The Real Option Approach applied on Foreign Direct Investment Scenarios.

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Abstract

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The Real Option Approach (ROA) has been put forth as the solution to the problem of valuing manager flexibility and project risk within the framework of capital budgeting. In this thesis the ROA is applied on one of the riskiest of corporate ventures namely foreign direct investment. The first two problems posed by the author are if the ROA is an attractive method of capital budgeting when it comes to foreign direct investment scenarios and why ROA is not widely used by corporations today. The answer that I have reached from the gathered material is that the Real Option Approach is a valuable budgeting method especially in foreign direct investment scenarios since these contain risk factors that are hard to assess and occur in foreign environments that negatively influence the judgement of managers. The real option approach is superior in comparison to older budgeting methods but cultural and political factors have a slowing effect on the adoption of more advanced budgeting techniques and deductively this also has detrimental effect on the adoption of the real option approach.

A secondary research problem was to explore if the real option method needs to be modified for each investment scenario and the conclusion of the study is that although the theoretical framework does not need adaptation each type of option situation needs a specific valuation technique and therefore some form of limited adaptation.

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Thesis Language
English
Dedicated to Evy & Tage Eklundh - in loving memory.

Special thanks to:
Dad & mom –
For always being there even in the darkest of times.

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For putting up with my stupid emails.
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It is a bad plan that admits of no modification.

Publilius Syrus, Maxims (~100 BC)

1 Problem Discussion
Swedish's larger corporations have a history of being active foreign investors, during the 1980ths Sweden was proportionally the world's largest originator of foreign investment and after a slowdown during the beginning of the 1990ths this process regained momentum.\(^1\) However the dominating part of Swedish production is located in other EU member states and most employees are found in EU15 and the USA, in other words countries with large markets, high salaries and production costs.\(^2\) Even though it is important to keep in mind differences between industries it is apparent that Swedish multinational companies prefer keeping a high profile on key markets. Recently the pressure on Swedish small and middle size companies has increased as a result of globalization. Globalization forces even small and middle sized companies to get more and more directly involved in foreign direct investment and the leap to an internationally distributed production network might be decisive for the future survival of these companies.\(^3\)

Budgeting techniques have an impact on which projects a company chooses and deductively impact how well a company will do. The ideal capital budgeting technique should maximize the owners' value and has according to Copeland & Weston four criteria which are listed below: \(^4\)

- All cash flows should be considered.
- The cash flows should be discounted at the opportunity cost of funds.
- The technique should select from a set of mutually exclusive projects the one that maximizes shareholders' wealth.
- Managers should be able to consider one project independently from all others i.e. the value-additivity principle.

However an investor or manager always faces uncertainty and risk\(^5\) to some degree.

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1 Braunerhjelm (2001) *Storföretagen och den ekonomiska geografin* p 421f
2 Mattila & Strandell (2006) *Att definiera och mäta flytt av produktion* p 5
3 Ibid. p 8
4 Copeland & Weston (1992) *Financial Theory and Corporate Policy* p 26
5 Uncertainty is defined as the randomness of the external environment and cannot be
hence there exists a need to enumerate and quantify them. Factors influencing the profitability of a project are often difficult to estimate or even unknown at the point of the investment decision. Uncertainty about the world around us and the future of the project increases pressure on profits but the manager cannot do much about his surroundings or the future. What remains for the manager or investor is to maintain or improve the projects flexibility. Hence if we consider projects as now or never investments then we would be satisfied with the four criteria given above when searching for the ultimate capital budgeting method. However, as the world is a complicated place we have to accept the fact that an investor or manager will adapt and revise the chosen strategy when facing changes that influence the project. Hence there is a fifth criterion we have to consider namely that the budgeting technique should be able to put a value to the managers' flexibility. This is a key assumption in the Real Options Approach (ROA) and this fifth criterion separates ROA from previous capital budgeting techniques. The ROA is at present rarely used by Swedish companies and there exists a persistent theory-practice gap between which capital budgeting methods that the business world utilizes and which methods recent academic research recommends.

Sandahl & Sjögren shows in their paper *Capital Budgeting methods among Sweden’s largest groups of companies.* (2003) that few large Swedish companies utilized advanced capital budgeting methods thus relying on less than modern methods of project evaluation as basis for decision-making. Since the utilization of more advanced capital budgeting techniques also is believed to correlate with the size of the company, even fewer small or mid size companies are believed to be up to date on this subject. The reason behind the reliance on older budgeting methods is in a systematic way influenced by tradition and various contexts within the companies. Failing to utilize the most up to date budgeting method should theoretically result in a disadvantage in comparison to those firms that do.

The real option method is in itself a theoretical description of an evaluation method or

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6 Trigeorgis (1999) *Real Options* p 1
8 Ibid. p 52
9 Ibid. p 68
in other words a model for capital budgeting. In its essence a model expresses a simplified view of a system and as such it or the data used in the model might need to be adjusted for use in cases that are out of the ordinary. The ordinary case for real options being oil exploration, medical research and other high risk endeavours where normal evaluation methods perform poorly.\textsuperscript{10} In this thesis I set out to study and present how real option theory is applied on foreign direct investment. I also want to illustrate with some sort of a test scenario and therefore chose to take an imagined small or mid sized Swedish company and put it in FDI scenario. The remaining question is where it should invest? Being close to a major market is a variable that is perceived as having strong influence on choice of location. Another important variable is the relative cost of wages, the lower the better.\textsuperscript{11} An ideal investment target would therefore be a country where you have a large and powerful market and yet low salaries in comparison to the country of origin of the investment, ceteris paribus. A number of developing countries might fit to this description but lately one has dominated them all namely the People's Republic of China. Swedish larger corporations have a long history of investing in the PRC and its now small and middle sized business that is waiting in line.\textsuperscript{12} The PRC is Sweden’s largest trading partner in Asia and Swedish companies amassed a US$ 4.6 billion in revenues during 2003 and employed approximately 28 000 persons throughout the PRC. These companies had invested 1.8 billion US dollar in PRC, mostly in the eastern parts.\textsuperscript{13} However profitable a direct investment into the PRC might seem factors such as distance, culture and language may deter especially smaller companies and these factors are obviously present in the PRC. Because of this the PRC will serve as setting for my imagined direct investment scenarios.

1.1 Research Question
As I am confident that the ROA at present is the superior budgeting technique I want to describe and scrutinize the ROA applied on FDI in order to test the following statements:

\textit{Advanced financial models are for academics, the layperson is deterred by complicity…}

Is the real option approach really attractive for investors and managers that are considering investing in foreign markets?

If this is the case, why is not the ROA being put to use?

\textsuperscript{10} Buckley & Tse (1996) \textit{Real Operating Options and Foreign Direct Investment}, p 304
\textsuperscript{11} Braunerhjelm (2001) \textit{Storföretagen och den ekonomiska geografin}, p 429 f
\textsuperscript{12} Schwaag, Serger & Widman (2005) \textit{Konkurrensen från Kina }A2005: 019 p 71
Models are simplifications of reality and therefore need to be adapted to each new application...

Does the real option approach need adjustments depending on in which environment it is used?

What does this mean for the spreading of this budgeting technique?

1.2 Purpose

The purpose of this thesis is first to describe the real option approach and foreign direct investment theory and then to build a case for or against the use of the real options approach when it comes to evaluating foreign direct investment projects.

1.3 Background

This thesis was completed during the spring semester of 2006 but the work had begun two years earlier. The work on my first draft was discontinued since I was rewarded with a scholarship by the Japanese Government and moved to Japan in order to study at the faculty of commerce at Doshisha University in Kyoto. The initial thought was that I would write a thesis about ROA adoption among Japanese companies but at the start of my stay my language skills were not sufficient and few people that I came in contact with could keep a dialogue about capital budgeting in English. A year into my studies I chose to change theme and got thumbs up from my supervisor Anders Sandoff to go ahead with this thesis. Unfortunately tragic events unfolded back in Sweden, during my stay my grandparents passed away suddenly. In 2006 I finished my studies at Doshisha University and also decided to finish the thesis. Quickly running out of time and without funding I spent a month putting this thesis together while sleeping on my father’s couch and attending unemployment training.
2 Method

There are many methods for predicting the future. For example, you can read horoscopes, tea leaves, tarot cards, or crystal balls. Collectively, these methods are known as "nutty methods." Or you can put well-researched facts into sophisticated computer models, more commonly referred to as "a complete waste of time".

Scott Adams, American Cartoonist, 1957

2.1 Choice of approach

How a person views reality and knowledge influences how he or she thinks information should be collected and analyzed. There exists a multitude of views on how knowledge should be viewed but two opposing standpoints are of main interest for this work: the positivistic view and the normative. The positivistic standpoint states that the scientist is an external observer that will in no way influence the object that is examined. Knowledge is thought of as a cumulative process where knowledge is gained through verification or falsification of hypotheses and theories and the result leads to objective and true knowledge.\textsuperscript{14} Subsequently this is a convenient standpoint for a researcher who does not need to worry about contaminating the research data with his own influence and a standpoint that suit a literature study perfectly since there is no two way communication possible between the researcher and the material that he or she studies. However the researcher needs to clearly motivate why certain sources are used and keep the selection process transparent. Personally I feel that the standpoint, whether it is positivistic or not should partially reflect the object that is being studied. My impression is that a positivistic approach might not be that fitting when studying people or events that might get influenced by the researcher.

Earlier I mentioned that positivism calls for a verification or falsification of hypotheses or theories in order to create knowledge but in this thesis I will frequently rely on deduction through logical arguments or analogies. This forces me to also rely on a normative approach. The normative approach examines factors that should exist but are not necessarily formed on an empirical basis. Adrian Buckley illustrates this by

\textsuperscript{14} Björklund & Paulsson (2003) Seminarieboken p 63
giving an example where a normative theory of business based upon the premise that firms maximize profits of shareholder value might lead to a theoretical model of what the firm should do in order to reach such a goal.\textsuperscript{15} For me this implies that the knowledge gained through inference, while not possible to prove at every point, has a value for understanding and improving the world if it is based on rational and logical arguments. However it is also easy to draw parallels to the discussion about Intelligent Design in the USA and how the normative approach puts science closer to the world of ideologies in which claims may be derived in the same way. Consequently I feel that the normative approach should not be relied on as the sole method of knowledge creation. I therefore will utilize both approaches in this thesis.

As it was pointed out by Sandahl G. & Sjögren S in their study \textit{Capital Budgeting Methods Among Sweden’s Largest Groups of Companies}, companies using more advanced budgeting methods such as the real option approach are almost non-existing.\textsuperscript{16} Considering this fact the likelihood of being able to carry out empirical studies of foreign direct investment done by Swedish companies with the real option approach is very low. This leaves me with the alternative of inference from known theory and data when studying this subject. I therefore decided to limit the research to literature studies and write a descriptive work of qualitative nature. A qualitative study is often based on systematic observations, for example detailed interviews or a limited case study. It has some benefits over the quantitative approach such as the fact that it provides the user with the flexibility to change disposition during the research period and is used when there is a need to get a deeper understanding for a specific subject, situation or event. However the researcher needs to stay alert of a comparatively higher risk of subjectivity which means that the opinions of the researcher just might taint the results. In a qualitative study sample size is often smaller than when using the quantitative research approach and this produces a higher risk of errors and a lower reliability.\textsuperscript{17} A qualitative study also decreases the possibilities to make general conclusions from the study.\textsuperscript{18} The methodology involved when conducting a literature study is less intricate than what is applied when following other research methodologies but being less intricate does not mean it is less strict. There exist two forms of data that the researcher can use namely, primary and secondary data. Secondary data has already been collected

\textsuperscript{15} Buckley (1998) \textit{International investment} p12 ff
\textsuperscript{16} Sandahl & Sjögren (2003); \textit{Capital Budgeting Methods Among Sweden’s Largest Groups of Companies} p 56
\textsuperscript{17} Holme & Solvang (1997) \textit{Forskningsmetodik} p 13 ff
\textsuperscript{18} Björklund & Paulsson (2003) \textit{Seminarieboken} p 63
and published by a third party while primary data is there for the researcher to collect and examine at first hand.\(^{19}\) A primary source is often preferred over a secondary since it has been gathered and examined only for the intended study\(^{20}\) but since this thesis is solely based on literature studies no primary data is used.

The theoretical basis for this thesis might be visualized as a triangular relation between FDI, ROA and TCB (Traditional Capital Budgeting) studies (See figure 1 below). I believe a combination of these three fields will work well as a model of reality. Using this model I will be able to discuss facts and deduce conclusions that lie close to reality.

\[\text{FDI} \quad \text{ROA} \quad \text{TCB} \quad \text{Reality} \]

*Theoretical basis. Figure 1*

2.2 Literature assessment and validity

Validity, reliability and objectivity are three things that can be seen as measurements of a study's trustworthiness. Validity describes to which degree the study really measures the things it is supposed to measure. Reliability on the other hand measures the degree to which the tools of measurements are trustworthy. This is important when one for example wants to repeat an experiment. Objectivity, the factor which is of most interest when considering this thesis, measures to what extent different estimations and values influence the study.\(^{21}\)

Objectivity is created and increased through transparency of the motives behind which choices are made and letting the reader make up their own mind about the results of

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\(^{19}\) Eriksson & Wiedersheim (2001) *Att utreda forska och rapportera* p 63 ff

\(^{20}\) Holme & Solvang (1997) *Forskningsmetodik* p 124 ff

\(^{21}\) Björklund & Paulsson (2003) *Seminarieboken* p 59
the study. In the case of this thesis I rely on a high number of references and quotations. It is therefore important to try to convey or translate the source as objectively as possible without errors, selectiveness or other limitations of the original sources. It is also important to try to keep a neutral language.\textsuperscript{22} To increase the validity of a study it is possible to use multiple methods when researching the same object.\textsuperscript{23} Because of the elusive nature of my subject of study I was limited to one research method. However approaching the subject from two different epistemological standpoints and three academic research areas should in a similar way provide a higher validity.

