

**HEURISTIC REASONING
IN THE SETTING OF HURDLE RATES
AND IN THE PROJECTION OF CASH FLOWS
IN INVESTMENT APPRAISAL**

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Abstract

A growing body of literature in investment appraisal has focused on bounded rationality of managerial decision-makers. It mostly addresses the actual investment decision stage, i.e. project approval. The investment decision is usually supported by a financial appraisal of the investment projects under consideration. Bounded rationality of the decision-makers determining the parameters of a financial appraisal have, however, attracted little attention.

In the field of judgement and decision-making, decision-makers have been found to rely on a variety of effort-reducing strategies, i.e. heuristics, when making a judgement. This work addresses heuristic reasoning in the narrow field of setting the parameters required for a discounted cash flow analysis. Both dimensions, the projection of cash flows and the setting of a risk-adjusted hurdle rate, have been found to incorporate a high degree of subjective judgement. Moreover, given the complex and uncertain environment of companies and of the investment context in particular, optimal parameters may be difficult to determine.

This work identifies heuristics that actors involved in this narrow stage of investment appraisal intuitively apply. It proceeds in two steps. First, and based on a conceptual framework, a qualitative study of practitioners detects and classifies indications of judgement in the projection of cash flows and in the setting of a hurdle rate. The findings that are indicative of heuristics translate into hypotheses for a second, quantitative study: Five experiments on practitioner-proxies are used to examine heuristic reasoning in the narrow contexts of investment appraisal.

We find evidence that the affect heuristic and the anchoring effect substitute the more difficult judgement of a project's risk that is manifested in a project-specific hurdle rate. Our hypothesis that the availability heuristic may also be involved in judging project risk cannot be confirmed; it is not found to contribute to an explanation of the paradox of setting hurdle rates higher than appropriate. As regards the projection of cash flows, application of the representativeness heuristic was not found to be applicable – despite strong indications in the qualitative study. Strong evidence is found in favour of the anchoring effect in making cash flow estimates – with finance or accounting experts being particularly prone to rely on arbitrary anchors. A sixth experiment investigates the practice of adjusting hurdle rates to mitigate the risk of overconfident cash flow projections.

This work therefore contributes to an enhanced understanding of the role of judgement and the underlying judgemental processes in the two dimensions of investment appraisal. It highlights boundedly rational behaviour of the actors involved in the vital process of investment decision-making which has not been systematically addressed elsewhere. It can contribute to an improved understanding of organisational behaviour and ultimately to corporate success.

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1 Aims and Scope

The capital investment decision-making process is one of the greatest challenges for senior management. There are many reasons why companies are making investments; for instance, the plan to expand production, to capture a bigger share of the current market, or to renew the processes within an organisation. Almost every activity of the company requires an investment; consequently, investment appraisal plays a critical role in corporate decision-making. Capital – or corporate – investments refer to substantial investments made by firms, which have a significant effect on the long-term performance and the company as a whole.

Undoubtedly, there is a crucial need to make the right decisions. For that reason, investment appraisal methods have been developed quite early during the academic development of business administration and management and many different models for assessing an investment project were derived.

Taking for granted that corporate decision-making takes place under uncertainty, most decisions in the business context require judgement that is based on subjective estimates and thus intuition (Knight, 1921). Thus, judgement is required at a variety of different stages of corporate decision-making as can also be assumed for the capital investment decision process and despite the availability of sophisticated appraisal techniques: “there is a strong ‘human element’ to the delegation of investment funds (capital allocation).” (Graham, Harvey and Puri, 2014, p.35)

A single piece of research cannot fully capture all judgemental aspects sufficiently. This work focuses on a particular stage of the investment decision-making process: the investment appraisal or project analysis stage. At this stage, potential investment projects are financially evaluated usually by use of an appraisal method after having been preliminarily screened, so that a limited number of possible projects is to be decided upon. Based on the discounted cash flow (DCF) methods as the most widely applied ones (e.g. Arnold and Hatzopoulos 2000; Graham and Harvey, 2001; Brounen, De Jong and Koedijk, 2004), a project’s cash flow profile and the appropriate discount or hurdle rate have to be determined. These decisions determine the outcomes of the appraisal such as the net present value (NPV) and thus influence the investment choice.

In contrast to traditional economics and finance being normative sciences dealing with modelling the behaviour of individuals or groups (i.e. markets and organizations), cognitive psychology and the field of judgement and decision-making (JDM) in particular adopt a descriptive approach in addressing actual judgement and subjective phenomena. Behavioural approaches to economics, corporate finance and management accounting, i.e. applying the

concepts found in the field of JDM, have evolved to better describe and understand actual decision practice in organisations. They particularly account for numerous observed violations of the assumption of a rational decision maker and, instead, assume bounded rationality – the term that has been shaped to a great extent by Simon (1955, 1956, 1979, 1991). Judgement is assumed to rely on computational simplifications (Simon, 1955) as has also been found for managerial decision makers who “frequently try to minimize, or at least reduce, cognitive strain when they search and process information” (Shields, 1980, p.430).

Judgement regularly results from the use of cognitive, often intuitive strategies or rules, so-called heuristics. Heuristics are employed by human beings to simplify, i.e. reduce effort of a complex decision task (e.g. Shah and Oppenheimer, 2008). These simplifications serve to cope with complexity and uncertainty (Simon, 1955, 1956). Heuristics as simplifying strategies may often be imprecise and therefore lead to systematic distortions, i.e. cognitive biases (e.g. Tversky and Kahneman, 1974; Kahneman and Frederick, 2002). This, however, is highly debated in literature and heuristics are also considered as skilled and helpful (e.g. Gigerenzer, Todd and the ABC Research Group, 1999).

A growing body of literature in behavioural accounting, management accounting and managerial decision-making has dealt with examining heuristics in the respective contexts (e.g. Smith and Kida; 1991; Basel, 2012; Artinger *et al.*, 2014). Capital investment appraisal has hardly been in the focus of research. If at all, the investment decision itself has been addressed, often with regard to observed biases that may not necessarily derive from the use of heuristics (e.g. Harris, Emmanuel and Komakech, 2009; Serfas, 2011b). As regards the parameters to be determined in the investment appraisal process, i.e. the projection of cash flows and the setting of the hurdle rate for applying a DCF analysis, heuristics (and potential biases) have not been comprehensively addressed.

In this work, heuristics related to these dimensions are explored. In particular, the central question comprises: In what ways and to what extent is corporate investment appraisal with its dimensions of the projection of cash flows and the setting of the hurdle rate, affected by heuristic reasoning? The following research questions (RQ) guide this work’s analysis:

- RQ1:** What insights on investment decision-making behaviour are derived from an interdisciplinary synthesis of the literatures relating to investment appraisal and to heuristics?
- RQ2:** To what extent does bounded rationality influence the projection of cash flows in investment decision making? Does heuristic reasoning apply?
- RQ3:** To what extent does bounded rationality influence the determination of the discount rate in investment decision making? Does heuristic reasoning apply?

First of all, the existing literature on investment appraisal and its parameters with particular focus on actual practice is addressed in Chapter 2. Chapter 3 examines the literature on judgement and decision-making including heuristic reasoning. Based on synthesising the investment appraisal literature and the literature on JDM, Chapter 4 elaborates on the importance of addressing bounded rationality in the field of investment appraisal. It outlines the stages where judgement is involved in investment appraisal: It reveals the influences and interrelations of bounded rationality addressed by existing literature in capital investment appraisal. More importantly, a framework is derived to structure the findings with regard to whether they address or can be referred to one of the two dimensions of investment appraisal or to the investment decision itself (thereby addressing RQ1).

Little is known about the judgement involved in the projection of cash flows and in the setting of hurdle rates, particularly to what extent effort-reduction strategies, i.e. heuristics, play a role. Based on the surveys reviewed in Chapter 2, Chapter 4 continues to address RQ1 by conceptualising the different types of judgement made to arrive at a cash flow forecast and to derive a risk-adjusted hurdle rate. For both dimensions, the links between the derived types of judgement and potentially applied heuristics are analysed. In this way, a significant first contribution to literature is made.

The potential for heuristics that have been identified before, is addressed by a qualitative explorative study. We believe that a useful survey of heuristics in investment appraisal could best be derived after preliminarily exploring their indications in the practitioners' context. This semi-structured interview study (Chapter 5) is followed by a quantitative experimental approach (Chapter 6).

In particular, the purpose of the interview study is to explore the indications for heuristic reasoning in the judgement of corporate decision-makers involved in the investment appraisal. It contributes to literature by examining the stages where subjective judgement and thus potentially bounded rationality enter the projection of cash flows (thereby addressing RQ2) and the setting of the discount rate (thereby addressing RQ3). It identifies the types of judgement and information used in these two dimensions of investment appraisal that can be linked to particular heuristics. Findings from this qualitative study are then used to test heuristics in both dimensions in a subsequent quantitative study.

The quantitative study intends to experimentally examine bounded rationality, more precisely heuristic reasoning in both, the projection of cash flows and in the setting of hurdle rates. It is based on those heuristics that proved relevant in this context as identified in the previous interview study. It thus seeks to demonstrate in a structured way how selected heuristics (thereby addressing the second parts of RQ2 and RQ3) can impact investment appraisal. RQ2 and RQ3 are therefore addressed in two ways: not only by the interview study

but also by the experimental one. Chapter 7 discusses the findings and limitations of the studies and outlining the directions for future research.

The conceptual framework derived in Chapter 4 and the conclusions from the empirical studies served to identify the judgemental rules applied in appraising projects. They thus contribute to an improved understanding and add to what is known about capital investment appraisal. Raising awareness about bounded rationality is certainly of interest to corporate decision-makers since a more rational investment decision-making process has been found to lead to better long-term performance (Papadakis, 1998).

2 Capital Investment Decision-Making

2.1 Introduction

Investment decision-making is among the most important tasks and challenges for upper management. Investments are crucial and occur constantly in corporate life and almost every activity of the company requires them; they have a significant effect on the long-term performance and the company as a whole. Consequently, investment appraisal plays a vital role. Corporate investment decision-making, and particularly the decision process and its components, will therefore be reviewed in the first section of this chapter (2.2).

Investment appraisal methods were developed early in the academic development of business administration and management and many different models for assessing an investment project have been derived. The selection of the method can influence the indication; Section 2.3 therefore aims to provide an understanding of the most widely applied discounted cash flow (DCF) investment appraisal methods. It furthermore outlines the underlying assumptions and requirements identified in academic literature and the related problems in practice.

The basis for any investment appraisal is the projected cash flow data. The accuracy of the cash flow projections is crucial for a DCF analysis. The less precise the forecast cash inflows and outflows, the less reliable the target criterion's outcome, i.e. the net present value (NPV) or the internal rate of return (IRR). Section 2.4 will address the projection of cash flows and establish why a closer look at the projections of cash flows from a behavioural point of view is justifiable or even necessary.

One of the most important concepts of discounted cash flow methods is the time value of money, i.e. making comparable figures that occur at different points in time and thus, deciding about the rate at which future cash flows are discounted to the present point in time. The discount rate as the minimum rate of return or hurdle rate that has to be surpassed, therefore exerts an important influence on the target criterion and significantly affects the outcome of the decision process. The search for the appropriate rate is widely discussed: Used as a company-wide hurdle rate, it influences more than single investment decision, but rather the whole company policy. At the other extreme a project-specific hurdle rate may be applied for projects of particular importance, but determining it requires further judgement. Why the process of determining discount rates needs to be addressed will be the focus of Section 2.5.

Sections 2.4 and 2.5 follow the same pattern; first, behaviour in practice will be outlined by referring to relevant surveys and then it will be contrasted against theoretical principles. This chapter will hence provide a literature-based survey and coverage of the most widely used

investment appraisal methods, cash flow projections and hurdle rates. It provides a starting point for the subsequent research on bounded rationality and heuristic reasoning in the two dimensions of cash flow projections and discount rate setting.

2.2 Capital Investment Decisions

2.2.1 Terminology

In this work, investments refer to ‘capital investments’ or ‘corporate investments’ which typically involve a significant initial cash outflow and justify a sophisticated decision process. These terms used synonymously refer to investments which involve “commitment of resources to long-term investment in productive capital” (Northcott, 1991, p.220). Capital investments can be of strategic nature in that they are undertaken to reach a particular competitive position or advantage. In many cases, and particularly in more recent literature (e.g. Carr, Kolehmainen and Mitchell, 2010; Harris, Emmanuel and Komakech, 2009), the terms capital investments and strategic investments seem to be used synonymously. In distinguishing these terms, we would like to refer to Alkaraan and Northcott (2006, p.150):

‘Strategic’ projects are substantial investments that involve high levels of risk, produce hard-to-quantify (or intangible) outcomes, and have a significant long-term impact on corporate performance.

The emphasis on ‘hard-to-quantify or intangible outcomes’ stresses the extraordinary nature of strategic investments. Strategic investments in practice may involve specific non-routine procedures or decision rules that do not follow the investment decision-making routine outlined below. This thesis will refer to capital investments rather than strategic investments (as for example used in McLaney *et al.*, 2004).

More important seems the demarcation of corporate investments opposed to purely financial investments in a narrow sense (e.g. buying shares as a financial investment). Financial investments may but are not primarily made by companies, unless investing financially represents their ordinary business activity and the services offered to customers.

Capital investments may include the development of new products, of new markets and customers, new facilities, locations, expansions or relocations, and, more generally, all acquisitions of long-term assets. This research aims at a generalised (or generalisable) view on this. As every investment project is individual, so might be its appraisal. Yet, in order to gain new insights into the decision-making process, the type of the investment project will not be considered as a factor and the underlying logic of the appraisal process will be analysed

independent from its type. Supporting evidence derives from the practice of most companies having a formal investment decision process.¹

As there are different uses and terminologies, and sometimes an unclear demarcation, ‘investment appraisal’ in this study will be used to refer to the narrow part of the capital budgeting process in which potential projects are (financially) appraised using one or more appraisal methods supported by qualitative risk analysis. A broader view of this process would be too wide to permit useful generalisation.

A company’s capital investment strategy should be related to its broader long-term strategy and will dictate the kinds of products, markets and technologies that the company will invest in – typically determined in an investment portfolio and in an annual budgeting process. The availability of funds also plays an important role and can cause suboptimal decisions. Generating investment ideas and defining and presenting possible investment projects can be further sources of distortions.

2.2.2 The Capital Investment Decision Process

There are many models of the investment decision process. The aim here is not to provide a full coverage of the whole decision process but merely the context for the investment appraisal stage that will be examined in detail later on.

One of the early studies of the investment decision process was published by King (1975), triggered particularly by earlier publications of Dean (1951, 1953). Dean (1953, p.119) reported a research gap of capital budgeting and pointed towards three practical problems: 1. The measurement of value (“worth of individual investment proposals”), 2. The need for standards of investment appraisal (“screening”) and 3. The projections of cash flows (“demand for and supply of capital funds”). In his publications he introduced the term “Discounted Cash-Flow” method contrasting it to the “Accounting Method” (p.121). He then suggested standards for the screening of proposals. His approach labelled ‘scientific model’ (or ‘rational model’) was used in most literature of those days.² The idea of discounting future cash flows had earlier been suggested by Fisher (1930, p.3), “income is a series of events”;³ he noted that discounting is fundamental and spoke of the capital value.⁴

¹ This is supported by empirical findings, such as Harris, Emmanuel and Komakech (2009, p.XV).

² For a review of this literature see for example Bromwich (1970).

³ Referring to the first who wrote about it, Rae (1834).

⁴ Parker (1968) extensively described the discounted cash flow idea in historical perspective.

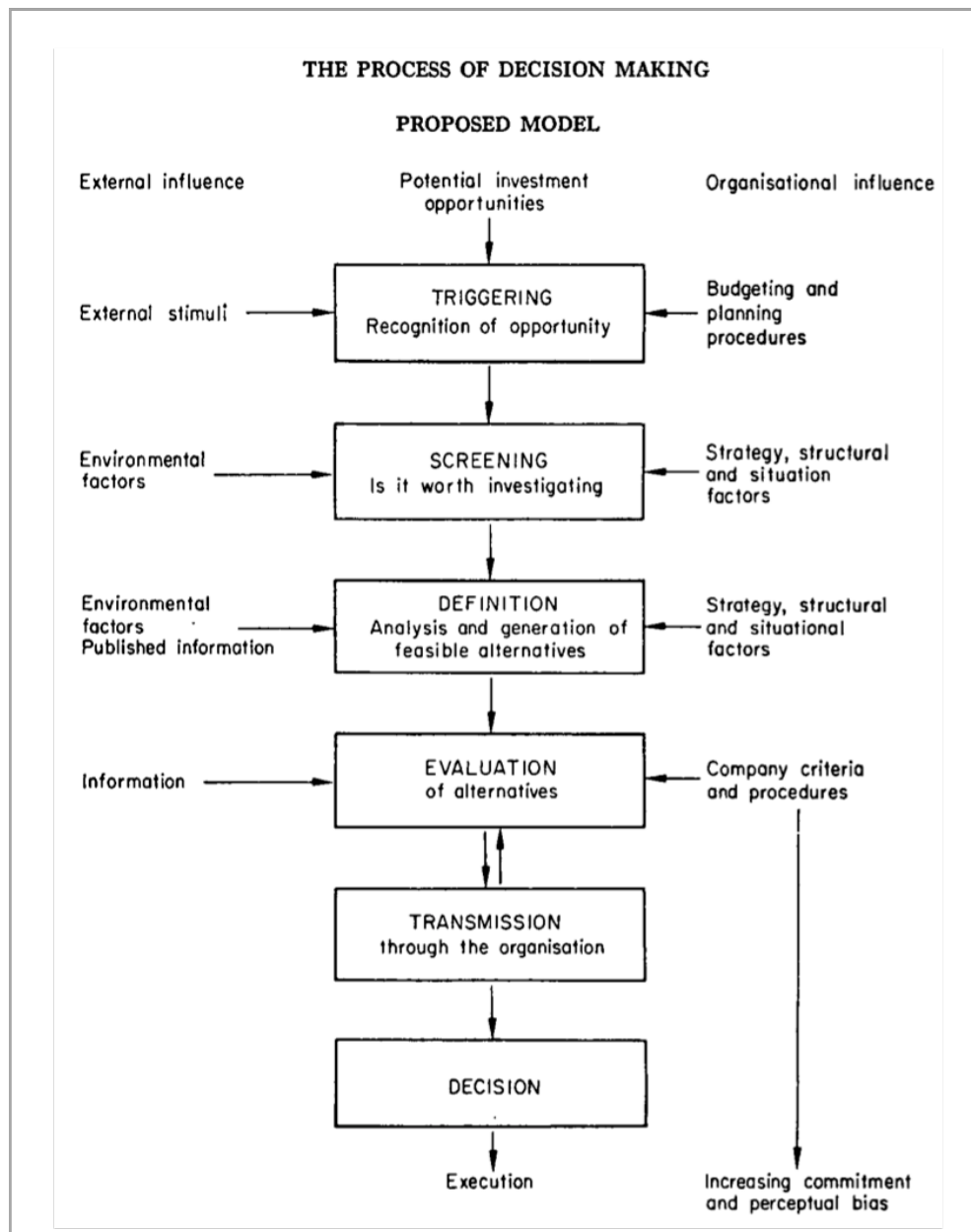


Figure 1 The investment decision process according to King (1975, p.72, used with permission of John Wiley and Sons)

Many other publications described the investment decision process, including popular textbooks (such as Bierman and Smidt, 1960), but Bower (1970) provided one of the first academic views on this issue. King (1975) criticised Dean's model and proposed a model illustrated in Figure 1. It was developed through practical experiences with large-scale investments of large and hierarchical companies. He identified six stages and incorporated both external and internal ('organisational') influences. He explicitly admits that the stages are both overlapping and interactive, which was the basis for some criticism of the model. The first stage, 'triggering', is the recognition of potential investment opportunities. He refers to the common assumption that "the existence of a set of capital investment projects from which

choice may be made is taken as given by capital budgeting theory” (King, 1975, p.73) and draws attention to the fact that such opportunities will not (always) arrive automatically. Because of that he sees the emphasis of capital budgeting theory misplaced. The opportunities are then screened, followed by the analysis and generation of feasible alternatives (‘definition’), evaluated and transmitted through the organisation before being decided upon. The limited (individuals’ and organisations’) problem-solving capacity does not allow all possible forms of projects to be brought to the evaluation stage and progress in the definition stage will be bounded by limited information and capacity and dependent on the ‘context’. He sees the ‘evaluation’, i.e. the actual investment appraisal stage according to his terminology, as the important stage, the “alpha and the omega” (King, 1975, p.75).⁵

King’s model helped develop concepts and ideas about how investment decisions are made. His approach, however, includes weaknesses and conceptual difficulties. The model to be used in this work treats corporate strategy as an independent first stage and not just an influence at other stages. Also, generating investment ideas is seen as a discrete subsequent step. The recognition of opportunities prior to screening of alternatives is regarded an independent stage. Investment opportunities, in this view, are outcomes of a certain corporate investment strategy and a meaningful generation of investment ideas.

Another influential model of the decision-making process is the one by Bower (1970). He suggested that capital investment should be investigated as an organisational process.

More recent models of the investment decision process such as the model by Harris (1999; see Figure 2) and the related model of Götze, Northcott and Schuster (2015, p.10, Figure 3)⁶ consider investment decisions from the investment planning perspective. Investments can be regarded as having a life cycle consisting of planning, implementation and utilisation. Their differentiation is essential for this work; it is vital to clearly identify the decision steps and the ex ante and ex post view. In this thesis we focus on the planning aspect and touch on the aspect of post audit. Planning here is interpreted as a general management process comprising several steps: (1) the setting of targets, i.e. the identification of problems and (2) the search for alternatives. The search for alternatives includes preliminary search, assessment of potential projects and decision-making. Parameters that have to be determined in the assessment will be addressed in this work. In doing so, bounded rationality and effort-reducing rules of thumb that potentially imply distorted decision-making in decision-makers’ judgement will be the focus.

⁵ For criticism of King’s approach, see for example Tinker (1976) and the reply of King (1977).

⁶ Their model does not derive from a particular empirical study; it, however, is considered suitable to derive a model to sufficiently illustrate and pin down this work’s focus.

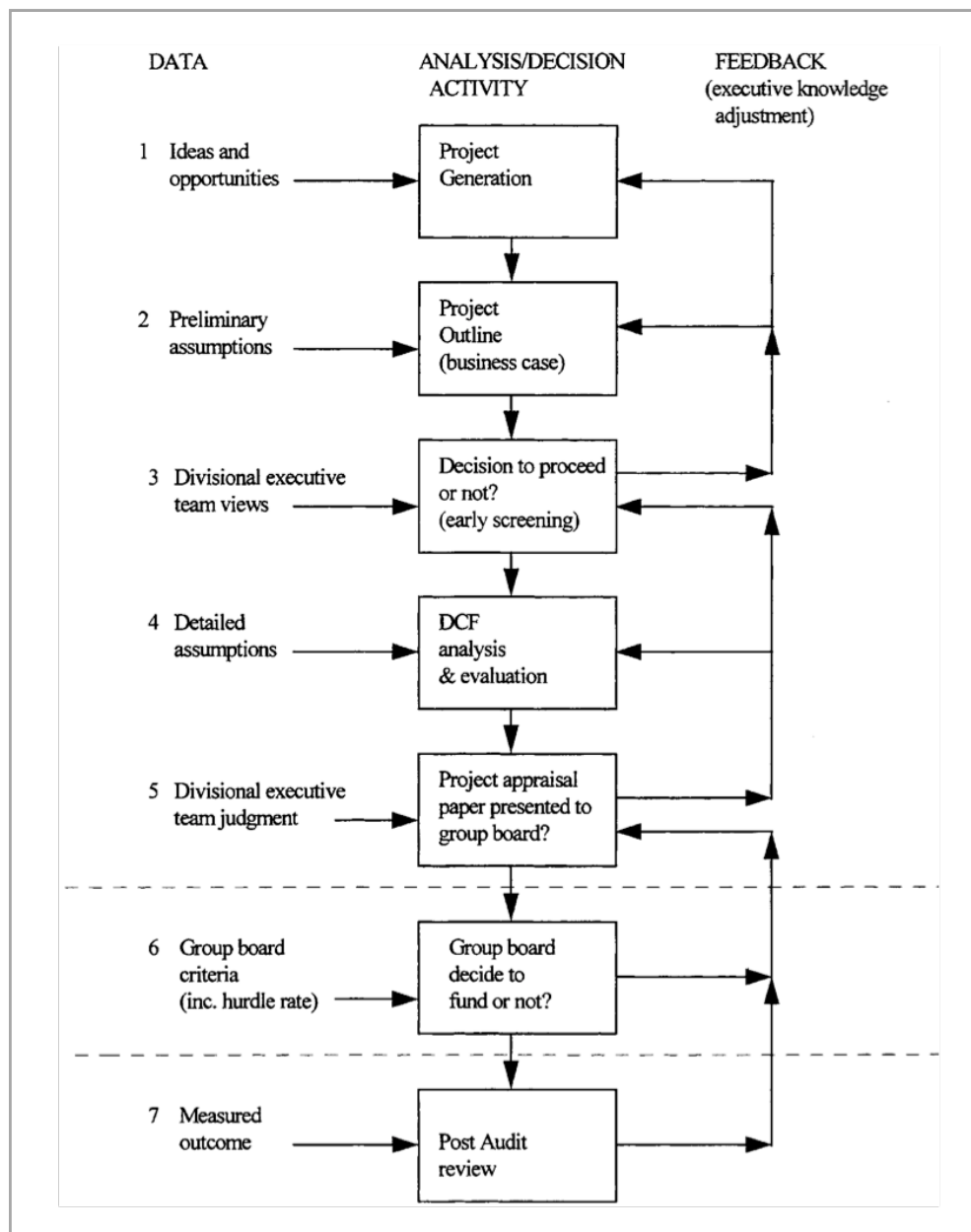


Figure 2 The investment decision process according to Harris (1999, p.352, used with permission of Elsevier)

Recent studies of the investment decision process (exemplified by Harris, 1999 and Götze, Northcott and Schuster, 2015) typically assume the following steps: a stage related to the determination of a budget and the dependence on an investment strategy (Stage 1 in Götze, Northcott and Schuster, 2015); a phase of search and development (Stages 1 and 2 in Harris, 1999; Stages 2 and 3 in Götze, Northcott and Schuster, 2015), a phase of evaluation and authorisation (Stages 3 to 6 in Harris, 1999; Stages 4 and 5 in Götze, Northcott and Schuster, 2015); and monitoring and control (Stage 7 and Stages 6 and 7 respectively).

Of particular interest to this thesis is the narrow stage of the investment appraisal using financial measures in a detailed analysis. It therefore does not deal with the final decision, nor

the implementation, monitoring or post audit review processes or the pre-screening of alternatives. Many models of investment appraisal combine evaluation and decision stages. However, separating them is appropriate for the purpose of this work as explained below.

In the model by Harris (1999), Stage 4 is DCF analysis; this implies that discounted cash flow methods are always used in that part of the decision process, but empirical studies (as described in Section 2.3) indicate that other methods such as the static⁷ payback period method are also used. Götze, Northcott and Schuster's (2015) fifth stage (Harris' fourth, 1999) which is in the centre of the focus here, does not exclude non-DCF analysis. However, DCF methods seem to be the most widely used ones and later on will be selected as a basis for the subsequent analysis.

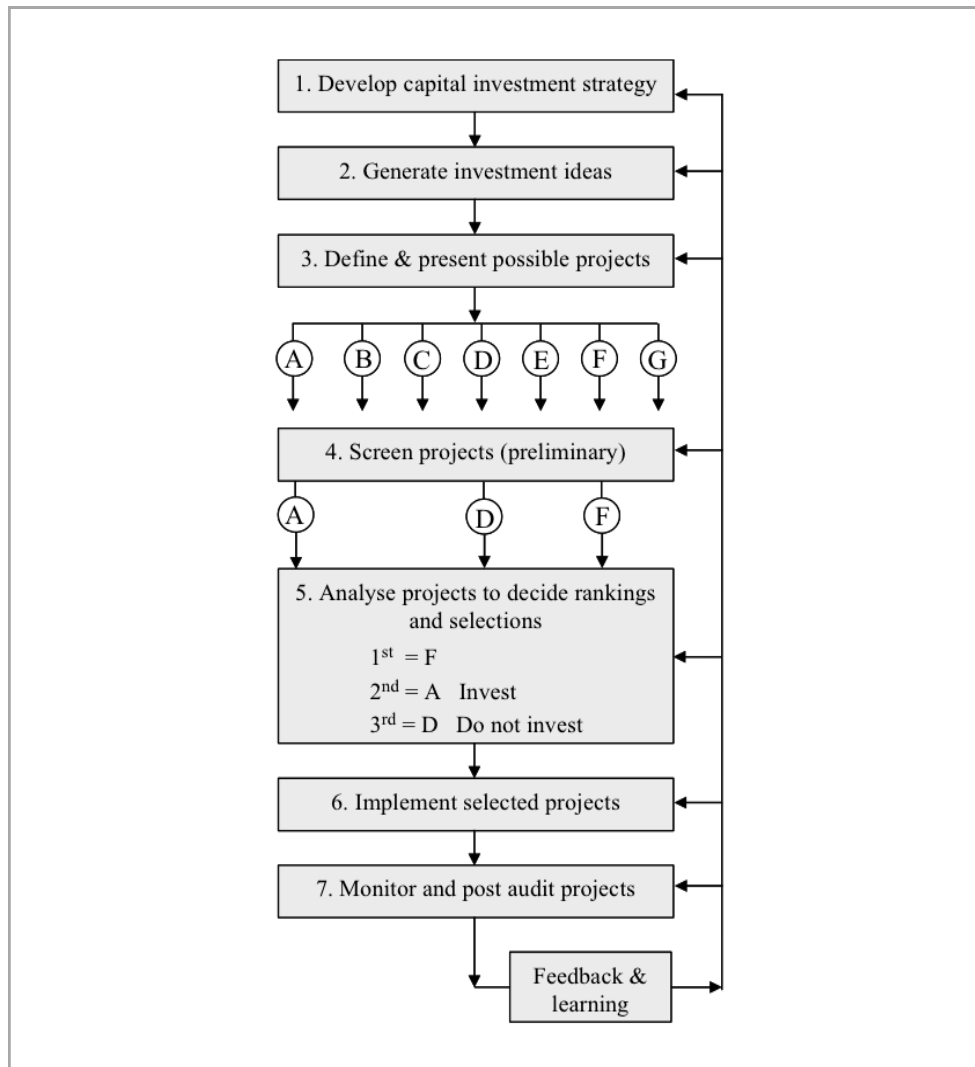


Figure 3 The investment decision process according to Götze, Northcott and Schuster (2015, p.9, used with permission of Springer)

⁷ Static methods do not consider the time value of money and base calculations on average periods.

Another difference between the two models is the more explicit analysis of group decision-making mentioned by Harris (1999); she builds in an additional stage connected to the project appraisal results to be presented to the group board (her Stage 5) and then sees the group board decision as Stage 6.

While board decisions might be a typical characteristic of the investment decision process, group board decision-making is not a necessary distinction for this research since the decision stage itself is not in the focus. Logically, also Harris' investment appraisal Stages (4, 5 and 6) may include both, group judgement and also individual judgement. We prefer to not limit the process model to particular individuals or groups. A clearer distinction is required which will be picked up later enriching existing investment appraisal models with the human influences as regards the reasoning processes involved.

In the model by Götze, Northcott and Schuster (2015) the derivation of parameters such as the cash flow profile and the setting and applying of the discount rate(s) is part of their Stage 5, as without the discount rates applied the project analysis cannot be operated. Harris sees the responsibility for this in the group board decision to fund (accept) or not fund (reject) the project, thus separating this feature from the project analysis stage.

As we focus on the appraisal parameters that enter the project appraisal before a final decision is made, we consider the approach of separating the appraisal stage to be valid. The appraisal parameters determine the outcome of the financial appraisal and thus influence the decision. Despite our narrow focus on the parameters to be determined in an appraisal, we integrate the actual decision of acceptance or rejection into the stage of project appraisal. We thereby adopt a more conceptual approach which is independent of the particular decision processes of a firm, for example a step to decide whether a proposal is presented to the group board or not. Despite its relatively low level of detail and its rather positive nature, the model by Götze, Northcott and Schuster (2015) covers all stages that empirical models such as Harris' (1999) include and allows more flexibility in the kind of method used, the parameters to be determined and roles involved, and represents an objective basis for the later analysis. Figure 4 illustrates the capital investment decision process adopted in this thesis.

Jones and Dugdale (1994) take a slightly different look at the investment decision process and identify and contrast academic and practitioner perspectives. They approach four facets of rationality of accountants: objective, subjective, inter-subjective and positional rationality; accounting practitioners have different perceptions of these four facets as regards appraisal methods, information use and procedure of decisions-making, compared to academics. Jones and Dugdale (1994) see the interaction of these different facets in complex reasoning processes resulting in the fact that there is no unique 'correct' outcome of the reasoning process – the appropriate context-specific procedure is an outcome of competing rationalities and influences.

They hold that practitioners take a broader view on the contexts and the investment decision process in general.

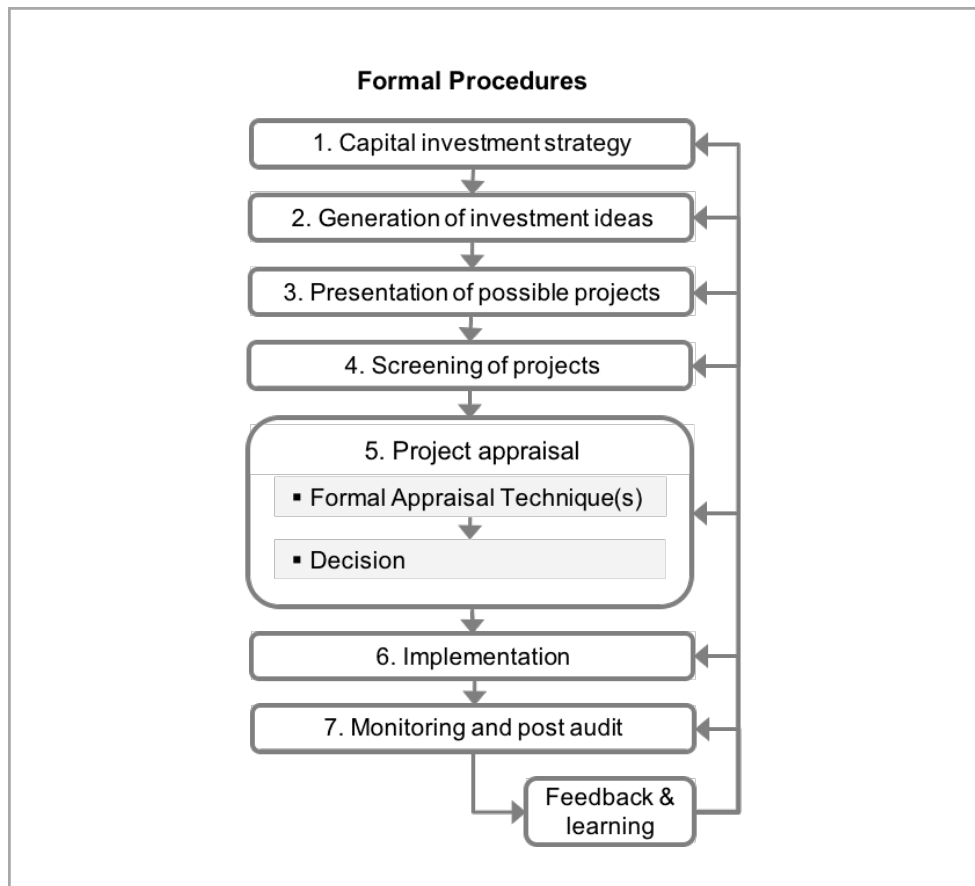


Figure 4 The investment decision process adopted in this thesis (based on Götze, Northcott and Schuster, 2015)

While an ‘academic rationality approach’ to investment appraisal has been adopted so far in this chapter, the main thrust of this study is concerned with the *subjective* rationality of practitioners and the reasoning processes involved. In this way it will attempt to capture parts of what Jones and Dugdale (1994) describe as the ‘practical’ reality of corporate decision-makers.

Effects of national culture may also be relevant and have been reported inter alia by Hofstede (1980, 1991, 2002), and Carr (2006) who compares practices in Russia, Great Britain, Germany, the United States and Japan. The aim of this chapter, however, is to present a decision model without considering cultural distinctions since all relevant research universally identifies the appraisal stage as an important part of investment decision making.

In general the components and stages of investment decision process models are rather similar; therefore, the particular model followed is unlikely to significantly affect the outcome of this research. It, however, is taken as a basis and, enriched by analysis of subjective factors

related to judgement in the investment appraisal stage in Chapters 3 and 4, provides a framework for empirical work reported in Chapters 5 and 6.

The central stage of many models and the focus of this work is the investment appraisal stage including formal analysis and the actual decision (Stage 5 of Figure 4). In this part of the process, potential investment projects are analysed after having been preliminarily screened, i.e. when there are a limited number of possible corporate investments to decide upon. Quantitative investment appraisal methods are used to decide upon the economic viability and profitability of the projects. Of central importance, but often neglected (Jones and Dugdale, 1994), is the projection of cash flows. And for discounted cash flow (DCF) methods, this stage also requires the decision of which discount rate(s) should be applied. As will be elaborated on below, this rate is theoretically treated as a datum, but given all market imperfections there is no uniform rate and it does have to be decided upon. Deciding about parameters in this stage will significantly influence outcomes of the financial result and potentially the decision outcome. The decision stage may incorporate proposal presentations, board discussions and the final accept or reject decision but these will not be further considered.

Much attention has been drawn to the investment decision stage, however, there is a crucial need to focus on the setting of the parameters that influence the financial result and thus potentially the decision, from a behavioural angle because little is known about how the judgement translates into financial estimates. Examining the reasoning processes particularly requires narrow focus and a thorough approach to examine and be mindful of the peculiarities of the context.

Focusing on a narrow stage of the investment decision process does not mean that one has to adopt an isolated approach and address investment appraisal independently from all other stages of the investment process. In fact, noting and addressing the potential feedback loops and the interaction of the stages with each other is important. Chapter 3 will outline behavioural phenomena that may play a role in any economic decision process. However, not even the fields of psychology and economics in particular are able to derive models to comprehensively and satisfyingly capture a particular decision process with all known behavioural phenomena and their interactions. Therefore, capturing the whole investment decision process in its entirety and with a variety of behavioural phenomena that are yet unknown in how they interact with each other is hardly possible given the current state of research from psychology.

This work intends to thoroughly examine the specifics of the investment appraisal stage with regard to the reasoning by heuristics in the setting of parameters. Determining a parameter estimate does not typically include the making of a decision such as, for example, whether or not to abandon or commit further to a project, as will also be outlined in Chapter 3. Thus reasoning processes may be different compared to a typical decision situation and therefore

require individual focus. The narrow focus of this work does not exclude reference to other stages such as the monitoring and post audit stage of previous projects if applicable; for example if the functioning of the respective heuristic assumes reference to the past. However, this focus on narrow investment appraisal in its complexity and depth will prevent an equally thorough focus on other decision stages such as the post audit stage, which would require a different study design. Future research may examine and incorporate the interaction with other stages in a way that a single piece of research like this work is not capable of.

2.3 Investment Appraisal Methods

The investment appraisal stage of the decision process has traditionally been in the centre of previous research. The use of present value techniques has a long tradition, although it took many years before widespread diffusion of sophisticated discounted cash flow methods was achieved. In 1582, Stevin, a Dutch mathematician, scientist and accountant published ‘interest tables’ and described the use of present values for loans.⁸ Compound interest was applied and served as a prerequisite for the development of life insurance; according to Dodson (1747) this started in England in the 18th century. The first authors suggesting the use of present value methods published as far back as the late 19th century.⁹ Nevertheless, it was many years before the application of such methods gained acceptance in practice. Before this was achieved, developments in three fields could be observed: actuarial science (as a result of Dodson’s tables and the development of life insurance contracts); the so-called engineering economics, and political economics.

To invest implies to refrain from present consumption with the objective of leading to higher consumption and investment in the future. Therefore, investment decisions directly affect the temporal distribution of capital and are compellingly related to the discounting of future receipts and payments. More sophisticated investment appraisal methods found their way into textbooks (Fish, 1915)¹⁰ and began to become popular in the 1920s (for example the ROI measurement at DuPont, see Brown, 1924; or the so-called present worth technique at AT&T, see Charlesworth, 1925, and Rhodes, 1925). Nevertheless, it was only after World War II that those methods, particularly DCF methods, were regarded to be more than obscure company-specific tools. Progress of methods and diffusion in practice was driven, although not with immediate impact, by academics and their influential publications, such as Fisher (1907, 1930), Coase (1938) who described the NPV method to an accounting audience and gained a wider

⁸ Even in the 14th century, Italian merchants were using DCF techniques to calculate discounts for customers paying in advance, see Parker (1968).

⁹ See for example Wellington (1877) and Pennell (1914).

¹⁰ The author brought in Wellington’s ideas in his classes at Stanford University and in his textbook. It was further developed by Grant (1930).

recognition only many years after his initial works, Lutz and Lutz (1951), Dean (1951, 1953, 1954), Hirshleifer (1958) as well as Anthony (1956) with the first textbook on management accounting. This impetus from economics and business academics was supported by activities from professional associations and consulting companies. Yet, by the end of the 1950s, only a few large companies used advanced investment appraisal tools and the National Association of Accountants (1959) reported a lack of use of such methods. Wider diffusion of DCF methods as the standard procedure in large companies was only gained between the late 1970s until the end of the century, as for example Graham and Harvey (2001) found in a 1998 survey among CFOs. Multiple empirical studies exist and will be picked up below.

2.3.1 Investment Appraisal Methods in Practice

Investment appraisal processes were set up as a result of developments in the business world: Growing company size and new technologies led to a multi-divisional structure of companies and, consequently, decentralised decision-making on the one hand, and non-owner managers on the other. Defining and presenting possible investment projects thereby gained importance. The owners of smaller companies decide about investment decisions, but as companies grew larger professional managers were appointed and started to use various techniques to ensure that the owners felt comfortable about their funds being used properly. After a period of little or no diffusion investment appraisal methods have now been widely accepted in company practice. There are numerous surveys of investment appraisal practices¹¹, from different time periods and for different countries, with publications such as:

Alkaraan and Northcott (2006), Anand (2002), Andor, Mohanty and Toth (2015), Arnold and Hatzopoulus (2000), Bierman (1993), Brigham (1975), Brotherson *et al.* (2013), Brounen, De Jong and Koedijk (2004), Bruner *et al.* (1998), Brunzell, Liljeblom and Vaihekoski (2013), Carr, Kolehmainen and Mitchell (2010), Cherukuri (1996), Daunfeldt and Harwig (2014), Epps and Mitchem (1994), Farragher, Kleiman and Sahu (1999), Gitman and Forrester (1977), Gitman and Mercurio (1982), Gitman and Vandenberg (2000), Graham and Harvey (2002), Graham and Harvey (2001), Hermes, Smid and Yao (2007), Holmen and Pramborg (2009), Jagannathan and Meier (2002), Jog and Srivastava (1995), Kalyebara and Ahmed (2011), Kester and Chang (1999), Klammer (1972), Liljeblom and Vaihekoski (2004), Mao (1970), Meier and Tarhan (2007), Pandey (1989), Payne, Heath and Gale (1999), Petry (1975), Pike (1996), Poterba and Summers (1995), Ryan and Ryan (2002), Sangster (1993), Shao and Shao (1996) or Wong, Farragher and Leung (1987). Empirical studies were particularly popular in the 1980s and 1990s. Andor, Mohanty and Toth (2015) provide a collection of studies researching usage of capital budgeting methods in 35 countries including their own on Central and Eastern

¹¹ Sometimes referred to as capital budgeting techniques, for example by Carr, Kolehmainen and Mitchell (2010, p.168).

European firms. They report that DCF methods are the most widely used methods in the USA, UK, Australia, Indonesia, the Philippines, Malaysia, and China with usage rates around 90%, often in conjunction with static methods. In countries such as Finland, France, Germany, the Netherlands and Sweden firms seem to use DCF less (around 60-80%), but still more often than static methods such as payback period or accounting-based methods.

Comparing the net present value (NPV) and the internal rate of return (IRR) usage, NPV seems to dominate; for example in Germany (48% and 42%, according to Brounen, De Jong and Koedijk's study in 2004, with a sample of 313 European companies), in the Netherlands (70% and 56% respectively; Brounen, De Jong and Koedijk, 2004) and in Sweden (61% and 30% respectively; Daunfeldt and Hartwig, 2014); static payback period (SPP) is used in about 50% of companies throughout these countries. On the other hand in the UK and in France, companies use the IRR method slightly more than the NPV method (53% and 47% respectively, in the UK according to Brounen, De Jong and Koedijk, 2004; 44% and 35% respectively, found by Daunfeldt and Hartwig, 2014).

Considering the USA (and Canada), Graham and Harvey (2001), with their study of 392 CFOs, indicate that internal rate of return (IRR) method and the net present value (NPV) method are the most popular – around 75% of respondents always or almost always apply each method. The SPP method and the dynamic payback period¹² (DPP) method achieve 57% and 29% respectively. Similar to Graham and Harvey's (2001) study, some Southern American countries including Brazil reveal about equal usage of NPV and IRR (72% and 70% respectively (Maquieira, Preve and Sarria-Allende, 2012). Meier and Tarhan (2007) examined the investment appraisal methods in responses from CFOs of 127 US American companies. They found that DCF was applied by almost 90% of companies as either first or second choice of method; the IRR technique was preferred in 42% of firms and the NPV technique in 37%; the SPP and return on investment were preferred by slightly less than 20% each, and DPP by around 5%.

Further methods assuming certainty include earnings multiples (39%), accounting rate of return (ARR) (20%) and profitability index (12%) (Graham and Harvey, 2001). Meier and Tarhan (2007) find much lower usage of profitability index and average rate of return, each at below 5%.

Differences between cultures and countries are apparent. For example, Shinoda (2010) shows that Japanese practices differ markedly from those in other industrialised countries. The percentage of Japanese companies that always or almost always use the following investment methods in 2009 were: NPV: 31%, IRR: 25%, SPP: 50%, DPP: 20% and accounting rate of return: 30%. Thus, a much stronger focus on static methods can be found. Country comparisons,

¹² Also known as discounted payback period.

based on small scale samples with particular reference on cultural studies, are found in a study of Carr (2006).

Despite the unquestionable trend of increased diffusion and of the use of discounted cash flow methods, comparing results of different studies is not useful. Obvious contradictions show up as a consequence of the dissimilar samples' data as for example Haka (2007) illustrates.

To arrive at a reliable evaluation of an investment project, uncertainty and its risks are regularly assessed and various techniques are applied in practice. Graham and Harvey (2001) find in their US American and Canadian sample that 52% apply scenario analysis, 27% consider real options, 14% use simulation analysis such as value-at-risk (14%) and 12% apply adjusted present value. Arnold and Hatzopoulos (2000) in their study of 296 UK companies and Kalyebara and Ahmed (2011) investigating 205 Australian companies, find that risk is most often considered in a sensitivity analysis¹³ (by 85%¹⁴ and 30% respectively respectively); secondly, and often in addition, the discount rate is adjusted for particular risk (by 52% and 23% respectively). They find adjustment of cash flows to be third most common way to account for risk, followed by probability distributions (9%), simulations (9%) and adjustments of the payback period (8%) and certainty equivalents (2%). In their survey, Arnold and Hatzopoulos (2000), examined cash flow adjustment with regard to inflation risk and additionally included a category of subjective adjustment, which was chosen by 46% of companies. Of minor importance were probability analysis (30%), adjustments of the payback period (20%), beta analysis (3%) or ignoring risk (1%).

Abdel-Kader and Luther (2008) also found sensitivity analyses to be important and more often used than stochastic analyses, yet having low importance and usage relative to other management accounting practices – however, the latter may be due to the fact that their study included small- and medium-sized firms who as a tendency use less sophisticated investment appraisal techniques. From reviewing the literature related to risk adjustments in discount rates, cash flows, intuitive adjustments and sensitivity analyses, we observe a rather pragmatic way of adjusting for risk denoted as *simple risk adjustments* by Ho and Pike (1992); whereas the use of *probabilistic risk analysis*, i.e. stochastic models such as simulations, seems rare.

Reasons for why probabilistic analyses seem to be less often applied by managers, may include that they do not want to be held responsible by fully disclosing their expectations, and also because “managers are generally uncomfortable with probabilistic estimates” (Arnold and Hatzopoulos, 2000, p.612; Neuhauser and Viscione, 1973). In contrast, familiarity with projects may also prevent them from estimating probabilities (Arnold and Hatzopoulos, 2000; Pike, 1982). Decision-makers may also refrain from employing risk techniques and probability

¹³ Including scenario analysis; scenario analysis can be considered a special case of sensitivity analysis as outlined below (cf. also sensitivity analysis of Type A in Götze, Northcott and Schuster, 2015).

¹⁴ In Arnold and Hatzopoulos' study (2000), multiple responses were allowed.

assessments to arrive at seemingly precise, but unreliable, estimates (Neuhauser and Viscione, 1973; Arnold and Hatzopoulos, 2000).

The most important risk factors that are taken care of in a project appraisal include market risk – as one risk factor accounted for via the beta factor – interest rate, in the exchange rate, in the business cycle and inflation; others include commodity prices, term structure, financial distress, market-to-book ratio and momentum as summarised by Graham and Harvey (2001). Chapman and Ward (2011) outline sources of risk for projects which as a practical guideline can and should be accounted for in project appraisal. They include differences in the organisation, definition, concept and design of the project, logistics, local conditions, communications, financing arrangements, resource estimates and industrial relations. This to a high degree overlaps the rather theory-based summary by Graham and Harvey's (2001).

As regards the consideration of risks in either in the cash flow projections, the discount rate or in both, a study of 392 US American companies (Graham and Harvey, 2001) examined that the discount rate is adjusted most often due to risks implied in the interest rate, the firm's size, inflation and the exchange rate. They find that cash flow projections are adjusted most often due to risk in commodity prices, business cycle fluctuations, exchange rates and inflation. To firms who adjust discount rates and cash flows), risks implied in interest rate, size, inflation and exchange rate also play an important role. These kinds of adjustments are elaborated on in more detail below.

