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1. Introduction and Abstract

Since the Real Option Theory was first introduced by Myers in 1977, its arguments had a great impact on decision making processes inside firms. Still, this theory is young in comparison and especially its importance in the field of outsourcing decisions is yet to be explored to a greater extent. It always has been vital to firms to know their strengths and weaknesses in order to make the right sourcing decisions.
There are many well-established theories surrounding the decision making aspect; all of them have their certain assumptions and different lines of argument. Therefore one has to distinguish between different models like Transaction Cost Theory, Resource Based View or Real Option Theory, because the theory of the firm, meaning the way we describe an organization, is directly related to decision making inside the firm.
Outsourcing inevitably is one of the most controversial topics to be considered by a firm's management. These kinds of decisions involve significant risks and benefits, which make it very important to measure the outcome in a realistic and convenient way.
In the last decade the Real Option Analysis has become a popular tool in certain industrial segments (especially in financial industries), but the reliability of the underlying models still is questionable. That especially applies to sourcing decisions, because questions of vertical disintegration always are associated to a vast range of risks. Therefore there certainly is urgent need for an authentic management framework in this area.

In the paper I will first introduce the main concepts of Financial Options in order to make the understanding of Real Options easier; those two derivative concepts share a common basis, nevertheless there are some strikingly important differences that need to be explained. During that process I will explain the option terminology, differentiate between call and put options and show how a change in one underlying variable (*ceteris paribus*) changes the overall value of an option.
Basic Concepts of Real Options will be examined, thereby also looking at valuation purposes, such as the Discounted Cash Flow and the Net Present Value method. Those

models almost perfectly apply to Financial Options; when it comes to Real Option valuation, however, those concepts are less reliable by far. In the following a possible classification of Real Options will be drawn, including the options of timing, staging, exit, operating, flexibility, switching, growth and compound options.

Then I will present the main differences as well as similarities between the widely used decision making theories, focussing on the Transaction Cost Theory, Resource Based View and Real Option Theory. With respect to the different theories I will point at the different assumptions underlying those schemes and describe their theoretical underpinnings. Various opinions of different authors will be included in this section – supporting ones as well as criticizing ones. Within this section the focus will be put on Real Option Theory and some individual options will be explained to greater extent, such as options to defer investment, growth options, embedded options, shadow options and option chains. Also investment timing (considering the option to wait), technological platforms, technology positioning and restructuring profiles will be taken into account.

The decisive part of this paper will be the application of Real Option Theory on sourcing decisions. Therefore I will first introduce some ideas that are important in sourcing decisions, concentrating on core competencies, partial outsourcing and equilibrium models (industry equilibrium, a duopoly case and Bertrand competition). Another important part will display analogies to other networking forms, drawing similarities to joint ventures and supply chain management in the high technology sector and the automobile sector. Lastly, more theoretical underpinnings and some valuation purposes will be introduced.

1.1. Methods

First I want to emphasize that my interest in this scientific field was inspired by the seminar “Internationale Unternehmensführung”, of which the central theme was the issue of outsourcing. During the course and while reading through the material I started to identify an incredible range of aspects that needed to be considered when discussing the question whether to vertically integrate or vertically disintegrate. My concern was further amplified by the introduction of the Real Option Analysis, because an approach on a financial derivatives basis to solve sourcing decisions appeared to be a very creative way to shed light on a yet well established topic from a whole new direction. Unfortunately I had volunteered for a different topic, but the motivation to do a thesis in this scientific area remained.

I made myself familiar with this topic through an extensive literature research. I have been searching in different kinds of public as well as academical libraries. In addition, my intention was to include different scientific papers – some of them were cited explicitly in literature, others were found through databank research (like ABI/INFORM Global, Blackwell Synergy, JSTOR, NBER working papers, ScienceDirect, Wirtschaftswissenschaften OLC-SSG, etc.).
For the first part of my thesis I have used literature in the field of financial mathematics, in order to explain the world of financial derivatives. During my research I found various authors describing the concept of Real Options. Concerning Transaction Cost Economies and Resource Based View there, without any doubt, was enough literature to cover the demands of this thesis. My task was to highlight the different theories from different points of view; the goal was not to present them as independently invulnerable and dogmatic theories, but also to show their shortcomings and disadvantages.

1.2. Conceptual Formulation

Up to now, scientific research and application of the Real Option Analysis was mainly associated with strategic alliances (especially joint-ventures), supply chain management and networking. In my opinion the scope of the Real Option Theory should be extended in greater form to clearly and more intensively address outsourcing decisions.
The Real Option Theory itself derives directly from the derivatives theory of financial options. In some fields the Real Option Analysis approach is better established than in others. Therefore many works I have included in this paper did not have, at first sight, a direct connection to sourcing relationships. I wanted to draw analogies and work out the main parameters of outsourcing decisions. The goal was to establish a broad framework for outsourcing decisions on a Real Option basis.

Nevertheless, one must not forget that also the Real Option Theory has its obvious shortcomings: it is a stochastic model that works on basis of approximations. Uncertainty and volatility seem to be underestimated in many cases. Such over-evaluations are regularly vended as an entity's future potential to the public, which in turn makes it a more attractive target to investors. One can see that many different and sometimes contradicting interests come into play, which makes the decision making process even more delicate.

2. Financial Options

„*An option is the right, but not the obligation, to buy (or sell) an asset under specified terms. Usually there are a specified price and a specified period of time over which the option is valid.*"[1]

Options are financial derivatives. Derivatives are used to understand contracting under uncertainty, as has been argued by Scholes (1998). According to him, "*any security is a derivative if its price dynamics depends on the dynamics of some other underlying asset or assets and time*"[2] The first option-like financial instruments date back to the 17th century, when they were traded on the Amsterdam Stock Exchange. Financial options generally save transaction costs and can be designed for both speculative and hedging purposes, although due to liquidity purposes, they are better for hedging. In theory everything can be hedged but the targets are mostly interest movements, foreign exchange rates and commodity price exposures.

I want to cite a now-famous example, stipulating that most financial contracts can be interpreted within a derivative regime: "*equity holders of a firm with debt in its capital structure have an option to buy back the firm from its debt-holders at maturity of the debt*"[3]

In the following I want to present the option terminology:

- The quantity and class of what can be bought or sold has to be defined; the asset in question is called underlying
- A strike price (also labelled exercise price) is specified. At this certain price the option holder can exercise the option
- Parties have to agree on the duration of the option – an expiration date is defined
- One has to distinguish between two types of options:

[1] Luenberger, D.G. (1998), p. 319
[2] Scholes, M.S. (1998), p. 351
[3] Scholes, M.S. (1998), p. 364

    - American option: here the option holder can exercise the option at any time up to expiration date
    - European option: exercise is allowed only at expiration date
- The price of an option is called the option premium
- Settlement terms have to be negotiated; for instance the actual asset can be delivered; cash settlement is another common possibility
- The option holder possesses the right to buy or sell the option; in this case one speaks of a long option
- The option writer has the obligation to buy or sell the option; in this case one speaks of a short option
- Option value = intrinsic value + time value, whereas
    - The intrinsic value of an option is the value that the option has in case of immediate exercise and
    - the time value of the option is always a positive probability of a favourable underlying price movement

These features generally characterize an option.
Normally two parties are involved: one writes (i.e. grants) the option, the other purchases the option. There are various ways of determining the value of an option. Those concepts will be presented later to greater extent – just keep in mind that the dynamic structure of both financial and real options is fundamental and causes huge problems in valuation. The owner of an option gains flexibility, because he can exercise the option in favourable states of nature or not exercise in unfavourable states.
Financial options play a very important role in business, because they are an excellent instrument for controlling risk. One can agree on option-style contracts on basically everything; most common, however, are options on stocks, currencies, futures, bonds, indices and other options. Because the owner of an option is not obliged to buy or sell, the value of an option can only be positive and, at worst, be zero.

2.1. Call Options

A call option "*gives the holder the right but not the obligation to buy the underlying asset by a certain date for a certain price*" [4] A graphical interpretation of a (long) call option can be seen below. The option holder makes a profit if the price of the underlying rises to such an extent that he is compensated for the pre-paid premium:

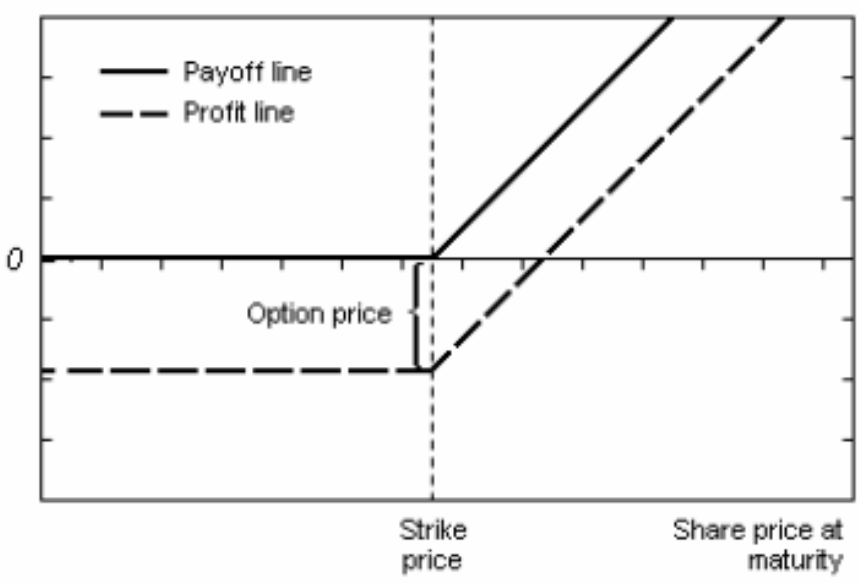

Figure 1: *Payoff of a long European Call option*

As long as the price of the underlying lies below the strike price, the option is said to de "out of the money", if the strike price equals the price of the underlying, the option is "at the money" and if the price of the underlying exceeds the strike price, the option is "in the money". Note that the hypothetical profit is unbounded.

[4] Hayden, E. (2006), p. 26

2.2. Put Options

A put option "*gives the holder the right but not the obligation to sell the underlying asset by a certain date for a certain price*"[5] Again, a graphical interpretation of a (long) put option can be seen below. The option holder makes a profit if the price of the underlying falls to such an extent that he is compensated for the pre-paid premium:

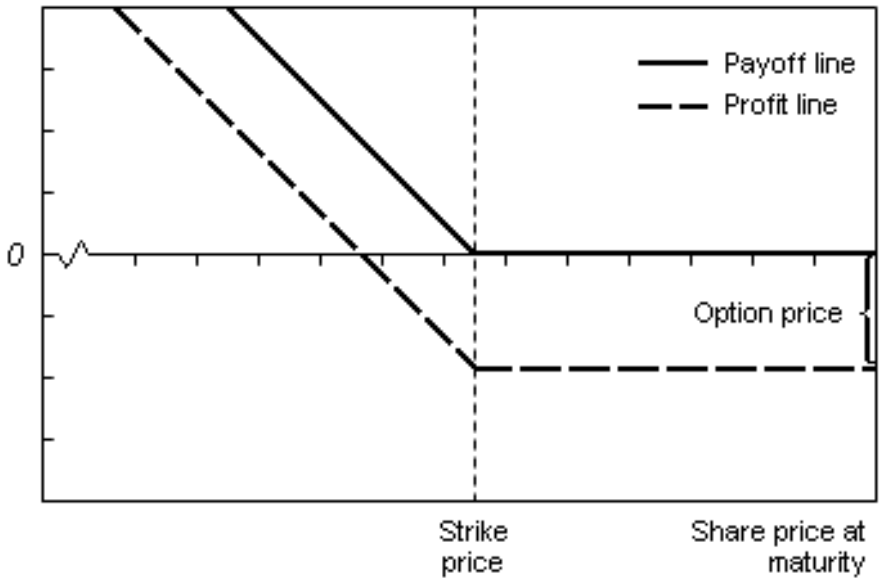

Figure 2: *Payoff of a long European Put option*

Please note that the value of the underlying can not fall below zero; therefore the value of a put option has a boundary.

[5] Hayden, E. (2006), p. 26

2.3. Comparative Statistics

In this section I want to analyze how the price of a call option reacts to changes in the underlying variables (ceteris paribus).

- The higher the spot rate, the more valuable is the option
- The higher the exercise price, the less valuable is the option
- The higher the volatility of the underlying, the more valuable is the option
- The higher the domestic (risk free) interest rate, the more valuable is the option, because a call option replicates the purchase of an underlying today but paying at date of expiration

The results are summarized in the following table:

Variable	Call Option	Put Option
Price of underlying	+	–
Strike price	–	+
Volatility	+	+
Domestic interest rate	+	–

Table 1: *Put and Call Options – Comparative Statistics*, Source: adapted from Hayden (2006), p.40

3. Real Options

According to Scholes (1998) "*Real options indicate that even the investment decisions of firms are better understood by using an option framework rather than a more conventional present-value-analysis framework*"[6]

One can explain the creation of a real option as an entrepreneurial process which transforms inventive ideas into profitable innovation. The subsequent development of competence necessary to exercise the option sets up boundaries, based on theories of the firm, for the often overoptimistic real option evaluation. Real options provide a way of valuing projects in terms of future benefits. Options provide a way of estimating benefits for projects that may or may not become economically viable in the future, but are nevertheless valuable in much the same way that an insurance policy protects its owner, whether or not an actual claim is filed. They can also be used as a tool to evaluate ongoing projects as to whether to deploy, abandon, or continue their development, as will be explained to a greater extent later on.

Myers (1977) was the founding father of real option theory, realizing that corporate growth opportunities can be seen as long call options. His influential paper "Determinants of corporate borrowing" established a completely new scientific field. Myers argued that debt policy would be carried out in response to imperfect markets and that in this context future opportunities would have to be taken into account, because they could positively contribute to an entity's value. As corporations normally work on a going concern basis, he stipulated that "*part of the value of a firm is accounted for by the present value of options to make further investments on possibly favorable terms*."[7]

Majd and Pindyck (1987) described the existence of real options by emphasizing that: "*the payoff from completing the project has some value today which is consistent with*

[6] Scholes, M.S. (1998), p. 364
[7] Myers, S. (1977), p. 148

capital market equilibrium. This value fluctuates stochastically over time […] so that its future value is always unknown. Access to the investment opportunity […] is analogous to holding a call option on a dividend—paying common stock, where 'exercising' the option is equivalent to making the investment expenditure. As with such financial options, increased risk increases the incentive to delay the investment expenditure, and for any positive amount of risk, the expenditure is made only when the project's value exceeds costs by a positive amount."[8]

In Sharp's (1991) terminology, the existence of real options is contingent on uncertainty, a real option being "*the ability, but not the obligation, to take advantage of opportunities available at a later date that would not have been possible without the earlier investment*"[9]

At present, expansion strategic decisions have option characteristics. This counters the point of view in the 60s, where organizations were considered to create buffers against uncertainty, which then was the mainstream treatment of risk. "*An established firm has the choice to exploit its resources in its current activities or to explore new markets*"[10] Especially under hypercompetition an option approach is useful, because timing and know-how are very important.

McGrath (1997) defined real options in the following way: "*Real options theory scholar seek to understand classes of investment decisions having a structure similar to financial options contracts but for which the assumptions made in valuing financial options do not hold. The distinguishing characteristic of an options approach lies in firms making investments that confer the ability to select an outcome only if it is favourable*"[11]

Following the Chandlerian (1962) definition of the firm, "*a firm needs a structure to conceive a strategy, and in return, a strategy modifies the structure and resources of*

[8] Majd, S., Pindyck, R.S. (1987), p. 3
[9] Sharp, D.J. (1991), p. 71
[10] Kim, D-J., Kogut, B. (1996), p. 293
[11] McGrath, R.G. (1997), p. 975

the firm so as to be able to follow long-term goals"[12] On the other hand, Penrose (1959) proposed a different approach to the firm, namely the competence-based approach. Most basic it has to be said that firms experience different levels of profit, because of heterogeneity of resources. Burger-Helmchen (2004) defined real options in the following way:" *Making good use of an opportunity that brings value to the firm is nowadays called the real option, so holding and being able to strike this real option depend fundamentally on the competences and learning activity of the firm.*"[13] Another point of interest is the analogy between core competencies and real options; they share three common features: irreversibility, flexibility and uncertainty. "*The value of the competence is a capital part of the real option value, and conversely future option determines partly the competences value*."[14] Another vital keyword is "tacit knowledge". Tacit knowledge can be acquired by learning or by experimentation. Please note that the building of new competences is not instantaneous. Irreversibility also has a positive effect, because it represents some sort of entry barrier, which distracts potential imitators from entering the market. Also uncertainty (market or technological uncertainty) may have positive as well as negative effects on the real option value. Market uncertainty is mostly an exogenous uncertainty, whereas technological uncertainty is somewhat more endogenously characterized.

Kirzner (1979) famously defined the term "opportunities": "*Opportunities (and not yet options) come into existence when individuals (individuals, decision makers, firms) have different beliefs in the possibilities offered by the available or potential resources to transform some inputs into some outputs that can be sold and raise a profit*"[15] Another author (Schumpeter, 1934) distinguished between invention and innovation; Another important concept is the "entrepreneurial resource". Again Kirzner (1979) spoke of "entrepreneurial alertness", meaning the ability of a businessman to detect market niches and make profits. Assumptions have to be made, which makes an *ex ante* analysis more vulnerable to mistakes.

[12] Burger-Helmchen, T. (2004), p. 4
[13] Burger-Helmchen, T. (2004), p. 5
[14] Burger-Helmchen, T. (2004), p. 24
[15] Burger-Helmchen, T. (2004), p. 8

3.1. Basic Concepts

First, I want to elaborate on a statement of the problem based on Myers' (1977) findings: a firm's value depends on assets already in place –valued on basis of market values and/or market values. The assumptions are that markets are perfect and complete, that bankruptcy costs are equal to zero and that there are no corporate taxes. The value of an entity can be calculated as the value of current assets plus the value of future growth opportunities. These opportunities require capital costs today, but are expected to yield positive future cash flows.

Imagine a firm with no current assets and only one future investment opportunity. It is easy to see that if the option expires, the corporation would be worthless. A graphical explanation of the firm's decision under those circumstances can be seen in the below inserted figure:

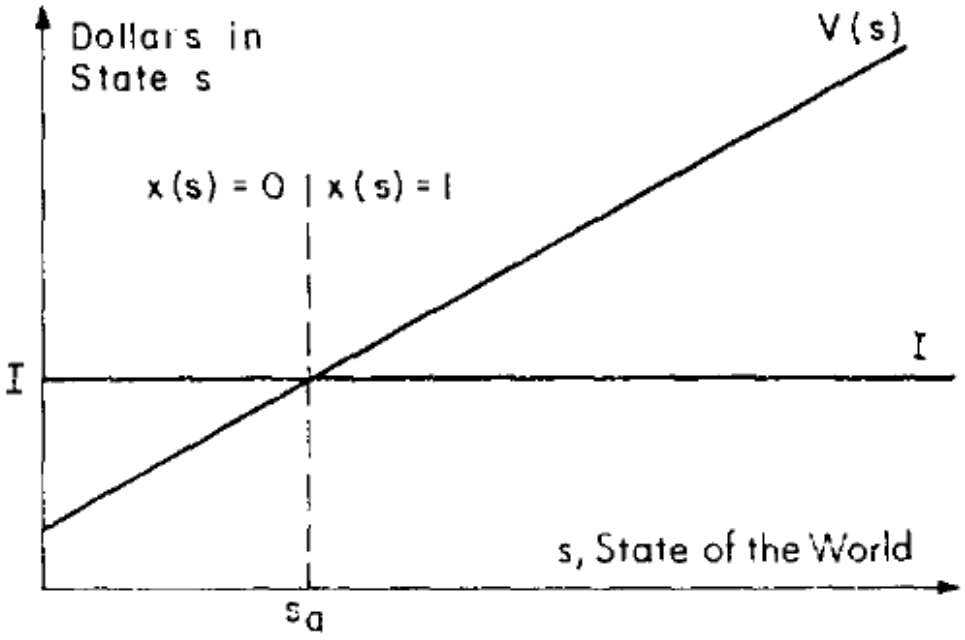

Figure 3: *"The firm's investment decision under all-equity financing as a function of the state of the world, s, at the decision point"* Source: Myers, S. (1977), p. 152

Secondly, the link between borrowing and the market value of the firm has to be analyzed, continuing the above stated example. Following Myers' (1977) line of argument, one arrives at an additional assumption, namely that "*the proceeds of the debt issue are used to reduce the required initial equity investment*."[16] and that shareholders are able to borrow the total value of the firm. The probably most compelling situation arises when the issued debt reaches its time to maturity after the corporate option has expired. This constitutes a break-even state, because creditors will receive no payments – remember that the only value-contributing item is the future investment opportunity – if this growth option is not exercised. Because of that the firm can not borrow additional capital, even by offering a higher interest rate, beyond some critical point. These dynamics are summarized in the following figure: Under such circumstances the optimal policy is to issue no debt at all.