The literature used is from three different areas namely methodology, capital budgeting, and foreign direct investment. Most of the literature that has been used has been found at the university library at Doshisha University in Kyoto, Japan but some has been gathered at the university library of Gothenburg University. Some books were ordered to complement the original literature makeup and yet other material was found on the internet through the use of different search engines. In general the literature used contains many cross references and there does not seem to be any major theoretical conflicts about the basic theories that I present and use in the thesis.

It is important to evaluate the material that is used in a literature study in order to try to shine light on possible biased material or see if facts have been left out or taken out of context.\textsuperscript{24} The secondary data used in this study has been scrutinized and a comparative perspective is used when discussing especially the real option theory.

The foundation of the Real Options Approach (ROA) or Real Option Theory of Investment (ROTI) lies in the research on option pricing done by Fischer Black, Myron Scholes and Robert Merton.\textsuperscript{25} Their formula for the prizing of financial options proved later to be useful when valuing real assets or real life options. The honour for this conclusion was also shared by Stewart Myers, the man that coined the term Real Options.\textsuperscript{26} Important extensions of the real options framework and its different applications have been done by Pindyck, Dixit, Trigeorgis, Mun, Luehrman, Kulatilaka and Hull. However the book I am putting to the use the most is Amram & Kulatilaka; \textit{Real Options: Managing Strategic Investments in an uncertain world} (1999). Although I

\textsuperscript{22} Björklund & Paulsson (2003) \textit{Seminarieboken} p 62
\textsuperscript{23} Ibid. p 76
\textsuperscript{24} Ibid. p 67
\textsuperscript{25} Amram & Kulatilaka (1999); \textit{Real Options}, s vii
\textsuperscript{26} Amram & Kulatilaka (1999); \textit{Real Options}, s x
read Mun’s book *Real Option Analysis* (2002) I was unable to use it as a reference because of problems getting access to the library copy at Handelshögskolans library when my own copy got stuck in shipping somewhere between Japan and Sweden.

The foreign direct investment theory part relies heavily on two main books and one literature comment but since these are based on well established theories, that can be found in almost any FDI related textbook, I feel comfortable with this. Quite a lot of space is still dedicated to MIT professor Westney Eleanor’s short commentary on foreign direct investment theory but considering the quality of this work I do not see any problem with this. I have also read most of the material that she refers to in order to get the most out of this paper. The theoretical framework borrows much from Tao Qu & Milford B. Green’s book *Chinese Foreign Direct Investment*. Other sources are reports written by such organisations as Swedish embassy in PRC, ITSP and OECD both in and outside of the PRC. The neutrality of the OECD reports is undisputed but the information compiled in mainland China must be scrutinized and compared carefully.

As the research in foreign direct investment through the ROA is rather new the literature in this area is limited much of the material consists of articles. Adrian Buckley, seems to be the leading authority in this field and his articles echoes the message he delivers through his books. As a final note I must add that some sources used in the discussion about capital budgeting were used as part of an assignment in a Real Options course at Handelshögskolan, Gothenburg University. All calculations have been done in Excel with the help of 2002 years version of Lattice Maker and a Black and Scholes formula constructed by Espen Gaarder Haug.

### 2.3 Building a solid case

As I wrote earlier a triangular relation between the theoretical fields is used as basis for knowledge creation but when it comes to building a case for or against the application of real options approach on foreign direct investment situations a mere description of the separate areas will not give an theoretical edge sharp enough to give the reader a good understanding of how I reach my conclusion. Instead I want the reader to visualize how the conclusion will be reached and understood through a system consisting of three theoretical lenses. At first I want to present the macro setting via the FDI theory. Then the traditional capital budgeting theory will provide us with an understanding of the organizational level of the investment decision. At the bottom of this theoretical microscope the ROA material will give the instruments that are necessary for the
investment decision and make it possible to test the knowledge gained from the earlier layers on a small number of imagined scenarios. At each lens I hope to take one step closer to a clear conclusion. The steps will be as follows:

Step 1: The FDI presentation in chapter 3 shows how the world is understood through FDI research. Here I want to explain the macro environment of the company which I also exemplify with a description of the investment climate in the PRC which is placed in appendix 1.

Step 2: Is a glimpse on organizational studies on budgeting procedures which I do in chapter 3.2. This provides the reader with the professional habitat of the manager and hopefully creates an understanding of the qualitative factors that influence the decision making.

Step 3: In chapter 3.3 I present the ROA and with it the ideas and problems that are noteworthy when this budgeting technique is applied to FDI scenarios. In the following chapter I describe through three examples the ROA applied on FDI scenarios (Calculations available in appendix 2). The results are summed up and discussed in the discussion and conclusion chapters.

This method will in my eyes describe how the decision and budgeting process is influenced by a multitude of factors on different levels and create an understanding of why it is important to utilize a budgeting system that addresses the problems that are visible on all these levels.
3 The theoretical setting

*If all economists were laid end to end, they would not reach a conclusion.*  
George Bernard Shaw (1856-1950)

3.1 Interpretation of reality through FDI: A continuing development.

3.1.1 Definition

Foreign direct investment is an international capital movement where the investor retains control over the use of the targeted resources. FDI is different from portfolio investment which is purely financial through the modality of the market and does not result in control over the final investment target.  

3.1.2 Motives behind FDI

The reason why FDI occur has been explored extensively. The conventional theoretical basis is found in the market imperfections approach from the 1960-70ths. This approach assumes that without market imperfections foreign direct investment would never occur. Market imperfections can be caused by goods, factors, markets, scale economies, government imposed regulations like tariffs and trade barriers. These and other imperfections prevent a more efficient allocation of resources and distribution of products. In a perfect market the only method needed to serve a foreign market is trade.  

In an imperfect world indigenous firms have advantages over foreign enterprises on the domestic market. In order to compete with local firms, foreign companies must have the upper hand in something in order to compensate for the disadvantage of operating in a foreign environment. Some type of market imperfection must also impede the local firms' access to the foreign enterprises' advantage. This leads to the assumption that a perfect competition status is not likely to be at hand in cases where FDI and multinational enterprises are present. The multinational enterprise (from now on referred to as MNE) arise as a response to market failures as a way to increase efficiency in the presence of the high costs of coordinating economic activity between

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independent economic agents.\textsuperscript{29}

A theory that puts the product and market maturity in focus is the Product Cycle Theory which has three basic assumptions. First, monopolistic advantages enable MNEs to take on the special costs and uncertainties of direct production abroad. Second, there are differences between the markets and factor conditions of home and host countries. Third, a new product or innovation possessed by an MNE is stimulated by the promises of its home market. \textsuperscript{30} This is a more complex explanation than the market imperfection theory. The possibility to protect a product through for example intellectual rights is consequently important for a company when expanding globally. This type of monopolistic advantage is in itself a market imperfection which supports the company and makes it possible to get established in a foreign market if other conditions are favourable.

The flow of intermediate products within the MNE including not only semi-processed materials but also knowledge and information in the form of technological expertise and human capital is one advantage that the MNE possesses. This flow is being studied in the Internalization theory. This theory puts the searchlight on the reasons behind internal trade in MNEs. When there is a lack of an appropriate external market or when the costs of operating in them are higher than the benefits, there are incentives for the MNE to develop its own internal organizational structure to achieve coordination of activities. Thus the internalization theory sees the MNE as the outcome of a process in which firms attempt to secure rents from their assets in the presence of market imperfections. In other words, the firms organize their activities in response to the nature, weaknesses and limitations of the markets.\textsuperscript{31} The internalization theory explains why MNEs chose to take joint ownership of both domestic and foreign value-added activities. However it does not explain why MNEs participate in international production in the first place. Instead it relies on the market imperfection theory to do this.\textsuperscript{32}

In order to bring all these theories together J.H Dunning in 1979 presented the eclectic approach. The primary proposition of the eclectic paradigm is that FDI only occurs

\textsuperscript{29} Blomström, Kokko & Zejan (2000) \textit{Foreign Direct Investment} p 2f
\textsuperscript{30} Tao & Milford (1997) \textit{Green Chinese Foreign Direct Investment} p 8
\textsuperscript{31} Blomström, Kokko & Zejan (2000)\textit{Foreign Direct Investment} p 2f
\textsuperscript{32} Tao & Milford (1997)\textit{Chinese Foreign Direct Investment} p 8
when there is a juxtaposition of three types of advantages related to a specific firm: Owner-specific advantages (O), Location-specific advantages (L) and market Internalization advantages (I). This gives the rise to the abbreviation OLI which is the more known name of the eclectic paradigm.\textsuperscript{33}

### 3.1.3 FDI – How it is done

Up until this point the theories presented have defined what FDI is, in which form it occurs and the motives behind it. The remaining thing to explain is how the FDI is conducted. Two models are considered to shed light on this. The first model is the Product Life Cycle theory that was discussed above. According to this theory an innovating company is likely to produce a new product first in its home market, for which the product had been originally designed. Over time as the product matures a dominant design becomes accepted and production processes stabilized. Meantime export markets develop for the product in those markets where high-end customers welcome the innovation. In due course, foreign demand grows, as foreign markets advance economically, and exports increase. The firm then eventually consider setting up manufacturing in its larger foreign markets. Westney describes how Vernon hypothesize that most managers are “myopic” –that is to say unlikely to incur the costs and uncertainties of moving production outside their home country unless pushed into doing so by a “triggering event” that threatens their export markets. This triggering event could be the emergence of local competitors trying to move in on the market created in their country by the firm’s exports, or the threat of tariffs.\textsuperscript{34} The firm then moves in to protect the perceived market. This seems like a fitting description off some corporate launches in the PRC.

Once the firm is established in larger markets offshore production facilities serves the local markets with local production substituting previous exports. The market expands since the price of the product is reduced by the beneficial factors of local production (In other words, lower labour costs and elimination of transport costs). Over time, this lower price encourages the growth of markets in less developed countries, which might well be served not from the home country factories but from the secondary factories. As the product becomes standardized, the firm might set up production in the most rapidly growing less developed countries, where economic growth creates new markets. Ultimately, the home country itself is served by products manufactured offshore, either

\textsuperscript{33} Tao & Milford (1997) \textit{Chinese Foreign Direct Investment} p 9
\textsuperscript{34} Westney (2002) \textit{A note on Sequential Models of Internationalization} p 1f
by the firm’s own subsidiaries offshore or by local competitors in the “follower” countries that emulate the by-now standardized production processes and take advantage of established and increasingly price-sensitive markets.\textsuperscript{35} However in reality instead of solely introducing a product at home and rolling it out gradually abroad MNEs were likely to introduce new products simultaneously in several markets.\textsuperscript{36}

The second theory is often referred to as the Learning model but it is also called the Incremental model. This model was created by the Swedish researchers Johanson & Vahlne and introduced with their work \textit{The Internationalization Process of the Firm – A Model of Knowledge Development and Increasing Foreign Market Commitments} in 1977. Johanson & Vahlne believe that the internationalization of the firm is the product of a series of incremental decisions but as their research disregarded the decision style of the decision-maker himself or the context they claim it to be of only limited predictive value.\textsuperscript{37} Johanson & Vahlne conducted their empirical study on Swedish firms but consider their results in no way constricted to pure Swedish corporations. The internationalization process is described as incremental in two ways namely in terms of the level of involvement (the mode), and in terms of the location.\textsuperscript{38}

The sequence that firms followed when they entered a country started with export through an agent. They then established a sales subsidiary, and eventually, in some cases, establishing a manufacturing subsidiary.\textsuperscript{39} This process can be illustrated by the following model that is presented and evaluated by Buckley & Tse.\textsuperscript{40} They argue that the Sequential model is too simplistic to explain real world FDI because of the existence of corporations that skip steps or even move back along the sequential range. However when applying the ROA to said model the rationale for jumping over stages or even stepping back to earlier ones may be found.\textsuperscript{41}

\textsuperscript{35} Westney (2002) \textit{A note on Sequential Models of Internationalization} p 2  
\textsuperscript{36} Ibid. p 2  
\textsuperscript{37} Johanson & Vahlne (1977) \textit{The Internationalization Process of the Firm} p 23  
\textsuperscript{38} Westney (2002) \textit{A note on Sequential Models of Internationalization} p 3  
\textsuperscript{39} Ibid. p 3  
\textsuperscript{40} Buckley & Tse (1996) \textit{Real Operating Options and Foreign Direct Investment} p 305  
\textsuperscript{41} Ibid. p 305
In Johanson & Vahlne’s article a form of limiting factor referred to as “psychic distance” of locations, defined as the sum of factors preventing the flow of information from and to the market is presented. These factors are things that differ between the home country and target country. Examples may be language, education, business practices, culture, and industrial development. According to the article Swedish firms often set up their first foreign subsidiaries in neighbouring Nordic countries, expanded into Northern Europe and ultimately farther away. Another example is presented by Westney as she claims that it was found that British firms in the 1930s were more likely to set up subsidiaries in India or Australia than in France. Westney summarizes the results of the incremental process as follows:

*Increases in interaction with and integration into a given market environment, through links with customers and growing familiarity with the business system, reduced uncertainty levels and increased the confidence of the managers of the firm in their ability to operate within those environments. Foreign experience in similar environments increased the company’s capabilities for operating across more challenging borders, and increased the company’s willingness to venture farther a field.*

For me this shows how knowledge creation and elimination of subjective impressions may positively influence the ability to properly evaluate an investment opportunity when it comes to FDI.