Having considered the investment appraisal methods applied in practice and the risk assessments made, we now refer to further, non-financial, criteria that play a role and become more relevant in the decision stage of investment appraisal. Arnold and Hatzopoulos (2000, p.611) amongst others find "strategic fit to be an important criterion for the acceptance of projects alongside the quantitative hurdles" pointing to the deficiency of, for example, a net present value criterion in reflecting all information relevant for decision-making. They further mention staff availability, management strain, cultural fit, options for skill and technology advancement as further important criteria apart from the financial appraisal. Kalyebara and Ahmed (2011) find the majority of companies (70%) accept investment proposals even if the financial results are negative – which supports the previous reasoning.

Determinants of Investment Appraisal Practices

Previous empirical studies about investment appraisal practices, which are available in great number, mostly exclude the discussion of which factors influence the choice of appraisal methods. The analysis of the large sample survey of Graham and Harvey (2001) produced interesting results. Respondents were asked to score how frequently different investment appraisal methods are applied, on a scale of 0 ("never") to 4 ("always"). Results were then compared against company characteristics. It was shown that the IRR method was more

frequently used by CEOs aged 59 and above than by younger CEOs, the NPV method slightly more often by younger CEOs, the static payback period method more frequently by older (59+) CEOs. The Accounting rate of return method was hardly used by either group. An MBA educational background of the CEO was associated with an increased frequency of use of both IRR and NPV methods but lower use of the static payback period method. In the same study, public companies showed a similar effect on the frequencies for the three methods, so did the results for NPV and IRR for companies with foreign sales and – with stronger differences – companies from Fortune 500.

Brunzell, Liljeblom and Vaihekoski (2013) using survey data from 157 Nordic companies in five countries find the use of the NPV method linked to CFO characteristics. Age and education are especially influential. Younger and better educated CFOs, particularly those with an MBA, are more likely to use NPV. A less surprising, yet important result is that the larger the company the more emphasis is placed on discounted cash flow methods, particularly small companies are less likely to use net present values, and hardly further new methods (e.g. Pike, 1996; Graham and Harvey, 2001; and Brunzell, Liljeblom and Vaihekoski, 2013).

Haka (1987) identified company characteristics that could support or impede the successful use of discounted cash flow methods; she found that a supportive information system, a long-term reward structure and a decentralised structure are crucial for successful DCF analyses. Chen (2008) identifies that companies with high product standardisation are more likely to apply NPV, and other discounted cash flow methods. In his empirical study, based on a sample of circa 600 publicly traded manufacturing companies in the USA, he like Haka (1987) found that the closer a company's strategy is to 'defender' strategy the more emphasis is put on discounted cash flow methods. An appropriate fit of DCF methods with product standardisation and company strategy is connected with a higher level of satisfaction with the investment appraisal process.

Hermes, Smid and Yao (2007) related the investment appraisal method choice to the level of economic development, in a cross-country comparison between China and the Netherlands. They found evidence of less use of NPV but more of the ARR method in the less developed country. In regard to the more sophisticated NPV technique they argue that more economically developed countries have more developed financial markets making DCF more convenient and appropriate. Financial markets place increased emphasis on shareholder wealth maximisation, better CFO training and financial tools and software that assist investment decision-making. Additionally, the wider use of technology and its lower cost contribute to increased application of more sophisticated investment appraisal methods. These findings are consistent with Holmen and Pramborg's (2009) which shows that the use of NPV decreases with political risk in a country, while the static payback period criterion is more used. Alkaraan and Northcott (2006)

have shown that the choice of investment appraisal methods appears to be independent of the type of the investment project.

In summary, surveys have found significant diffusion of the discounted cash flow methods. One robust determinant of the use of net present values is company size; this will become relevant in the sample selection later in this work. Managerial characteristics such as age and education were also found to significantly determine the use of DCF and NPV methods. As regards company characteristics, a firm's strategy and structure, information system as well as the reward structure and the level of product standardisation can contribute to the successful use of discounted cash flow methods. Higher technological and economic development increase the use of DCF methods while political risk is negatively correlated.

Clearly, and unsurprisingly, discounted cash flow methods and particularly, the net present value technique, are the most widely used by large companies' appraisal of investment projects in especially but not exclusively Anglo-American countries, Western Europe, Australia or China. As indicated, this thesis adopts a descriptive approach addressing actual judgement and behavioural phenomena. Besides the choice of the appraisal method and after a preliminary screening of projects, the input parameters of the method have to be determined. This step is of central importance and significantly impacts the appraisal outcome. How a method is applied may not only depend on the decision-maker's knowledge about the method itself and about the investment object and environment, but also on the decision-maker's judgemental mechanisms. In particular, the judgement applied in the setting of the parameters may also influence how actual investment appraisal is done. This perspective has not received adequate attention; thus, examining the judgement processes of this narrow stage of corporate investment appraisal plays an essential role in the investigation of contributing to an improved understanding of this central managerial task.

To adequately examine the determination of the parameters, broad usage of a particular appraisal method provides a strong argument in favour of considering this method the basis of analysis. DCF analysis as an eminently wide-spread family of methods therefore signifies an adequate choice. Representing DCF methods, NPV makes a strong case for examining appraisal practice since it is sufficiently precise on the one hand, and at the same time generalisable to other DCF methods due to identical assumptions on the other hand. Moreover, due to its broad coverage, the choice of NPV method as the primary focus of this work is particularly beneficial since the results of this work can directly reach a broad number of corporate decision-makers and thereby help increase awareness about bounded rationality and contribute to lead to better performance.

Thus, in our effort to illuminate actual practice, we will particularly focus on the net present value method as the dominant method in terms of usage and on its theoretical foundations in

Section 2.3.2 to identify indications of bounded rationality. The focus on NPV may be limited as it a priori excludes other methods' peculiarities from analysis. However, this focus provides the necessary attention required to examine a problem in adequate detail. Widening the focus of analysis and including other methods would not necessarily provide additional benefit; and particularly since most of NPV's content is equally applicable to all other DCF techniques and to non-DCF methods, too, as will be picked up below in more detail. Moreover, expanding the scope to other, particularly non-DCF methods would increase the level of complexity and abstractness of analysis which would impede precise conclusions and recommendations for practitioners.

2.3.2 Discounted Cash Flow Methods in Theory and Their Suitability for Practice

Accounting literature on investment appraisal has seen little development over the years with regard to actual investment appraisal practices and has led to the widely known gap between theory and practice (Miller and O'Leary, 2007).

The finance profession has concentrated on how capital investment decisions should be made, with little systematic study of how they actually *are* made in practice. This narrowly normative view of investment decisions has led the profession to ignore what has become a major worldwide efficiency problem that will be with us for several decades to come. (Jensen, 1993, p.870)

'Theory' refers to the normative, often non-evidence based perspective of deriving how investment appraisal should be applied; it is typically characterised by a set of assumptions about for example the markets and their actors and thus about the requirements for the methods' parameters. Theoretical investment appraisal is partially and by no means exhaustively also reflected in major textbooks (e.g. Brealey, Myers and Allen, 2013; Pike, Neale and Linsle, 2012; Götze, Northcott and Schuster, 2015). 'Practice' is considered the evidence based perspective addressing how investment appraisal actually is applied; it on the other hand has been found to apply such recommended methods but in inconsistent and partial ways, i.e. with inappropriate consideration of the requirements of the respective parameters or without discussing the limitations as regards the expressiveness of a method's target criterion.

The theoretical concepts have been discussed in detail and for a long time. However, the gap remains between actual practices and the academic literature's advised practices. While more recent literature has developed richer methods and variations of existing ones, little is known about what *sufficient* – as opposed to optimal – decisions should consist of.

It is useful first to briefly outline the basic methods¹⁵ of investment appraisal (e.g. Brealey, Myers and Allen, 2013; Pike, Neale and Linsle, 2012) including one rather theoretic perspective to outline what university education on an advanced level may include (e.g. Götze, Northcott and Schuster, 2015). Such textbooks shape practical knowledge and applications as many corporate decision-makers have undergone academic business education.

Basic investment appraisal methods include static methods that consider earnings figures rather than cash flows; these do not consider the time value of money and assume an average period to be representative for the whole economic life of a project. (Götze, Northcott and Schuster, 2015). As mentioned in 2.2.1 they include the static payback period and the accounting¹⁶ rate of return method (e.g. Brealey, Myers and Allen, 2013). DCF methods include not only NPV and IRR but also the annuity method and the dynamic payback period (e.g. Brealey, Myers and Allen, 2013). Compounded cash flow methods include the compound value method, the critical debt interest rate method and the visualisation of financial implications (VoFI) method; these relax some of the assumptions of DCF regarding the perfect capital market but are rarely covered in the Anglo-American literature (e.g. Götze, Northcott and Schuster, 2015).

Methods that also assume certainty but that relax DCF's assumption of one target criterion and thus explicitly also consider different, non-financial target criteria include utility value analysis, analytic hierarchy process (AHP), multi-attribute utility theory and the preference ranking organization method for enrichment evaluation (PROMETHEE) (e.g. Götze, Northcott and Schuster, 2015). Simultaneous decision models allow for simultaneous investment, financing and production programme decisions and include the Dean model, Hax and Weingartner model and the extended Förstner and Henn model (e.g. Götze, Northcott and Schuster, 2015).

As pointed out in the previous section, the most popular methods are DCF methods. We will therefore address the characteristics of the primary DCF methods including assumptions and limitations and how to theoretically incorporate uncertainty.

As shown NPV and IRR are the most popular investment appraisal methods. The NPV represents the net monetary gain or loss of a project. Among its assumptions (e.g. Götze, Northcott and Schuster, 2015) are that the data of projects are known (i.e. certainty exists; there are ways to overcome uncertainty and this will be picked up later), the linkages between different points of time are also known. Moreover, all relevant effects are assumed to be measurable, isolatable and presentable in accounting figures, usually cash flows. When projects are compared they are assumed to be mutually exclusive (or else in each case only absolute

¹⁵ Often, variations of methods exist, such as the modified internal rate of return or a profitability index, but they are not treated as separate methods in this survey and not considered further.

¹⁶ Or 'average'.

profitability would be a criterion and all absolutely profitable ones would be invested in) and without relationship between them otherwise. It is further assumed that the firm's decisions from other areas, such as financing or products and production are made beforehand, i.e. will not influence the essential investment decisions. The economic life of a project is assumed to be known *ex ante*; it is possible to lift this assumption. It is assumed that incremental cash inflows (for example resulting from production and sales of a product) can be attributable to the project and a specific period, so investment projects that relate to more than one product or products that are connected to several investments present a problem.¹⁷ An important assumption of all DCF techniques, including NPV method, is that any net cash inflow surplus not needed for balancing cash outflows can be reinvested at the uniform discount rate. One unified discount rate is assumed to balance the capital demand and all reinvestments at the capital market. The discount rate is also used for discounting the future cash flows to the time period $t=0$ (or any other point in time). Therefore, a perfect capital market is assumed, and the result for both absolute and relative profitability is independent from the form of capital. Under the perfect capital market unlimited borrowing lines and investment opportunities are implicitly assumed and without this assumption investment and financing projects cannot be treated as independent.

The Discounted Cash Flow Methods' Suitability for Practice

Based on the various assumptions of DCF methods, there are a number of practical limitations of the discounted cash flow methods, that are of importance: Researchers, for a long time, have acknowledged that discounted cash flow methods have deficits in that they are not unconditionally appropriate and their suitability depends on the projections (and forecast quality) of future cash flows, the investment project's impact on cash flow generation and on future investment opportunities as well as on the determination of a 'suitable' discount rate to be used as discount rate (e.g. Myers, 1984; Chen, 2008; Haka, 1987). We will refer to these issues in the final part of this chapter.

Clearly, one of the main problems is the consideration of uncertainty: The combination of certainty and perfect capital market works very well in theory and conceptually, except for that both are not very realistic in practice. Methods that explicitly incorporate uncertainty are strongly demanded in the literature; they have gained importance during the last decades and have found their way into textbooks and partially into practice: As we have seen in Section 2.3.1, various methods which are also theoretically recommended to consider uncertainty are considered in practice. The following outline presents the basic ways recommended by textbooks to incorporate uncertainty; it largely relies on Götze, Northcott and Schuster (2015) which in this case is generally consistent with Brealey, Myers and Allen (2013) or Pike, Neale and Linsle (2012). We will refer back to these methods below when discussing the projection of

¹⁷ This critical discussion is largely ignored in company practice.

cash flow and the setting of hurdle rates and the effects of the adjustments made in the NPV calculation due to uncertainty.

Risk-adjusted analysis includes various adjustments of the parameters of a method under certainty such as the NPV method. One way to account for risk is to (largely subjectively) correct input measures such as cash flows or discount rate, which, however, is not considered suitable because of methodological shortcomings (Götze, Northcott and Schuster, 2015). More sophisticated adjustments include the adjustment of the discount rate based on models such as the Capital Asset Pricing Model (CAPM) (see below Section 2.5.2, also for original references) or the adjusted present value (APV) developed and recommended by Myers (1974) that relies on the NPV concept and particularly considers different costs and effects of equity and debt; yet this method does not consider the different degrees of uncertainty in the cash flow projections (Götze, Northcott and Schuster, 2015). Furthermore, the risk adjustment can be made at the level of cash flows via certainty equivalents (that can also be used with the NPV method) or the time state preference model, which have practical shortcomings of how to determine the underlying functions and data procurement (Götze, Northcott and Schuster, 2015).

Sensitivity analysis can also be based on methods under certainty and considers variations of the target variable such as NPV if the input variables change (e.g. Götze, Northcott and Schuster, 2015). If the effect of a combination of input variables' changes are considered, we may denote it a scenario analysis. Alternative, the critical values of the input variables can be examined for the target variable to achieve a specific value (e.g. Götze, Northcott and Schuster, 2015) and may for example include a break-even analysis. It is considered a good method to shed light on the underlying relationships of the, yet few, variables and their effects.

Risk analysis refers to stochastic models that assume probability distributions of (a number of) uncertain variables and their interdependencies. It requires a decision model to be formulated and the probability distribution of the target variable (e.g. NPV) can be calculated often by use of simulation, for example the value at risk can also be determined; simulation is assumed to deliver a well-founded decision basis but may also require subjective estimations of initial data particularly if a new project does not resemble a past project (Götze, Northcott and Schuster, 2015).

Decision-tree analysis dynamically considers scenarios including assumed probabilities and flexibility in future alternative, also to be connected with DCF methods, however, at a limited number of scenarios, alternatives, and uncertain measures (Götze, Northcott and Schuster, 2015).

Options pricing or real options analysis considers an investment project's options to wait/delay, to terminate, to interrupt, to continue, to extend/restrict capacities, to change or to innovate. Various approaches exist, the original real options approach has been developed by

Black and Scholes (1973) for financial assets. Better than the decision-tree method, it does not include subjective estimates; however, shortcomings include the assumption of a perfect capital market, the determination of counterpart assets in the market, options' links to each other. Due to various assumptions, the empirical validity, however, is limited, but the general and more information consideration of options by decision-makers (i.e. if real options analysis is not applied as formally as suggested), may contribute to a more informed and more analytic approach to investment selection. (Götze, Northcott and Schuster, 2015)

Further concerns about the NPV method applied in practice are addressed by various publications. Adler (2000, p.16) for instance criticises traditional approaches of investment appraisal and identifies several problems. First, "investment proposals are often viewed through an exceedingly narrow decision-making lens, examined almost invariably from the sole perspective of the investing department". Second, investment projects may also be characterised by non-financial benefits. These are typically insufficiently incorporated in a formal way. He also claims the short-term focus of traditional methods and the status quo assumption, that "it is generally assumed that the current competitive position will remain unaltered" (Adler, 2000, p.17). His further arguments include the insufficient consideration of inflationary effects and incentive problems and resulting non-objective managerial behaviour.

Berkovitch and Israel (2004) present a theory showing how the application of the NPV method and the NPV criteria leads to suboptimal investment decisions and explain the discrepancy between theoretical and practical investment criteria and appraisal methods by the existence of cost of information, i.e. information asymmetry. When decentralised managers intend to maximise their managerial utility and if the headquarter cannot observe all projects available then these managers are inclined to manipulate the selection process. NPV being a suitable way of measurement of value added in many real-world situations of companies will then be suboptimal due to information asymmetry. In their model, the use of NPV rule does not implement the selection of the investment projects with the highest NPV while they prove that the use of IRR can achieve this. For example, they show that a modified internal rate of return, where the discount rate is different to the risk-adjusted cost of capital, is feasible, and thereby explain the contradiction found that companies use real hurdle rates considerably higher than the cost of capital would suggest, found by for example Poterba and Summers (1995), which will be addressed in a later part of this work.

McDonald and Siegel (1986) and McDonald (2000) address whether seemingly 'incorrect' investment appraisal practices serve as substitute or reconciliation, in the sense as proxies for economic considerations not properly accounted for by the NPV method. They show that it can be optimal to use a hurdle rate or to use the profitability index, as a rule of thumb, when a company cannot determine the true net present value. Similarly, Magni (2009) concludes that non-proper use of the net present value methods in using a hurdle-rate rule in fact leads "to

close-to-optimal solutions when confronted with the expanded NPV” (Magni, 2009, p.976). The issue of hurdle rate setting and hurdle-rate rules will be referred to in more detail below in Section 2.5.

Magni (2009, p.968) notes that the expanded NPV is in fact a real options approach (Dixit and Pindyck, 1994; Trigeorgis, 1995), which from a textbook perspective has been outlined above, “which is but a sophisticated version of the traditional NPV model, where the set of alternatives is inclusive of the options implicit in the project”. Magni (2009) explains that simple net present value calculations can deviate from the real option value of a project, thus leading to the rejection of investment projects that in reality have absolutely profitable option values. Real options, in particular the option to wait, undoubtedly are accepted as a valid, rational reason to complement the ‘simple’ net present value.

Further approaches taking into consideration various of the above-mentioned methods to consider uncertainty have been developed, exemplarily mentioning Carmichael (2011) or Blatt (1979); for investments that change the capital structure, Wood and Leitch (2004) for example derived an adjusted approach to NPV. Interestingly, Boyle and Guthrie (2006) show that the static payback period method can be an intuitive rule to better include information, cash inflows and outflows or costs and benefits, and thus against academic recommendation support investment decision-making, finding optimum decision when discount rates are uncertain.¹⁸

As regards the practice of investment appraisal methods, we can conclude that the investment appraisal process has become more sophisticated and that the diffusion particularly of DCF and with it, the NPV method, has increased. This is obvious and does not result in new insights for investment decision-making. With the increased use of DCF methods, the setting of discount rates and the projection of cash flows have gained crucial importance because they will determine the expressiveness of the financial result of the investment analysis. It is by far not a new piece of insight that DCF methods when applied in practice come at serious limitations. Butler and Schacter (1989, p.14) put the consequences of the limitations into a nutshell with particular consideration of DCF methods’ influencing factors, “With estimation risk in the estimates of either the cash flows or RADR [risk-adjusted discount rate], there must be estimation risk in the resulting PV [present value].” In this way, the practice of determining cash flows and discount rate may always lead to a less than optimal target variable of a DCF analysis.

In terms of the NPV method’s theoretic background and its derived suitability given the non-applicability of its assumptions in practice, the conclusion of many academics is that the NPV criterion – even if properly applied – is insufficient and inefficient for capital allocation

¹⁸ Boyle and Guthrie (2006) suggest that under uncertainty the dynamic opportunity costs of an investment are greater for projects with longer payback, so that the target to maximise values needs to incorporate the payback criterion to justify investment being an increasing function of payback.

decisions and that additional methods should be used. But apart from focusing on the inherent problems of applying a highly theoretical method in practice, we have also seen indications that behaviour in practice may not necessarily worsen the applicability of the NPV method, but may even compensate for some of its shortcomings.

Providing more insights in how reasoning actually is done can contribute to shedding light on estimation errors and thus minimise estimation risk of the methods in use. We will therefore more closely address the DCF methods' – exemplarily NPV's – main dimensions: The projection of cash flows required for a DCF analysis will now be addressed by contrasting theory and practice. We will proceed analogously with addressing the setting of the discount rate, which is – due to its function – often called hurdle rate.

The results of our analysis with regard to the NPV method are transferrable to other DCF methods as the same parameters – cash flow projections and hurdle rate(s) – and thus the same judgement is required. The results may partially be transferrable to methods other than DCF that may or may not require risk assessment. For example, for the static payback period, an average profit estimate has to be made that may exhibit similar reasoning processes due to actual uncertainty as in a cash flow estimate. Or for example in a real options analysis in determining the options' cash flows and thus values. This provides huge potential for future research.

The use of a particular method may lead to behavioural effects that might not occur to the same extent when applying a different method (e.g. as Denison, 2009, found in comparing NPV to real options analysis; the latter outperformed NPV method due to resulting in a lower degree of escalation of commitment; thus the real options method had less negative behavioural and decision consequences compared to the NPV method). However, the use of methods such as real options analysis that are less wide-spread or relatively slowly adopted in practice may result in further mistakes being made. Further mistakes may be grounded in a false understanding or flawed application of a method by those who prepare the investment decision paper; or decisions may be wrong if the decision-maker falsely interprets the result. Hence, focusing on the well-known and wide-spread NPV method represents an advantage. Whether mistakes offset the advantages could be subject of future research, too.

Figure 5 illustrates the main dimensions or tasks in the investment appraisal stage (cf. Stage 5 of Figure 4) for a discounted cash flow analysis and in particular, for calculating the target measure such as NPV (or IRR, DPP etc.). Deriving all incremental cash flows into a particular cash flow profile will always serve as the basis for a DCF analysis. Additionally, a discount rate is required; it may not necessarily be determined each time a project is evaluated as will be outlined below in more detail. The figure is thus to outline the general requirement of these two

main dimensions for the financial analysis and to provide a basis for further analysis.¹⁹ Sections 2.4 and 2.5 will elaborate on the two dimensions in detail.

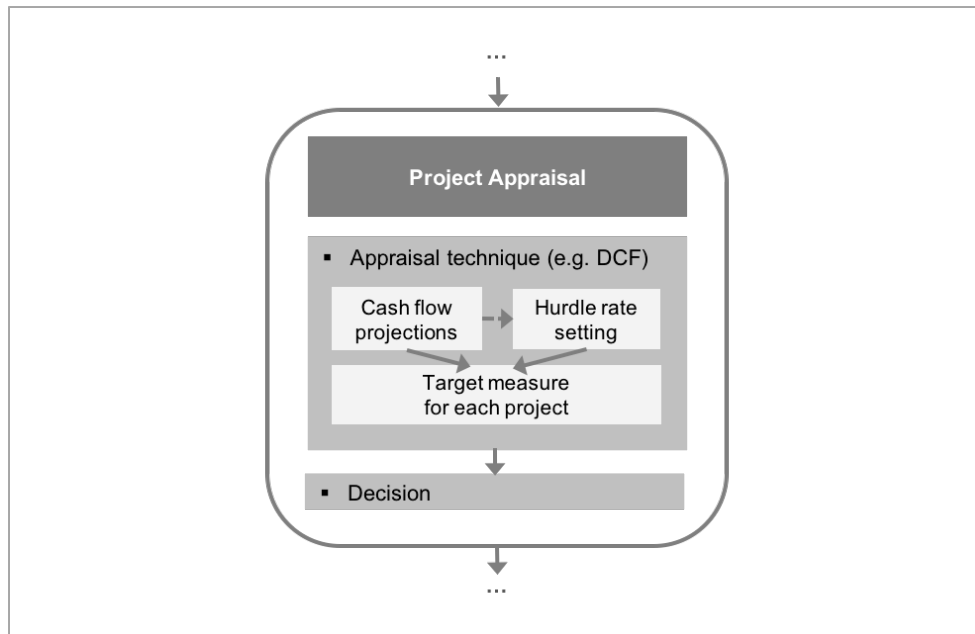


Figure 5 The project appraisal stage

2.4 The Projection of Cash Flows

2.4.1 The Projection of Cash Flows in Practice

“Judgment pervades all aspects of forecasting.” (Armstrong, 2001, p.9) And in fact, the practice of projecting cash flows for appraising an investment exhibits many inconsistencies or systematic distortions that are traceable to judgemental influence as we will outline in the following. Woods (1966, p.95) has already noted one aspect of the huge gap between theory and practice:

In estimating the value to the company of a potential investment, the managers in the organisations studied are preoccupied with searching for a comparable prior investment rather than identifying the relevant variables and forecasting the underlying uncertainty.

He also pointed to the practical problems associated with point estimates (or best estimates) accompanied by few additional best or worst case estimates of cash flows. And Miller (1978, p.22) hints at knowledge learnt from textbooks, which may largely still be true today: “one makes the best estimates possible and then inserts the estimates into the textbook net present value formulas”.

¹⁹ In the figure, both dimensions are situated next to each other, this, however, does not mean that both are determined simultaneously.

Studies with particular focus on the practice of cash flow estimation are rarely found. Pohlman, Santiago and Markel (1988) examined 232 large US American companies. As regards the type of estimates, they find point estimates to be the most common type (indicated by 56% of companies), only few (8%) companies use estimate ranges and 36% use both types.

The majority of companies apply a standard procedure to forecast cash flows (85%); moreover, most of them (78%) employ standard forms or worksheets for cash flow estimates (Pohlman, Santiago and Markel, 1988). Lazaridis (2006), who largely replicated Pohlman, Santiago and Markel's (1988) study in 573 Greek and Cypriot companies, generally confirms the previous findings.

The ways how firms actually derive cash flow estimates are investigated in a study by Meier and Tarhan (2007) with 123 finance directors; they find the indirect method to derive the net cash flows to dominate: Unlevered cash flows, i.e. earnings before interest and after taxes (EBIAT) + depreciation - capital expenditures and changes in net working capital, appeared to be the predominant way of calculation (46%); levered cash flows, i.e. net income + depreciation - capital expenditures and changes in net working capital, are used by 25% of companies; both ways are considered correct if the discount rate adapts to or matches the respective method (Meier and Tarhan, 2007). The remaining companies obviously apply techniques that are modified versions of levered or unlevered cash flows (and thus incorrect).

Cannibalisation, i.e. losses of existing products due to the introduction of new products, is considered in the appraisal of new projects by 81% of the companies in Meier and Tarhan's (2007) US American study; this behaviour would imply that there are low entry barriers which seems highly unlikely for the industries surveyed, as indicated by the authors. Sunk costs, which should not play a role, are included by slightly more than half of companies in their survey. Vera-Muñoz (1998) finds the inclusion of opportunity costs in a resource allocation decision negatively correlates with accounting knowledge.

Among forecasting methods for cash flow estimates and naturally to account for uncertainty, subjective forecasts were the most commonly used ones (91%); further methods included sensitivity analysis (69%), consensus of experts' opinion (67%), simulation (52%), sophisticated mathematical models (48%) and probability theory (43%) in the rather old study by Pohlman, Santiago and Markel (1988, p.74).²⁰ Lazaridis (2006) found estimates made subjectively by 48%²¹; the second most common techniques are experts' consensus and simulation (17 and 14% respectively), the other techniques (sophisticated mathematical models, sensitivity analysis and probability theory) are applied by below 5% each. Both studies thus reveal the strong dominance of judgement though many other quantitative supportive models

²⁰ Multiple responses possible.

²¹ Single response only.

are also used and combined. It comes as no surprise that the identified methods or techniques partially overlap with the general risk assessment and adjustment techniques outlined in Section 2.3.1 due to the lack of discriminability of incorporating uncertainty in the appraisal method or in the CF forecasts. In addition, no research has been found that surveyed the way how information is used to derive a *subjective* cash flow forecast under uncertainty or *subjectively adjust* forecasts derived from models.

In the literature of managerial judgement and their forecasts of for example earnings or other performance indicators such as investment cash flow of the financial statement, a variety of studies note a forecast bias, i.e. overestimating the projected outcomes or assuming too narrow confidence intervals of estimates (e.g. Woods, 1966; Lowe and Shaw, 1968; Statman and Tyebjee, 1985; Russo and Schoemaker, 1992; Heaton, 2002; Malmendier and Tate, 2005, 2015; Libby and Rennekamp, 2012; Adam, Fernando and Golubeva, 2015; Mohamed, Bouri and Fairchild, 2013; Dambra, Wasley and Wu, 2013; Hilary and Hsu, 2011; Glaser, Schäfers and Weber, 2008). These insights about managerial forecasts however largely refer to general managerial behaviour and are connected to the decision stage of investment appraisal (see the second phase of Stage 5, Figure 4). They usually imply an aggregate perspective on investment activity of a firm, rather than to particular cash flow estimates for a project appraisal.

The risk of distorted forecasts in the projection of cash flows as data basis for an investment project appraisal has been known for a long time (e.g. Woods, 1966; Statman and Tyebjee, 1985; Bierman, 1986; Pruitt and Gitman, 1987; Guilding and Lamminmaki, 2007; Turner and Guilding, 2012). This bias typically may not only involve an inflation of cash inflows in particular rather than a deflation (e.g. Guilding and Lamminmaki, 2007; Turner and Guilding, 2012) but also an underestimation of cash outflows (as Flyvberg *et al.*, 2002, who examined public works projects). These forecasts are not normally made on the CEO level, but on the management accountants' or the operational/technical managers' (i.e. experts) level; deciding about acceptance or rejection of a project, however, is a decision regularly made by top management (e.g. Woods, 1966; Miller, 1978; Pruitt and Gitman, 1987). There may certainly be similarities, particularly operational or technical managers who prepare cash flow forecasts may – as managers – have similar characteristics as top managers and thus results are transferrable.

As a result, forecast bias is often assumed to lead to overinvestment, for example if managers overvalue project performance, they may accept negative-NPV projects (Heaton, 2002); or they may perceive external funds as overpriced and invest excessively if substantial internal funds are available (Malmendier and Tate, 2005). Perceived overpricing of external funds, i.e. supposed undervaluation of the firm's assets may lead to rejecting positive NPV projects and thus underinvestment (Heaton, 2002; Malmendier and Tate, 2005).

Flyvberg *et al.* (2002) mention to the following reasons for an underestimation of cost in large public investment projects: technical reasons that comprise sheer mistakes or problems predicting future outcomes in general; economic reasons implying that it can be economically rational to underestimate costs and overestimate benefits, namely to increase chances for acceptance; political reasons referring to interests and power; and psychological reasons. These reasons for the cash flow forecast bias in public project appraisal might be similarly transferrable to corporate projects. It may certainly also depend on the individual incentive schemes of the decision-makers involved. Correlations could only be found in few cases (see Turner and Guilding, 2012, for a review): Overestimation of cash flows was not found to correlate with company size, industry, region, investment incentives but a positive correlation was identified with technology and complexity, managerial short-term horizon (Turner and Guilding, 2012, Merrow *et al.*, 1981; Soares *et al.*, 2007). What Flyvberg *et al.* (2002) mentioned as one reason, has become an important stream of literature: the focus on psychology, i.e. behavioural explanations that bring forth managerial overconfidence and optimism, that will be referred to in Chapter 3.

As regards the post audit of projects, it is common practice to compare actual with forecast values (75% of respondents in the study by Pohlman, Santiago and Markel, 1988; even more in the study by Lazaridis, 2006); in particular, all of them compare operating cash flow estimates; 95% are found to compare initial investment outlays; and 68% to address liquidation values (Pohlmann, Santiago and Markel, 1988).

In summary, we find forecasts that are point estimates in most cases; they are sometimes complemented by uncertainty ranges and other techniques such as sensitivity analyses. Highly complex forecasts based on modelling or simulation are seldom found. If we take this behaviour for granted, highly complex cases (that would require different treatment) either seldom occur or are often simplified in the appraisal.

The stream of future cash flows is not consistently derived for example whether sunk costs or cannibalisation are included depends on the company. A consistent forecast bias, i.e. overstating cash flows or being too confident about them, which is empirically found, can be explained in various ways; however, a behavioural explanation requires further attention.

2.4.2 The Projection of Cash Flows in Theory and Their Suitability for Practice

As noted above, the cash flow projections in a discounted cash flow analysis from a normative point of view must represent all effects caused by and in relation to the investment project and allocated to specific future periods of time. This implies that all effects are measurable,

particularly in monetary terms; in an isolated way, they must be attributable to the single project under consideration.

Eschenbach (2011, p.449) summarises the categories that a project can relate to – to derive the cash (out)flows that should be considered in the project appraisal: working capital, training, public relations, accounting and auditing, general management and administration, contract services, software design, development and maintenance, security, insurance and workers' compensation, taxes, fringe benefits, capital recovery and return requirements, design and engineering, and tangible and intangible benefits.

Cross-sectional relationships between cash flows and time-series effects of projects and thus future options should also be considered which, however, a net present value would not be able to capture (Myers, 1984). If decision-makers maintain investment appraisal based on discounted cash flow methods and do not adopt improved tools, as many studies suggest, the quality of the appraisal thus strongly depends on the quality of forecast (e.g. Chen, 2008; Haka, 1987; Myers, 1984). Kalyebara and Ahmed (2011) also find that the projection of cash flows in practice is considered the most difficult stage in the capital budgeting process and it in fact is the second most critical one after the project definition.

Regarding the feasibility of the theoretic requirements of cash flow projections for practice, Myers (1984, p.133) asserts the impossibility “to forecast most projects’ actual cash flows accurately. DCF calculations do not call for accurate forecasts, however, but for accurate assessments of the mean of possible outcomes.” Knowing that an accurate forecast cannot be made, he advocates the goal to derive the best estimate in the sense of the expected value as a basis for calculation. Having solved the practical puzzle how to determine the optimal hurdle rate would not warrant an undistorted net present value:

Even if a firm is using a correct capital budgeting method, and computing its discount rate correctly, it could still undertake value-destroying investments by making errors in the computation of project cashflows and/or by using incorrect cashflow/hurdle rate combinations. (Meier and Tarhan, p.28)

Moreover, problems for the person in charge such as the operating manager making accurate forecasts about the future relate to the difficulty of the task: “the operating manager is asked to look into a far future he is not used to thinking about” (Myers, 1984, p.133). Myers (1984) also notes that forecasting *accounting* variables is different to a more familiar task of forecasting *operating* variables and acknowledges that, anyhow, macroeconomic variables are not easily projected (Myers, 1984).

‘Forecasts’ generally refer to the formal techniques that are required for decisions involving uncertainty and stand in marked contrast to planning: “Planning concerns what the world *should* look like, while forecasting is about what it *will* look like.” (Armstrong, 2001, p.2). Schoemaker (2004) distinguishes different types of forecasts according to their level of uncertainty and

complexity and proposes a two-by-two matrix, differentiating each by low and high. The basic tools that he considers suitable for practice do not deviate much from those applied in practice. Forecasts can come in various forms; depending on the levels of uncertainty and complexity and given the impossibility of determining accurate forecasts, different forecasts are recommendable:

Low complexity and low uncertainty projects include for example “forecasting the demand for a known product in a stable environment”; for such types of forecasts, typically point estimates are suitable (Schoemaker, 2004, p.275). For low complexity but high uncertainty such as “trying to estimate the oil reserves in a new offshore field about to be prospected” (Schoemaker, 2004, p.275), point estimates plus confidence ranges can be applied, partially also risk analysis (probability distributions). To reduce too narrow confidence ranges and biased estimates, decision-makers should make use of more analytic models such as decision trees or simulation. For these two cases, i.e. cases which are not very complex in general, numerical point estimates are justifiable. For low uncertainty but high complexity in such as projecting short-term economic growth, the relations of all variables in effect have to be modelled supported by qualitative methods investigating cause and effect, comparing to past project or considering outliers (Schoemaker, 2004). Finally, for highly uncertain and equally complex cases (as for example to estimate the “future market size of genomics-based drugs” or “outcome of the war on terrorism”, p.283), he asserts that stochastic models are required rather than striving for a particular numerical estimate, also complemented by qualitative techniques and scenario planning.

Undoubtedly, procedure in investment appraisal practice *should* come as closest to optimal behaviour as possible. However, as cited above, in practice we find forecasts that are point estimates in most cases, sometimes complemented by uncertainty ranges and other techniques such as sensitivity analyses. Highly complex forecasts based on modelling or simulation are seldom found. “It would be wrong to jump to the conclusion ... that, in time, managers will become sufficiently well informed to be able to handle the complexity involved” in assessing risk (Arnold and Hatzopoulos, 2000, p.612). At least from considering the behaviour implied in the survey findings above, we may infer that suboptimal behaviour is found in that forecasts of cash inflows and outflows are rarely resulting from sophisticated complex models even if theory would suggest.

Forecasts may always include judgement. And behaviour in practice that is biased into one direction therefore certainly points to this, too. Above, we have outlined the forecast bias as a strongly discussed and major shortcoming in cash flow projections. The intense focus of researchers on this aspect again reveals that point estimates play a major role in appraisal practice. Thus, almost independent of how forecasts should be made, estimates may be treated as belonging to a low-complexity category.

In the striving for unbiased estimates in general, judgemental adjustment to estimates should generally be made with care; Sanders and Ritzmann (2001, p.405) recommend the following steps to decide whether judgemental forecasts should be made:

- (1) Adjust statistical forecasts if there is important domain knowledge;
- (2) in situations with a high degree of uncertainty:
- (3) ... when there are known changes in the environment;
- (4) structure the judgmental adjustment process:
- (5) document all judgmental adjustments made and periodically relate to forecasts accuracy;
- (6) consider mechanically integrating judgmental and statistical forecasts of adjusting.

As regards the finding of forecast bias in practice, it does not seem fully clear whether it has only negative or also positive implications on investment decision-making on average. A large body of literature, however, has advocated the correction of this bias in estimates for long. This certainly implies the striving for unbiased estimates as has also been advocated by Schoemaker (2004) and Sanders and Ritzmann (2001). The fact that judgement in estimates in practice cannot be avoided and is actually often intentional without clear knowledge of the motivations, also argues in favour of adjustment to correct for forecast bias. In general, trimming or downwards adjusting profitability – in our case: cash flow – estimates have been recommended (e.g. Statman and Tyebee, 1985), rather than increasing the hurdle rate as for example Mukherjee (1991) recommends (see below Section 2.5.2). In this context, it is important to aim for a *formal* downward correction of profitability estimates instead of rather *informal* adjustments made, and for “greater attention [to] be paid to eliminating the incentives for project profitability overstatement by all corporate employees” (Pruitt and Gitman, 1987, p.51; Miller, 1978).

Surveys about forecasting project cash flows for appraising an investment, to our knowledge, have not examined how exactly information is used to arrive at a subjective cash flow forecast. We may to some extent attribute this to the fact that the forecast process is highly individual depending on the type of project and cash flow, the corporate environment and the decision-maker. Moreover, the techniques used in practice to derive cash flows address the utilised tools rather than the way how information is used, and particularly how a subjective forecast under uncertainty is derived. This may mean that subjective cash flow forecasts have not been sufficiently researched yet in the context of investment appraisal. Chapter 4 will develop our empirical approach to address this issue.

2.5 The Setting of Hurdle Rates

2.5.1 The Setting of Hurdle Rates in Practice

Determining the hurdle rate²² is of critical importance since it contributes to determine the value of investment projects and thereby to the future value of the firm. Empirical research confirms that companies apply company-wide as well as project-specific discount rates or division-specific ones. A single company-wide discount rate always or almost always is applied by less than half of companies (35% found by Andor, Mohanty and Toth, 2015, in their Eastern European study; 37% found by Brotherson *et al.*, 2013, USA; 38% found by Kalyebara and Ahmed, 2011, AUS; Brounen *et al.*, 2004, find 59% for the USA, 41% for UK, 65% for the Netherlands, 42% for Germany and 24% for France; older studies report higher figures on average, e.g. 59% by Graham and Harvey, 2001; Arnold and Hatzopoulos, 2000, UK; 41% by Bruner *et al.*, 1998).

Different discount rates for individual projects to account for their specific risk are applied by numerous firms surveyed (65% found by Andor, Mohanty and Toth, 2015; 53% found by Brotherson *et al.*, 2013; 46% found by Kalyebara and Ahmed, 2011; Brounen *et al.*, 2004, find 51% for the USA, 24% for UK, 27% for the Netherlands, 25% for Germany and 27% for France). According to McLaney *et al.* (2004), 22% adjust the discount rate for the project's size. They however did not capture how many companies adjust for individual project risk in general. Nevertheless, we observe that adjustments due to project-specific risks or characteristics are quite common and often even more frequently observed for capital investment projects than company-wide hurdle rates only. Kalyebara and Ahmed (2011), McLaney *et al.* (2004) and Graham and Harvey (2001) did also observe adjustments for a division's specific risk; 12, 18 and 15% respectively are found. Moreover, adjustment due to foreign/regional risk was also found to be made in their studies. McLaney *et al.* (2004) also find adjustments made due to the cost of non-economic projects by 14%.

Based on the reported project risk factors of projects in Section 2.3.1, Table 1 collects the drivers that may influence a project-specific rate or adjustments to a base rate; however, risk drivers may not be limited to those.

In practice, the discount rate is most often determined on the basis of the cost of capital (84% in Brotherson *et al.*, 2013; 89% in their predecessor study by Bruner *et al.*, 1998). For measuring the cost of capital, the weighted average cost of capital (WACC) is undoubtedly the favoured method (e.g. 85% in Bruner *et al.*, 1998; 54% in Arnold and Hatzopoulos, 2000; 53% in (McLaney *et al.*, 2004); 42% in Kalyebara and Ahmed, 2011; 95% in Brotherson *et al.*, 2013;

²² We consider it synonymous to 'discount rate'.

33% in Andor, Mohanty and Toth, 2015). Adjustments to WACC are also found such as WACC plus safety margin or WACC plus inflation (Arnold and Hatzopoulos, 2000). The cost of equity is also used as discount rate (13% in Kalyebara and Ahmed, 2011; 11% in McLaney *et al.*, 2004; 8% on average for companies of all sizes, large companies even more – in Arnold and Hatzopoulos, 2000); and the cost of debt (21% in Kalyebara and Ahmed, 2011; 28% in McLaney *et al.*, 2004; 11% in Arnold and Hatzopoulos, 2000, for small companies even higher, for large ones insignificantly low) for example in the form of the long-term borrowing rate (McLaney *et al.*, 2004) or sometimes amended by a risk premium (Kalyebara and Ahmed, 2011), is often mentioned as the third way to determine the discount rate.

Project risk factors
Project size
Project organisation, design, concept, definition
Division/department
Communications
Logistics
Financing: financing agreements, financial distress
Prices: inflation, commodity prices, exchange rate, level of and term structure of interest rates
Local conditions
Firm size
Resources
Market
Industrial relations
Economic or business cycle

Table 1 Project risk factors²³

Cost of equity are majorly calculated based on the capital asset pricing model (CAPM), only in few cases other models such as the arbitrage pricing theory were used (Bruner *et al.*, 1998) – this, however, cannot be found any more in their updated study in 2013 and the CAPM remains the only model used (Brotherson *et al.*, 2013). The dividend discount model was found to be used, but the CAPM approach to the dominant one (28 and 69%, respectively, as found by McLaney *et al.*, 2004); Brounen, De Jong and Koedijk (2004) also find the CAPM approach to be dominant most surveyed countries²⁴ except Germany, where the investors' requirements slightly more often (39% vs. 34%) specify the cost of equity, which ranks second in the Netherlands and in France. US American and British companies second most often use average

²³ Based on Graham and Harvey (2001), Chapman and Ward (2011), McLaney *et al.* (2004) and Kalyebara and Ahmed (2011).

²⁴ USA, UK, Netherlands, Germany, France.

historical returns on common stock. Other methods surveyed by Brounen *et al.* include the CAPM modified by further undefined risk factors, discounted dividend or earnings models or regulatory decisions.

Further ways to calculate the discount rate include the risk-free rate of return (Gitman and Mercurio, 1982), the dividend yield on shares plus estimated growth in capital value, earnings yield on shares (Arnold and Hatzopoulos, 2000), current prime interest rates, rates for similar projects undertaken elsewhere or combinations of two or more bases (Kalyebara and Ahmed, 2011); arbitrarily chosen figure (6%, Arnold and Hatzopoulos, 2000; a non-calculated rate chosen by even 44% in Andor, Mohanty and Toth, 2015). The practice that arbitrary or other unspecified rates are used is also indicated by McLaney *et al.* (2004) for example rates that consider market, product and technology and other risks; the rate of return previously earned may be used for project replacement or upgrade.

Beyond the project-specific adjustments implied above (such as using or considering the rates applied for similar projects), considering project specifics is found in the cost of equity and therefore also in the WACC if CAPM is used, namely by considering project-specific beta factors or calculating a weighted average of equity and debt betas (around 10% each), often with a debt beta of zero (McLaney *et al.*, 2004). In their study (pp.128-129), they also find that WACC can be amended by a risk premium (“WACC plus a risk factor”) such as for example due to country risk or that the hurdle rate is set intentionally higher than WACC.

The use of formulas and models such as WACC and the CAPM requires several selections to be made (see e.g. McLaney *et al.*, 2004; Tucker, 2009). For example, which data to use, whether to use market or book value weights²⁵, which risk-free rate of return, how to calculate beta factors²⁶ or which cost of debt to use²⁷. Tax rates and whether marginal or average or other rates may be used certainly also influence the final cost of capital, but is disregarded in this work.

The choice of model parameters or input data to be used, making adjustments to calculated figures or considering rates of similar projects and the use of non-calculated, even arbitrary rates, particularly stress the importance of judgement, which we will revert to in the course of this work.

Studies sometimes do not particularly distinguish between cost of capital and hurdle rate (e.g. McLaney *et al.*, 2004) – not least since the cost of capital is the most common approach to the discount rate and thus implicitly understood as such. However, this intertwining is inevitable

²⁵ Higher costs of capital are found be related to book value usage by McLaney *et al.* (2004).

²⁶ Which poses an even more difficult problem to non-listed company (McLaney *et al.*, 2004).

²⁷ Long-term debt rates may result in too low cost of capital which was also indicated in their data (McLaney *et al.*, 2004).

due to the fact that company practice of investment appraisal is unregulated and thus highly manifold.

Cost of capital are often adjusted annually: Brotherson *et al.* (2013) in the US American study find 53% of companies to update it annually, McLaney *et al.* (2004) find a similar number (54%) of companies in the UK; more frequent than annual revisions are made by 42% and 25% of companies (Brotherson *et al.*, 2013, and McLaney *et al.*, 2004, respectively); occasional revisions are made by 5% and 9% (Brotherson *et al.*, 2013, and McLaney *et al.*, 2004, respectively) including when the environmental conditions change or project-dependent. An older study by Gitman and Mercurio (1982) finds a less regular revision and stronger dependence on environmental conditions' change. If the cost of capital is used as a discount rate, the discount rate will self-evidently adjust accordingly.

Discount rates in general are found to be updated annually by 25% of companies and by 53% less than annually (Meier and Tarhan, 2007). Kalyebara and Ahmed (2011) identify 40% of companies to regularly update the hurdle rate and the remainder adjust the rate only in case of a change of environmental conditions – similarly to what Gitman and Mercurio (1982) found for the cost of capital. Occasions for updating the discount rate primarily include changes in interest rates and in the expected risk premium; changes in the industry's business cycle are important to half the companies; changes in corporate tax rates, in the economic cycle and political uncertainty are of importance by one fourth to one third of firms (Meier and Tarhan, 2007). This may also remain subjective to some extent as to what the critical environmental conditions are that have changed. And in fact, adjustment of the hurdle rate has been found to be suboptimal by Meier and Tarhan (2007) exemplarily for interest rate changes in the market that did not translate into equivalent changes in the cost of capital.²⁸

An important empirical result indicated before is that hurdle rates can vary to a great extent, from a seemingly objective rate such as the cost of capital approximated via the WACC, to an arbitrary rate. As regards the DCF analysis by for example a net present value, the behaviour of diverse ways to determine the discount rate is also known as the hurdle-rate rule (McDonald, 2000). Magni (2009, p.968) stresses the subjective aspect in determining hurdle rates:

Past and recent empirical evidence shows that actual decision makers turn the NPV model into a rule of thumb: they use a *subjective* discount rate as opposed to a *rational* cost of capital derived from some market model (e.g. CAPM, arbitrage theory, multifactor models).

This is even intensified considering project-specific discount rates since they require additional judgement as to the additional risk and how much this should find expression in the

²⁸ The frequency of adjustment of the discount rate (and of the cost of capital) as outlined largely refers to company-wide contexts, needless to say that project-specific rates are updated on a project-dependent basis and perhaps are implied in answers stating irregular or occasional reassessment.

rate. As regards the latter question, Brotherson *et al.* (2013, p.28), in their qualitative part of the study, highlight the critical problems in practice:

First, it is often not clear precisely how much a given investment's risk differs from average, and second, even when this amount is known, it is still not obvious how large an increment should be added to, or subtracted from, the firm's WACC to determine the appropriate discount rate.

They therefore clearly identify a risk adjustment to be made in the form of a positive or negative premium to the company-wide benchmark. Adjustments including flat-rate mark-ups to the cost of capital are made depending on a particular (risk) category or characteristic as found by Brotherson *et al.* (2013).

Determining discount rates does clearly not belong to operational tasks of the finance department or the financial director and are crucial from a strategic point of view (McLaney *et al.*, 2004). Often, in 62% of firms, as studied by McLaney *et al.* (2004), the board of directors decides about the hurdle rate; otherwise, as regards the involvement of the board, they report responses indicating that the board is only informed about the hurdle rate adopted in a project proposal and that investment may determine when to notify the board. As regards the decision-makers involved, they find that several companies of those where the board is not in charge have the finance director set the hurdle rate, very few additionally involved the CEO; a lower number indicated that executive members are responsible. Alternatively, the rate may be determined by consultation, discussions or consensus of the finance director and management board and/or the CEO.

Despite the hurdle rate decision often being made on the basis of consultation, discussions or consensus of boards, we claim that the reasoning processes of the individuals play an important role. Individuals may intuitively make a judgement before discussions begin. Our focus is the reasoning of finance professionals rather than board members who rarely come into contact with hurdle rates and would presumably not exert as much influence as finance experts.

Risk is obviously not the only factor for deriving company-wide or other for example division- or project-specific discount rates; or other factors may implicitly be subsumed as risk that should or should not be given weight, as will be addressed in the next section. As we have also noted earlier and as Magni (2009) notes, risk is not translated into the rate as it should be according to analytical models; additionally, further factors play a role that from a normative point of view are not necessarily relevant; they include “decision flexibility, future opportunities, rationing of managerial skills, strategic considerations, agency costs, and costs of external financing.” (Magni, 2009, p.976). As Magni (2009, p.976) summarises, companies seem to apply a ‘base level hurdle rate’ and adjust it; adjustments “depend on various domain-specific and project-specific factors (such as the drivers just mentioned)”. These factors are included in Table 2.

