequence can lead to unexpected opportunity costs. Analogous, changes in the exchange rates can cause transaction uncertainties concerning the execution of multinational projects and translation uncertainties considering the consolidated financial statements of multinational companies. Political uncertainties mainly refer to investments in developing or emerging countries. Analogous to the amount of endogenous uncertainties, the amount of exogenous uncertainties is determined by the combination and interaction of the complexity and dynamics of their different textual sources.

After analysing the parameter values of the different sources of endogenous and exogenous uncertainties for a specific setting, companies should have a clearer picture

of the overall complexity and dynamics of the investment's environment. In this context it is important to keep in mind that the parameter value of the overall uncertainty ceteribus paribus decreases over time. This is due to the fact that firstly, the relevant decision makers get a better overview with respect to the complex interactions and secondly the shorter period of time until the actual start of production reduces the potential impact of dynamics.

3.2 Irreversibility

The degree of an investment project's irreversibility is mainly due to the amount and character of a company's fixed costs and therefore determined by two forces, its operating risk and the degree of the reselling potential of the involved resources.

The operating risk refers to this part of the variability of a company's profit that results from its operating structure and is mainly driven by a company's ratio of fixed and variabel costs (Micalizzi/Trigeorgis, 1999, p. 2). In this sense it is widely accepted that a firm structure with a prevalence of fixed costs is ceteribus paribus rigid and difficult to modify if the relevant economic conditions change. In this context, the strength that the volatility of sales has for a company's operating results is referred to as its operating leverage.

The second force that drives an investment's irreversibility is the degree up to which the invested resources can be sold efficiently. In this context *Pyndick* (Pyndick, 1991, pp. 1110-1111) differentiates between the specificity of an investment, the efficiency of the second hand markets for the considered resources, political and legal regulations and the pressure from the public.

One of the most important reasons for the irreversibility of an investment is its specificity. In this context we use the same definition that was presented in the section of transaction costs economics (chapter 2.2.3) and transfer it also to those decisions where the level of analysis is not a single transaction. The degree of specificity is therefore also determined by the amount of the quasi-rent. Furthermore we differentiate between different forms of specificity, namely industry specificity and firm specificity. An example for industry specific investments are steel producing facilities as they can only be used to produce steel. Although the equipment in general could be sold to other steel companies, especially in competitive industries the investment costs can mostly be viewed as irreversible as the value of the equipment will be about the same to all

companies. As a consequence there is likely to be little gained by selling the resources. Firm specificity refers to those investments that are only of use for a specific company. Possible good examples can be found in human capital investments (knowledge transfer in trainings) or brand capital investments (brand or product specific investments). Those investments can't be reversed by selling them to competitors.

Another important driving force for the irreversibility of an investment is the degree of efficiency of the second hand markets for the involved resources. In this context especially the before mentioned[2] problem area of adverse selection is of great importance. In his famous acticle, Akerlof (Akerlof, 1970, pp. 488-500) building on the insights of information economics and principal-agent-theory explains the "lemon problem" in the market for used cars. The basis of his description is a market with heterogenous quality characteristics, which can't be identified by the buyer (principal) before the conclusion of the contract (quality uncertainty) and can't be influenced by anyone at the point of the contract's conclusion. As a consequence the buyer is not able to assess the quality of a good in a differentiated way and consequently only pays a price which amounts to the subjectively assumed average price. The sellers (agents) of goods with a higher than average quality will not accept this price and leave the market. As a consequence the average quality decreases and even more high quality sellers withdraw from the market. The last consequence of this phenomenon is the collapse of the market. On markets with such a "lemon problem" even non-specific goods, like office-equipment, cars or computers can only be sold well below their investment costs

As described before other reasons for irreversibility can be found in regulations. In this sense capital control mechanisms can prohibit the selling of foreign direct investments or working law regulations can make human capital investments irreversible. Furthermore, sometimes even the public opinion can cause investments to be irreversible, e.g. in the case when a company wants to sell its pollution control equipment.

As a consequence companies that want to assess the degree of irreversibility of a specific investment, respectively the involved resources have to analyse the cumulated impact of the before described forces. In this context they have to take into account that the degree of irreversibility will increase until the completion of an investment as the

investment ceteribus paribus will get more firm specific and the interaction of more input factors increases the relevance of adverse selection problems

4 RELEVANCE OF THE DIFFERENT CATEGORIES OF REAL OPTIONS

After having substantiated the abstract determinants of the relevance of action flexibility we will now analyse which consequences the before derived results have for the relevances of the different categories of real options.