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42 Johanson & Vahlne (1977) *The Internationalization Process of the Firm* p 24
43 Westney (2002) *A note on Sequential Models of Internationalization* p 3
44 Westney (2002) *A note on Sequential Models of Internationalization* p 3
3.1.4 FDI and Country Specific Risk

An important concept in the FDI research is the *country risk*. This factor is of main concern for the FDI risk assessment process. There country risk in connection to portfolio investments is defined as:

*The possibility that a sovereign state or borrowers of a particular country may be unable to fulfil their obligations towards a foreign lender and/or investor for reasons beyond the usual risks which arise in relation to all lending and investments. Country risk is composed of political and transfer risk.*

Political risk is defined as the risk incurred by lenders and/or investors that the repatriation of their loan and/or investment in a particular country is restricted by the administration in that country for political reasons only. Transfer risk is defined as the risk that a particular country may impose restrictions on remittances of capital, dividends etc, to foreign lenders and/or investors as part of its economic policy.

Political risk can also be defined more shortly and in its essence be described as the probability of politically motivated change that affects the outcome of FDI.

Country risk and classification of countries is carried out by several organizations and independent investors such as major banks or investment funds and I have chosen to see how the OECD calculates and grades country risks. OECD does not quantify political risk instead it sticks with the country risk concept which it limits to the credit risk. OECD grades the countries into eight country risk categories (0-7) on which 0 is the lowest. Below is a passage from the OECD country risk classification.

*The classification of countries is achieved through the application of a methodology comprised of two basic components: (1) the Country Risk Assessment Model (CRAM), which produces a quantitative assessment of country credit risk, based on three groups of risk indicators (the payment experience of the Participants, the financial situation and the economic situation) and (2) the qualitative assessment of the Model results, considered*  

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45 Krayenbuehl (1985) *Country Risk – Assessment and Monitoring* p 3
46 Ibid. p 3
47 Clark & Tunaru (2000) *Real Options and the Quantification of Multiple Political Risks* p 17
High political risk is often connected to political turmoil or revolution. Embargoes or boycotts are measures instituted for whatever reason and will lead to solvency problems for the borrower since it might, for instance, no longer be in a position to run his company. Other examples may be substantial changes in the foreign currency reserve position of a country, severe labour unrest such as large strikes and lockouts or extreme governmental actions such as syndication or nationalization of the assets in a country. In FDI theory country risk and in particular political risk may constitute a large part of the total risk the investors or managers face when investing in emerging markets but it is difficult for the individual investor or manager to assess this factor alone and maybe even more difficult to put it into the evaluation of a project.

3.1.5 Thoughts about FDI theories

The material on foreign direct investment show that research in this area is complex and that the theories provide explanations of how FDI develop and why it occurs. However, the complexity is also something that is likely to feed subjective fears in the managers and up the ante when it comes to project profitability. The sequential model presents a foundation that together with the flexibility perspective of the ROA creates a rather convincing depiction of the possibilities and decision points that managers face. The pull factors of the market imperfection perspective and the push mechanism of the internalization theory gives an dynamic environment filled with objective factors that motivates FDI but at the same time the incremental process describes the subjective psychological and cultural factors that channels and regulates the FDI flows. The chance is that companies miss out on good investments because of these subjective factors. The ideal would therefore be a system which focuses on the objective evaluation of FDI projects while valuing the flexibility that is needed to parry environmental factors.

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48 OECD 2005/01/03
http://www.oecd.org/document/49/0,2340,en_2649_34171_1901105_1_1_1_1,00.html
49 Krayenbuehl (1985) Country Risk – Assessment and Monitoring p 12
3.2 Discussion about Capital Budgeting Methods

For a researcher the difference between theory and reality can sometimes be grim. This seems to hold true also in the area of capital budgeting. Researchers try to explain the persistent theory gap from different approaches and the conclusions has differed greatly over time. Whatever the outcome might be the company's survival and vitality are determined by how well it succeeds to regenerate itself through the allocation of capital to productive use. Failure to provide a return higher than the cost of capital will be detrimental to the value of the company.\(^50\) The application of the different fundamental concepts of the capital budgeting theory results in a considerable mass of combinations and groups of budgeting approaches. Some companies might use combinations of budgeting theories while others might only utilize one or even no one at all. The general perception seems to be that the theory-practice gap is a catch up process in which the business gradually grows accustomed to and applies increasingly advanced budgeting theories that the academic world produces. However the opposite stance is also present in the discussion.

It might just be the case that the theoretical world is closing in on the reality that the managers are facing.\(^51\) Arnold & Hatzopoulos reveal that the *now or never* mentality of the fundamental NPV techniques and the assumption of unison knowledge or unanimous decision making, following the unacceptability of asymmetrical information between different parts of the decision making body, creates a theoretical mindset far from the reality that the managers face.\(^52\) On the other hand a lack of risk assessment and probability analysis creates a blind spot for the managers but quantifying and presenting uncertain numbers is also problematic. Predicting the future is risky business and putting down a definite probability for a specific scenario on paper might come back and haunt the manager later on.\(^53\)

The mathematical theories for rational decision-making in connection to capital budgeting are not considered sufficient and accordingly there should be more attention paid to how decisions are made from an organizational standpoint. Factors that have to be considered in this case are among other multiple goals within the organization, political and social environments inside the company and the reality of information

\(^{50}\) Arnold & Hatzopoulos (2001) *The theory-practice gap in capital budgeting: Evidence from the United Kingdom* p 603

\(^{51}\) Ibid. p 609

\(^{52}\) Ibid. p 609

\(^{53}\) Ibid. p 612
asymmetry.  

### 3.2.1 Traditional CB perspective on Risk

As mentioned in the Arnold & Hatzopoulos article the risk assessment is an important factor when evaluating projects. James Mao discusses the role of risk and how it is evaluated in his article *Survey of capital budgeting: Theory and practice*. In his dialogue with the participating companies he derives to the conclusion that risk means different things depending on the size of the project that it is related to.\(^5\) If the project scale is small the project risk is defined as the chance of not meeting the projected return of the project. However when the scale of the project increases the quantifiable risk gradually starts to encompass the risk of insolvency of the whole firm. The management also emphasizes the downward/negative risk which makes the use of semi-variance more appropriate than the common variance when discussion risk for these companies.\(^6\)

Mao reaches the conclusion that although top management tries to use the concept of portfolio investment in their budget decision process they fail because decisions are taken at each separate division within the company and this result in the fact that the overall co-variance for all the projects that are possible for the company gets distorted. This puts the theoretical frame of that time in stark contrast with its reality.\(^7\) Mao accordingly attacks the IRR and payback methods for their failure to take the size of the projects into account and clearly show the risk of the project.\(^8\)

As the size of the project in comparison with the size of the company becomes an important factor the question arises if companies in certain business areas or of certain sizes apply similar capital budgeting techniques.\(^9\) In the case of Swedish companies the factor size correlate with the utilization of DCF capital budgeting techniques. That is to say that it is more likely that larger companies utilized DCF. Larger companies also more often applied more than one capital budgeting method.\(^10\) The use of the payback method was independent of size. The overall result from Sandahl & Sjögren’s

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\(^5\) Arnold & Hatzopoulos (2001)*The theory-practice gap in capital budgeting: Evidence from the United Kingdom* p 623  
\(^7\) Ibid. p 354  
\(^8\) Ibid. p 357  
\(^9\) Ibid. p 358  
\(^10\) Moore & Reichert (1983)*An Analysis of the Financial Management Techniques* p 623  
research was that Swedish public companies have not adjusted to the current theoretical high esteem of the shareholder value in the aspect that they have not increased the use of DCF techniques since earlier empirical studies.

3.2.2 Theory Practice Gap

If we leave the quantitative studies behind for a while and focus on a more qualitative approach Stewart C Meyers has tried to explain the theory practice gap with three key ideas:

- Finance theory and traditional approaches to strategic planning may be kept apart by differences in language and culture.
- Discounted cash flow analysis may have been misused and consequently not accepted in strategic applications.
- Discounted cash flow analysis may fail in strategic applications even if it is properly applied.

Myers presents these three explanations as each being partially true but as a total not sufficient to add up to the whole truth.\(^{61}\) Myers goes on to mention the smart managers which know that all projects have zero NPV in the long run competitive equilibrium. Therefore, a positive NPV must be explained by short run deviation from equilibrium or by some permanent competitive advantage. If neither explanation applies the positive NPV is suspect. Conversely a negative NPV is suspect if a competitive advantage or short run deviation from equilibrium favours the project.\(^{62}\)

Myers’s main conclusion seems to be that a lot of strategic planning does not rely on modern capital budgeting theory at all. The main reason for this is that many financial models ignores factors that otherwise are considered important in the decision making. The managers also perceive risk in a different way than the owners of the company. In this case the managers think of their company as a portfolio and try to keep a low risk profile despite that this is unfavourable to the owners’ investment. The owner can diversify much easier than the managers and the managers should therefore focus instead of diversify.\(^{63}\)

Continuing on the same track R.H Pike argues that the traditional investment research has contained a limited assessment of the real organizational facts that play key role in

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\(^{62}\) Ibid. p 130

\(^{63}\) Ibid. p 136
the decision process. According to Pike it is difficult to find strong empirical evidence between sophisticated capital budgeting techniques and good results. Instead Pike seems to follow Bower who argues that:

planning is for practical purposes a complex process which in addition to intellectual activities of perception and analysis, involves the social process of implementing formulated policies by means of organizational structure systems of measurement and allocation, and systems for reward and punishment, and, finally, involves a dynamic process of revising policy as shifts in organizational resources and the environment change the context of the original planning problem.

The main point is to discuss the decision process within its context. This is important if we want to understand why different organizations utilize different capital budgeting methods and how complex networks of interdependence among variables function.

The discussion of risk and risk measurement is continued by for example Schall & Sundem. Their hypotheses is that firms operating in environments with a great deal of uncertainty use more sophisticated capital budgeting methods, especially risk analysis methods, than do firms operating in more certain environments. Sophistication refers in this case to the extent to which formal methods are applied, the type of models used and the method(s) of risk assessment. This hypothesis follows from their assumption that more sophisticated techniques lead to superior decisions and that the advantages are greater the more uncertain the environment. The result from their research did not support this hypothesis instead the opposite pattern was found. Firms in less certain environments tended to use less sophisticated capital budgeting methods. The researchers see problems in their study both in the method chosen and the language used. Their conclusion was that it might be the case that there is no clear relationship between a firm’s environmental characteristics and the benefits to be obtained from different capital budgeting methods.

In more recent years Joseph Bower together with Tomo Noda wrote a new article that

64 Pike (1986) *The design of capital budgeting process and the corporate context* p 194
65 Bower (1970) *Planning within the firm* p 186
66 Pike (1986) *The design of capital budgeting process and the corporate context* p 194
67 Schall & Sundem (1980) *Capital budgeting methods and risk* p 7f
68 Schall & Sundem (1980) *Capital budgeting methods and risk* p 10
connects to Bower’s earlier work *Planning within the firm*. Their article is based on the so called Bower-Burgleman process model that is applied to strategy making in large, complex firms, illustrating multiple, simultaneous, and interlocking managerial activities. Strategic initiatives emerge primarily from managerial activities of front and middle managers but the top managers can exercise critical influence on these activities by setting the structural context to reflect the corporate objectives, i.e. manipulating the context in which the decisions and actions of the lower-level managers are made.\(^69\) The Bower-Burgleman model also reflect the resource allocation process in which bottom-up strategic initiatives compete for scarce corporate resources and top managers’ attention to survive within the corporate contexts. Bower & Noda’s paper concludes that the above mentioned factors can cause two firms which are facing similar business opportunities and are virtually practicing the same marketing and technological methods to respond differently. However the overall strategic direction for an enterprise has noticeable impact on the business development at operating levels of a complex firm.\(^70\) The paper shows that a firm may exhibit an evolutionary internal development of strategies which reflects the political environment in which capital budgeting decisions are taken. For my paper I see this as an explanation to why more advanced capital budgeting techniques have not been adopted. The need to justify and explain the use of a budgeting method in a tough political environment might just mean that the managers has to adjust to the *lowest* level in order to attract the most supporters. Bower & Noda shows that the mangers on different levels relate to external and internal forces at the same time as they must in first hand deal with the political, structural and cognitive consequences of their actions.

### 3.2.3 Conclusions drawn from the TCB

As conclusion to this discussion about the more traditional views on capital budgeting and the theory gap the bottom line is that companies might miss out on important chances by utilizing outdate capital budgeting methods. In doing this they also fail to guard or increase the value of the owner’s investments to what is theoretically possible. In the material above the managers’ perception of risk is based on a concern about the wrong factors. Instead of considering the whole perspective of outcome (the volatility of a project) it focuses exclusively on the downside risk which might prove negative if the company ignores the need to be able to adjust its production output upwards. To only

\(^70\) Ibid. p 189
considering volatility (risk) and flexibility as costs makes definitely these factors unattractive. The value of being able to tackle volatility should be shown on the balance sheet.

It is striking that both the FDI and CB material presents the notion that alien or hostile target and decision environments makes it more difficult for the managers to behave rationally and trust objective evaluation tools. But since the studies are conducted in different time and cultural settings it is hard to make general conclusions. The traditional budgeting methods are often praised for their simplicity but many authors such as Tao & Milford contend that in the real world of business good managers are frequently good because they pursue policies that maintain flexibility on as many fronts as possible; when considering investment decisions they maintain options that promise upside potential and/or limit downward risk. 71 I think that in order to do so efficiently and continually a manager needs a tool that reflects the reality they are facing. A tool able to express the world and the manager’s actions in a comprehensive way so that the following evaluation will not be a process based on internal politics.

The real option approach is derived from financial theory so the first thing that has to be defined when discussing the real option approach is the concept of options. The textbook definition of an option is that it is the right, but not the obligation, to take an action in the future. Options are as most valuable when there is uncertainty. In this case uncertainty is considered to be the randomness of the external environment that will have impact on the object of the budget process. This randomness cannot be influenced by the manager and is sometimes defined as the sensitivity of a firm’s cash flows and value to a source of uncertainty. It is determined by a number of factors such as the line of business, the cost structure and the nature of contracts to obtain inputs and sell outputs.