Non-risk factors affecting the hurdle rate	Indicative Reference
Strategic considerations	Magni (2009); McLaney <i>et al.</i> (2004)
Growth	Meier and Tarhan (2007)
Particular costs: costs of external financing, financial situation	Magni (2009); Meier and Tarhan (2007)
Rationing mechanism	Jagannathan <i>et al.</i> (2016); Titman and Martin (2015); Allen (1996)
Decision flexibility	Magni (2009)
Correction of forecast bias	Mukherjee (1991); Titman and Martin (2015)
Future opportunities, real options	Magni (2009); Wambach (2000)
Information asymmetry: agency costs, signalling and motivation	Magni (2009); Brunzell <i>et al.</i> (2013); Graham <i>et al.</i> (2006); Liljeblom and Vaihekoski (2009); Titman and Martin (2015)
Motivation	Titman and Martin (2015)
Preference for low-risk projects	Titman and Martin (2015)
Short-termism, short-term pressure	Dobbs (2009); Allen (1996); Brunzell <i>et al.</i> (2013)
Sophistication of appraisal method	Brunzell <i>et al.</i> (2013)

Table 2 Non-risk factors potentially affecting the hurdle rate

There is numerous evidence that companies often use hurdle rates considerably higher than the cost of capital would suggest (Brunzell, Liljeblom and Vaihekoski, 2013; Meier and Tarhan, 2007; Poterba and Summers, 1995; Gup and Norwood, 1982. For example, Poterba and Summers (1995) prove for a period of half a century that the average real discount rate was 12.2% and considerably higher than the average equity's or debts' return (approximately 7% and 2%). Meier and Tarhan (2007) find premia of 5.1-5.3% (or in a lower equity premium case, 7.3-7.5%). Those studies contrast optimal and actual, i.e. self-reported, hurdle rates. Optimal rates were approximated by externally calculating WACC with data derived from the market and financial statements. This paradox that the self-reported hurdle rate exceeds the optimal one is known as the Hurdle Rate Premium puzzle. Evidence for this paradox is provided in studies of US American companies by Meier and Tarhan (2007) and Poterba and Summers (1995)²⁹ and in Nordic companies by Brunzell, Liljeblom and Vaihekoski (2013).

A higher than optimal hurdle rate reduces profitability and implies a bias against lower-risk projects relative to riskier projects (Titman and Martin, 2015). It can also lead to a short-

²⁹ The authors prove for a period of half a century that the average real discount rate was 12.2% and considerably higher than the average equity's or debts' return (approximately 7% and 2%).

termism; companies may systematically favour projects with relatively high cash inflows in the close future by more strongly discounting cash flows that occur at a later point in time (Dobbs, 2009; Allen, 1996). Certainly underinvestment may be a result, too, and it will imply an incentive for the project sponsor to make efforts and thus waste resources to argue in favour of a low rate (Titman and Martin, 2015).

The Hurdle Rate Premium has been known for many years and various explanations and justifications have been put forward. Many of those justifications have already been addressed above, e.g. that its advantage is that real options are already included in the discount rate (e.g. Dixit and Pindyck, 1995; Wambach, 2000; Chittenden and Derregia, 2015). Wambach (2000, p.247) stresses that applying a hurdle rate rule “allows to distinguish between projects with different values of waiting”. Dixit and Pindyck (1995) even indicate that in this way, the option to delay is included and asymmetric information does not even have to be considered a reason for a higher hurdle rate.

Imposing a higher hurdle – this may be done purposely as a rationing mechanism of capital and other resources (Jagannathan *et al.*, 2016) in that higher performance is required for a project to be considered profitable. Strong natural fluctuations may also explain the premium to some extent (Allen, 1996). Besides higher project-specific, unsystematic risk and thus higher cost of capital as implied in the risk factors above, a higher rate may be applied due to personal reasons: “it could also reflect an undiversified manager’s private interest in safer projects” (Jagannathan *et al.*, 2016, p.446). Titman and Martin (2015) imagine the potential scenario of capital rationing with mutually exclusive projects in which the hurdle rate might be raised to equal the opportunity cost, i.e. the rate of return of the next-best project, and thus requires higher performance. Titman and Martin (2015, p.177) claim that high rates signal good investment opportunities; motivate project sponsors to present good proposals.

A relatively high hurdle rate might also be chosen to compensate for a forecast bias (Mukherjee 1991; Titman and Martin, 2015), which will be referred back to in Chapter 3, which typically leads to too narrow confidence intervals and/or inflated cash flow projections as mentioned above in Section 2.4.1. This explanation could be valid where different level managers are involved in generating proposals from those making the investment decisions, since the higher level might want to adjust for biased behaviour below. However, instead of increasing the hurdle rate to correct for the bias, reducing the projected cash flows across the project term would be more straightforward; this would also avoid unintended compounding of the correction beyond the planning horizon (Titman and Martin, 2015).

Brunzell, Liljeblom and Vaihekoski (2013) empirically find that the sophistication of a company’s investment appraisal method is inversely related to the hurdle rate premium (the more sophisticated the method, the lower the hurdle rate). Additionally, they find that short-

term pressure felt by decision-makers has a positive impact on the hurdle rate. Brunzell, Liljeblom and Vaihekoski (2013), Graham, Harvey and Rajgopal (2006) and Liljeblom and Vaihekoski (2009) support the idea that investment projects possess the character of real options and that agency problems (and agency costs) have to be considered since these explanations indicate the higher use of multiple sophisticated investment appraisal methods and higher discount rates applied. Meier and Tarhan (2007) also find that the growth potential and the financial situation of a company are positively associated with the hurdle rate premium. However, these are merely statistical observations, and do not provide logical explanations for the paradox.

Table 2 collates all drivers of a hurdle rate which may not be primarily attributable to risk but which are found to be considered in practice or to be correlated or contribute to explain to the systematic hurdle rate premium. Literature, however, has not clearly demarcated explanations based on deliberate or unconscious, intuitive reasoning. There is no sufficient argument in the hurdle rate premium literature that the premium is only attributable to a conscious (upwards) adjustment of the cost of capital to derive a hurdle rate – the premium may also be applied without much thought or awareness as highlighted above. The adjustment of hurdle rates due to the explanations above mostly require conscious adjustment, other are pure correlations; they may not fully solve the puzzle.

Meier and Tarhan (2007) additionally find further inconsistencies between the cash flow estimation method (levered or unlevered, correctly or incorrectly calculated) and the hurdle rate used (levered or unlevered). Only about 38% correctly combine hurdle rate and cash flow; most of them (35%) correctly combine unlevered cash flow estimates and WACC. In terms of real or nominal hurdle rates and cash flow estimates used, 68% of companies correctly deal with inflation; 30% apply nominal values, 38% use real values consistently (Meier and Tarhan, 2007).

In summary, the determination of a company-wide cost of capital – potentially adjusted for a project's specific risk – is a well-established approach. WACC is a widely used concept but so are project-specific, judgemental hurdle rates. Factors other than risk are also important in the setting of the hurdle rate in practice. Moreover, various studies have proven that hurdle rates on average significantly exceed the cost of capital or the 'true' risk-adjusted rate.

Based on surveying the literature, the forms and compositions that the discount rate may conceptually take – independent of whether a company-wide or division- or project-specific rate is applied – are illustrated in Table 3.³⁰ First of all, the discount rate may equal a defined key rate that is based on a rule or formula such as the cost of capital or current market interest rates.

³⁰ WACC, cost of debt, cost of equity can be determined in various ways; for example using levered or unlevered, before- or after-tax WACC, deriving the cost of equity based on the CAPM, based on dividend yield or on the earnings yield on shares.

The cost of capital itself may be determined based on various versions of the WACC, the cost of debt or the cost of equity, which in turn are based on models such as the CAPM or discounted dividend model. A benchmark interest rate used as a discount rate may be the risk-free rate of return determined via the return of short- or long-term government bonds. Secondly, we find adjusted rule- or formula-based rates used as discount rates, mostly adjusted cost of capital. Thirdly, the discount rate may be an arbitrary rate that is not based on calculations or rule- or formula-based rates.

Hurdle Rate	Composition
Rule-/formula-based rate	Cost of capital - WACC - Cost of Debt - Cost of Equity Benchmark (interest) rate(s)
Adjusted rule-/formula-based rate	Rule-/formula-based rate + premium(s) ³¹
Arbitrary rate	Non-calculated, unspecified

Table 3 Compositions of the hurdle rate in practice

A variety of explanations have been proposed – not only to explain the hurdle rate premium puzzle but to explain adjustments to and deviations from the cost of capital approach or any other benchmark rates. Based on the mentioned surveys³², adjustments to a base level first and foremost depend on (divisional or independent) risk; moreover, adjustments may be made to incorporate or account for further factors (that may not be distinct and to some degree also be perceived as accounting for ‘risk’).

These adjustments or considerations may also influence the setting of an arbitrary rate. In practice, it is impossible to precisely distinguish whether a hurdle rate is the result of for example an adjustment of existing company-wide cost of capital or a purely arbitrary rate. In the latter case, cost of capital or other reference points might be known but not explicitly used as base level. Moreover, the mentioned adjustment factors may partially overlap with risk considerations.

In the case of company-wide rates, we find all three approaches outlined in Table 3, most often the cost of capital approach, but also adjusted or arbitrary. In the case of project-specific rates, the *cost of capital approach* is also used to derive project-specific cost of capital. Most often, we will find the second approach, a *premium to account for project-specific*

³¹ A premium is usually understood as a mark-up or a reduction to a particular level and will characterise most adjustments of the cost of capital in general, as outlined earlier.

³² Based on the findings by Andor, Mohanty and Toth (2015), Brotherson *et al.* (2013), Kalyebara and Ahmed (2011), McLaney *et al.* (2010) Magni (2009), Meier and Tarhan (2007), Brounen *et al.* (2004) Jagannathan and Meier (2002), Graham and Harvey (2001), Arnold and Hatzopoulos (2000), Bruner *et al.* (1998), Titman and Martin (2015).

characteristics that will be added to the cost of capital. *Arbitrary rates*, the third approach, are presumably not found, since project-specific rates will always have to be argued and negotiated based on the specific project characteristics that justify adjustments.

We have also seen that risk is not the only determinant of the discount rate and that many more ‘soft’ factors play a role. Much more than the weighted average cost of capital applied as discount rate, a project-specific discount rate requires and thus implies judgement. Judgement has not been comprehensively investigated in this context, which may admittedly be difficult to investigate in any context. Nevertheless, compared to the various approaches of examining judgement in other fields, the hurdle rate deserves a closer look and the judgement involved in determining it is of particular relevance to this work. In doing so, and besides adding to literature by shedding light on the actual setting of discount rates, we will address an aspect of judgemental adjustments that may lead to a hurdle rate premium, i.e. systematically setting a rate higher than idiosyncratic risk would require; and thus add to existing explanations of a hurdle rate premium.

2.5.2 The Setting of Hurdle Rates in Theory and Their Suitability for Practice

As indicated above, discount rates play a major role in discounted cash flow methods and thus in most investment appraisal methods. From a theoretical perspective, they are of crucial importance in enabling comparability of cash flows occurring at different points in time and permit comparisons between investment alternatives; they are applied to balance out differences in tied-up capital and in economic lives and reflect how much the future cash flows will be devalued. Beyond the assumptions of discount rates in Section 2.3.2, the assumption of a perfect capital market also requires one unified rate that applies to the financing of the project and also to the reinvestment of the project proceeds on the capital market. And the result for both absolute and relative profitability is independent from the form of capital. It also expresses unlimited borrowing lines and investment opportunities at this discount rate; and the return and cost of capital of all future investment opportunities, not to forget about opportunity costs of the investment project under consideration.

Under certainty, deriving and using the cost of capital as hurdle rate seems unproblematic by considering the actual cost of equity and debt (Modigliani and Miller, 1958). However, certainty does not hold and as outlined earlier, a rate that can fulfil all of these requirements does not exist in an imperfect capital market.

If at least the assumption of certainty is given up, several approaches have been developed to derive a risk-appropriate rate. Modigliani and Miller (1958) for example already talked about a risk discount deducted from the expected return or in other words, a risk premium to be added

to the market interest rate to adjust the result of the analysis under certainty, yet referring to a perfect capital market.

The (risk-adjusted) cost of capital can be derived making use of numerous models to explain the relationship between risk and return mostly originated in Markowitz' portfolio selection theory (1952) and in models by Treynor (1961), Sharpe (1964), Lintner (1965) and Mossin (1966) who laid the groundwork for the Capital Asset Pricing Model. As regards a proper rate of return, Mossin (1966, p.774) noted, that

[i]n general, we may think of the rate of return of any asset as separated into two parts: the pure rate of interest representing the 'price for waiting,' and a remainder, a risk margin, representing the 'price of risk',

which he also described as the price of risk reduction. Their models were followed by publications of Black (1972), Black *et al.* (1972), Rubinstein (1973), Fama and MacBeth (1973), Black and Scholes (1973), Ross (1976) and Ross (1977) with his arbitrage pricing theory, and have been further developed for example by Merton (1973) and Dolde *et al.* (2012). The Capital Asset Pricing Model has seen serious criticism, for example by Jagannathan and Meier (2002) critiquing it as a wrong model not properly reflecting the market risk premium; by Wood and Leitch (2004) questioning its applicability if capital structure changes; or Fama and French (2004) pointing to its empirical problems resulting in invalid applications. For a debate on the CAPM, see for example Jagannathan and McGrattan (1995). Gordon and Shapiro (1956) developed what later was known as the dividend-discount model as an alternative optimal way to derive the minimum required rate of return.

Despite its drawbacks, the single risk-adjusted cost of capital approach as the major textbook approach is considered suitable or at least most practical for determining an appropriate discount rate (e.g. Brealey, Myers and Allen, 2013). It is the minimum average rate of return needed to satisfy the requirements of the providers of funds and should recognise the effect of the project on the overall level of risk to the company's funders. It should be determined by the weighted average cost of capital (WACC) calculated at current, market-based and not historical (after-tax) cost of debt and equity and market-based weights of equity and debt respectively; with the cost of debt derived from debt financing agreements, and the risk-adjusted company (or project-specific) cost of equity (e.g. Brotherson *et al.*, 2013). Cost of equity should be based on the Capital Asset Pricing Model, CAPM (Brealey, Myers and Allen, 2013). If different projects or company divisions are associated with different levels of risk compared to average company risk, the specific risk should be reflected in the discount rate (e.g. Brealey, Myers and Allen, 2013). Various approaches exist to refine or improve discount rates. Project-specific cost of capital is also recommended by for example Miller (1978, p.16) who proposes an uncertainty premium for all projects of the same risk class as the "difference between the minimum acceptable true return and the estimated return required for project

acceptance is the uncertainty premium”. Donaldson (1992) also considered the bottom-up approach that implies the use of a company-wide cost of capital faulty and points to a more qualitative procedure, developing a set of rates that represent the “real strategic or tactical alternatives appropriate to the question” (p.50), i.e. based on a set of appropriate questions about the investment. Rubinstein (1973) advocates for the use of the marginal cost of capital as the project-specific discount rate instead of the WACC.

Conducting project-specific risk adjustments, however, is not unanimously supported by corporate finance literature. For example, Reimann (1990) suggests establishing a regularly updated cost of capital based on the CAPM principle, applied as a common hurdle rate. Moreover, risk adjustments are often recommended to be made at the cash flow level or by further analyses (e.g. sensitivity analyses, simulation, see above; e.g. Titman and Martin, 2015). If at all, risk should be the only factor for deriving company-wide or other for example division- or project-specific discount rates (Meier and Tarhan, 2007).

For a case of asymmetric information, i.e. in cases where the manager is better informed than the shareholders, Antle and Eppen (1985) propose a model with the optimal hurdle rate being always higher than the cost of capital. In a case where the manager has superior information by upfront development activities, Dutta and Fan (2009) derive the optimal hurdle rate to be lower than in a situation assuming symmetric information; it can even be lower than the average firm’s cost of capital. As we have seen in the previous section, a case of asymmetric information can ‘naturally’ cause higher hurdles and thus underinvestment (e.g. Harris and Raviv, 1996), but as indicated above, this in turn can be optimal to compensate the information advantage (Antle and Eppen, 1985) contradicting opinions to downward adjust the rate due to asymmetry. For a case of symmetric information, Chen and Jiang (2004) also defend higher hurdle rates observed in practice to be optimal since it will motivate a manager to acquire more information about the project. These examples demonstrate that there is no agreement in literature about how information symmetry should or should not be considered in a hurdle rate.

Particularly including options theory in general (e.g. the option to wait, to expand or contract, abandon, delay) in the hurdle rate has been postulated by various authors such as Black and Scholes (1973), Myers and Turnbull (1977), Dixit and Pindyck (1995), Jagannathan and Meier (2002), Wambach (2000) and Chittenden and Derregia (2015): The CAPM being widely acknowledged and deriving discount rates from it being frequently recommended, Myers and Turnbull (1977) warned that risk-adjusted discount rates based on the CAPM “will generally lead to biased hurdle rates if the firms examined have valuable growth opportunities” (p.331). Raising hurdle rates above WACC, however, is even considered a valid approach since it intuitively incorporates real options, particularly the option to wait (Magni, 2009; Chittenden and Derregia, 2015).

Butler and Schacter (1989, p.14) already pointed to the need for adjusting due to estimation risk in the rate, i.e. the risk “to measure the true discount rate with error” representing many of the in Section 2.5.1 mentioned practical shortcomings, either on an ad hoc basis; or more formally by an options-based approach considering certainty equivalents or an adjustment of cash flows by an analytically derived correction factor.³³

Undoubtedly, from a normative perspective, companies should always adjust hurdle rates in the case of changes in the market conditions; this is of particular relevance nowadays; declining cost of equity and debt that are not mirrored in the hurdle rate will systematically lead to underinvestment (Meier and Tarhan, 2007).

As indicated above, using a company-wide or even a project-specific hurdle rate based on the cost of capital can be generally criticised due to its ambiguous way of determination and shortcomings in the models, which is particularly true for individual projects; scope for discretion in the hurdle rate decision can induce distortions such as those mentioned above which advocates for the use of a company-wide discount rate rather than a project-specific one. Acknowledging that the distortions may be worse in the case as opposed to a single company-wide rate, Martin and Titman (2008) also propose project-specific discount rates that consider a project’s debt capacity³⁴; such a rate could be applied to a category of projects with the same risk factors.

In summary, the requirement that one discount rate in each period fulfils all the different kinds of functions poses a major problem; it is easy to see that in reality there cannot be one ‘rational’ discount rate that represents the cost of capital in all forms at different points of time, and all (re)investment options and opportunity costs etc. simultaneously. Even determining a rate based on one of the models will contradict other assumptions of the discounted cash flow models required to properly interpret a net present value. It therefore does not come as a surprise that in the literature we find anything but consensus about which rate to apply as a discount rate; thus we find Pinches’ (1982, p.11) claim still applies today:

Indeed, given the lack of agreement in the academic community concerning the proper treatment of risk for capital budgeting purposes, it is no wonder specific risk adjustments (other than the use of often *ad hoc* adjustments to arrive at risk-adjusted discount rates) are not widely employed in practice.

As is the standard solution advocated by textbooks, the cost of capital and thus the WACC as discount (and therefore hurdle) rate seems the most practical and most often used way to resolve the problem of determining the theoretically required rate. Assuming that the projects under consideration have the same risk as the company’s current projects on average, there is no

³³ The correction represents the expected value of estimated PV/true value or an unbiased estimation through an analytic approximation which sampling distribution of the parameters have to be known (Butler and Schacter, 1989).

³⁴ They define project debt capacity as “an investment’s debt capacity to be the maximum amount of new debt that can be used to finance the investment without resulting in a decline in the firm’s credit rating” (Martin and Titman, 2008, p.80).

better indicator of the company's future risk than the current market-based cost of capital which reflects the expectations of creditors and shareholders given the current level of information and market efficiency.

In practice we observe applying the hurdle-rate rule – hurdle rates that do not necessarily derive from quantitative models and that are often extraordinarily high; this practice may in fact be justified for several reasons since we find indications that the hurdle-rate rule or rates higher than the cost of capital, in general do not automatically lead to bias in the light of all imperfections of the markets. However, it also comes at several drawbacks; and with it the fact that this practice deviates most from the original assumptions of the discounted cash flow method which ensure the meaningfulness of the target criterion.

There are numerous advocates in favour of a project-specific risk-adjusted hurdle rate for individual projects. However, a huge degree of subjectivity is entailed not only in arriving at a weighted average cost of capital for use as a general hurdle rate, but even more so – in determining the rate for a specific project.

We conclude this chapter with Table 4 in which we present a summary of the gaps of assumptions, processes and prescriptions, relating to cash flow projections and to discount rates in DCF analysis, that exist between the normative, often non-evidence based views that may include major investment appraisal textbooks on the one hand and, on the other, what seems to occur in practice. Table 4 summarises the main aspects of the above literature review and thereby specifies the theory-practice gap explained in Section 2.3.2. In the left hand column, under theory, are portrayed the normative perspectives while the right hand column contains descriptions of what may happen in 'real life'. For both, the cash flow projections and the discount rate in a DCF analysis, in its left hand column the table lists each parameter's main requirements assuming a perfect capital market and certainty of data. Based on the reviews above in Sections 2.4.2 and 2.5.2, respectively, the predominantly recommended methods, concepts and consistency prescriptions are outlined. With regard to these three categories, the right hand column consolidates actual practices indicated in the reviews above in Sections 2.4.1 and 2.5.1, respectively; the column additionally covers empirical findings in the literature that represent particular gaps to 'theory'.

The practice of applying hurdle rates – as opposed to deriving rates primarily from quantitative models and thus using normatively suitable methods – may in fact be attributed to boundedly rational behaviour (Magni, 2009): Cognitive reasoning systematically and unconsciously guides decision-makers to make less than optimal decisions but these are decisions which are frugal and helpful and not irrational at all. Nevertheless, insufficient attention has been paid to a more detailed identification of the influence factors of a hurdle rate, specifically how the corporate decision-makers' reasoning process is influenced in the specific

corporate situation of the hurdle rate setting. The particular practice of determining hurdle rates that are based on – or even require – subjective judgement, will be assessed in the following chapters. Similarly, and as outlined above in Section 2.4.2, the practice of deriving cash flow forecasts shows a substantial degree of subjectivity and deviations from the normative view; judgement-based cash flow projections will therefore also be investigated in the following.

	Theory	Practice
Cash Flow Projections		
<i>Model assumptions</i>	<i>Perfect capital market and certainty</i> Accurate cash flow projections - Represent all effects caused by and in relation to the investment project. - All effects are quantifiable, particularly in monetary terms, in an isolated way. - All effects are attributable to the single project. - Allocation to specific future periods of time.	
<i>Forecast method</i>	<i>Suitability for practice</i> Appropriate cash flow projections Depends on the level of uncertainty and complexity	<i>Cash flow projections in practice</i> Inconsistent cash flow projections Does not consistently correspond to the level of uncertainty and complexity (e.g. point estimate)
<i>Concept</i>	Expected value concept (for point estimates): Accurate assessment of the expected cash flows	Often subjective forecasts
<i>Consistency</i>	Correct combination of discount rate and cash flow projections	- Incorrect combination of discount rate and cash flow projections (e.g. with regard to leverage) - Incorrect consideration of components, (e.g. sunk costs, cannibalisation)
<i>Other</i>		- Forecast bias - Overestimation of outcome variables - Underestimation of costs - Too narrow confidence intervals
Discount Rate		
<i>Model assumptions</i>	<i>Perfect capital market and certainty</i> Uniform rate That simultaneously implies the price of borrowing and lending, opportunity costs, reinvestment options.	
<i>Method</i>	<i>Suitability for practice</i> Risk-adjusted cost of capital Derived from quantitative market model	<i>Discount rate in practice</i> Hurdle-rate rule Not necessarily using a market model (e.g. use of arbitrary rates)
<i>Concept</i>	Cost of capital based on individual risk	Not necessarily based on a risk-adjusted cost of capital approach
<i>Consistency</i>	Market-based parameters (costs of equity and debt; market-based weighting)	Not necessarily using market-based parameters
<i>Other</i>	Preferably company-wide cost of capital; partially recommended: marginal cost of capital as project-specific rate	- Various forms of subjective adjustments (e.g. to quantitatively derived rates) - Deliberate adjustments (e.g. to compensate forecast bias) - Unconscious adjustments - Particular empirical finding - Hurdle Rate Premium Puzzle

Table 4 Theory-practice gap

The next chapter will review behavioural theories from psychology and review to what extent they have found their way into investment appraisal. Chapter 4 will attend to linking the two dimensions of interest, the setting of hurdle rates and the projection of cash flows, to behavioural theories – particular to heuristic reasoning. We will then derive the foundations for empirically approaching them.

3 Judgement and Decision-Making

3.1 Introduction

Economics and finance on the one hand and psychology on the other hand are both sciences that address decision-making of individuals and groups. However, research in psychology, and in particular its subfield of judgement and decision-making (JDM), generally adopts a descriptive approach to decision-making whereas economics or finance have generally assumed a normative one.

Based on JDM research, behavioural economics – a relatively young stream of research – aims to explain systematic deviations from the normative rules postulated by traditional economic theory in the behaviour of individuals. Bounded rationality is seen as the source of these deviations. Behavioural finance, a descendant of behavioural economics, has encouraged a variety of different behavioural approaches to related fields such as corporate finance or accounting.

Corporate decision-makers' behaviour, particularly in the sphere of investment decision-making, reveals deviations, i.e. systematic biases, from the sophisticated qualitative and quantitative techniques that have been developed to support decision-making. The role and the functioning of judgement in this context therefore deserve closer attention. This chapter outlines the foundations of judgement and bounded rational behaviour with particular focus on heuristics, the simplified decision strategies that guide judgement:

After an introduction to decision-theoretic underpinnings, this chapter traces developments concerning fundamental assumptions about the human decision-maker – from the economic approach of a rational decision-maker to the behavioural economic recognition of bounded rationality. Different notions and diverse approaches have evolved with the aim of developing more realistic models of economic judgement and decision-making. We will address the concept, purpose and role of heuristics and briefly outline the different approaches and the framework that we will rely on in this work. The chapter serves as a basis for delineating behavioural approaches to management accounting and corporate finance and, more precisely, as the starting point for the synthesis of behavioural approaches and investment appraisal and heuristics that may be applicable in this context and hypothesised in Chapter 4.

3.2 From Traditional to Behavioural Economics Approaches

3.2.1 *Decision-Theoretic Foundations*

Decision theory provides models of human decision-making. Decision theories can be classified into normative, descriptive and prescriptive theories (e.g. Bell, Raiffa and Tversky, 1988). *Normative decision theory* attempts to explain how decisions should be made. It defines optimal behaviour and stipulated standards (Baron, 2004) or “rules to follow or conform to that supposedly make our thought rational” (Over, 2004, p.3).³⁵ Such rules are usually derived through reflection and logic, such as by probability theory, utility theory or statistics (cf. Baron, 2004).

Descriptive decision theory describes and models actual behaviour to explain how decisions are made (Over, 2004). Actual decisions and judgements are evaluated by the extent they fulfil the norms or standards (Newell and Bröder, 2008). The descriptive approach implies that the closer a decision is to normative standards, i.e. the more rational it is, the better (Baron, 2004).³⁶ Thus actual behaviour can and often does deviate from normative standards. I.e. ‘how a decision is made’ does not equal ‘how a decision should be made’. The psychological field of *judgement and decision-making (JDM)* particularly investigates such systematic deficiencies (Baron, 2004; Dunning, 2012). These deviations or distortions can be called biases.³⁷ “It assumes that people show systematic flaws and biases about how they weigh evidence and reach decisions. These flaws can be quite fundamental and far-reaching in their consequences.” (Dunning, 2012, p.252) “[A]nd this in turn has raised important questions about the causes of such discrepancies” (Einhorn and Hogarth, 1981, p.2) which are seen to be complex and relate to the coordination and interrelations of “attention, memory, cognitive representation, conflict, learning, and feedback” (Einhorn and Hogarth, 1981, p.27). JDM is a descriptive approach aiming to describe and explain biases and can have prescriptive implications in the sense of recommending how to improve decision-making.

JDM is often used synonymously with judgement and choice, behavioural decision theory or decision theory (e.g. Dunning, 2012; Einhorn and Hogarth, 1981).³⁸ ‘*Behavioural*’ typically denotes JDM applied to a discipline such as economics, finance or accounting (Dunning, 2012). In this work we will refer to JDM as the descriptive approach to decision-making that tries to explain why or why not deviations (biases) between observed behaviour and normative rules

³⁵ For a definition of rationality, see the end of this section.

³⁶ This appears circular considering for example Over (2004, p.3) who notes that “whether a theory, or one of its rules, is truly normative or relevant in some context depends, at the deepest level, on our definition of ‘rationality’”.

³⁷ In case of no deviations between ‘how decision should be made’ and ‘how a decision is made’, JDM also examines why not (Baron, 2004)

³⁸ ‘Decision theory’ is considered in the psychological context here, i.e. as descriptive decision theory. However, in this thesis the term decision theory will not be used interchangeably to JDM as it cannot be contrasted against other decision-theoretic approaches, such as normative or prescriptive approaches.

occur. Behaviour is considered the result of decisions made. JDM accounts for the bounded rationality of decision-makers.

JDM can be considered a branch of cognitive psychology. Cognitive psychology refers to the states and processes which act between the perception of a stimulus and behaviour (Hoffmann, 1999, p.352).³⁹ It embraces the “study of perception, problem solving, judgemental processes, thinking, memory, concept formation and human information processing in general” (Hogarth, 1987, p.4). Human cognition is its focus (Newell and Bröder, 2008) and it deals with “internal processes, mental limitations, and the way in which the processes are shaped by the limitations” (Kahneman, Tversky and Slovic, 1982, p.xii). It thus investigates the functioning of judgements and decisions, such as the individual decision rules applied by a decision-maker, typically by use of experiments to observe behaviour.

Fluid boundaries to social sciences and social psychology in particular can also be observed in JDM since JDM also gives attention to interpersonal behaviour (Birnberg, Luft and Shields, 2007; Goldstein and Hogarth, 1997).⁴⁰ Social topics in JDM relate to for example group decision-making, game theory or cultural influences (see e.g. Koehler and Harvey, 2004); theories about role, social comparison, social identity and group identification are even referred to by management accounting; similarly motivation psychology has been addressed (Birnberg, Luft and Shields, 2007).

JDM is applied to a wide variety of objects and is relevant to various disciplines. It is also regarded an applied science (Newell and Bröder, 2008) with applications and influence in medicine, public policy, finance, accounting, law, artificial intelligence (Chapman, 2004; Pidgeon and Gregory, 2004; Glaser, Nöth and Weber, 2004; Kotchetova and Salterio, 2004). JDM also tends to be regarded as a subdiscipline of experimental psychology (Koehler and Harvey, 2004), owing to its methodical approach.

JDM will henceforth be used as a broad term as outlined above: a descriptive and interdisciplinary approach revealing and explaining judgements and decisions to uncover the bounds of rationality – limited to the definition of cognitive psychology and excluding social and motivational psychology aspects. Consistent with Birnberg, Luft and Shields (2007, p.114), we will address “how and how well individuals subjectively process accounting information to make planning and control judgments and decisions” with reference to capital investment appraisal and decisions.

As indicated above, the discrepancy between how decisions are made and how they should be made may occur because of decision-makers’ subjectivity and thus including intuition.

³⁹ Author’s translation.

⁴⁰ For a more elaborate description of the field of JDM and its historical development, see Goldstein and Hogarth (1997) or Koehler and Harvey (2004); see also Birnberg, Luft and Shields (2006) for a collection of references about JDM’s intersections to cognitive psychology, social psychology/social sciences and motivation.

Intuitions are “thoughts and preferences that come to mind quickly and without much reflection” (Kahneman, 2003a, p.697). The use of intuition or gut feeling may be more or less conscious. At one extreme, decision-makers may not want to apply what normative rules tell them how to decide and may prefer to save effort and time by consciously applying intuitive rules to make a judgement or a decision. At the other extreme, they may be unaware of ignoring normative rules or which rules they follow at all – thus they use their intuition completely subconsciously.

Prescriptive decision theory, also called decision analysis (e.g. Edwards, Miles Jr. and Winterfeldt, 2007; Raiffa, 1968; Eisenführ, Weber and Langer, 2010), uses insights from normative and descriptive decision theory. Based on the observations of descriptive models, prescriptive decision theory aims to “improve judgments according to the normative standards” (Baron, 2004, p.19) and develop decision aids (Patterson, Quinn and Baron, 2012). It is justified by the discrepancies between normative and descriptive models (Bell, Raiffa and Tversky, 1988) and the complexity and difficulty of decisions (Eisenführ, Weber and Langer, 2010).

Sometimes there is little or no distinction made between normative and prescriptive theories (e.g. Klimoski *et al.*, 1975). Normative models provide the standards/the rules for reaching the optimal decision. Prescriptive models also stipulate ‘how decisions should be made’, but on the basis of real world observations of descriptive models, and with the intention to develop models to improve decision-making and avoid bias.⁴¹ “Good descriptive models help create good prescriptive models.” (Patterson, Quinn and Baron, 2012, p.20) JDM’s task therefore is to create transparency for decision-makers to help them make better decisions (Over, 2004).

Decisions can be classified according to what is known about the future: For decisions under *certainty*, the decision outcomes, i.e. the consequences of all alternatives are known in advance/before making the decision (e.g. March and Simon, 1993; Eisenführ, Weber and Langer, 2010). Decisions under risk and uncertainty account for the fact that consequences or outcomes of alternatives are not known as there is no certainty about the future. Decisions under *risk* refer to scenarios where the probabilities of the outcomes are known or can be determined objectively (e.g. Wu, Zhang and Gonzalez, 2004; Eisenführ, Weber and Langer, 2010); whereas decisions under *uncertainty* denote scenarios where the outcome probabilities are unknown or can only be determined subjectively (cf. for example March and Simon, 1993; Eisenführ, Weber and Langer, 2010).

Knight (1921) has approached risk and uncertainty with regard to real world problems differently: Risk is considered measurable and separates into situations of *a priori* probability, where probabilities are known, or *statistical* probability, where probabilities can be estimated empirically. Uncertainty in contrast is unmeasurable and inferences of probabilities of outcomes

⁴¹ Eisenführ, Weber and Langer (2010) provide a broad overview about decision analysis tools/rational decision support models.

cannot be made by quantitative analysis; such a situation only relies on *estimates* which he considered equal to judgements or intuition. Miller (1987, p.27) confirms this: “Real life decisions must be made with estimates, not precisely known probability distributions.” As optimisation is not possible in a situation under uncertainty, Mousavi and Gigerenzer (2014) derive this decision process of estimation to be *heuristic*, which we will refer back to in Section 3.3.

A *decision* is defined as the choice of an action, an option or an alternative (that are associated with outcomes or consequences). Actions, options and alternatives grouped as stimuli, a decision refers to “the choice of a stimulus ... from a set of stimuli” (Luft and Shields, 2010, p.201). More general, decisions are seen as outcomes of tasks if actions are taken (Solomon and Trotman, 2003) as “judgments about what to do” (Baron, 2004, p.19) or as “an intention to pursue a particular course of action” (Hardman, 2009, p.3). A decision generally presupposes a decision problem: The current state, situation, environment or context may determine the problem, as it does not equal the desired state. The desired state may be determined by the decision-maker’s goal/objective.

Defining the structure of a decision depends on the underlying approach – owing to different decision-theoretic approaches. However, a universal notion of what precedes a decision may be identified: All models seem to assume a stage of making an estimate (such as about possible states of the future/outcomes, the individual value, the perceived value, determining subjective probabilities of outcomes) or evaluating information (such as whether an outcome is considered good/bad, to what extent the outcome fulfils the goal, to what extent the individual preferences are satisfied). A decision model may particularly describe what the process is to arrive at a decision; it for example may precisely determine how stimuli (information/options) with their respective outcomes are evaluated, which pieces of information are taken into consideration or which other factors are relevant in the decision-making process.

A decision requires *judgement(s)* made (Bonner, 1999). Even though its general role in cognitive psychology and psychology-oriented research in economic decision-making is clear, judgement remains a vaguely defined term. Its definitions vary in their reference to judgement as the outcome of an evaluation process or as the evaluation process itself. On the one hand, a judgement is considered an evaluation (of a current situation), an estimate/prediction (about future outcomes) or a preference expression (Hardman, 2009; Bonner, 1999; Hogarth, 1987). It is thus the outcome of a task if subjective evaluations are included (Solomon and Trotman, 2003). On the other hand, judgement can be defined as the process of evaluation or estimating itself (Libby, 1981). In this work, the term judgement will not be considered as an evaluation process. Instead, it will denote the (subjective) estimate, the prediction or the outcome of the process of evaluating and judging. The term *decision-making* will be used in a broad sense to

cover the process once a problem is identified and should be solved, the involved judgement and the decision.

However, Hogarth (1987) points to the impossibility of sure insights about the human decision-maker's intuition that neither cognitive psychology nor neurology has fully solved. But what is known is that an individual is highly adaptive and flexible given their limited information-processing capacity (e.g. Payne, Bettman and Johnson, 1993), which we will refer back to at a later stage of this work.

Which decision is considered *rational* depends on the decision-theoretic approach. What economics and cognitive psychology have in common is that individuals' actions are based on reasons and that they employ some sort of reasoning to attain goals (Simon, 1986). Rationality in neoclassical economics means achieving the best outcome from an objective or substantive point of view based on an individual's utility function, thereby focusing on the quality of the decision outcome and thus represents *substantive rationality*. On the other hand, rationality in cognitive psychology addresses the procedure or process to arrive at a decision given available information and resources and is therefore called *procedural rationality* (Simon, 1986; Klimoski *et al.*, 1975). Procedural rationality is what is preliminarily investigated in this work, as the way a judgement or decision is made is focused on.

3.2.2 Traditional Approach to Economics

Decision-making was traditionally normative in nature and mainly investigated by economics and statistics (see e.g. Fishburn, 1989; Goldstein and Hogarth, 1997). Expected utility theories linked with Bayesian models (i.e. updating prior probabilities) were the dominating normative decision-theoretic approaches for explaining how decision-makers arrive at a decision in economics (see e.g. Edwards, Miles Jr. and Winterfeldt, 2007; Gigerenzer, Todd and the ABC Research Group, 1999; Kahneman, 2003b). Individuals are supposed to maximise their own utility and are able to properly incorporate new information into their belief system (see e.g. Edwards, Miles Jr. and Winterfeldt, 2007). Bernoulli (1754) laid the foundation for decision-making under risk by claiming a decision-maker bases his or her decision on the expected utility of an outcome, i.e. weights the outcomes by their probability of occurrence. He assumed an increasing utility for increases in wealth but decreasing marginal utility the higher the wealth level of an individual. This assumption of reference dependence that utility depends on absolute states of wealth was central (see e.g. Kahneman, 2003b). Bayes (1763) theorised how individuals update their beliefs (prior probabilities) if new information arrives and thereby introduced the notion of subjective utility (Edwards, Miles Jr. and Winterfeldt, 2007).

Influenced by these insights, Von Neumann and Morgenstern (1944) developed one of the most influential theories referred to by economics in the 19th century, which is considered “a

major step toward ‘fundamental’ measurement in the social sciences” (Goldstein and Hogarth, 1997, p.5). Their expected utility theory (EUT) models an individual’s choices: Individuals choose an option that maximises their utility (Von Neumann and Morgenstern, 1944). Utility is considered in the sense of satisfaction (as regards consumers) or profit (as regards entrepreneurs) assuming the common goal to increase monetary wealth (Von Neumann and Morgenstern, 1944). A – presumably risk-averse – decision-maker is assumed to have a stable utility function with his or her preferences always consistent, transitive and complete (e.g. Klimoski *et al.*, 1975); the probabilities or weights are assumed to be objectively determinable (Fishburn, 1989). EUT has seen various further developments, in particular Savage’s (1954) subjective expected utility theory.⁴²

Rationality – Algorithm

- | | |
|----|--|
| 1. | Considering all relevant information |
| | Knowing and considering all relevant cues (pieces of information) |
| 2. | Unlimited retrieval, processing and storage |
| | Unlimited cognitive capacity for retrieval, processing and storage of cues and their utility values. |
| 3. | Appropriate weighting |
| | Appropriate weighting of cues (or their cues’ utility values respectively). |
| 4. | Integrating all relevant information |
| | Integration of all cues (utility values of cues) to arrive at a value about an alternative = judgement. |
| 5. | Comparison of alternatives |
| | Comparison of all alternatives’ values and choice of the alternative with the highest value = decision. |

*Table 5 Rational decision-making*⁴³

Thus, from this normative economic point of view, substantive rationality means a rational decision-maker always optimises by maximising his or her utility.⁴⁴ This notion of a rational decision-maker also referred to as ‘homo oeconomicus’ or ‘economic man’ ascribes to him knowledge and consideration of all courses of action (options) and all relevant pieces of information (cues⁴⁵) associated with the options. Further characteristics include a given stable

⁴² Savage’s (1954) theory on decision-making on the other hand builds upon von Von Neumann and Morgenstern (1944) but assumes subjective probability estimates building on earlier work by Ramsey (1931), De Finetti (1937) and Bayes (1763). For a broader historical review or further utility theories, see for example Fishburn (1989), Goldstein and Hogarth (1997) or Klimoski *et al.* (1975). Extensions of subjective utility theory are for example discussed by Nau (2007).

⁴³ Based on the previous reasoning and Shah and Oppenheimer (2008).

⁴⁴ Simon (1986) notes that apart from subjective expected utility maximisation that is always in the focus when talking about what rationality is in economics, there are more assumptions on how decisions are made, i.e. “auxiliary empirical assumptions about actors’ utilities, beliefs, expectations, and the like” (p.S209).

⁴⁵ From a psychology perspective, a cue is a piece of information (Shah and Oppenheimer, 2008), predictor (Gigerenzer, 2001) or attribute (Luft and Shields, 2010), that are available to the judge (Kahneman and Frederick, 2002). From an economics point of view, a cue can be an outcome/state of wealth or a utility associated with an outcome/state of wealth (e.g. Von Neumann and Morgenstern, 1944). We will consider ‘cue’, in a wide sense, as a general piece of information which is used in the judgement process to arrive at a decision; it may for example include attributes, outcomes, utilities or values.

utility function, unlimited information-processing capacity always choosing the option with the highest (weighted average) utility (March and Simon, 1993; Simon, 1955).⁴⁶ Knowledge of all relevant pieces of information implies that the decision-maker is able to view the world⁴⁷ as it really is (Simon, 1986). And by knowing the true world, optimal decisions are predictable. A specific situation presented differently would not be perceived differently due to the rational decision-maker and would lead to the same decision. Table 5 summarises the characteristics or requirements of a rational decision as EUT would also imply.

3.2.3 Behavioural Approaches to Economics

During the 20th century, more and more inconsistencies with the assumption of a rational economic agent's behaviour were discovered and discussed.⁴⁸ Often, judgemental errors were blamed as the source of mistaken behaviour (Nisbett and Ross, 1980). Rational utility maximisation did not satisfy as a model of economic decision-making; increasingly psychologists and economists desired a more descriptive approach "taking as its central goal an attempt to build a description of the human decision maker that better approximates how people go about the business of their daily lives" (Dunning, 2012, p.252). Moreover, the assumption that individuals act *as if* they were rational could not hold (Gigerenzer, Todd and the ABC Research Group, 1999). Many studies in the 1950s tested the assumptions of economics for empirical validity and developed alternative approaches.

One stream of research trying to develop more realistic models was initiated by the psychologist Edwards; he adopted a mathematic approach to describe what behaviour tells about the way individuals perceive and calculate probabilities. Edwards introduced the term behavioural decision theory (Newell, 2009, p.694). The research stream initiated by Edwards, without losing sight of normative theory, evolved to a decision-analytic one.⁴⁹

Decision analysis is normative at its roots, but becomes prescriptive in recognizing the limitations of human decision makers and the complexity of the environment in which it has to be implemented. (Edwards, Miles Jr. and Winterfeldt, 2007, p.7).

Similarly, the economist Allais (1953) focused on departures from rationality and rejected the normative approach of expected utility theories including probability judgements and mathematic formulations. Instead, he included psychological factors and described behaviour by the so-called complementarity effect (Allais, 1953).⁵⁰ The so-called Allais Paradox (Allais,

⁴⁶ Newell and Bröder (2008) label the *homo oeconomicus* "with the apparent reality of a cognitive miser (or even loser) and has been enormously influential and useful." (p.195).

⁴⁷ Synonyms include: situation, context or state.

⁴⁸ Inconsistencies in (human) economic behaviour were already noted by Adam Smith: "We suffer more, it has already been observed, when we fall from a better to a worse situation, than we ever enjoy when we rise from a worse to a better." (Smith, 1759, Part IV Section I Paragraph 6); moreover, by Jeremy Bentham, Irving Fisher, William Jevons and many others (mentioned in Camerer, 2006).

⁴⁹ "Today one might characterize Edwards as a Bayesian decision analyst with a very keen eye for human limitations and biases." (Fishburn, 1989, p.391).

⁵⁰ Later denoted as certainty effect by Tversky and Kahneman (1986).

1953) and the Ellsberg Paradox (Ellsberg, 1961) showed inconsistencies with the axioms of normative expected utility theories.

Simon (1955, 1956, 1979, 1991) was one of the main proponents of the notion that the assumption of (unbounded) rationality is not valid any more and requires revision and thereby contributed to establish research on *behavioural economics*. Simon (1991, p.132) notes “the limits upon the ability of human beings to adapt optimally, or even satisfactorily, to complex environments” which he called bounded rationality. Even under consideration of limited information-processing capacity and limited information, decision-makers would not act rationally given these restrictions, as procedural rationality would imply (Simon, 1979). With particular focus on information processing, he finds individuals use “substantial computational simplifications in the making of a choice” (Simon, 1955, p.104): He argues that decision-makers choose strategies adapted to the environment that help them decide when to stop the search for more information and to find an acceptable solution that nevertheless satisfies all their needs; he describes this behaviour as selective search plus ‘satisficing’ (Simon, 1956, 1979).⁵¹ Research at that point concerning quality of choices based on simplification was neither very advanced nor esteemed; “we cannot, of course, rule out the possibility that the unconscious is a better decision-maker than the conscious” (Simon, 1955, p.104). Further thoughts on the occurrence and circumstances of these simplified computations were not considered; however, Simon (1955) notes their relatively high frequency of use as a way to cope with complex decision settings. The study of simplifying cognitive strategies, i.e. heuristics, as is the main focus of this work, will be picked up in Section 3.3 in detail. Before, we will refer to basic behavioural economic concepts that may be important to provide context for the concept of heuristics and become relevant in future research. We may refer back to those at a later stage of this work.

Another milestone of behavioural economics is Kahneman and Tversky’s (1979) *Prospect Theory* (PT) – “[o]ne of the most prominent descriptive models of decision making under uncertainty” (Edwards, Miles Jr. and Winterfeldt, 2007, p.5), which considers known probabilities and therefore risk in a narrow sense rather than uncertainty. Similar to EUT, in PT, a decision-maker chooses an alternative (prospect) that yields the highest value to him or her. An important difference to EUT is the mental processing (‘editing’) stage that happens before a prospect is evaluated; outcomes or prospects are modified⁵² to facilitate decision-making (Kahneman and Tversky, 1979).

For example, simplification: outcomes are not considered at all if their probability is extremely small. Simplified information can more easily be evaluated to ‘compute’ the

⁵¹ Satisficing: “a blend of sufficing and satisfying” (Gigerenzer and Goldstein, 1996, p.2).

⁵² By means of coding, combination, segregation, cancellation, simplification and detection of dominance (Kahneman and Tversky, 1979).

maximum value of a prospect. What was considered utility in EUT is now considered a value assigned to an outcome – that denotes a certain level of happiness or regret. Outcomes are not perceived as final states of wealth (cf. Von Neumann and Morgenstern, 1944), but as changes in states of wealth or more general: as gains or losses relative to a reference point. The value function (equivalent to the utility function in EUT) is no longer assumed to be stable, but it depends on whether the outcome is a gain or a loss. Value is viewed as reference-dependent – as opposed to reference independence in EUT. In the domain of gains, decision-makers are risk averse, whereas in the domain of losses, decision-makers change their risk attitude to risk seeking.⁵³

Furthermore, to a decision-maker it does not matter whether it is a real gain or loss or whether they only perceive it as such. The same effect on risk attitude and on the decision can be noted; this effect is called *framing* (Kahneman and Tversky, 1979). Whereas in EUT the weighting of the utility values for all consequences of an alternative is assumed to be done via the outcomes' (objective or subjective) probabilities, in PT the decision-makers are observed to apply decision weights to the outcomes' values that do not correspond to the true probability but vary. In this way, individuals' limited ability to imperfectly process probabilities, and extreme probabilities in particular, is considered.⁵⁴

Additionally, decision-makers are observed to be *loss averse*, i.e. a loss has a stronger impact than a gain of the same size (in absolute terms): Individuals seem to suffer more if they perceive a loss of a certain amount of money for example than they are happy if they win the same amount (Kahneman and Tversky, 1979).

Mental accounting is often considered an outcome of PT depending on to what extent information (about previous gains or losses) is integrated or segregated (Thaler, 1985, 1999). This refers to individuals' tendency to organise information especially as regards monetary information in so-called mental accounts. If previous losses are integrated, i.e. considered in a decision situation, the decision-maker may still feel in the loss domain and act as a risk seeker; whereas if prior losses are not considered and thus segregated from the current decision – representing the rational way – they may decide differently. Escalation to commitment may be a result (e.g. Staw, 1976).

We will briefly mention further basic concepts of behavioural economics (as summarised by Camerer, Loewenstein and Rabin, 2004). As regards the impact of the dimension of time in *intertemporal choice* (e.g. Frederick, Loewenstein and O'Donoghue, 2004; Camerer, 2006;

⁵³ In their revised theory, Cumulative Prospect Theory (1992), Tversky and Kahneman show that risk aversion for gains and risk-seeking behaviour for losses is observed for high outcome probabilities only; whereas for low outcome probabilities, risk attitude is reversed (Tversky and Kahneman, 1992). They also show inconsistencies of the human information processing capacity for example as weights do not add up to one (subadditivity; Kahneman and Tversky, 1979; Tversky and Kahneman, 1992).