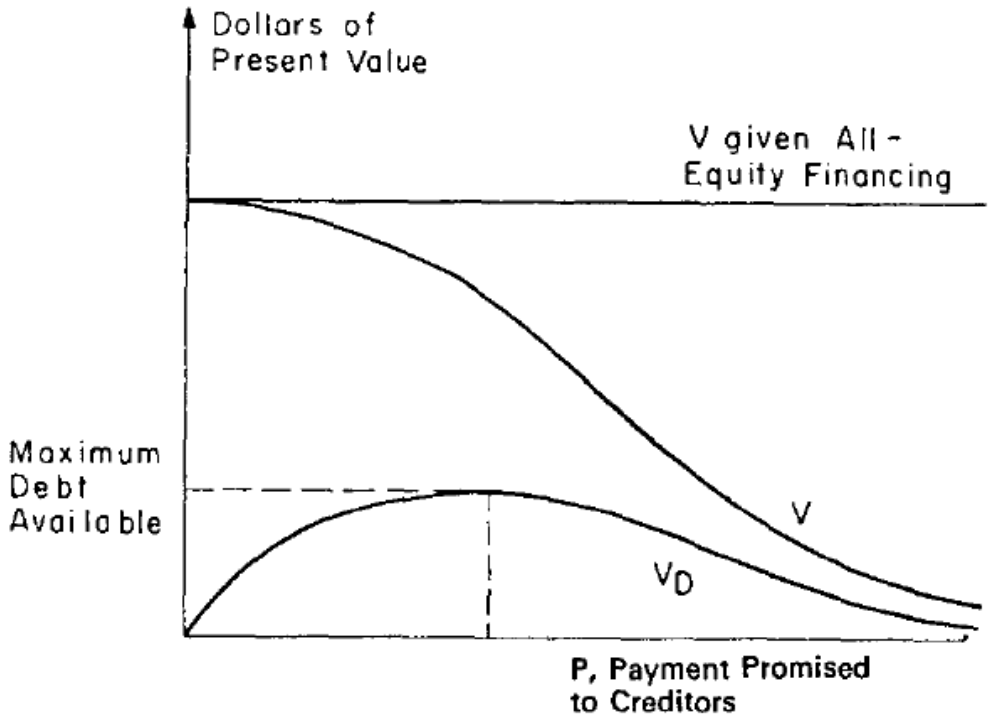

Figure 4: *"Firm and debt values as a function of payment promised to creditors"* Source: Myers, S. (1977), p. 154

[16] Myers, S. (1977), p. 152

Interestingly, "*The example shows how the existence of corporate debt can reduce the present market value of the firm by weakening the corporation's incentive to undertake good future investments*."[17] The extreme example established leads to an equally extreme result: corporations whose value mostly consists of future growth opportunities would issue no risky debt at all.

Thirdly, it is important to mention that a real option can be defined as a call option on a real asset with an exercise price equal to capital commitments required to acquire the asset. The decision whether to exercise the option depends on the amount of promised payments to bondholders. Conceptually, the term "discretionary investment" is a critical one and can be explained in the following way: one can distinguish options by determining if their ultimate value depends on further discretionary investments or not, meaning if additional investments are necessary or not. "Discretionary" in the sense that all variable costs follow a discretionary distribution.

Fourthly, the question arises how a firm can decide whether to exercise the option or not. As we have seen, the decision depends on the promised payment amount to creditors. The straightforward way to deal with this obstacle would be to include a legal clause in the contract that obliges the firm to initiate and realize every project that has a positive net present value. The difficulty is that this clause comes at very expensive costs, namely monitoring costs and contract enforcement costs.

Another possibility is to rewrite the debt contract: in order to prevent the clause to be an empty promise, it has to be somehow enforceable. All stakeholders would have to sign the contract as well (and as individuals), because otherwise they would be protected by limited liability anyway. Even more critical is the aspect that there hardly exits a case imaginable where one can objectively judge when the optimal moment to exercise the option has been reached. Probably the only enforceable contract would be to oblige the company to take on literally every investment project. This solution neither can be optimal, because it means that the entity would also have to accept projects with a

[17] Myers, S. (1977), p. 155

negative net present value and poor future prospects. Also renegotiating the debt contract, although not impossible, is very costly. The same applies to a shortening of debt maturities of debt outstanding. Here, "*Debt that matures before an investment option is to be exercised does not induce suboptimal investment decisions*."[18] The problem is that monitoring costs are not reduced and that the maintenance of such a relationship would be pretty costly, as well.
In addition, a mediator – an independent fact-finder – could be installed *ex post*, because creditors could insist on that. Maybe it would be better to put the negotiation in the hands of a third, external party than to bargain bilaterally. Nevertheless, the timing problem persists, because the time point when the mediator would be called in can not be defined objectively.

Jeffery Halis (1976) proposed a restriction on dividends; he "*described how restricting dividend payments can protect against the suboptimal investment decisions induced by risky debt*."[19] In the case of restricting dividends, the firm still must invest in something. For various reasons also this approach only yields a partial solution of the problem, because there are still monitoring costs, investment incentives are not perfectly aligned (shareholders will prefer risky assets) and the company may be pressured to invest in projects with a negative net present value.
A rather idealistic approach requires the firm to issue a compliance statement, announcing a policy of exercising all options with a positive net present value – the compliance of this self-obligation yet would depend on the company's honesty alone.
Finally, a very hypothetical concept is based on a secondary market for real assets: "*In each period the firm will compare the present value of using the asset (for at least one more period) with the cash it could obtain by selling it. If it decides to use the asset, it is in effect investing the secondary market value*."[20] An offsetting effect would be observable if the growth potential of an asset would be exactly equal to the "debt capacity" of the same asset. This effect is not transferable into real world.

[18] Myers, S. (1977), pp. 158f.
[19] Myers, S. (1977), p. 159
[20] Myers, S. (1977), p. 162

As we have assumed previously, an entity's value comprises of its real assets and its real options. The sheer existence of real options implies imperfect markets and the ongoing analysis unconditionally depends on those imperfections. Another critical argument is that the value of an option, in case it is not exercised, vanishes. This dissolving can be justified in basically two ways: Real options may be firm-specific, thereby having zero value for other market participants and if the real option is not firm-specific, it could be traded on a secondary market.

Dixit (1992) stated that investment in theory would differ a lot from investment decisions in practice. In general, firms only invest if prices rise over long run average costs substantially – i.e. they are more reluctant to invest than in theory; the same effect can be observed when it comes to disinvestment decisions. Some authors argue that such inertia can indeed be optimal in an uncertain environment.
Another interrelationship tells us that if opportunity costs are large, the value of the investment is reduced. Regarding flexibility, it has to be said that projects often can be carried out using different construction techniques. They primarily differ in providing different levels of flexibility. Technologies have to be ranked with respect to this flexibility, because technologies allowing a greater flexibility are more expensive, affecting total investment.

During our analysis the existence of real options has been determined exogenously and, notably, stockholders are the ones, who were investing, as opposed by bondholders, who made no investments – as an outcome there is a transfer of capital from stockholders to bondholders. Summing up one can say that "*the amount of debt issued by the firm should be set equal to that amount which maximizes the market value of the firm*."[21] The main assumptions stated that managers are able to write contracts and to specify a distribution of returns.

[21] Myers, S. (1977), p. 170

3.1.1. Valuation

The real options approach is an extension of options theory towards management of real assets. Real option tools enhance the traditional approaches to capital budgeting and valuation and are not publicly traded and replicable like financial options. Still, it is possible to use the pricing method of financial options to understand them and calculate their values.

In a world of uncertainty, companies have the flexibility to defer a project to adjust its scale (expansion, contraction, or abandonment) and to extend or shorten the life of the project in response to technological and economic developments over time. These opportunities and flexibilities can be valued using pricing methods of financial put and call options.

Real option analysis generalizes the traditional valuation methods such as Net Present Value (NPV) or Discounted Cash Flow (DCF) to take the values of the different options associated with the investment into account. During that process imprecision is inevitable, because we are moving from a hypothetical world to the real world, where many assumptions that have been established earlier do not longer hold.

3.1.1.1. Discounted Cash Flow

DCF is a valuation method used to estimate the attractiveness of an investment opportunity. Discounted cash flow analysis uses future cash flow projections and discounts them (mostly using the weighted average cost of capital) to arrive at a present value, which in turn is utilized to evaluate the potential for future investment. If the computed value at time to maturity is higher than the current cost of the investment, the opportunity generally can be considered a valuable one.

$$DCF = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \ldots + \frac{CF_n}{(1+r)^n}$$

CF = Cash Flow

r = discount rate (WACC)

Purpose of a DCF analysis is to estimate the profit one would make from an investment and to adjust the expected profit by the time value of money. Instead of trying to project cash flows towards infinity, a terminal value approach is regularly used. In this case annuities are used to estimate the terminal value.

3.1.1.2. Net Present Value

NPV is used in capital budgeting to analyze the profitability of an investment or project. NPV analysis is sensitive to the reliability of future cash inflows that an investment or project will yield.

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0$$

NPV compares the value of a dollar today to the value of that same dollar in the future, taking inflation and returns into account. If the NPV of a prospective project is positive, it should be accepted. However, if the NPV is negative, the project should be rejected because of a negative cash flow structure.

3.1.1.3. Problems with Real Option valuation

NPV or DCF analyses are based on one or all of the following assumptions: The investment is an ‘all or nothing’, ‘now or never’, project and is held passively. A single expected cash flow forecast is used; therefore all possible future cash flows and their probabilities, for any given time, are collapsed into a single expected cash flow. The main problems are huge variations when picking different proxies for discount rates and cash flows, because DCF is merely a mechanical valuation tool, which makes it subject to the axiom "garbage in, garbage out". Small changes in inputs can result in large changes in the value of a company. This ignores the fact that managers can take advantage of futures developments. Managers can add value to the project by responding to changing circumstances – making the most of opportunities when conditions turn out to be better than expected or reducing losses when conditions turn

out to be worse than expected. The expected cash flows are discounted using a constant risk-adjusted interest rate, which implies that risk is assumed to be constant over the lifecycle of the project.
Real option analysis generalizes the NPV and the DCF rules by including the values of different options and opportunities associated with the investment.

McDonald and Siegel (1986) noted that the classical NPV decision rule does not hold, because in a Real Option case "*The rule 'invest if the net present value of investing exceeds zero' is only valid if the variance of the present value of future benefits and costs is zero or if the expected rate of growth of the present value is minus infinity*"[22]

Majd and Pindyck (1987) argued in a similar direction by stating that many investment projects would have similar characteristics: first, spending decisions and cash outlays often occur sequentially over time; secondly, there is a maximum rate at which outlays and construction can proceed - it takes "time to build"; Thirdly, the project yields no cash return until it is actually completed.
"Time to build" still is an important suggestion, because it has heavy impact on the investment project: "*the effects of time to build are greatest when uncertainty is greatest, when the opportunity cost of delay is greatest, and when the maximum rate of construction is lowest*."[23]

In this context, classical discounted cash flow methods again are inadequate, because they could lead to heavy overinvestment. Therefore other option pricing methods have to be used. The corporation faces an investment problem, because, as new information arrives over time, the firm has to make sequential and irreversible commitments. Majd and Pindyck (1987) gave the examples of aircraft and mining industries, where those characteristics are of high relevance. Empirically, one can observe that it might still pay off to enter into a project with has a negative net present value at initial stages. Because of the irreversible investment problem, it is natural that "*uncertainty over project*

[22] McDonald, R., Siegel, D. (1986), p. 708
[23] Majd, S., Pindyck, R.S. (1987), p. 17

returns creates an incentive (an 'option value') to postpone the investment and wait for more information to arrive, even if the firm is risk neutral."[24]
The value of an investment project is positively related to the degree of volatility. Dynamic option valuation techniques have a great advantage over traditional net present value valuations: they enable for flexibility during construction period.

Sharp (1991) proved that even using the famous Black-Scholes formula, one simply cannot precisely calculate the value of a real option. His lines of argument are summarized in the figure below. Note that in Sharp's system the value of an option depends on uncertainty and duration of an investment project; hence, the longer the time horizon and the more environmental uncertainty involved, the higher the option value.

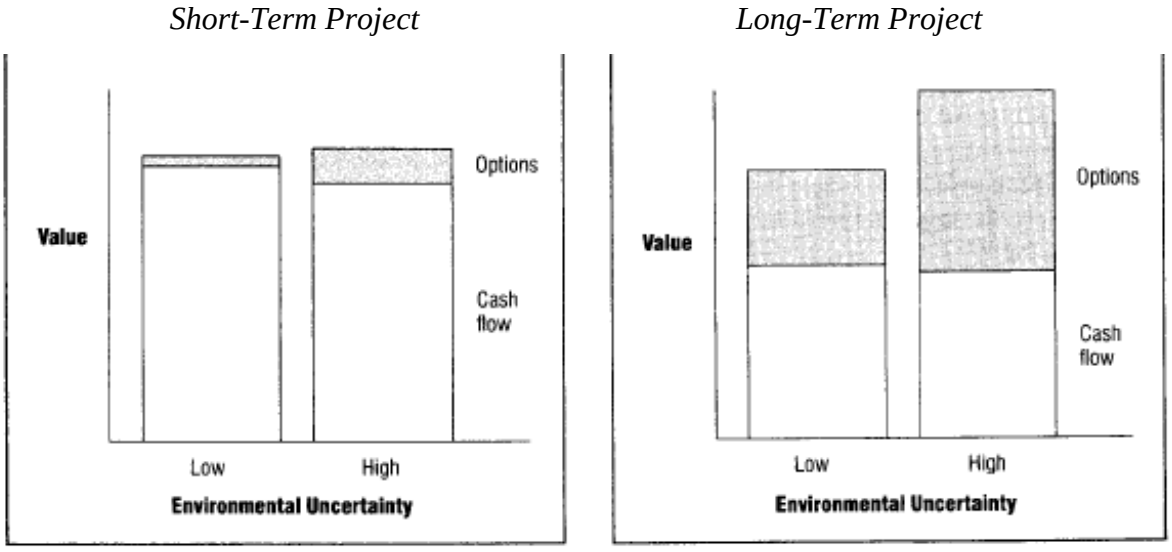

Figure 5: *"Option value of an investment project under different degrees of uncertainty and different time horizon"* Source: Sharp, D.J. (1991), p. 71

So the main problem remains: what is the value of a real option? Maybe Luehrmann was right and honest enough by saying that managers should "take an educated guess". There are many different approaches in valuating real options; therefore the results vary, due to contrary hypotheses. Before a real option is created, firms face the

[24] Majd, S., Pindyck, R.S. (1987), p. 2

additional problem of evaluating shadow options, i.e. "*The output of the knowledge building process*"[25]

Already in the early 20th century it was understood that stock prices could be described by stochastic models – namely diffusion models. These ideas relied on the concept of equilibrium pricing, because it "*separates the preferences of traders and the formation of market prices*."[26] Taking hedging into account, i.e. the creation of a riskless position, one finds it hard to translate this technique into real option world. Furthermore, utility preferences of managers are not treated properly. NPV analyses do not only undervalue investments in innovation, but additionally a possible postponement of an investment has a strong impact on the NPV and the initial investment may be uncorrelated with the market.

Looking at real options, the definition of pricing a real option is the following: "*actors consider irreversible investments under dynamic uncertainty. By dynamic, it is meant that the uncertainty endures over a period of time and initial decisions are subsequently revisited. In this environment, choice is both ex ante and ex post simultaneously. Actors decide what to do based on the realization of current prices (or events); action is ex post to prices. Actors decide what to do based on the future; action is precipitated on the basis of expectations.*"[27] Decision makers have to anticipate an expected future decision environment. Such decisions are exposed to various biases, for instance it matters a lot if a project is currently in or out of the money. Generally, managers may find it attractive to over-evaluate projects, which already led to creation of speculative bubbles in the past. On the other hand learning effects inside firms regarding the used heuristic models should not be disregarded. In practice, studies show that real option valuation is scarcely used by managers, mostly because some of them simply do not like to revisit past decision. "*Nevertheless, real option considerations appear to represent a significant component of value, and firms that take them into account in*

[25] Burger-Helmchen, T. (2004), p. 15
[26] Kogut, B., Kulatilaka, N. (1994), p. 4
[27] Kogut, B., Kulatilaka, N. (994), p. 6

appropriate situations should outperform firms that do not."[28] Firms were largely tied to use rules of thumb in order to approximate optimal decisions.

Concerning decision making rules one has to distinguish between negative rules, such as rejecting all projects with a negative NPV, and positive ones, such as carrying out option valuations. Positive decision making rules often conflict with biases of behavioural and organizational nature.

A basic but very useful rule is to review performance more frequently – reviews should be carried out periodically and option pricing techniques have to be applied. Kogut and Kulatilaka (1994) introduced a two-parameter model: the first parameter is uncertainty (σ), the second parameter is the status quo bias (k):

volatility	Status quo bias, *k*							
σ	0	10%	25%	40%	50%	75%	100%	150%
0	(15.00)	(18.00)	(22.50)	(25.00)	(25.00)	(25.00)	(25.00)	(25.00)
20%	(1.85)	(4.15)	(7.05)	(9.27)	(10.70)	(14.02)	(16.16)	(16.85)
40%	29.57	25.34	19.67	14.77	11.75	4.46	(0.43)	(5.05)
60%	70.17	63.91	55.01	47.12	42.03	31.27	22.01	12.87
80%	118.08	106.64	94.85	83.76	77.39	62.06	47.69	35.68
100%	163.97	149.36	133.51	120.17	111.34	92.71	75.25	58.97
120%	199.95	183.80	165.41	150.69	141.00	117.97	98.52	79.93
Note: *k*>1 can be thought of as projects incurring cleanup costs								

Table 2: *"Value of Project under annual review"* Source: Kogut, B., Kulatilaka, N. (1994), p. 14

As one can see, when there is no uncertainty (σ = 0), the option value is negative; therefore the option will not be exercised which results in zero value. Looking at the status quo bias one can examine that solutions are sub-optimal and that the value of the project is reduced. Please note that this applies to the case of annual reviewing.

The second table shows the results if the project is evaluated on a quarterly basis, resulting in "*more opportunities for the firm to correct the investment decision and avoid regret*."[29] The option value is higher in every state of nature, because the status quo bias decreases as the reviews increase:

[28] Kogut, B., Kulatilaka, N. (1994), p. 10
[29] Kogut, B., Kulatilaka, N. (1994), p. 15

Volatility	Status quo bias, k							
σ	0	10%	25%	40%	50%	75%	100%	150%
0	(15.00)	(16.50)	(18.75)	(21.00)	(22.50)	(25.00)	(25.00)	(25.00)
20%	(1.85)	(3.77)	(6.14)	(7.80)	(8.82)	(11.23)	(13.35)	(14.34)
40%	29.57	25.94	21.20	17.07	14.49	8.89	5.19	2.06
60%	70.17	64.78	57.24	50.62	46.49	37.70	29.72	23.70
80%	118.08	108.63	98.07	88.80	83.40	70.61	58.97	49.99
100%	163.97	151.68	137.99	126.37	119.08	103.85	90.12	77.66
120%	199.95	186.58	171.00	157.93	150.04	131.83	117.17	103.23

Table 3: *"Value of Project under Quarterly review"* Source: Kogut, B., Kulatilaka, N. (1994), p. 15

3.2. Types of Real Options

By now it should be obvious that real options can be associated with a broad range of business problems. Therefore it is practically impossible to perfectly distinguish between different option classes. Myers (1977), for instance, argued that: "*One can think of real options that are separable, objectively identifiable, relatively long-lived, and for which reasonable secondlyary markets exist. Examples are patents, certain trademarks, franchises and operating licenses*."[30] In the following, I will present a classification mostly based on the classification of Trigeorgis (1996).

3.2.1. Timing Options

The ability to postpone an investment and to decide when it is initiated, allows managers to await the arrival of more information about the project. The value of postponement must be weighed against the time value of profits from the project. An example of timing option is an undeveloped land plot held by a real estate developer. For a certain price, the developer can start to build and thus receive cash flows. But because there is uncertainty about interest rates, building costs (in this context the

[30] Myers, S. (1977), p. 164

exercise price) and expected cash flows, it may be valuable to “wait and see” if this uncertainty is (partly) resolved as time passes.

3.2.2. Staging Options

Closely related to the timing option is the staging option. This type of option allows the holder to invest in a project in small increments. Again, the rationale is that uncertainty is resolved by awaiting the arrival of better information, so managers can learn about the profitability of project before committing more funds. For some projects, uncertainty is not only resolved over time, but investment must be undertaken to learn about the true cost or profitability of a project.

3.2.3. Exit Options

This type of option is also one that most people intuitively agree with. It might be advantageous for a firm to maintain an “escape route” if an investment should turn out to be unsuccessful. A software development firm that employs programmers on short-term contracts and leases its building and operating assets is in effect buying itself an exit option. A premium must be paid to both staff and leasing agencies to be allowed to terminate contracts on short notice, but a software development project turned sour can be shut down pretty quickly.

3.2.4. Operating Options

Operating options are quite similar to exit options. They come into existence when a company scales some of its business processes to react quickly to changes in the commercial environment. A manufacturing firm that builds a plant with more excess capacity than a “median forecast” would suggest effectively purchases the option to take advantage of demand conditions that are stronger than anticipated.

3.2.5. Flexibility Options, Switching Options and Incremental Options

Building flexibility into assets so they can be put to several different uses is another example of a real option. A bilingual employee is more valuable that one who is not, even when there are no immediate plans to send him or her abroad; or consider a power plant, which can be operated by coal, oil or natural gas as fuel. If the relative prices of the fuels were fixed, there would be no value in building such flexibility; one would always opt for the cheapest solution. However, if the relative prices of alternative fuels are volatile and not perfectly correlated, one can take advantage of these fluctuations and the extra investment in flexibility, clearly has a positive value.

Leiblein and Miller (2003) argued that a switching option comes into existence when investing rather small amounts in various product markets. Those kinds of options are presumably influencing the decision whether to produce internally or via a sourcing arrangement. There are two properties: first, when a firm's production is well diversified across many product markets, a decline in demand in one of the target markets has a comparably little effect; secondly, when a technology becomes useless in one market, the company can easily shift the application of the technology to another product market. Note that the latter argument has greater relevance for industries with shorter technology-cycle times.
Sharp (1991) made the following distinction: incremental options are found in virtually all kinds of investments; they are incremental in nature. One example would be learning. Flexibility options are different in the sense that they are based on already existing investments and therefore do not require additional investments, as opposed by incremental options.