The most fundamental division of financial options is in call and put options. It is possible to either purchase or issue financial options which creates a number of fundamental option strategies. A call option is a contract that is contingent on the value of an underlying asset which gives the holder a right but not an obligation to buy the underlying asset at a specified price. A put option works in the opposite way; the holder has the right to sell the underlying at a specified price. In order to acquire the right to an option the purchaser must pay the so called option price or premium. Besides this basic division there are a multitude of subdivisions and combinations of options which all except the call and put are unessential for the progress of the theoretical discussion of this thesis. However there are two additional factors that have to be acknowledged when discussing options namely the time of exercise and the possibility of leakage of value through for example dividends. Considering the timing of the exercise there are two main types of financial options on which the calculations for real options are based namely European and American options. The differences between these are that the European options can only be exercised on their maturity date and that there exists no cash payments such as dividends made by the underlying asset, in other words there exists no leakage of value. American options on the contrary, can be exercised at any time and have leakage of value from the underlying through dividends etc. Because of the restrictions placed on European options they are easier to price than the American

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72 Amram & Kulatilaka (1999) *Real Options* p 5
73 Ibid. p 8
75 Brach (2003) *Real Options in Practice* p 16
The basic concept that enables the application of financial option pricing models on real life options is the notion that through the construction of a portfolio incorporating a number of shares of the underlying asset (e.g. common shares) and borrowing against them a specific amount at the riskless rate a portfolio that produce the future returns of the option in any state of nature is created. The option and the equivalent portfolio which in short is a levered position in the stock will provide the same future returns and must therefore sell at the same current price. If this was not true there would be the possibility to make risk-free arbitrages. This is also called the Law of One Price which states that two assets that have the same future payoffs must have the same current value and ensures that the value of the option equals the value of the portfolio as the price evolves something that is called dynamic tracking.

When valuing financial options there are two basic approaches: the Binomial model and Black & Scholes option pricing model. These models have both their own benefits and drawbacks of which the more fundamental will be discussed briefly. The financial option valuation theory is based on certain factors which have their corresponding counterparts in the ROA theory. Brach presents these factors as follows:

<table>
<thead>
<tr>
<th>Financial Option</th>
<th>Variable</th>
<th>Investment Project/RO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise Price</td>
<td>$K$</td>
<td>Cost to acquire the asset</td>
</tr>
<tr>
<td>Stock Price</td>
<td>$S$</td>
<td>Present value of future cash flows from the asset</td>
</tr>
<tr>
<td>Time to Expiration</td>
<td>$t$</td>
<td>Length of time option is viable</td>
</tr>
<tr>
<td>Variance of Stock Returns</td>
<td>$\sigma^2$</td>
<td>Riskiness of the asset, variance of the best and worst case scenario</td>
</tr>
<tr>
<td>Risk-free rate of return</td>
<td>$r$</td>
<td>Risk-free rate of return</td>
</tr>
</tbody>
</table>

The building block of financial and real options. Figure 3

Besides these there are other factors that influence the evaluation of both financial and real options namely the uncertainty of the investment, its irreversibility and the uncertainty of the investment, its irreversibility and the

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77 Trigeorgis Lenos (1999) *Real Options* p 72
78 Amram & Kulatilaka (1999) *Real Options* p 32
79 Brach (2003) *Real Options in Practice* p 44
possibility to choose between two or more alternatives.  

However, even though financial options and real options are similar in many ways there are some fundamental differences in both their nature and the philosophy involved in the evaluation and utilization of them.

3.3.2 The Binomial Model

Despite the fact that the Binomial Model is considered easier and more intuitive than the Black & Scholes Option Pricing Model it was developed after the birth of said model. The Binomial model can be used to solve both European and American options. In the Binomial model time to maturity is divided into a number of discrete intervals and it therefore fails to make a continuous valuation which is possible with the Black & Scholes model. This creates a difference in the end value between the two methods but this gap can be minimized by increasing the amount of intervals that the Binomial model utilizes. An advantage with the Binomial model is that it can span a large range of real option applications, including those with some complexity. The approach is also considered comfortable for some users because it retains the appearance of discounted cash flow analysis. The uncertainty and consequences of contingent decisions are also laid out in a natural way which generates an easy to grasp visual image. In short the Binomial option valuation model therefore has flexibility and can allow the user to show the basic steps in the option valuation to curious managers.

3.3.3 Black & Scholes Option Pricing Model

This is a method that utilizes partial differential equations and defines the evolution of the value of the option in terms of the value of the underlying asset, its volatility and the risk free rate of return. This method is common when valuing financial options and is easy to apply within that limited framework. It relies on some fundamental assumptions that often need to be relaxed in order for the model to be useful when valuing real options. However, the Black & Scholes Option Pricing Model is well suited for simple real options, in other words those with a single source of uncertainty and a single decision date. The Black & Scholes model assumes that:

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80 Brach (2003) *Real Options in Practice* p 45
83 Amram & Kulatilaka (1999) *Real Options* p 36f
84 Ibid. p 109
86 Amram & Kulatilaka (1999) *Real Options* p 36
• The option may be exercised only at maturity – i.e. it is an European Option.
• There is only one source of uncertainty – rainbow options (options with multiple underlying assets) are ruled out and the interest rate is assumed to be constant.
• The option is contingent on a single underlying risky asset therefore compound options are ruled out.
• The underlying asset pays no dividends. No leakage is accepted.
• The current market price and the stochastic process followed by the underlying are known (Observable).
• The variance of return on the underlying is constant through time.
• The exercise price is known and constant. 87

It is important to note again that the Black & Scholes formula is only possible to apply on European type options and therefore is restricted to simple real option cases.

3.3.4 When should the ROA be used?
Doing business sometimes requires making decision with elevated levels of uncertainty. Managers are aware of the fact that it might be necessary to change the course of a project during its lifetime but the standard financial tools do not work under those conditions. 88 As we come to accept the value of flexibility and the problems with traditional budgeting techniques we once again need to revisit the theory-practice gap discussion in order to explain the benefits that the managers will receive from adopting the real option approach. ROA is not just a budgeting method it is also a philosophical approach to business which probably has been around for a long time and just recently been articulated in a more methodical manner. 89

As the managers still heavily rely on traditional budgeting techniques they miss important strategic opportunities because tactics, strategy and valuation are considered separately. Signs of this can be found in the discussion about traditional capital budgeting. In contrast the ROA helps the managers to form a unified budget that integrates valuation and decision making across different levels of uncertainty and over

88 Amram & Kulatilaka (1999) Real Options p 4
time. This is so because the ROA does not solely ask for cash flows and interest rates it also addresses many of the same questions as corporate strategy. The first thing to make clear before the ROA is drawn on is to make sure that it is really needed. So when should the ROA be brought into play? Amram & Kulatilaka answers that an analysis utilizing the ROA should be applied under the following conditions:

- When there is a contingent investment decision.
- When the uncertainty is large enough that it is sensible to wait for more information, avoiding regret for irreversible investments.
- When the value seems to be captured in possibilities for future growth options rather than current cash flows.
- When uncertainty is large enough to make flexibility a consideration.
- When there will be project updates and mid-course strategy corrections.

3.3.5 Types of Real Options

As we now have defined what an option is we need to learn how to recognize and utilize them. In the financial world this is an easy task but in the realm of capital budgeting just as in real life it can be quite difficult to see what options exists and how to make use of them. The different real options presented in the literature vary somewhat from author to author. Brach discusses six major managerial options which he summarize with their real option counterparts; the option to defer, the option to abandon, the option to switch, the option to expand/contract, the option to grow and the option to stage. Amram and Kulatilaka points in their book to only five major option types namely; waiting to invest options, growth options, flexibility options, exit options and learning options. Consequentially depending on how the major real options are defined the possibility of overlapping definitions between the literature sources seems to be great. Some fundamental options are modelled after specific financial options, subsequently the understanding and application of at least the most basic of financial options is beneficial when studying the real option approach. With the basic financial options in mind it is easier to see the similarities between the differently named options and spot the simpler real world options. In order to explain and make the connection clearer between previous mentioned real option categories and basic financial options.

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90 Amram & Kulatilaka (2001) *Real Options* p 6f
91 Ibid. p 24
92 Brach (2003) *Real Options in Practice* p 67
93 Amram & Kulatilaka (1999) *Real Options* p10f
the combinations are listed below.

<table>
<thead>
<tr>
<th><strong>Brach’s major managerial options</strong></th>
<th><strong>Type of financial option</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The option to Defer</strong></td>
<td>Wait until further information reduces market uncertainty.</td>
</tr>
<tr>
<td><strong>The option to Abandon</strong></td>
<td>Dispose of an unprofitable project.</td>
</tr>
<tr>
<td><strong>The option to Switch</strong></td>
<td>Change input/output parameters or modus operandi.</td>
</tr>
<tr>
<td><strong>The option to Expand/Contract</strong></td>
<td>Alter capacity depending on market conditions.</td>
</tr>
<tr>
<td><strong>The option to Grow</strong></td>
<td>Entertain future-related opportunities.</td>
</tr>
<tr>
<td><strong>The option to Stage</strong></td>
<td>Break up investments into incremental conditional steps.</td>
</tr>
</tbody>
</table>

*Brach’s major managerial options. Figure 4*

| **Waiting to invest options** | Expresses the value of waiting with an investment. Equal to the option to Defer. |
| **Growth options**           | The option to take on follow-on projects if the initial investment was successful. Equal to the option to grow. |
| **Flexibility options**      | Showing the value of flexibility in a future process such as switching production. Equal to the option to Switch and to Expand/Contract. |
| **Exit options**             | The valuation of the option to end a project. Equal to the option to abandon. |
| **Learning options**         | Calculating how each stage of the project creates better information about the total profit and options to make later investment decisions. Similar to the option to Stage. |

*Amram & Kulatilaka’s major real options. Figure 5*

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94 Brach (2003) *Real Options in Practice* p 67ff
At a glance the similarities between the option to grow and the option to expand/contract might be striking but these options vary intrinsically in the fact that the growth option values the option to grow after an initial investment in for example a new market, a new product line etc while the expand/contract option values the option to alter the output from an already existing project in response to external factors.\textsuperscript{96}

Besides these fundamental options there are more complex ones like the compound option, which is composed by several types of options that arise during the sequential progress of a project. Compound options are considered to be an option on an option.\textsuperscript{97}

3.3.6 The methodology suggested when applying ROA
Up until now I have presented the theories that the financial option valuation rests upon and briefly looked at the different real options types. We have seen that the ROA rests firmly on the financial theory from which it was derived but which methodology and what components do you need in order to utilize this budget method? Copeland and Antikarov describe the overall process when applying ROA as a four step sequence.\textsuperscript{98}

Step 1
Here the base case present value is computed without flexibility using DCF valuation model. The objective for this process is to compute the base case present value without flexibility at t=0. This produces the traditional present value as it is described in for example a NPV calculation.

Step 2
Model the uncertainty using an event tree. The objective here is to understand how the present value develops as time passes. We still do not take into account the value of flexibility. That is to say that the value is equal to the value from Step 1. The estimation of uncertainty is done using either historical data or management estimates as input.

Step 3
In the third step the managerial flexibilities are identified and incorporated which results in a decision tree. The objective is to analyze the event tree to identify and incorporate managerial flexibility in order to respond to new information that might appear during the project. In this phase flexibility is incorporated into the

\textsuperscript{95} Amram & Kulatilaka (1999) \textit{Real Options} p 108
\textsuperscript{96} Brach (2003) \textit{Real Options in Practice} p84ff
\textsuperscript{97} Ibid. p 95ff
\textsuperscript{98} Copeland & Antikarov (2001) \textit{Real Options- A Practitioners Guide} p220
event tree which transforms it into a decision tree. The flexibility alters the risk characteristics of the project and therefore, changes the cost of capital.

**Step 4**

In the last step the real options analysis is conducted. The goal here is to value the total project using a simple algebraic methodology and an Excel spreadsheet. ROA will include the base case present value without flexibility plus the options (flexibility) value. Under high uncertainty and managerial flexibility the option value will be substantial.

This step by step approach gives the user a guide of how to utilize the ROA efficiently but is in my eyes not detailed enough to present a complete checklist for an implementation. If we look at step three we see that this is where the real ROA philosophy comes into play. Amram & Kulatilaka shows this process in a figure presented below (it has been simplified for this thesis).