⁵⁴ I.e. relatively unlikely events are usually ignored or overweighted implying risk-seeking behaviour; relatively high probabilities are underweighted by a decision-maker implying risk aversion; the difference between 100% certain outcomes and almost certain outcomes also plays an important role (Kahneman and Tversky, 1979).

DellaVigna, 2009), individuals do not constantly or consistently ‘discount’ future utility; i.e. consider the delay of an outcome and its reduced or additional utility (Frederick, Loewenstein and O’Donoghue, 2004). The preference of outcomes today to the equivalent amount at some point in the future varies. Hyperbolic discounting, i.e. short-term (‘cognitive’) discount rates are relatively high, whereas long-term ones tend to be lower. Other anomalies are for example discounting gains more strongly than losses, i.e. losses tend to be preferred to be delayed, immediate gains tend to be preferred even though the discount to the future gain is relatively high; or discounting small outcomes more strongly than large outcomes, or outcomes considered each by itself discounted in another way than sequences of multiple outcomes (Frederick, Loewenstein and O’Donoghue, 2004). *Choice avoidance* or postponing is also true in general in the case of difficult decisions or difficult trade-offs to make (e.g. Luce, Payne and Bettman, 1999).

Besides the above-mentioned concepts of individual behaviour, behavioural economics furthermore addresses *social behaviour and interaction*. Human beings do not egoistically maximise their individual wealth or utility. A variety of studies on social interaction point out that fairness, equity, reciprocity, trust and altruism play an important role (for reviews, see e.g. Camerer and Loewenstein, 2004; Camerer, 2006; DellaVigna, 2009).

Another concept that we would like to emphasise is overconfidence because it is considered a significant contribution in behavioural economics, finance and similar fields (see Olsson, 2014, for a collection of statements pointing to the importance). Various approaches or definitions exist (see also Olsson, 2014) which are linked to the estimation of one’s skill: Overestimation of own performance contrasted to estimated performance; overplacement, i.e. own performance contrasted to other people’s performance; or miscalibration, i.e. confidence contrasted to actual accuracy (Olsson, 2014). The latter definition seems most common (e.g. Lichtenstein, Fischhoff and Phillips, 1982; Fischhoff, 1982; Brenner *et al.*, 1996; Keren, 1991, 1997). In other words, it describes inappropriate, too high confidence that an estimate is correct (Lichtenstein, Fischhoff and Phillips, 1982; Fischhoff, 1982)⁵⁵ and thereby implies unjustified, too high confidence in own judgement and thus in skill. Various explanations have been put forth; Kahneman and Tversky (1973) for example relate overconfidence to result from the representativeness heuristic (explained in Section 3.3.2) and term excessive confidence as a bias of illusion of validity. It is considered robust and difficult to eliminate (Kahneman and Tversky, 1973). Problems associated with explaining and measuring general overconfidence are outlined by for example Olsson (2014) who claims that statistical measures can often explain what is called overconfidence.

⁵⁵ “Formally, a judge is calibrated if, over the long run, for all propositions assigned a given probability, the proportion that is true equals the probability assigned.” (Lichtenstein, Fischhoff and Phillips, 1982, p.307)

Optimism is also addressed in JDM research (e.g. Hey, 1984) and also particularly seized on in managerial and financial decision-making. Optimism implies over-estimating the likelihood of favourable outcomes and underestimating the likelihood of unfavourable outcomes; which is shown to violate SEU (Hey, 1984).

In neoclassical economics, *learning* is assumed to represent proper updating of prior beliefs according to the rational Bayes' rule; however, decision-makers fail to objectively update their beliefs (e.g. Fischhoff and Beyth-Marom, 1983). Considering bounded rationality, learning is more of a general JDM topic than particularly dealt with in behavioural economics. In general, learning from experience can generate skill (justified confidence) (Kahneman and Klein, 2009). Einhorn (1982, p.270) has noted that "[i]n any event, the rules we develop seem directly tied to learning what outcomes will follow from particular actions." – thereby emphasising the importance of feedback and the inductive nature of learning or developing rules, i.e. heuristics. However, learning has serious limitations. On the one hand, this can be due to imprecise, noisy feedback. The real world is complex and often, feedback about whether a decision was a good or bad one, cannot be isolated (Einhorn, 1982). Thus, false or biased judgements may not be eliminated and generate skill. It may cause persistent overconfidence instead of eliminating it. On the other hand, performance evaluation ex post and thus learning depends on whether personal performance is considered successful or not. *Self-attribution* might make decision-makers attribute success to skill and make them believe they are more skilled than they actually are. Previous success is typically attributed to skill whereas previous failure is not seen as result of skill (Hastorf, Schneider and Polefka, 1970; Miller and Ross, 1975; Miller 1976; Hogarth, 1987) and is also called self-serving bias.

Out of behavioural economics, the field of *behavioural finance* has emerged. It "builds upon behavioural economics, but does not replace it" (Thaler, 2005, p.xi). Behavioural finance generally deals with the boundedly rational behaviour of participants, mostly investors, in financial markets with the aim to better understand developments in markets such as how assets are priced or market performance in general (e.g. Daxhammer and Facsar, 2012; Shleifer, 2000). Major criticism is brought forth by for example Fama (1998) showing that in the long run, observed anomalies disappear.

Moreover, and certainly partially due to its descriptive aspiration, behavioural economics (and finance) has largely been a loose network of observed phenomena whose compatibility is often not easily answered, with a lack of formulating models. Other concepts or refinements have been developed, in addition to those presented above, and more factors may play a role in economic decision-making that such a single piece of work cannot capture.⁵⁶

⁵⁶ For further surveys of behavioural economics cf. Camerer, Loewenstein and Rabin (2004); Camerer (2006); DellaVigna (2009); Pesendorfer (2006); Rabin (1998, 2002); Wilkinson and Klaes (2012).

A human being is a complex organism, thus we cannot rule out the possibility of several or many factors playing a role interactively. We will, however, single out the study of heuristics since judgement and thus decisions regularly result from the use of heuristics, i.e. cognitive, often intuitive strategies or rules, to cope with complexity and uncertainty. As will be elaborated in Chapter 4, judgement is an integral part of investment appraisal in general and of determining the appraisal parameters.

To understand heuristics, it is important to provide context and not only know about the actual judgemental or decision strategies that individuals have in mind, but also the further behavioural concepts and phenomena that have been found to also influence decision-making. These findings including various biases have been included in this review because of their rather ‘compartmentalised’ nature – to show the neighbouring concepts that leave room and even call for future research to examine contradictions or reinforcement of individual findings and phenomena.

To identify a gap in current research and to prepare future research as regards the interaction of behavioural concepts, Chapter 4 will address which of the reviewed behavioural concepts have been explored in the investment appraisal literature – beyond investigating previous work on heuristic reasoning in investment appraisal.

Particularly interesting may be the relationship between individual reasoning by heuristics and social interaction as in group-think in future research. In a group, however, individuals’ reasoning processes typically precede interaction in a group and therefore represent an inevitable stage before the effect of group dynamics. Comprehensively examining the potential and functioning of heuristics in the context of investment appraisal should thus be the initial step. The extent of conflict or reinforcement of group-think with heuristics for example, or the interaction of different biases in general, could then be investigated and would require an at least similarly comprehensive and thorough discussion. This huge potential of examining the interaction of different behavioural concepts in general may be addressed by psychological research but also by behavioural economists with focus on economic decision-making and the specifics of the field of investment appraisal.

3.3 Heuristic Reasoning

3.3.1 Concept

As noted above, Simon's (1955) notion of individuals' use of substantial computational simplifications may have initiated the study on heuristics. The term heuristics⁵⁷ was shaped to a great extent by Tversky and Kahneman and their 'heuristics-and-biases' programme for judgement under uncertainty. In their early paper, Kahneman and Tversky (1972, p.431) claim that when judging the probability of uncertain events, "people replace the laws of chance by heuristics, which sometimes yield reasonable estimates and quite often do not"; which is reasonable given these laws' difficulty to apply or their limited obviousness, but on the other hand this is surprising since the subjective estimates do reliably, systematically and persistently deviate from objective ones (Kahneman and Tversky, 1972). Given their work on adaptive decision-making as noted in Section 3.2.2, Payne, Bettman and Johnson (1993, p.2) claim that in relatively easy decision problems, often all relevant information is used. However, in complex tasks, individuals have developed simplifying strategies that select which pieces of information to use, i.e. heuristics (Payne, Bettman and Johnson, 1993). Gigerenzer, Todd and the ABC Research Group (1999, pp.6-7) point out their notion of heuristics as as models of bounded rationality that include inferences facing limited time and knowledge and which "do not involve much computation, and do not compute probabilities and utilities".

In contrast to optimisation models or algorithms – and even for replacing them (Newell and Simon, 1972) – heuristics are "methods for arriving at satisfactory solutions with modest amounts of computation" (Simon, 1990, p.11). The axioms of expected utility theories or the weighted additive rule (which can be considered EUT's equivalent in psychology) are examples of complex algorithms as optimisation models (Shah and Oppenheimer, 2008; Payne, Bettman and Johnson, 1993).

In an attempt to harmonise various approaches and in response to the excessive use of the term heuristics⁵⁸, Shah and Oppenheimer (2008, p.207) considered heuristics in the light of increasing cognitive demands, as "methods or strategies that reduce the effort they expend on computation". In the following, we will define *heuristics* as (cognitive) strategies or rules that are employed by humans to simplify, i.e. reduce the effort of, a complex decision task. Due to limited cognitive capacity and limited information of the environment, heuristics serve to decrease cognitive effort and therefore must violate one or more of the rational requirements or

⁵⁷ Derived from Greek *heuriskein*: to find (Oxford English Dictionary, 2016b).

⁵⁸ Shah and Oppenheimer (2008, pp. 207, 219) have noted and criticised the over-extensive and superficial use of the term heuristic including 'rule of thumb', 'mental shortcut', 'curious behaviour' or 'suboptimal choice', which has made the term "vague enough to describe anything, it has been used to describe nearly everything. It seems that we have reached the point where the literature has become flooded with so many heuristics as to make the term arbitrary." Sometimes the term heuristic is even used to denote a prescriptive rule (for example Hershey, 2007), all of which will not be addressed by this work.

demands (Shah and Oppenheimer, 2008). There are heuristics for formulating judgements (or inference) and heuristics for making a decision or choice (Shah and Oppenheimer, 2008). Judgement-related heuristics will be the focus of this work because projecting cash flows and setting hurdle rates, as outlined in Chapter 2, are clearly tasks that terminate by a judgement in the form of an estimate, rather than making a choice between alternatives; the latter may be more interesting for investigating the project approval, i.e. the investment decision itself. Distinguishing judgement and choice will be again addressed below in Section 3.3.5 and in Chapter 4 with particular focus on the projections of cash flow and the setting of the hurdle rate.

Similarly, in the field of computer science, a heuristic means relying on a rule that specifies the conditions and actions “suggesting plausible actions to follow or implausible ones to avoid” (Lenat, 1982, p.192) with a focus on simplification but aiming for an effective result: “easy-to-apply optimization concepts that are widely used for fully-automated decision making and problem solving” (Rothlauf, 2011, p.1).

Research on heuristics – if we exclude the superficial use of heuristics as a ‘catch-all term’ – faces several weaknesses (Shah and Oppenheimer, 2008): Among these is the fact that few approaches or frameworks dominate the existing literature. The early research by Tversky and Kahneman in the 1970s focused on judgemental heuristics and has remained almost unchallenged for a long time. Payne, Bettman and Johnson (1993) brought forth research on adaptive decision-making; it also served as a basis of the fast-and-frugal programme by Gigerenzer and collaborators. We will briefly refer to the discussion including the overlap and main differences in Section 3.3.4.

Prospect Theory, in contrast to the study of heuristics, is a consistent but also limited theory. It primarily studies decision-making under risk in a narrow sense (i.e. known outcomes and probabilities). The study of heuristics is not a ‘closed’ theory in the same vein but – and this can also be a point of criticism – a strongly discussed and evolving set of decision rules that decision-makers may apply in different, uncertain environments; yet both approaches, Prospect Theory and the study of heuristics imply steps for information perception, processing, making judgements or decisions. A strict differentiation is neither possible nor required.

3.3.2 The Heuristics-and-Biases Approach

The earliest and still widely discussed approach is Tversky and Kahneman’s heuristics-and-biases programme (1974). In Tversky and Kahneman’s (1974) early model about judgement under uncertainty, they vaguely defined ‘heuristics’ as principles used to simplify complex decision environments and to arrive at a judgement under uncertainty. “The vagueness did no damage because the research program focused on a total of three heuristics of judgment under uncertainty that were separately defined in adequate detail.” (Kahneman, 2003a, p.707) At this

point, it was merely a collection of heuristics rather than a framework of what heuristics are and how they work.

The three basic types of general-purpose heuristics were ‘availability’, ‘representativeness’ and ‘anchoring and adjustment’ (Table 6). They describe the way an individual selects, uses and processes information. The *availability* heuristic implies that – if a decision is to be made about the probability of occurrence of an event (e.g. snow in November) – an individual ‘searches’ the memory with regard to which events are easily recalled or imagined (e.g. last November) and concludes that those events which come to mind (more) easily appear to be (more) frequent and therefore probable (Tversky and Kahneman, 1973, 1974). This procedure is useful because in general more likely events happen more often and are thus more likely recalled; however, as the memory does not provide a perfect representation of the population and the judgement is likely to be biased (Tversky and Kahneman, 1974). Retrieving instances, furthermore, is difficult when for example “the total number of items is large, when their distinctiveness is low, or when the retention interval is long” (Tversky and Kahneman, 1973, p.221).

Heuristic	Description	Indicative references
Availability	A person evaluates the frequency of classes or the probability of events by availability, i.e., by the ease with which relevant instances come to mind.	Tversky and Kahneman (1973, p.207)
Representativeness	People have erroneous intuitions about the laws of chance. In particular, they regard a sample randomly drawn from a population as highly representative, that is, similar to the population in all essential characteristics.	Tversky and Kahneman (1971, p.105)
Anchoring	People make estimate by starting from an initial value that is adjusted to yield the final answer.	Tversky and Kahneman (1974, p.1128)

Table 6 Heuristics in the heuristics-and-biases approach

The *representativeness* heuristic suggests that – if a decision is to be made about the probability of occurrence of an event – an individual concludes that events, which are similar to a typical event or stereotype, appear to be particularly probable (Tversky and Kahneman, 1971, 1972, 1974). In other words, any given outcome or object is not evaluated based on its individual features or circumstances but based on how similar it is to and thus how representative it is of a particular group; thus, the more similar to a typical outcome or object, the more likely it appears. However, similarity should not tell about probability because a single draw from a population can deviate quite strongly from the average characteristic of a group and further factors may play a role that are more expressive to judge an outcome or object (Tversky and Kahneman, 1974).

Heuristic	Bias	Description	Indicative references
Availability	Bias due to the retrievability of instances	Instances that are more easily recalled from memory due to recency, familiarity or salience, are judged to be more likely.	Tversky and Kahneman (1973, 1974)
	Bias due to the effectiveness of a search set	Instances that are more easily recalled due to the memory structures affecting the search, are judged to be more likely.	Tversky and Kahneman (1974, 1973)
	Biases of imaginability	Instances that are more easily imagined, are judged to be more likely.	Tversky and Kahneman (1973, 1974)
	Illusory correlation	Several instances that have co-occurred in the past tend to be judged to correlate with each other.	Chapman and Chapman (1969); Tversky and Kahneman (1974)
Representativeness	Insensitivity to prior probability of outcomes ⁵⁹	Individuals tend to ignore the general probability of occurrence of an instance.	Tversky and Kahneman (1974)
	Insensitivity to sample size	Individuals tend to fail to consider sample size but conclude that a small sample behaves as a large sample.	Tversky and Kahneman (1972)
	Reflection of randomness ⁶⁰	Individuals tend to expect a sequence of random instances to show the same properties as the population. 'law of small numbers'	Kahneman and Tversky (1972, 1971)
	Insensitivity to predictability	If people predict solely in terms of the favorableness of the description, their predictions will be insensitive to the reliability of the evidence and to the expected accuracy of the prediction.	Kahneman and Tversky (1974)
	The illusion of validity	Individuals show unwarranted confidence when they predict an outcome depending when the input information seems representative.	Tversky and Kahneman (1974)
	Misconceptions of regression	If the value of an input variable is extreme, individuals tend to predict that the outcome is similarly extreme and thus fail to recognise regression toward the mean.	Kahneman and Tversky (1974)
	The conjunction fallacy ⁶¹	A conjunction of several instances are judged to be more likely than one of its constituent instance.	Tversky and Kahneman (1983)
	Anchoring	Individuals' insufficiently adjust from a given reference point (anchor) so that the final estimate is closer to the reference point than without this reference point.	Tversky and Kahneman (1974)

Table 7 Biases in the heuristics-and-biases approach

Anchoring refers to a scenario in which a quantitative value is to be estimated. For this purpose, an individual relies on a reference point (i.e. the anchor), which might be given externally or implicitly by the individual himself/herself – consciously or unconsciously; the individual uses this anchor as a starting point and uses other information available (such as own

⁵⁹ Insensitivity to base rates (Bazerman and Moore, 2013)

⁶⁰ Also known as gambler's fallacy.

⁶¹ Tversky and Kahneman (1983) explicitly note that the conjunction fallacy can occur because of the availability *or* the representativeness heuristic.

knowledge) to adjust the judgement, to arrive at a final estimate (Tversky and Kahneman, 1974). An important feature, they remark, is that adjustment is usually insufficient.

Table 7 summarises the biases of Tversky and Kahneman's original approach. These biases were assumed to potentially arise from the use of availability, representativeness or anchoring.

3.3.3 The Attribute-Substitution Approach

In later work in the beginning of the 21st century, Kahneman and Frederick (2002)⁶² amend the approach to heuristics. Instead of approaching their three general-purpose heuristics (availability, representativeness and anchoring), they develop a framework of general-purpose heuristics, acknowledging that the list of three heuristics is largely arbitrary and not exhaustive (Kahneman and Frederick, 2002).

When a judgement has to be made in a complex setting, i.e. when an aspect of a judgemental object, the target attribute, has to be assessed, an individual searches for a reasonable value. In doing so, their judgement may be based on an assessment of an attribute that is easier-to-access than the target attribute, and the search is stopped (Kahneman and Frederick, 2005). In other words, when trying to find an answer or solution to the original task, an individual substitutes an easier task for it (Kahneman, 2003a). This boundedly rational simplification of an individual's judgement process is termed 'attribute substitution'. A so-called heuristic attribute automatically substitutes for the more difficult-to-access target attribute on which a judgement has to be made by providing a plausible answer (Kahneman and Frederick, 2002, 2005; Kahneman, 2003a). The more easily it comes to mind, i.e. the more accessible it is, the more likely it is to be employed to arrive at a judgement (Kahneman, 2003a, p.697). Accessible cues can be representativeness or availability of instances from memory. In this way, the new framework can capture the previously defined heuristics availability and representativeness.

To, for example, examine the risk of death caused by a snakebite, an individual may use instances available in memory by consulting whether s/he knows of someone or has heard or read about someone dying from one; i.e. they use the heuristic attribute of availability as a cue to judge the risk (Kahneman and Frederick, 2002). Alternatively, representativeness may be used as an attribute substituting for general 'risk of death' and thus make the same judgement if instances are not available in memory. An example includes considering how dangerous a typical snake is (Kahneman and Frederick, 2002). This highlights the various options of different heuristics for perhaps the same judgement and the dependency on the individual decision context (Kahneman and Frederick, 2002).

⁶² Kahneman only; Tversky died in 1996.

Kahneman and Frederick (2002) note that the analysis of attributes used is also valid if an objective criterion is not available and thus if a fully objective judgement is impossible, as is the case for a hurdle rate estimate and in most cases also for cash flow projections due to complexity and uncertainty.

They mention three conditions for attribute substitution to occur (Kahneman and Frederick, 2002, p.54):

- (1) the target attribute is relatively inaccessible;
- (2) a semantically and associatively related candidate attribute is highly accessible;
and
- (3) the substitution of the heuristic attribute in the judgment is not rejected by the critical operations of System 2.

Kahneman and Frederick (2002) extend the general-purpose heuristics of availability and representativeness by the *affect heuristic* that bases a judgement on a positive or negative affect to an event, outcome, object or similar (Kahneman and Frederick, 2002). Affect⁶³ is considered an additional candidate for attribute substitution because affect is a natural assessment that means it is regularly and generally evaluated by an individual, and therefore highly accessible by itself (Kahneman and Frederick, 2002). “In terms of the scope of responses that it governs, the natural assessment of affect should join representativeness and availability in the list of general-purpose heuristic attributes.” (Kahneman, 2003, p.710) Slovic *et al.* (2002, p.400) also indicate that affect is much easier to retrieve compared to what we ‘should’ do, i.e. “weighing the pros and cons or retrieving from memory many relevant examples”, particularly for complex judgements or decisions. Affect can thereby be considered a heuristic. This also links to the previously examined availability heuristic in that affect may even be easier to retrieve than any available instances from memory. Kida, Moreno and Smith (2001; see also for further references on affect) note that affect may also imply very basic evaluations (positive or negative) toward objects. It constitutes an additional heuristic in their list of heuristics and also a source of bias because it might influence judgements and keep an individual from a rationally best decision.

Findings indicate that affect influences the perceived benefit and thus the risk attributed to an object and thereby also indicating high relevance for judgement in the investment appraisal context:

[P]eople base their judgments of an activity or a technology not only on what they *think* about it but also on what they *feel* about it. If they like an activity, they are moved to judge

⁶³ Derived from Latin *affectus*; *affect*: an (immediate) emotional response; an inner disposition or feeling (towards or in favour of a person or thing) (Oxford English Dictionary, 2016a).

the risks as low and the benefits as high; if they dislike it, they tend to judge the opposite – high risk and low benefit. (Slovic *et al.*, 2002, pp.410-411)

These findings are also transferrable to judgements about the risks and returns of (unfamiliar) financial assets (e.g. Ganzach, 2000, as also cited by Slovic *et al.*, 2002).

The definition of a heuristic that functions by means of attribute substitution does not apply to the concept of anchoring (Kahneman and Frederick, 2002). An anchor (a numerical value provided), is not a heuristic *attribute* that substitutes the target attribute (a numerical estimate); however, the effects of anchoring can be subsumed under the concept of accessibility:

In attribute substitution, a highly accessible attribute controls the evaluation of a less accessible one. In anchoring, a highly accessible *value* of the target attribute dominates its judgment. (Kahneman and Frederick, 2005, p.272).

However, many studies and surveys have not given up the idea of anchoring being a heuristic (e.g. Harvey, 2007; Marsden, Veeraraghavan and Ye, 2008; Luft and Shields, 2010, Shefrin, 2010). They may refrain from adopting a revised definition of what a heuristic may be or simply take other publications referring to the easier to grasp original definition for granted. We will follow Chapman and Johnson (2002), Mussweiler and Strack (2001) and others, calling it an ‘*anchoring effect*’. We will nevertheless consider this effect in our analysis – acknowledging its importance since it is still considered enormously relevant as a generally occurring effect in financial and in numerous other fields of decision-making when making quantitative judgements (e.g. Mussweiler and Strack, 2001; Chapman and Johnson, 2002). But, to distinguish from the narrow definition, we will not speak of ‘heuristic attribute’ in this context but of a highly accessible and thus ‘salient value of the target attribute’ (based on Kahneman and Frederick, 2005).

The judgemental anchoring effects, which are also well-known from the heuristics-and-biases framework, “result because the semantic knowledge about the target object that is activated during the comparison with the anchor influences the absolute judgment” (Mussweiler and Strack, 2001, p.234); i.e. the anchor activates knowledge that is perceived to be more relevant.

Anchors can be informative, or uninformative (e.g. random); both may influence judgement, even unconsciously when decision-makers are not prompted to consider or compare them (e.g. Wilson *et al.*, 1996). The anchoring effect is stronger, the more informative an anchor is perceived (Chapman and Johnson, 1999; Wilson *et al.*, 1996). Anchors can also be self-generated and thus not explicitly provided (Chapman and Johnson, 1999). The requirement for an anchor to be influential is that sufficient attention is paid by the decision-maker; judgement may be influenced even if aware of an anchor (Wilson *et al.*, 1996).

An uninformative anchor influencing judgement – also called basic anchoring – is stronger for a less knowledgeable decision-maker than for a more knowledgeable one (Wilson *et al.*,

1996). In contrast, Chapman and Johnson (1999) find that the anchoring effect is stronger if a decision-maker has more information about a target value because more knowledge can be accessed and thus activated.

Heuristic attribute	Description	Attribute substitution	Indicative references
Availability	Judgement is based on the assessment of availability.	The heuristic attribute is easier to assess than the target attribute: ↓ Substitution of the heuristic attribute for the target attribute	Kahneman and Frederick (2002, 2005)
Representativeness	Judgement is based on assessing the degree of resembling a category.		Kahneman and Frederick (2002, 2005)
Affect	Judgement is based on the positive or negative feeling or quality associated.		Slovic et al. (2002); Kahneman and Frederick (2002, 2005)

Table 8 The attribute substitution approach

Table 8 summarises the identified heuristics under the conception of the early 2000s proposed by Kahneman (2003) and Kahneman and Frederick (2002, 2005). This updated approach represents a more concise conception of the heuristic process in that it revises the ‘collection’ of heuristics of the 1970s in the light of new insights and develops a more generally applicable framework in that this approach provides “no finite list of heuristic attributes” (Kahneman, 2003a, p.710). It does not contradict the outcomes of those heuristics of the original heuristics-and-biases approach – the judgemental outcomes and potential biases are not assumed to be different only because the underlying theory of functioning has changed.

3.3.4 The Fast-and-Frugal approach

As indicated above, Payne, Bettman and Johnson (1993) address adaptive decision-making and provides a general framework of judgemental and choice heuristics based on a classification of six binary features. This research was also influential in introducing the concept of fast-and-frugal heuristics. Gigerenzer, the ABC Research Group and collaborators, from the 1990s onwards present the ‘fast-and-frugal’ framework that includes heuristics of judgement and of choice and that opposes the heuristics-and-biases framework mainly as regards the performance of heuristics. Literature on heuristics seems restricted to either the heuristics-and-biases programme or the fast-and-frugal one.⁶⁴

In contrast to Kahneman and Tversky’s heuristics-and-biases programme of the 1970s, Gigerenzer, Todd and the ABC Research Group (1999) derived a generally more open and non-stringent approach to heuristics: the fast-and-frugal framework. To them heuristics are not a

⁶⁴ Without considering heuristics that only vaguely denote a general rule or strategy, as addressed above.

fixed set of decision rules applied, but decision rules that fit the situation at hand and can be built from the so-called adaptive toolbox (and previously used heuristics) (Gigerenzer and Brighton, 2009). Heuristics are built from the adaptive toolbox that consists of so-called building blocks. Building blocks may comprise for example rules how information is searched for, when to stop searching and what judgement to infer or decision to make. (Gigerenzer, 2008; Gigerenzer and Brighton, 2009). Through combining a limited number of building blocks, a variety of heuristics can be developed (Gigerenzer, 2001). Table 9 lists ten well-studied heuristics (Gigerenzer and Brighton, 2009).

Heuristic	Description	Indicative References
Recognition	If one of two alternatives is recognized, infer that it has the higher value on the criterion.	Goldstein and Gigerenzer (2002)
Fluency	If one alternative is recognized faster than another, infer that it has the higher value on the criterion.	Jacoby and Dallas (1981)
Take-the-best	To infer which of two alternatives has the higher value: (1) search through cues in order of validity, (2) stop search as soon as a cue discriminates, (3) choose the alternative this cue favours.	Gigerenzer and Goldstein (1996)
Tallying; unit-weight linear model	To estimate a criterion, do not estimate weights but simply count the number of favouring cues.	Dawes (1979)
Satisficing	Search through alternatives and choose the first one that exceeds your aspiration level.	Simon (1955); Todd and Miller (1999)
1/N; equality	Allocate resources equally to each of N alternatives.	DeMiguel et al. (in press)
Default	If there is a default, do nothing.	Johnson and Goldstein (2003); Pichert and Katsikopoulos (2008)
Tit-for-tat	Cooperate first and then imitate your partner's last behaviour.	Axelrod (1984)
Imitate the majority	Consider the majority of people in your peer group and imitate their behaviour.	Boyd and Richerson (2005)
Imitate the successful	Consider the most successful person and imitate his or her behaviour.	Boyd and Richerson (2005)

Table 9 The fast-and-frugal programme (extracted from Gigerenzer and Brighton, 2009, p.130)

In contrast to Kahneman and Tversky's (1974) approach, a heuristic "is not general-purpose, but selected in an adaptive way that depends on the environment (i.e., ecology)" (Gigerenzer and Goldstein, 2011). Thus, they do not specify which heuristics exist as they fit to the situation at hand. Depending on the situation or environment, different heuristics can be built and seem appropriate to the decision-maker. They are said to be ecologically rational: Cues have to fulfil a certain condition, under which they are valid and thus, ecologically rational, and as a result lead to accurate judgements, i.e. good predictions (Gigerenzer and Goldstein, 2011). The structure of the environment determines the ecological rationality; this means the rationality

in a given situation is oriented to the circumstances. The implicit adaptive toolbox of an individual provides the tools ('building blocks') for developing or using (new) heuristics and permanently adapts to an individual's environment (Gigerenzer and Brighton, 2009). In their view, heuristics may not be optimal but nevertheless reasonable. This explains their general rejection of talking about biases resulting from heuristics and their negative connotation. Furthermore, ecological rationality of heuristics is contrasted to logical rationality since it does not "fit to laws of logic and internal coherence, such as transitivity and additivity of probabilities" (Gigerenzer, 2001, p.17).

Beside their claim that a heuristic is chosen according to its ecological rationality, Gigerenzer and Brighton (2009) identify further selection principles when choosing a heuristic for making a judgement: Only information available in memory can be used to arrive at a judgement. Feedback allows the decision-maker to learn strategies or heuristics (Gigerenzer and Brighton, 2009; Rieskamp and Otto, 2006).

For example, as regards their most popular heuristic – the recognition heuristic: "If one of two objects is recognized and the other is not, then infer that the recognized object has the higher value with respect to the criterion." (Goldstein and Gigerenzer, 2002, p.76), i.e. the more easily recognised alternative appears to be more frequent or likely in general and therefore might be a good choice. It is always emphasised that this strategy does not automatically lead to bad decisions. An object may in fact be better recognised for a reason: More easily recalled may be an object which is more likely than others. The question is whether the sample of recognition or recall is representative for the population – a similar logic compared to the availability heuristic of the heuristics-and-biases programme.

Based on the building blocks available in the adaptive toolbox, a heuristic consists of certain rules that an individual develops with experience (Gigerenzer and Brighton, 2009): A search rule initiates a search through the present cues focusing on their validity or environmental accessibility; a stopping rule or confirmation rule indicates when the search is stopped, e.g. when a certain cue is sufficient, or several cues point at the same object; the process ends with a decision rule, the inference concerning the target value, i.e. the evidence collected is used to come to a solution to the problem. How much an individual knows about the validity of a cue, i.e. its significance for the target criterion, and the cost of cues, i.e. of information gathering, determines which heuristic is applied (Gigerenzer and Brighton, 2009).

The fast-and-frugal framework assumes that validity of the stimuli plays a critical role: Its degree significantly affects which building blocks to use, thus which rules or which set of rules, i.e. which heuristic, to apply (e.g. Gigerenzer and Brighton, 2009); thereby the decision is affected. One can identify a relation to Kahneman's (2003) concept of accessibility. The concept of accessibility determines which heuristic, or which heuristic attribute, is applied for

substitution and finally, for making a judgment. A high level of accessibility of the stimuli is required to ‘activate’ the process of making a judgment by heuristic principles. This is equivalent to the validity approach and ecological rationality.

Tversky and Kahneman’s approach to applying heuristics in making judgements under uncertainty has developed over time. They viewed heuristics as intertwined with the occurrence of distortions: “These heuristics are highly economical and usually effective, but they lead to systematic and predictable errors.” (Tversky and Kahneman, 1974, p.1131) In 2003, Kahneman admits that in his and Tversky’s earlier work, “heuristics of judgment were to be identified by the characteristic errors that they tend to cause” (Kahneman 2003, p.707), and that “[t]he study of biases is compatible with a view of intuitive thinking and decision making as generally skilled and successful” (Kahneman 2003, p.697), leaving the idea that biases are generally regarded as errors in decision-making and indeed reveal advantages.

Gigerenzer and collaborators on the other hand state that leaving out information, i.e. heuristics, requires lower effort and at the same time can lead to higher accuracy. They are thus considered ‘fast and frugal’ (Gigerenzer and Brighton, 2009). For this reason, they avoid the term ‘bias’ in order to emphasise the positive nature of heuristic reasoning: “decisions can actually be more frugal and more accurate than strategies that look rational by traditional standards.” (Gigerenzer, 2001, p.17) This explanation is expanded in Gigerenzer and Brighton (2009, p.116):

All inductive processes, including heuristics, make bets. This is why a heuristic is not inherently good or bad, or accurate or inaccurate, as is sometimes believed. Its accuracy is always relative to the structure of the environment. The study of the ecological rationality asks the following question: In which environments will a given heuristic succeed, and in which will it fail?

Accordingly, the use of heuristics can have negative decision results depending on the ‘ecological rationality’. Thus, the circumstances of a decision-maker are crucial for the quality of the judgement.

However, both fundamental approaches have in common that they “emphasize the important role that simple psychological heuristics play in human thought, and both are concerned with finding the situations in which these heuristics are employed” (Gigerenzer, Todd and the ABC Research Group, 1999, p.28). Both approaches attempt to specify the scope of the application of judgemental heuristics; they identify categories of heuristics and discuss the quality of the judgements and decisions.

3.3.5 The Effort-Reduction Framework

The approaches outlined above have mainly been based on experimental studies of bounded rational behaviour. Many of the heuristics identified within the frameworks show substantial unrecognised overlap as Shah and Oppenheimer (2008) point out, concluding that redundant

aspects have neither been sufficiently discussed nor eliminated. For this reason, Shah and Oppenheimer (2008) have developed a framework which may be seen as a further development of Payne, Bettman and Johnson's (1993) framework but encompasses the heuristics-and-biases theory, which is assumed to include the attribute substitution approach, and the fast-and-frugal heuristics camp.

Principle	Bounded rationality – heuristic	Rationality – algorithm
1	Omitting information Examining fewer cues than objectively relevant	Considering all relevant information Knowing and considering all relevant cues
2	Simplified retrieval and storage Reducing the difficulty associated with retrieving and storing cue values: considering easy-to-access information	Unlimited retrieval, processing and storage Unlimited cognitive capacity for retrieval, processing and storage of cues ⁶⁵
3	Simplifying the weighting principles Simplification of the weighting of cues	Appropriate weighting Appropriate weighting of cues
4	Incomplete integration of information Integrating fewer information; not an overall impression of an alternative is formed	Complete integration of information Integration of all relevant information to arrive at a value about an alternative
5	Omitting alternatives Examining fewer alternatives	Comparison of alternatives Comparison of all alternatives' values and choice of the alternative with the highest value

Table 10 Contrasting rational and effort-reduction principles (based on Shah and Oppenheimer, 2008)

Synthesising previous approaches, Shah and Oppenheimer (2008, p.209) “propose a framework for studying how heuristics reduce the effort associated with a task”. This approach will be built on in the following reasoning since it reduces diffuseness/blur between the heuristics-and-biases and the fast-and-frugal approaches and captures their commonalities in heuristic reasoning. Heuristics are characterised as according to how they depart from optimal or rational decision behaviour. Rational behaviour is considered in terms of expected utility maximisation. A heuristic is an effort-reduction principle that reduces effort by departing from one or more of the characteristics or requirements of rationality, represented by EUT or a weighted additive rule. Table 10 contrasts the principles of a rational rule (see Table 5) with the effort-reduction principles that characterise heuristics. Those five effort-reducing principles refer to all stages of information search, information processing and judgement and decision. A judgement is made after integrating information (4). A decision or choice is made after comparing alternatives (5).

⁶⁵ Including their utility values. A ‘cue’ can also represent a utility value.

Shah and Oppenheimer (2008) elaborate on their identified principles: The identification of cues may be susceptible to effort-reduction as not all relevant cues might be examined by the decision-maker. Only few indicators may be used to make an inference, for example only those that are held in memory such as in the availability heuristic. This refers to Principle 1 – omitting pieces of information. Principle 2, i.e. reducing the difficulty associated with retrieving and storing, may also occur at the beginning of a judgemental process when information such as data, attributes, past instances or similar are easily recalled and used as cues for the judgement; the affect heuristic for example produces affect as an easy-to-access cue that is used when a judgement is formed. According to the cues' (subjective) validity and relevance for the target criterion – rather than objective validity or probability – cues will be weighted, representing Principle 3. Simple unconscious weighting techniques may be applied, for example the tallying heuristic implies that all cues are weighted equally. Principle 4 implies that not an overall impression of an alternative is formed given the examined cues and weights when a judgement is formed; pieces of information are not combined as they should be; for example in the satisficing heuristic, if a minimum accepted level in a cue (that have been previously specified by a the decision-maker) is reached, the search is stopped and the alternative that satisfies this minimum level on this cue is chosen, knowing that other cues are generally considered relevant. Forming a judgement may be explicit (by for example making an estimate) or implicit (by for example evaluating an instance/an object/an outcome/a person). In case a decision or choice has to be made, complexity and thus effort are reduced if only few alternatives out of many are considered, highlighting Principle 5; for example, the equality heuristic assumes that only those alternatives are considered that provide an equal distribution of resources.

As regards the different number of principles that a heuristic may imply, Shah and Oppenheimer (2008) provide the example of anchoring: an easily accessible value (Principle 2) is used and the outcome set of potential estimates diminishes and in this way alternatives are omitted (Principle 5). Table 11 illustrates the heuristics with regard to the rational principle(s) they violate.⁶⁶

Owing to the significant overlap between and number of heuristics, this work will not refer to each heuristic. Based on the heuristics' characteristics and their descriptions given, investment appraisal practices will be analysed to what extent the principles of effort-reduction are involved in a typical investment appraisal and decision.

⁶⁶ Provided they were included in Shah and Oppenheimer's (2008) list; several ones identified by Gigerenzer and Brighton (2009) were not included. The affect heuristic is attributed to the second principle, the easier retrieval and storage of information (Shah and Oppenheimer, 2008), but originally was not included in their list. However, Shah and Oppenheimer (2008) do not address whether other heuristic principles apply as regards the affect heuristic. We therefore only tick Principle 2.

Heuristic	(1) Examining fewer cues	(2) Simplifying the retrieval and storage of information	(3) Simplifying the weighting principles	(4) Incomplete integration of information	(5) Examining fewer alternatives
Affect		X			
Anchoring		X			X
Availability	X	X		X	
Equal weighting/Tallying			X		
Equality					X
Fluency		X			
Recognition	X	X	X		
Representativeness	X	X		X	
Satisficing			X	X	
Take the Best	X			X	X

Table 11 Effort-reduction principles underlying heuristics (based on Shah and Oppenheimer, 2008)

Moreover, what is not considered by Shah and Oppenheimer's (2008, p.217) approach is whether individuals "process the same information for each alternative (i.e., consistent) or they can engage in variable processing (i.e., selective)" or what the sequence of evaluating is (attribute-based or alternative-based). Furthermore, their approach does not address potential distortions and the quality of judgements and decisions made by heuristics. However, this is not considered problematic.

It is taken for granted that the different camps have different notions particularly about the usefulness of heuristics. This hampers generalisability. Shah and Oppenheimer's (2008) approach is considered convincing and serves as a basis for illustrating the relevance of heuristics in the field of investment appraisal; for considering the conditions under which several heuristics are applicable, and thirdly, for testing several heuristics in a new domain.

3.3.6 Criticism

Shah and Oppenheimer's (2008) non-exhaustive list of (42) heuristics complemented with Gigerenzer and Brighton's (2009) and Kahneman and Frederick's (2002) lists of well-known heuristics, and amended by a systematic search of relevant databases identifying newly developed heuristics (Appendix 1) yielded 97 heuristics – showing the huge interest in the study of heuristics and the dynamic evolvement.

The list of heuristics may however show overlap owing to the fact that they are based on different approaches or frameworks of heuristics (Shah and Oppenheimer, 2008). This weakness of the loose compilation may not be easily reduced because of the various different approaches or the lack of identifying the underlying framework.

The heuristics we have identified above in Sections 3.3.2 to 3.3.4 can largely be considered domain-general. Domain-general does not necessarily mean that these heuristics are applied or applicable to any environment but have been found in a variety of contexts. The compilations by Shah and Oppenheimer (2008) and the one in Appendix 1, however, highlight the general criticism that many heuristics are extensively domain-specific. For many domains such as marketing and the related consumer decisions, heuristics have been identified that denote behaviour in a specific situation (e.g. in perceiving a brand name or a price) even though the underlying heuristic process might be the same. Thus, as indicated above, the term heuristic is used excessively – each researcher trying to derive and name a heuristic based on the cue used rather than on what it does or what the underlying reasoning process is.⁶⁷ This is also illustrated by the relatively high number of domain-specific heuristics: 37 out of 97; see Appendix 1).

The inherent characteristic of a heuristic to reduce effort is not necessarily found in domain-specific heuristics: “In a sense, these heuristics are implicitly defined as cues that are used when they are present, rather than processes that reduce effort by using certain cues.” (Shah and Oppenheimer, 2008, p.209). Moreover, domain-specific heuristics refer to a particular situation but could be described by a general-purpose heuristic. This work aims to investigate whether heuristics apply to the domain of judgement in narrow aspects of investment appraisal. Hence, only general-purpose heuristics that specify the judgement process should and will be considered.

As Einhorn (1982) has noted, and also claimed by the fast-and-frugal researchers, heuristics are highly context-dependent and thereby specific. At the same time, they are general because tasks are grouped by similarity for which a heuristic may be applied (Einhorn, 1982). However, generality can refer to different levels (Einhorn, 1982) and therefore are not necessarily contradictory. The specificity that is emphasised in the fast-and-frugal programme does not mean ‘domain specificity’ in the sense that has been outlined above; it is rather meant to show that not every heuristic is applicable in any context. Einhorn (1981, p.271) for example has considered the well-known heuristics of the heuristics-and-biases as ‘metaheuristics’ at that time, as “rules how to generate rules”; while this preserves the required and very individual generality.

The strong role of reinforcement in the learning of heuristics as well as their limitations have been indicated above in Section 3.2.3. Reinforcement by feedback can help improve whereas it can also be faulty and may not necessarily lead to the elimination of incorrect heuristics; false rules may also be reinforced (Einhorn, 1982).

⁶⁷ “[C]ues are not heuristics themselves – the true heuristic is the underlying method or strategy that selects easy-to-access cues.” (Shah and Oppenheimer, 2008, p.220). The hurdle-rate heuristic (Magni, 2009) may also belong to this category as will be outlined in Chapter 4.

Not only is the literature on heuristics sometimes diverse and inconsistent, so is the literature on *cognitive biases*. Moreover, cognitive biases are not necessarily assumed to emanate from a heuristic; some may only be termed bias to denote a ‘surprising’ or suboptimal effect in general. For example, Wagenaar and Timmer’s (1979) misperception of exponential growth, which is termed ‘linear bias’ by Arnott (2006).⁶⁸

Due to the vague boundaries of what heuristics and biases are they are often confused (e.g. the ‘unit bias’ heuristic by Geier, Rozin and Doros, 2006, for the domain of portion size on food intake). What is called a heuristic by some authors may be denoted a bias by others, “in some cases the distinction between effect and process is moot” (Kahneman, 1991). Renaming or re-organising is also common. For example, apart from availability, representativeness and affect, Bazerman and Moore (2013) speak of a confirmation heuristic that may result in a confirmation bias and anchoring as bias.

Kahneman (1991, p.143) attests usefulness to an explanatory notion such as a heuristic, if it explains not only one but multiple effects, such as representativeness that is able to explain several behavioural phenomena (biases). Moreover, observed effects may be the result of several explanatory concepts; Kahneman (1991) for instance mentions overconfidence, optimism and escalation of commitment.

This thesis adopts a balanced and more pragmatic approach to the quality of heuristics. It neither assumes that judgement by heuristics is generally bad since it is biased, nor takes for granted a general positive effect of heuristics. A heuristic is a simple effort-reducing strategy and describes the process of a judgment. Identifying a bias always depends on the definition of the default, i.e. a bias always denotes a discrepancy to some rational solution or benchmark in general. A cognitive bias is usually considered to be an effect that occurs due to the use of judgemental heuristics.

Addressing cognitive biases is of limited value in our context. As explained what may be true for most complex and uncertain problems, and particularly in the context of business and of investment appraisal, the optimum in most cases cannot be found or is difficult to determine. This implies that judgement may always be suboptimal to some extent. And the use of heuristics may not produce optimal results. Nevertheless, in many cases we are able to assess whether a judgement may be closer to the rational solution due to given objective knowledge or not, which we will do. Moreover, and as we will see, feedback is often weak or does not provide insight on how sound the estimation has been.

Despite the perhaps inevitable avoiding of bias, the performance of heuristic reasoning can be good (or even better than a slow optimisation technique as Gigerenzer and Brighton, 2009,

⁶⁸ There are several publications collecting cognitive biases, see for example Bazerman and Moore (2013) or Arnott (2006).

show) and skilled, as implied before. Furthermore, many corporate decision-makers consider gut feeling vital and clearly helpful for judgement and decision-making. Following this logic, it is not intended to primarily judge behaviour and thus evaluate a heuristic as good or bad but to raise awareness of the underlying processes in judgement of investment appraisal parameters.

3.3.7 Two-System View

Concerning the question of how heuristics function as opposed to the question of how heuristics are conceptualised, there has been a lively discussion during the last decades. The starting point – again – will be Tversky and Kahneman, whose early thoughts and approaches from the 1970s indicate that intuition guided the behaviour of respondents in their studies and that responses significantly deviated from deliberate reasoning when making casual statistical judgements. More recent literature relates to the so-called ‘two-system view’ (Stanovich and West, 2000; Kahneman and Frederick, 2002) also known as dual-process theories since two different systems of reasoning have been identified by various authors (e.g. by Sloman, 1996; see Stanovic and West, 2002, and Chaiken and Trope, 1999, for a broad discussion). They assume that cognitive functioning works in a framework of two systems:

Stanovich and West (2000) denoted it the System 1 and System 2 model. System 1 resembles fast, effortless and associative intuition and System 2 represents slow, effortful and rule-governed reasoning (Table 12).

	System 1 <i>Intuitive</i>	System 2 <i>Reflective</i>
Process characeristics	Automatic	Controlled
	Effortless	Effortful
	Associative	Deductive
	Rapid, parallel	Slow, serial
	Process opaque	Self-aware
	Skilled action	Rule application
Content on which processes act	Affective	Neutral
	Causal propensities	Statistics
	Concrete, specific	Abstract
	Prototypes	Sets

Table 12 Two cognitive systems (adapted from Kahneman and Frederick, 2002, p.51)

It is widely discussed in psychological research how both systems work together. However, there is no controversy that controlled or rule-based reasoning is often inconsistent with the automatic reasoning based on association – both within and between individuals (Sloman, 2002). One of the most difficult problems in decision behaviour occurs if both systems arrive at different solutions and provide opposing advice in the decision-making situation (Sloman,

2002). Nevertheless, some approaches about both systems working together exist. System 2 that is associated as reflective, is considered to monitor the operations by System 1 and its judgements. Judgemental errors may then not be due to purely intuitive reasoning (Kahneman, 2003).

Kahneman (2003a, p.717) presents five ways to make a judgement:

1. An intuitive judgment or intention is initiated [by System 1], and
 - (a) Endorsed by System 2;
 - (b) Adjusted (insufficiently) for other features that are recognized as relevant;
 - (c) Corrected (sometimes overcorrected) for an explicitly recognized bias; or
 - (d) Identified as violating a subjectively valid rule and blocked from overt expression.
2. No intuitive response comes to mind, and the judgment is computed by System 2.

This implies that System 2 is always involved to some extent. If System 2 does not modify the judgement brought forth by System 1, the judgement is typically called intuitive (Kahneman and Frederick, 2002). System 1 is directly responsible for the degree of accessibility as also highlighted above in Kahneman and Frederick's (2002) notion of heuristics. Whether System 2 corrects an intuitive thought by System 1 is "attributed to the accessibility of competing considerations and to the accessibility of metacognitive awareness of bias" (Kahneman, 2003a, p.716). Additional rules for corrective operations can be identified, for example by findings that "averages are more accessible than sums", "changes are relatively more accessible than absolute values" or framing, i.e. the way a problem is presented can alter the accessibility of thoughts (Kahneman, 2003a, p.716).

Sloman (2002) presents a discussion of these two systems of reasoning and their relation to heuristics, i.e. whether heuristics are of unconscious or of conscious nature: On the one hand, and as Tversky and Kahneman (1983) have noted, heuristics are in fact seen as natural assessments which impact judgement and are not necessarily deliberate. On the other hand, heuristics considered as controlled and deliberate processes or rules argue in favour of a human beings as 'cognitive misers' where heuristics are considered a "product of lazy and inattentive minds" (Gilovich and Griffin, 2002, p.4) with "coherent, justifiable sets of beliefs and plans of action" (Sloman 2002, p.379) and where a decision-maker is said to "draw inferences from learned associative pathways" (Sloman, 2002, p.379). Following that, a heuristic solely relies on System 2 if a decision rule has been purely derived from deliberate deduction and own insights how to make a good decision. Moreover, if a heuristic relies on a first intuitive judgement evoked by System 1 but then System 2 mainly governs judgement, one may conclude that a heuristic largely relies on System 2 (Gilovich and Griffin, 2002).

Where an attribute or a thought is highly accessible⁶⁹, System 1 processes the so-called attribute substitution by substituting a heuristic attribute for the target attribute, since it can be brought to mind easily. System 2 corrects the intuitive System 1 judgement only if System 2's identification of a bias is accessible enough for System 1, or, in case of current competing thoughts, demands a judgement. Several additional factors⁷⁰ may lead to an improved possible intervention of System 2, others⁷¹ to a disturbance.