3.2.6. Growth Options and Options to Expand

Growth options give a firm the ability to expand its business. Examples include research and development, brand development, mergers and acquisitions, leasing or

developing land, or launching a technology initiative. Managers may undertake investments that seemingly have little immediate value in terms of expected cash inflow, but improve the market position of the firm in the long run. Such investments are called "strategic investments" and should form the platform for future expansion. Another property of real option theory is the growth option. They are defined as to "*provide the firm with the right, but not the obligation, to later expand or develop a related product or technology*."[31] These sorts of options are especially important in high technology industries. Under such circumstances it regularly is advantageous to keep R&D activities internalized to profit from future usage of technology.
Demand is uncertain when expanding into a new product market.
Kogut (1991) stipulated that initial investments are equivalent to buying the right, but not the obligation, to expand in future and that the term "real" in Real Option refers to the fact that it is an investment in operating and therefore is different to financial capital. Furthermore he argues that this future potential, the opportunities of growth can represent a high share of a firm's value.

3.2.7. Compound Options

A compound option combines two or more of the above presented options. As can be seen easily, innumerable combinations of various option classes are possible. Below you can see some other classifications:

[31] Leiblein, M.J. (2003), p. 949

Option	Description
Defer	Wait to determine if a better state of nature obtains
Abandon	Obtain salvage value or opportunity cost of the asset
Shutdown and restart	Wait for a better state of nature and re-enter
Time-to-build	Delay or default on a project
Contract	Reduce operations if current state of nature is worse than expected
Switch	Use alternative technologies depending on input prices
Expand	Expand if state of nature is better than expected
Growth	Take advantage of interrelated future opportunities

Table 4: *Alternative classification of Real Options*, adapted from Trigeorgis (1996)

Majd and Pindyck (1987) also qualified many options as compound options:
"*Formally, the investment program is a contingent claim. However, it is not a simple contingent claim: at every instant the manager can choose whether or not to Invest and continue construction. Hence the project is a compound option, where each expenditure buys an option to make the next expenditure*."[32]

[32] Majd, S., Pindyck, R.S. (1987), p. 8

4. Real Options and Financial Options – similarities and differences

Many aspects of financial and real options are quite similar. The most obvious difference lies in the scope of definition: financial options exclusively refer to buying or selling a clearly defined underlying asset, whereas in a real option world the underlying is often not perfectly definable and somewhat vague.

Using financial options, the investor wants to speculate in order to make profits or hedge some specific position against risks; using real options the investor makes a capital investment today in order to realize some future potential. Also in the latter case the investor is not obliged to carry out further investments, but is free to choose whether or not to make additional commitments in future. The main analogies are summarized in the following figure:

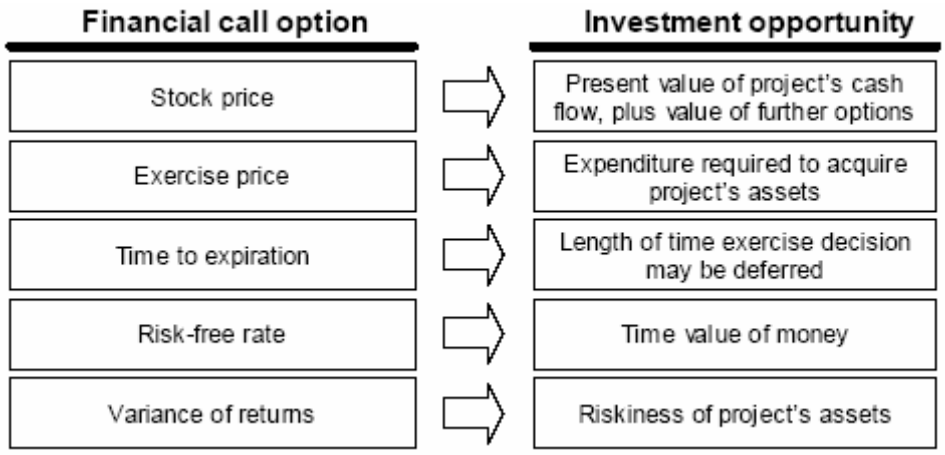

Figure 6: *"Analogy between financial options and real options (investment opportunities)"* Source: adapted from Luehrman (1998)

Dixit (1992) drew a nice analogy between financial and real options: "*The opportunity to make a real investment is akin to an American call option – a right but not an obligation to buy a stock at a present price called the strike price or exercise price. For the real investment I am considering, the exercise price is the sunk cost of the project. If the option is exercised, the firm acquires ownership of a stock that pays a dividend*

stream […]. The net worth is called the 'intrinsic value' of the option. But exercising the option at the instant at its intrinsic value becomes positive is not optimal, because the option also has a value of waiting, called the 'holding premium' or the 'time value'. One should wait until the holding premium falls to zero."[33]

Burger-Helmchen (2004) also composed analogies between real and financial options: "*The financial option is one contract specifying the different 'options' the buyer and the seller have, and none can influence the value of the option. In the opposite for a real option, the different action that the firm as a whole or the different individuals composing the firm can undertake change the value of the firm. This is especially due to uncertainty. In the case of financial option the uncertainty is on the underlying asset movements, there is no uncertainty in the course of action that must be taken to maximise the value of the option holder e.g. if the price of the underlying asset is above the striking price at the expiration date, exercise the option. For real options the course of action that must be taken is more uncertain and can be modified by organisational pressure*."[34] In addition, the company has two distinct advantages over the market: First, incentives can be aligned in a more effective way and secondly the firm can define its own employment rules.

Without any doubt there are certain transition problems if one moves from the financial world to organizational decisions. There are various technical and theoretical challenges that need to be addressed to answer the following question: "*does option pricing of contingent claims work in the context of organizational and behavioral biases*?"[35]

[33] Dixit, A. (1992), p. 116
[34] Burger-Helmchen, T. (2004), p. 17f.
[35] Kogut, B., Kulatilaka, N. (1994), p. 2

5. Conceptual approaches describing organizational decision making

One of the milestones in the evolution of firms' theory was Coase's famous scientific article "The nature of the firm" (1937). His goal was to establish clear assumptions in economic theory.

His central question was the following: "*why is there any organization?*"[36] Well, the main goal of a firm is to coordinate production. One has to keep in mind that planning processes within firms are different to planning in a whole economy. And, when looking at various sectors of an economy, one notices that even firms are not homogenous at all. A firm supersedes the price mechanism. Smith, discussing the conception of the capitalist, prominently pointed out that "*the undertaker busies himself with the division of labour inside each firm and he plans and organises consciously*," but "*he is related to the much larger economic specialisation, of which he himself is merely one specialised unit. Here, he plays his part as a single ceIl in a larger organism, mainly unconscious of the wider role he fills*"[37] The main goal was "*to bridge what appears to be a gap in economic theory between the assumption (made for some purposes) that resources are allocated by means of the price mechanism and the assumption (made for other purposes) that this allocation is dependent on the entrepreneur-co-ordinator*."[38] Most of the discussed problems have been approached by other economists earlier, but from a different point of view – mostly from a labour division perspective.

Using the price mechanism in markets inherits costs, which gives an incentive to establish a firm in order to lower these costs. In general, costs associated with organizing production through price mechanism are costs from identifying relevant prices, costs from negotiating, costs from transaction contract formation and costs of entering a long-term contractual relationship.

[36] Coase, R.H. (1937), p. 387
[37] Coase, R.H. (1937), p. 388
[38] Coase, R.H. (1937), p. 388

Concluding: "*When the direction of resources becomes dependent on the buyer in this way, that relationship which I term a "firm" may be obtained*"[39] This statement is more applicable to the service sector than to the commodity sector. Making a final statement, Coase (1937) wrote the following: "*the operation of a market costs something and by forming an organization and allowing some authority (an 'entrepreneur') to direct the resources, certain marketing costs are saved*."[40]

Note that it is always possible to switch back to open market transactions. In case of complete certainty, no firms would be established, because resources would be allocated exclusively via the price mechanism. "*A firm, therefore, consists of the system of relationships which comes into existence when the direction of resources is dependent on an entrepreneur*"[41] The firm therefore grows as additional transactions are organized by the entrepreneur. It is important to mention that the relationship between size and efficiency is generally unclear, but a possible formation of a monopoly gives incentive for continuous and unlimited expansion.

To examine the issue from a contrary point of view the question to ask would be why do – under uncertainty – market transactions occur, if production costs are lowered within firms? The first argument is diminishing marginal returns with respect to the degree of organization, the secondly failure to put the factor inputs to its best use and Thirdly the price of one needed production factor might rise if the firm gets bigger. These lines of argument can be summed up as diminishing return to management. Regarding these ideas it is also important to note that "*once it becomes economical to have a market transaction, it also pays to divide production in such a way that the cost of organizing an extra transaction in each firm is the same*."[42]
There is a trade-off between diminishing returns to management and rising supply prices, so the question is which factor tends to be more important. Coase presented the following arguments:

[39] Coase, R.H. (1937), p. 390
[40] Coase, R.H. (1937), p. 390
[41] Coase, R.H. (1937), p. 391
[42] Coase, R.H. (1937), p. 392

"Other things being equal, therefore, a firm will tend to be larger:
a. the less the costs of organizing and the slower these costs rise with an increase in the transactions organized.
b. the less likely the entrepreneur is to make mistakes and the smaller the increase in mistakes with an increase in the transactions organized.
c. the greater the lowering (or the less the rise) in the supply price of factors of production to firms of larger size."[43]

A firm basically can expand in two forms: via combination or via integration: "*There is a combination when transactions which were previously organized by two or more entrepreneurs become organized by one. This becomes integration when it involves the organization of transactions which were previously carried out between the entrepreneurs on a market*."[44]

He stated that the price mechanism itself forms an integrating force in the economy. The remaining question is "*why one integrating force (the entrepreneur) should be substituted for another integrating force (the price mechanism)*.[45] Uncertainty implies that future wants of consumers have to be predicted by entrepreneurs.

Summing up, one can say that the definitions of Coase (1937) seem to be fairly realistic; the vital question is "*will it pay to bring an extra exchange transaction under the organizing authority?*"[46] The method behind his theory works in the following way: "*Initiative means forecasting and operates through the price mechanism by the making of new contracts. Management proper merely reacts to price changes, rearranging the factors of production under its control*."[47]

Conner (1991) argued that management would have to identify if inputs are likely to generate rents in the short but also in the long run. She concentrated on inputs able to generate rents: The process of discerning relevant inputs relies on managerial intuition and vision. Nonetheless, is has to be mentioned that for such inputs two types of constraints are in existence:

[43] Coase, R.H. (1937), p. 393
[44] Coase, R.H. (1937), p. 393
[45] Coase, R.H. (1937), p. 394
[46] Coase, R.H. (1937), p. 399
[47] Coase, R.H. (1937), p. 399

External constraints on inputs can be summed up in three points: "*(a) conditions of demand relevant to the product, (b) public policy and (c) entrepreneurial action.*"[48] In this context, a shift in the market position can also result from sheer luck, such as a change in consumer taste.

Internal constraints on inputs depend on the history of the firm, labelled the *resource endowment*. In the spirit of Rumelt (1987) a firm is a "*bundle of linked and idiosyncratic resources and resource conversion activities*"[49] Those internally linked resources are heavily interrelated. Importantly, it has to be said that input specificity can not be the only source of profits.

A firm can obtain the first-mover advantage if it acquires important resources before competitors can do so. This advantage then translates into lower input costs. In this case the persistence of rents depends on the contract's characteristics, namely on its duration and the costs of enforcement. If a firm finally is the owner of a specific input, this input has to be protected thorough *isolating mechanisms*, as argued by Rumelt (1987). Such isolating mechanisms are for instance the avoidance of imitation by competitors or searching and switching costs resulting from incomplete information.

Dierickx and Cool (1989) formed the argument that " *purchasable assets cannot be sources of long-lived rents, because these assets* can *be traded in the market*"[50] Conner (1991) in turn stipulated that the potential rent of an input is dependent upon the individual input specificity, meaning that the same input might be more valuable to one firm than to another. Nevertheless, she partly shared Dierickx and Cool's (1989) opinion on intangible assets, such as corporate learning, knowledge and competencies. Intangible assets cannot be purchased and therefore can be expected to be more significant to profits than inputs that can be purchased on the market.

[48] Conner, K.R. (1991), p. 134
[49] Conner, K.R. (1991), p. 134
[50] Conner, K.R. (1991), p. 137

5.1. Transaction Cost Economies

The two primary conceptual insights provided by transaction cost theory are that the governance of exchange agreements between economic actors is costly and that governance forms vary in their ability to facilitate exchange depending on the attributes in the transactional environment.

A very important person for the development of the transaction cost theory is Oliver Williamson, whose influential paper "The economic institutions of capitalism" was published in 1985. Processes within institutions – namely firms, markets and relational contracts – were not described as actions inside a "black box"; therefore the governance structure had to be analyzed. Transaction cost economies were applied to "*with special reference to firms, markets, and relational contracting. […] from discrete market exchange at the one extreme to centralized hierarchical organization at the other*"[51]

Coase (1937) was first to formulate the TCE in the 30s. In his words, " *firms and market exchange are alternative methods for coordinating production: the distinguishing mark of the firm is the supersession of the price mechanism*"[52] Via an organization, one can save marketing costs and only has to handle one – although more complex – contract instead of many.

Williamson started to extend this approach in the 70s by focusing on opportunistic potential. Three conditions are relevant in this case: "*asset specificity, small numbers of potential transactors, and imperfect information*."[53] He argued that if there was no opportunistic potential, firms simply would not exist, because their purpose is to decrease this kind of potential.

Further extensions were made by Klein and Leffler (1981) and again Williamson (1985) in the 80s. They argued that the opportunistic potential of two independent parties can be offsetting and therefore that a stable relationship can be maintained.

[51] Williamson, O.E. (1985), p. 16
[52] Conner, K.R. (1991), p. 130
[53] Conner, K.R. (1991), p. 131

5.1.1. Assumptions

There are two main assumptions associated with TCE: First, individuals within a firm are exposed to bounded rationality and secondly, economic actors are behaving opportunistically. That implies that individuals basically are confined in planning the future and in assessing all possible alternatives. The accumulation and interpretation of information is costly, the same applying to the identification of potentially opportunistic behaviour.

5.1.2. Theoretical Underpinnings

Williamson stated that TCE, in comparison to other economic organization approaches…

"(1) is more microanalytic,

(2) is more conscious about its behavioral assumptions,

(3) introduces and develops the economic importance of asset specificity,

(4) relies more on comparative institutional analysis,

(5) regards the business firm as a governance structure rather than a production function, and

(6) places greater weight on the post institutions of contract, with special emphasis on private ordering (as compared with court ordering)."[54]

Hereby the basic unit of analysis is the transaction. If transactions are assigned to governance structures, transaction costs can be minimized.

The commonly used definition of transaction costs was given by Kenneth Arrow (1969): He defined "*transaction costs as the 'costs of running the economic system*"[55]

An interesting analogy to the world of physics indicates the following: the absence of frictions in physics is an unrealistic assumption – the same applies to its equivalent in the economic world, namely transaction costs. Due to the fact that transaction costs

[54] Williamson, O.E. (1985), p. 18
[55] Williamson, O.E. (1985), p. 18

could not be described conceptually, they were largely neglected by scientific research. Most commonly, the firm was described as a production function.

Transaction costs occur *ex ante* and *ex post* of a transaction. Let's first take a look at the *ex ante* types:
"*The first are the costs of drafting, negotiating, and safeguarding an agreement*."[56] If contracting difficulties occur, parties tend to substitute internal organization for open market transactions.
Ex post costs of contracting arise from different sources: These include
"(1) the maladaption costs incurred when transactions drift out of alignment in relation to what Masahiko Aoki (1983) refers to as the "shifting contract curve"
(2) the haggling costs incurred if bilateral efforts are made to correct misalignments,
(3) the setup and running costs associated with the governance structures (often not the courts) to which disputes are referred, and
(4) the bonding costs of effecting secure commitments."[57]
Especially the way in which expected benefits will be divided is target of intense bargaining.
Ex post and *ex ante* costs of contracting are heavily interdependent and difficult to quantify. There are few valid valuation techniques, therefore stochastic models have to be applied.

Summing up, there are five relevant TCE factors:
"1. Holding the nature of the good or service to be delivered constant, economizing takes place with reference to the sum of production and transaction costs, whence tradeoffs in this respect must be recognized.
2. More generally, the design of the good or service to be delivered is a decision variable that influences demand as well as costs of both kinds, whence design is appropriately made a part of the calculus.

[56] Williamson, O.E. (1985), p. 20
[57] Williamson, O.E. (1985), p. 21

3. The social context in which transactions are embedded-the customs, mores, habits, and so on-have a bearing, and therefore need to be taken into account, when moving from one culture to another.
4. That relies in a general, background efficacy of competition to perform a sort between and less efficient modes and' to shift resources in favour of the especially if the relevant outcomes are those which appear over intervals of five and ten years rather than in the very near. This intuition would nevertheless benefit from a more fully developed theory of the selection process. Transaction cost arguments are thus open to some of the same objections evolutionary economists have made of orthodoxy (Nelson and Winter, 1982, pp. though in other respects there are strong complementarities (pp. 34- 38).
5. Whenever private and social benefits and costs differ, the social cost calculus should govern if prescriptive treatments are attempted."[58]
As one can see in the graph inserted below, there is a basic distinction between the monopoly and the efficiency branch. To put it more precisely: "*The monopoly approaches ascribe departures from the classical norm to monopoly purpose. The efficiency approaches hold that the departures serve economizing purposes instead*."[59]
There are four *monopoly* approaches: leverage, price discrimination, entry barriers and strategic behaviour. The leverage and the price discrimination theory both focus on buyers. Entry barriers and strategic behaviour in turn focus on contracting practices in response to competitors. They formalize the concerns of a monopoly to lose its privileged position. Again, under a neoclassical regime the firm is considered to be a production function.

On the *efficiency* side one finds four approaches as well, namely property rights, agency, governance and measurement. Regarding the property rights literature "*ownership matters, where rights of ownership of an asset take three parts: the right to use the asset, the right to appropriate returns from the asset, and the right to change*

[58] Williamson, O.E. (1985), p. 22 f.
[59] Williamson, O.E. (1985), p. 23

the form and/or substance of an asset."[60] This concept refers to the *ex ante* side of the contract and resource misallocations occur frequently.