![Step 1: Identify and Define Real Options](#) ![Step 2: Establish the Mathematical Representation](#) ![Step 3: Choose Method of Solution](#) ![Step 4: Choose Option Calculator](#)

The ROA process according to Amram & Kulatilaka. Figure 6

I find that their model can be applied on or used as a complementary to Copeland & Antikarov’s previous model and in that case from step three onwards. Amram & Kulatilaka focuses here on the rather broad step two in which the method of solution is chosen. This is an important part of the real option approach. The methods available are Dynamic Programming, Simulation Models and Partial Differential Equation (PDE). PDE relates the continuously changing value of the option to observable changes in market securities. Choosing PDE gives the possibility to use calculators that utilizes the Black & Scholes formula to do an Analytical Solution (e.g. Black-Scholes), an Analytical Approximations and/or Numerical Solutions (e.g. Finite Difference Method). An

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99 Amram & Kulatilaka (1999) *Real Options* p 108
analytical solution is a direct function of the inputs and is easy and fast. Analytical solutions calculators that fit the specific case that the ROA practitioner has in mind can be hard to find and modifications might be needed. The Numerical Solution is used when it is impossible to use an Analytical Solution and convert the partial differential equation into a set of equations that holds true over short time intervals.\footnote{Amram & Kulatilaka (1999) Real Options p 109f}

The Dynamic Programming method solves the problem of how to make optimal decision when the current decision influences future payoffs. This method handles complex decision structures as well as complex relationships between the value of the option and the value of the underlying asset well. Solving these problems and so called leakage of value in the option calls for the Binomial option valuing model.\footnote{Ibid. p 110f}

The final method is the Simulation Modelling. Simulation models roll out a high number of possible paths of evolution of the underlying asset from the present to the final decision stage of the option. It can solve path-dependent option in which the value of the option depends not solely on the value of the underlying asset but also on the particular path followed by the underlying assets and the Monte Carlo simulation method is often practiced in this case. This method is not well suited for American options, nested options or sequences of options because each possible decision starts a new path and therefore complicates the scenario.\footnote{Ibid. p 111}

For the user the choice stands between those models that fit the option or options that he or she is facing. However it might be fitting to make a quick test run with one of the simpler or standardized types like the Analytical solution to get an idea of what the user is facing. Amram & Kulatilaka suggests that if you accept the relaxation of some of the assumptions behind the Black-Scholes model you should choose an Analytical solution if one is available because it is fast and easy to use. In the case where the user is stuck with sequence decisions, multiple sources of uncertainty or rather complex options you should leave the Analytical solution behind for the other two alternatives. Other important factors to consider are the ease of use, transparency and ability to reuse code in the calculator. This will make the process easier to repeat and adopt for future use.\footnote{Ibid. p 125}
3.3.7 Volatility and risk

Volatility, standard deviation of expected outcome, shows the uncertainty inherent in an option and consequently gives a hint about the value of it. In the case of a financial option the value the option depends on the uncertainty of the stock price (the underlying asset) which is estimated as the standard deviation of the stock’s return. A real option has often a more complex relation between the underlying and the option value but follows the same principle.\textsuperscript{104} For volatility to occur there is a need for a time span during which the price of the underlying may fluctuate. In the case of stocks the periods usually are 30 or 90 days but for a real option there is a need for the historical time period to be as long as the time to maturity of the option. The basis of the calculation of the volatility is calculated from the continuously compounded returns of the underlying asset. The volatility itself is then calculated by the use of a normal standard deviation formula.\textsuperscript{105}

For real options the volatility is calculated from historical data in the same way as in the case of financial options. However it is also possible to use the implied volatility of any tracking financial device such as option contracts that are traded on the underlying asset.\textsuperscript{106} For this thesis I have used Amram & Kulatilaka’s definition of risk as the negative economic effects of a firm’s exposure. However often the concepts of risk and volatility seem to be confused and referred to as a negative outcome of something. My conclusion from that is that this form of risk is similar to what often is referred to as downside or negative risk. The total risk that an investor or manager faces consists of two parts namely private and market risk. The first is diversifiable and the other is not. The private risk has to be projected on the basis of historical data or some form of estimation however the data available and the data that would be preferred varies depending on the application.\textsuperscript{107} Risk may also be divided into reversible risk and irreversible risk of which the later kind is frequently occurring when real options are concerned. Risk itself has just as volatility connection to time and do rise significantly as the timescale increase.\textsuperscript{108} For something to be perfectly reversible the company has to be able to regain the present value of its initial investment whenever it wants to, without any transaction costs. Hence, all things being equal, the lower the reversibility of an investment decision, the greater the gain will be of delaying the investment under

\textsuperscript{104} Amram & Kulatilaka (1999) \textit{Real Options} p 16f
\textsuperscript{105} Ibid. p 213
\textsuperscript{106} Ibid. p 100
\textsuperscript{107} Ibid. p 100
\textsuperscript{108} Boer (2002) \textit{The Real Options Solution} p 219f
The inherent volatility of an asset drives the option value for both financial and real options but it is the ability of the management to respond to this factor in order to enable an organization to take benefit from upside potential. Information plays a key role when responding to risk or volatility in the underlying asset. Even faced with perfect information the managers need to have an ability to exercise the options even if it means to abandon a project.109

### 3.3.8 Shortcomings of the ROA

The math behind the Real Option Approach is sometimes considered to be technical and cumbersome and this is a notion that must be overcome in order to increase the adoption of this budgeting technique.111 There seems to be plenty of computer aids that the managers can utilize and instead of being concerned with the difficulties of differential equations the managers should focus on the philosophy that lies behind the real option approach to capital budgeting.

For the academic or advanced user there are some inherent problems in the ROA that should not be ignored. These problems can be tracked back to the financial theories that are the building blocks of the ROA. The main problem is the possibility of tracking errors which are caused by leakage of value from the underlying asset, the existence of a basis risk and private risk.112 A tracking error occurs when the *Law of One Price* is obstructed by one of these factors and means that the constructed tracking portfolio takes another value than the option really has. This contradicts the basis for the option pricing theory that assumes that there is no possibility to make arbitrage positions between the tracking portfolio and the underlying asset.113 The size of the tracking error is decided by two real asset features namely the costs of tracking and the quality of the tracking.114 Leakage in value is something that is likely to occur when handling real assets and this must be adjusted for in the real options model otherwise the calculated value will not reflect the correct value. Sources of leakage include explicit positive cash flows such as dividends, rental, interest, license or royalty income, explicit negative cash flows such as storage costs, taxes, licensing and royalty fees.115

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109 Buckley & Tse (1996) *Real Operating Options and Foreign Direct Investment* p 310
110 Brach (2003) *Real Options in Practice* p 103ff
111 Teach (2003) *Will Real Options Take Root?* p 1
112 Amram & Kulatilaka (1999)*Real Options* p 54
113 Ibid. p 32f
114 Ibid. p 52f
115 Ibid. p 127
ROA shows the values of options that might have been hidden by previous budgeting methods but there is the possibility that these options might have remained hidden because of their inherent low value. The mentality or philosophy behind the ROA is supposed to have existed for a long time and much of the literature points out that managers frequently are good because they can utilize flexibility and take chances when they arrive. Hence good companies and managers inherently should have been good at utilizing flexibility. What ROA will bring to these potential users is, as described throughout the reference literature, a possibility to quantify the value of their options.

Furthermore, in order to possess a possibility to utilize a range of options during a specific time frame the company probably must set aside otherwise free resources in order to keep these options open. This option cost, which might be considered a sunk cost in the financial world because of the nature of financial options and derivatives, should on basis of the alternative cost argument be kept as low as possible and the nature of the resources reserved should be of highest possible flexibility. This in order to maximize the value of said resources and investments.

3.4 Previous studies of ROA applications on FDI

The basic idea behind the application of FDI on ROA is to add further breadth and depth to the existing models of FDI.116 By doing this researchers want to correct the fact that in present FDI theory the value of flexibility is ignored in the same way as traditional capital budgeting techniques. So what happens when the value of options are added to the normal FDI thinking? Buckley & Tse gives four different examples comparing licensing with FDI, exports with FDI, selling out with Joint Ventures and Organic expansion with acquisitions. The conclusion from these examples is that the possibilities of successful FDI leading on to additional opportunities may be so high – especially where there is a noteworthy explicit advantage or market imperfection linked to the investment – that the value of the real operating option is significant. Therefore the contribution of real options theory might be significant when trying to explain preferences of FDI over exports, licensing or selling technology or the right to brands in foreign markets. ROA also makes it possible to model the loss of value through trade conflicts or barriers of entrance for latecomers which may put an early investment in a positive light because it opens up options that the company would not possess.117

116 Buckley & Tse (1996) Real Operating Options and Foreign Direct Investment p 304
117 Ibid. p 308f
In his books Buckley discusses the combined approach in detail and seems to take a stance closer to the individual firm or manager than in the previous research done together with Tse. Buckley considers the real option analysis as a reinforcement of the normal DCF evaluating processes and repeats the message of good managers being good because they pursue policies that maintain flexibility on as many fronts as possible and maintain options that promise upside potential. Buckley continues with putting forward the central argument for why a real options approach is superior to a standard DCF analysis. The reason being that basic DCF analysis lack flexibility and only give rise to a basic case set of incremental cash flows, therefore being less than perfect in simulating the real world. Buckley sees international investment as an example where the ROA should be applied since it is something that contains considerable upward potential but also great financial risk. Furthermore the firm conducting international investment possesses flexibility in terms of its course of action which in its turn is depending on the outcome of previous stages and factors that are unknown at the time of the start of the project. This is something that is very similar to the perspectives presented by the fundamental research about real options done by such authors as Amram & Kulatilaka et cetera. For Buckley one key issue when valuing foreign direct investment is, just as in the case with normal investment, the taxes that will be levied on the investment and on the cash flows that it will generate. The present value of a project is to the parent company a function of the future cash flows that are remittable back to it. However for projects conducted overseas there may be cash flows which are blocked by different type of exchange controls. These blocked cash flows will not contribute to the wealth of the shareholders. In addition the possibility exists that a host government may impose even stricter exchange controls sometime in the future.

Consequentially this leads to a need to view foreign direct investment from two different angles namely incremental project cash flows versus incremental parent cash flows. In other words which and how much money that makes its way back to the parent company. Buckley argues that for the multinational company it is only the remittable, incremental parent cash flows that matter. Buckley continues with stating that calculations of the parent cash flows should begin with an analysis of overseas cash flows in local currency, at local rates of inflation. The calculations should then be

118 Buckley (2004) Multinational Finance p 441
119 Ibid. p 441
120 Buckley (1998) International investment p 239
converted to home currency flows using expected future exchange rates, allowing for home taxes and then discount at a risk adjusted rate which allows for anticipated inflation in the home country. Preferably this estimation should be done utilizing a forward rate or a purchasing power parity analysis or both.  

Several scholars have applied the ROA on FDI in different types of tests scenarios or case studies. Theoretical tests have been conducted by Pennings & Lint, Pennings & Sleuwaegen, Chen & Funke, Nordal and Waldron. Andrew Vonnegut has conducted a small number of case studies which confirm that firms in FDI scenarios tended to behave along the lines predicted by ROA. The result suggests that ROA manages to pinpoint some of the forces that drive up hurdle rates in FDI in emerging economies. The real option approach gives better understandings of possibilities that exists for the companies and increase the value of projects with previous unvalued options. In addition it can be used by policy makers to pinpoint what is needed in order to attract capital to their countries through lower of hurdle rates. These previous analysis shows that ROA is a tool that can explain micro level events connected with uncertainty and investment choices through a mathematical language suited for macroeconomic analysis.

Chen & Funke and Nordal focuses on working out the function of country specific risk and defining this risk. Nordal sees country risk as a downside risk but does not connect this risk to the volatility of the underlying in the way it is done in other ROA literature he therefore wants it to be added to calculations through a mathematical function based on country risk indices. Chen & Funke creates a model that connects policy uncertainty, option value and the timing of FDI at firm level with the goal to clarify if and when a company should conduct FDI.

When applying a ROA analysis to a FDI problem Buckley agrees with Amram & Kulatilaka that the decision tree method, more properly referred to as the Binomial model, is more applicable to international investment situations than the Black and Scholes approach because the application limits of Black and Scholes are too tight and

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121 Buckley (1998) *International investment* p 240
122 Vonnegut (2000) *Real option theories and investment in emerging economies*. p 82ff
will be breached. However as a method of approximation it might be considered useful because of the simplicity of its application.\footnote{Buckley (1998) \textit{International investment} p 276} From the material I conclude that there seems to be no need to do any adaptations of the ROA when using it together with traditional foreign direct investment theory. Instead they seem to complement each other and the traditional FDI theory shows several clear cases where option theory would be applicable.
4 Exemplification

In this chapter I wish to exemplify how the ROA puts a value on flexibility, eliminates subjective factors that might influence the project value and monetarily recognizes future problems and possibilities. The calculations behind these examples are available in appendix 2.

4.1 Basic Scenario

In this scenario an imagined mid-sized Swedish company in the robotics and automation business is considering entering PRC. It needs a factory in mainland China to serve future regional demand. The company produces solutions that need manufacturing and maintenance relatively close to the customers and they believe that there is a large growth potential in mainland China. I have done a short country profile which is available in appendix 1. The main conclusion from this profiling is that the sheer number of factors that the manager faces on all level of the investment decision makes it likely that managers overestimate the risks of an investment much in the way Johanson & Vahlne predicted.

In my scenario the managers know that one production site will not be sufficient to cover the whole country so if the first project performs well they will increase the number of sites. From experience the company’s managers know that setting up a production facility in a foreign country is a time-consuming process and that they will need to have patience before results show. However they also acknowledge that there might be problems in the future and want to be able to shut down and pull out quickly. The company will use internal funds and borrow from their main bank in Sweden in order to finance the production launch. It is therefore safe to say that an investment into the PRC would be likely to have a higher hurdle rate than a domestic or local investment.

The example provides us with three obvious options; a growth option, a learning option and an option to abandon the project. Besides these there also exists the option to alternate production volumes once the production site is up and running but this option will be left out of this study. To keep the door open for a speedy retreat the managers decide to rent space in an available industrial park in one of the economic zones. They also decide to try to lease as much equipment as possible and use a proportionally large number of consultants and subcontractors. Renting space will keep down the initial negative cash flows but it is just as with the other choices not the superior cost strategy
in the long run. The manager also decides to put a higher than average hurdle rate for the project of 20%. The forecasted cash flows show that the project will not pay back within the time limit and therefore the project is shelved.\textsuperscript{126}

We now take a step back and look at the case again and this time recall the theories that were presented about foreign direct investment. The first thing we see is that the company now is standing at a major crossroad where they are considering leaving exporting behind and move fast ahead to a production plant, skipping three steps in Johanson & Vahlne\'s model. It might just be that the company should wait with a full launch of production and follow the steps in the model in order to launch slower or learn and cut the cost of a future production launch. The final value of calculations done in RMB should then be exchanged into Euro or SEK through forecasted exchange rates however I have decided to skip this as well as calculations on trade barriers such as taxes and duties. Hence all cash flows are considered directly remittable which would not be the case in reality.