4.1 Lern options

As described before learn options occur before the start (options to wait), respectively the completion (option to stage investment) of an investment. They enable a company to postpone the principal decision whether to undertake the initial investment or not as well as to decide stepwise whether to continue a project or not. The typical activities at this stage of an investment refer to the build-up of the tangible and intangible infrastructure as well as R&D investments. Both investment activities have in common that they constitute the largest portion of a company's fixed costs. As a consequence, besides the relevance of uncertainty, which is highest at that point of an investment, the relevance of learn options is influenced especially strong by the degree of irreversibility. For this reason learn options are particularly important if in addition to a great uncertainty in the sense of the cumulated impact of the presented forms of uncertainties, the share of fixed costs in the total costs is high and the reselling possibilities of the invested tangible and intangible resources are low. The contribution of learn options towards an efficient investment management results therefore mainly from an improvement of the management of fixed costs.

4.2 Expansion options

Expansion options refer to a point of time after the completion of an investment and the start of the actual production. Analogous to learn options the relevance of expansion options is also strongly determined by an investment's degree of irreversibility. This is due to the fact that the relevance of the possibility to generate additional sales through the expansion of production and distribution is highest, if the operating risk is high and the reselling possibilities are low. It is only under those circumstances that the overcompensation of fixed costs through an increased sales volume is of exceptional

importance. The impact of uncertainty on the relevance of expansion options is, relatively to its importance with learn options, lower because management gained a better overview with respect to complexity, the impact of dynamics decreased and most important, the relevant uncertainty refers only to a probable increase in market demand for the existing product. The contribution of expansion options to an efficient investment management is mostly due to an improved sales situation.

4.3 Assurance options

Assurance options also refer to a point of time after the completion of an investment and the start of the actual production. In contrast to the before described two categories of real options, in the context of assurance options irreversibility is of much lower relevance. Moreover, the relevance of assurance options is the higher, the higher the share of variable costs in total costs and therefore the lower the operating risk is. It is only under those conditions that the possibility to reduce the production and distribution (temporary) or to vary the input factors is of great importance. The argumentation is supported by the fact that the relevance of the option to abandon as the extreme form of assurance options is negatively correlated to its specificity and positively correlated with its reselling possibilities. Concerning uncertainty it can be mentioned that with respect to switching options its relevance is, compared to expansion options, relatively higher because the market demand uncertainties of different products are of relevance. Considering volume options (options to contract, options to shut down and restart, options to abandon) the role of uncertainty is even higher as more textual sources can cause a company to reduce its production. In the consequence the contribution of assurance options to an efficient investment management is primarily founded in the management of a company's variable costs. An exception are output-switching options which are mainly aiming on increasing a company's sales.

4.4 Growth options

Growth options also refer to action flexibilities that exist while and after the actual investment. In contrast to the before described categories of expansion and assurance options, growth options refer to qualitatively innovative projects. Similar to its role concerning learn options, the relevance of growth options is also especially strong in those situations where the different forms of uncertainties as well as the irreversibility

of an investment are very high. In this sense growth options are very often related to platform investments, which are characterised by a high degree of irreversibility, but enable companies in highly uncertain environments to quickly penetrate into different potentially developing markets. In this context it is especially important to generate sales in future markets and in doing so overcompensate the initially high fix costs. The contribution of growth options to an efficient investment management is therefore in principal focused on improving the future sales situation.

5 CONCLUSION

After sketching the paper's theoretical foundations we have first of all substantiated the abstract constructs of uncertainty and irreversibility which together drive the relevance of action flexibility. Furthermore we have outlined that the relevance of the different categories of action flexibility, respectively real options, are influenced in different manners by the determinants uncertainty and irreversibility. In this sense, for investments that can be characterised by a high operating risk and low reselling possibilities as well as high parameter values of the different forms of uncertainty (e.g. market demand, competitor's actions and technological developments), especially learn and growth options are of importance. In the case that uncertainty only refers to the possibility of an increase in market demand for one product, also expansion options are relevant. Given the situation that uncertainty is relatively high, but the operating risk is low and the reselling possibilities of the invested resources are low, assurance options are of great importance.

On the basis of this paper, companies have a much better guideline to assess the principal application potential of real options theory for an investment's context. Furthermore they get valuable insights with respect to the categories of real options they should focus on. This fact seems especially important as the different real option categories require diverse models and approaches.

However we have to mention that the postulated results of our conceptual paper tentatively remain theoretical in nature. As a consequence, future research should focus on the operationalisation of the relevant constructs and dimensions as well as on emprirical testing.

Remarks

[1] For a similar categorisation see Hommel/Pritsch, 1999, pp. 13-14.
[2] Compare section 2.2.3

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