The agency literature basically stipulates that "*principals contract in full awareness of the hazards that contract execution by agents poses. Thus although the separation of ownership from control attenuates profit incentives, that is anticipated at the time separation occurs and is fully reflected in the price of new shares*."[61] Also in this case *ex ante* decisions are decisive – namely the alignment of incentives. The same problem is considered in the principal-agent literature. Here contracting dysfunctions occur due to differing private information. The TCE approach is divided into a governance and a measurement branch. Under a TCE system the importance of *ex ante* incentive alignments is emphasized. A rather new finding is that also institutions that provide support *ex ante* should be taken into account. The complexity of the problem further rises, because "*The behavioural attributes of human agents, whereby conditions of bounded rationality and opportunism are joined, and the complex attributes of transactions […] are responsible for that condition.*"[62]

[60] Williamson, O.E. (1985), p. 27
[61] Williamson, O.E. (1985), p. 27
[62] Williamson, O.E. (1985), p. 29

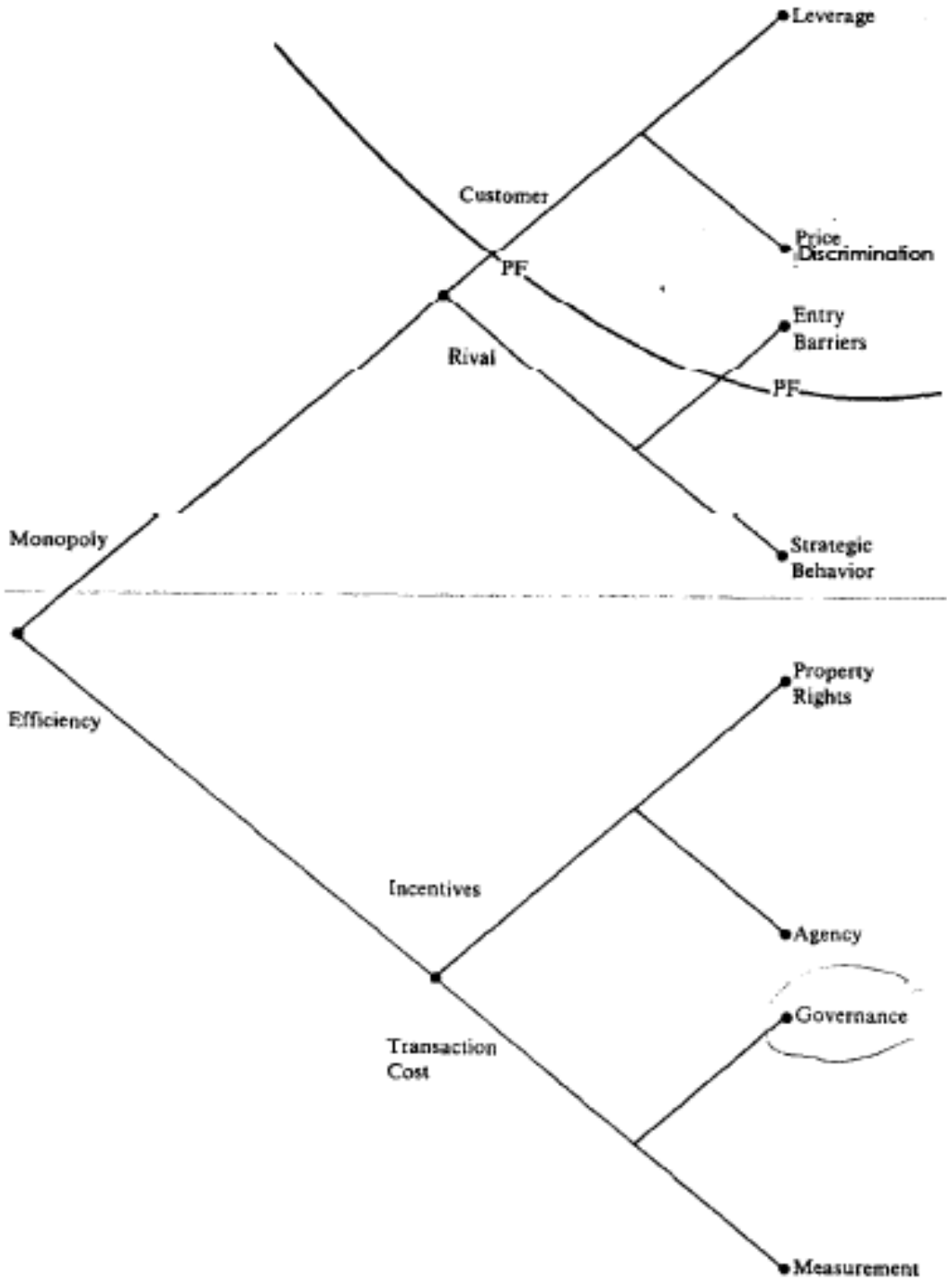

Figure 7: *"A cognitive map of contract"* Source: Williamson, O.E. (1985), p.24

Also the world of contract should be discussed to some extent; the world of contract is usually described as "*one of (1) planning, (2) promise, (3) and (4) governance (or*

private ordering)."[63] The main TCE parameters are bounded rationality, opportunism and asset specificity. Four contracting processes result out of those four dimensions, as can be seen in the table:

Behavioral Assumption

Bounded Rationality	*Opportunism*	*Asset Specificity*	*Implied Contracting Process*
0	+	+	*Planning*
+	0	+	*Promise*
+	+	0	*Competition*
+	+	+	*Governance*

Table 5: *"Behavioural assumption"* Source: Williamson, O.E. (1985), p. 31

To describe the table more precisely, it can be said that unbounded rationality results in a world of planning, that in absence of opportunism a world of promise is prevalent and that if assets were unspecific, we would have a world of competition. The last case establishes the framework for TCE: "*Each of the three devices fails when bounded rationality, opportunism, and asset specificity are joined. Planning is necessarily incomplete (because of bounded rationality), promise predictably breaks down (because of opportunism), and the pairwise identity of the parties now matters (because of asset specificity). This is the world of governance*."[64] Under such a regime a more complex and larger conception of economic problems is supported.

5.1.3. Asset Specificity and Uncertainty

Williamson identified six forms of asset specificity, being site specificity, physical asset specificity, human asset specificity, dedicated asset specificity, brand name capital specificity and temporal specificity. All those specificities have to be related to uncertainty in order to measure their effects on organizational choice.

[63] Williamson, O.E. (1985), p. 30
[64] Williamson, O.E. (1985), p. 32

In 1994 Dixit and Pindyck identified two kinds of uncertainty:
Technical uncertainty: "*relates to the likely costs and probabilities of accomplishing technical success;*"[65] This sort of uncertainty puts pressure on the company to invest immediately, which leads to timing dilemmas.
Input cost uncertainty: is related to the outside world of the firm, i.e. it is an exogenous factor. This kind of uncertainty is in opposition to the previous one, because it poses an incentive to delay investment until the arrival of new information.
McGrath (1997) conceptualized a third type of uncertainty that lies in between the previous two. "*It is present when sources of uncertainty are largely 'external' to the firm […] but can be influenced by strategic action.*"[66]

5.2. Resource Based View

Conner (1991) examined if the RBV would be elaborated enough to stipulate a complete theory of the firm. She compared the RBV to five more established theories of the firm. In general, following Holmstrom's and Tirole's (1989) argument, a theory of the firm should try to answer two vital questions: first, what is the purpose of the firm and secondly how are scale and scope of the firm determined. In any case, the central goal of a firm in this context is to maximize profits, but it tries to achieve that by different means.

She additionally gave the following example: A firm wants to engage in a research project to develop a new product. It faces the two possibilities of in-house research or contracting an outside team: In-house development will be more attractive, if the research project is potentially specific to already existing operations inside the firm, because the process of researching alone can already add additional value and the firm

[65] McGrath, R.G. (1997), p. 976
[66] McGrath, R.G. (1997), p. 977

might find it advantageous to find the know-how possessor inside its own ranks. Remember that rents can stem from the sheer linkedness of a firm's resources. The firm may also find it appealing to form a joint venture, because it "*may offer the benefits of exposure to outside capabilities, but also can be expected to involve the costs of results that are less specific to and harder to redeploy within the firm*"[67]

The last question addressed by the author was: "*Why are the firm's activities conducted as a firm instead of as a collection of market transactions?*"[68] The RBV establishes a reason for the existence of a firm in the absence of opportunism, because it implies "*a theory of the firm's existence that turns on advantages (over the market contract) in inter-component knowledge transplantation and in the creation-redeployment of specific assets*."[69] Here, firms exist because they can take advantage of idiosyncratic assets through their equally idiosyncratic structure.

5.2.1. Assumptions

The most important assumptions connected with RBV are that profit-maximizing entities are directed in a world of bounded rationality and that firms must make up-front investments.

Managers are boundedly rational, which means that they cannot objectively predict and measure every single future contingency. Additionally, companies have to invest in opportunities whose potential value is vague and uncertain at present time.

5.2.2. Theoretical Underpinnings

Looking at competitive advantage and performance, it can be said that the RBV has created four predictions:

First, certain attributes of resources can be a basis for competitive advantage. RBV in this context distinguishes between valuable resources (resulting in a higher willingness

[67] Conner, K.R. (1991), p. 141
[68] Conner, K.R. (1991), p. 141
[69] Conner, K.R. (1991), p. 142

to pay and reduced opportunity cost, respectively), rare resources (in this case demand is higher than supply) and non-substitutable resources (have a unique value for the implementation of a strategy). This classification was confirmed by various empirical studies.

Secondly, RBV theory discusses the question if a competitive advantage might be sustainable over time. The resource-based view supports this opinion if competition is limited, because under such circumstances successful imitation of crucial resources is difficult.

Thirdly, RBV analyzes the circumstances under which economic profits may be realized. The basic logic is that resources have to stimulate more profit than estimated at their entrance into the organization.

Fourthly, companies can experience constant inflow of economic profits by leveraging resources (of valuable, rare or costly to imitate nature). These positive effects of leveraging can only be realized if competitors cannot anticipate them, if these resources are exposed to imperfect mobility (which implies more value to the "host firm") and if these resources are generalizable (i.e. can also be used for new applications).

5.3. Comparison TCE - RBV

Conner (1991) compared various organizational theories, thereby focussing on the Resource Based View and Transaction Cost Economics. In order to make an exact and sound distinction, she concentrated on attributes that are costly to copy, namely comparative advantages or core capabilities, because they are the source of economic profits. The main aim is to defend such advantageous positions, because resources are directly linked to products and therefore to the firm's payoff. A strategy has to be formulated, being a "*fit between the internal competencies of the firm and external opportunities.*"[70]

[70] Conner, K.R. (1991), p. 122

In this context she also presented the "TCE test" by Coase and Williamson: "*for the existence of a firm to make sense in some business activity, the firm, with its internal network of relationships, must outperform the alternative, in which all such relationships are external, arms-length, market transactions.*"[71] In a RBV context, "*existence needs to be explained in terms of a firm's superiority to* two *alternative forms of organization: a collection of market contracts* and *other firms.*"[72]
In RBT, the concept of asset specificity is central, whereas the avoidance of opportunism has relatively little relevance. "*instead of viewing the firm as an 'avoider of a negative', the resource-based literature tends to see the firm as the 'creator of a positive', as creator of unique productive value.*"[73] Firms can also supersede the market by higher productivity or higher efficiency.

The objective of any firm in our context is to earn above-normal returns. A firm can realize that objective through either distinctiveness (from the consumer's point of view) or through lower costs in production. The central question posed by the RBV is how can the firm maintain its advantage of low costs or distinctiveness? The firm in this context is an input-combiner. In a RBV world, persistent above-normal earnings are possible through the application of uncopyable assets that were achieved through innovation. To sum up, "*RBT sees these returns as resulting primarily from the acumen or luck of the firm in acquiring, combining, and deploying resources*.[74] Therefore the company tries to find unique or at least costly-to-copy inputs.
The main similarity between RBV and TCE is that "*asset specificity and small numbers are critical concepts constraining the firm's strategic options*" and the main distinction that "*the heart of the firm centers on deployment and combination of specific inputs rather than on avoidance of opportunism.*"[75]

The main difference between TCE and RBV, again regarding to Conner (1991), is the following: In a TCE world, the same inputs are equally effective in the firms or the

[71] Conner, K.R. (1991), p. 139
[72] Conner, K.R. (1991), p. 139
[73] Conner, K.R. (1991), p. 139
[74] Conner, K.R. (1991), p. 132
[75] Conner, K.R. (1991), p. 133

market – except for problems of opportunism, there would be no difference. Under a RBV regime, inputs will be more specific to one firm than to any other institution. However that does not mean that the RBV rules out the existence of opportunistic behaviour, it only presents a different approach. The firm is an input combiner and efficiency seeker with respect to distribution and production; furthermore success also depends on the firm's environment which can be shaped partly by the company itself.

5.4. Real Option Analysis

One field of application of ROA lies in organizational strategic management. A definition concerning strategy by Schendel and Patton (1978) stipulated that "*Strategic decisions usually, if not invariably, involve choices regarding the investment of organizational resources*"[76] The key objective of strategic management is to capture rents. There are basically two ways of doing so: first through formation of a monopoly, secondly through successful application of firm-specific routines that represent a comparative advantage. Such relative advantages can be achieved in various ways, for instance through learning processes or sheer luck. Due to those situations, different firms have different uncertainty profiles, influencing their options.
This decision making process is exposed to uncertainty. The basic idea is that strategy is not something which can be applied exogenously, but it rather emerges directly from disposable resources. Options in that context form a process of how to allocate the resource investments inside the firm. These processes are subject to many interrelationships, which makes the solution anything but trivial.

The idea behind option theory is to leave various alternatives open – "*retain the right to future investment choices without being obliged to invest (Cox, Rubinstein, 1985)*"[77] Sunk cost premium payments are the only risk associated with (long) options. The

[76] Bowman, E.H., Hurry, D. (1993), p. 760
[77] Bowman, E.H., Hurry, D. (1993), p. 761

choice that the owner of the option has to make is to exercise the option, if conditions are favourable or to abandon the option, if conditions are unfavourable. Today it is commonly accepted that initial, prior investments are necessary to increase the probability of later success.

An option gives "*preferential access to an opportunity for investment choice*"[78] At the same time, downside exposure is limited, because the tenant has the right but not the obligation to exercise the option.

"*The resource-based analysis gives us minimal values of the real option, and real option analysis can give us the maximal values of the resources. So we obtain lower and upper limits, the value of the firm must be somewhere between those two extremes.*"[79]

Real option theory connects the choice of the governance form with a firm's performance. Leiblein in 2003 made a review of already existing literature "*as applied to decisions involving firm boundaries, the acquisition and development of resources, and economic performance*."[80]

The real option theory is one of the emerging theories to valuate investment opportunities in an uncertain environment. It up to now has been applied to many fields of business: corporate growth, flexibility, entrepreneurial failure, joint-ventures, market entry and organizational governance. Also the boundaries of the approach have been discussed in literature.

Concerning strategic management the scientific research identifies two aspects:

First, "*there are opportunity costs associated with irreversible investment under uncertainty*."[81] Because of that the ability to defer investments under uncertainty is of great importance. Secondly, growth options, that are sequential investments opportunities of foregoing investments, have to be considered.

Those two aspects create management flexibility. The aim must be to actively confront uncertainty, rather than trying to avoid it.

[78] Bowman, E.H., Hurry, D. (1993), p. 762
[79] Burger-Helmchen, T. (2004), p. 24
[80] Leiblein, M.J. (2003), p. 938
[81] Leiblein, M.J. (2003), p. 948

The final property is that real option theory helps "*how firm-level characteristics affect decisions regarding organizational form.*"[82] As an example one could state that even if the demand for a given process technology is low, the potential future applications of this technology can positively exceed the R&D costs in the long run and eventually lead to a comparative advantage. A well diversified firm is more likely to act in such a way.

Based on the idea of resource heterogeneity "*the real option theory indicated that governance choices may also be shaped by firms' unique perceptions regarding future value generating opportunities*."[83] The real option approach lays a strong emphasis on risk, because the possible future cash flows are discounted and potential follow-on investments are taken into account. More precisely, the real option theory puts weight on the upside potential for profits associated with uncertainty. Firms take decisions subjected to their estimations. The identification of a bundle of resources forms the centre of real option analysis.

5.4.1. Assumptions

Two key assumptions underlie the real option perspective:

Leiblein (2003) identified the two assumptions underlying the real option perspective: "*The first assumption is the ability of managers to write contracts that provide the opportunity for follow-on investments. This assumption implies that managers possess a level of foresight sufficient to engage in negotiation over the price and provisions associated with a call option, ex ante, that will mitigate ex post bargaining costs and opportunities for the seller to hold-up the buyer*."[84]

The second assumption depicts that it has to be possible to specify an expected future stream of cash flows associated with an investment. The potential future value has to be estimated.

[82] Leiblein, M.J. (2003), p. 950
[83] Leiblein, M.J. (2003), p. 951
[84] Leiblein, M.J. (2003), p. 948

Out of those two assumptions, one can get to the following implications:
First the author presents the concept of Modigliani and Miller (1963), stating that the overall value of a company has to components: the present value of both current assets and expected profit from current assets. Myers (1977) argument forms the second implication that traditional evaluation techniques will often underestimate the value of the option, because managers can react flexibly to changes in the environment.

5.4.2. Theoretical Underpinnings

It is well understood that a real option theory needs a theory of the firm as a foundation, to better identify the different value drivers. Generally, the firm's role is the most appropriate form of handling future's uncertainty and protecting knowledge.
Leiblein and Miller in 2003 elaborated a convenient overview on some of the most important findings in Real Option Therory, thereby including scientific discoveries of Bowman and Hurry (1993, definitions), Kogut (1999, Real Option Theory) and Trigeorgis (1996, examples).

During that process three mechanisms of the real option theory that could possibly influence the decisions of a company have been identified:
The first argument relies on the perception that firms are an aggregation of investment opportunities. Secondly, the importance of real options under high uncertainty is emphasized. The basic thought is that a firm can achieve higher flexibility via market contracting than via integrated production. "*real options theory suggests market exchange may still be the optimal form of governance if the flexibility benefits created by avoiding irreversible commitments offset the cost of these more immediate inefficiencies*."[85] The third and final argument deals with platform investments. This point relies on findings by Kim and Kogut (1996): "*firms will be more likely to vertically integrate whenever the manufacturer of one product provides a secure,*

[85] Leiblein, M.J., Miller,D.J. (2003), p. 843

preferential claim on the option to later develop a (potentially lucrative) related product."[86]

Leiblein (2003) presented the properties of ROA: "*The Real Option approach has been used to generate a number of predictions regarding the potential value associated with investments that provide the option holder with the ability to improve performance by expanding into attractive markets or technologies as well as the opportunity to contain downside risk by deferring investment, abandoning operations, and expanding or contracting activities*."[87] This statement again describes the ability to create future opportunities through investments. The easiest possibility to do so is to defer investment, called the option of waiting. This is an important source of flexibility. Even if the expected net value of an investment is positive today, it might still be valuable to wait even longer if expectations point to an again higher net value in future. One of the main dilemmas of this thesis is very well summarized: "*integration will expose the firm to the risk of owning assets that may turn out to have little value due to changes in either the underlying technology or product demand. Market contracting, in contrast, may incur greater short-term marginal production costs but provide the firm with the flexibility to pursue alternative technologies in the future*."[88] Real option theory suggests that it may be suitable to use close to market mechanisms under uncertainty to preserve flexibility.

5.4.3. Individual Options

5.4.3.1. Options to defer investment

Some investments are irreversible, meaning that their future value is uncertain and that costs are incurred in case of full recovery. Committing resources to such options therefore puts more risk on the firm. The option to defer investment consequently is

[86] Leiblein, M.J., Miller,D.J. (2003), p. 843
[87] Leiblein, M.J. (2003), p. 949
[88] Leiblein, M.J. (2003), p. 949

important for flexibility purposes, as it allows the firm to wait for the arrival of new information.

5.4.3.2. Growth Options

Growth Options are also known as options to expand. They are a platform of growth in either yet existing lines of production or in related product markets. These options play an important role in the IT sector, because appropriation regimes are rather weak.

5.4.3.3. Embedded Options

Sharp (1991) emphasized the importance of embedded options and developed a decision-making process partly based on experience and managerial intuition in high-risk environments. The option value increases with uncertainty and time.
His framework basically rests on two assumptions: "*well-informed, experienced managerial judgement is an excellent, practical substitute for exact option valuation; and that managerial judgements must be embedded in a formal decision-making process.*"[89]
One can hardly imagine an investment project that does not contain certain real options besides the obvious cash flow structure. After the valuation of cash flows, the option component of a project should be identified and evaluated. Sharp (1991) suggests three steps in doing so: "*First, managers identify the options embedded in a given investment. second, they evaluate the environment and circumstances in which each might be exercised. Finally, managers judge whether the aggregate value of the options sufficiently outweighs any shortfall in the project's cash flow value*"[90]

He additionally introduced an "option checklist", containing the following points:

[89] Sharp, D.J. (1991), p. 70
[90] Sharp, D.J. (1991), p. 72

Identify options: At first the incremental option component has to be identified; most straight forward is learning that can be transferred to other sectors. Next, flexibility options should be identified. They are often created by excess of exact requirements for one certain project; the most convenient example here would be multiple sourcing.
Analyze environmental uncertainty: "*Uncertainty creates firm-specific opportunities: investments in which learning can be exploited and flexibility exercised*"[91] In the early 90s the majority of investments in the former Soviet area had a "food-in-the-door" function. Investments were not aimed at short-run profits, but rather at the exploitation of future opportunities. Also in this context, incremental options were more important than flexibility options, which were not the primary source of the positive investment decision.
Value project options: Assessment of real options is a very subjective process, because option pricing theory formulas are, due to their heavy assumptions, inapplicable and experience, intuition and sound judgement play a major role. What can be stated, however, is that an increase in uncertainty invariably leads to an increase in option value, that option value increases conformingly to project duration and the value of the option is moving between two limits, namely zero and the NPV of the best – which is the most profitable - alternative.