3.4 A Model of Judgement by Heuristics

The Lens Model (Brunswik, 1952; adapted by Libby, 1981, see Figure 6) may serve as a framework to illustrate the judgement process with its important features, i.e. the interaction with the environment (Libby, 1981). Libby (1981, p.4) summarises what judgements in accounting are about:

In most decision-making situations, judgments about the environment must be made in the absence of direct contact with the object or event to be judged. In such circumstances, 'most likely' judgments are formed on the basis of information or cues whose relationships to the object or event of interest are imperfect or probabilistic. That is, judgments and decisions are made under conditions of *uncertainty* about the relationships between cues and events.

An individual perceives the environment through a lens of cues (Libby, 1981). For a judgement to be formed about the event of interest or target object (or the to-be-judged criterion, as Hastie and Dawes, 2010, call it), a number of cues are used. The cues represent pieces of information, i.e. "predictors of the environmental state", which, however, may (individually and collectively) be imperfectly related to the target object, and may even overlap (Libby, 1981, p.6).⁷² The right side of Figure 6 reveals the decision-maker; the left side represents the environment. 'Achievement' describes how well the individual has estimated the uncertain state of the world (Libby, 1981).

⁶⁹ Referring to the second principle of effort-reduction (Section 3.3.5).

⁷⁰ For example statistical thinking as in Agnoli (1991) or intelligence as in Stanovich and West (2002).

⁷¹ For example time pressure as in Finucane *et al.* (2000) or a good mood as in Bless *et al.* (1996).

⁷² Indicated by the dashed lines (as in Libby, 1981).

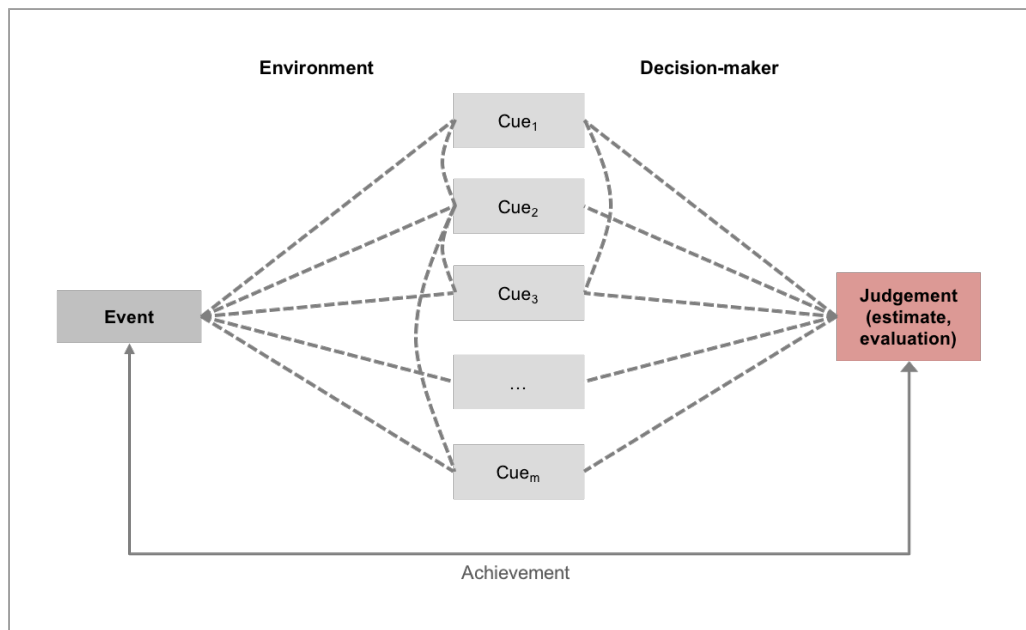


Figure 6 Lens Model conceptual framework for the global judgment process (adapted from Libby, 1981, p.6)

Internal control evaluations, predicting business failure or loan default or other future events are examples of judgements (Libby, 1981). For example, to estimate a loan default as a “function of the future cash flows which will be available to the customer to service the debt”, cues may comprise liquidity, leverage, management evaluations, discussions, external credit ratings, “some of which are probabilistically related to future cash flows” (Libby, 1981, p.6). Cues may be redundant, due to the same information prevalent in various indicators, and imperfect (Libby, 1981). A judgement is formed by combining the indicators to predict future cash flows. Eventually, comparing the cash flow prediction with actual figures serves to quantify achievement. If achievement can be measured, it can provide insight into improving future investment appraisal decision-making (Libby, 1981).

Libby (1981, p.7) points to the following questions to be asked in examining decision-making:

1. What information about the event is available to decision makers?
2. How accurate is the information?
3. How is the information combined in forming judgments?
4. What attributes of the information set, the context, and the decision maker affect the quality of the judgments?
5. How might the quality of judgments be improved?

In this work, we will focus on the third question: How is information combined to form a hurdle rate estimate or a cash flow projection? Considering the information-processing variables identified by Libby and Lewis (1977; see Figure 7) this question refers to examining the process itself, with the added interest of recognising heuristics.

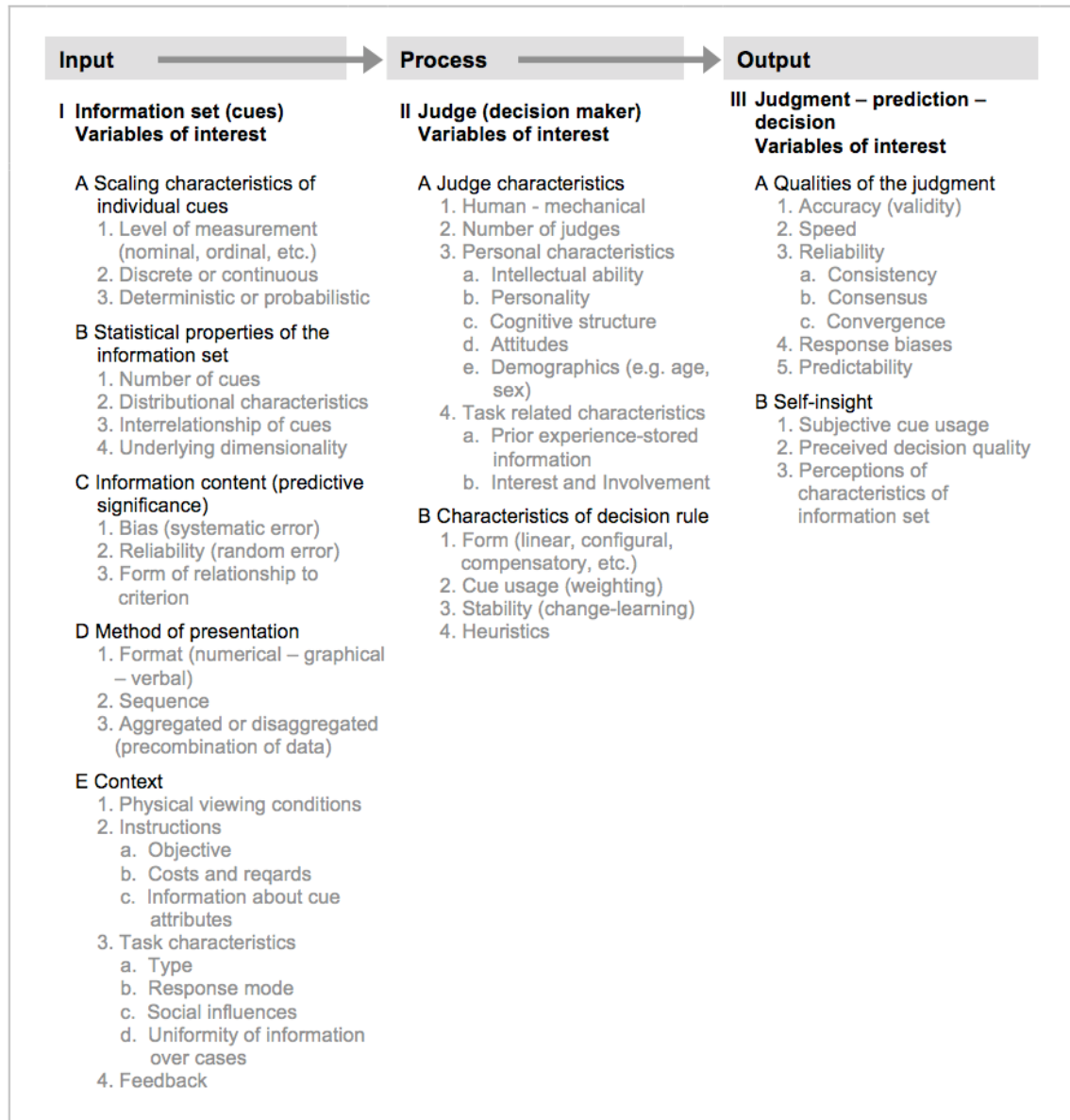


Figure 7 Classification of information-processing variables (Libby and Lewis, 1977, p.247, used with permission of Elsevier)

Based on Libby (1981), heuristics can be integrated into the right part of the Lens Model representing the cognitive processes of an individual. Figure 8 conceptually illustrates the process of heuristic reasoning with regard to how effort may be reduced, i.e. integrating the

effort-reduction principles outlined in Section 3.3.5, marked in red colour.⁷³ Based on the event or to-be-judged criterion – in this study the estimation of cash flows or the determination of a hurdle rate – we will, in Chapter 4, derive the cues relevant to the decision-maker in each context.

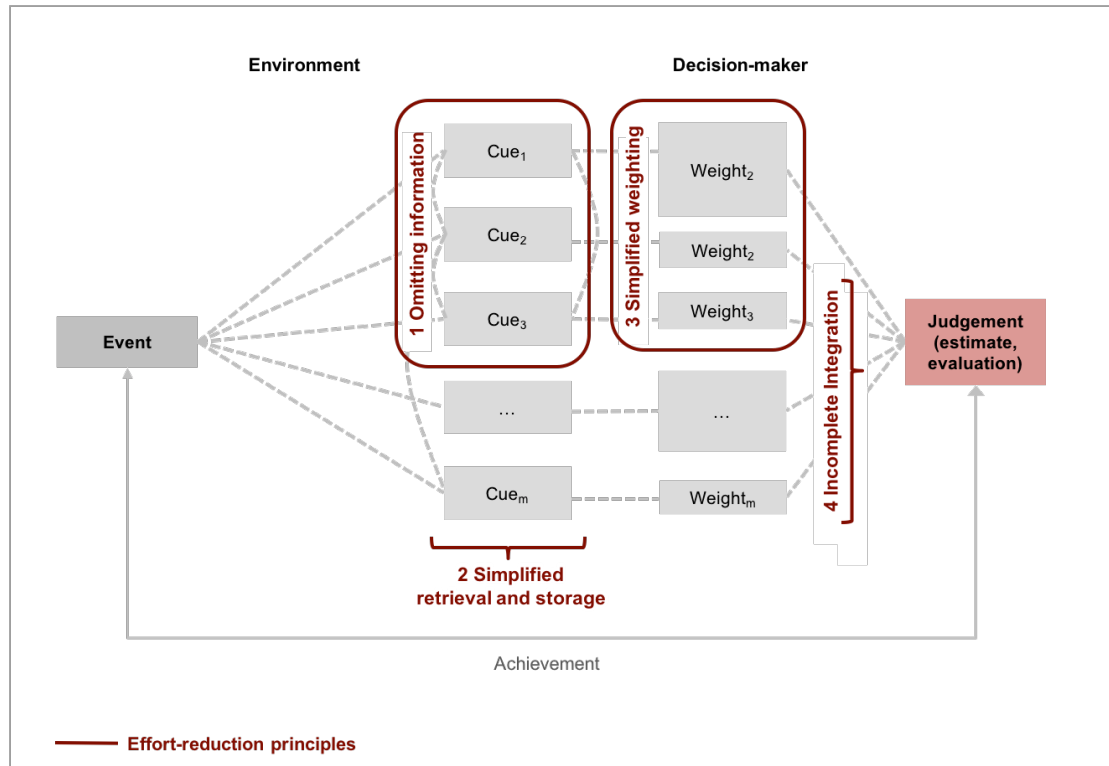


Figure 8 Model of judgement by heuristics⁷⁴

⁷³ Principle 5 is not included since it refers to a decision made.

⁷⁴ Own illustration based on Brunswik (1952), Libby (1981) and Shah and Oppenheimer (2008). Effort-reduction principles are marked in red colour (based on Shah and Oppenheimer, 2008).

4 The Potential for Heuristic Reasoning in Investment Appraisal

4.1 Judgement and Decision-Making in Investment Appraisal

4.1.1 *Judgement and Decision-Making in Management Accounting*

After the introduction to investment appraisal in Chapter 2 and the introduction to behavioural issues in Chapter 3 this chapter aims to synthesise these two streams of knowledge and to examine indications of subjective judgement and the potential of heuristics in investment appraisal. A growing body of literature has investigated boundedly rational influences on fields related to investment appraisal, yet its application to investment decision-making and investment appraisal represents a gap in the literature.

As regards the investment decisions themselves, the executive level or board of directors of a company are generally in charge, as has been noted in Chapter 2. Determination of the parameters of an investment appraisal in the form of a discounted cash flow (DCF) analysis typically involve the management accounting department and the finance director and in this section we will review behavioural influences on managerial decision-making in the context of management accounting.

During the last decade there have been many publications reporting attempts to systematise behavioural accounting research (BAR; e.g. Birnberg, 2011), accounting behavioural research (e.g. Schmitt, 2014) or behavioural research in accounting (BRIA; cf. the same-titled journal). BAR generally deals with

the influence of management control systems on the behaviour of organisational participants, the influence of accounting information on internal and external users, and the behaviour of accountants themselves (including auditors) (Ashton, 2010, p.5).

It is noteworthy that even though BAR seems a ‘catchy’ new topic, it is not new to accounting.⁷⁵ Research on JDM in accounting traces back to for example Birnberg and Nath (1967); Bruns Jr. and DeCoster (1969); Bruns Jr. (1966); Caplan (1966); Stedry (1960).⁷⁶ The behavioural approach’s long existence is not surprising – first of all because decision-making (performance) research has always been the core of business and accounting due to accounting’s function of decision support and influencing. During the decade of the 1960-70, several attempts were made to examine behaviour from a descriptive point of view. Basic axioms and assumptions were kept similar to traditional economic theory (the basic assumption of profit

⁷⁵ It replaces the previously used term ‘human information processing’ or in general ‘behavioural decision making research’ (e.g. Libby and Lewis, 1977).

⁷⁶ Trotman, Tan and Ang (2011) and Basel (2013) provide an overview of five decades of JDM research in accounting; Trotman, Tan and Ang (2011) also with particular reference to management accounting.

maximisation of the firm with managers acting to maximise profit of the firm for example) amended by some more realistic, descriptive premise. ‘Behavioural’ at that time seems to often denote the behaviour of all actors of an organisation in an aggregate way rather than individual cognitive behaviour; it moreover addressed the role and impact of the accounting system on the behaviour of employees or supervisor. These include the impact of budgets, control systems, incentives, and communication of information (Benston, 1963; Caplan, 1966; Birnberg and Nath, 1967; Fertakis, 1969).

The 1970s revealed more specific focus on investigating information aggregation processes, the quantity and the way of presentation of accounting information (Trotman, Tan and Ang, 2011), see for example Burns (1972) for a collection of behavioural experiments in accounting. Trotman, Tan and Ang (2011) identified relatively sparse research in management accounting in the 1970s and some attempts to describe individual judgements and decision-making. The prevailing notion was of “decision quality largely being determined with reference to economic theory, i.e., decisions that were closer to theoretical predictions were considered to be better” (Trotman, Tan and Ang, 2011, p.327). By the end of this decade, some seminal publications dealt with heuristics in accounting which at that time were intrinsically linked to biased judgement; for example Magee and Dickhaut (1978, also mentioned by Trotman, Tan and Ang, 2011) who examined the effect of a compensation plan on the problem-solving of employees and relying on Tversky and Kahneman (1974) heuristics-and-biases approach.

Reflecting the interest of accounting in the JDM topic, Einhorn and Hogarth’s (1981) publication about the processes of judgement and choice – originally addressing audience in psychology – attracted attention in the accounting audience at the beginning of the 1980s.⁷⁷ Libby (1981) laid many foundations of today’s definitions and characteristics of for example judgements, with reference to the accounting context and even pointed to potential remedies for mistaken judgement and decision-making. Libby (1981) also integrated the insights from the heuristics-and-biases programme and encouraged their integration into accounting. Thus, bounded rationality with its potential cognitive biases was a key line of research, but did not address capital investment decisions. There was a strong focus on actual behaviour versus economically optimal behaviour – in contrast to today’s notion of heuristics as not necessarily sub-optimal. Further studies incorporated or touched heuristics and/or biases in accounting, for example Joyce and Biddle, (1981), Copeland, Taylor and Brown (1981), Ferris and Haskins (1988) and Shields (1980) and Smith and Kida (1991). However, management accounting and financial accounting played a subordinate role in BAR; most BAR literature including research relating to heuristics and biases deals with auditing. Thus, BAR is a broad and evolving field

⁷⁷ Originally published by the Annual Review of Psychology (1981) and reprinted in the Journal of Accounting Research (1981).

and its boundaries have not been fully determined. It even covers topics such as culture and its impact on decision-makers (Birnberg, 2011, pp.7-8).

The decade between 1990 and 2000 is an era that Kotchetova and Salterio (2004, p.549) call the “era of expertise”. It is characterised by an ongoing “interest in information processing limitations and the role of management accounting in motivating superior performance” (Trotman, Tan and Ang, 2011, p.330). Reference to investment decision-making was made as regards the escalation of commitment in project evaluation decisions (Harrell and Harrison, 1994).

In the 2000s and recent years, several developments in research on heuristics and biases have emerged: The programme has become mainstream in behavioural economics and wider audience⁷⁸ and has even been incorporated into various textbooks. More and more applications to a variety of domains (such as management accounting, corporate finance and strategic decision-making) have followed their original idea – not least since Tversky and Kahneman’s original programme from the 1970s is an accessible concept for non-psychologists (Kahneman and Frederick, 2002). Recent publications are now also closing the gap between the ‘original programme’ and the fast-and-frugal heuristics conceptions (Basel, 2012).

A search of nine major accounting journals (Basel, 2013) reveals that the number of accounting publications that deal with heuristics as a topic in general is relatively low, yet slowly increasing; from 9 publications in the 1980s, 13 in the 1990s and 16 in the 2000s; among those only 10 with ‘heuristic’, ‘bias’, ‘representativeness’ or ‘availability’ in the title. We extended this search for the period of 2011-2015 and found 18 publications, among which mostly related to auditing; none related to capital budgeting.⁷⁹ Nevertheless, and as Basel (2013) has indicated, this search algorithm may be too porous to capture all publications.

As regards the research method to be applied when borrowing concepts from psychology, the use of *experiments* in accounting, particular in management accounting has increased during the last forty years (Trotman, Tan and Ang, 2011, in their study four major accounting journals); from 15 in the 1970s to 63 in the 2000s.

In behavioural management accounting, two foci of research can be identified (see also Luft and Shields, 2010): One stream of research investigates the way accounting information is processed and how this influences management accounting (Libby and Lewis, 1977; Libby and Lewis, 1982). The other research stream examines how management accounting and its systems, such as budgets, influence decision-making behaviour (e.g. Weber and Schäffer,

⁷⁸ Cf. also Kahneman’s (2011) bestselling book ‘Thinking fast and slow’. Their generalised findings, which are typically a loose collection of biases, have gained popularity, particularly in the management literature.

⁷⁹ And adding further keywords of ‘anchoring’ and ‘affect’ yielded only 1 (5) additional publication(s) in the period of 2000-2010 (2011-2015).

2014). This work concentrates on the drivers of DCF analysis in investment appraisal, and thus largely on the first focus mentioned. However, the second focus may be relevant since all decisions to determine parameters and information is processed may also be influenced by, for example, how information about past instances in accounting records is provided.

In contrast to behavioural management accounting, the tradition of *behavioural corporate finance* is much shorter. It has mainly gained attention during the 2000s (Barberis and Thaler, 2003; Schwartz, 2010; Shefrin, 2010; Fairchild, 2007) despite early proponents of incorporating psychology into corporate findings (e.g. Simon, 1955; Cyert and March, 1963). It largely investigates financing decisions and shareholder/investor behaviour and interrelations based on different rationality assumptions of the manager and the market: Decision-making of a bounded rational or even irrational manager in the face of rational investors/or a rational market of potential investors or vice versa (or both) (e.g. Stein, 2005). Particularly, the role of the manager, information asymmetry (principal agent relationships) and overconfidence are dealt with (e.g. Ackert and Deaves, 2010).

Overconfidence, as generally addressed in Section 3.2.3, is an effect that has attracted much attention in recent research despite its origin from the previous decade. It also represents an evolving field of research in the projections of cash flows, as we will note below. For this reason, we also highlight its relevance in the field of management accounting. Overconfidence is found to manifest itself in an overestimation of future corporate performance or success including projected investment as has been mentioned as practical problems associated with forecasts in Section 2.4.1 (e.g. Russo and Schoemaker, 1992; Heaton, 2002; Malmendier and Tate, 2005, 2015; Libby and Rennekamp, 2012; Adam, Fernando and Golubeva, 2015; Mohamed, Bouri and Fairchild, 2013; Dambra, Wasley and Wu, 2013; Hilary and Hsu, 2011; Glaser, Schäfers and Weber, 2008). Optimism is not as strictly contrasted to overconfidence as it is done in more psychologically oriented publications; often both terms are used synonymously and are assumed to capture the behavioural effect of overestimation of outcomes⁸⁰ (see e.g. Malmendier and Tate, 2005). Section 4.1.3 will address overconfidence with reference to investment appraisal. Overconfidence has also been found in other fields such as operational budgeting (e.g. Lowe and Shaw, 1968), financing decisions (e.g. Gider and Hackbarth, 2010; Hackbarth, 2008; Fairchild, 2005) or combined fields of project selection, abandonment and evaluation (Klauss, 2006).

Research on limitations of human rationality and biases in *strategic decision-making* traces back to themes such as structuring strategic decisions (Mintzberg, Raisinghani and Théorêt, 1976). Schwenk (1985) who was the first one who theoretically applied selected heuristics and

⁸⁰ Even the term ‘overoptimism’ is used as noted by Malmendier and Tate (2005).

biases to managerial decision-making. Similar to the behavioural corporate finance stream, literature in strategic management has strongly focused on the cognitive limitations or biases – rather than on the (functioning of) heuristics as their cause (see e.g. Lowe and Shaw, 1968; Larwood and Whittaker, 1977; Bohlin, 1997; Tiwana *et al.*, 2007). More recent publications have started to deal with management decisions from the fast-and-frugal perspective (Artinger *et al.*, 2014; Azar, 2014).

It has been shown that research in the field of heuristics in management accounting is quite diverse with regard to the selected heuristics approach and the focus on bias. The next section reviews the literature as regards the identification of subjectivity and the influence of judgement in investment appraisal and ends in conceptualising it and highlighting the gaps in research. We will particularly examine the degree of attention paid to highlighting intuitive influences and potential judgement processes including heuristics in the stages of projecting cash flows and determining the hurdle rate.

4.1.2 Bounded Rationality in Investment Appraisal

As pointed out above, behavioural influences in the economy, within organisations, groups and the decision-making of individual economic agents are widely observed. Luft and Shields (2010, p.202) point out that

[s]ubjective phenomena play an important role in management accounting because subjective decision making is widely prevalent in organizations, in spite of the array of sophisticated quantitative techniques available to support managerial decisions.

We will now consider subjective phenomena with particular focus on investment appraisal and identify the relevance of researching JDM in this context. Based on this, we examine the potential for heuristic reasoning.

Analysing the characteristics of a typical strategic business decision situation, Knight (1921) characterised managerial decisions as decisions under uncertainty – rather than risk⁸¹, as distinguished above in Section 3.2.1: Most business decision-making is made in situations where probabilities of outcomes and even outcomes themselves may be unknown. He refutes the notion that uncertainty can be reduced and perfect knowledge is possible implying that financial evaluation optimisation techniques are not necessarily applicable at all, i.e. *rational* decision-making in terms of substantive rationality is not possible. Instead, estimates in the sense of judgements – interpreted as intuition by Mousavi and Gigerenzer (2014) – are the basis for decisions under uncertainty (Knight, 1921, p.223).

⁸¹ Despite the obvious relevance of Knight's (1921) notion of uncertainty – as opposed to risk – in investment decision practice, practice usually speaks of 'risk'. As 'risk' is the common term to consider any kind of uncertainty about the future in practice, we will henceforth not distinguish between risk and uncertainty throughout this work unless noted otherwise.

Mousavi and Gigerenzer (2014, p.1676) deduce that this decision process of estimation that relies on intuition gut feeling (intuition) is “typically based on *heuristics*” and a clear example of *satisficing* in a case where optimisation is not possible. Further evidence revealing the use of gut feeling or satisficing strategies in general is provided by for example Bingham and Eisenhardt (2011); for managerial judgement in investment decisions in particular by Alkaraan and Northcott (2007) or Graham, Harvey and Puri (2014).

Most decision problems in investment decision practice are unique (e.g. Zanibbi and Pike, 1996) as managers have limited experience of similar instances. In such circumstances under risk simple models with known outcomes and probabilities do not apply. Models of statistical inference⁸² may be applicable, but in the capital investment context – most likely – estimates must be made. As outlined in Section 3.2.1, and relying on Knight’s (1921) notion, estimates imply the use of intuition as means to cope with uncertainty.

Hogarth (1987, p.2) already notes the importance of judgements in capital budgeting and points to the fact that the “frequency with which people are called upon to make an important judgment in unfamiliar circumstances is growing”, for example judging the advantages and disadvantages of potential investment objects, and the costs, benefits and risks associated. He recognises the problem “that managers are sometimes incapable of understanding the situations in which they have to make crucial judgements concerning the survival of their organizations” (Hogarth 1987, p.2). To point to the fact that judgements often include simplified strategies for reducing effort, Shields (1980, p.430) emphasises that managerial decision-makers, when searching or processing information, “frequently try to minimize, or at least reduce, cognitive strain when they search and process information”.

The relevance of researching judgement and decision-making becomes even more obvious when examining the use of financial appraisal methods for strategic investments: Despite their theoretical role of formalising and assessing investments, methods play a subordinate role with regard to strategic investments, as also summarised by Alkaraan and Northcott (2007). Butler *et al.* (1991) have found that the judgemental process seems to be equal or even more important than computational (method-based), bargaining or inspirational process types in strategic investment appraisal. Alkaraan and Northcott (2006) have attributed a significant role to intuition and judgement when evaluating strategic characteristics of projects, particularly to judge their financial outcome.

This finding is picked up by Mousavi and Gigerenzer (2014, p.1676) who point to the “assumption that all decisions need to be justified by numbers, as if all risks could be calculated” which is also true for literature on investment appraisal. Financially appraising an

⁸² For situations where probabilities are not known a priori but can be statistically inferred, see Section 3.2.1.

investment may not determine the final decision but in larger firms does play an essential role, as shown in Chapter 2. Various studies confirm the use and reliance on financial analysis tools (such as NPV) which implies that they can help organisations respond to uncertainty – even though they may just pretend to cope with uncertainty by raising confidence in a decision. This contradiction is, however, not surprising and given that much financial education advocates methods of questionable suitability in practical settings. Harris (2000) addressed managerial judgement and how a framework can be developed to support decision-making which provides a more ‘natural’ synthesis between formal evaluation techniques and actual reasoning.

Furthermore, heuristics are believed to perform well (perhaps even better than slow optimisation methods) claiming that financial analyses may not be required (Mousavi and Gigerenzer, 2014). But this relative performance requires that the heuristics fit the environment and that the decision-maker has partial knowledge about the problem (Mousavi and Gigerenzer, 2014). And despite techniques such as NPV leading the ranking of the most recommended techniques among all flawed methods (see Chapter 2), a particular technique perhaps should not be used for reasons of uncertain benefits of using it, costly data or incapable employees (Luft and Shields, 2010). Nevertheless, corporate financial planning remains crucial because investments significantly impact future performance, so investment appraisal has not lost its *raison d’être*.

According to Einhorn and Hogarth (1981) and Luft and Shields (2010) in addition to the way that an analysis tool or method is chosen, subjectivity exists in the choice of variables that affect cash flow profiles in an appraisal and the relationships between variables, as will be addressed below in Section 4.2. The deriving of a discount rate also involves subjectivity (McLaney *et al*, 2004; Tucker, 2009).

As regards the degree of consciousness of subjective judgements and decision-making – judgements can vary from deliberate to unconscious as outlined above in Section 3.3.7 referring to Systems 1 and 2. This issue is addressed by Luft and Shields (2010, p.202) who point to the fact that there are “purely intuitive (automated or gut feel) decisions, in which the decision-maker is not fully conscious of why one alternative ‘feels right’ and others do not.” As both, hurdle rate and cash flows are eventually consciously determined, we can assume that while intuition may have an influence, System 2 will always have the chance to correct the operations of System 1.

To conclude, this section has aimed at bridging broad approaches to investment appraisal with findings about existing approaches concerning bounded rationality. The relevance of judgemental influences in investment decision-making and thus of heuristics is notable. Based on the investment appraisal stage derived in Chapter 2, Figure 9 illustrates where judgement plays a role. The general wide use of judgement in capital budgeting establishes the importance

of researching JDM. In particular, judgement in the cash flow projections and the hurdle rate setting has not been sufficiently addressed. The remainder of this chapter will therefore deal with them after reviewing JDM and heuristics in investment appraisal in more detail and considering the extent to which heuristics play a role in the cash flow projections and the hurdle rate setting.

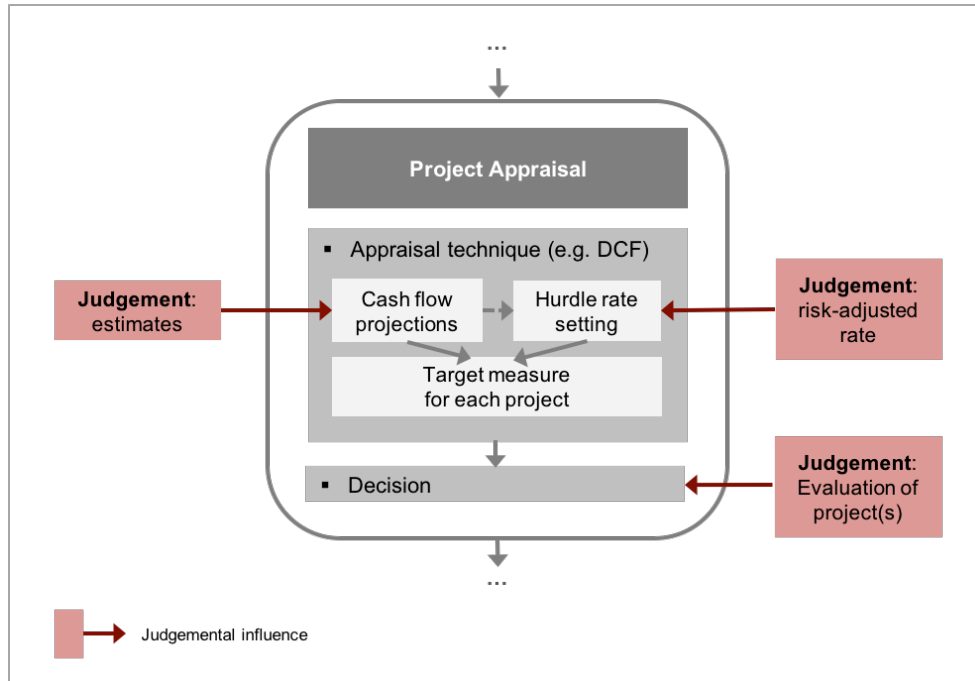


Figure 9 Judgemental influences in the project appraisal stage

4.1.3 A Conceptual Framework of Bounded Rationality in Investment Appraisal

This section intends to offer a conceptual framework of judgement and the resulting behavioural influences in the projection of cash flows and in the setting of hurdle rates. First of all, it distils the literature on JDM concepts in investment appraisal in practice, thereby linking Chapters 2 and 3. Based on these insights, we highlight the the need for examining heuristic reasoning and its applicability in the context of determining cash flows and hurdle rate and provide a framework for further analysis.

In Chapter 3, we reviewed the behavioural approaches to economic and financial decision-making. Borrowing from Luft and Shields' (2010) classification of psychology models in management accounting, we addressed the following topics. We will outline the studies that

investigated the reviewed behavioural approaches or JDM concepts in the particular context of investment appraisal.

1. Subjective valuation of non-monetary outcomes

Theories of subjective valuation of non-monetary, i.e. qualitative outcomes, against monetary outcomes (Luft and Shields, 2010) include but are not limited to the importance of self-attribution, fairness and social behavioural concepts as touched on above.

Affect, influencing risk taking behaviour and capital investment decisions is addressed by Kida, Moreno and Smith (2001) and Moreno, Kida and Smith (2001). They claim that besides the results of financial evaluation of investment projects, affect in general and interpersonal affect in particular impact the investment decision. Interpersonal affect can include negative feelings such as frustration and anger towards other people involved in a project (Kida, Moreno and Smith, 2001; Moreno, Kida and Smith, 2001).

Social interaction might also be relevant in board decision-making. Addressing group behaviour seems sensible since investment decision-making, and to a lesser extent hurdle rate setting, are commonly board processes. Knowledge about how group dynamics influence meetings to reach consensus may be valuable. In addition to the above-mentioned studies addressing group behaviour in investment decision-making (Whyte 1991, 1993; Rutledge and Harrel, 1993), Zanibbi and Pike (1996) reviewed and investigated consensus in investment decision-making, also with regard to different hierarchy levels. Harris, Emmanuel and Komakech (2009) also investigated group dynamics to arrive at consensus in investment decision-making, for example managerial influence and power. The role of trust in a moral hazard problem has been modelled by Fairchild (2004). However, in this work, we focus on individual reasoning processes which may precede board decisions, and analysis of them should also precede analysis of group decision-making. Even if they may not persist, we nevertheless consider them relevant.

2. Subjective valuation of monetary outcomes

Particularly in Section 3.1, we addressed how monetary metrics are perceived and valued, i.e. how individuals value increases or decreases in wealth or specific figures, such as prospect theory, framing, mental accounting, hyperbolic discounting, and their related behavioural consequences. In management accounting and investment appraisal, examples include costs, revenues, profits, prices, bonus incentives, budget goals (Luft and Shields, 2010).

Prospect Theory has shed light on how individuals perceive such outcomes. The importance of reference points, instability of preferences and changing risk attitude depending on whether a gain or loss is perceived, were illustrated in Section 3.2.3. Framing as the cause of changing risk attitudes also plays a role. Luft and Shields (2010) make reference to risk attitude and capital budgeting and budget goals: Facing ambitious budget goals, decision-makers behave in a risk-

averse way; if budget goals are relatively low, individuals appear to be risk-seeking (Sprinkle, Williamson and Upton, 2008). Risk-averse behaviour implies that investment projects tend to be selected which promise to be less volatile and vice versa; risk-seekers appear to be more strongly committed than risk-averse decision-makers, as summarised by Luft and Shields (2010). Rutledge and Harrel (1993) for example studied the effect of framing on risk attitude in groups.

Evidence on loss aversion is found in Ho and Vera-Muñoz (2001) who related that past performance of a division to led to altered behaviour when new investments were proposed. Ashta and Otto (2011) observe that loss aversion influences the investment appraisal after economic crises and even advocate a premium in the discount rate.

Statman and Caldwell (1987) observe loss aversion in project terminations and also attest regret aversion. They perceive framing as the evaluation stage of Prospect Theory at which mental accounts are formed; these mental accounts may include sunk costs and thus result in escalated commitment and not abandonment of failing projects. This may also be due to cognitive dissonance that results in self-justification (e.g. Staw, 1976). This is a bias often mentioned in regard to investment decision-making referring to the project monitoring stage (Stage 7 of Figure 4) but it may also refer to new projects since previous experience with losses may always play a role. Escalation of commitment in the investment context, i.e. failing to ignore sunk costs has been widely addressed in investment decision-making (e.g. Staw, 1976; McCain, 1986; Garland, 1990; Harrell and Harrison, 1994; Wilson and Zhang, 1997; Duxbury, 2012, including reference to further studies). Such behaviour may actually worsen a project's NPV compared to if the commitment to an investment was abandoned. Interestingly, escalation of commitment to failing investment was found to be corrected in group decision-making (e.g. Whyte, 1991, 1993).

Cheng *et al.* (2003) provide an application to hurdle rates by investigating the effects of hurdle rates on the escalation of commitment in capital budgeting with reference to cognitive dissonance; they find that individually determined hurdle rates result in reduced escalating commitment compared hurdle rates determined centrally by the organisation or no hurdle rate.

Escalation of commitment with reference to framing has been modelled by Fairchild (2004). Furthermore, indications of framing in capital investment decision-making have also been found in the survey by Harris, Emmanuel and Komakech (2009).

Loss aversion may also include the issue of the preference of present versus future outcomes (Luft and Shields, 2010, p.212) and thus the topic of hyperbolic discounting. In terms of losses, postponing the equivalent payout to a future point in time is preferred. In this context, we may mention Sawers (2005) who provides evidence of higher choice avoidance in capital

investment decisions, the more difficult a choice and thus, the more negative their affective response is.

If hyperbolic discounting can be extended to not only comparing the present point in time to a future one but also assuming continuity and that payoffs in closer future are preferred to more distant future ones, it is hypothesised that even if a project should be preferred to another one based on their NPVs, the project with a relatively high positive net cash flow occurring rather early during the course of the project is preferred. This is despite the discount rate balancing the fact that the more in distant future the more uncertain and risky is a cash flow. Along these lines, a project with an earlier payback period may be chosen (*ceteris paribus*) as has been mentioned in Chapter 2. Some studies that deal with examining real options suggest that selecting projects with earlier payback or applying a particular hurdle rate consider the value of waiting (Boyle and Guthrie, 1997; Wambach, 2013).

A decision-maker's personal valuation of monetary outcomes may in general – with regard to narrow investment appraisal and therefore this work – refer to the results of financial evaluations such as a NPV or IRR. This may affect the perception and behaviour of the persons involved in making the investment decision such as managerial level and the board of directors. Moreover, all other persons involved in the project appraisal may be affected because any kind of monetary outcome learnt about may intuitively be evaluated. And when making estimates (hurdle rate or cash flow), decision-makers may be influenced by their valuations of previous monetary outcomes. This is undoubtedly an important field of research, however it will not be considered further at this point as we are interested in isolating the judgemental rules in *making estimates* rather than *evaluating outcomes* which is outside the scope of this work.

3. Subjective decision models: heuristics and biases

Subjective decision models in management accounting take various forms (Luft and Shields, 2010). This section considers boundedly rational strategies in the literature of investment appraisal.

Investigating the importance and applicability of heuristics research in investment appraisal has gained increased attention, particularly during the last decade. Several publications deal with the topic of general purpose heuristics in capital budgeting and investment appraisal in particular. Krabuanrat and Phelps (1998) define heuristics as organisational routines, thus very broadly, and loosely categorise them based on 'simplification', 'reference to past cases', 'imitation', 'risk aversion', 'satisficing' and 'cooperation' without further reference to literature: In a case study approach, they found that competitor imitation is relevant in capital budgeting project, past cases play a role in an overseas set up, and in new product launch, and in the latter case also simplification. Harris, Emmanuel and Komakech (2009) investigate indications of

heuristics (of the heuristics-and-biases programme) in the particular context of investment decision-making. They only provide survey-based evidence of indications that mental models and intuition are applied. Biases related to anchoring, framing and asymmetric dominance (i.e. preference reversal in the case of irrelevant additional alternatives which can also be attributed to prospect theory, Serfas, 2011a) at the capital investment decision stage have been experimentally investigated by Serfas (2011a, 2011b).

Domain-specific heuristics have been found by for example Maitland and Sammartino (2014) who identify a variety of discovery and evaluation heuristics in the form of the questions asked or implicit rules applied by the involved decision-makers in their case study of a foreign direct investment decision of a mining company. Magni (2009), based on McDonald (2000) and as mentioned in Section 2.5.1, is the only one that relates heuristics to one of the investment appraisal dimensions of interest in this work: He identifies the ‘hurdle-rate heuristic’ by indicating that a subjective hurdle rate instead of the cost of capital for example was applied.⁸³ One may argue that the ‘hurdle rate’ allows the decision-maker to avoid the potentially difficult judgement of deriving risk-adjusted cost of capital. However, it is not a heuristic that sheds light on the cognitive processes how cues are selected to determine a rate (apart from ‘too high’), but rather on how the appraisal method is composed. Clearly, as Magni (2009) argues, the behaviour of using subjective hurdle rates can be considered boundedly rational.

The availability heuristic has been theoretically addressed by Hornung, Luther and Schuster (2016): It examines the setting of the hurdle rate and the influence of previous project failures. Negative project outcomes – due to their salience – may represent cues that are more available than successful projects and thus more easily retrievable so making future projects appear relatively riskier. Hence, a bias may occur that makes decision-makers systematically set project-specific discount rates higher than appropriate. We will refer back to this hypothesis in Chapter 6.

As regards the evaluation of judgemental or decision outcomes compared to a normative standard, i.e. *biases*, as touched in Chapter 3, research in investment appraisal mainly addresses overconfidence and optimism: In Chapter 2, we have outlined the literature relating to biased cash flow forecasts; this originally outlined and widely researched forecast bias is often believed to occur due to overconfidence or optimism⁸⁴, as has been related to general managerial decision-making in Section 4.1.1. With regard to the projection of cash flows of an investment

⁸³ In addition to the profitability-index rule.

⁸⁴ Usually, overconfidence has to be distinguished to optimism. It implies overestimating the probability of future (positive) events (Gervais, 2010). Although these two concepts differ, “the two biases are often taken to mean the same thing in the finance literature. In the context of capital budgeting, this turns out to be legitimate, as only information that leads to new investments affects firm value.” (Gervais, 2010, p.417) This means that both are likely to lead to overestimated cash flow projections and thus lead to systematic overinvestment. This has also been addressed by Malmendier and Tate (2005); therefore, in this work, we will not distinguish between both terms.

appraisal, overconfidence has also been addressed widely (e.g. Woods, 1966; Statman and Tyebjee, 1985; Bierman, 1986; Pruitt and Gitman, 1987; Guilding and Lamminmaki, 2007; Turner and Guilding, 2012). As indicated in Section 2.4.1, overestimating cash inflows or underestimating costs may even be done on purpose to get a project accepted or rather unconsciously due to for example the characteristics of the (typically experienced) managerial decision-maker (e.g. Malmendier and Tate, 2005).

Pinches (1982) explained overconfidence by managerial behaviour when competing for limited funds. Russo and Schoemaker (1992) in their effort to mention the cognitive causes of overconfidence, yet relatively superficially, have noted that heuristics (availability, anchoring), confirmation and hindsight bias play a role.⁸⁵ Metcalfe (1998, p.106) discusses the reasons of overconfidence in more detail; she contrasts self-deception and heuristic reasoning as reasons for overconfidence and argues in favour of heuristics. She argues that people cannot know whether the retrieved information or the evoked feeling they use for a judgement are always correct, but people assume that the retrieved information is correct (Metcalfe, 1998, referring to Koriati, 1993, 1994); if then, all retrieved pieces of information are used, the judgement is necessarily biased even though it is believed to be right (Metcalfe, 1998). Lawrence *et al.* (2006) also provide a summary of potential sources of overconfidence in forecasts. Tversky and Kahneman (1971) have seen overconfidence to also originate in representativeness but Kahneman (1991) claims that also acknowledges that overconfidence may stem from various mechanisms. Thus, a variety of highly different explanations have been proposed; yet identifying a relation to heuristic reasoning as well and therefore we include it in the category on heuristics and as one potential consequence of applying heuristics despite acknowledging that it may have various reasons.

Undoubtedly a distortion should generally be eliminated in the striving for unbiased estimates. However, for example, Gervais, Heaton and Odean (2003) claim that overconfidence may even serve to overcome principal-agent problems between shareholders and management. Moreover, overconfident investment planning behaviour in combination with escalating commitment may in fact have a positive effect: Their intrinsic commitment to meet project goals may rise (Heath, Larrick and Wu, 1999).

As regards eliminating overconfidence, Flyvberg (2002) claims that intuitive, i.e. unconscious, overconfidence will not persist due to learning, which however is questioned since: Feedback about the performance of past decisions affects learning and plays an important role for becoming or staying overconfident. Overconfidence is hard to correct due to the

⁸⁵ Availability: due to the failure to envision future outcomes; anchoring: due to making a forecast first before estimating confidence ranges; confirmation bias: “seek one-sided support”, particularly “the more complex and uncertain a decision is”; hindsight bias: ex-post predictability (Russo and Schoemaker, p.11).

possibilities of limited learning in capital budgeting (see below on limited learning for elaboration on this issue). From a corporate perspective, one option is to monitor cash flow estimates and trim them if they appear inflated; alternatively, the hurdle rate may be used to adjust for overconfidence in the cash flows. In this way, cash flows and hurdle rate are connected (see Chapter 2). The setting of higher hurdle rates due to overconfidence, however, could not be found by Jagannathan *et al.* (2016).

The forecast bias, however, may persist even if estimates were unbiased, they may ex post appear biased due to biased selection procedure, i.e. overestimated projects are more likely to be chosen, whereas underestimated projects less likely; thus on average a too optimistic choice is made and more projects that should not be chosen are finally selected and therefore more projects turn out worse than expected (Brown, 1974, 1978, taken up by Miller, 1978).

Nevertheless, we may assume that decision-makers interested in a most objective appraisal possible would strive for unbiased estimates for keeping total bias including selection at a relatively low level. As a connection between hurdle rate and cash flow projections, we will keep in mind whether correction due to overconfidence is considered in setting a project-specific hurdle rate in practice if the preferred option of trimming cash flows is not possible. If this is not the case, decision-makers may in fact consider other countermeasures that may be regarded in future research.

Whenever reference is made to capital budgeting or investment appraisal, most often the *decision stage* itself is addressed as is the case in the studies mentioned above. The grey arrows in Figure 10 mark the relationship of the bounded rationality concepts to investment appraisal – the dashed lines in particular point to a potential but not a direct influence on cash flow projections and hurdle rate, since they may impact these two dimensions but no direct examination was made in the respective publications. A more intensely researched stage represents the implementation stage, such as deciding to abandon a non-promising project, and certainly the project review stage (Stage 7 of Figure 4) as indicated in the previous section.

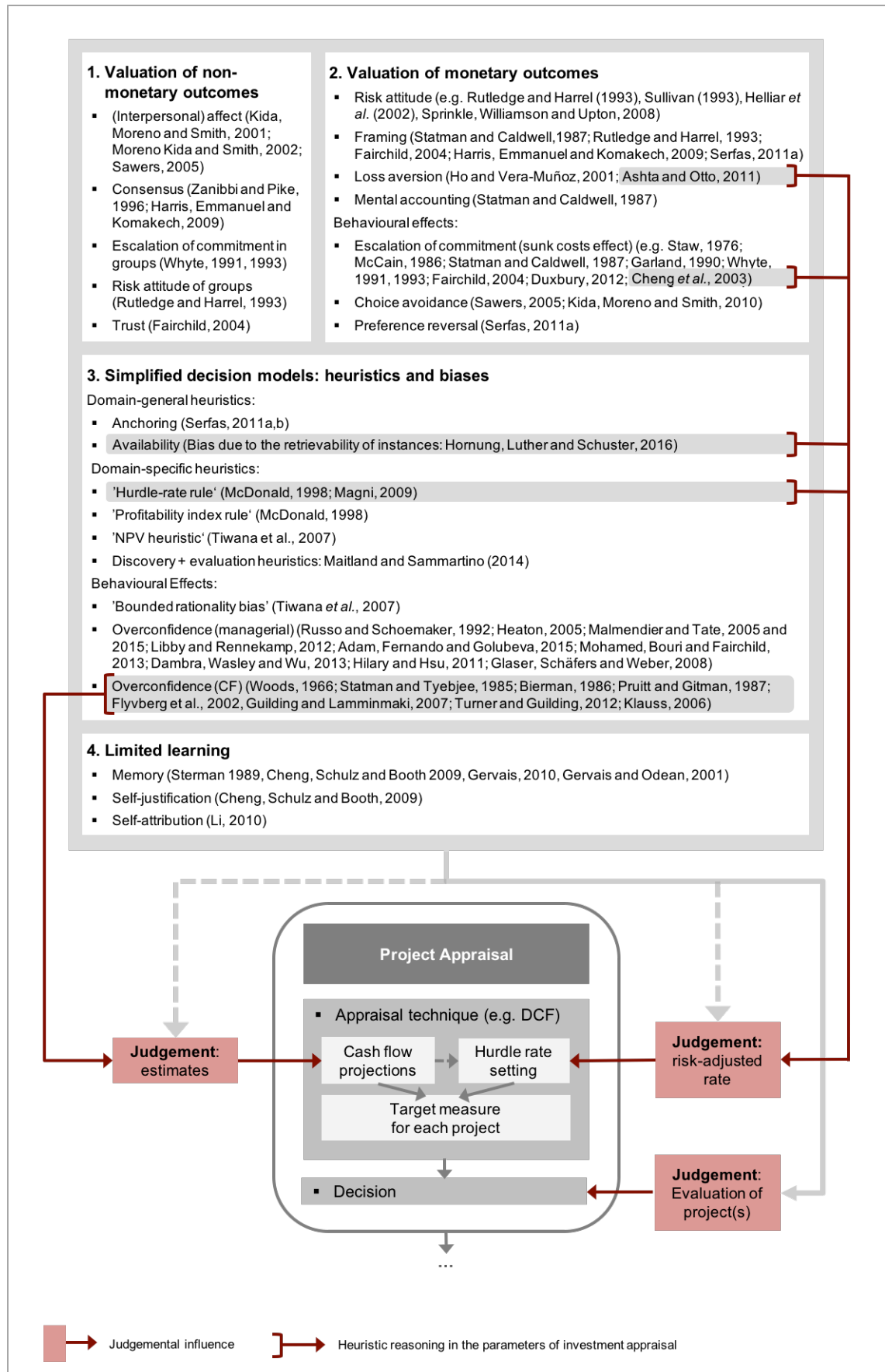


Figure 10 Conceptual framework of judgement in investment appraisal

Particular reference to heuristic reasoning when deriving the parameters of investment appraisal is rarely found; in Figure 10 they are marked by red arrows. The hurdle-rate heuristic identifies boundedly rational hurdle rate setting, and the cash flow projections are generally examined with reference to being biased due to overconfidence; whereas the latter is a consequence of presumably a variety of drivers including heuristics than a heuristic itself. Loss aversion and a resulting distortion and escalation of commitment have also been addressed with particular regard of the hurdle rate. And as outlined in Chapter 2, many suboptimal practices of determining the rate have been found, but in very few cases, concepts of bounded rationality and heuristics in particular have been investigated.