4.2 The Learning Option

The first option I want to exemplify is the learning option. The managers are aware that it will take time before things run smoothly but they lack the tools to express this knowledge in budgetary terms. It is therefore important to show the value of learning from this project. We start by defining this option stricter. Learning from this project will reduce the cost of a second launch both through a shorter learning curve and through the knowledge if it is necessary with the same high flexibility that the managers are aiming for with this first launch.

- Shortening of the learning curve is based on earlier launches and considered to be worth about 10% of the initial launch cost.
- Lowered cost through cutting down on subcontractors etc is considered to be 35% of initial launch cost and 25% of annual spending.

Since the Binomial model is proposed as the superior alternative for complex options and this type of options is considered to be complex I decided to use the Binomial model. The option itself is considered to be American since it has positive and negative cash flows before the expiry and the inputs will be as follows:

\textsuperscript{126} See Appendix 2
- $A$ or the current value of the underlying asset: The value of the project is equal to the value that it will have at its final stage when it is fully up and running. In other words, the underlying asset will be a fully operational product facility in PRC.
- Leakage in the value that occurs between decision points: The leakage from this project is considered to be the negative and positive cash flows up until the end of the 5 year period which means that we have an annual leakage which is not constant. However in order to make calculations easier leakage is considered to be at a constant rate.
- $\sigma$ or the volatility of the underlying asset (market priced risk): The company is not noted on any stock market which denies an easy way to calculate the volatility. Instead the managers decide to base the volatility on an analogous study and use the volatility of publicly traded companies in the same business in the PRC. The result is an annual volatility of 30%.\(^{127}\)
- $r$ or the risk-free rate of return: This should be based on where the capital is obtained. In this case the risk free rate is considered to be equal to a short term bond with 5% interest. It is also possible to use the WACC or weighted average cost of capital for the actual project.

The first basic DCF calculations show that the learning option the company holds is worth 13.7 million RMB and would bring this investment *in the money* so to say. However the value is only there if the option is exercised and the next plant is built. The fold-back shows that the chance that the project will be profitable is close to 50% and this should be pointed out. The overly negative values in the rollout are possible but since this is no financial option and the negative cash flows that are calculated are pure investment cash flows the company can not lose more than the invested amount and therefore should ignore the overly large losses shown. This conclusion points out that I do not believe in a normal distribution of the outcome of this project and that it might be preferential to recalculate with another distribution.

### 4.3 The Growth Option

The size of the Chinese market has grown considerably since the opening in the end of the 1970ths however the demand that is seen today is nothing compared to what is expected in the future. The growth potential of the PRC internal market is huge to say

\(^{127}\) This number is purely fictional.
the least. But translating market growth into sales growth is not easy and competition is already fierce. The managers will only know if its worth to expand further at the end of the five year term they have set. The value in a growth options comes from an initial launch investment and is for me similar to a European call option. The initial investment gives the company an option to further grow on that market. In this example the Black & Scholes formula would be enough to give a good estimation of the value of the growth option and the inputs are similar to the previous case but the calculations only involve year one and the NPV of possible sales outcome for 5 years ahead. So what is the underlying asset in this example? Amram & Kulatilaka\textsuperscript{128} discusses the evaluation of start-ups and I suggest that the underlying asset is, just as in the case of the valuation of a start-up business, the current value of the company’s opportunity. To get this value the sales has to be forecasted and the average market value-to-sales of established publicly traded companies in the same business is calculated. For the forecasted sales I use the previous five year forecast and the average value-to-sales is set to 2 creating a value of the company of roughly 17.3 million RMB. The final value of the growth option is 0 (it is not suggested that it should be exercised) when calculated with the Binomial Model and 1.7 million RMB when calculated with the Black & Scholes formula. When comparing with the other numbers it is important not to use the sales data twice. What I mean is that it is at a glance possible to use both the value of the forecasted growth option which contains the forecasted sales numbers and the total NPV of the project which contains same forecasted sales numbers. To avoid this one has to calculate the NPV without the sales income. The pretty bad results reflect the low sales forecast and non-existing growth of the simplified sales prognosis. A sensitivity analysis shows that at an annual sales growth of 28% the option value would cover the option cost within five years.

4.4 The Option to Abandon

This option is the one that the managers seem to value the most but this far it is only the cost side of this option that is apparent in the budget. It is largely the cost for this option that makes the launch unattractive so there is a need to calculate the value of this option. This option is based on a notion that sometime in the future this company will need to pull out and do it rather quickly. I compare two scenarios; in the first case the company has a high flexibility setup with a lower cost of exercising the option; in the second case the company will in addition to the option price need to pay the cost of one

\textsuperscript{128} Amram & Kulatilaka (1999) \textit{Real Options} p 145
year of operations before pulling out. The setting for this comparison is somewhat unrealistic but necessary in order to keep things simple. It is reasonable to argue that this is an American option with a five year length. The price of the option which in my eyes is the difference in cost at the first year for an American option and the annual acquisition price (price difference for that particular year) is the price for the European option. The value of the underlying is set to the value of continuing. The leakage is considered constant as before and the volatility is the same as in the first option. The result is that the value of the option for the high flexibility case is 2.2 million while the low flexibility scenario has a negative option value or in other words should be shut down as soon as possible.

To sum things up the option value of 17.7 million from all of the three options brings even the first budget to a positive result. The option to learn has the highest value but this value can not be realized without a second launch. The growth option and option to abandon has much lower value but can be realized within the time span of the first budget but they do not influence the project value much. The conclusion from this exercise is that the with the option value added the project show a positive value and should therefore be launched but considering that in the basic scenario there is no sales growth and a 20% hurdle rate I recalculated with a 10% annual sales growth and risk neutral interest rate and reached a 15.1 million RMB surplus with the option values included. The modified budget is in its fundamental form not profitable but it is enough to add the growth option value and the value of the option to abandon to reach a positive result.
5 Discussion

Mister Rich Person:

“I used to surround myself with yes men... now, all I can afford are these maybe men.”

Scott Adams, Bring me the head of Willy the mail boy. (1996), United Feature Syndicate, USA

I want to start with summing up what the theories that I have presented provides us with. The FDI theories give us a basic understanding of how companies act and explain where and when the individual manager can expect to encounter possible options. This is important knowledge that, on the basis of historical data, gives the manager the possibility to prepare for uncertainty by increasing flexibility. However, if the manager stays with the older capital budgeting techniques the manager will be unable to show the value of these actions as efficiently as if the real option approach was utilized. Investors should not be satisfied with managers that does not use budgeting techniques that are not up to date and subsequently does not maximize the shareholders profit. Throughout the literature ROA is described a valuable tool that will make it possible for managers to do just this: to show the value of the flexibility that the organization possesses. However the problems that ROA inherit from the financial theories that it is based on should not be ignored. The tracking error is the main problem but adjustment of this error is more of a question of resources than of manager skills. Infrequent trading, low liquidity, cost of monitoring, coordinating and documenting together with infrequent observability are factors that affect the possibility to keep the tracking tight.\(^{129}\) Most of these factors are obviously easy to correct with an increase in resources or a shift of content of the tracking portfolio. The low number of factors that needs to be assessed for a real options analysis is also one of the advantages of this budgeting technique. Using the risk free rate of return as basis, finding the volatility of the project from historical data or corresponding studies and applying this on the DCF calculus is to me simpler than trying to assess, create and motivate a subjective number as a hurdle rate for a project. Volatility is connected to the statistical data of a specific underlying asset and therefore a manager with experience and knowledge about that particular asset should feel that this objective data reflects the managers subjective

\(^{129}\) Amram & Kulatilaka (1999) *Real Options* p 58
experience. An example could be a manager who experienced the oil shocks and therefore has an understanding of oil price volatility. In this case the volatility will be, if calculated properly, the piece in the ROA that connects to the manager’s subjective experience through objective numbers. The problem that remains is to choose the right underlying.

However risky a FDI project might seem, Buckley & Tse showed that when the value of the options that a company possesses is added the view on a range of projects change significantly. Reviewing the ROA studies of FDI in general and Adrian Buckley’s work in particular I get the feeling that just staying with the methods and examples stated in Buckley’s *Multinational Finance* would not suffice. The merge of ROA and a FDI perspective should not stop with just cash flow calculations but also, as among others Amram & Kulatilaka states, involve and influence managers at all levels. I personally doubt that calculating the value of cash flow variations and connecting these to options will increase the likelihood that there will be actual flexibility at the level where it is most needed. Both the FDI theory and the presentation of the investment situation in the PRC show that the factors that the managers or investors need to enumerate and assess is quite overwhelming and the possibility for errors such as risk overestimation is high. As it was shown in the examples a manager that uses the real option approach and relies on the risk free rate of return as basis for calculations decreases the possibility that a project is rejected or accepted because of subjective speculations about hurdle rates. Subjective factors that breed in the psychological distance presented by Johanson & Vahlne. The material dealing with capital budgeting confirmed this and showed how different factors influence the choice of budgeting method and indirectly influence the selection of projects. When judging a project in a volatile investment environment the subjectivity of both the manager and the budgeting tool should be minimized.
In figure 7 I try to visualize the risk related costs involved in the calculations when using a traditional budgeting technique and when one uses the ROA. In the traditional approach we have a basic risk free rate to which we add the cost of flexibility for the specific project. To the project hurdle rate a subjective number is added which is according to the FDI literature based on country risk, psychological distance and the project specific risks perceived by the manager. However when applying the ROA on FDI I argue that country risk is a factor that is obsolete. The reason for this is that while the factors included in the country risk might have a large impact on a specific project most of the factors should already be included in the volatility assessment of the underlying asset and the risk free rate, especially when procuring or transferring assets in the local currency. If country risk was included it most likely contains multiple factors that already are accounted for in the ROA framework and would therefore be added again with detrimental effect on the project profitability.

When it is possible to eliminate the guessing associated with subjective factors such as country risk the managers can focus on is the project specific risk and the flexibility cost. If there is a fear of government actions such as expropriation or increased tariffs this should be reflected on the strategic side of the ROA analysis and not through subjective elevation of hurdle rates. The cost of keeping a project open for a fast pull out of a
country is in this way only included once.

If we go back to the model of reality that I presented in the method chapter (Figure 1) I feel that it has worked for this study. With the knowledge gained from the literature studies I can flesh it out and verify the interaction between the separate areas. The result is a self-explanatory model in which the theories and factors are even more interconnected than what I perceived at first (See figure 4). The results from my study do create some implications that elevate the discussion above the original problem and purpose of this thesis. As stated earlier the ROA is described by some as a tool with its basis in the financial theory that lets the researcher catch up with the reality that managers face. However the link between ROA and the real asset world through financial theory is somewhat unstable. If one rejects duplication and the theory of one price the whole connection fails and ROA with it. But if we recall the four criteria that Copeland & Weston used for judging a capital budgeting technique and the fifth that Trigeorgis suggests I feel that at present ROA is to the best budgeting method available and far superior to most others. But let’s briefly speculate about what can be done in order to strengthen ROA.

Result of the theoretical framework. Figure 8

Financial markets are obviously already much closer to an efficient market state than physical asset markets but the theories for financial markets are through the ROA already present in the evaluation of real assets. So in order to give more credibility to
the ROA either the connections made within the theoretical framework of the ROA must be strengthened or the markets for handling physical assets and company risks must increase their efficiency. The conclusion might be a step away from deduction and a step towards speculation but with improved markets for real life assets risk or much more correctly refereed to as volatility would be estimated and traded to a more correct price than what is possible at present. This would be achieved through standardizing and increasing information, assessment methods and trading tools. Effective spot markets for all commodities including company projects is also needed. This would decrease the size of tracking errors and also further the basis for the law of one price. Such a development would undoubtedly increase the efficiency of the global economy through more effective resource allocation and would allow the model to influence the reality that it portraits.
A conclusion is the place where you got tired thinking.

*Martin H. Fischer (1879-1962)*

I start the conclusion with the quotation of Sun Tzu that I used on the front page of this thesis. Translated into English it reads:

*And as water has no constant form, there are in war no constant conditions. Thus, one able to gain the victory by modifying his tactics in accordance with the enemy situation may be said to be divine.*

In my eyes Sun Tzu expresses the essence of real option theory namely that the changing world around us demands of us to be flexible and adaptable and that the person that excels at this will be successful.

If we recall the claim that good managers are good precisely because they keep and promote flexibility, it is, as stated by some researchers, compelling to say that they in some way already have both a notion and understanding of the fundamentals of real option thinking. Hence one might be tempted to say that these managers do not need such a complicated device as the ROA is perceived to be. Nevertheless relying on gut-feeling and lacking the possibility to put down in financial terms what one perceives as the best alternative for one’s firm is obviously an inferior alternative. The impression I have got, based on the literature used for this thesis, is that implementing ROA in a FDI scenario is more of a mental and cultural challenge than a mathematical one. The unification of the foreign direct investment theory and the real option approach provides the user with much more than just the sum of its parts. The FDI macro perspective opens up a bird’s eye view which can be readily connected with hands on management and budgeting through the ROA. At the same time ROA has been shown to be useful as a tool for explaining micro economic event in a mathematical language that can be used in a macroeconomic analysis. Options do have a value but it is fundamental to be able to calculate the costs correctly and objectively, or else the most option laden budget alternative always will appear superior. The globalization process

_Suginou (2001) Compendium of Strategic Studies part one – Sun Tzu p 78_

Translation from kanbun into English is available in the book. The title of the original is *The Art of War* written by Sun Tzu in the 6th century BC.
is one thing that might put the pressure on companies of all sizes to adopt this new budgeting philosophy. As the competition grows fiercer even for middle and small scale companies the demand for more advanced and precise capital budgeting methods should increase. However considering how slow the adoption of other budgeting techniques has been it might take many years before the real option theory takes a definite hold on larger corporations and even longer before it trickles down to small and midsize companies.