5.4.3.4. Shadow Options and Option Chains

Opportunities have to be recognized by decision makers, otherwise the firm can not profit from them. Those undiscovered opportunities are labelled "shadow options". At some point in time some of those opportunities become visible and therefore exploitable. After an option has been struck, the effect of exercise will yield a bundle of new options. This process of sequential striking can be seen as an option chain. The ultimate goal of this sequence is to convert shadow options into real options. In the inserted figure, one can see a graphical overview of such an option chain:

[91] Sharp, D.J. (1991), p. 73

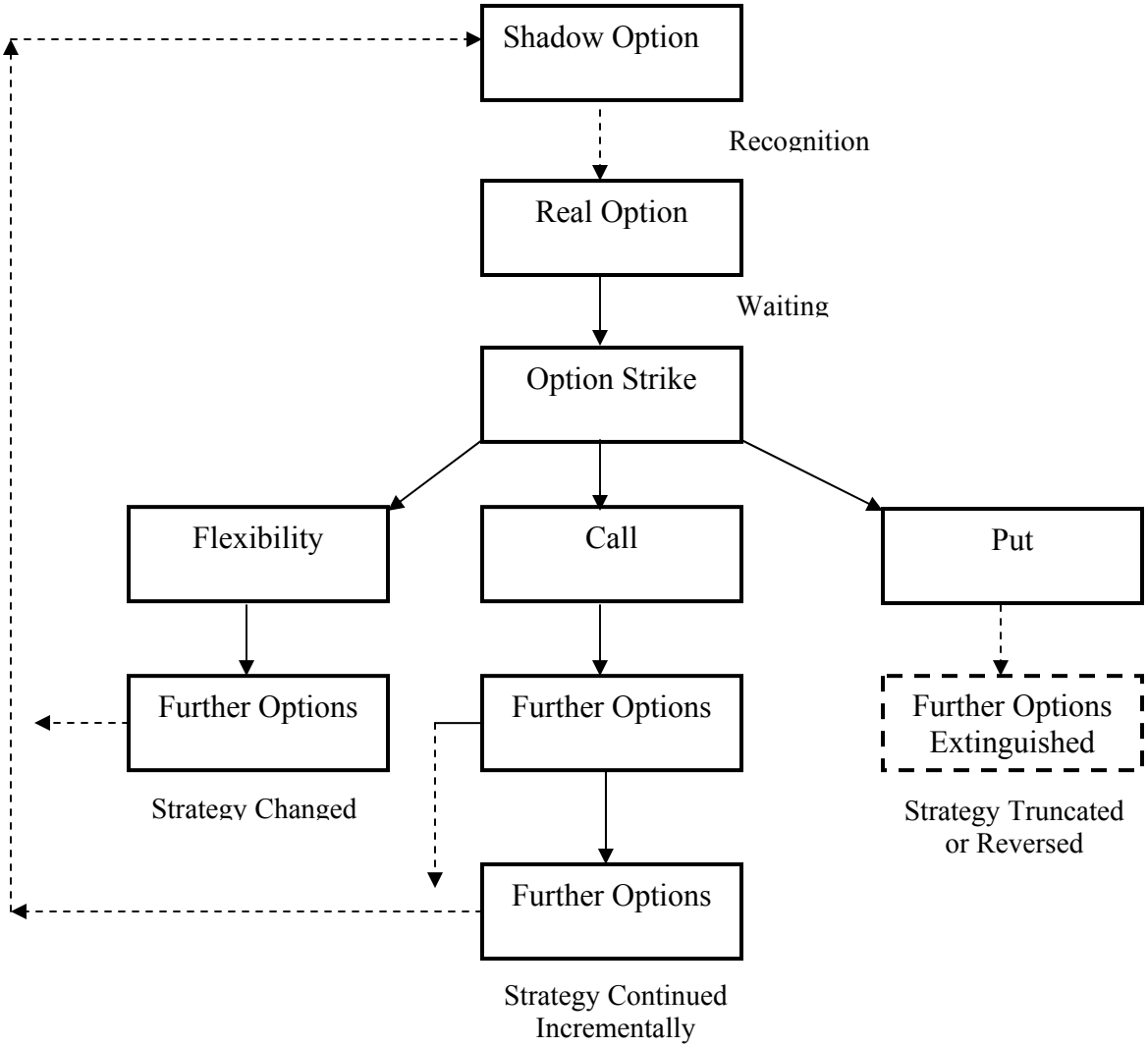

Figure 8: *"A typical Option Chain"* Source: Bowman, E.H., Hurry, D. (1993), p. 764

In the following, I want to present different research propositions to show some of many possible applications:

Downside risk and optimal inertia: in this context the term "bundle of options" should be defined: "*An organization's bundle of options cushions the downside risk of future investments, strengthening its ability to expand aggressively and to withstand losses during the course of growth*"[92] Of great importance are sunk costs, because the previously made payment gives an incentive to the firm to hold on to these investments,

[92] Bowman, E.H., Hurry, D. (1993), p. 765

thereby lowering the share of new investments. This is what is understood by the term "investment inertia". A zone of optimal inertia can be calculated. Certain trigger points are decisive (e.g. maximum loss).

Perceived environmental uncertainty: the well-known argument that an option's value increases with market volatility also holds here. If volatility is high, the company has an incentive to hold on to the option, because of future gains expected to be higher. In case of a smaller volatility, the company has an incentive of exercising the option earlier. What has to be mentioned is that environmental uncertainty is influenceable to some extent, because due to corporate learning the perceived external uncertainty can be diminished. According to March (1991), "*the organization progresses from a phase of exploration to a phase of exploitation*"[93]

The size of organizational investments: one way of looking at small incremental investments is that they help to learn and to experiment before committing a larger bundle of resources. As a rule of thumb a firm uses small investments to develop necessary capabilities before making larger investments that are required to make substantial profits. This means can be seen as resembling the corporate option chain.

The timing of organizational investments: Merton (1973) distinguished between two different types of options: If the underlying asset yields no income, it is optimal to hold the option until its maturity. Theoretically, options can have infinite times to maturity, but in reality the underlying opportunity at some point in time fades away. If the underlying asset is yielding an income, an early exercise may be optimal, however. In this case waiting comes at an opportunity cost.

Hurry in 1993 established the concept of market strike signals, differentiating between two cases: First the signal that indicates the arrival of the opportunity. Secondly the expiration signal: "*Thus, if the first signal merely 'suggests' a practical termination date for the option, the second signal actually 'enforces' it.*"[94] Another positive aspect of waiting is learning about the effects. The expiration signal is less likely to be missed, because decision makers tend to perceive threats more clearly than opportunities.

[93] Bowman, E.H., Hurry, D. (1993), p. 767
[94] Bowman, E.H., Hurry, D. (1993), p. 769

Generally, if an option is exercised very early, the performance is likely to be rather poor. Concerning puts one has to remark that they always carry an opportunity cost, if the money could have been invested more profitable elsewhere.

The portfolio of options: it is vital to sharply distinguish between the terms "portfolio of options" and "an option on a portfolio of assets". A portfolio of options is in existence if "*the organization's structure allows individual options at the business and functional levels of operations to be struck independently*"[95], whereas an option on a portfolio of assets prevails if "*it is possible for a single decision [maker] at the top of the hierarchy to summarily dispose of a business.*"[96] It is considered to be more profitable to hold an portfolio of options, because corporate options are held separately, thereby increasing the firm's flexibility.

Four decisive theoretical themes need to be discussed from an option perspective, namely resource allocation, sense making, strategic positioning and learning. These four issues can be distinguished along two dimensions that can be seen in the graph below:

[95] Bowman, E.H., Hurry, D. (1993), p. 770
[96] Bowman, E.H., Hurry, D. (1993), p. 770

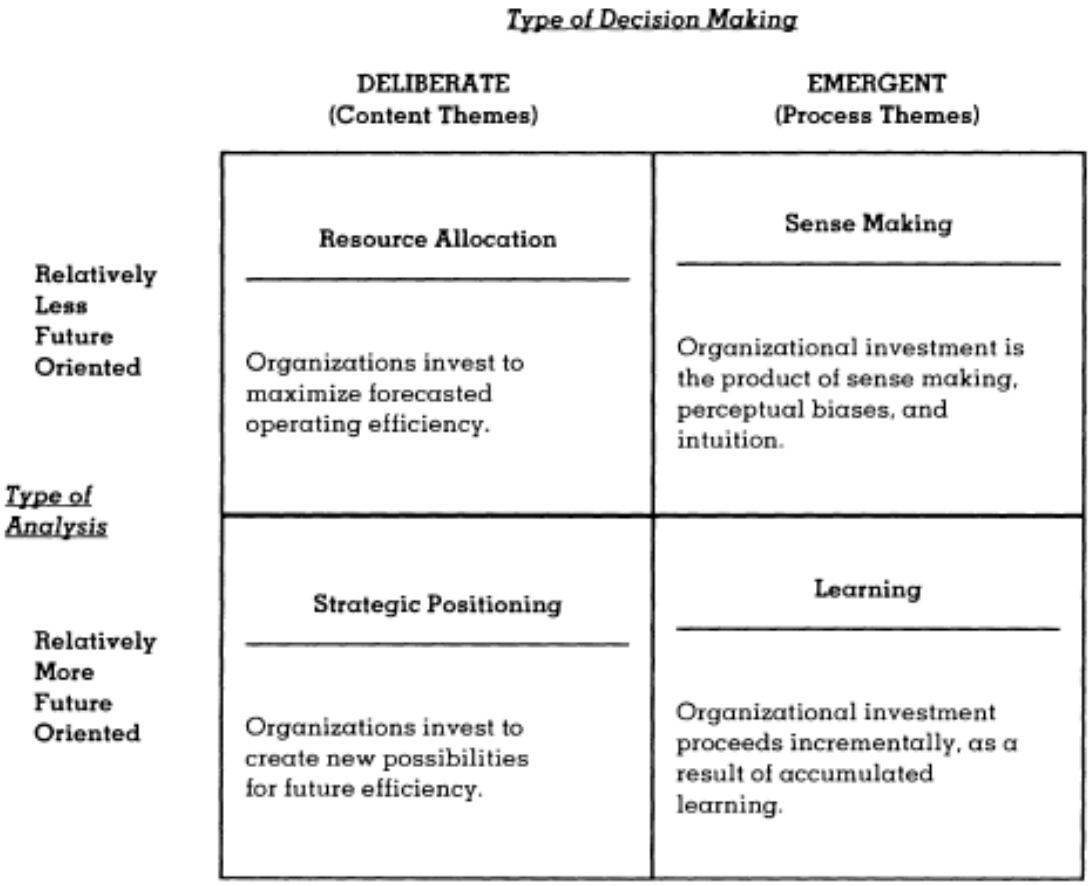

Figure 9: "*Strategy Themes integrated by the Option lens"* Source: Bowman, E.H., Hurry, D. (1993), p. 772

Resource allocation: deals with the efficient use of a company's resources.
Sense making: emphasizes the point that decisions are not rational, but rather depend on interpretation, experience and intuition. They form a natural decision making process.
Learning: means acquiring knowledge and is often based on trial-and-error experiments.
Strategic positioning: the basic idea is that every company wants to sustain superior performance in the long run. The concept of competitive advantage is primarily important in this context.

If one integrates these four themes under the regime of option theory, one can see that organizational investments are always ambiguous: "*Organizational investments provide current returns and cash flow, on the one hand, and they open up options, on the other.*

A firm is valued as a going concern on the assumption that it will continue to invest. Therefore, its market value includes the value of these options. The value of the firm is thus the sum of earnings generated by investments in place plus the option value of future strategic choices."[97] According to Kester (1984), this option component, representing growth potential, can make up for more than 50% of a firm's value. So-called "latent assets" are included.

A nice example was stated by Bowman and Hurry (1993): They apply the option theoretic approach to Research & Development, claiming that "*Investment in R&D […] is like a bet. […] … 'R' represents the price of the option, and the 'D' represents its strike value should the bet turn out favourably.*"[98] Going back to the option chain, it is important to say that small and large investments are strongly interrelated. Summarizing, the authors declared that "*Options thus actually form the inimitable resources that give an organization its sustained performance and competitive advantage.*"[99]

At the end of this section I want to present some counter-intuitive findings:
Strategy and selection: an organization is permanently exposed to changes in its immediate environment. The environment at some points in time offers opportunities that are inexistent at other points in time. A company has to position itself in an advantageous way today to profit from opportunities tomorrow.
The garbage can: March and Olsen argued in 1976 that solutions exist in advance of problems. To draw an analogy to Bowman's and Hurry's (1993) model, one can view shadow options as solutions and opportunities as problems.
Means consensus: to find consensus about corporate goals is less important than finding an agreement about the means of corporate strategy.
The risk-return paradox: if we consider rather risk-seeking strategies like leveraged operations, managers tend to strike options earlier, even with insufficient information. There is a clear problem of asymmetric information: "*In this case, because they are*

[97] Bowman, E.H., Hurry, D. (1993), p. 773
[98] Bowman, E.H., Hurry, D. (1993), p. 774
[99] Bowman, E.H., Hurry, D. (1993), p. 775

protected by limited liability, owners gain from the upside potential of the firm's investments, leaving debtors to carry the full downside risk of bankruptcy. In this situation, managers have an incentive to take more risks in maximizing shareholder wealth."[100]

Burger-Helmchen (2004) also laid the focus of his scientific research on shadow options and the option chain. He stated that the shift from a shadow to a real option includes some heuristics. Heuristics are commonly used in science, especially in business: "*In using heuristics they make simplifications that allow the development of ideas, enable them to continue without answering all possible problems that can arise*."[101] This evolution often contains coincidence and does not only follow a logical path. He then made a distinction between epistemic and practice communities (Cohendet and Llerena, 2003), applying it to the real option world by declaring that: "*The passage from a shadow to a real option corresponds to the modification of the epistemic community into a community of practice. The type of management has also to change from an entrepreneur to a manager*"[102]

A differentiation between shadow and real options, can be seen in the below inserted table.

"*We determine boundaries for four variables that intervene in the real option analysis namely: the premium that is endured to acquire the option, the striking price for exercising the option, the gain if the option is exercised and the value of the option. Two parameters usually found in real option are omitted, the interest rate (assumed constant) and the time to expiration*."[103]

The most important aspect of this discussion is that the value of a shadow option is equal to its intrinsic value plus the speculative value, that the value of a shadow option is only a transition point to guide real option evaluation and that overoptimistic analyses confuse value of shadow option with value of real option; generally,

[100] Bowman, E.H., Hurry, D. (1993), p. 776
[101] Burger-Helmchen, T. (2004) p. 12
[102] Burger-Helmchen, T. (2004) p. 15
[103] Burger-Helmchen, T. (2004) p. 19

competences can be obtained either through R&D (which is time consuming) or through acquisition (which is expensive).

	Shadow option (SO)	Real option (RO)
Premium (P)	P_{SO} -The cost of the entrepreneurial resource that launches the process. -Organizational Slack -Cost of additional formation, without a direct link to productivity.	P_{RO} -If follows the exercise of the shadow option, the exercise price and the premium of the shadow option ($P_{SO} + K_{SO}$). -If the firm does not have the previous shadow option, at least S, given though dynamic transaction costs.
Exercise price (K)	K_{SO} -Cost of convincing decision maker to spend financial resources to search and tie row resources. - Cost of monitoring the employee.	K_{RO} Cost to acquire the necessary assets to enter production (plant, workers…)
Gain if exercise (S)	S_{SO} The value of best use of the new combination of resources.	S_{RO} Present value of future cash flows generated.
Value of the option (V)	V_{SO} The value of the shadow option is greater than the gain S because it incorporates the strategic possibilities of the future.	V_{RO}. As calculated by traditional real option evaluation models (uncertainty on demand, further development etc…)

Table 6: "*Cost and Value of Shadow and Real Options"* Source: Burger-Helmchen, T. (2004) p. 29

5.4.4. Investment Timing and the Option to Wait

Concerning timing of investment, Dixit (1992) argued that waiting to invest has a positive value, when the following conditions are present: investment is linked to sunk costs, uncertainty prevails, additional information arrives gradually and the investment opportunity will not disappear. Nonetheless, there is an obvious trade-off: The question is when an investment opportunity is sufficiently favourable to enter into. The same applies again to questions of disinvestment. So far, the argument simply said that "*waiting has a positive value, but not whether this value is typically large enough to have a significant impact on investment and disinvestment decisions.*"[104]
Within his regime, Dixit (1992) undertook the following assumptions: Future revenues are not perfectly predictable; hence they can only be estimated. Revenues increase or decrease by a fixed percentage per time unit (to be more precise it follows a geometric Brownian motion). For simplicity, the trend rate of revenues is set equal to zero. The goal is to maximize the present value of profits and investors are risk neutral.

There are some concepts that require closer examination:
The effect of waiting: If it is possible for an investor to wait and reassess the decision later, the following can be observed: "*waiting for a certain amount of time enables an investor to avoid the downside risk in revenues over that interval, while realizing the upside potential. […] On the other hand, the cost of waiting is the sacrifice of the profit flow over the period of waiting*."[105] If a certain, exogenously determinable trigger is reached, investment is finally carried out.
The optimal policy: Now the investment trigger is no longer given externally, it has to be chosen internally. Purely conceptually, the trigger should be "pushed" as far as possible in order to maximize value. The problem associated with this tendency is that a speculative bubble would be formed: "*the value of waiting would be high because the*

[104] Dixit, A. (1992), p. 109
[105] Dixit, A. (1992), p. 111

prospect of reaching an even higher R [= revenues] *would offer an even higher value of waiting, with no actual investment ever in sight.*"[106]
The importance of option values: Most generally, when there is little uncertainty, also the value of waiting is low.

This above stated model is oversimplified due to its very rigid assumptions. For instance, considering a geometric Brownian motion implies that uncertainty is roughly symmetric when looking at the trend. This does however not correspond to reality, as Bernanke's (1983) bad news principle stated: "*the downside risk is the primary force governing optimal investment decisions when waiting is possible.*"[107] Moreover, when there are many competitors in the market, waiting may not be longer optimal, because there is a contest for this scarce opportunity. Lastly, information between firms may simply differ.
What happens if a firm suffers operating losses from a project? In this case temporary suspension will be carried out, if possible. Here the option to wait influences the abandonment decision: "*The gross revenue has to fall some way below the operating cost before abandonment becomes optimal.*"[108] Interestingly, the possibility of abandonment directly influences the entry trigger:"*if abandonment is costly […] then the entry trigger is higher; firms are more cautious in undertaking a venture they may have to abandon later at a cost."*[109]

Also management culture matters a lot. If we look at the economic situation in the 90s, among US managers, in comparison to their Japanese colleagues, short-term thinking was prevalent, leading to the phenomenon that US firms tended to abandon projects after short periods of losses, while Japanese firms were more reluctant to leave such projects, if there was some potential for future improvement. One argument for these findings was the lifetime employment system in Japan; in such an environment labour is quasi fixed.

[106] Dixit, A. (1992), p. 114
[107] Dixit, A. (1992), p. 118
[108] Dixit, A. (1992), p. 120
[109] Dixit, A. (1992), p. 120

The introduction of competition leads to a new assumption: uncertainty is exogenously given to all the active, price-taking firms. Here the market price of a product will oscillate between two prices: if the upper limit is reached, new firms will enter the market and prevent an even further rise. If the lower limit is reached, firms will enter into bankruptcy and therefore exit the market, preventing an even further decline.

McDonald and Siegel (1986) also wrote about optimal investment timing when a company faces an irreversible project, such as building a plant. Their goal was to establish an optimal decision guideline under the assumption that investors are well diversified and risk-averse. They explained the prospect of their scientific paper in the following way: "*In this paper we explore the practical importance of the value of waiting to invest, assuming that investment timing decisions are made by risk-averse investors who hold well-diversified portfolios.*"[110] Their model is based on the option to wait – i.e. timing considerations are important.
A firm facing an investment opportunity bases its decision on discounted expected cash flows. The future value of the project is exposed to uncertainty and follows a stochastic movement. In addition, there is a problem of "optimal scrapping": "*In general, it will be optimal to scrap only when the selling price exceeds the project value by a positive amount.*"[111]

As with financial options, an increase in the variance leads to an augmentation of the maximum possible gain, while leaving the maximum possible loss unchanged. Similarly, a decrease in the correlation will increase the option value as well. Investors are well diversified and because of that they only require compensation for the systematic risk part of investment projects. An increase in the systematic risk component leads to a decrease of the option value. A risk premium is an additional earned unit in proportion to the underlying asset's risk. The optimal decision rule stipulates the following: "*it is optimal to invest when the opportunity cost from not*

[110] McDonald, R., Siegel, D. (1986), p. 707
[111] McDonald, R., Siegel, D. (1986), p. 711

installing the project equals or exceeds the opportunity cost saved by deferring installation."[112]

5.4.5. Technological Platforms and Technology Positioning

Kim and Kogut (1996) discussed the formation of so-called technological platforms and the derivation of technologies. One aim is to acquire know-how that is applicable to a vast range of market opportunities and thereby achieving competitive knowledge. "*The authors propose that a firm's experience in platform technologies increases the likelihood of diversification when environmental opportunities are favorable*."[113] As a sample this paper considered 176 semiconductor start-up companies. The most important finding was that diversification depends on two things, namely on technological experience and on market opportunities.

"*Developing competence in new but broadbased technological skills is an investment in a platform to participate, by a process of expansion and diversification, in the evolution of future opportunities.*"[114] In order to expand under favourable market conditions, it is especially important to accumulate experimental know-how. Such opportunities provide an option to diversify into new markets. Technologies differ in their usefulness to diversify in new fields: they can, on the one hand, be a starting point for the development of new resources and, on the other hand, be limited to certain applications. One has to distinguish between the above described experience and the timing of diversification. The authors found strong support for the opinion that certain subfields serve as platforms for the entry into other market segments.
Their findings can be summarized in the following way: First, the stronger markets grow, the more likely firms will diversify into new markets and secondly "*Diversification is the outcome of temporally ordered decisions to adapt or acquire*

[112] McDonald, R., Siegel, D. (1986), p. 717
[113] Kim, D-J., Kogut, B. (1996), p. 283
[114] Kim, D-J., Kogut, B. (1996), p. 283

knowledge for exploitation of new markets"[115] and diversification should follow a rather broad direction.

McGrath (1997) also examined technology positioning projects and how real option theory can be applied to these projects. There are certain differences between technology options and financial options, but also striking similarities: First, the price of a technology option is the cost of development; secondly, there exists an underlying right to commercialize this technology; thirdly, exercise, i.e. commercialization, involves further investment and fourthly "*the option is like an American call: it can be exercised or traded any time after technology development is completed, or not at all. Completing commercialization creates another asset, which is the underlying right of the firm to extract returns from the exploitation of the now-commercialized technology.*"[116]

There is another special similarity between financial options and technology options: the volatility of financial options behaves in a way comparable to the variance of a technology option. One big difference is that a technology option typically inherits several embedded options. Therefore potential amplification opportunities have to be taken into account. Note that these embedded options are highly individual – they can only be exercised successfully in the context of the individual firm.

McGrath (1997) also gave a numerical example: imagine that the development of a new technology will cost $10 million. The NPV of the commercialization costs will be either $100 million or $50 million. A favourable regulation will result in a NPV of revenues of $180 million, unfavourable regulation in a NPV of revenues of $0. Both events have a probability of 50%.

Expected value of the project: NPV method

0,5 * (- 100 + 0,5 * 180 + 0,5 * 0) + 0,5 * (- 50 + 0,5 * 180 + 0,5 * 0) -10 = $5.000.000

The NPV criterion suggests immediate investment.

[115] Kim, D-J., Kogut, B. (1996), p. 285
[116] McGrath, R.G. (1997), p. 975 f.