Thus, despite the tremendous research on heuristics in general and in strategic and managerial decision-making, growing research in management accounting and corporate finance, further research is required to address narrow investment appraisal. Heuristic reasoning has not been empirically addressed, neither in the cash flow projections, nor in the setting of the discount rate.

4. Limited learning

A fourth category refers to feedback and learning, as briefly touched in Chapter 3, insofar as regards the management accounting system and in particular as regards the persistence of heuristics and biases. At this point, we intend to only briefly address how learning in the particular context of investment appraisal may be possible.

Information in management accounting is typically acquired from organisational records or from memory, for example sales per period, machine hours, means, the amount of current-period sales, of future-period sales (Luft and Shields, 2010) and thereby all project-related planned and actual figures. Luft and Shields (2010) stress that the format, the class, the aggregation level of data influences memory and attention.

Besides learning from education or from advice, experience can contribute to learning (Harvey, 2012). In general, learning through analysing feedback in complex judgements and decisions demands a lot of cognitive resources (Harvey, 2012). “people may have some control over the way that they allocate cognitive resources in such [processing feedback to achieve learning] cases” (Harvey, 2012, p.220). Certainly, the ease of interpretation of outcome feedback influences learning from feedback (Harvey and Fischer, 2004). Feedback to past capital investment decisions, however, is typically “slow, infrequent, and imprecise” and thereby unlikely to correct mistakes and prevent future bias (Gervais, 2010, p.425; Zanibbi and Pike, 1996), also because no single investment decision equals another. In addition, Zanibbi and Pike (1996) found the dysfunctional behaviour to be particularly reinforced in large

organisations, under intense financial short-term and incentives based on accounting performance indicators.

Moreover, “heuristics are generally viewed as rather inflexible means of making judgments” and once a heuristic is chosen, it “is generally regarded as immutable” (Harvey and Fischer, 2004, p.132). Sterman (1989) has stressed that to realise that the applied heuristic is not robust in this particular context, simple outcome feedback is not sufficient; ‘action feedback’ would be needed, i.e. a mistaken judgement led to a salient environmental change and influence on future decisions. This implies that learning is less likely if heuristic reasoning does not lead to severe consequences and if these consequences are not attributed to other circumstances.

Formally, and more as regards organisational learning, feedback is provided in the post audit stage of investment decision-making (Figure 4). Cheng, Schulz and Booth (2009, p.89) particularly emphasise the importance of involving management accountants:

The important role of management accountants in helping organization to gain knowledge by learning from its past operations is reflected in their involvement in the project review process.

However, managerial behaviour might interfere: Managers might be reluctant to share information if they were personally involved in the decision, which appeared particularly relevant when a project’s performance is evaluated; interestingly, less so when organisational learning was the declared focus of a project review; with their findings mainly based on agency theory and cognitive dissonance and thus self-justification (Cheng, Schulz and Booth, 2009).

Self-attribution, as mentioned above in Chapter 3, as a natural tendency that failures are not attributed to own skill, is an additional factor that facilitates biases. It fosters overconfidence in skills in future decisions. Thus, biases in managerial decision-making are typically difficult to correct and tend to occur systematically. Larwood and Whittaker (1977) and Li (2010) have for example investigated self-serving attribution bias of managers in general; Li (2010) addressed found biased managers to be prone to overinvest and in less than optimal decisions.

An interesting insight is that overconfidence seems a natural consequence that may prevail in repeated decisions (Gervais, 2010, Gervais and Odean, 2001); and similar investment decisions will be made in the future because of the overconfidence that originated in the success of prior investment projects (Gervais, 2010), particularly if no follow-up is made and success is the only feedback considered.

Figure 10 collates the identified JDM concepts that are addressed in the investment appraisal literature. We intended to consider only those studies that make particular reference to investment appraisal with the decision at the end of this stage and the investment appraisal parameters of hurdle rate and cash flow projection which is the particular focus of this work.

In summary, this review of JDM concepts addressed in investment appraisal suggests several conclusions: On the one hand, it shows the huge interest and relevance of JDM topics in investment appraisal. On the other hand, research in this area is still fragmentary but provides a sufficient basis for a closer look at heuristic reasoning, i.e. effort-reducing strategies that are common practice and widely researched elsewhere.

The valuation of monetary or non-monetary outcomes refer to the perceptions or observed (risk or social) behaviour depending on the specific circumstances or frame provided; they are behavioural constructs underlying many judgements and decisions and may directly or indirectly influence a specific heuristic to be chosen. Limits of learning have been addressed to raise awareness of the impossibility of objective unambiguous feedback in the domain of investment appraisal to foster future learning. To these concepts, reference will be made whenever it is considered relevant, but is not central to this work.

Research on *judgements in cash flow projections*, the first dimension of investment appraisal, is already quite numerous – but with a strong tilt towards overconfidence in a wider sense as an explanation for the commonly known forecast bias. Ascertaining the existence of overconfidence that manifests itself in forecast bias as a bias that identifies that there is a deviation from a defined standard (with the consequence of biased forecast), but it does not explain any reasoning processes.

Judgement is undoubtedly an important factor in both, the projections of cash flow and the setting of the hurdle rate; and facing limited cognitive processing capacity and constraints in the task environment, as outlined in Chapter 3, may make individuals reduce effort in processing and do not adhere to what a (close to) optimal rule would yield. Thus, exploring whether the reasoning to arrive at cash flow estimates might also be the result of effort-reducing heuristics is worthwhile and needed: “Aside from the work on overconfidence, there appear to be almost no studies investigating heuristics and biases in judgmental probabilistic forecasting contexts.” (Lawrence *et al.*, 2006, p.503)

Research on the second dimension of investment appraisal, i.e. *judgements in the setting of hurdle rates*, apart from surveying their drivers, is rather poor. More behavioural research is required in general to shed light on the reasoning process that may contribute to determine a risk-adjusted hurdle rate – knowing that in practice, not least due to the very complex and abstract nature of risk and the related strategic and behavioural consequences such as incentive problems, a single heuristic applied by an individual may not finally determine the rate.

This work will contribute to literature by investigating widely researched general-purpose heuristics in the context of the dimensions of appraising investment projects via DCF analysis that have proven relevant in the respective domain. After referring back to the heuristic

approach adopted in this work, we will classify and structure judgements in both dimensions of investment appraisal and bridge to potential heuristics that appear relevant in our context.

4.1.4 Selection of Heuristics

As indicated in Section 3.3.6, this work will only consider general-purpose heuristics for examination. This is appropriate because only heuristics found in general – as opposed to domain-specific heuristics – can be used to judge the extent to which they are applicable to a particular investment appraisal context. Based on the compilation of heuristics in Appendix 1, 60 heuristics are classified as domain-general. Using Shah and Oppenheimer's (2008) synthesising approach to studying heuristics, Table 10 in Section 3.3.5 conceptually illustrates the options of how the five effort-reduction principles can work and thereby how judgement by heuristics is formed. As outlined earlier, Shah and Oppenheimer (2008) provide a non-exhaustive, though well-researched collection of heuristics that traces the links between each heuristic and one or more of the five effort-reduction principles. In the absence of further reliable indications of principles to heuristics in the literature, this work will rely on Shah and Oppenheimer (2008).

Shah and Oppenheimer (2008, p.213) point out that principles do not need to occur together but “can either co-occur or operate individually”; a heuristic may reduce effort by one or more principles. For this reason, identifying heuristics based on the combination of principles in use is not sufficient. Moreover, the same principle (or combination of principles) can be used by several heuristics and thus does not provide a clear indication. Hence, identifying heuristics in this work's context requires further consideration and better differentiation as is done in the following.

As another criterion for heuristics to be examined in this work's context, heuristics were required to be empirically testable and therefore thoroughly studied which narrows down the potential heuristics to the ten heuristics shown in Table 11, i.e. the heuristics of the heuristics-and-biases approach, those of the attribute substitution approach and the main heuristics of the fast-and-frugal programme as identified by Shah and Oppenheimer (2008). Moreover, Shah and Oppenheimer (2008) emphasise that the three well-studied heuristics of the initial heuristics-and-biases approach (Tversky and Kahneman, 1971, 1973, 1974; see Section 3.3.2), i.e. availability, representativeness and anchoring, represent the second effort-reduction principle, i.e. effort reduction that takes place via the simplified and thus effortless retrieval of information. In addition, the attribute-substitution approach (Kahneman and Frederick, 2002), which represents an upgrade of the heuristics-and-biases programme as noted in Section 3.3.3 and which extends the initial programme by the affect heuristic, also represents the second

principle, the use of information that can be accessed in an effortless way because of its availability or quick computation (Shah and Oppenheimer, 2008).

As regards the fast-and-frugal framework (e.g. Gigerenzer, Todd and the ABC Research Group, 1999), Shah and Oppenheimer (2008) recognise its proximity to the effort-reduction framework with regard to various principles and also identify overlap with some heuristics of the heuristics-and-biases programme. They however claim that the principles identified in the fast-and-frugal heuristics have not been sufficiently investigated. We will therefore concentrate on the attribute-substitution approach and thereby on the second principle of effort-reduction.

Based on our literature review in Chapter 2, we identify a variety of cues that may be relevant to derive appropriate cash flow projections and hurdle rates; however, there is a lack of knowledge how or if the cues are used to arrive at a subjective estimate. By focusing on this second principle of how cues are retrieved and stored, we will be able to answer this question. Thus, to approach the specified dimensions of investment appraisal, the well-studied heuristics, availability, affect, representativeness, and the anchoring effect prove a viable starting point.⁸⁶

Despite our main focus on the attribute substitution approach, we do not deny that highly individual heuristics can be developed depending on the context (as Gigerenzer *et al.* stress, e.g. 1999) or further general-purpose heuristics can be found (Kahneman and Frederick, 2002) as indicated in Section 3.3.3. For the purpose of this work, however, reflecting the decision-making context in practice, we will deductively investigate whether heuristics that are well-proven to be applicable in other domains, are also applicable in our context.

4.2 Judgement and the Potential for Heuristics in the Projection of Cash Flows

4.2.1 Judgement in the Projection of Cash Flows

Cues in the projection of cash flows refer to all pieces of information that may be used as hints to derive estimates, individually or collectively, and that may not imply an obvious link to the estimate, noted by Libby (1981). From a normative point of view, we may conclude that all incremental cash in- and outflow estimates should be derived depending on their levels of uncertainty and complexity. ‘Hard’ data which are considered certain, such as for example the

⁸⁶ Kahneman and Frederick (2002) note that the biases that attribute substitution may generate, relate to the weighting of cues. However, their concept of relying on ease-of-recall undoubtedly refers to Shah and Oppenheimer’s (2008) second principle. This discrepancy does not provide a limitation to this work because we will later experimentally examine whether attribute substitution is applicable independent of which principle it has been attributed to in the previous reasoning.

cash flows derived from contracts or other fixed or minimum values that can be attributed to specific periods, self-evidently provide the basis of the cash flow profile.

As we have seen in reviewing the projection of cash flow in practice (Section 2.3.1), most cases refer to types of forecast made in cases of low complexity (see Section 2.3.2). For these cases, a point estimate has been identified as sufficient if uncertainty is low, complemented by a confidence range if uncertainty is high (Schoemaker, 2004) and is also the most widely used type of CF forecasts, even if it is potentially followed by further analysis tools to account for uncertainty such as assessing sensitivities or simulation.⁸⁷ In this type of forecast, overconfidence is likely to occur (Schoemaker, 2004; Russo and Schoemaker, 1992). As regards the judgement involved in estimates or forecasted values, Harvey (2007) refers to different types of judgement: aided judgement (*I*) and pure judgement (*II*) (Figure 11).

Aided judgement is typically formula-based. According to Harvey (2007, p.7), it includes:

- Judgement on which terms or variables to consider in the formula that generates the forecast (*Ia*).
- Judgement to adjust an estimate that has been generated by a formula for factors that have not been considered (*Ib*).
- Judgement how to combine estimates that are based on formulas and estimates that are based on pure judgement (*Ic*).

The judgement about which terms or variables to consider in the formula or reckoning (*Ia*) to arrive at a forecast or estimate can be seen as a function of the chosen variables. This type of judgement may imply the discretion of what the incremental CFs are that are triggered by the investment project under consideration in a particular period of time and which thus should be included in the appraisal (see Section 2.4); for example, the choice of considering detailed cash flows during the first five periods of a project and assume a stable growth rate afterwards, the cost of maintenance of a project increasing production capacity project that include the technician's labour cost, cost for the technician's journey, cost of spare parts, cost of machine stoppage, the non-consideration of tax effects etc. Moreover, and as we have also reviewed in Chapter 2, judgement ascertains for example whether opportunity costs, cannibalisation or sunk costs are considered or whether unlevered or levered values will be used. Luft and Shields (2010), as referred to in Chapter 3, considered the choice of variables and the identification of relevant relations between variables as subjective components thereby also point to their relevance in this context.

⁸⁷ "We usually estimate next quarter's unit sales before we come up with a confidence range." (Russo and Schoemaker, 1992, p.11)

Judgement to adjust a formula-based estimate for factors that have not been considered (*Ib*) may comprise adjustments to fixed cash in- or outflows or to a quantitative model's estimate or safety mark-ups (or mark-downs) in general (see Section 2.4.1), for example mark-ups to the 'certain' cash flows that represent 'hard' data such as particular cash outflows derived from given contracts; as a cost of maintenance estimate, to account for uncertain events that affect the project's cash flows over its economic life.

Judgement how to combine formula- and purely judgement-based estimates (*Ic*) may imply how a cash inflow or outflow estimate provided by a formula may be merged with a decision-maker's estimate (such as an expert's judgement) or to for example arrive at experts' consensus (Section 2.4.1). The judgement about the particular adjustment in forecast of Type *Ib*, or the judgement assumed in *Ic*, can be seen as pure judgement analysed further in Category *II*.

Unaided, i.e. pure judgement (II) matches the practice of subjective CF estimates outlined in Section 2.3.1. may be used for making forecasts in the following ways (Harvey, 2007, pp.7-8); instead of formulas, the decision-maker may rely on:

- Information retrieved from memory.
- Information about the value of another variable that is explicitly available.
- Information about past values of the same variable that is explicitly available.

Judgement retrieved from memory only refers to information that is *implicitly* and not explicitly, i.e. externally available. Judgement in the projection of a cash flow for a period will just be based on mentally available pieces of information. Not having available information at all may not represent the usual case in practice since some kind of financial data may be available from accounting records that provide explicit information.

Judgement based on the value of another variable makes use of *explicitly* available information, i.e. using data from another variable to derive a forecast (Harvey, 2007). It can also be considered a "mental equivalent of a simple regression model" (Harvey, 2007, p.8). This implies drawing conclusions from combining data of other variables and their known effects that may be relevant for the forecast – assuming a particular relationship. e.g. forecasting the change in revenues if the marketing expenses are doubled (Harvey, 2007). Data about different variables may for example be resources available and/or parameters provided by the supplier to forecast production volume and cash inflows from revenues; or the use of machine hours of existing machines to forecast direct and indirect costs of a new machine.

Judgement using information about earlier values of the variable under consideration and thus also *explicitly* available, can also be considered a "mental equivalent of some type of time series analysis" (Harvey, 2007, p.8). Data of the same variable, for example past costs

associated with energy consumption (price per kilowatt hour) or sales are may be used to make a cash flow estimate for a particular or various periods. This type of judgement in point forecasts may relate to one of the two ways Schoemaker (2004, p.280) identifies, i.e. to “start with a convenient reference point and then adjust to reflect other factors”. The second way of determining point forecasts he mentions is to “seek to integrate numerous factors all at once” which may relate to the second and third type of (pure) judgement outlined before.

For the case of determining an optimal cash flow in the form of a point estimate, all *relevant* cues should be used – these would include all pieces of information that influence the volatility of a cash flow component – after analytically having ensured completeness of information; these should be properly weighted according to their objective importance or probability of occurrence, which are then completely and in an unbiased way combined to arrive at a judgement and thus an expected cash flow estimate. A nearly perfect estimate may therefore only be found making use of a highly analytical and objective approach taking uncertainty into consideration. We have seen that subjective components and thus judgement are natural components in making cash flow forecasts, which brought us to infer that the processing of information is simplified at some stage or the other – this clearly points to the relevance of heuristics.

4.2.2 The Potential for Heuristic Reasoning in the Projection of Cash Flows

Hogarth and Makridakis (1981) have already addressed the relationship between forecasts and planning and heuristics including biases primarily as an explanation of why decision-makers do not produce optimal forecasts; similarly, Beach, Barnes and Christensen-Szalanski (1986) found judgemental forecasts to be automatically linked to heuristics and decision-makers use a repertory of strategies that they can access depending on the task. Bolger and Harvey (1993) relate heuristics to point forecasts, particularly to anchoring. In the same context of point forecasts, Harvey (2007) refers back to Hogarth and Makridakis (1981) and others and discusses various heuristic approaches in all three types of forecasts (Category II) and outlines ongoing debates on similarities, on potential controversies and concludes that the following heuristics remain highly plausible for describing forecast behaviour. He argues that for judgement relying on information exclusively held in memory and thus retrieving information, the *availability* heuristic may play a role. And in fact, the availability heuristic, as outlined in Chapter 3, uses available information as an easily accessible cue to derive a judgement.

Judgemental forecasts of the second type are linked to the *representativeness* heuristic (Harvey, 20007). In the representativeness heuristic, a similar easy-to-access instance serves as an indication for judgement. This does not necessarily imply that similarity only to an explicitly

available object, as Harvey (2007) identifies it, is assessed; a similar object may also be imagined; or retrieved from memory (in which case overlap with for example availability is found); or a similar case imagined also evokes an affective response etc. – these are only very basic examples of the complexity and diffuseness of cognitive behaviour. As the studies at hand, however, have derived this type of judgement based on explicitly available information to be applicable in forecasts, we will examine this in the domain of cash flows as a next step.

The third type of judgement is found to be relevant for the *anchoring* effect – which in a narrow sense is not considered a heuristic any more as outlined in the previous chapter (Harvey, 2007). Schoemaker (2004), too, for this type of judgement, mentions the anchoring effect; judgement in his second way of determining forecasts (integrating numerous factors) may comprise the availability and representativeness heuristics among few other biases⁸⁸ to become relevant. As we have noted in Chapter 3, a reference point (anchor) that is available is an easy-to-access value that may generally lead to a final estimate too narrow to the anchor provided; anchors can be explicit or implicit; explicit means an anchor can be any arbitrary or non-arbitrary figure available, mentioned or proposed; implicit refers to for example own knowledge, previous experience and thus stored values. However, we believe that the cash flow projections do rely on hard factors, e.g. raw financial data, contracts, and thereby underline the explicit use of information.

The *affect* heuristic, the third heuristic identified by Kahneman and Frederick (2002) to be mentioned in the list of general purpose heuristics, has not been dealt with in the forecast literature. Affect certainly is only implicitly available to the decision-maker, the decision-maker may not even be aware of it. However, the affect heuristic is usually seen as judgement based on the supposed benefit and feeling towards an object that correlates with the perception of risk (Alhakami and Slovic, 1994; Finucane, Alhakami and Slovic, 2000; Slovic *et al.*, 2002). Affect does not imply retrieving instances from memory, but from a so-called affective pool as Finucane, Alhakami and Slovic (2000, p.3) outline:

[R]epresentations of objects and events in people's minds are tagged to varying degrees with affect. People consult or refer to an 'affective pool' (containing all the positive and negative tags associated with the representations consciously or unconsciously) in the process of making judgments.

For the purpose of this work, we may classify it as another, separate type of judgement that uses information implicitly available, similarly to the first type mentioned above, but does not retrieve information held in memory. Figure 11 outlines the different types of judgement in forecasts and the potential heuristics. We will take these lines of argument as a hypothesis for our qualitative study (Chapter 5) where we will explore which types of judgemental forecasts

⁸⁸ Such as misjudging exponential growth found by Wagenaar and Timmers (1979).

may play a role in the practice of projecting cash flow projections. Based on these findings, we will experimentally examine those heuristics that proved applicable.⁸⁹

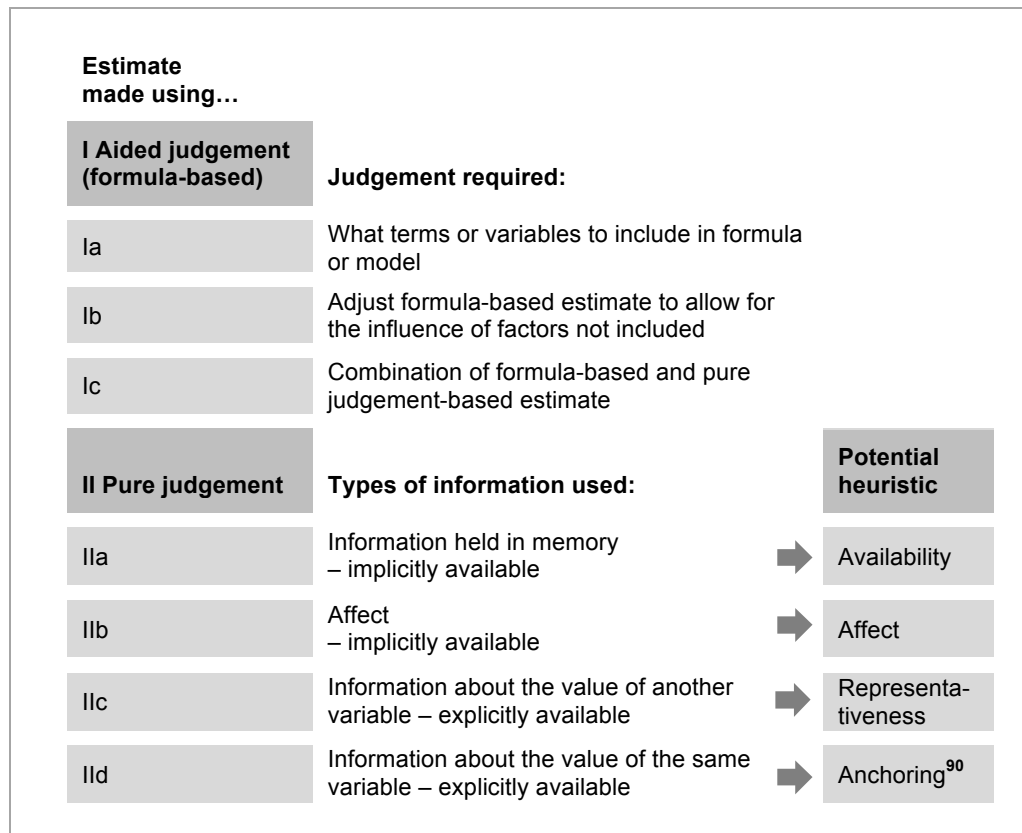


Figure 11 Types of judgement and potentially related heuristics (based on the Harvey, 2007)

4.3 Judgement and the Potential for Heuristics in the Setting of Hurdle Rates

4.3.1 Judgement in the Setting of Hurdle Rates

Cues in the setting of the hurdle rate may include some or all pieces of information that are used as hints to derive a hurdle rate as have been described in Sections 2.3 and 2.5, individually or collectively, as Libby (1981) noted. From a normative point of view, this implies the practically hard to grasp/identify and abstract concept of risk. We will now pick up the survey results of Chapter 2 and categorise the variety of cues.

⁸⁹ Category II as outlined here self-evidently does not capture *all* potential implicit decision-making strategies and heuristics that may play a role in individual decision-making. It should serve as a starting point to consider *some* heuristics that have proven relevant in many domains, in the domain of CF forecasts (and also the setting of the hurdle rate).

⁹⁰ Not considered a heuristic based on attribute substitution theory.

As outlined in Chapter 2, hurdle rates conceptually take various forms, from a very formal, rule-based composition (such as equalling the cost of capital or a benchmark interest rate) to an adjusted rule-based rate to a rate that has not been calculated at all (see Table 3). Judgement may be present in all of the three forms as will be elaborated on below.

First of all, the rate or premium may be rule- or formula-based in the way that a specific model (e.g. the Capital Asset Pricing Model, dividend discount model), formula (e.g. WACC) or choice of benchmark (e.g. the interest on borrowed capital or an externally given benchmark interest rates) are used as a basis. Judgement is required which of these ‘rules’ is used and as a result, which input data to include for a particular chosen ‘rule’ (see Section 2.5.). For example, which risk-free rate of return to apply, which time horizon of interest rates or how to derive beta. The latter becomes even more judgemental in the case of a non-listed company. The setting of the (project-specific) discount rate⁹¹ does therefore genuinely not comprise forecasted values in the same way as projecting the cash flows. However, risk judgement indeed requires an implicit or explicit analysis of what potential future outcomes are. Moreover, we find the judgement that is required to determine rules or formula is equivalent to the judgement of type *Ia* (outlined in Section 4.2.1), i.e. aided judgement with the choice of which variables to include to derive the discount rate.

Adjusting a rule-based rate, for instance to determine the risk premium, may be done using formulas (e.g. project-specific beta factors or deriving company-specific adjustments based on historical price volatility – if not implied in the rule of *Ia*) or using judgement (or a combination of both, which we will pick up in the following paragraph). As noted earlier, this practice exists to consider the influence of factors (i.e. project-specific risk) not accounted for in the formula. If we only consider the case if judgement is used for this, this type of determining a discount rate would correspond to a formula-based estimate to allow for the influence of factors not included in the estimate, and thus judgement of Type *Ib*. As indicated, in practice, this type of judgement may refer to adding a premium due and represent the most common type of accounting for project-specific risk. This will be picked up below.

Using judgement to combine formula-based and purely judgemental estimates (judgement of Type *Ic*) may be found in the setting of the hurdle rate in the following way: As outlined in Chapter 2, this may for example refer to reassessing the company-wide discount rate by using WACC as one proposal and a purely judgemental/arbitrary rate of return proposed by a board member or finance director.

⁹¹ The adjustment required for the determination of an adjusted company-wide discount rate may be conceptually similar to the adjustment required in the setting of the project-specific discount rate due to the fact that both should express appropriate risk; but the setting of a company-wide rate substantially involves much more strategic consideration and thereby has far-reaching consequences, as indicated by for example (McLaney *et al.*, 2004).

A purely judgemental or arbitrary discount rate, as found in the literature of Chapter 2, is less often used but existing. It may be more common when determining a company-wide rate derived on grounds other than of models or financial rules. In the project-specific context, this type of judgement may rarely be found since a rate adjusted for project-specific risk usually relies on benchmarks such as WACC. The premium itself, however, may be determined based on purely judgemental considerations. This may include a judgement on whether a project is of higher (or lower) risk than the overall company on average or other factors that a project is characterised by. In this way, we can consider deriving the types of information used when determining a purely judgement-based premium in analogy to Sections 4.2.1 and 4.2.2, and thus to similarly refer to Category *II*. As noted earlier, this category distinguishes between explicitly available information and information that is retrieved from memory or the only.

The factors constituting or potentially carrying project risk are summarised in Table 1; they may be available externally or internally when taken into consideration and analysed in terms of their uncertainty and potentially positive and negative consequences. Moreover, and as noted in Section 2.5.1 as well, further factors appear relevant for decision-makers in practice, see Table 2. These drivers have also been found to impact hurdle rate – though to highly different degrees depending on the company or decision-maker. All potential factors that influence the rate – whether they are considered objectively relevant or not – represent the cues, i.e. the pieces of information that practitioners may use to make a judgement about the appropriate hurdle rate. In addition, and as with reference to the ways to determine a hurdle rate, any rule- or formula-based hurdle rates – newly derived or those of similar projects undertaken elsewhere or combinations of several rates – may serve as cues.

Using of *implicitly* available information in the setting of hurdle rates may happen when imagining and evaluating the negative and positive outcomes without the help of accessing databases or similar information externally. Many of the risk factors indicated in Table 1 may be available by imagination or memory, such as the location risk of a project which may be imagined based on knowledge and experience about a foreign market; or expected inflation; including gut feeling about a future development. These evaluations may not be independent of what a decision-maker personally has experienced. Further, mainly non-risk factors as collected in Table 2, such as strategic considerations, future options imagined or intending to correct a forecast bias, may largely represent implicitly available information. Previously used rates for other projects may either be accessed in accounting records or also be available from memory (*Ila*). As another type of implicitly available information not dealt with in the hurdle rate setting before, but which has proven its relevance in the literature of judgement and decision-making, affective responses, i.e. the feeling towards an investment object, may play a role as a cue in the hurdle rate setting as well (*Ilb*).

Explicitly available information may include information about the project's risk factors, about further non-risk factors that the decision-maker considers relevant and certainly most importantly reference to other newly derived formula-based hurdle rates or those of similar projects or combinations of several rates. Information from accounting records (about similar instances or about historical values) or industry data, forecasts or other proposed benchmarks may certainly play the most important role. We may structure externally available information rate according to whether a decision-maker accesses information about other past (potentially similar) investment projects and related instances and draws conclusions about this project's risks, or whether s/he accesses instances or propositions that directly refer to the project under consideration. In this way, the judgements of Types *IIC* and *IId* identified for the cash flow projection can be derived analogously.

Explicitly available data about another variable, as judgement of Type *IIC* indicates, would in our context include a variable other than a discount rate; and would refer to available data about qualitatively similar or dissimilar projects. Data may for example include outcomes such as the success/failure of a project, how the cash flows/the NPV turned out or what events influenced its success or failure. Judgement may be implied in concluding from these outcomes (about the probability of failure and other outcomes and eventually) how risky the proposed investment proposal is and thus which discount rate would be appropriate. This Category *IIC* therefore covers the practice of judgementally using the volatility of previous project outcomes to predict the risk of a similar asset and thus to derive a hurdle rate premium – in this sense it could also be seen as a 'mental regression analysis' (Harvey, 2007).

Using explicitly available data about the same variable (*IId*) may simply refer to previously applied discount rates or -premiums or other reference discount rates/-premiums such as one suggested by consultants or banks. This seems of particular relevance in practice since the formula- or rule-based rate such as the WACC may always represent a reference point of this kind; further examples include a proposed rate by the finance director to the CEO or deciding about the company-wide hurdle rate in board meetings if previously applied rates or suggested rates are discussed. This may imply judgement of whether and to what extent a proposed or mentioned rate or a previously applied rate is adjusted to the project at hand; with particular risk categories, as mentioned in Chapter 2, to potentially also playing a role. Reference discount rates may also be available implicitly from which rates decision-makers may remember particular from their experience or considerations. This, however, does not propose a problem to this work's logic.

Explicitly available perfect information about the risk of a project of a specific category does certainly not exist. There is no database with a large enough number of data that includes all project outcomes and allows some inference about the riskiness in terms of percentage of

failed projects. Additionally, future outcomes and their probabilities would have to be included as well. Explicitly available information in practice will be provided by the available accounting records. These may provide data of past projects and their outcomes including the particular risk categories and hurdle rates applied. Since there cannot be a sufficiently large pool of similar investment projects, and the law of large numbers does not apply, judgement is used to consider the potential negative outcomes and their probabilities to evaluate how likely a project of the same category (or of a new one) will fail and thus how risky it is. However, in practice, scenarios may be considered and their probability of occurrence may be determined by rough estimates rather than by calculations. Thus the estimate of a project's risk includes a variety of components that themselves require probability judgements. Since the human mind is limited in its processing capacity, effort-reduction mechanisms may be used. It is hypothesised that individuals retrieve a few pieces of information.

As is the case for determining optimal cash flows or an optimum in general, for setting the optimum hurdle rate, all *relevant* cues should be used – these would traditionally be only such cues that indicate project risk – after analytically having ensured completeness of information; these should be properly weighted according to their objective importance or probability of occurrence, which are then completely and in an unbiased way combined to arrive at a judgement and thus a risk-adjusted rate. Undoubtedly, a nearly perfect discount rate may only be found making use of highly analytical and objective models taking uncertainty into consideration. Having ascertained that subjective components and thus judgement are self-evident, all hurdle rate setting behaviour that does not purely rely on analytical judgement-free computation implies heuristic reasoning since at least one effort-reduction principle is applied.

4.3.2 The Potential for Heuristic Reasoning in the Setting of Hurdle Rates

Hypothesising, if a hurdle rate or premium is based on information that is retrieved from memory (*Ila*), the availability heuristic may be found, namely risk and finally the hurdle rate are judged based on the retrievable information from memory rather than based on more difficult reasoning of appraising risk and deriving a rate. More easily stored and retrieved memories have a stronger influence on the the hurdle rate estimate rather than more-difficult-to-retrieve information. More easily stored and retrieved information may include salient instances that have been experienced before – for example as an economic or market down turn, a crash of stock markets, political crisis in an emerging market, an unexpected break-down of a machine with serious losses in sales or insolvency of an important customer. If these are more accessible, their probability may be considered higher and thus the perceived risk of a project and hurdle rate would be affected.

The affect heuristic as relying on a feeling towards an object (*I Ib*) as a cue for the target variable may particularly apply to the setting of discount rates. A feeling – evidently a non-externally available piece of information – is easier to access and evaluate than the complex phenomenon of risk. As outlined in Chapter 3 and above in Section 4.2.2, liking an object typically goes together with the notion that this object is of relatively high benefit and thus relatively low risk, whereas when disliking an object, this object may be perceived relatively riskier (see Chapter 3). We hypothesise the same to be true for project-specific hurdle rates.

Information from accounting records or other externally available data based on similarity to previous projects (*I Ic*) may be used as a hint for the risk of the current project under consideration since similarity may represent easier-to-access information than attempting to acquire more difficult-to-access information that may additionally be relevant.

As regards the fourth type of judgement (*I Id*) and in analogy to the outline in the previous section and in Chapter 3, a reference point (anchor) can be any kind of hurdle rate proposed which may influence the final hurdle rate estimate. Based on our knowledge from literature, we may even go that far as to claim that any mentioned figure in the format of a rate (i.e. percentage) may affect the hurdle rate.

The different types of judgements relevant for the setting of hurdle rates have been found to be largely analogous to those of Section 4.2. Figure 11 thus may also represent the different types of hurdle rate estimates (or premium estimates).

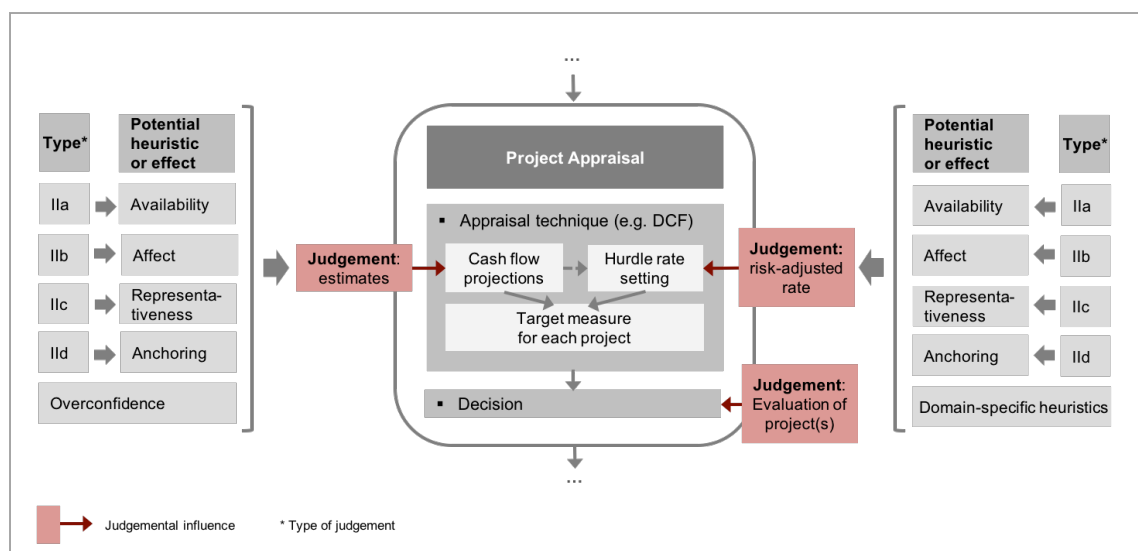


Figure 12 Refined conceptual framework of heuristics and biases in the projection of cash flows and in the setting of hurdle rates

Figure 12 refines the conceptual framework of judgement in investment appraisal but with limited focus on (3), simplified decision models. It synthesises the heuristics or effects found in literature (Section 4.1.3) with the potential for heuristics identified in Sections 4.2 and 4.3 and illustrated in Figure 11. The identified types of judgement give insight of which domain-general heuristics may be applied.

Having argued about the heuristics potentially applied, the interview study (Chapter 5) will explore which types of judgements may play a role in the practice of hurdle rates and thus provide indications of heuristic reasoning in this context (indicated by the grey-framed squares of the middle column of Figure 13). As a final step, we will examine whether these hypothesised heuristics are experimentally found in the context of setting hurdle rates for project appraisal (Chapter 6).

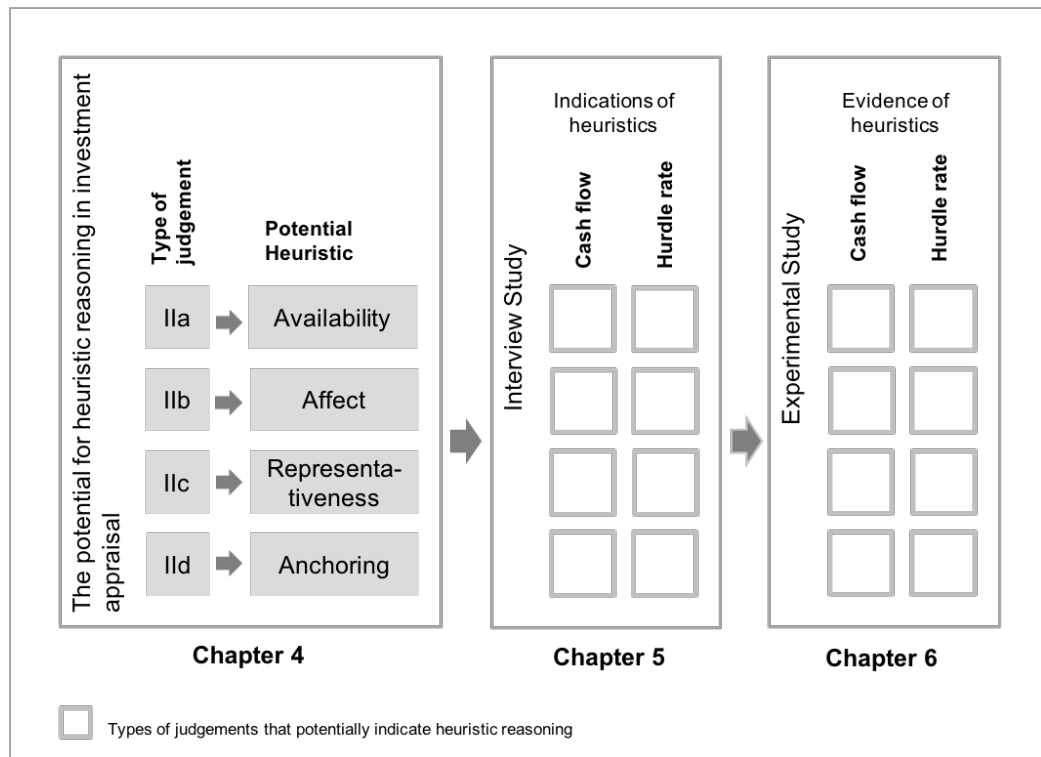


Figure 13 Schematic procedure of analysis

5 Qualitative Study: Semi-Structured Interviews

5.1 Methodology

5.1.1 Purpose

This programme of interviews is intended to explore how subjective judgement and thus potentially bounded rationality and heuristic reasoning influence investment appraisal. Its purpose is neither to investigate the general investment decision process as a whole nor to explore the investment decision itself. Instead it focuses on the stages where judgement is applied in the dimensions ‘projection of cash flows’ (thereby addressing RQ2) and ‘setting of the hurdle rate’ (thereby addressing RQ3).

Chapter 4 has addressed the potential for heuristic reasoning based on reviewing the literature on the projections of cash flows and the setting of the hurdle rate in practice and their gap to theory (Chapter 2) and on judgement and decision-making with particular focus on heuristic reasoning (Chapter 3). It has derived a framework that reveals the need for a closer focus on the judgemental processes of estimating cash flows for appraising a project and of determining a risk-adjusted hurdle rate for a DCF analysis. Chapter 4 also outlines how judgemental processes that rely on effort-reducing decision rules, i.e. heuristics, can be identified. Limiting our analysis to heuristics that primarily rely on the ease of access of information to arrive at a judgement (Principle 2 according to Shah and Oppenheimer, 2008), we could distinguish different types of information used for a judgement; based on which type of information is used in making a judgement, different heuristics are employed (based on Harvey, 2007).

Based on the experience of practitioners from relevant professional backgrounds, this study identifies what kind of judgements are applied in these dimensions of investment appraisal as outlined in Chapter 4. Based on the types of judgement identified, we are able to derive which heuristics potentially play a role in the respective contexts. The study thus addresses the gap of investigating judgement with regard to heuristic reasoning in the projections of cash flows and in the setting of hurdle rates and thereby informs the literature-based framework of judgement and decision-making in investment appraisal (see Figure 10).

As regards the procedure of analysis, for both dimensions of investment appraisal, statements are identified that indicate subjective judgement. Based on the types of judgement elaborated on in Chapter 4, aided and pure judgement with their subcategories are extracted in Sections 5.2 and 5.3. Section 5.4 briefly reports additional findings on analysing risk and group decision-making with regard to their influence on judgement in the context of this work. The

identified types of judgement provide indications of the use of particular heuristics and are discussed in Section 5.5 (marked by the grey-framed placeholders in the middle column of Figure 13). Based on this discussion, this section will hypothesise which heuristics are worth being experimentally investigated in which particular context – thereby leading over to a quantitative study design: In an experimental study (Chapter 6), the hypothesised indications of heuristic reasoning in the setting of the hurdle rate and in the projection of cash flows will be examined.

5.1.2 Participants

Companies differ in terms of which roles and positions are involved in the appraisal process. Thus, the subject pool included various roles and positions. Participants should be corporate decision-makers personally involved in investment appraisal. Therefore, three roles of decision-makers were aimed for: (1) financial/investment directors or persons in similar leading positions – since they represent the stage that is likely to be involved in the hurdle rate decision (cf. Chapter 2); they are also typically involved in the stage where all pieces of information of a project appraisal merge (at the latest). The second type (2) were people primarily involved in cash flow projections: project, divisional or technical managers or persons in roles who may have initiated investments or assist in projecting cash flows for a project they have initiated or will be involved in, and management accountants who may compile and classify the figures. Management accountants (3) may or may not be primarily involved in the hurdle rate setting, they may significantly be involved in proposing an appropriate project-specific rate and usually have superior knowledge in corporate finance and management accounting compared to (2). The latter, technical managers or similar, nevertheless may have acquired a particular management and business knowledge due the requirements of the managerial position they fill. Thus, despite the different hierarchical levels of (1) and (3), we may have difficulties judging *ex ante* whether for example a head of the management accounting department would primarily belong to (1) or (3) since s/he may have different responsibilities across countries. We summarise them into finance and/or accounting professionals due to their specialised knowledge (coded by F in Table 13); and distinguish from those without a particular finance and/or accounting background (3) but who are involved in the appraisal and whose knowledge – besides technical knowledge – extends to general business and management knowledge (T).

A sophisticated investment appraisal process seems to correlate with company size (e.g. Graham and Harvey, 2001). The use of at least one discounted cash flow (DCF) method typically applies to larger companies (see Chapter 2). Small- and medium-sized companies might not use DCF techniques due to more limited (human) resources and less focus on administration and finance. Thus, the main focus lies on exploring large-scale companies in their investment appraisal. Due to its exploratory nature, the study included two small- and

medium-sized firms but, as expected they do not have a formalised investment decision process using sophisticated appraisal methods, thus confirming the relevance for larger companies, as noted in Chapter 2; and were excluded from further analysis.

Larger companies are likely to have more formalised investment decision processes and more specialised roles. It is thus less likely that the CFO is directly involved in the investment appraisal (apart from the investment decision itself). The smaller a company, the fewer people are involved and the more often a single person makes the investment decision with basic financial appraisal only. For this reason, interviewing the head of management accounting of a global company with more than 50,000 employees was considered appropriate, whereas for a globally operating company with 500 employees only, the CFO was considered for the purpose of this study. The companies interviewed, the interviewees' roles and selected company characteristics have been summarised in Table 13. Names were anonymised for reasons of data protection and coded by F or T as indicated above.

Firm	Industry	Interviewee	Background⁹²	ID⁹³
1	Transport, aviation	Head of management accounting	Business	1_F
2	Manufacturing, automotive	Managing director	Technical/Business	2_T
3	Manufacturing, engineering	Finance director	Business	3_F
4	Manufacturing, automotive	Finance director	Technical/Business	4_F
5	Manufacturing, engineering	General manager/head of production	Technical/Business	5_T ⁹⁴
6	Transport, aviation	Head of management accounting	Business	6_F1
		Head of investment (aviation)	Business	6_F2
		Head of investment (non-aviation)	Business	6_F3
7	Manufacturing, steel	Finance director	Business	7_F
		Production manager	Engineering	7_T
8	Manufacturing, steel	Senior management accountant	Business	8_F
9	Energy	Coordinator of investment valuation	Business	9_F
10	Energy	Head of management accounting	Business	10_F1
		Analyst	Business/Technical	10_F2
11	Manufacturing, automotive i.a.	General manager, consultant	Business	11_F
12	Service, IT	Head of IT infrastructure	IT	12_T
		Management accountant	Business	12_F1
		Business economist corp. planning	Business	12_F2
13	Manufacturing, wood	Head of technology	Technical	13_T
14	Manufacturing, health care	Finance director	Business	14_F1
		Management accountant	Business	14_F2
15	Manufacturing, automotive	Head of technology and investment	Technical	15_T

Table 13 Interview study: sample characteristics

⁹² This is to note their general background; 'business' may relate to any kind of study programme in the business field including finance.

⁹³ Interviews in Companies 1-6, 10, 12-15 have been translated by the author.

⁹⁴ Strong business and finance (investment appraisal) knowledge in addition to major technical background.

The sample comprised four interviewees that may be subsumed as finance directors (3_F, 4_F, 7_F, 14_F), five decision-makers experienced in the role as head of management accounting or investment (1_F, 6_F1, 6_F2, 6_F2, 10_F1), six interviewees can be matched as belonging to the level of management accountants or similar supportive functions (8_F, 9_F, 10_F2, 12_F1, 12_F2, 14_F2) and seven decision-makers in responsible roles as managing directors (2_T, 5_T, 11_F) or heads of production or technology (5_T, 7_T, 12_T, 13_T, 15_T).

The interviews were conducted in 15 large companies from various industries.⁹⁵ In five of them, interviews have been conducted with more than one person (three companies with two interviewees each, another two companies with three interviewees each, i.e. 22 interviewees in total).⁹⁶ The duration of each talk ranged from 60 to 90 minutes. All talks – except for three interviews conducted via telephone – were face-to-face interviews and were audio-taped and transcribed. Interviews were conducted in German language (except for companies 7, 8 and 9 that have been translated into German).⁹⁷

5.1.3 Design

A qualitative design was chosen due to the exploratory nature of the study which seeks to capture the experience of individual decision-makers in their particular companies. Due to the fairly narrow focus of this thesis, we decided to preliminarily approach the heuristic reasoning in the mentioned investment appraisal dimension by an interview study to capture sufficient detail. The design allowed for asking more in-depth questions if this seemed sensible and for keeping narrow focus on particular steps and thoughts in the decision process of a person, which was considered most suitable. What we considered crucial therefore was the decision context with regard to the structure and decision format, the task, role and experience of the decision-maker, which may shape the strategies used to arrive at particular estimates in the capital investment appraisal. We were mindful for any contextual factors implied. Whenever judgement seemed to be affected, factors such as company history, strategy, environment, actors, their personal motivations and interpersonal dynamics were considered. The study thus contains elements of case studies of the involved actors' behaviour and context.

In terms of heterogeneity, the interviewees' roles were rather heterogeneous as is the case in practice, however, the actual task of forecasting cash flows however does not vary much, just as the conception of a hurdle rate, as we have seen from reviewing related surveys in Chapter 2. Thus, we believe that our focus was broad enough to capture the influencing factors of heuristic

⁹⁵ According to the definition of company size by the European Commission (2003), all companies can be characterised as large, except for Firm 2, which can be characterised as medium (to large) (due to not fulfilling one of the two criteria).

⁹⁶ Creswell (1998) recommended 20-30 interviews to reach saturation in grounded theory, even less for phenomenology, i.e. up to 10; Mason (2010) found 20 and 30, with 28 participants as a median, to be the most often used numbers of participants in qualitative interviews of PhD studies. Basel (2012), for example, included 8 interviewees in a qualitative study on heuristic reasoning in management accounting.

⁹⁷ Where there was uncertainty about a translation, supervisors were consulted.

reasoning in the appraisal context but sufficiently narrow to approach the specifics of the two dimensions. It aims to allow for a deeper reflection on the investment appraisal stage.

Interview prompts developed upfront ensured a comparable interview process and questions; the semi-structured design allowed for interaction such as asking supplementary questions or re-directing the respondent's answer if it appeared appropriate, and was considered the best way to capture the complexity of the subject. Open questions were chosen to create an agreeable conversational atmosphere and get rich answers that allowed for spotting subtle differences with as few post hoc rationalisations as possible. Based on Krabuanrat and Phelps' (1998, p.86) exploratory study⁹⁸, the interviewees were asked to recall a typical capital investment project and to give an outline of their investment decision process. Specific questions by the interviewer followed if some aspect of the process was not referred to (initiative, preliminary screening of alternatives, appraisal method, persons involved, follow-up monitoring).