The presentation of the PRC and FDI in general shows how difficult it is for the manager of a small- or mid-size company to avoid overestimating risks and put too high hurdle rates on investments in developing countries. ROA takes away much of the guessing and estimation when it comes to rates in budgeting and takes the user closer to an objective form of budgeting. The factors left to estimate are the fundamental cash flow analysis and the volatility of the project, in other words the private risk and its outcomes. These factors are the things the managers should know better than anyone else. ROA cuts down on the factors that the manager has to deal with and at the same time helps him putting down on paper the costs and benefits of managerial flexibility in the face of an uncertain world.

The problem for this thesis was divided into two statements followed by four questions. The conclusions I have gathered from the material processed is that the ROA is an attractive budgeting method for both managers and investors however there are several obstacles within a firm that slows down adoption of new capital budgeting methods in general and deductively ROA in particular. When it comes to the question of adjustment the model framework as such does not need adjustment in order to be applied efficiently on FDI scenarios it also does not need any adjustment when shifting investment targets. However since each investment should be considered as unique the binomial approach will need a thorough adaptation to each separate project. Quick estimations may be done with the Black & Scholes formula if the limitations of this approach are fully acknowledged. If the user does not want to build an option calculator from scratch there exist a variety of calculators which can be used for both types of evaluation models so the technicality of the approach seems to be the smallest challenge. Nevertheless it must be noted that the perceived level of technicality might hamper the spreading of this budgeting technique. For the manager the biggest adjustment is not of technical nature instead it is the mental and cultural challenge that seems to be most cumbersome. Learning a new way to think about and value risk, volatility and
flexibility is a challenge and this is probably what is holding this technique back.

Since this is a descriptive thesis my contribution is small in comparison to other types of academic work however there is knowledge contribution in this thesis. I present a visual comparison of the risk related cost and point to the need of better connection between reality and the financial theories used in ROA. The compilation of theories from three research fields that I present form a view of reality which explains the budgeting process and the factors involved.

During the work on this thesis I had many opportunities to evaluate the method used and contemplate other possible research paths. This literature study helped me to, within a reasonable timeframe gather and process a vast amount of material of which most was used in this thesis. However as stated in the method chapter it is important to pay attention to the fact that the material I found in general was not created with the same questions and views as the ones I wanted to test in this thesis. A real life case study of the budgeting process at two or more foreign direct investment projects with and without the real option approach would have been the perfect scenario for this study or a future study with similar theme. However in order to be able to do that there is a need for both more time and resources. Another possibility is to create a simulation of decision making in connection to budgeting within a game environment. This would cut down on resources needed but also take away some factors of reality such as organizational tradition and culture.

The purpose of this study was to describe and to some degree test the real option theory in connection to foreign direct investment. I feel that the first part of the purpose was reached but a more thorough test would have been possible if another method had been used. I relied on secondary data and based the discussion and conclusions on a normative approach which in itself does not give a definite answer in the same way as a more positivistic research method would have done. Testing of the theories through examples is not the best way to verify if the knowledge gained is useful especially since the scenarios are imagined. But in the spirit of positivism I might claim that I have strived to achieve a neutral position and that if the examples were to be repeated with other numbers the results would still be the same namely that options give an extra value in the face of uncertainty. However this is not the sole conclusion that can be made from the examples so this fact should not be stressed since it represent a simplistic view on real options and there definitely does not exist a need for testing this
claim. Personally I feel that the validity, objectivity and reliability of this literature study are acceptable but another research method and more critical studies of the real option approach would have had elevated them further.
Resources


Clark & Tunaru (2000): *Real Options and the Quantification of Multiple Political Risks* http://mubs.mdx.ac.uk/research/Discussion_Papers/Accounting_and_Finance/dpap_a&f_no5.pdf


Vonnegut A. (2000): *Real option theories and investment in emerging economies,* *Emerging Markets Review*, nr 1, p 82-100

**Newspaper articles (Chronological order)**

BBC 20 February 2006 *China sees end to power shortages*

Newsweek 25 October 2005 *Line of Defense*

DN 4 september 2005 *Kina har fått världens sämsta luft*

DN 3 september 2005 *Otillräckliga raffinaderier torrlägger mackar i Kina*

DN 26 december 2004 *Kineser ratar låglönejobb*

DN 20 december 2004 *Kinas familjepolitik mjukas upp*

BBC 8 January, 2002 *China's fearful Muslim minority*

**Internet**

OECD Country Risk Classification 22 October 2004

OECD Homepage 2005/01/03
http://www.oecd.org/document/49/0,2340,en_2649_34171_1901105_1_1_1_1,00.html

Sveriges Ambassad i Peking, *China Business Climate Report, 2004* 06 21
http://www.swedenabroad.com/pages/general___22757.asp
Lectures
Asian accounting seminar at Kyoto University, fall semester 2004. Hosted by Professor Tokuga Dept of Finance and Accounting Kyoto University, visited by PhD Matsumoto Toshifumi Doshisha University, Kyoto, PhD Wang Yu, Ryukoku University, at a seminar at Kyoto University, Japan 2004-11-23, All translated from Japanese by the author.

Tools
Black-Scholes Directly in an Excel Sheet, by Espen Gaarder Haug.
LatticeMaker www.investmentscience.com
Appendix 1 - Area description: People’s Republic of China

FDI in the Peoples Republic of China.

FDI towards the PRC is divided by the PRC in these following four groups:

- Wholly foreign owned ventures (WFVs).
- Equity joint ventures (EJVs).
- Cooperative joint ventures (CJVs).
- Joint exploration ventures (JEVs). 131

JEVs are usually formed between the Chinese government and foreign companies to explore offshore oil resources in China’s sea territory. The amount of this type of companies is negligible. CJVs is when a Chinese firm and a foreign firm work together on a specific project usually with the Chinese side contributing mainly with land or buildings and the foreign investor contributes with technology and capital. Profits are distributed according to a formula specified in their contracts. The CJV form of definition of FDI is dubious from an international standpoint and has in many cases been treated as EJVs. This venture type was important in the early years of primarily for investors from Hong Kong. 132

A short background

The PRC emerged as a foreign investment market in 1978 after the declaration of the open door policy by Chairman Deng Xiaoping. However it would take some time until the foreign investment took off. During the 1980ths the isolationist policies of the previous decades were rolled back and new legislation was passed both to stimulate FDI in PRC and to strictly control its influence. Notwithstanding the PRC remained a highly protected economy and was still in the early 1990ths aspiring self-reliance rather than full participation in the global arena. 133

Besides the open door policy the PRC adopted a system of special economic zones (SEZs) in which the economic rules were quite different from the rest of PRC. These areas enjoyed an upswing in almost all economical aspects and it was in these zones that the largest portion of the early FDI and governmental spending ended up. These zones were often located in the periphery of China so as to limit the inflow of negative foreign influence. The first zones were opened in 1979 close to Hong Kong. The administrators

132 Ibid. p 3
133 Shapiro, Behrman, Fischer & Powell (1991) Direct Investment and Joint Ventures in China p 12
of these zones had the possibility to grant FDI project direct access (cutting down on the otherwise excessive red tape around FDI projects) and among other incentives completely eliminated enterprise income tax.\textsuperscript{134}

During the 1990ths the foreign investment rose rapidly despite the 1989 Tianmen Square incident. In addition the accession to the WTO in 2001 showed China’s intention to further opening up its economy and the event marked a milestone in the history of the PRC. It took about 15 years of negotiations before PRC was accepted into the organization. The focal point in China’s commitment for joining the WTO was related to liberalising markets in the service sector, agricultural sector and tariff reductions. All these changes will increase the areas in which FDI is possible and relax the still complicated legislation around said activity. In short the environment for foreign investments in all forms even pure portfolio investments will improve.\textsuperscript{135}

The economy in PRC is marked by uneven regional development. The highest degree of modernization and progress can be found in the eastern coastal regions and it declines as one moves west into the continent. The poorest areas are subsequently Tibet (Xizang), Qinghai and similar western regions. As for now it is clear that west China holds the key to the nation’s economic growth and holds the prime target areas of foreign direct investment.\textsuperscript{136} The gap between the regions can to a considerable extent be deduced to the different degrees of openness towards foreign investment. East China is the major beneficiary of the rising foreign trade and investment that has stemmed from the open door policy.\textsuperscript{137} The major reasons to this difference in development lies in the following factors:

- Government Policy
- Geographic Location
- Natural Conditions
- Central Government’s Investments\textsuperscript{138}

The opening of the PRC offered two opportunities to the mostly Western investors: an expansion of the world economy with wider industrial integration and the opening of

\textsuperscript{134} Shapiro, Behrman, Fischer & Powell (1991) \textit{Direct Investment and Joint Ventures in China} p 63ff
\textsuperscript{135} OECD (2002) \textit{Foreign Direct Investment in China} 2002 p 148
\textsuperscript{136} Ibid. p 53
\textsuperscript{137} Ibid. p 54
\textsuperscript{138} Ibid. p 61
new opportunities for business in the PRC.139

Present situation
The first question when considering investment in PRC is what is the nature of the investment? Is the company aiming to serve the local market, an export market or even both? In the early years after the adoption of the open door policy the internal market of PRC was very small however the strong growth of the internal market has made many foreign companies to diversify their investment planning as the “sleeping giant” seems to be awakening.

The present GNP per capita is very low in comparison with more developed countries but if a growth rate of 5 percent per year can be maintained the GNP will double every fifteen years or so. The result will be an increasingly attractive market for consumption goods and an increased influence on the international community.140 However the PRC government is not satisfied with this and has put a growth target to fourfold the size of the economy between 2000 and 2020.141 This is something that we in the past year already have been made aware of by the increase in steel and oil prices. The high rise in these commodity prices have by many been contributed to the increasing demand in the booming PRC market.142 PRC is described by some as experiencing its industrial revolution with a high amount of investments in infrastructure and production facilities. This demand together with a high amount of exports has driven up the GDP. Trade is also a large part of GDP even when compared to other large economies. 143 The main attraction to all outsiders is the size of the potential PRC market. This seducing factor causes the investor to eagerly enter in an early phase.144 For me this shows a managerial faith in what the ROA formulate as growth options.

It is important to understand the motive behind the actions that the local and central government takes. Each government level is seeking to maintain a balance between attracting the foreigner, giving them greater leeway than has existed in the past for domestic enterprise, and at the same time protecting the community's interest. This

139 Shapiro, Behrman, Fischer & Powell (1991) Direct Investment and Joint Ventures in China p 1
140 Ibid. p 2
142 BBC, Mary Hennock, (2004) China’s coming out party 2004-12-21
143 Schwaag Serger & Widman (2005) Konkurrensen från Kina p 15f
144 Shapiro, Behrman, Fischer & Powell (1991) Direct Investment and Joint Ventures in China p 3
includes protecting the power and position of officials in the government and staying aware of the potential dangers of being “too close to the foreigners”.\textsuperscript{145}

The PRC is Sweden’s largest trading partner in Asia and a report published in 2004 concerning the business climate in PRC and Swedish direct investments showed that the surveyed companies’ revenues were 4.6 billion US dollars in 2003 and that they employed approximately 28 000 persons throughout the PRC. These companies had invested 1.8 billion US dollar in PRC, mostly in the eastern parts.\textsuperscript{146}

The paper \textit{Konkurrensen från Kina – möjligheter och utmaningar för Sverige} \textit{A2005:019} produced by ITPS (Institutet för tillväxtstudier) shows that PRC is a promising market also in the service sector and further states that there are large opportunities for small and mid size companies (SMC). Up until now most of Swedish direct investment has been done by larger corporations resulting in a lower than average presence of small and mid size companies of Swedish origin in the PRC.\textsuperscript{147}

However SMCs meet specific challenges when entering the Chinese market. In general they lack the funding and resources necessary for a launch. They have problems recruiting and face high costs for education of available staff. Other problems are high personnel turnover ratios leaving the SMC to rely on a few skilled key figures. The first years after launch are plagued by big losses. Barriers of trade are also a severe problem for SMCs along with counterfeit products. Two things that are particularly difficult to handle for small companies with little resources for legal disputes.\textsuperscript{148}

\textbf{Future risks and problems}

In comparison with other developing countries PRC is considered to be a safe country. The current country risk assessment of China by the OECD resulted in a grading of 2. This can be compared with Brazil (6), Mexico (3) or India (3).\textsuperscript{149} A country risk of 0 is the lowest possible. However there are several problems that the investor or manager should be aware of and even if I cannot summarize all of them in this thesis I will try to

\begin{flushleft}
\footnotesize
\textsuperscript{145} Shapiro, Behrman, Fischer & Powell (1991) \textit{Direct Investment and Joint Ventures in China} p 2f
\hline
\hline
\textsuperscript{147} Schwaag Serger & Widman (2005) \textit{Konkurrensen från Kina} p 71
\hline
\textsuperscript{148} Ibid. p 71f
\hline
\textsuperscript{149} OECD (2004) Country Risk Classification 2004-10-26
\hline
\end{flushleft}
give a short briefing below.