If the firm waits for the pending regulation to be truncated, uncertainty might be solved. The company's discount rate is 10% and the issue will be solved in one year's time. The result shows that the option value increases:

0,9 * {0,5 * [0,5 * (180-100) + 0,5 * (180-150) – 10] + 0,5 * (- 10)} = $38.250.000

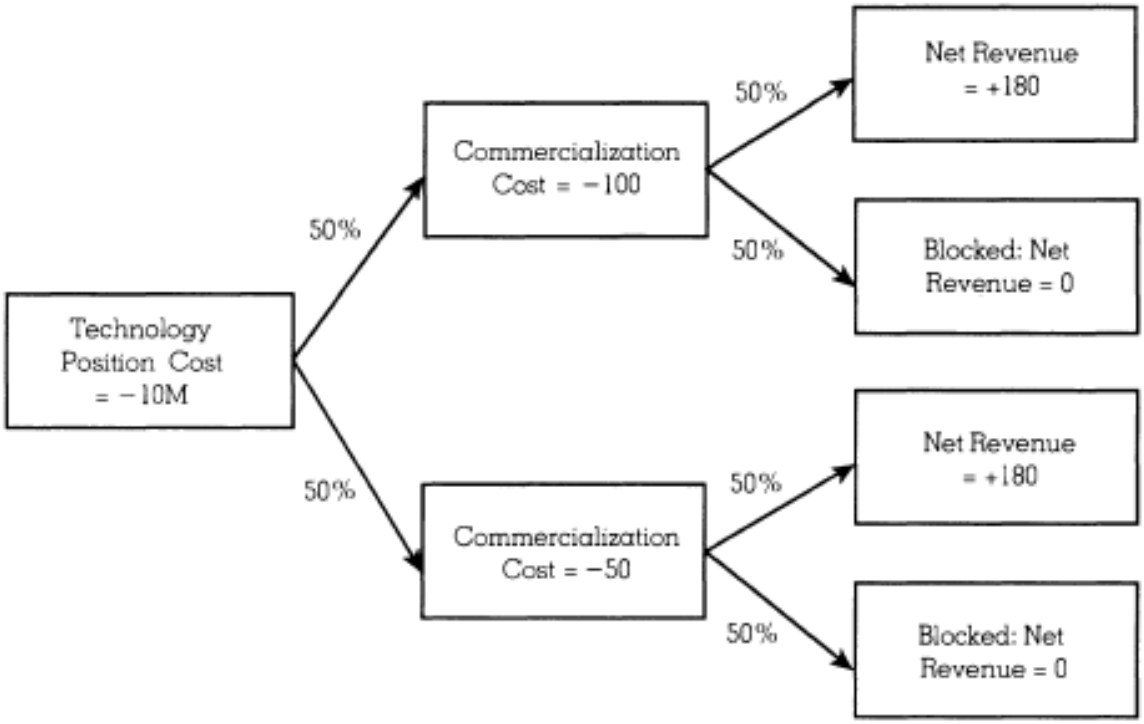

Figure 10: *Technology Positioning Option Decision Tree,* Source: McGrath, R.G. (1997), p. 978

Looking at this example, one can say that "*uncertainty both constraints the positive potential of the project and establishes an expiration date for options on the technology.*"[117] To minimize uncertainty the company could for example engage in lobbying activities. In this sense the firm may find it advantageous to rather invest in legal boundary conditions than in the technology itself.

The value of waiting must not be underestimated and regarding technology options a good closing statement might be that "*This motivates a view of technology that does not exist in isolation but, rather, is one element in an overall strategy to capture rents, clearly embedded in a competitive and institutional context.*"[118]

[117] McGrath, R.G. (1997), p. 978 f.
[118] McGrath, R.G. (1997), p. 992

5.4.6. Restructuring Profile

Hurry (1993) introduced the concept of restructuring profiles, which is a tool to carry out strategic choices. He thereby examined the linkages between US and Japanese firms with respect to their portfolio choices. "*Japanese – US strategic linkages create choices in the form of a call option on portfolio reconfiguration for the Japanese firm, and a put option on financial restructuring for its US partner.*"[119] These developments were initiated by the dramatic pace of globalization. There are two different forms of restructuring, namely portfolio and financial restructuring.
Also the role of global restructuring has to be analyzed. Hoskisson and Turk (1990) defined corporate restructuring in the following way: "*Corporate restructuring has been defined as a major change in strategy.*"[120] It is an empirical fact that simultaneous restructuring occurs, when firms are interlinked in the market. The purpose of restructuring again is value-maximization.

According to Myers (1977), the value of a firm consists of the firm's assets and the firm's future opportunities. Bowman and Hurry (1993) stipulated that future growth options result in a bundle of options for strategic choice. The underlying logic is the following: "*The option bundle contains two primary options: calls (i.e. future strategic choices to invest, or expand the portfolio) and puts (i.e. choices to divest, or contract). A firm expands by 'striking' calls. A firm contracts, and generates cash for financial restructuring, by striking puts.*"[121] The final definition of Hurry (1993) said that "*Global restructuring is the strategic process of striking options to capture complementary opportunities, across global firms, for changes in the portfolio scope and financing.*"[122] The resulting dimensions are calls, puts and the time to maturity, so we are moving in a real option world.
Restructuring patterns in Japan and in the US were – and still are - very different. There are vast differences between management style instruments. Japanese companies tend

[119] Hurry, D. (1993), p. 69
[120] Hurry, D. (1993), p. 69
[121] Hurry, D. (1993), p. 70
[122] Hurry, D. (1993), p. 70

to cushion themselves against downside risk, they generally carry out their investments in a more aggressive way and they usually favour holding on to investments for a longer time span. In contrast, US firms "*largely hold an option on a portfolio businesses*"[123], as Fligstein (1990) put it; therefore they only posses one strategic choice. Under the typical Japanese keiretsu system, "*the group holds a bundle of business-level and functional-level options*".[124]

Next, both global strategic interrelationships as well as portfolio restructuring are inspected:

The restructuring effect of strategic linkages: If two firms are interdependent to a great extent and one of the firms is currently in a weak condition, the stronger firm is forced to help the weaker to reinforce. Those strategic linkages also have a strong effect on resource dependencies. Within these strategic alliance-like relationships, shadow options may be exposed to the counterparty, even if the companies are operating in different industries.

The dynamics of linked restructuring: Japanese firms regularly carry out their strategy in the following stages: First, recognize a shadow option, secondly make a small investment to secure the option, thirdly hold the option until a favourable market signal arrives and fourthly strike the option.

Hamel (1991) defined global alliances in the following way: "*Global alliances are transition mechanisms that allow firms to internalize their partner's skills.*"[125] Inside such alliances, one firm, in our context typically the US firm, at some point in time transmits a recognition signal. This kind of signal permits the other firm to acquire a call option on future expansion. Nevertheless, companies have to think about contingencies that could potentially erase their option, such as competitor's action, changes in the ownership structure, financial collapse or governmental intervention. What undoubtedly is worth reasoning is that from the identification of a shadow option to proper exercise of the option several years can easily pass. Also the degree of competition (i.e. stabile or instable) has to be taken into account. To go back to our

[123] Hurry, D. (1993), p. 72
[124] Hurry, D. (1993), p.73
[125] Hurry, D. (1993), p. 74

example, the average Japanese firm's portfolio is likely to widen substantially in comparison to the average US firm, whose portfolio probably will be contracted. Still "*the overall restructuring time spans will be asymmetrical (since firms typically hold many linkages simultaneously.)*"[126] The creation of an industry-wide call option is also possible.

When discussing concepts of financial restructuring and strategic linkages, also motivational aspects have to be addressed. Without a consensus between the parties an option cannot be struck. The firm that possesses the put option, so in our case mostly the US firm, intends to seek an early strike, because of competition, possible financial distress and to earn capital gains to enable financial restructuring. Coffee (1988) and Boot (1991) both argued that, due to information asymmetries, "*In a stable corporate control market, managers tend to overinvest in expansion, while unstable conditions induce the opposite effect.*"[127] The result should be the realignment of incentives on both managerial and owner side. Brennan (1990) defines a latent asset as a unique opportunity for a company to expand. The value of such an asset is exposed to changes over time and Japanese firms are usually bidding rather high for one of the following reasons: either because of the degree of opportunity cost if the bid would be rejected, or because the appearance of a rival bidder leads to an auction-like process. This phenomenon is labelled "Japanese premium".

One reason why firms often choose to cooperate is that they are more likely to gain a comparative advantage. All those developments have to be discussed on basis of a globalized economy. Concerning strategy, Hurry (1993) opined that "*given bounded rationality, strategy may be viewed as a combination of economic logic and managerial intuition.*"[128] Therefore also cognitive aspects play an important role in this context. Because future opportunities are yet unknown, the resources have to be allocated in a mostly intuitive way. Shadow options allow for future competitive advantages.

[126] Hurry, D. (1993), p. 76
[127] Hurry, D. (1993), p. 77
[128] Hurry, D. (1993), p. 79

6. Real Option Analysis on Outsouring

6.1. Outsourcing – main concepts

The term "outsourcing" first appeared in literature as late as 1982. It basically depicts the practice of one company providing a service or good for another company. An important issue is the differentiation between "subcontracting" and "outsourcing". Subcontracting "*typically refers to the situation where the contractor "procures an item or service that is normally capable of economic production in the con- tractor's own facilities and that requires the contractor to make specifications available to the subcontractor (Day 1956).*"[129] whereas outsourcing "*refers to the special case where the contractor has no in-house production capability and is dependent on the subcontractor for the entire product volume.*"[130]

Billington, Johnson and Triantis (2002) looked at emerging business models: also in the IT sector a clear trend towards outsourcing was observable. Using outsourcing agreements permits the company to pool its risks and to realize economies of scale. Those new business models involve significant amounts of risk at the beginning; the objective is to achieve a comparative advantage. Firms need to participate in those new business models to remain competitive: "*significant investments in staffing, professional development, processes, and infrastructure to execute these activities not only can be justified, but may prove necessary to compete*."[131] Nevertheless, one must never forget the associated risks, which could easily overcompensate for the realized benefits.

Looking at the hype accompanying outsourcing, it is important to highlight the main disadvantages of vertical disintegration: On the one hand the control within the supply chain is clearly lowered; on the other hand the direct access to information is reduced.

[129] van Mieghem, J. (1999), p. 954
[130] van Mieghem, J. (1999), p. 954
[131] Billington, C., Johnson, B., Triantis, A. (2002), p. 40

This can diminish the expected gains of a sourcing relationship. Concerning flexibility the authors again drew an analogy to options by saying: "*an option's value reflects the quality of the available information about the underlying asset insofar as this determines the ability to exercise the option effectively.*"[132]

6.1.1. Core Competencies

Firms decide to outsource some activities in order to concentrate on their core competencies and to increase their competitiveness. The act of outsourcing literally any activity but the core can lead to the following benefits: Returns on internal resources are maximized, highly protected and well elaborated core competencies serve as a barrier to possible market entrants, access to the expertise and the contingents of an external supplier and higher flexibility, because in general risks are diversified and investments are lowered. Famous examples of successful companies that carry out a lot of sourcing activities are Nike and Apple; decisive questions are what a core competency is, which activities should be outsourced and which should be kept in-house and the estimation of possible risks and benefits associated with an outsourcing relationship.

Alvarez and Stenbacka (2007) argued that a firm needs to keep its core competencies in-house so as to avoid becoming too vulnerable to opportunistic behaviour of the supplier. "*Within the framework of the present model partial outsourcing follows from an optimal dynamic tradeoff between a current reversible mode of in-house production and an irreversible organizational redesign with an option of marginal cost savings*."[133]

Hilmer and Quinn (1994) discussed the term "core competency" and compiled the following findings answering the question what a core competency would be:

[132] Billington, C., Johnson, B., Triantis, A. (2002), p. 42
[133] Alvarez, L.H.R., Stenbacka, R. (2007), p. 99

Skill or knowledge sets, not products or functions: a valid example is internal skills – maybe acquired through learning – or certain management systems. This expertise has to create a maintainable competitive advantage in order to be a core competency. Of special importance in this context are skills that connect traditional functions.
Flexible, long-term platforms – capable of adopting or evolution: Here flexibility is the key to success – managers must not focus too narrowly on few products. The company should identify those sectors that can be expected to be highly valued by customers in the long run. Trends have to be reassessed constantly.
Limited in numbers: Without any doubt, a company can not reach excellence in every single activity – the secret is to concentrate on just a few.
Unique sources of leverage in the value chain: Hilmer and Quinn (1994) stipulate that "*Effective strategies seek out places where there are market imperfections or knowledge gaps that the company is uniquely qualified to fill."*[134]
Areas where the company can dominate: The key to dominance is effectiveness. Benchmarking has to be implemented at every stage of the value chain in order to stay competitive.
Elements important to customers in the long run: Customers needs have to be analyzed steadily.
Embedded in the organization's systems: The firm has to establish a sound corporate culture based on a good reputation that outlives single successful products.
Preeminence: Once a core competency has been identified, the company must do everything to maintain its superior position. As the authors write, a strategic block has to be erected to protect these most essential skills. Furthermore, "*as a company's preeminence in selected fields grows, its knowledge-based core competencies become ever harder to overtake. Knowledge bases tend to grow exponentially in value with investment and experience.*"[135] Core competencies basically offer long-term advantages in the market environment, as opposed by peripheral activities, which are not essential to the company's success.

[134] Hilmer, F.G., Quinn, J.B. (1994), p. 45
[135] Hilmer, F.G., Quinn, J.B. (1994), p. 47

Concerning strategic outsourcing, if we look at the case of totally efficient supplier markets, it can be argued that an entity would be ready to outsource literally every activity except its core competencies. Management must not forget about transaction costs associated with outsourcing, namely searching, contracting and controlling costs and has to answer the following questions: Is it possible to obtain a competitive advantage in this outsourced activity? To what extent is the company vulnerable if the relationship should fail? How can the trade-off between control and flexibility resolved in the best way?

The main problem is to reach an equilibrium between independence and incentives on the supplier's side and control and security on the contractor's side. This interrelation between vulnerability and advantages can we very well seen in the inserted graph:

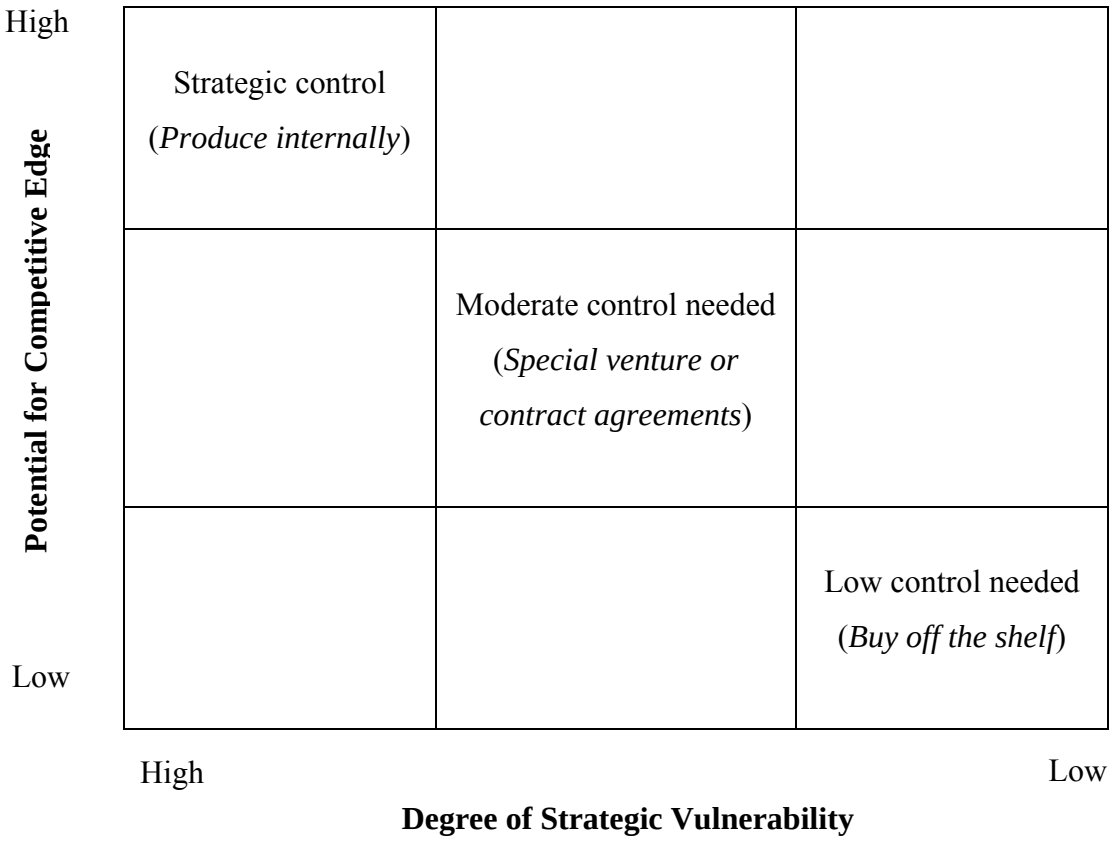

Figure 11: "*Competitive Advantage VS. Strategic Vulnerability"* Source: Hilmer, F.G., Quinn, J.B. (1994), p. 48

Next we should focus to the concept of competitive edge. A useful technique in that field is the so-called "best-in-class" worldwide benchmarking. Companies regularly fail to identify such suppliers, because their focus is often too limited to domestic markets. Also transaction costs must be measured by management. Two tendencies are that management often tends to underestimate backup costs; on the other hand there exists one big advantage that is often overlooked: the increase in executive time, because peripheral activities no longer need attention.

"*When there are many suppliers[…]a potential buyer is unlikely to be more efficient than the best available supplier*"[136] One problem here is a possible lack of information, another the fear of opportunistic behaviour by the supplier.

Managers have a wide range of options how to form and control a sourcing relationship. Inside this vast range of options, there "*are opportunities for developing special incentives or more complex oversight contracts to balance intermediate levels of vulnerability against more moderate prospects for competitive edge.*"[137] The range of sourcing options can be seen in the following graph:

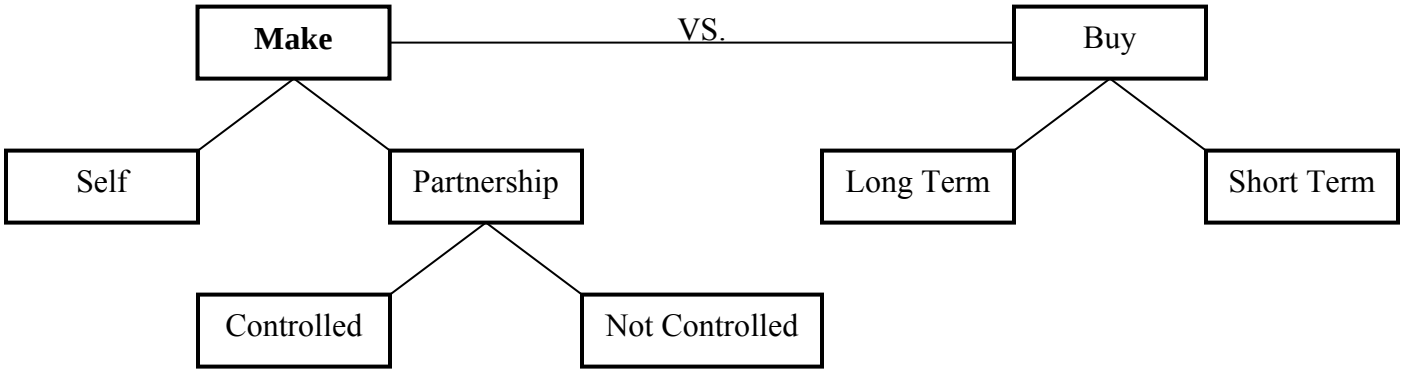

Figure 12: *"Range of Outsourcing Options"* Source: Hilmer, F.G., Quinn, J.B. (1994), p. 50

There is a trade-off between flexibility and control. Again, there is a big variety of sourcing arrangements, resting on the needed flexibility-control relation. The vital task

[136] Hilmer, F.G., Quinn, J.B. (1994), p. 49
[137] Hilmer, F.G., Quinn, J.B. (1994), p. 50

is how to optimally structure these relationships. Hilmer and Quinn (1994) stated that "*specialized suppliers can often produce higher value added at lower cost for that activity than almost any integrated company.*"[138] The spectrum of sourcing relationships can be seen below:

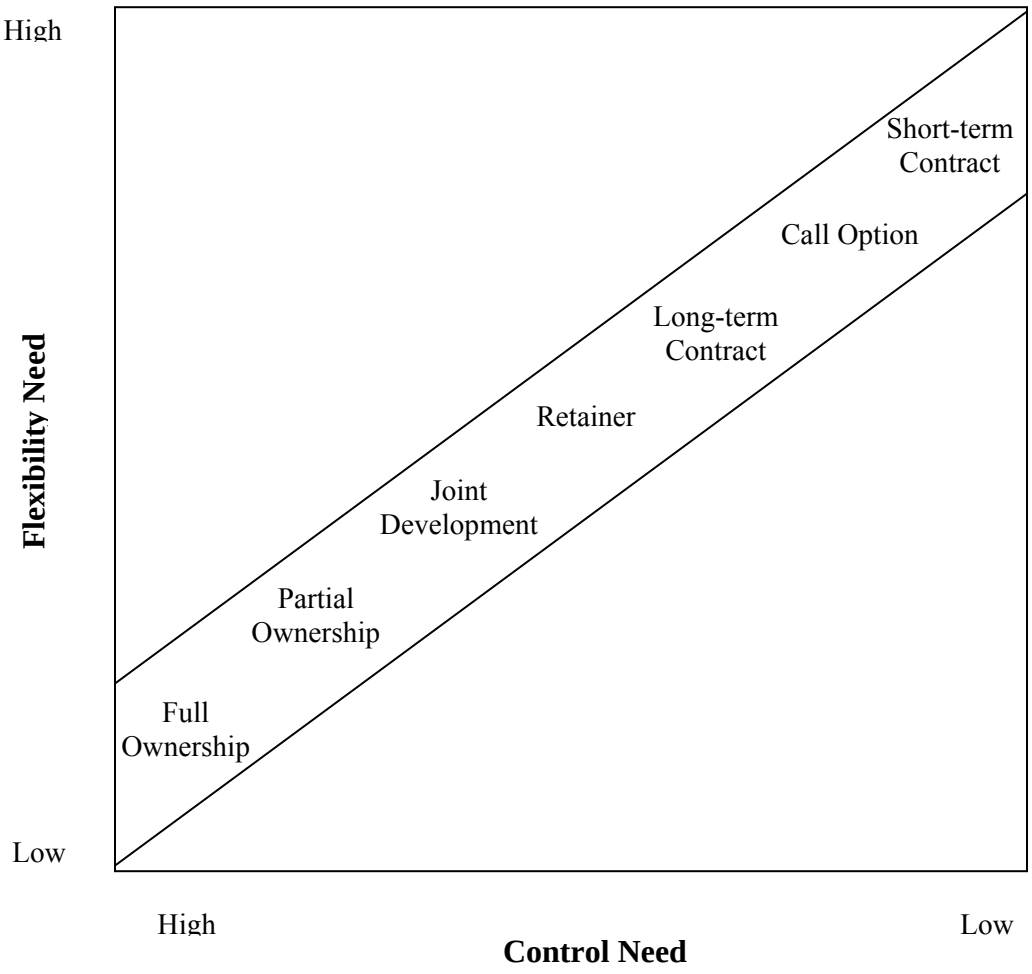

Figure 13: *"Potential Contract Relationships"* Source: Hilmer, F.G., Quinn, J.B. (1994), p. 50

With respect to sourcing arrangements, management always has to assess strategic risks and benefits. The main problem is the following: "*Too often companies look at outsourcing as a means to lower only short-term direct costs. However, through*

[138] Hilmer, F.G., Quinn, J.B., "Strategic Outsourcing", Sloan Management Rev. Summer; 35,4 (1994), p. 51

strategic outsourcing, companies can lower their long-term capital investments and leverage their key competencies significantly."[139]

The most important strategic benefits of outsourcing are greater flexibility, reduction of design-cycle times, diversification of company's risk across many suppliers and exploitation of new innovative areas. Historically, since the 60s, strategic outsourcing has increased dramatically, whereas the average firm size has decreased. The main motivation for this development has been the desire to leverage internal technical capabilities.