Based on the interviewee's review of the decision process, its elements and parameters were then discussed in more detail – with more in-depth questions whenever indications of subjectivity, judgement and rule of thumb decision-making emerged. Inquiring about the investment decision process and following specific guidelines of asking may not lead to full insights about heuristics applied but can provide indication of heuristic reasoning only, which represents a limitation of this study approach. Certainly, all information is gathered through the lens of the interviewees. And since most processes happen unconsciously, the interviewee cannot retrieve them easily and typical statements may include “‘it just feels right’ or ‘the overall balance seemed to indicate,’ without being able to give a logical sequence of considerations leading to the decision choice.” (Krabuanrat and Phelps, 1998, p.86). It was attempted to avoid feeding “unwarranted possibilities to the subject by way of question or example, since there is a danger of post hoc rationalizations being constructed by the subject on such suggestions” (Krabuanrat and Phelps, 1998, p. 86). Additionally, some degree of subjectivity might be included in the interview process due to deciding which additional questions may be appropriate (Krabuanrat and Phelps, 1998). However, this methodological approach is considered most appropriate: “for an exploratory study outside a controlled experimental situation it provides a good balance of surface level reporting and in-depth probing of the decision process in as far” (cf. also Krabuanrat and Phelps, 1998, p.86). In line with Maitland and Sammartino (2014, p.9), interview questions – particularly in the beginning of a topic – attempted to be direct but not pre-defined in detail. For example, it was asked which pieces of information were sought when determining a parameter (such as a safety margin for a cash flow estimate or a discount rate premium); this allows for non-manipulated answers about

⁹⁸ Even though Krabuanrat and Phelps (1998) adopted a sequential approach in repeated interview sessions, fulfilling their requirements was also aimed for in the present study.

real decision-making rather than providing normative criteria ('how things should be') that make respondents confirm practices they in fact do not engage in.

In line with prior studies (e.g. Brounen, De Jong and Koedijk, 2004; Maquireira et al., 2012; Andor, Mohanty and Toth, 2015), the sample companies mostly relied on DCF and the net present value method, most often in combination with payback period; the internal rate of return being considered as an additional criterion if the NPV is negative or for a better understanding when justifying a project.

Results of the use of investment appraisal methods in relation to the size of a firm (cf. Chapter 2) are confirmed by the interviews. The additional interviews conducted with small- and medium-sized firms reveal that they generally do not have a formalised investment decision process using sophisticated appraisal methods that consider the time value of money. The financial evaluation of an investment project attracts little attention.

What is considered a strategic investment project by the interviewees is consistent with our definition in Chapter 2: A strategic investment was generally considered by interviewees to be an 'exceptional' project that has been initiated by the top management and that may be undertaken for reasons of competitive positioning in the long-run and where the investment itself may financially not be easy to grasp or it may even reveal a negative NPV. However, a typical capital investment appraisal with a regularly formalised decision process does not depend on whether a project is labelled strategic and is rather depending on the volume of a capital investment which makes it a formal process.

5.2 Analysis of the Projections of Cash Flows

5.2.1 Indications of Judgement

To clarify terminology and as outlined earlier (cf. Chapter 2), the cash flow profile includes the net cash flows of each period t over the economic life of the investment project with the net cash flows as the sum of all cash flow components, i.e. cash inflows and outflows in a period t . These cash flow components can be seen as variables that have to be estimated. A forecast or estimate e can theoretically be any cash flow component in a given period, for example the final net cash flow estimate, or it can be any estimate for a cash flow component such as some type of costs such as the cost of maintenance or the cost of the technician's journey to the plant – depending on the level of detail that the decision-maker chooses to apply.

The interview data confirm the dependence of judgement on the level of *uncertainty*. Information received by decision-makers ranges from relatively certain to uncertain or no information at all. Some data are relatively certain and do not have to be estimated subjectively.

It can be provided from contracts (e.g. the price of the investment object (taken from offers), price per kWh electricity fixed across a two-year period, service fees agreed on, additional workers needed etc.) – those values are also seen as ‘*hard factors*’ (14_F1). Hard factors thus do not require (subjective) judgement.

“In this profession you always have to make estimates.” (14_F1) – The fewer pieces of information are available/known, the ‘*softer*’ the factors and the more uncertain the cash flows and thus the more judgement is required in the cash flow components. Examples of ‘soft’ components include estimates of the costs of quality (5_T), retrenchment (5_T), cost savings (3_F) or lump sum estimates for investment budgets (“because we are stepping into a new technology ... we will then need fewer desktop systems, so we just apply a lump-sum reduction and this is actually a very subjective affair”, 12_F2, being primarily involved in corporate planning). Being aware that those estimates may in reality exceed or undercut the estimated values due to unforeseen events, has been added by one interviewee (5_T).

Indications of satisficing behaviour can be found in for example the following statement:

“The question is what goal do you have; do you prefer pseudo-precision which is not accurate? ... does not make sense either. In this case I prefer to continue my calculation with a value where I say, it must be plus/minus 10. I mean, somehow starting to drawing up a list where I don’t know exactly what is going on ... this is equally imprecise as if I decide that we will calculate using plus/minus 10.” (15_T)

“One becomes more and more versed ... I’ll write it [the calculation] down for you in 20 minutes ... and I can think about it two more hours, it won’t get more precise. Sure, one could now say, the dominating number is the first one [initial outflow] and one could think about it not being precise enough ... after a particular point, there is a sufficient degree of detail and thinking more about it and doing more research does not add because the [numbers’] expressiveness does not increase” (13_T)

Moreover, risk mark-ups, safety margins or buffers seem to be applied in many cases to account for uncertainty and the ‘unknowns’ and may include rounding off to an amount. This will be followed-up later in more detail.

It was evident that uncertainty about cash flow projections reflect uncertainty about assumptions such as how the price of electricity will develop (12_T). It is unclear whether assumptions include judgement (for example when using estimates about the investment object’s space requirement and estimates of cost per square metre resulting in the derivation of costs for space). Interviewee 12_T considers that those derivations are relatively objective; whereas one could argue that the assumptions may include judgement. Thus, case-based analysis is required about what the assumptions are based on.

It is also worth noting that depending on the assumptions made, estimates can be strongly *manipulated*. As a managing director and shareholder of their family-owned company with thereby aligned interests and information, 2_T clearly views this issue:

“Determining machine hours is highly subjective; it is easy to influence the figures because these are assumptions only. ... We can let it [the machine] run some hours more, some hours less ... I can influence the numbers the way I like to have them; this is why the final decision is a gut decision, ... where one decides, it fits or it does not fit.”

‘Softer’ than the data provided in offers or contracts but ‘harder’ than the soft factors identified before, *formulas* are also used to make cash flow component estimates, as 14_F2 exemplifies as a management accountant typically involved in project forecasts: “An example would be labour cost estimates of a period, we typically estimate them as, let’s say, 20% of the revenues of a period.” This statement may be the result this person him- or herself but also of a long-time company memory and conclusions drawn from it. The elaborations of 14_F2’s finance director (14_F1) on what, to him, ‘experience’ means, may explain how an estimate of the e.g. 20% can be derived: *Experience* plays a role in arriving at an estimate and helps to judge plausibility:

“Experience ... means whether I’ve seen something before, is it plausible or does it not make sense ... consequently, a certain amount of at least ... must result, plus or minus, with a relatively high noise factor but you will find out whether you are in the right size category ... well, you probe this in the mind’s eye with the experiences made.” (14_F1)

Yet, experience does not necessarily imply decades of work experience as for example 14_F2’s work experience comprises only two years and not even one year having worked for this company.

In general, difficulties arise when estimating company data as opposed to estimating much more tradable assets such as securities, illustrating the generic problem of determining the true value of a firm’s assets including investment projects: “An industrial enterprise is not a fungible good ... thus you actually would have to add another premium for the fact that it is not a fungible good” (14_F1).

5.2.2 Aided Judgement

Based on the types of judgement involved in estimates or forecasted values of variables (Figure 11), the statements were organised according to two different types of judgement: aided judgement (*I*) and pure judgement (*II*).

As regards *Ia*, judgement about which terms to consider in the formula that generates a forecast, they are mostly similar to what has been described in literature. Incremental cash flows associated with a project are for example drawn from contracts and functional specifications certainly specify which components and amounts to include in the associated cash flow profile. Potential for error may be implied in if one forgets to include components, for example additional infrastructure of a project such as laying additional cable, pipes or wastewater pipe (5_T).

It is not surprising that few cash flow choices may require this kind of judgement *Ia* as there are templates and information from accounting records that provide a framework/structure of which components to include.

Judgemental adjustments for the factors that have not been considered in the formula that derives a CF estimate (*Ib*) are considered in the following ways: Depending on the level of knowledge and thus uncertainty, safety margins, ‘buffers’ or premiums are included and the original estimate (that may also come from contracts or other fixed data) is adjusted to arrive at a final estimate for a cash flow component by adding/subtracting a percentage or a monetary amount to the formula-based estimate.

For instance, and as casually known, as a project sponsor who will have to defend the project to the managing director and who is interested in getting the project approved, a reasonably higher amount than a safety margin is often asked for, often as a flat-rate premium:

“If the facility costs €229,000, then I won’t ask for 229,000, but for 249,000 in our case. ... Then I know I will have 20,000 for unforeseen things ... sometimes when tearing down a facility, one finds the floor damaged so that it has to be renewed ... There may always be some small buffer that may lie between 5 and 10%.” (5_T)

Safety margins, in the form of percentages, are commonly found as illustrated, for instance:

“The risk mark-up may just be a feeling ... I know what went wrong last time and I tell myself, this has to be avoided this time ... there are unforeseen events ... – therefore I add 5 percentage points – this represents such a [subjective] value.” (5_T)

In a case where the decision-maker was particularly experienced and all uncertain components were thought to be known or where the decision-maker was relatively sure that all factors are considered, the safety mark-up was found to be an absolute figure:

“In this case here [new machine] the buffer is not a percentage – there are a lot of things happening in my head ... – in this case it is rather an absolute figure, because I think that we have included all main aspects, the machine just has one power connection, there is no second one, ... and even if one forgets to include one thing, this will not get the project out of control.” (13_T)

4_F, as the head of management accounting department who therefore acts as a corrective to check the provided data forecasts and who is interested in an objective appraisal⁹⁹, even reports a formal rule to incorporate uncertainty in cash flow estimates depending on the project’s respective category: “We have percentages depending on the size of a project, and depending on its complexity there may also be global rules, but they may just range between two and five percent.” (4_F)

The following statement highlights a crucial point illustrating bounded rationality related to this type of judgement of subjective safety margins: It reveals the inconsistent practice of trying

⁹⁹ This is the main task of the head of finance according to 10_F1, the support of managerial decision-making so that management can complete a real trade-off of risk and return.

to have very precise formulas quantifying and measuring many details and changes in the independent variables and their precise effect on the dependent variable, with the practice of afterwards adding rough margins:

“We try to calculate as precise as possible in for example recording time ... If we accelerate a specific movement [of the machine], we see how many seconds are saved per cycle, how many cycles per day, per month, per year. ... you calculate periods of times the machine is not running – we have an excellent database from our ERP system ... and we think about the theoretical calculations made and whether they are plausible. And you may have calculated an estimate possibly based on one-tenth of a second and then you add 50% safety margin due to your gut feeling, something may slow you down.” (13_T)

The limitations of quantitative methods are widely noted by the interviewees. Not only for cash flows, but for an appraisal in general, a highly quantitative process may be applied and perceived, comparable values may be derived, conclusions drawn, but the use of subjectivity and gut feeling is widespread across the whole process.

As regards *Ic*, an estimate provided by a formula and a decision-maker's estimates are merged using judgement, seems to have little relevance. 14_F2 notes:

“There may be cases where the cash flow forecast predicted by a formula provides one estimate and where I personally believe it should be a different value, I may simply use the mean value of both estimates”.

As indicated in Chapter 4, the judgement about for example the buffer value that is included in forecast of Type *Ib*, or a judgement assumed in *Ic*, can be considered pure judgement analysed further in Category *II*.

5.2.3 Pure Judgement

Pure judgement is of central importance in being the ‘zone’ in which heuristics are particularly apparent: As regards the type of judgement in Category *Ila*, cases where information that is purely retrieved from memory is used to derive a cash flow estimate are not common. We found one exception of a highly experienced decision-maker, 13_T, who has high degrees of freedom granted by the managing director who also owns the relatively small company (500-1000 employees at different locations). He has planned and implemented various large-scale projects and often does not rely on employees preparing cash flow estimates. 13_T, interestingly, provides several examples of deriving monetary estimates purely based on memory. However, he notes the highly subjective nature of this vague estimate. When listing technical activities and terms which describe what kind of costs must be considered in an appraisal, 13_T thinks aloud: “engines, sensors and so on ... some security equipment, and then you see the amount of €15,000 for miscellaneous – and this [estimate] is then really made up out of thin air”. However, if we consider the estimation of safety margins, we found many instances where the mark-up itself is gauged without consulting explicit sources of information, as outlined above in 5.2.2.

Independent of deriving cash flow estimates: when inquiring about *past events* that have shaped experience and decision behaviour, the following peculiarities were found: Whenever negative events were reported, details and stories showed that several projects left a tangible impact on experience; whereas, when positive aspects were mentioned, mostly general statements were made similar to: in many cases, things went well.

With regard to highly negative events out of a series of majorly positive ones with one highly negative event, 5_T confirms, “This sticks in one’s mind.” Asking for salient events that are remembered, the financial crisis as a more general external but vivid event has for example been mentioned:

“Well, 2008 was such an impressive event, where we ourselves had not anything wrong, our clients had not, our suppliers had not and nonetheless, sales halved ... from one day to the other. And no one has expected it. Similar to the current interest rate situation which no one has expected. Indeed, I think that this shapes experience, that one has realised that things can change over night, that things can be completely different and one has to be extremely careful.” (2_T)

Moreover, personal disappointment was also found to be a vivid event:

“If there is something that stays in memory then it will be personal disappointment ... that person has let me down ... I waited 72 hours for getting a spare part. It refers more to the personal level; disappointing stays in memory.” (5_T)

Project failure may for example result in scepticism (despite knowing that this should not have any impact on future decisions):

“Well, if an employee has an idea but I know that we have done it five years ago in another subsidiary and it was a complete flop; originally it should cost €100,000 but eventually it cost 500,000 – ... this is where I once burned my fingers. But this usually not what happens and what should not happen at all.” (13_T)

However, and against what would be assumed, we also found evidence for the opposite: A very salient recent event, a fire in the production site has destroyed one major plant completely, did not have a strong impact on the decision-behaviour, as reported by 5_T. However, the interviewee acknowledges the sufficient insurance coverage which allowed that the plant is fully rebuilt and even in a slightly improved way. Thus, this instance did generally not invoke negative consequences or perceptions *ex post*.

Direct impact of remembered salient instances on deriving particular cash flow estimates, aside from the ones mentioned above, is not found.

Judgement of Type *Iib*, affective responses, could not be detected apart from gut feeling that may determine how to proceed. We would not attribute the undefined term ‘gut feeling’ to a particular affective response but rather to boundedly rational behaviour in general.

Despite its potential for error, relying on accounting records to analyse performance, outcomes, projects etc. as powerful tools to support decision-making, as overall indicated in the statements, implies relevance for judgements Types *Iic* and *IId*.

As regards judgement of Type *IIC*, using externally available information or data from ‘another variable’, or the mental equivalent of regression analysis may be illustrated by for example any kind of cross-comparison of projects. Various types of outcomes and assumptions are analysed using for example internal databases or accounting records, to make inferences about what the new project’s cash flow estimates could amount to. Drawing analogies is common, for example comparing subsidiaries and deriving estimates (8_F); comparing countries (based on similarity, analogies may be drawn from German or the Dutch markets, not necessarily to the British one, as 10_F2 notes). Moreover, the following statements exemplify further use of cross-comparisons from available data sources internally and externally, and of comparables, adjusting for such factors that differentiate to the project under consideration:

“We take our data from our ERP system, cost of maintenance for example from similar offers that have been placed. We have two homogenous plants, use the same [input] and now we introduce producing the same product ... same process, a little more up to date, the other plan is a little older and grown, ... for this reason we have done most things already and we would just make a comparison ...” (13_T)

“In this ‘comparables’ stage, we would look at our internal data base that we have and both shareholders, one of the shareholders is a big power generation company, so ... we have this expertise in house so we know how we are aware of the numbers which were practiced in previous transactions, so we would make this analysis. We also have databases, ... for example economics is one of them where you can see prices, quotations and lots of multiples of lots of companies, so we could look at that or market, financial information the we get also from the market.” (9_F)

Deriving an estimate is made with differing degrees of deliberation of how the estimate is derived as the following three statements exemplify: 13_T points to the hardly graspable nature of turning cross-reference into a cash flow estimate:

“Yes, we had a buffer of 3% or similar. ... it is some kind of gut feeling, one thinks about the reserves at some other points and how strong is their expressiveness. Would this be a project in the centre of all machines, where there are many applications around, one can hardly estimate. It may be different if the machine can be constructed when the other machines are already running as well which is a huge advantage.”

Based on past experience using available information about the various facets and costs of customer claims, 5_T derives a rule-of-thumb estimate to project future claims:

“As regards mechanics, a relatively high amount of claims is made, but which have relative low effects for the client ... therefore one arrives at such points of reference ..., spare parts, handling expenses ... €2,500 as a point of reference which is heavily subjective; there are no analyses, it is an empirical value.”

15_T, with a vast experience in manufacturing and related projects, and as an executive of a large and renowned engineering and manufacturing company that is part of the vigorously competing Germany automotive industry, self-evidently illustrates deriving estimates based on what is known about previous component costs (which themselves in turn may represent judgement):

“What is done based on gut feeling is when someone is experienced in planning ... or I may go to a supplier and try to assess the particular amount, he has told us; then you would do it

yourself and you also go through: ... How much movement do I have, how many cylinders ... there is just one process per station; then you have it [the estimate] per cabin, and three processes per cabin; just one control for three processes ... and you would roughly estimate and I would say you end up at plus/minus 10%.”

Not surprisingly, we found indications that the fewer experiences a person has had with similar projects, the higher the estimate which is added as a mark-up on a previously derived or given figure; but this may be highly dependent on the individual case.

Some peculiarities are mentioned noticing the importance of not becoming careless: Buffers should not be unreasonably high as 13_T, acting in the role of the project sponsor, notes:

“... however, on the other hand, I also would not include too many reserves in my calculations of the project because I still want to undertake the project and get the project approved ... and therefore I prefer to keep everything tight and sharply calculated.”

Similarly, in the individual case of Company 7, a mark-up estimate may be preferred in the form of rounding up; but only to a reasonable extent: As an original equipment manufacturer with relatively few big clients, the volume that is produced highly depends on the demand by those few clients and is highly volatile into both directions; thus including high positive buffers is not considered sensible for reasons of arriving at most realistic estimates, as a finance director interested in forecasts equalling actual figures.

The quality of estimates certainly depends on the quality of accounting records and the more ‘corporate memory’ the better. Moreover, an indication that individual experience may distort a comparison is noted: 10_F2 notes the helpfulness of comparisons, but warns about the uncertainty of whether the comparisons are correct; false aspects may be compared with each other because experience may be distorted. 10_F1 adds that the closer the look at comparisons, the more differences are found; this highlights the highly subjective nature of objectively ‘similar’ instances.

As regards judgement of Type *IId*, using information such as past values (or other reference values) of the variable under consideration to make an about a cash flow estimate in a given period, is found in a number of statements. For cost components where no data are externally available through for example contracts but where past values or a series of past data is known, many examples were provided by the interviewees. For example, when projecting the price for electricity after the period where the price per kWh of electricity is contractually fixed, judgement is required to forecast the price: “We inflate by for example 10% to make a more realistic assumption.” (12_F1). In the case of no externally available, uncertain data, one obviously must rely on historic data:

“[Whether] the EEG [renewable resources reallocation charge in Germany] is increased – we do not have any forecast for this, we can only make a derivation from the actuals: the charge has increased during the last five years, then, based on gut feeling, I’ll go in line with the trend.” (12_F1)

Further cases include similar phenomena where the forecasts are based on how past values have developed, such that a mental time series analysis (Harvey, 2007) would describe the reasoning.

Several interviewees reported situations where initial values are considered (or oriented to) that do not represent *past* values of the same variable (i.e. same cash flow component to make an estimate about), but other *reference values* in general, such as internal estimates or – if not internally available – estimates from suppliers (8_F) or suggestions from consultants' reports (9_F).

A reference value and whether it will an own estimate will be formed, can have can be related to other soft factors that serve as a filter, such as trust, which in turn may reinforce *confidence*, as 5_T outlines in this context: "Such a figure provides safety. Someone has calculated it, it thus conveys trust ... or in the case I mistrust, I will re-calculate it." Thus, the case of mistrust may already be a way to preserve objectivity. 9_F, with a strong valuation background, in contrast and unsurprisingly from a normative point of view, emphasises the pursuit of objectivity facing potential reference values prepared by for example consultancies.

Investigating (over-)confidence in estimates, corporate decision-makers from the management accounting or finance perspective, have noted extensive confidence – in one's own skills and thus estimates or in others'. 10_F1 as the head of management accounting of a large energy generation company, for example notes hubris that may go together with too low cost estimates or time to complete, thus confirming what has been outlined in Chapters 2 and 3. 8_F, in the role of a senior management accountant where estimates are collated, also notes indicators for confidence due to the incentive to have a project approved, but suggests that this is not necessarily conscious behaviour:

"Most of the time the managers they want that investment should be approved so they will do everything to make it happen. Sometimes they are more confident than they should and sometimes they just don't realise that."

3_F, as a finance director, also advocates care:

"For projects that are new and where there are no empirical data, it is dangerous and risky to say, well, I expect savings of a particular amount; and if the actual figures are measured later on, there may not be any savings any more."

6_F1, however, notes that sometimes, if some department prepares estimates, such as the sales department forecasting market rents that have to be estimated for constructing a new building, management accounting has to accept the forecast and is not in a position to correct these estimates for the lack of expertise in this area. That is, even if some degree of overconfidence is hypothesised, considering corrections may not be readily enforceable.

The point of view of someone who is in a leading technical role may show different nuances. 12_T, similarly to 4_F, for example emphasises the importance of confidence in own skills and the caveat of too detailed dealing with an aspect.

“A person who does that [being too confident], I think, will not do it on purpose to harm the company. ... Confidence is strongly depending on own experience ... and to me personally, I favour people who are very experienced to be confident to the same extent. Because things can also be discussed too intensely until they do not seem to make sense any more – based on both, the time used and on the arguments.”

4_F, goes one step further and considers excessive confidence an important characteristic of decision-makers in domains where risking something for example by investing is crucial; being too careful is not generally helpful:

“A sales or marketing person must have a positive approach and must be extensively convinced by the things he is doing. ... and one has to have some kind of entrepreneurial foresight, otherwise ... one can close down the company. ... One has to objectify and view things as realistically as possible but as ambitiously as possible.” (4_F)

Therefore, correction of estimates due to overconfidence is not unlimitedly advocated by high-level decision-makers and may even be considered detrimental. However, it seems self-evident from a management accounting perspective – also in the light of what has been stressed before, i.e. that the finance department is responsible for checking reliability and objectivity of data and adjust if it seems appropriate. However, both arguments are not necessarily contradictory; in the role of preparing information for decision-making, the data may need to be as objective as possible, as the final decision-maker(s) cannot evaluate the origin of the projections and whether the confidence put into those is appropriate from their point of view. According to our data, managerial decision-making in the investment decision therefore can and should feature a relatively sound level of confidence.

Section 5.5.2 summarises the findings of the different judgement types identified in the projection of cash flows. Beyond, it derives the heuristics that these types of judgement may suggest.

5.3 Analysis of the Setting of the Hurdle Rate

5.3.1 Indications of Judgement

Several approaches of how the discount rate is determined were found in the data and mirrored largely the practices summarised in Chapter 2. In most cases, a company-wide discount rate has been applied. The points in time when the company-wide rate is updated range from annual updating (including re-calculation of the risk-adjusted cost of equity via the CAPM) to irregular update intervals (update only in the case of some general environmental changes such as the

extreme decline of the interest level) to hardly any updates of the rate (such as having used the same rate for more than two decades). In the case of occasional update intervals, judgement would also be required when an update is necessary: “Once in a while, noticing if for several years, the rate has not been changed, but the interest level did, we have to act.” (6_F2) This implies that some degree of accumulation of instances of discrepancy takes place which finally triggers action.

Those companies who engage in the practice of determining project-specific discount rates may not do so for all investment projects under consideration equally, but for those of particular importance and size only, which may also comprise strategic investments:

“... only if we see that it’s a very strategic investment and there are the benefits which are hard to measure using the DCF approach, so we may do that, but its a much more specific situation.” (9_F)

We also found the practice of adopting hurdle rates that do not explicitly rely on the cost of capital approach but which are exceptionally high and assumed to be high enough to cover at least the cost of capital, i.e. their premium may be sufficiently high. This is particularly true in times of low interest levels and thus relatively lower cost of capital.

The relevance of adjusting in the form of a risk premium for projects of particularly high risk – such entering a new market, exceeding a particular investment volume, entering into a new line of business, new products etc. – was acknowledged; sometimes also organised in particular *risk categories* for different business lines that make the project-specific risk, which is not a surprising finding. 9_F outlines this in the energy sector:

“We have well-defined rates for different classes of projects, we already have a central field for wind, another one for biomass, another one for hydro ... we use the same cost of capital [in each field].”

Risk may be identified in a relative way. 10_F1 reported that there may be a *feeling* of higher or lower riskiness of a project even within a particular business line, but this would be very difficult to substantiate. This notion would reinforce the subjective nature of the term ‘risk perception’ as used by 9_F.

The setting of the discount rate, similar to cash flow projections, requires *hard* and *soft factors*, illustrated by 14_F1: “Even though in the end you arrive at a value of 7.35%, this is the result of hard and soft factors and the soft ones you have to estimate to the best of your knowledge.”

Certainly, the problem of determining an objectively appropriate risk-adjusted rate for an individual project is widely acknowledged, as 8_F exemplifies:

“I understand they need to do what you learn at the University, what is better to do with your money – in the market or put your money in the bank ... You need to do an estimate, but I think that the number that they ask inside the companies they will not find.”

There was consensus among the interviewees about the topic of the prevailing pressure to justify and discuss project-specific rates internally. For example, the pressure by a particular division arguing why a higher hurdle rate is imposed on their division compared to another one which consequently more easily gets projects approved. Similarly, for project-specific rates, this pressure for justification is of important concern. For this reason, a relatively simple estimation is preferred to avoid entering discussions at the same time that the cash flows are being discussed, and to impose the rate to the project owners to be treated as given. For those companies which do not use project-specific rates, this pressure has been the most important reason for either discontinuing the setting of project-specific rates or for not practising it at all. Moreover, in their reasoning, a general rate ensures comparability and comparisons of projects may be done as regards different dimensions or characteristics of investment proposals.

As an alternative to considering particular risk in the discount rate, and as advocated by several publications as outlined in Chapter 2, risk may be considered in the cash flow projections, for example, by scenario analyses or percentage haircuts on the projections. This may also represent an easier task and easier to justify than an (admittedly subjective) premium of particular percentage points added to the hurdle rate, as 10_F2 indicates.

In terms of the persons or *roles* involved in the setting of the discount rate, not surprisingly, the sample varied in their answers as neither company structure perfectly resembles another. Among the interview companies, in the case of a company-wide rate, the larger the companies, the higher the hierarchical level the rate is determined (e.g. the cases indicated it is typically determined by the finance director (of the group) or by the finance or management accounting department and then approved by the finance director or the managing directors). Determining project-adjusted rates is a more operative task; the rate seems to be determined (not surprisingly, since knowledge about the project under consideration is required) by the finance department, where a rate or a range is proposed by one person – potentially with the involvement of the finance director if consensus cannot be reached (particularly in the event that the proposing division does not agree with the rate): 9_F, in the capacity of coordinator of investment valuation, corporate finance and investors' relations of a relatively young listed joint venture and financially strong, notes:

“Me or my colleague would come up with the estimate of the proposal ... and then it would be discussed with the other colleagues, and then there was one proposal, the colleagues may think it should be different ... then we would of course try to find facts and figures which can justify both approaches and have a broader discussion with the director, and then try to reach a consensus there.”

One interviewee in the role of a technical manager of a particular branch of business – educated in both the technical and the business field including investment appraisal – reported that it was him who determined the risk-adjusted rate for a project. However, in this particular context, we have to note the high degrees of freedom of the technical manager in this decisions

since the management accounting department was not always involved in project appraisal, only in cases where available data were vague or estimates are too complex to be calculated or gauged.

As the above practices indicate what the literature review has yielded, judgement is an undeniable component particularly of project-specific hurdle rates. The first step, however, should be the attempt to mitigate risk:

“That’s our preference, we try to mitigate risk, and if it’s not possible to mitigate then we would try to incorporate that in a higher cost of capital considering that the project is risky. But then again that’s even more subjective.” (9_F)

5.3.2 Aided Judgement

As regards Category *Ia* of aided, i.e. formula- or rule-based judgement, the judgement that is required to choose which variables to include in a model, e.g. the time period of the rates to base the return on, as was hypothesised in Chapter 4, is confirmed by the interviewees. In terms of selecting parameters for the CAPM, 10_F1, broadly experienced in financial decision-making, also notes the variety of options to select that yield a broad range of possible costs of capital. For non-listed companies, comparable factors have to be used for example for the CAPM calculation, implying judgement in selecting, as noted by 9_F: “companies which we think that are comparable to ours, ... from the universe of firms we need to choose some – there is always some subjectivity.” 14_F1 adds, “How can one be sure about which comparable is the most suitable for the individual case – this is only judgemental.”

As regards potential mistakes in selecting, 9_F notes that being guided by further soft factors such as personal motivation, may also play a role:

“[For determining beta] I see for example, which companies are selected, I think, lets say those that are performing well, that we would like to get there, also we look at them and say, ah, that’s an interesting company, I would like to be as big as they are. so we use them.”

As regards judgement of Type *Ib*, i.e. subjectively adjusting model-based rates or premiums, is applicable whenever comparisons deliver rates, premiums (or even intermediate values such as beta factors of other companies) which are then adjusted using own judgement since some intuition may dictate that the company’s or project’s risk is in fact slightly higher than the value retrieved by a formula. This type of judgement is seized upon below discussing *IIC* and *d*. As a peculiarity, however, not very surprising, one interviewee mentioned that before accounting for individual project risk, the cost of capital is adjusted by a premium to ensure a minimum value added or a minimum rate of return; this is also supposed to hedge against potential forecast errors.

As regards *Ic*, i.e. judgement referring to how a model-based rate or premium and a rate/premium determined by pure judgement are linked: This practice was found in statements

referring to deriving cost of equity or beta values from listed companies and combining them to derive a particular company-wide or project-specific discount rate.

5.3.3 Pure Judgement

Pure judgement has been identified to apply in deciding about the project-specific discount rate (premium) in the following forms: Instances for judgement of Type *Ila*, where information is retrieved from memory, that may influence risk assessment have extensively been dealt with in Section 5.2.3. 14_F2 for example also provides reference to past (and similar) projects:

“If a project shows the same structure or conditions (including contractual conditions) as a previous one that turned out negative ... I would consider an increase in its discount rate to reflect the expectedly higher risk. ... I would not expect the project to be equally negative, but my expectation with regard to it would be more negative.”

Similarly, when for example inflation is projected – which may and should be incorporated in the reasoning of a discount rate, as for example general manager 11_F notes – recent negative experience about the country’s economic situation causes anxiety and makes forecasters estimate an exceptionally high rate:

“There are lots of people which are proposing very high figures, even for the long term, which are not very coherent with most economic studies or most forecasts etc. ... because they say the [current economic] situation [in Brazil] is really bad ... and that may have an impact on our cost of capital depending if you are computing a nominal or real basis.” (9_F)

6_F2, head of investment of a recently very successful company of the aviation sector, however, notes that the impact of wrong decisions or failing investments may depend on the general business situation: in a very comfortable financial situation,

“a wrong decision from our management accounting perspective would not be regrettable and from the firm’s perspective, it would also be considered O.K. – this would not hurt so much that we next time needed to have a closer look at an appraisal”.

Notably, being overly influenced by those events is something that is negated: In several cases, clear statements were made (particularly by the management accountants) revealing the conviction that negative events experienced in the past do not influence their reasoning in a strong way. The reason that they put fourth is that most of the time financial data are analysed which then cannot distort their judgement. This belief went along with the notion that decision-makers on the top level such as the directors do consider other qualitative, non-financial factors where experience may influence current decisions.

As regards judgement of Type *Iib*, personal feeling of like or dislike for an object may have an effect on personal assessment of whether it will be successful or not, its risk assessment may be influenced, as implied in 4_F’s statement: “Everyone likes to have nice cars. And one easily gets enthusiastic about ‘everything will work out wonderfully.’”

To arrive at a judgement about a rate (premium), the risk assessment of the project is crucial. Risk is identified qualitatively and rather a relative way, i.e. by assessing whether a project is more or less risky than another object (including the determination what the other object actually is). Thus the question is: What is the difference between two or more objects? The comparative values (indicators) may be retrieved and adjusted for the different degrees of riskiness implied. The use of accounting records or other databases for deriving personal judgement in this context is self-evident:

“We have a very broad database which is regularly and extensively analysed; thus, one gets a feeling for what is possible and what is not possible and additionally, one can make risk assessments subjectively.” (6_F1)

Judgements of Type *IIC* and *IId* may be difficult to distinguish. If a project is considered similar based on specific characteristics and is retrieved from accounting records, this may include information about outcome, cash flow and also the discount rate or discount rate premium applied. This implies the usage of both, information about other values (*IIC*) and information about the same value (*IId*). Thus, substantially, judgements may not differ much in what the information they use. However, conceptually, as regards the format of information that is used, we must distinguish between information about the same variable in the sense of a rate, or information with perhaps the same content about a project's riskiness. Judgement may be differently affected.

Information in the form of rates or rate premia may or may not be considered suitable and adopted directly without amendment as a new estimate and thus rate (premium); or they may be amended if some difference is perceived that may affect the risk (e.g. take the mean of several rates retrieved from the database). Using a rate or premium that has been previously applied serves as a reference point, which may have an impact as the anchoring effect dictates as we will refer to in the next section.

Judgement of Type *IIC* therefore, comprises for example the variability of a return figure or the use beta(s) branches. 14_F1 hypothetically notes what could be done:

“[For a private company] one could certainly analyse the volatility of the annual statements' returns of innovative companies. This would at least represent some indicator for what kind of buffer I would include”

Similarly, 9_F recognises the practical difficulty of quantifying adjustments to the cost of capital; there is no more or less efficient market that values a similar to their company, “It's very hard to quantify, we because it's very hard to find a dictate about projects, there are no for example biomass traded companies, that we could use data from and lever.”

As regards judgement of Type *IId*, the use of past rates or premiums has been indicated by for example 10_F1: for reasons of consistency across comparisons, a look at past procedure is common practice; if slightly higher risk is observed, the same rate may be used plus a small

one-digit percentage point. The use of other reference data that deliver one or several rates or premium estimate(s) may include listed companies' cost of capital (or industry's – in case the new investment opportunity refers to a different sector), or minimum rates of return, exemplified by for example the following statement:

“Methodologically, we have oriented ourselves to other companies[’ hurdle rates] and tried to gather data to get a rich picture; then we concluded, using 8%, we suit well into the landscape of other companies” (6_F1)

The use of other reference rates, e.g. the use of cost of debt of the branch of interest and analogous adjustment: 9_F, who noted that there are no other comparable listed biomass firms to derive risk adjustments for a biomass energy project for example, refers to external financing to draw analogies from:

“OK, let's say, our cost of capital is 10% and we see that hydro projects lenders require, let's say, 9% and then we see that in biomass projects, lenders are requiring 11%, so we will say for example, our 11% is 20% higher than 9%, so that's the lenders' required spread, ... we would try to apply a, let's say, proportional adjustment to our cost of capital. ... Lenders were requiring 9, they went to 11, we were at 10, we would go to 12%.”

Section 5.5.1 summarises the findings of the different judgement types implied in the setting of hurdle rates. It furthermore derives the heuristics that these types of judgement may suggest.

5.4 Additional Findings

5.4.1 Risk analysis

Various forms of formal and informal risk assessments take place. Undeniably, everyone involved in appraising an investment project has some sort of risk perception in mind. Many of the risk factors summarised in Table 1 have been mentioned or implied by the interviewees. Moreover, attempting to mitigate or minimise risks is common practice and strongly accentuated by the interviewees (via e.g. “try and buy” or becoming informed about liquidity of suppliers, 12_T). 12_T suggests first of all a general examination whether a specific risk is particularly high which would entail necessary adjustment and whether the ‘not take any action’ alternative is not the desired one; and after such considerations, risk is (formally) integrated, i.e. considered and assessed, in the decision paper or formal template as found to be standard procedure, see Chapter 2.

As regards formal risk assessments in general, no surprising insights can be derived aside from what should be done in an appraisal as suggested by literature: Investment proposals for the (board of) directors do consider specific risks qualitatively: a list or a catalogue of ‘soft

factors' includes the 'non-monetary benefits' of the investment proposal complements the financial appraisal.

Quantitative risk adjustment of a DCF analysis may be done in the form of for example scenario analyses as excessively outlined in the literature review of Chapter 2; the consideration of scenarios in the form of computer-aided simulations would be an elegant way to consider risks and what happens if the factors vary, as one finance director (14_F1) indicates, but this is seldom done in practice, as also has been noted elsewhere, and a more pragmatic, i.e. simplified procedure like the before-mentioned scenario analysis is used – including an implicit subjective assessment is made what the most likely problems are, as stated by the same person:

“In reality, one analyses, what the highest risk is, for example the client discontinues to work with us, or my production is more inefficient by 2%, this means one identifies a scenario rather depending on what the most likely problems are ..., e.g. perhaps we need two more years to develop this item and the client does not pay for it, then you have a closer look. But we would not do the analysis with fixed values, say +/- 20% or similar.” (14_F1)

Interestingly, we found some indication for intuition to influence formal risk analysis:

“We will often calculate scenarios – different ones where we just calculate once we have a bad feeling. We would, in any case, consider how does a value change if the ... revenues or the costs are higher by a certain amount.” (6_F1)

With reference to a decision paper and the outline of risks, which level of detail of risks should be included may depend on the recipient(s) to not overwhelm him or her: “The recipients are important and thereby the level of detail Are details relevant for the decision? ... This also requires experience how much detail is included.” (12_T)

As regards informal risk assessments or incorporating risks, we did not find surprising results as compared to what has been identified in the literature. Scenarios may also be thought through intuitively, particularly if scenarios are not formally considered:

“In any case it [an analysis of scenarios] does not use a specified formula or rule, but it is considered mentally, sure. ... Well, in estimating costs, I always do it ... unless we buy an engine and it has a fixed price.” (13_T)

An interesting point has been made by 12_T as to what risk also is: “Well, risk considerations are a trigger for investment decisions from my point of view, because the basic risk in the first place is: what happens, if I don't make this [investment]?” Certainly, a firm's management would not consider an investment if the current situation were not undesirable, required improvement, or for strategic reasons, some action should be taken. However, 12_T's perspective may shift focus from solely considering the risks of the project under consideration, which is usually advocated, but to the risks of refraining from investing and not taking any action, which typically does not find expression in a hurdle rate.

5.4.2 Group Decision-Making

In general and as commonly known, discussions in small groups are generally practiced and considered a helpful tool to make a decision more objective; procedures certainly vary, but generally, the management accounting department is always involved to review the proposed cash flows. Although we are primarily concerned with judgements rather than decisions made, the peculiarities of relevance for this work are noted.

As one of several managing directors and as the head of production at the same time, interviewee 5_T stresses that every member of a group has certainly made different experiences and may judge a situation differently, “I will not make the decision by myself ... and most of the time there are five people, who all have had their experiences.” Thereby, various evaluations of the same situation may exist which may mutually influence each other.

A group in such cases is generally seen as corrective of individual judgement which may potentially be distorted: Not only will management accounting critically review proposed and potentially biased figures to ensure a most objective decision basis (6_F1) – but also may teams or boards aim at eliminating potential distortions including a four-eye-principle on appraisals:

“What we also have done for many years is having implemented the four-eye-principle within the management accounting department; someone with not such a close proximity to the project will critically look at the appraisal including a check for plausibility.” (10_F1)

Knowing very well about the limitations of rational decision-making in practice, individual judgement seems to be potentially more (simplified and) flawed than group judgement:

“A group is actually a good corrective factor There is also the question of, are there any rational decisions? – I may doubt this; but there may be a decision with a broad common denominator.” (5_T)

And as may be implied in previous statements and in Chapter 3, judgement may also be skilled. If this can be assumed, skilled judgement has to be recognised by the group for this judgement not to be corrected.

However, at some point, it is a person’s individual responsibility even though having dealt with a proposal in teams: “Eventually – if a higher amount of money is at stake – one person has to sign the proposal” (12_T). Despite the relevance of group judgement and decision-making, this highlights that an individual eventually has to sign what s/he considers most relevant and plausible. Particularly if an individual is highly confident in estimates, own judgement may be given more weight than other people’s opinion, which clearly marks the relevance of addressing individual reasoning.

5.5 Indications of Heuristic Reasoning in Investment Appraisal

5.5.1 Indications of Heuristic Reasoning in the Hurdle Rate

Having hypothesised about the potential for bounded rationality and heuristic reasoning in the projections of cash flows and in the setting of the discount rate in Chapter 4, the interview study aimed at identifying the indications of heuristic reasoning. Examining practitioners' behaviour, we identified the practice of cash flow estimation and hurdle rate setting according to the different types of information outlined in Chapter 5 (Harvey, 2007). Based on these findings, we now discuss which types of information showed significant relevance in project appraisal practice. Accordingly, we hypothesise about the relationship to heuristic reasoning in the particular contexts of cash flow projections or hurdle rate setting which will lead to the experimental study addressed in Chapter 6.

As regards judgement based on the retrieval from memory (*Ila*), the *availability heuristic* plays a role (Harvey, 2007), as indicated in Section 4.3.2. Referring to the hurdle rate setting, it may assume that instances retrieved from memory that are easy to access, serve as a cue for assessing the risk of a project which translates into a hurdle rate.

We found a variety of indications for recalling past projects and outcomes from memory – the particularly negative ones were reported at a relatively higher level of detail, the positive ones were certainly not forgotten, but they were elaborated on at a lower level of detail. This may certainly be due to the fact that successful projects represent the 'normal' case to the decision-makers – otherwise, the firm may not be in business any more. The exceptional and mostly negative cases such as project failures or nosedives, may have been remembered in more detail and thus were more prevalent due to for example their salience or vividness. Hence, they may be easier to retrieve from memory than more ordinary past outcomes.

Hornung, Luther and Schuster (2016, see Appendix 2 for the full text of the journal article) already hypothesise that the availability heuristic is employed to make a judgement about the appropriate hurdle rate. The paper even goes one step further than only hypothesising about a heuristic¹⁰⁰ and a potential bias which we will outline in the following paragraphs: It explicitly considers potentially incorrect assessments and feedback to previous appraisals, i.e. the project post audit stage and how thereby future hurdle rates may be influenced. The paper systematises scenarios, outcomes and feedback options and outlines how project failures and incorrect assessment – as far as one can assess what is correct or incorrect in the hurdle rate decision –

¹⁰⁰ Hornung, Luther and Schuster (2016) relied on the original concept of the heuristics-and-biases programme (e.g. Tversky and Kahneman, 1974) in theoretically deriving what the underlying heuristic is for an observed suboptimal effect in practice. As indicated before, Kahneman and Frederick (2002) revised this concept and in a more detailed way, specified the mechanics of heuristics. However, the assumed behaviour i.e. the judgement resulting from heuristic reasoning that functions via attribute substitution, is not assumed to be different.

may systematically lead to too high hurdle rates and thereby even contribute to explain the so-called Hurdle Rate Premium Puzzle (see Chapter 2).

Figure 14 systematises and graphically depicts the problem by identifying eight cases, their decision outcomes and interpretations by the decision-maker. In Cases A, B, F and H decision mistakes were not made because even with the appropriate hurdle rate, the decision (accept or reject project) would have been the same. Cases D and E represent appropriate risk assessments and settings of the hurdle rate and are therefore not considered further.

In Case A, the decision-maker has – based upon their risk assessment – set the hurdle rate too high but the project nevertheless is accepted and will not lead to a loss in company value, i.e. with hindsight, it will be seen to be ‘good’. This implies that the projected cash flows must have been sufficiently high to compensate the inappropriately high hurdle rate effect. Error does not result from the hurdle rate being set too high in this case. The same logic applies to Case F which was correctly accepted, due to strong positive cash flows, despite an underestimation of risk and an inappropriately low hurdle rate.

With regard to the feedback provided to the decision-maker we should now consider the investment decision-making process and its final step the follow-up monitoring phase of a project (Stage 7 of Figure 4) and in particular of the cash flows and the risk assessment (target-actual comparison and resulting analyses) followed by feedback and learning. This stage is illustrated in the right column in Figure 14. If a routine mechanism is established which *ex post* explicitly analyses projects that have been accepted (i.e. the cash flows and whether the risks were adequately considered and thus the reasons why a project may not have turned out as projected) then decision-makers will get feedback on projects that have been accepted, such as Cases A, D, F and G. The analysis will reveal that the cash flows had been estimated too high, too low or appropriately and what risks were considered adequately or not and why (cf. Category II). In doing so, a false appraisal of the hurdle rate in Cases A and F will become evident (green feedback fields). However, the decision-maker is unlikely to perceive the non-appropriate risk assessment and hurdle rate as significant because the decision would not have been altered using the ‘correct’ rate.

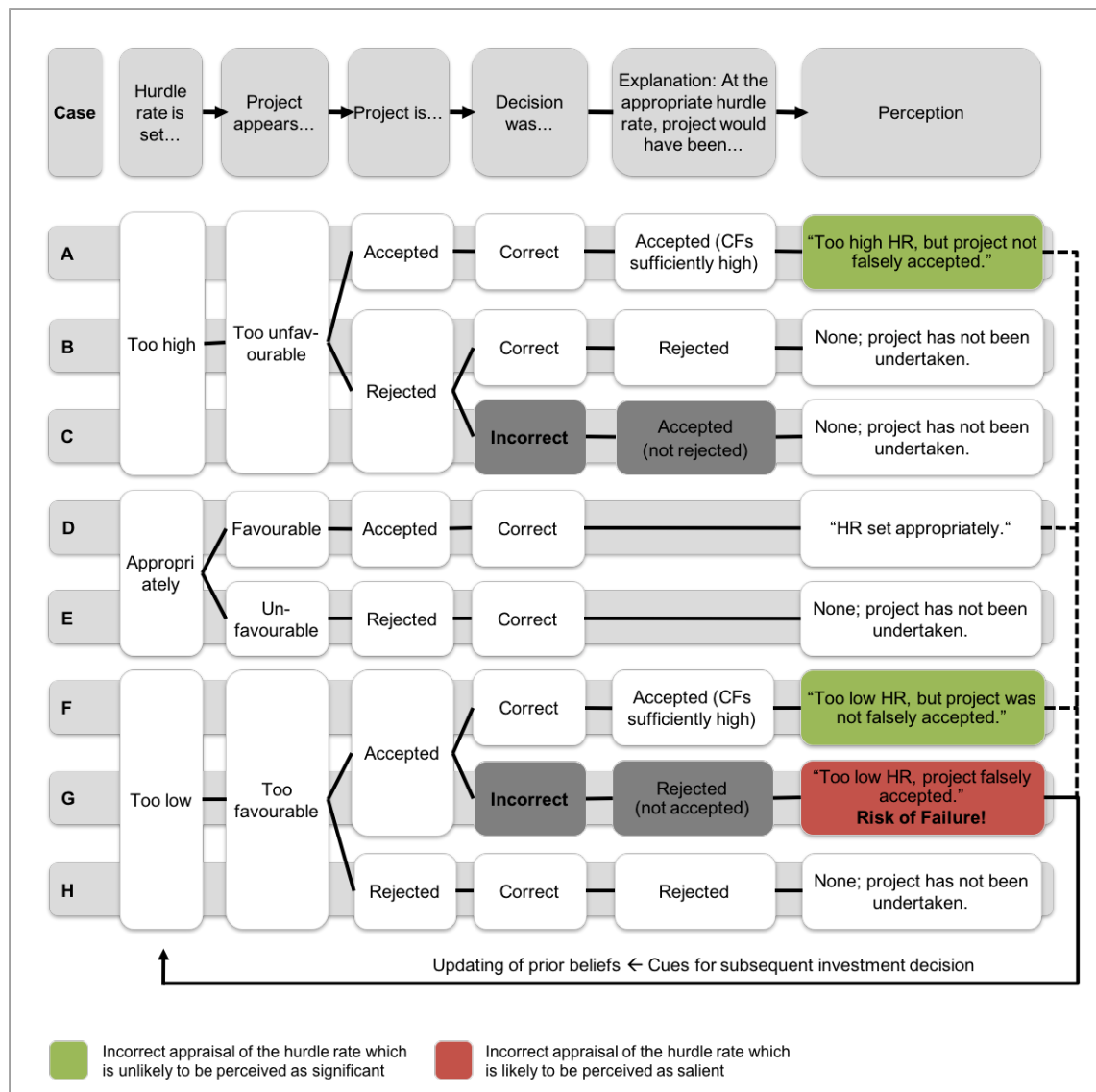


Figure 14 Decision-maker's perception of the setting of the hurdle rate (HR)

When evaluating a similar project next time, this analysis with its insights on the (inappropriate) risk assessment and thus setting of the hurdle rate (should and) probably will be taken into account by the decision-maker. The bottom arrow of Figure 14 represents learning about one's ability and updating one's prior idea about the appropriate risk and hurdle rate when new information arrives (see Gervais, 2010). New information comes particularly from post audit feedback on projects that get adopted (A, D, F and G); this will affect the decision-maker's subsequent estimates of the most appropriate hurdle rates. We note that the feedback that managers get can be of low quality as it is imprecise and slow, and investment decisions are made infrequently and irregularly, which complicates learning (Gervais, 2010). Knight (1921, p.281) cautions that "in business management no two instances, perhaps, are ever very closely alike, in any objective, describable sense." However, we can assume that experienced decision-makers have capacity to integrate new information and compare it to previous situations so that

learning does happen. A formal or an informal post audit of projects may provide information about the mistakes in the appraisal; realising that the initial risk assessment was insufficient may happen consciously but, more importantly, also unconsciously.