PRC’s demographic profile is changing rapidly due to the one child policy that was adopted by the communist party after the war. The population explosion was thwarted but another problem germinated, namely a quickly aging society. Before 2045 the percentage of the population that is 65 or more will have grown from 7 to 25 percent which will, just as in the western world, put pressure on society and business in different ways.\textsuperscript{150} However, there are already reports about the younger generation being less and less willing to accept low status jobs even though they face unemployment if they do not. Younger professionals have access to, if not through the whole internet but at least a major part of it, information about living conditions and sometimes even experience from abroad. In addition the one child policy is thought to have made especially the 1980ths generation to grow up to become more or less spoiled brats that are not as willing to take jobs in heavy or dirty industries.\textsuperscript{151} These factors together with the inflation is putting upward pressure on the cost of labour making the most highly developed parts of the PRC already to expensive for labour intensive industries resulting in firms already moving production to other low-cost countries.\textsuperscript{152} The result is a growing gap between the flourishing regions and the ones left behind. UN Development Program reports that the PRCs Gini coefficient is .45 which is above .4 which by experts is considered to trigger social upheaval.\textsuperscript{153} The public discontent showed in the more than 74 000 incidents of protests or demonstrations that took place in PRC during 2004.\textsuperscript{154}

Infrastructure in the larger industrial areas is good and offers nearly everything that can be wished for but this is not the case in rural areas. Same goes for energy supply where the electric supply has been stabilized\textsuperscript{155} while some provinces still experience shortages on different forms of energy, for example gasoline.\textsuperscript{156} The environmental effects of industrialisation are severe with both nature and people paying a high price. For example suffers the PRC now the consequences of relying on coal as one of its main

\textsuperscript{150} DN 20 december (2004) Kinas familjepolitik mjukas upp
\textsuperscript{151} DN 26 december (2004) Kineser ratar låglönejobb
\textsuperscript{152} JETRO (2001) Made in China p 107ff
\textsuperscript{153} Newsweek October 25 (2005) Line of Defense
\textsuperscript{154} Schwaag Serger & Widman (2005) Konkurrensen från Kina p 18
\textsuperscript{155} BBC 20 February (2006) China sees end to power shortages
\textsuperscript{156} DN 3 september (2005) Otillräckliga raffinaderier torrlägger mackar i Kina
energy sources as it has the most polluted air in the world.157

Besides these internal problems there are also problems of a more international aspect. Trade conflicts with US, Japan and EU together with other more delicate matters especially when it comes to the diplomatic connections to Japan makes it clear that there are several problems besides just the Taiwan conflict that needs to be solved urgently in order to make path for a smoother future development. Not to mention such internal problems as the Muslim minorities158 in the west struggling for more equality and the Tibet issue.

All these macro factors are important in themselves but it is hard for the individual to get a grasp of them and even harder to put numbers on them. ROA avoids this problem by trusting the market on the global risks and focusing on the private risk and opportunities. Most problematic for the managers might be the fact that what is shown on the balance sheet of business partners or even subsidiaries might not be true. During one of many discussions and lectures with Professor Wang Yu from Ryukoku University she stated the following:

There are sometimes big differences between what the company shows on its balance sheet and the real conditions. Implementation of reliable auditing is still to be desired. In my own experience a large share of the companies I have visited in China have problems meeting even the most fundamental of accounting standards. 159

This affects even the most fundamental part of capital budgeting namely the cash flow analysis and creates yet another risk factor which is hard to get around.

157 DN 4 september (2005) Kina har fått världens sämsta luft
158 BBC 8 January, (2002) China’s fearful Muslim minority
159 Wang Yu PhD. Finance Ryukoku University, at a seminar at Kyoto University, Japan 2004-11-23, Asian accounting seminar. Translated from Japanese by the author.
# Appendix 2 - Excel Calculations

## Basic budget

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investments</td>
<td>-20,00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs</td>
<td>-20,00</td>
<td>-5,00</td>
<td>-5,00</td>
<td>-5,00</td>
<td>-5,00</td>
</tr>
<tr>
<td>Sales</td>
<td>10,00</td>
<td>10,00</td>
<td>10,00</td>
<td>10,00</td>
<td>10,00</td>
</tr>
<tr>
<td>Net profit</td>
<td>-30,00</td>
<td>5,00</td>
<td>5,00</td>
<td>5,00</td>
<td>5,00</td>
</tr>
<tr>
<td>Total option value</td>
<td>-25,00</td>
<td>3,47</td>
<td>2,89</td>
<td>2,41</td>
<td>2,01</td>
</tr>
<tr>
<td>npv total</td>
<td>-14,21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Option Values for the Basic Budget

- **Option to Learn**: 13,75
- **Growth Option**: 1,76
- **Option to Abandon**: 2,23

### Total option value: 17,74

### Budget Npv in RMB: -14,21

### Basic, 20% Disc Rate + Option Value: 3,53

## Budget with 10% sales growth and with 5% discount rate

### Discount Rate: 0,05

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investments</td>
<td>-20,00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costs</td>
<td>-20,00</td>
<td>-5,00</td>
<td>-5,00</td>
<td>-5,00</td>
<td>-5,00</td>
</tr>
<tr>
<td>Sales</td>
<td>10,00</td>
<td>11,00</td>
<td>12,10</td>
<td>13,31</td>
<td>14,64</td>
</tr>
<tr>
<td>Net profit</td>
<td>-30,00</td>
<td>6,00</td>
<td>7,13</td>
<td>8,31</td>
<td>9,64</td>
</tr>
<tr>
<td>Total option value</td>
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<td>5,44</td>
<td>6,13</td>
<td>6,84</td>
<td>7,55</td>
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<tr>
<td>npv total</td>
<td>-2,61</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Option Values

- **Option to Learn**: 13,75
- **Growth Option**: 1,76
- **Option to Abandon**: 2,23

### Total option value: 17,74

### Budget Npv in RMB: -2,61

### 10% Growth, 5% Disc Rate + Option Value: 15,14
Learning option (Savings calculated for a launch in year 6)

<table>
<thead>
<tr>
<th>Values in million RMB (Renminbi)</th>
<th>RMB</th>
<th>Total value prognosis at year five</th>
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<tbody>
<tr>
<td>Agg. Savings on Initial Launch</td>
<td>0.45</td>
<td>e</td>
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<tr>
<td>Sum of Annual Savings</td>
<td>0.25</td>
<td>T</td>
</tr>
<tr>
<td>total savings</td>
<td>-13.75</td>
<td>σ</td>
</tr>
<tr>
<td>% savings of total value of present project</td>
<td>118%</td>
<td>A</td>
</tr>
<tr>
<td>r</td>
<td>5%</td>
<td>u = e σ</td>
</tr>
<tr>
<td>Value of option to learn</td>
<td>13.75</td>
<td>d = 1/u</td>
</tr>
</tbody>
</table>

Million RMB

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Riskneutral probability</th>
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<tbody>
<tr>
<td>Investments</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>p = (e^r - d) / (u - d)</td>
</tr>
<tr>
<td>Costs</td>
<td>-20</td>
<td>-5</td>
<td>-5</td>
<td>-5</td>
<td>-5</td>
<td>(1 - p)</td>
</tr>
<tr>
<td>Sales</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Net profit</td>
<td>-30</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td></td>
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</table>

Identical launch in year 6

<table>
<thead>
<tr>
<th>Year</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>npv total</th>
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<tr>
<td>Annual Savings</td>
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<td>-0.85</td>
<td>-0.81</td>
<td>-0.77</td>
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</table>

Sum of annual savings in NPV

<table>
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<th>0</th>
<th>1</th>
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<tbody>
<tr>
<td></td>
<td>-11.69</td>
<td>-16.56</td>
<td>-23.46</td>
<td>-33.25</td>
<td>-47.11</td>
<td>-66.76</td>
<td>3.4%</td>
</tr>
<tr>
<td></td>
<td>-8.25</td>
<td>-11.69</td>
<td>-16.56</td>
<td>-23.46</td>
<td>-33.25</td>
<td>15.8%</td>
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</tr>
<tr>
<td></td>
<td>-5.82</td>
<td>-8.25</td>
<td>-11.69</td>
<td>-16.56</td>
<td>31.3%</td>
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<td></td>
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<tr>
<td></td>
<td>-4.11</td>
<td>-5.82</td>
<td>-8.25</td>
<td>31.3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-2.90</td>
<td>-4.11</td>
<td>15.5%</td>
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Foldback and AK

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Likelihood of positive outcome

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<td>49.6%</td>
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<tr>
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<td>11.71</td>
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<td>49.6%</td>
<td>31.3%</td>
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Growth Option
Value Calculated with Black & Scholes
Total value prognosis at year five  43,29477
\( e \)  2,71828
\( T \)  5
\( \sigma \)  30%
\( A \)  17,31791
\( u = e^{\sigma} \)  1,34986
\( d = 1/u \)  0,740818

Black-Scholes Directly in a Excel Sheet by Espen Gaarder Haug
\( S \)  17,317907
\( X \)  38,095238
\( T \)  5
\( r \)  5,00%
\( v \)  30,0%

\[ \text{B&S} \quad V = N(d_1)A - N(d_2)Xe^{-rT} \]

\begin{align*}
V &= \text{Current value of the call option} \quad 1,760 \\
A &= \text{Current value of the underlying} \quad 17,318 \\
X &= \text{Cost of the investment} \quad 38,095 \\
r &= \text{Risk-free rate of return} \quad 5\% \\
T &= \text{Time to expiration} \quad 5 \\
\sigma &= \text{Volatility of the underlying asset} \quad 30\% \\
N(d_1) &= \text{normal distribution at } d_1 \quad 0,32021 \\
N(d_2) &= \text{normal distribution at } d_2 \quad 0,127574 \\
d_1 &= \frac{\ln(A/X) + (r + 0.5 \sigma^2)T}{\sigma \sqrt{T}} \quad -0.46711 \\
d_2 &= d_1 - \sigma \sqrt{T} \quad -1,13793 \\
\text{call value} &= 1,7604 \\
\text{put value} &= 14,1111
\end{align*}
### Growth Option

Values in million RMB (Renminbi)

- **X**: Start-up cost = 38,10
- **r**: 5%
- **Value to sales**: 2
- **n**: 5

#### Million RMB

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
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<th>3</th>
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<td><strong>Investments</strong></td>
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<td>0</td>
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<td>0</td>
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<td><strong>Costs</strong></td>
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<td>-20</td>
<td>-5</td>
<td>-5</td>
<td>-5</td>
<td>-5</td>
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<tr>
<td><strong>Net profit</strong></td>
<td>-38,10</td>
<td>-4,54</td>
<td>-4,32</td>
<td>-4,11</td>
<td>-3,92</td>
<td>npv total</td>
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#### Sales

- **Annual**: 10

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<th>5</th>
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<tbody>
<tr>
<td><strong>NPV of sales (A)</strong></td>
<td>8,66</td>
<td>9,52</td>
<td>9,07</td>
<td>8,64</td>
<td>8,23</td>
<td>7,84</td>
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<th>Year</th>
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<td><strong>Binomial Value</strong></td>
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<tr>
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Option to Abandon
High Flexibility Example - 2.23 Value of option to abandoning a High Flexibility Project
Number or years 5
Discount rate 5%

<table>
<thead>
<tr>
<th>Million RMB</th>
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<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>Investments</td>
<td>-20</td>
<td>-5</td>
<td>-5</td>
<td>-5</td>
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</tr>
<tr>
<td>Costs</td>
<td>-20</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
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<tr>
<td>Sales</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
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<tr>
<td>Net profit</td>
<td>-30</td>
<td>4.5</td>
<td>4.3</td>
<td>4.1</td>
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| npv total   | -11.69 |

Difference in NPV Value -1.99

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<tr>
<td>Total value prognosis at year five</td>
<td>-11.69</td>
<td>4.22</td>
<td>5.98</td>
<td>8.48</td>
<td>12.01</td>
<td>17.02</td>
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<td>Option Value</td>
<td>4.22</td>
<td>2.98</td>
<td>4.22</td>
<td>5.98</td>
<td>8.48</td>
<td>12.01</td>
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<tr>
<td>Option Price</td>
<td>-1.99</td>
<td>2.10</td>
<td>2.98</td>
<td>4.22</td>
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<td>Sum</td>
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<td>2.10</td>
<td>2.98</td>
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<table>
<thead>
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<th>American Option</th>
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<tbody>
<tr>
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<td>4.22</td>
<td>2.98</td>
<td>4.22</td>
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<td>8.48</td>
<td>12.01</td>
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<td>X (Price of option)</td>
<td>1.99</td>
<td>1.48</td>
<td>1.05</td>
<td>1.48</td>
<td>0.74</td>
<td></td>
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<tr>
<td>T</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>r</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>ν</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
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<tr>
<td>u=(e^\sigma)</td>
<td>1.35</td>
<td>1.35</td>
<td>1.35</td>
<td>1.35</td>
<td>1.35</td>
<td>1.35</td>
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<tr>
<td>d=1/u</td>
<td>0.74</td>
<td>0.74</td>
<td>0.74</td>
<td>0.74</td>
<td>0.74</td>
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<td>e</td>
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<td>2.72</td>
<td>2.72</td>
<td>2.72</td>
<td>2.72</td>
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</table>

The underlying is the value of continuing or in this case the average npv of year 2-5
Price of the option is the difference of income between the two budgets.
Option to Abandon
Low Flexibility Example Value of option to abandoning a Low Flexibility Project
Number of years 5
Discount rate 5%

Million Euros

<table>
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<th>4</th>
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</tr>
<tr>
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<td>-3</td>
<td>-3</td>
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<tr>
<td>Sales</td>
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<tr>
<td>Net profit</td>
<td>-35</td>
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<th>4</th>
<th>5</th>
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<tbody>
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<tr>
<td>Costs</td>
<td>-15</td>
<td>-3</td>
<td>-3</td>
<td>-3</td>
<td>-3</td>
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<tr>
<td>Sales</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
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<tr>
<td>Net profit</td>
<td>-35</td>
<td>7</td>
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Salvage Value 10 m NPV 7.84
One year operations cost NPV 2.83

Total value prognosis at year five -9.69
Option Value 7.84
Option Price -9.52
Sum -11.38

A value equal to salvage value means that the project should be abandoned in favour of the salvage value.

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<td>7.84</td>
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<td>11.87</td>
<td>16.82</td>
<td>23.83</td>
<td>33.76</td>
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American Option
S (Value of Underlying) 5.91
X (Price of option) 9.52
T 5
r 5%
v 30%
u = e^{\sigma}
\sigma 1.35
d = 1/u 0.74
e 2.72

The underlying is the value of continuing or in this case the average npv of 1.03.
In this case the price of the option is a discounted 10 million extra investment in year.