Looking at those benefits, one has to keep various strategic risks in mind:

Loss of critical skills or developing the wrong skills: The main problem is loss of internal corporate strategic flexibility. Citing an example: "*the buying company had lost the skills it needed to reenter manufacture and could not prevent its suppliers from either assisting competitors or entering downstream markets on their own.*"[140]

Loss of cross-functional skills: If activities are kept in-house, the firm might benefit from unexpected insights due to internal collaboration. These cross-functional benefits become less likely, the more activities are outsourced. In addition, the relationship has to be rather close in order to ensure sound evaluation by the buyer.

Loss of control over the supplier: This can happen when there is a serious mismatch between the parties' priorities. Suppliers that behave opportunistically might enter directly into the market with their accumulated expertise to compete with the contractor. Another problem is the possible diffusion of knowledge through selling knowledge to competitors. Many large companies nowadays have very sophisticated evaluation techniques. Management has to cope with greater scale and diversity concerning outsourcing, but this often comes at benefits: "*many companies have found that they actually improve their knowledge base through strategic outsourcing.*"[141]

[139] Hilmer, F.G., Quinn, J.B. (1994), p. 52
[140] Hilmer, F.G., Quinn, J.B. (1994), p. 53
[141] Hilmer, F.G., Quinn, J.B. (1994), p. 54

6.1.2. Partial Outsourcing

Alvarez and Stenbacka (2007)) described partial outsourcing in the following way: "*optimal sourcing decision maximize the option value associated with subcontracting*.[142]

Shy and Stenbacka (2005) established a framework to explain outsourcing decisions with many required inputs. An example for such practice would be the mobile phone industry, where literally thousands of components are subcontracted. A trade-off exists between saving costs, for instance due to lower wage levels, and the costs of monitoring that inevitably arise. Therefore some components will be more effectively produced in-house, although production might be cheaper if the activity would be vertically disintegrated. The effects of partial outsourcing, *id est* when only a certain proportion of components are produced externally, have to be measured. In such a context, the boundaries of the firm have to be taken into account and concepts such as transaction costs, incomplete contracts and asset specificity have to be examined. More precisely, Shy and Stenbacka (2005) examined an oligopolistic market situation, where many inputs – not only one input, as in many other models – are required.

A reasonable argument indicates that diminishing advantage in production applies to technologically sophisticated components. Therefore a manufacturer tends to produce those high-tech components in-house. Monitoring costs arise, because external production lines have to be managed and coordinated. Important to mention, monitoring costs are independent from the scale of production.

Another decisive implication is that "*consumers' willingness to pay exceeds the final-good's unit production cost even when no inputs are subcontracted (hence unit cost is at its maximal level).*"[143] The basis of the firm's production decisions are the formerly chosen organizational modes. Outsourcing is promoted with intensified product market competition, even though monitoring costs increase.

[142] Alvarez, L.H.R., Stenbacka, R. (2007), p. 93
[143] Shy O., Stenbacka, R. (2005), p. 1181

Also the duopoly case is worth investigating. Here the firm's respond directly to decisions of the rival firm – often in the opposite way. If one firm decides to reduce its amount of outsourcing, for instance, the rival entity will increase its outsourcing ratio. Furthermore, again looking at the duopoly case, the outsourcing decision does not depend on the degree of product market competition. Outsourcing decisions can be regarded as being strategic substitutes: "[It] *captures the intuitive idea that the firms have a strategic incentive to differentiate their production modes from one another.*"[144]

One can also imagine a different production mode, where market participants are manufacturing differentiated products. Now companies engage in price competition. Under this new regime, entities are indifferent what heterogeneous components to outsource and which to produce in-house. "*Therefore, the outsourcing decisions are strategic substitutes independently of whether competition in the market for the final goods takes place with respect to prices or quantities*."[145]

6.1.3. Equilibrium Models

6.1.3.1. Industry Equilibrium

Grossman and Helpman (2002) established an equilibrium model where the organization of the company is created endogenously. Inputs are specialized and there are two types of firms: first, vertically integrated firms who produce the goods they need in-house, but are facing higher governance costs and secondly specialized firms who are searching for a partner, which leads to searching costs, but then again lower production costs.

The decision to make or buy is one of the most fundamental questions a company faces. Organizational design is the keyword and these corporate configurations can be very

[144] Shy O., Stenbacka, R. (2005), p. 1185
[145] Shy O., Stenbacka, R. (2005), p. 1187

different even within the same sector of an industry. Between decisions of firms exists a strong interrelationship. Grossman and Helpman (2002) developed a model, in which "integration *and outsourcing are treated as equilibrium phenomena*."[146] In addition, they emphasized on a "*trade-off between the costs of running a larger and less specialized organization and costs that arise from search frictions and imperfect contracting*."[147] The two possible ways to produce final goods are vertical integration and specialization.

One version relies on the assumption that inputs have to be exactly tailored to a pre-specified final good. Therefore the supplier can only sell its intermediate product to one single manufacturer. There are fixed costs of entering the market and fixed search costs and inputs have to be of high quality. A vertically integrated firm is yet exposed to additional fixed costs, namely market entry costs, production design costs and corporate governance costs. Contracts are incomplete; therefore market participants experience a lack of verifiability.

A serious obstacle is the potential hold-up problem. This kind of difficulty arises, because the component producer tailors his products to the very particular final good of the manufacturer. Because of that, this input has no value to anyone else but the manufacturer, which gives the final producer a substantial degree of bargaining power: he can simply refuse to accept the intermediate goods, until the price is sufficiently low. This, in turn, gives firms an incentive to vertically integrate in order to get rid of the hold-up problem.

Note that if goods are nearly perfect substitutes, the industry sector is highly competitive; on the other hand, if goods are very distinct, the manufacturer enjoys monopoly power. Looking at sensitivity, it can be declared that "*an increase in the elasticity of substitution increases the relative viability of outsourcing*."[148]

Also the distribution of bargaining power has to be taken into account when thinking of outsourcing. The sustainability of the equilibrium depends on the bargaining power of

[146] Grossman, G.M., Helpman, E. (2002), p. 86
[147] Grossman, G.M., Helpman, E. (2002), p. 86
[148] Grossman, G.M., Helpman, E. (2002), p. 105

the intermediate producer: if it is either too high or too low, the industry equilibrium will not be consistent. A vital question is why different modes of organization are in existence at all. One way to explain this is that the required level of demand depends on the absolute number of firms entering the market.

If intermediate products are not fully tailored, extra labour is required to meet individual purposes. Input specificity now is more important than before. Under these circumstances outside options can make a difference, when potential partners meet to negotiate terms of transaction. A second market is created, because technology is more flexible than before. Both sides now have the possibility to find another partner if initial negotiations should fail. Furthermore, the degree of specialization is determined endogenously. An increase with respect to specialization enhances expected profits but simultaneously higher specialization implies lower value in the secondary market. The most important concluding statement confirms that firms face a trade-off: "*We have modelled* a *firm's 'make or buy' decision as a trade-off between the transaction costs that stem from search and incomplete contracts on the one hand and the extra governance costs associated with vertical integration on the other*."[149] A company has to be very careful which organizational mode to choose, because its market opportunities are dependent on this decision.

6.2. Analogies to other Networking Forms

6.2.1. Joint Ventures

Kogut (1991) discussed that joint ventures should be seen as options to expand. The importance of market signals was emphasized. There are certain hazards with respect to acquisition decisions after a joint venture – a temporal agreement – has reached its end. The statistical results "*indicate that unexpected growth in the product market increases*

[149] Grossman, G.M., Helpman, E. (2002), p. 118

the likelihood of acquisition; unexpected shortfalls in product shipments have no effect on the likelihood of dissolution. This asymmetry in the results strongly supports the interpretation of joint ventures as options to expand."[150]

Inside a joint venture it might be argued that the partner also places a bet on future market developments. Costs and benefits are shared; therefore joint ventures represent an attractive option to expand in risky markets. The special problem associated with joint ventures is that exercising the option requires further capital commitments, thereby urging the need of renegotiations. "*The exploration of the link in the timing of the acquisition of joint ventures and of the exercise of the option to expand is the focus of the following empirical investigation*."[151] In a real option sense joint ventures are a possible way of both exploiting and buffering uncertainty.

At first, the concepts of real options in this very specific context shall be explained: in our framework real options are the right to buy and sell equity in the joint venture. As stated above, when it is decided to exercise the option, one party is likely to divest of the joint venture, because the value added arising from exercise of the real option to expand to one entity might be very different from the value added to another entity. These are differences in option valuations due to "*potential spill-over effects of the venture's technology complement the product portfolio of one partner more than the other*."[152]

Therefore joint ventures can be interpreted as being real options: there are two extremes in our framework: In the first case, it is valuable to wait with investments, because it pays off before committing more resources. In the second case, investment commitments are necessary to retain the right to exercise the option to expand in future. What is important to emphasize is that the financial burden of establishing a joint venture is sometimes not only dividing the overall sum, but reducing it, because total investment costs can be lowered due to complementary skills. The motivation divesting is the realization of capital gains or the absence of additional technology to launch a market product.

[150] Kogut, B. (1991), p. 19
[151] Kogut, B. (1991), p. 20
[152] Kogut, B. (1991), p. 21

Arguably one of the most delicate issues when thinking about options is the timing of exercise. In our joint venture context exercising means acquiring the venture. It represents a long call option; consequently, "*acquisition is justified only when the perceived value to the buyer is greater than the exercise price*."[153] There are mainly two reasons for exercise: First, if further investments are not made, the future cash flows would be inevitably lost. Secondly, if capitalization needs to be increased, normally renegotiations are required, often leading to termination of the joint venture. To buy the partner out of the venture is common business practice, because opportunities are perceived in different ways. In the spirit of this argument, Kogut (1991) set up the hypothesis that "*The venture will be acquired when its valuation exceeds the base rate forecast*."[154]

In our framework a special market valuation problem arises, because there are no prevalent markets that would indicate changes in the value of the option. It is practically impossible to collect objective data. Parameters vary over time and decisions are contingent on estimates. The motivations for forming a joint venture may be heterogeneous as well. Besides of developing an option to expand in new markets also the sheer benefits of sharing assets in the current use could be decisive. A further property of joint ventures is that "*a joint venture serves as a vehicle of managerial and technological learning*."[155]

The author's statistical results show that the hypothesis is confirmed: joint ventures are regularly used as an intermediate stage to complete acquisition. Concerning governance, an interesting result is that "*a decision by managers whether to acquire or divest the joint venture is more significantly sensitive to annual departures from a long-term trend than to short-term indices of industry growth*."[156] Management decisions therefore are "cued" by market signals and acquisitions often occur when an industry is performing superior with respect to historical trends. Those decisions are imperatively based on managerial interpretations – especially the recognition that short term market

[153] Kogut, B. (1991), p. 23
[154] Kogut, B. (1991), p. 24
[155] Kogut, B. (1991), p. 26
[156] Kogut, B. (1991), p. 30

fluctuations may be outliers is often misjudged. One concluding statement is that "*Once the capital is committed, the downside risk is low, especially if there is a market for the acquisition of the assets and operating costs are not high. The selling of the venture means that one firm puts a higher value on the assets; it does not mean the venture is unprofitable*."[157] This strongly supports the opinion that joint ventures can be designed as real options.

Citing a closing assertion: "*This article has investigated the proposition that joint ventures are designed as options that are exercised through a divestment and acquisition decision*."[158]

6.2.2. Supply Chain Management

6.2.2.1. Supply Chain Management in High Technology

The IT sector is a market segment that is said to be highly volatile and risky with respect to both supply and demand, where uncertainty is prevalent. Now the task is to gain from – and not only adjust to – such uncertainty: "*such uncertainty is increasingly recognized as a key source of comparative advantage and shareholder value*."[159] IT sector risk management processes that were formerly almost exclusively used in financial industries now become more important, namely the active handling of the balance between assets and liabilities. Risk in institutions such as banks has been handled as follows: "*These banks design especially tailored optionbased products and strategies to retail and institutional clients that exploit the presence of uncertainty in financial markets, and use quantitative models for measuring and hedging their*

[157] Kogut, B. (1991), p. 30 f.
[158] Kogut, B. (1991), p. 31
[159] Billington, C., Johnson, B., Triantis, A. (2002), p. 32

residual risk exposures."[160] Companies in the IT sector developed appropriate approaches to manage uncertainty.

One can identify four characteristics that are typical for high technology industries: There are significant risk exposures (short product life cycles, rapid technological change, etc.), especially risky are demand for products and supply for inputs, large expenditures on research and development and manufacturing capacity have to be made and vertical disintegration has led to a higher need for procurement and sales contracts. Nevertheless, the later cited results will largely be applicable to other industries as well. The main task is to develop a portfolio of real options available to the company, whose value depends on both the timing and the diversity of alternatives. A special focus will be put on contractual options that can be embedded into procurement contracts.
The basic question is how to exploit uncertainty: "*Uncertainty can be exploited to create value if a company can find ways to mitigate 'downside' risk while preserving the 'upside' effects of uncertainty*."[161] Real Options have to be created at an amount below their current value. If this task can be carried out successfully, the risk exposure of the firm is reduced and at the same time the shareholders value is augmented, because of the now lower cost structure.

There are two key dimensions for real options: time and scope. Concerning timing, Billington, Johnson and Triantis (2002) stated that "[speaking of] *the temporal dimension, options are created by postponing investment or operating decisions in order to make them in as "informed" a way as possible*."[162] As we know that argument follows the logic that an option with a longer time to maturity is preferable to an option with a shorter time to maturity. Concerning scope one has to think about an array of choices. The objective is to find the alternative that gives the best result, i.e. maximizing future return. To put it in technical terms: "*A company will continue to increase the number of future alternatives until the derived expected value from an*

[160] Billington, C., Johnson, B., Triantis, A. (2002), p. 33
[161] Billington, C., Johnson, B., Triantis, A. (2002), p. 34
[162] Billington, C., Johnson, B., Triantis, A. (2002), p. 34

additional alternative no longer exceeds the associated cost."[163] The redesign of the real option portfolio is implemented in response to uncertainty in both supply and demand. These real options are classified in three different categories: sales, manufacturing and procurement.

First, we should take a look at *sales options*. The most basic ambition associated with sales is to augment the product palette for the consumer. One possibility to realize this is through a build-to-order model, where the consumer himself specifies the desired configuration. With such an implementation the company can erase a lot of uncertainty by postpone procurement of the components, because supply can be synchronized with the precisely known demand. Under these conditions, where "just-in-time" logistics are dominant, inventory becomes almost obsolete. From an real option point of view, inventory can be seen as: "*a form of insurance, a costly real option that pays off in periods of high demand, but expires worthless in periods of low demand.*"[164] In this case volatility basically equals the volatility of demand. The cost of inventory is directly positively correlated with the volatility of demand.
Furthermore, prices can be adjusted dynamically, depending on demand and availability. The definition of the term "spread" in this environment is also provided: "*The spread is the difference between the price at which the company is able to sell a product with a particular configuration and the cost of delivering the product*."[165]

Secondly, *manufacturing options* have to be taken into account. A large product variety that results from a manufacturing process is primarily value-increasing. Also here the above presented concept of inventory comes into play: a huge inventory can be effectively avoided by exact staging of the manufacturing processes. A special real option is "dual response manufacturing". Flexibility is the most important factor here. The dual response manufacturing concept can be explained as follows: "*If demand exceeds this base level, additional capacity with lower fixed but higher variable costs*

[163] Billington, C., Johnson, B., Triantis, A. (2002), p. 34
[164] Billington, C., Johnson, B., Triantis, A. (2002), p. 35
[165] Billington, C., Johnson, B., Triantis, A. (2002), p. 35

can then be brought on to manage such short-term fluctuations."[166] There are other methods of balancing capacities, such as using similar processes internationally. The organization can combine the efforts of several production facilities to cut down on lead time, for instance. To get used to the terminology in the option world, I want to cite the following statement: "*the maturity date of the company's options to produce can be extended to make it closer to the sales date. While the exercise price (cost of production) may be higher, this may be more than offset by the option's longer maturity date, particularly when uncertainty is great*."[167]

Thirdly, I want to turn to *procurement options*. When we are thinking about procurement options, we largely have to consider embedded contractual options. This form of agreement is called structured contract. By using such options, a rather rigid long-term contractual agreement can be made more flexible by inducing short-term clauses. Those embedded options are understandably target of negotiations and therefore rest on the relative bargaining power. It is an interplay between the value for the purchaser and the cost for the supplier of the flexibility option in question. A huge problem associated with procurement options was the underdeveloped and illiquid spot market in technological components, but the situation keeps improving. A final important aspect can be identified in the case of "overbuying", which is when a company chooses to buy more than its actual demand, because of volume discounts. The arising question is how to formalize those findings to define a proper risk management. When we reconsider the ways of exploiting uncertainty, one can sum up by stating that "*The various supply chain options introduced above focus primarily on creating value by managing temporary imbalances in demand and supply.*"[168]

The task of managing the resulting real option portfolio is by no means trivial. There are four reasons for that: There are a large number of operating options that mature daily, the exercise decision is complex due to a large variety of alternatives, options

[166] Billington, C., Johnson, B., Triantis, A. (2002), p. 36
[167] Billington, C., Johnson, B., Triantis, A. (2002), p. 37
[168] Billington, C., Johnson, B., Triantis, A. (2002), p. 37

often are interlinked in a complex way and even with a sound real option portfolio, the company still is heavily exposed to risk.
Considering these very different problems, it becomes clear that the firm has to use quantitative techniques such as simulations and optimizations in order to manage their risk properly. The risk management process in high technology sectors is similar to risk management in financial industries: First, establishment of a clear objective, secondly development of a suitable policy. The main problem here is that it is often difficult to find an appropriate benchmark; because of that one commonly has to rely on estimates.

Contracts can be structured along three dimensions, namely volume, service and price. All various procurement contracts add up to a single procurement portfolio. "*Each procurement portfolio produces a different trade-off between the costs and risks of material purchases, inventory, and shortages; and different supply agreements and portfolios of supply agreements can be compared based on the company's trade-off between risk exposure and value creation across these performance dimensions*."[169]
The sourcing agreements have to be constantly monitored to find out whether the performance has been satisfying. It obviously is a dynamic process, in which new contracts are established and simultaneously old contracts are renegotiated. The importance of spot markets should be emphasised again, because the portfolio should always reflect current market conditions. Another characteristic of spot markets is that they are intermediating between short-term mismatches between supply and demand.

Another grand issue is a possible opportunistic behaviour of supply chain participants, because they frequently possess sensitive information. Biased information exchange within the supply chain should be largely avoided by emerging methods.
It is evident that through the use of structured contracts, efficiency has been gained. Some organizations already became "virtual organizations" that avoid large investments in physical capital. Their only obligation is to manage the resulting set of real options. The performance of firms over the economy depends on the successful

[169] Billington, C., Johnson, B., Triantis, A. (2002), p. 39

quantification of risk and the valuation of flexibility. Summarizing one could say that financial aspects are becoming increasingly important also in non-financial industries. Concerning valuation, Billington, Johnson and Triantis (2002) noted high demand for sound performance metrics in the IT sector. Performance metrics in general "*address risk and flexibility; in the parlance of supply chain management*: *the costs and risks of not having the right products in the right places at the right times.*"[170] A rather simple approach is the "total sourcing cost" method, where the total costs of a sourcing relationship results from the sum of the costs of inventory plus the costs of shortages. A more sophisticated approach is the "Value at Risk" concept, which is very popular and frequently used in financial industries. The problem of all potential risk measurement concepts is that risk in such an environment can not be addressed explicitly. High-tech companies generally have to consider three main risks at the end of their supply chain: demand, availability and input prices. Nowadays risk management means managing "spread options". One has to think in terms of possible scenarios and not in expected demand or supply, to better understand interconnections.

6.2.2.2. Supply Chain Management in the US Automobile Industry

Helper (1991) analysed the situation of the US automobile industry in the 80s. In general, relationships "*had been characterized by short-term contracts (usually one-year), arms'-length relationships, and many (usually six to eight) suppliers per part.*"[171] This has changed a lot: Nowadays, supplier relations are different in the sense that information is exchanged far more extensively between the buyer and a more and more decreasing number of suppliers. These changes have to be explained, because at first sight the contractor gives up some of its market and bargaining power by supplying to fewer parties. There is the following trade-off: "*the buyer faces a trade-off between promoting technical progress in the industry and maintaining buyer bargaining power.*"[172] In the US, companies have waited for too long to sacrifice some of their

[170] Billington, C., Johnson, B., Triantis, A. (2002), p. 40
[171] Helper, S. (1991), p. 781
[172] Helper, S. (1991), p. 782

bargaining power for the sake of innovation and improved quality. Still, they finally started to re-define their preferences.

Helper (1991) developed a conceptual framework. She assumed that the producer has only two possibilities regarding the production of components: either he can produce them in-house or contract production out to a supplier. What really matters and often is underestimated is the commitment between the two parties; communication is vital in that context. Following Hirschman's (1970) terminology: "*we can identify two types of responses to problems arising in a buyer-supplier relationship: 1) exit, where the buyer's response to problems with a supplier is to find a new supplier, and 2) voice, where the buyer's response is to work with the original supplier until the problem is corrected.*"[173]

Along two dimensions one can distinguish between voice and exit strategies: the degree of administrative coordination and the nature of incentive systems. Contractors that follow a voice-based strategy need a high degree of administrative coordination and strong commitment. The opposite applies to the exit-based strategy. In general, using an exit strategy, the buyer improves his bargaining power, whereas the voice strategy is superior when rather high investments are required. Summarizing: "*I have argued that the exit strategy maximizes buyer bargaining power, whereas the voice strategy maximizes the rates of most types of technical change. Therefore, a trade-off exists between buyer bargaining power and industry technical change.*"[174] Historically, an oscillation between the two strategies can be observed in the automobile sector.

At the beginning of the automobile industry, voice systems were prevalent with producers being largely dependent on suppliers. The contractor and the supplier were working together very closely and therefore also suppliers played an important role in innovation. These relationships with financially unstable suppliers eroded, because part makers were specializing in some inputs that were only applicable to some buyers. The

[173] Helper, S. (1991), p. 784
[174] Helper, S. (1991), p. 786

contractors had "*the desire and the wherewithal to use voice within their organizations while moving toward exit relationships with outside suppliers*."[175] One should not forget, however, that vertical integration inherits various advantages, like geographic proximity. As consumers became keener on new products, the voice-based strategy was becoming less attractive. Many industry participants began to enter into exit strategy relationships with independent suppliers. This led to a highly competitive supplier market, and innovation mostly exclusively took place inside the firms. Although this strategy of vertical integration of R&D and exit strategy relations with outside suppliers first helped to increase growth, it was little helpful when Japanese car producers entered the market in the 70s.

Now let's take a closer look at the exit-based system. The distinction between exit and voice is a rather vague one and in reality things are more complex. Between the 50s and the 70s systems were largely exit based: "*The relationships within this exit-based system fell into three main modes, which I will call 1) simple exit, 2) voice with cheating, and 3) financial integration*."[176]

Simple exit: every part under a simple exit regime was exposed to annual competitive bidding. This system was applied to easy-to-make parts, where the firm did not expect to gain a competitive advantage.

Voice with cheating: here some suppliers were given a higher degree of commitment, particularly those who provided some sort of superior service to the contractor. Such relationships were often characterized by mutual dependence and a high level of trust between individuals of the opposing parties.

Financial integration: under this regime, one can find 100% ownership structures. Commitment was therefore very high, while the administrative coordination did not necessarily have to reach such high levels.

The final product market was an oligopoly and the producers succeeded in preventing their suppliers from taking their share of the oligopolistic revenues. "*The source of their success lay in the ability to maintain a credible threat of exit, which they did by using*

[175] Helper, S. (1991), p. 790
[176] Helper, S. (1991), p. 793

rents gained from power in their final-product market to transform the structure of their input markets."[177] At the same time they were facilitating access to the supplier markets to guarantee competition and impeding their suppliers from developing own expertise. Automakers wanted to ensure that complementary assets would be produced under heavy competition. The problem with this system was little innovation for the companies and the consumers. Also the rather low degree of administrative coordination had a negative impact on product quality. As commitment was even stronger on the rise, stagnation eventually set in.

I want to continue the analysis by discussing the voice based system in supplier relations. As stated above, we are examining the situation of the industry in the 80s. In this decade technology became more important again, due to fiercer competition from abroad (mostly Japan). Producers uncommonly made a move towards voice based strategy. A new classification had to be made, distinguishing between reputation-based voice strategy and financially-based voice strategy.
Concerning reputation-based voice systems, the administrative coordination was substantially higher than in traditional voice relationships. This development resulted in long-term rather than short-term contracts. Long-term contracts are exposed to opportunistic behaviour in a stronger way, because they inherit a higher degree of incompleteness. Under financially-based strategy, administrative coordination was also high, but more among inside suppliers. "*Whereas in the reputation-based voice mode, the automakers sought to increase administrative coordination by increasing commitment to their outside suppliers, in financially based voice in the mid-1980s they sought to increase coordination by decreasing commitment to their inside suppliers.*"[178]
A common example is internal benchmarking, where in-house divisions are forced into competition with each other on an internal market. Due to faster market changes, producers implemented just-in-time techniques and simultaneously increased R&D spending. At the same time the bargaining power of the contractors was reduced and consumers demanded higher quality standards.

[177] Helper, S. (1991), p. 796
[178] Helper, S. (1991), p. 801

Summarizing the prevalent lines of argument: "*the automakers' power over their suppliers is due not to some exogenous characteristic of the industry, but rather to a particular strategy adopted by Detroit's Big Three. The auto companies, […] are highly vulnerable to oligopolistic suppliers. The automakers' investment in keeping the supplier industry competitive has been the key to their success in maintaining bargaining power.*"[179] Because uncertainty in the industry was on the rise, inside suppliers suffered from divestments.

The above described transition from exit to voice relations is highly capital intensive. Internal organizational structural changes have to be made, because "*The exit-based strategy requires the buyer to invest heavily in design engineers and only a little in internal communications, whereas the voice strategy requires expensive communication and evaluation systems and few design engineers.*"[180] Suppliers also had to change and laid their focus to a greater extent on innovative capabilities. Some of the rather new relationships should be classified in a new way; Helper (1991) for instance labelled one of the new categories as "new exit": "*New exit differs from the old exit system in that suppliers have a slightly longer leash (three-year contracts instead of one-year), and buyers threaten to exit not just because of high prices, but because of low quality and lack of just-in-time delivery as well. The increase in commitment (though often quite contingent) should offer some incentives for investment, but this scenario offers little prospect of developing the trust necessary for long-term high levels of administrative coordination or of technical change.*"[181]

6.3. Theoretical Underpinnings

Alvarez and Stenbecka (2007) observed that outsourcing had become a commonly used business practice in recent years. Outsourcing processes are mainly due to marginal

[179] Helper, S. (1991), p. 804
[180] Helper, S. (1991), p. 806
[181] Helper, S. (1991), p. 807

cost economies, where mostly North American or European companies contract out to low-wage countries such as India or China. This outsourcing decision inherits a trade-off between the necessary monitoring costs associated with a sourcing relationship and the cost advantage associated with such an agreement. The whole analysis depends on the fact that a firm can decide independently which proportion to outsource and which proportion to produce in-house.

Before actually conducting their explications, Alvarez and Stenbacka (2007) made an important assumption: The potential suppliers have comparative cost advantages in producing the demanded good or service, due to higher efficiency. There is a trade-off between achieving a higher efficiency – and therefore higher revenues – and the commitment of making an irreversible investment in a sense that sunk investments have to be made in order to establish such a sourcing agreement. Outsourcing is always accompanied by uncertainty about future profit.

Under one condition complete outsourcing is optimal. Judging a critical-cost ratio, it can be argued that "*increased volatility decelerates the introduction of a system of outsourcing,*"[182] which in my opinion is a debatable argument. Secondly they attest that increased overall market uncertainty will inevitably postpone the sourcing decision, because the real option value of the postponement is increased under such circumstances. This clearly is in conflict with other author's opinions. On the other hand, an increase in market uncertainty can also stimulate outsourcing, because the optimal sourcing proportion might also be increased.
Outsourcing can also be interpreted as "*a disciplining device with the purpose of generating a benchmark against which to foster the competitiveness of in-house production*."[183] Undoubtedly the most important finding was the proof that if market uncertainty increases, the decision to vertically disintegrate is postponed. As stated above, this argument is inconsistent with common business wisdom. Nevertheless, one has to be careful about this conclusion, because once the production mode has been

[182] Alvarez, L.H.R., Stenbacka, R. (2007), p. 97
[183] Alvarez, L.H.R., Stenbacka, R. (2007), p. 98

introduced, increased market uncertainty more likely leads to a higher outsourcing proportion.

6.4. Valuation

Van Mieghem's (1999) aim was to constitute a sound valuation technique for the option of subcontracting by using a market stochastic game. Participants are a manufacturer and a subcontractor. Subcontracting can be viewed as an exchange between the product provided by the supplier and the money of the manufacturer. What is important to mention is that in some cases it might be advantageous to leave some contract parameters unspecified.

There are different ways of looking at subcontracting: First, strategic literature argues that "*a firm should concentrate on its core competencies and strategically out- source other activities (Quinn and Hilmer 1994).*"[184] The decision to subcontract inherits many risks, most notably the dependence on the subcontractor and overall vulnerability, like the possible loss of a competitive advantage. Secondly, looking at options literature, the biggest advantage of outsourcing lies in a significant increase of flexibility with respect to production and capacity planning. Thirdly, from a financial perspective, the most important aspect is risk diversification. Operating costs are lowered and therefore overall cost efficiency is improved. A firm entering in a subcontracting relationship probably also will experience smoothing of production levels.

The firms will only enter into a relationship if it is beneficial for them and contract compliance is voluntary. Considering transfer prices, the author stipuilated: "*Thus, for low to medium transfer prices, more uncertainty makes higher manufacturing requests more likely, creating a stronger incentive for the supplier to invest in extra capacity, which makes outsourcing more likely. For high transfer prices, on the other hand, more*

[184] van Mieghem, J. (1999), p. 955

uncertainty increases the expected total transfer cost to the manufacturer who will prefer more in-house capacity, making outsourcing less likely."[185]

6.5. Discussion

The most popular motives for outsourcing are the realization of cost savings, the wish to focus on a core of business and cost restructuring. Nonetheless, many more motives can be identified, such as tax benefits, risk management considerations, access to knowledge or capacity management. Sourcing decisions are often accompanied by public criticism – especially in the case of offshoring (i.e. when a company transfers an organizational function to another country). Opposition claims that the national labour market is damaged due to disruption of jobs and insecurity of employment, whereas proponents argue that outsourcing – if exercised correctly – should decrease prices in the long term, thereby providing economic benefit.

If a company outsources to a low-wage country, the question of corporate social responsibility or business ethics come into play. Again, there are two different lines of argument: On the one hand, many people are of the opinion that lower paid workers are exploited by globally operating firms, on the other hand at least some people in those low-wage countries are employed and overall wealth may be increased.
Another controversial topic is quality. A sourcing contract should always contain a so-called service level agreement, which is a measurement tool of quality; nevertheless, there are many contracts that in fact do not inherit such a clause. Again, many different interests come into play: Management might accept lower quality to address certain business needs such as realizing a lower price, whereas end consumers might be unsatisfied when realizing a change in product or service quality.

[185] van Mieghem, J. (1999), p. 966

Considering sourcing decisions, one can identify an incredible need for information. Innumerous parameters come into play and the firm has to rely on many approximations, based on heuristic models and managerial intuition and experience. In history we have seen different outsourcing trends in different sectors of the economy. Successful vertical integration depends on extensive and fluent exchange of information, which is nowadays easier due to an increasingly globalized world on basis of a high standard in information technology. In my opinion sourcing relationships often lack sound strategy communication and clear definition of responsibilities.

Core competencies are vital to a firm, because they provide consumer benefits and – per definition – are difficult to imitate; they are relative strengths in comparison to competitors. Various aspects surrounding those abilities are hard to identify. Companies must do everything to achieve such a position is some field of operation if they want to stay competitive.
There are some important trade-offs: a firm should concentrate only on some core competencies, because it cannot reach highest industry standard in many activities simultaneously. Still, management should not make the mistake of concentrating on only one core competence, because external market changes that are not influentiable by the company might erode the potential. So there is a trade-off between concentration on and diversification between core competencies. A firm's competences form a portfolio that has to be managed on basis of risk deliberations.

Furthermore, core competencies have to be protected from imitation by competitors. As we have heard earlier, a process that is easy to copy can never provide a competitive advantage. Occasionally the toughest task is the identification of a core competency, because corporate strategy concentrates on those activities. Over time companies may face the problem of having labelled a peripheral activity as being close to the core. This leads to fatal implications, because the firm loses its base of success.
Finally discussing Real Option Analysis, I want to emphasize that all underlying models provide only vague approximations that in fact contain a lot of uncertainty. Models in Real Option valuation originate from Financial Option valuation and many

assumptions that are already problematic in the financial world, become yet more complex and massive in a Real Option context. Management has to take both external (mainly political) and internal (organizational) considerations into account and should never rely exclusively on purely technical valuations. The importance of such deliberations is, in my opinion, underestimated in Real Option literature.

Another problem is contradicting interests: stakeholders have the incentive to overevaluate Real Options and vend those over-optimistic valuations as “future potential” or “growth opportunity” to shareholders. Those values are plainly hypothetical numbers that often lack connection to real values.
Increased flexibility is always seen as a very positive implication of Real Option thinking. Still, management should be aware that the maintenance of a significant degree of flexibility inherits costs and is again associated with a higher level of uncertainty. In this context I would like to make a reference to the “Investment timing” section.

7. Conclusion

Summing up, we have analyzed the main aspects surrounding Real Options, looked at various organizational decision making theories and finally showed the importance of Real Option thinking in the context of sourcing decisions. It was difficult to clearly address, compare and evaluate the different implications from different fields of scientific research. While always focusing on the core, I have tried my best to also include seemingly rather peripherical facts. Nontheless, one always has to keep in mind that all these models rest on different assumptions, which exacerbates the development of a sound strategic governance policy.

The most obvious difficulty of the Real Option approach lies in its inherent impreciseness. One has to rely on proxies, based on probabilities, and volatility in my opinion is underestimated in many cases. Still, it is a powerful tool to make uncertainty more understandable and measurable – at least to some extent.
The transition from Financial Options to Real Options bears many problems, because we transfer assumptions from a perfect, highly competitive economy to reality – just think of Black/Scholes or Merton in this context.
Furthermore, it has to be stated that we only analyzed the position if the contractor. The subcontractor in our surroundings faces a short option and up to now only few authors have concentrated on this other side of the medal.

Also the classification of Real Options is not perfect. Categories do overlap a lot and one could think of many more dimensions as a means to differentiate between Real Option characteristics (such as size, hierarchy, maturity, economic sector).
From my point of view the role of flexibility is overoptimistically interpreted by many authors. Even though flexibility increases the managerial scope of action, the cost of a higher level of flexibility should not be forgotten and also overall uncertainty rises.
In addition, Real Option Analysis should include more external (political) and internal (organizational) considerations, as both of them heavily influence the calculations.

My main criticism lies in the over-evaluation of future potential. This effect of "vending" future potential to shareholders already has been discussed to greater detail. We have seen that many different and sometimes contradicting interests come into play.

Without any doubt, there are many fields that need closer scientific examination – mainly in organizational questions, but also from a financial point of view. The above stated dilemmas are some of the future challenges in scientific research; the goal remains unchanged: to establish a broad framework for outsourcing decisions on a Real Option basis.

8. Appendix

8.1. English Summary

In this paper I first introduced the main concepts of Financial Options in order to make the understanding of Real Options easier; those two derivative concepts share a common basis, nevertheless there are some strikingly important differences that needed to be explained. During that process I explained the option terminology, differentiated between call and put options and showed how a change in one underlying variable (*ceteris paribus*) changes the overall value of an option.
Basic Concepts of Real Options have been examined, thereby also looking at valuation purposes, such as the Discounted Cash Flow and the Net Present Value method. As we have seen, those models almost perfectly apply to Financial Options; remember that when looking at Real Option valuation, those concepts were by far less reliable. A possible classification of Real Options was drawn, including the options of timing, staging, exit, operating, flexibility, switching, growth and compound options.

In the second section of the paper I discussed the main differences as well as similarities between the widely used decision making theories, focussing on the Transaction Cost Theory, Resource Based View and Real Option Theory. With respect to the different theories pointed at different assumptions underlying those schemes and described their theoretical underpinnings. Various opinions of different authors were included in this section – supporting ones as well as criticizing ones. Within this section the focus has been put on Real Option Theory and some individual options were explained to greater extent, such as options to defer investment, growth options, embedded options, shadow options and option chains. Also investment timing (considering the option to wait), technological platforms, technology positioning and restructuring profiles were taken into account.

The decisive part of this paper was, without any doubt, the application of Real Option Theory on sourcing decisions. Therefore I first introduced some ideas that are important in sourcing decisions, concentrating on core competencies, partial outsourcing and equilibrium models (industry equilibrium, a duopoly case and Bertrand competition). Another important aspect was to display analogies to other networking forms, drawing similarities to joint ventures and supply chain management in the high technology sector and the automobile sector. Lastly, more theoretical underpinnings and some valuation purposes were introduced.

8.2. German Summary

Am Anfang dieser Diplomarbeit stand die Präsentation der wichtigsten Charakteristika von Finanzoptionen, um ein besseres Verständnis von Realoptionen zu ermöglichen. Wie gezeigt wurde, haben diese beiden Konzepte eine gemeinsame Basis (vor allem im Hinblick auf die Finanzmathematik). Trotzdem wurden die größten Unterschiede hervorgehoben und die Konsequenzen derselben aufgezeigt.
Um eine Grundlage für die späteren Kapitel zu schaffen, wurde die Terminologie der Finanzoptionen erklärt und die wichtigsten Konzepte kurz umrissen: Zum einen der Unterschied zwischen einer Put- und einer Calloption und zum anderen die unvergleichliche Eigendynamik, die diese Instrumente entwickeln, wenn sich eine wichtige Variable ändert. Wie aufgezeigt wurde, können schon kleine Änderungen in einer Variablen zu großen Unterschieden im Gesamtwert einer Option führen.

In weiterer Folge wurden drei wesentliche Organisationstheorien vorgestellt – die Transaktionskostentheorie, die Ressourcentheorie und natürlich die Realoptionentheorie – und ihre wesentlichen Merkmale aufgezeigt. Danach wurden diese besagten Entscheidungstheorien auf Unterschiede und Gemeinsamkeiten untersucht. In diesem Kapitel ging es mir besonders darum, die wichtigsten Prämissen der einzelnen Theorien zu zeigen und hervor zu streichen, dass eben diese Unterschiede in den Annahmen einen Vergleich nach streng wissenschaftlichen Maßstäben kaum

ermöglichen. Weiters wurden möglichst entgegengesetzte Meinungen von diversen Autoren präsentiert, um die auf Spannungsfelder innerhalb dieser Organisationstheorien aufmerksam zu machen.
Einzelne Facetten von Realoptionen, die konzeptionell von größerer Bedeutung als andere sind, wurden eingehender untersucht. Unter ihnen fanden sich die Verzögerungsoptionen, Wachstumsoptionen, Schattenoptionen und das Konzept von Optionsketten, aber auch die Wichtigkeit des Timings bei Investmententscheidungen, technologische Plattformen und technologische Positionierung sowie mögliche Formen einer Restrukturierung eines Unternehmens.

Der zweifelsohne wichtigste Teil dieser wissenschaftlichen Arbeit war die Anwendung der Realoptionentheorie auf Outsourcingentscheidungen. In Zuge dessen war es notwendig, die wichtigsten Aspekte von Auslagerungsentscheidungen vorzustellen. Besonders die Bedeutung von Kernkompetenzen, gradueller Auslagerung, sowie unterschiedliche Gleichgewichtsmodelle (industrielles Gleichgewicht, die Existenz eines Duopols und Bertrand-Wettbewerb) wurde hervorgehoben.
Um eine Analyse im Bereich Outsourcing überhaupt zu ermöglichen, wurden Parallelen zu anderen Netzwerkformen gezogen – insbesondere zu Joint Ventures, Management von Lieferketten in der Hochtechnologie und der Automobilindustrie.
Zu guter Letzt wurden noch in aller gebotener Kürze weitere theoretische Konzepte, sowie Bewertungskriterien präsentiert.

8.3. Curriculum vitae

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