The essential point is that the feedback on some investment decisions, such as G, which ‘go wrong’ might be more salient and vivid than on others such as A and F which turn out as successes. With regard to Case B (H): The project’s risk is not adequately recognised and may be underestimated (overestimated); thus the hurdle rate is set too high (low) and the project is rejected due to a negative NPV, but the erroneous rate is not obvious; the decision-maker will not be aware of the false setting of the rate, because companies seldom organise follow-up monitoring on projects that have been rejected. The decision-maker is thus not in a position to use this information when assessing the next project. Furthermore, even if *ex post* reviews were carried out on B and H, they would show that despite the inappropriate hurdle rates the appraisal outcomes were, in fact, the right ones.

Our model contains two scenarios for incorrect accept-reject decisions: First, a false positive case is represented by Case G in Figure 14. The project was not rejected but with an appropriate rate it would have been rejected. The hurdle rate was set too low, which resulted in insufficient discounting of future cash flows. This can result in accepting a project which is later seen to generate a negative NPV. The poor decision evidenced by a poor outcome is likely to be a salient event (red feedback field in Figure 14) and can generate the previously described retrievability bias and an incorrectly raised hurdle rate in future appraisals.

Secondly, a false negative case is given in Case C of Figure 14. The project risk is overestimated, the hurdle rate therefore set too high, and the project is rejected due to a negative estimated NPV. With an appropriate (lower) hurdle rate, the appraisal would have correctly shown a positive NPV for the proposed project and the project might have turned out to be successful *ex post*. However, the decision-maker will not realise the false decision because the project will not be undertaken. The decision-maker is unlikely to get feedback on the mistaken risk assessment and having set the hurdle rate too high and so does not learn from the experience. This case illustrates the long-term consequences of setting the hurdle rate too high; projects are falsely rejected resulting distorted estimates of projects’ profitability and in underinvestment. Moreover, and as indicated above, risky projects are systematically preferred to low-risk projects (Titman and Martin, 2015) and a short-term bias is induced (Dobbs, 2009).

Figure 14 summarises the different combinations of ‘too high/too low’ and ‘accept/reject project’ and shows the cases in which feedback is provided to the decision-maker on the project appraisal that may influence the setting of the hurdle rate. Perception and cognitive processes, reinforced by the one-sidedness of the post-audit process in concentrating only on adopted proposals, will impact the decision-maker’s judgement and subjective reasoning when

evaluating future projects. As Case G is a much more salient event, the false risk assessment and thus inappropriate setting of the hurdle rate (too low) will influence the judgement more severely than Cases A (too high, but project succeeded nevertheless) and F (too low, but project succeeded nevertheless).

Furthermore, we can assume that projects which proved to be successful are subjected to investigations less frequently and thoroughly than those, which fail. I.e. cash flows and discount rates might not always be evaluated in a detailed and comprehensive way for positive NPV projects *ex post*. If so, then Cases A and F will result in even less feedback to the appraisal including the risk assessment than will Case G and the argument is strengthened further.

The two extremes of *ex post* feedback – on the one hand, no (or lax) follow-up in the case of non-adopted or successful proposals and, on the other, a thorough follow-up mechanism on bad investments – give different levels of information to the decision-maker. A rigorous follow-up monitoring of all proposals could uncover the false setting of hurdle rates. However, these procedures might still not overcome the disproportionate effect that an accepted project's failure has on the decision-maker's intuition and the retrievability bias may persist. Failure of the project in general, and the failure of a project due to a false appraisal as regards the setting of the hurdle rate, as in Case G, remain the most influential events and will be more available in memory for the next project decision when events like these are retrieved. It will serve as a strong cue to influence cognitive reasoning and thereby the judgement.

The event 'hurdle rate has been set too low' stays in memory more easily. The event '(possible) failure' is likely to come to mind more easily and thus a higher hurdle rate appears to be more suitable, and is therefore more 'probable', than the truly appropriate one. To the decision-maker, it seems it might help to avoid a decision mistake and wrong acceptance of a project, and will thus influence judgement. In other words, if – next time – information on which hurdle rate to set is retrieved from memory as the availability heuristic would suggest, the setting of an underestimation of risk (and thus a too low rate) leading to an error, will be the cue that is intuitively more promising. Hence, the decision-maker will tend to revise the previous hurdle rate upwards but would not systematically set a hurdle rate too low; this explanation is in accordance with empirical findings relating to the hurdle rate premium.

While they are not claiming to provide a complete explanation of the Hurdle Rate Premium Puzzle, Hornung, Luther and Schuster (2016) believe that the availability heuristic and the noise in feedback on adopted investment proposals play a systematic part in explaining why hurdle rates are set above the rationally advocated discount rate, and thus help solve the paradox.

Hornung, Luther and Schuster (2016) also hypothesise about empirical testing to validate the observed effect in the setting of the hurdle rate. An experiment could address the effect of past experience of failed investment projects, and of the review process, on future risk

assessments and thus the hurdle rate decisions. They suggest a testable hypothesis: The more failures of investment projects a decision-maker has experienced, the higher the risk premium incorporated into the hurdle rates applied in future project appraisals. This will hypothesis will be examined in *Experiment 1* of the quantitative study of Chapter 6.

As regards judgement of Type *Iib* – another type of implicitly available information – a remark that was particularly interesting refers to the influence of the feeling of like/dislike, which appears particularly interesting. However, their impact on decision-making and the derivation of a hurdle rate has not been fully clear considering the interview data. As a particularity, affect and especially the feeling of dislike or like that are evoked may influence the risk assessment as previously outlined in Chapters 3 and 4. In the sample statement identified above, liking a product or project implied that the implementation and sales figures of the investment into launching a new product appear less risky than they are. These links between feelings and risks results in the affect heuristic taking affect as an effortless cue to arrive at a judgement. *Experiment 2* elaborates on the potential influence of affect on a hurdle rate estimate.

Searching and retrieving information that may provide a hint for the risk of the current project under consideration based on explicitly available data (*Iic* and *Iid*), appears to be the most common practice among the interviewees deriving project-specific discount rates. Judgement can be based on analogy to similar instances.

Judging the particular risk of a project may be replaced with the easier question of how a similar project turned out. This result may be available in various forms or formats. Either information about other variables' outcomes, such as actual cash flows, environmental events, NPV, volatility indicators and other analogy data may be retrieved pointing to mainly the representativeness heuristic as derived in Chapter 4; or information about the same variable, i.e. previously applied rates (*Iid*) with the proposed rate representing plausible information to serve as an anchor point. We found more indications and fewer indications of *Iic*, the instances reported do seem that common or effort-reducing. Relying on other rates in general is almost always possible and much more salient and common practice *Experiment 3* will examine the relevance of previously applied hurdle rates and will be further developed as to whether other proposed rates that bear no relationship to a project under consideration (i.e. representing implausible information) are used as cues for determining a project-specific rate.

Correction of the hurdle rate due to overconfidence also played a role and whether excessive confidence or optimism are traits to be eliminated is highly debated. Aside from adjusting cash flows, we found decision-makers recommend the adjustment of the discount rate in this cases. Adjusting the hurdle rate due to overconfidence is not considered a heuristic but can be seen as the relatively rational response to biased cash flow projections. Nonetheless, and

as a side effect in this work, we are interested in investigating the relationship of a common proven cash flow bias and the hurdle rate. In other words, we aim to observe whether overconfidence of the person responsible for preparing an investment project's cash flow estimates influences the risk-adjusted hurdle rate estimate. *Experiment 4* therefore investigated whether – if too optimistic cash flow forecasts were present – adjustment in the hurdle rate in terms of an upwards adjustment is actually made.

5.5.2 Indications of Heuristic Reasoning in the Projection of Cash Flows

As regards the cash flow projections, the following types of pure judgement were considered relevant: Considering judgement of Type *Ila*, deriving a numerical (e.g. Euro or Pound) estimate purely based on retrievable information from memory without the help of any explicit data, is rarely found; this strongly depends on experience and technical expertise, which would be therefore less relevant for finance or accounting professionals. Percentage safety margins in turn, as indicated, are common practice and also applied by less experienced or less technically knowledgeable decision-makers. Further investigation would be needed to better distinguish these cases. Due to this ambiguous result, we may give priority to the more obvious relationships in the quantitative study to follow up; however, we do not intend to understate the importance of experience and relevance of heuristics in this judgemental type.

No indication was found for affectively loaded judgement in the context of projecting cash flows. A clear tendency could however be found that judgement of Types *Ilc* and *Ild* seem to represent typical cases when making an estimate about a cash flow component.

Based on our reasoning in Section 4.2.2, the following heuristics in the judgement of projecting cash flows can be hypothesised: The retrieval from information from accounting records, i.e. making cross-reference, and deducting what this would mean for the project under consideration represents retrieval of explicitly available data of other variables (*Ilc*). This points to the representativeness heuristic as Harvey (2007) noted: Similarity may serve as indicator for how data from accounting records may be used and adapted to the current situation, despite one or several instances from databases may not capture the universe of possible outcomes for a project under consideration, but reasoning analogously may intensely facilitate reasoning. Therefore, the question of what the best estimate is may not be based on a consideration of the full range considering probability distributions, but may be replaced with the easier question of how a similar project turned out, i.e. how representative the considered project is for a project of a database or similar, and an estimate is made by reasoning analogically. This claim will further be developed and picked up in *Experiment 5*.

We have also frequently observed decision-makers to report reliance on past outcomes or estimates of cash flows or for example growth rates of particular cash flows) from databases,

which implies the retrieval of explicitly available data of the same variable (*IId*), i.e. a cash flow component. The numerical value may have an impact on the final judgemental estimate of the cash flow estimate since potentially relevant knowledge may be evoked which makes adjustment to the given anchor using knowledge not sufficient; reliance on it may be stronger than without it, thus giving an indication of the anchoring effect. Rather than a slower, more sophisticated analysis, a quicker mental time series may be conducted, as picked up by *Experiment 6*.

Estimate made using...		Relevance for...	
I Aided judgement (formula-based)	Judgement required:	Cash flow	Hurdle rate
	Ia What terms or variables to include in formula or model	•	•
	Ib Adjust formula-based estimate to allow for the influence of factors not included	+	+
	Ic Combination of formula-based and pure judgement-based estimate	•	-
II Pure judgement	Types of information used:	Potential heuristic	
	Ila Information held in memory – implicitly available	→ Availability	• +
	Ilb Affect – implicitly available	→ Affect	- +
	Ilc Information about the value of another variable – explicitly available	→ Representativeness	+ •
	IId Information about the value of the same variable – explicitly available	→ Anchoring ¹⁰¹	+ +
+ High relevance • Low/medium relevance - No relevance Types of judgements to be further examined			

Figure 15 Types and judgement and indications of heuristics¹⁰²

The results of the interviewees' judgement in the two investment appraisal dimensions are summarised in Figure 15: The different types of judgements' relevance in practice has been

¹⁰¹ Not considered a heuristic based on attribute substitution theory.

¹⁰² Results of the interview study types of judgement and heuristics based on Harvey (2007), see Figure 11.

consolidated, acknowledging that this way of illustrating the findings does not lend itself to all facets or detail. Those categories that evoked high relevance or indicated surprising results, framed in red colour in Figure 15, will be examined in detail in our quantitative study in Chapter 6.

An analytical process of estimates uninfluenced by subjective judgement is clearly impossible. Thus, behaviour by definition is suboptimal in this sense, as outlined in Chapter 4, which however does not pose a problem: Most strategies that have evolved may therefore be considered boundedly rational since they may have proven to deliver reasonable results until it will be known better and new procedures/ways of reasoning replace the previously used ones.

As argued, effort is reduced by any strategy that does not equal the analytical, mostly computational way. The indications of judgemental rules that we have identified do quite often represent plausible strategies. Judgement in no case has been objectively found to be false; instead, strategies must come at a certain advantage in obviously providing a good judgement at lower effort.

5.5.3 Summary and Limitations

Based on the hypothesised potential for heuristic reasoning when estimating both, the project cash flows and a risk-adjusted hurdle rate in Chapter 4, this chapter intended to examine the specific types of judgements involved by a qualitative study of practitioners involved in investment appraisal: Two different types of judgement were addressed (see Figure 11): aided (*I*) and pure judgement (*II*) (Harvey, 2007). Aided or formula-based judgement conceptually refers to what kind of options exist to combine personal judgement and formulas. Purely judgement-based estimates are identified by reference to the type of information used. For those types of information that were found relevant, the potentially resulting heuristics were identified that serve the basis for the experimental study of Chapter 6.

As regards aided judgement (*I*) in the determination of the *hurdle rate* or a premium, various indications were found where, in addition to formulas, judgement is applied. Judgement is used to select the model or the parameters of the model to get an estimate, as for instance selecting the parameters such as for the CAPM to calculate a cost of capital estimate (*Ia*). Judgemental adjustments based on formula-based figures (*Ib*) with a premium added seems to be the most common practice for project-specific rates. If company-wide rates were applied, the cost of capital or adjusted relatively higher than the cost of capital were found. This, however, does not yet provide a sufficient indication about how the adjustment, i.e. a premium itself, may be determined. We may find explanations in considering ‘pure judgement’ (*II*). Instances of *Ic* were not found.

Judgement of Type *I* served to conceptually identify where (pure) judgement is included in the hurdle rate (or in the cash flow forecasts) and often supports pure judgement by formulas, rules or models as indicated in Chapter 4; this category will not be considered further in this work.

With regard to the pure judgement in the setting of the hurdle rate, we considered judgement of Type *Ila* to provide an interesting case for the availability heuristic. It may contribute to explain the widely detected practice of systematically setting hurdle rates too high and will be examined in Experiment 1. Moreover, few instances pointing to the use of affect (*Ilb*) towards an object were reported by the practitioners. Nevertheless, despite the rare indications in the study and thus the possibility that affect partially or fully substitutes risk judgement in the context of project appraisal, highly surprising and thus worth being investigated further (Experiment 2). Though we have seen that judgements are widely based on similarities to previous projects, both Types of judgement *Ilc* and *Ild* were considered relevant. The reliance on other rates, when assessing risk and deriving a project's hurdle rate, was of particular relevance since a variety of other rates in- and outside of a company are employed as reference points. We will therefore also investigate the effect of anchoring in Experiment 3.

As an additional effect of interest, we identify the relationship between overconfidence resulting in forecast bias and the hurdle rate setting; in particular, whether an adjustment of the hurdle rate is considered when the person responsible for preparing cash flow estimates can be assumed to be excessively confident. This will be addressed in Experiment 4.

As regards the *cash flow projections*, all three conceptions of how judgement may be involved in formula-based estimates could be identified in the sample companies. Particularly judgements to adjust initial (given) cash flow data *Ib* (such as including safety margins) in absolute ways (adding an amount or rounding) or relative (adding a percentage) represent typical practice (Category *Ib*) were found, though the latter practice was clearly dominant.

For the projection of cash flows, we found judgement of Types *Ilc* and *Ild* most relevant. We claim that representativeness serves as a heuristic attribute when facing the difficult task to estimate a cash flow in a complex or unknown environment, which will be examined in Experiment 5. Secondly, the anchoring effect may occur in that a numerical anchor influences cash flow estimates which will be addressed by Experiment 6. The findings as regards the judgement of Type *Ila* were ambiguous and would require further analysis.

In summary, rich statements could be identified as indicators for heuristic reasoning by individuals which will be followed up in the experimental study. As heuristics are effort reducing decision strategies used by individuals, it is self-evident that group decision-making may only indirectly include heuristic reasoning, namely to the extent that individuals have used heuristics to arrive at a judgement or decision. However, and as board decision-making is

common practice in companies, the process of what happens with potentially biased judgement in small groups becomes more interesting but beyond the scope of this work. As indicated in the data, small groups may serve as a corrective and to make a judgement or decision more objective. Nevertheless, if one person is made responsible for a particular evaluation, outcome or decision, reliance on own judgement should not be underestimated.

The interview study may be limited to the coding and interpretation of the interviewees' statements, which came through the lens of the researcher. However, interpretation and application to the topic under consideration was certainly necessary and cannot fully be avoided in a qualitative study. Moreover, getting a rich sample of companies from various industries and people with various roles and positions that are relevant for the present topic was aimed for and undoubtedly benefited from it. However, the interview study's expressiveness may be restricted to the peculiarities of the sample companies and experience of the interviewees. As outlined, the next step will include an experimental examination of whether judgement relies on the hypothesised heuristic reasoning in practice, based on a large sample; it will thus serve to overcome parts of this limitation.

6 Quantitative Study: Experiments

6.1 Methodology

6.1.1 Purpose

Based on the previously refined conceptual framework model, an experimental study will examine the selected heuristics in both dimensions of investment appraisal (the cash flow projections and the hurdle rate determination). It will seek to demonstrate in a structured way how bounded rationality in the form of reasoning by heuristics, supplemented by further potentially relevant judgemental rules, can impact investment appraisal. Therefore, the experiments in this chapter complement the addressing of RQ2 and RQ3 by interviews reported in Chapter 5.

The heuristics under consideration refer to making judgements about magnitudes, frequencies and probabilities based on limited information and making use of easy-to-access cues (Shah and Oppenheimer, 2008) rather than reasoning based on slower analytical procedures. Judgements to be made include the choice of risk-adjusted hurdle rate and cash flow estimates. We will investigate major general purpose heuristics based on the interview study and the literature concerning the reasoning process applied by human beings. Making use of experiments by modelling fictitious short company cases (as for example Barton and Mercer, 2005) allows the researcher to control and manipulate information to be used.¹⁰³

Heuristic reasoning will be studied by way of outcome analysis.¹⁰⁴ Outcome analysis means observing the decision as to which of the alternatives provided will be chosen and outcomes have to be separable. In this study the variables, hurdle rate and cash flows, are non-discrete and estimates are sought as outlined below. Outcomes were thus not separable; however, comparing different groups (treatment and control) to each other is feasible: We are then able to observe whether a particular piece of information which is easy to access, is used as an effort-reduction cue to arrive at an estimate; and in this way we can conclude whether heuristics play a role in a particular context of the project-specific hurdle rate setting or the cash flow projections in investment appraisal. We may also find a person's estimate to be significantly distorted because of the use of easy-to-access cues.

This outcome-based approach of investigating heuristics requires that there is a common (objective) basis for all respondents, i.e. an objectively identifiable non-biased judgement and

¹⁰³ As is the intention and major purpose of conducting experiments (see e.g. Libby, 1981; Creswell, 2014).

¹⁰⁴ As Shah and Oppenheimer (2008) point out, outcome analysis is one way to study heuristics besides computer simulations and process tracing such as eye-tracking.

therefore value. In each scenario or case, the respondents are divided into one control and one or more treatment groups. By observing the control group, we can conclude what a non-biased response may be: a ‘default’ that we can compare the treatment groups’ responses to. In this way, we counter potential objections that there may not be a perfectly rational answer or value to be derived in the fields of hurdle rate decisions and cash flow forecasts.

The search for reasonable values for our target attributes – as outlined in Chapter 3 – can summarised as follows: A hurdle rate estimate is expected to be based on a previous analysis of potential risks and their probabilities with regard to average company risk; such analysis will conclude with an estimate of how likely a project is to fail and thus, how risky a project is, compared to the overall company risk. A cash flow forecast is also based on a variety of considerations of different courses of action, their probabilities and the relevant underlying assumptions; i.e. both target attributes are relatively complex and difficult to determine and thus per se not easy to access. Based on Kahneman and Frederick (2002, p.54), “The intent to judge a target attribute initiates a search for a reasonable value.”, we claim that easier-to-access attributes serve to approximate the target attribute. We therefore develop short corporate cases that for the treatment group(s) include different relatively easy-to-access cues, representing easy-to-retrieve information, that “is computed quickly or has been made readily available through other means” (Shah and Oppenheimer, 2008, p.210). We will then be able to observe how people’s judgement is influenced by the existence of the cue. In this way, we have considered the following requirements of attribute substitution and thus for heuristic reasoning to take place:

- (1) the target attribute is relatively inaccessible; (2) a semantically and associatively related candidate attribute is highly accessible; and (3) the substitution of the heuristic attribute in the judgment is not rejected by the critical operations of System 2. (Kahneman and Frederick, 2002, p.54)

6.1.2 Participants

Subjects were required to be financially educated, typically experienced business or finance/accounting postgraduate students who are trained for upper management decisions and their instruments. Participants were expected to have knowledge about evaluating an investment using the Net Present Value Method and about the role of cash flow projections and hurdle rate setting. Student groups were selected from the researcher’s contacts in various business schools.

Participants were randomly assigned to either the control group or one of the treatment groups; which experimental group a subject belonged to varied between the different experiments/cases. Since the focus was on how subjects integrate particular pieces of information rather than on observing decision performance, the experiments were not incentivised on the basis of their responses.

The study analyses responses from 328 students. 65% were male, the mean age was 25.2 years and they included 8% 4th year undergraduates (see Table 14 for more details about the sample). Participants attended The study 17 universities in six countries (Brazil, Germany, Italy, Spain, UK, USA) with students from 64 nationalities. 80% of the respondents already had work experience with an average of 3.4 years; 18.7% had managerial work experience with 2.6 years of experience on average.

The study was designed to identify those respondents who have a solid understanding of a concept crucial for a hurdle rate judgement, namely of the role a discount rate plays in a net present value calculation in investment appraisal. This was examined in a control question asking of which statement is true for a ‘typical’¹⁰⁵ investment project of whether a) ‘The higher the discount rate, the lower the net present value’, b) ‘The higher the discount rate, the higher the net present value’, c) ‘A net present value is not affected by the discount rate’ or d) ‘Don’t know’. 70% of all respondents answered the control question correctly.

As to the interpretation of the control question, we speak of ‘experts’ denoting those who have correctly solved the question and thus display an appropriate technical understanding of what a discount rate does; and non-experts denoting those who have responded incorrectly. We apply the following reasoning:

‘Experts’ denote those student respondents who have a deeper knowledge of financial relationships. They represent the finance and/or accounting professionals who are primarily involved in setting of hurdle rates in large firms; consequently, we can focus on analysing this group’s behaviour in the hurdle rate experiments. ‘Non-experts’ denote those respondents who are educated in business administration as by their previous and/or current study programme but who do not have superior knowledge about an appraisal method and a hurdle rate; they represent other corporate decision-makers who may not be finance or accounting professionals but who may also be involved in investment appraisal by collaborating to prepare cash flow projections and who may nonetheless have acquired a solid understanding of business and management since they fill senior or even managerial positions. They may have strong expertise in other fields, but represent ‘non-experts’ in the field of accounting and finance.

The expert group still serves as the main group to be focused on. For hurdle rate problems, we will exclusively examine the expert group since this represents a problem typical for a finance or accounting professional. For CF problems, we may consider the expert and non-expert group in total since this represents a problem typical for corporate decision-makers

¹⁰⁵ The respondents were told “typical: an initial cash outflow followed by mainly cash inflows over the life of the project”. Options included: a) “The higher the discount rate, the lower the net present value”, b) “The higher the discount rate, the higher the net present value.”, c) “A net present value is not affected by the discount rate.” or d) “Don’t know.”

involved in providing data for an investment appraisal, where finance/accounting professionals and non-professionals are involved.

In addition to the misunderstanding, by some respondents, of the relationship between discount rates and NPVs, some also suggested highly implausible cash flows or hurdle rates (e.g. 80%). Such ‘unreliable’ responses were not clearly related to the control question or other respondent characteristics. We can therefore not infer what their intention was; a future study of this kind may ascertain this. However, due to the large sample size, the analyses are not affected by ‘noise’ from these outlier values as will be pointed out in the respective sections below.

Experiments 2, 3, 4 and 6 were slightly modified after a first cohort of 275 subjects (see the respective Sections 6.1.5, 6.1.6, 6.1.7 and 6.1.9 for an elaboration on the reason for and the kind of modification and interpretation); the non-modified ones (1 and 5) continued as before. For the modified experiments, a separate analysis is made. Giving an overview, there were 275 respondents in the first cohort and 53 in the second one. Sampling did not change; respondents continued to be filtered according to the above-mentioned criterion (advanced students in business and/or finance/accounting).

		Total	1 st Cohort	2 nd Cohort
Number		328	275	53
Control question	correct	229	184	45
	incorrect	99	91	8
Gender	m	.66	.63	.77
	f	.34	.37	.23
Age	mean	25.2	25.4	23.7
	median	24.0	24.0	23.0
	sd	4.3	4.6	1.9
Work experience	yes	.80	.82	.69
	no	.20	.18	.31
Years of work experience	mean	2.7 (3.4) ¹⁰⁶	3.1 (3.7)	.9 (1.3)
	median	1.5 (2.0)	2.0 (2.0)	.5 (1.0)
	sd	3.4 (3.5)	3.6 (3.6)	1.0 (.9)
Managerial work experience	yes	.19	.21	.04
	no	.81	.79	.96
Years of managerial work experience	mean	.5 (2.6) ¹⁰⁷	.5 (2.7)	.2 (.6)
	median	.0 (2.0)	.0 (2.0)	.0 (.6)
	sd	1.5 (2.6)	1.6 (2.6)	.1 (.6)
Study programme	MBA	.28	.33	.04
	MA/MSc Fin/Acctg	.30	.19	.87
	Other	.26	.29	.08
	NA	.16	.19	0

Table 14 Experimental study: sample characteristics

¹⁰⁶ Value in parentheses relates to those who indicated they do have work experience.

¹⁰⁷ Value in parentheses relates to those who indicated they do have managerial work experience.

6.1.3 Design

The, in total six, experiments outlined below presented different cases to the participants who were required to make judgements or decisions on each of them.

The first four experiments address the setting of the project-specific hurdle rate r and thereby the premium π that represents the target (and thus the dependent) variable. We have outlined in Chapter 2 (Section 2.4.1) that a common procedure of accounting for the specific risk of a project is to adjust the discount rate. The average company-wide cost of capital is usually known (determined by e.g. models such as the CAPM) and represent the company's average risk. The known average cost of capital c is typically adjusted; in this way, a project-specific rate r , and thereby a premium π , is determined ($r = c + \pi$). As we concluded from our interview study (Chapter 5), this premium may be determined based on judgement using different types of available information. Experiments 1 and 2 will address judgement based on *implicitly* available information (judgement of Type *Ila*). In particular, Experiment 1 will examine whether experience and thus implicitly available information from memory serves as a cue for the hurdle rate decision (availability heuristic). Experiment 2 will test for an affective response that is implicitly available and that may influence the hurdle rate (*Ilb*) (affect heuristic). Experiment 3 will examine to what extent *explicitly* available information about – plausible or implausible – rates plays a role in the hurdle rate setting (*Ild*) (anchoring effect). Experiment 4 will address whether corporate decision-makers intuitively correct for presumably biased cash flow projections due to overconfidence.

The final two experiments approach the projection of cash flows. They refer to types of forecasts that are of low complexity as described in Chapter 2 (Section 2.3.2). For these cases, a point estimate has been identified as sufficient if uncertainty is low, complemented by a confidence range if uncertainty is high (Schoemaker, 2004). As outlined in Chapter 4 and analysed in the context of cash flow projections in Chapter 5, using *explicitly* available information is relevant in the projection of cash flows. Experiment 5 will consider a case where an explicitly available instance that is similar, but unrelated may be used to arrive at a cash flow estimate (*IIC*) (representativeness heuristic). Experiment 6 will investigate to what extent explicitly available information about – plausible or implausible – estimates of the same cash flow plays a role (*IId*) (anchoring effect).

Figure 16 schematically outlines the procedure of analysis as illustrated before. E1-E6 denote the experiments as outlined below. E4 addresses the correction of a potential overconfidence bias in the setting of the hurdle rate; it is not directly related to heuristics and will thus not be listed in this figure. According to the previous interview study (Chapter 5), the hypothesised heuristics (red frame) will now be tested experimentally in the identified context.

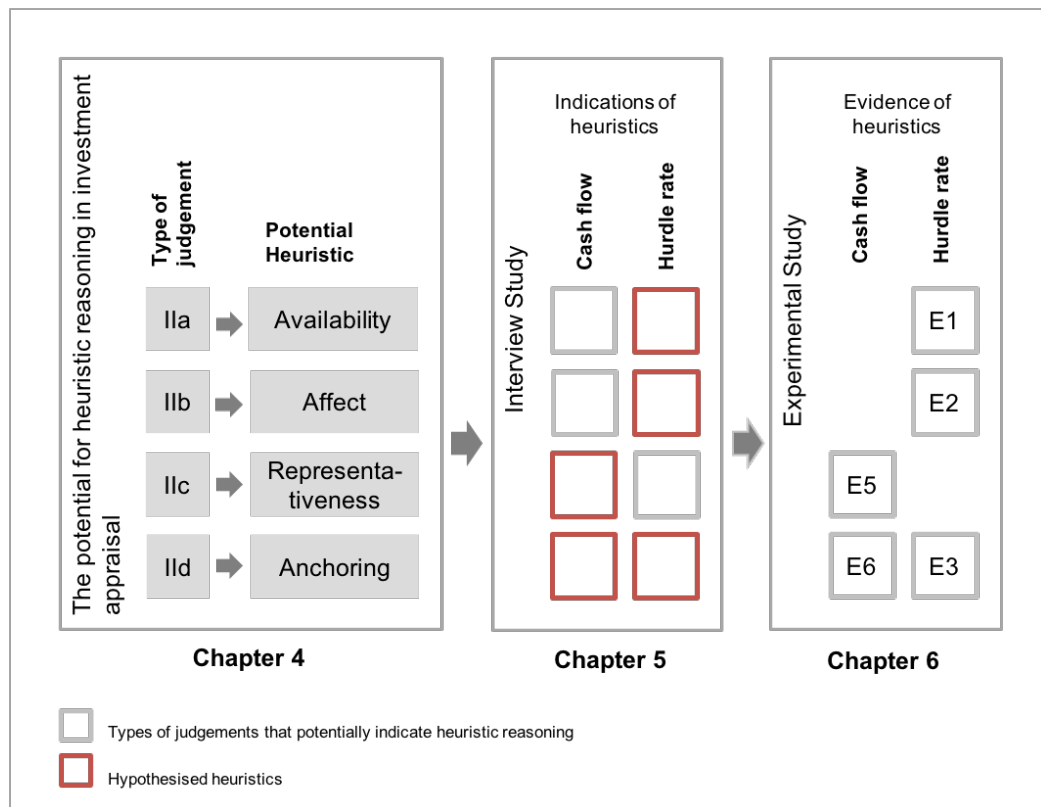


Figure 16 Schematic procedure of analysis including the generalised findings of the qualitative study

For each of five effects under consideration and similarly to Barton and Mercer (2005) and Cheng et al. (2003), a scenario about a fictitious company was provided to each participant. This includes a brief background about an investment project to be decided on with a few additional pieces of information to make the setting more plausible but not too complex. The role to be adopted by the participant was also explained at the beginning of each case. The cases and tasks will be outlined in detail below. Generally speaking, participants were asked to answer a series of questions about acceptance/rejection of a proposal, make judgements about the probability of project failure due to different causes implying the investment project's prospects and determining parameters based on the information provided (cash flow component, hurdle rate estimate). In this way, we were able to comply with "[t]he major purpose of experimental design [which] is to arrange observations of effects and causes or treatments so that we can be sure that observed effects are the results of our treatments" (Libby, 1981, p.11). This will be elaborated on in more detail in each experiment's section below. The survey of case studies concluded with a voluntary questionnaire about socio-demographic variables (age, gender, nationality, study background, work and managerial experience).

The experiments were designed as computer lab experiments programmed using the software SoSci Survey. As they were not interactive ones, subjects theoretically could take the survey individually at any place and time. However, preference was given to a lab or classroom setting to control the environment and the resources used. The software allowed validity checks by providing the time it took the subjects to respond to the questions or the whole survey to check whether subjects only ‘clicked through’ or whether it can be assumed that they have read the cases carefully.

Permission by the University of the West of England’s ethical review committee was obtained on November 15th, 2015. The experiments were pilot-tested with a group of 22 graduate business students at Schmalkalden University of Applied Sciences.

The experimental study used a between-subject design: In this way, control group and treatment group(s) can be compared to each other and the impact of the treatment can be observed. This study generally used a post-test-only control group design (using the Campbell and Stanley, 1963, notation system¹⁰⁸):

Group A R -----O

Group B R -----X-----O

Unless noted otherwise, there was one control group (here: Group A), and one or more experimental groups (represented by Group B here). The variable(s) X used in each experiment and the random assignment R of treatment groups will be discussed in the respective sections below.

External validity involves “the ability to generalize results beyond the specific tasks, measurement methods, and actors of a specific study” (Libby, 1981, p.11). Threats to external validity (as outlined by e.g. Creswell, 2014, pp.176-177) relevant to this current piece of research are addressed in the following way: Generalisation to individuals who do not have exactly the same characteristics as the participants in the study may be questioned. Many business and finance students lack managerial experience and this may partially influence judgement. Nisbett and Ross (1980, p.14) agree to Tversky that

there is *no* inferential failure that can be demonstrated with untrained undergraduates that cannot also (at least with a little ingenuity) be demonstrated in somewhat subtler form in the highly trained scientist).

Elsewhere, there is agreement that students can serve as proxies for decision-makers: (Experienced) graduate business students are considered proxies for (experienced) managerial decision-makers (Kotchetova and Salterio, 2003). And as regards management accounting

¹⁰⁸ The symbol O denotes the observation, here: a decision, judgement or estimate; X denotes exposing Group B to a treatment; R denotes participants being randomly assigned to groups (Campbell and Stanley, 1963).

experimental research: “[M]anager participants likely would exhibit many of the same cognitive biases as student participants” except for budgeting behavior or negotiation (Birnberg, 2011, p.6, pointing to e.g. Kennedy, 1993, Gilad and Kliger, 2008 and Vance, Kennedy and Webb, 2008). Several studies use graduate or even undergraduate business students unconditionally for making conclusions about corporate decision-making (e.g. Cheng *et al.*, 2003; Kotchetova and Salterio, 2003; Lewis, Shields and Young, 1983). The participants in this research are being trained for and have knowledge about upper management decisions and their instruments. Moreover, and what is an advantage relative to randomly selected corporate decision-makers, we know their study background and can thus be sure that they have been introduced to investment appraisal methods (Cheng *et al.*, 2003). In addition, surveying practitioners in an experimental design would not provide the same degree of control over the variable ‘experience’. Experience is induced in this study, so that every participant’s recent ‘experience’ is largely equal. Given information and simulated experience will be made use of – serving as a common means of experimentation.

Internal validity refers to designing the treatments in the way to be able to conclude that the results derive from them (Libby, 1981). Threats to internal validity (as outlined by e.g. Creswell, 2014, pp.174-176), relevant to this current research are reduced in the following way: All participants in control groups and in treatment groups experience the same external effects thus ensuring that distortion or undesired influences are avoided. Furthermore, during the duration of study, the economic environment and circumstances have not changed substantially so that the participants’ judgement is not influenced. Participants were not selected as individuals but because they were enrolled on a suitable course. This is to ensure that they understand the problems and they have a similar mind-set as corporate financial decision-makers. Besides, participants were randomly allocated to either a control group or a treatment group. Communication was not allowed during the experiments, so that participants could not influence, or be influenced by, others. The experiment starts with three cases to intentionally make a participant familiar with the judgements and decisions to expect and to induce experience; thus, the impact of earlier cases was even intentional. The following Sections 6.1.4 to 6.1.9 will describe each experiment including its ‘treatments’ and the variables measured.

6.1.4 Design of Experiment 1: Hurdle Rate – Availability Heuristic

This first experiment examines whether the failure of one or more investment projects make a decision-maker overestimate the percentage/probability of failure of projects in general and make a future similar project appear riskier so that they employ a higher hurdle rate.

As outlined in Section 2.4.1, in practice we find the so-called hurdle rate premium puzzle – a systematically overstated hurdle rate. As was hypothesised, this hurdle rate premium that

cannot be explained by risk considerations alone, may have a behavioural explanation in that people adjust the hurdle rate upwards due to less conscious influences such as availability or other effects.

Tversky and Kahneman (1973, p.209) noted many decades ago that “Availability is an ecologically valid clue for the judgment of frequency because, in general, frequent events are easier to recall or imagine than infrequent ones.” More available instances are perceived more frequent and thus more probable in general. The difference to their research in the 1970s relates to the functioning of a heuristic; they now claim that attribute substitution defines a heuristic (Kahneman and Frederick, 2002). This, however, and as noted in Chapter 3, does not principally contradict the relationships that were valid more than 40 years ago.

We examine attribute substitution here by identifying an inaccessible target attribute; this target attribute relates to the judgement required to set a project-specific risk-adjusted rate, as argued above (6.1.1). The target attribute is the risk of a project. Some other attribute, the available instances of failures experienced, may serve as a cue to arrive at a risk judgement and rate. We assume that frequent failures are salient events – more salient than successes – and are easier to recall/access and therefore they will act as a cue guiding the judgement of probability of future project failure, thus making projects appear riskier. Available instances of project failure may thus serve as heuristic attribute to replace the target one. In other words, instead of answering the target question of what the project’s risk is, individuals may answer the easier question of ‘Do instances of failed projects of this kind come readily to mind?’¹⁰⁹

Target attribute: Risk of the project.

Heuristic attribute: Available instances of project failure.

The procedure is similar across all experiments so that the results can indicate whether, and to what extent, each cue was used, or whether the analytical reasoning (‘System 2’) prohibited the use of this cue as outlined in Chapter 3. Thereby, the three conditions for attribute substitution to occur¹¹⁰ are examined. semantically and associatively related candidate attribute)

To investigate prior failures as an accessible cue that the researcher can control, we had to induce experience about previous investment projects. For this, respondents received a short case (see Appendix 3) of a company in the automobile industry and were asked to sequentially decide about three different investment proposals – each with different risk (average, slightly higher than average or much higher than average risk). The description provided information about the projects, their riskiness, the CF profile and the hurdle rate chosen. Each investment

¹⁰⁹ In analogy to Kahneman and Frederick (2002) stating that attribute substitution implies that an easier question is answered instead of the more difficult one.

¹¹⁰ I.e. the target attribute is relatively inaccessible; a semantically and associatively related candidate attribute is relatively accessible; System 2 does not correct intuitive judgement (Kahneman and Frederick, 2002), as outlined in Section 3.3.7.

appraisal was based on a net present value calculation for which a project-specific discount rate, was derived. After each decision to accept or reject the proposal, the ‘outcome’ of the completed project was presented, i.e. the actual CF profile and whether the project was considered successful or not (i.e. negative NPV) and why.

Whether a project succeeded or failed depended on the risk of the project – a random process made Project 1 (average risk) fail 25% of the time, Project 2 (much higher than average risk) with a 50% probability and Project 3 (slightly higher than average risk) with 33% probability. The event of success or failure – now isolated –provides a case to the decision-maker contributing to his/her experience – even though induced externally. This was designed to make the respondent involved and responsible. In this way, the number of failures ‘experienced’ in the first three cases (e) represented the experiment’s treatments ($e = [0, 1, 2, 3]$).

After this induction, the subsequent question asked about the respondents’ perception of the percentage of projects that fail in the automobile industry (f). Then a fourth project (of average risk) in the same company was given and the respondent had to decide which hurdle rate (r) they would choose for this.

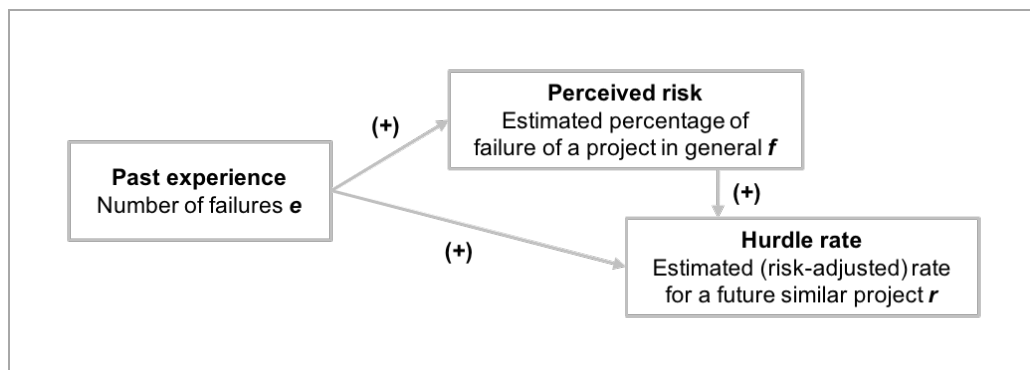


Figure 17 Experiment 1: hypothesised relationships¹¹¹

We will then be able to conclude about the relationship between the experienced failures e used as an indicator for the risk expressed by percentage (probability) estimates f of how likely a project is to fail in general. If this relationship is observed, we then examine whether the correlation between probability estimate e and proposed rate r for a similar project is in fact positive. If so, an analysis of the impact of failures e on the rate r will yield a positive relationship, too. If not, we will see how they relate to each other. Figure 17 highlights these relationships.

¹¹¹ (+): positive relationship

6.1.5 Design of Experiment 2: Hurdle Rate – Affect Heuristic

This second experiment seeks to examine whether affect is used to judge the risk of a new project and thus to determine the hurdle rate. As noted earlier, affect is considered a candidate for attribute substitution because affect is a natural assessment that means it is regularly and generally evaluated by an individual, and therefore highly accessible by itself (Kahneman and Frederick, 2002).

We can examine attribute substitution here by identifying an inaccessible target attribute: This target attribute – the same as above in Experiment 1 since hurdle rate is to be determined – is the judgement required to set a project-specific risk-adjusted rate used in an appraisal. Affect, being highly accessible may serve as a cue to arrive at a risk judgement and thus a rate.

We anticipate observing a similar effect to previous findings in psychology and various applied domains as noted in Chapter 3: When judging the risk about an object, in case of a positive (negative) feeling, individuals are inclined to perceive lower (higher) risk and thus attribute higher (lower) benefit to an option.

For such a complex judgement, we posit that affect as a feeling of like/dislike will serve as a cue to judge project risk: Liking a project (positive affect) may result in lower perceived risk, whereas disliking (negative affect) may result in relatively higher perceived risk, and thus different feelings will result in different hurdle rates.

Target attribute: Risk of the project.

Heuristic attribute: Feeling towards the project.

In other words, instead of answering the target question of what the project's risk is, individuals may answer the easier question of "Do I like or dislike the proposed project?" This may go together with the question of considering the project's benefit high or low as the affect heuristic suggests.

Three conditions have been derived: a positive-affect condition (T_+), a negative-affect condition (T_-) and a control condition (CG).

Respondents received a case (see Appendix 3) acting as the finance decision-maker responsible for investments of an automobile company. The respondents are asked to consider a project proposal prepared by the finance department to be approved by the board of directors. The proposal includes the company's plan to invest in an additional plant for the production of a new car model. Being told that all market studies have been completed and the new model which has many innovative features providing 'technical assistance' to the driver, has passed all reliability checks. The cash flows in the proposal are largely confirmed by the market study outcomes. Furthermore, they are told that as always, the risk that the new car will not be

popular, remains. And that the company's cost of capital ($WACC = 6.2\%$) is generally applied as hurdle rate for all projects. It is now up to the respondent to decide whether a project-specific rate – instead of the WACC – is adopted due to the project's specific characteristics.

The positive-affect condition (T_+) puts the respondent into the situation of liking the new prototype and considering buying one for themselves because they are attracted by the increased safety from the technical assistance. The negative-affect condition (T_-) induces the respondent to dislike the prototype and not consider buying one for themselves because of the feeling that relinquishing driver responsibility reduces safety. The neutral condition (CG) did not put respondents in the role of liking or disliking the prototype, but intended to represent the uninfluenced decision-makers who may or may not have a certain feeling towards the project (which can be criticised for its non-controllability, see below); i.e. in this condition, no affect was triggered.

To address these limitations and to better control for affect, the experiment was modified after the first cohort. The second cohort of respondents received the same case information (the same as the control group of the original experiment). Based on the question of which statement best represents their personal opinion, they themselves were asked to check whether they are attracted by additional technical assistance of a car and feel safer (T_+), whether they are put off by additional technical assistance of a car and feel that relinquishing driver responsibility reduces safety (T_-) or whether they are indifferent (CG). Their answers translated into which condition they were in. This modification ensured that first of all, affect is really felt rather than induced by the experimenter and secondly, that the control group consists of people who are *not* influenced by affect because they feel indifferent.

6.1.6 Design of Experiment 3: Hurdle Rate – Anchoring Effect

The third experiment examines an effect that is not considered a general-purpose heuristic any more: For anchoring and adjustment, the definition of a heuristic that functions by means of attribute substitution, does not apply (Kahneman and Frederick, 2002), as noted in Chapter 3, because an anchor is not an accessible attribute that replaces the target attribute, but rather an accessible value that activates knowledge related to the target. We will examine to what extent semantic, hurdle rate-consistent knowledge is activated in the setting of hurdle rates in the presence of numerical anchors. We will distinguish between informative and uninformative anchors expecting the uninformative ones to also influence judgement but to a lower extent (e.g. Wilson *et al.*, 1996).

We will nevertheless follow up on this effect in the domain of determining a hurdle rate – acknowledging its importance as outlined in Chapter 3. As indicated and as based on Kahneman

and Frederick (2005), we will examine whether an anchor as an accessible ‘salient value of the target variable’ that activates related knowledge, influences judgement about the hurdle rate.

We expect to observe similar results in the domain of the hurdle rate setting: A highly accessible value – be it informative or not – serves as a cue for the hurdle rate estimate.

Target value: Hurdle rate.

Salient value of the target attribute: Informative (plausible) and uninformative (implausible) hurdle rates provided.

Respondents received a case (see Appendix 3) acting as the finance decision-maker responsible for investments of an automobile company. The respondents are asked to consider a (new) capital-intensive investment project: One component of the paintshop in one of the production lines is to be replaced. The respondents are told that as usual, the finance department is evaluating the project, and that company policy requires all projects to be double checked by an independent colleague who is not involved in the appraisal. This serves to check the project appraisal for plausibility and to decide on a project-specific hurdle rate for the NPV calculation. The respondent has been appointed to that role for this project. They furthermore are told that they are provided with a forecast of cash flows and that the company WACC, based on overall risk, is 6.2%. Moreover, they learn that the project proposal indicates that a part of the project includes software adjustment by the engineers to attach the component to the existing machines; and that the physical attachment of the new component does not imply higher than average risk. However, the supplier includes a new operating system that the engineers now have to use to technically integrate the component.

Besides the control condition, where the case description was followed by the question of which hurdle rate they would recommend for the project appraisal, three treatments were included:

A: “Your colleague has proposed a project-specific hurdle rate of 9.75% indicating: ‘That seems to be the right figure and I seem to remember that rate was used last year. Do you think the hurdle rate should be higher or lower than your colleague’s proposed rate (9.75%)?’”

B: “Do you think the hurdle rate should be higher or lower than 9.75%? 9.75 was a randomly generated number drawn from a set of numbers from 0.00 to 20.00.”

C: “Do you think the hurdle rate should be higher or lower than 7.98%? 7.98 was a randomly generated number drawn from a set of numbers from 0.00 to 20.00.”

A fourth treatment was added in the second cohort of experiments (see above 6.1.2, n=53); C – the random anchor of 7.98% – was replaced by D – a random anchor of 2.65%; CG, A and B were held constant:

D: “Do you think the hurdle rate should be higher or lower than 2.65%? 2.65 was a randomly generated number drawn from a set of numbers from 0.00 to 20.00.”

Our expectation is that A and B, where the proposed rate is significantly higher than implied by the case information about the project’s risk¹¹² but still within a theoretically plausible range of rates, will lead to higher rates on average than in the control group and for C. We will test whether there is a difference between the informative, plausible anchor point (A) and an uninformative, arbitrary anchor point of the same size (B). We would think that although the latter anchor is neutral or informative (see e.g. Wilson *et al.*, 1996; Chapman and Johnson, 2002), the orientation towards it will happen but to a lower extent than in A. Nevertheless, we will test whether the use of irrelevant data provides an anchor and makes the estimated number to be closer to 9.75 (B), 7.98 (C) or even 2.65%.

9.75 lies 58% (or 3.55 percentage points) above the WACC – a randomly chosen figure that could be used as a plausible anchor in A and as an arbitrary anchor in B; neither appearing too ‘flat’ nor too ‘random’. Moreover, we wanted to keep the single-digit dimension to not impose another frame or further confuse the reader.

Condition C was included to compare to the first arbitrary condition B and to see what effect a lower anchor point has: 7.98 was chosen as half the difference between 9.75 and the WACC of 6.2 ($7.98 = 6.2 + 3.55/2$). And if the anchor of 9.75 proves to have an impact, the experiment will test whether a weaker anchor of only half the difference to the previous, higher anchor. Admittedly, 7.89 may come closer to the risk-specific rate to recommend for the appraisal; we would expect a small premium on 6.2% due to the new operating system implying slightly increased risk. However, we expect the anchor to reduce variance and thus to make the respondents be more ‘confident’ in their estimate. Recognising that the extra insight from this lower anchor point of 7.89 could be rather small, for the second cohort (53 participants), C was replaced by D, where a significantly lower than WACC rate, 2.65%, was made salient. This random anchor of 2.65% was added to the experiment (replacing C) to check whether an anchor lower than the WACC had an impact, because we had seen from an intermediate analysis that anchors/reference points obviously mattered. 2.65 differs from the WACC by the same amount (-3.55) as 9.75 lies above the WACC.

6.1.7 Design of Experiment 4: Hurdle Rate – Correction of Overconfidence

As we have pointed out in Chapter 3, overconfidence of project sponsors may lead to inflated cash flows and overinvestment. To correct for inflated cash flows, the cash flows themselves

¹¹² We would expect a risk premium of about 1-2 percentage points due to the only slightly increased risk.

may be adjusted or the hurdle rate increased. We observe from the interview study that decision-makers do consider adjusting the hurdle rate. In contrast to heuristic reasoning, adjusting cash flow projections via the hurdle rate due to overconfidence may certainly require some degree of awareness since it represents a rational process to adjust. Presumably, most companies employ a mechanism to check for plausibility of cash flow projections.

As indicated in Section 5.5, the correction of the hurdle rate due to overconfidence is not considered a heuristic in the sense of attribute substitution. Nonetheless, and as a side effect in this work, we are interested in investigating this relationship of a common proven cash flow bias and the hurdle rate estimate. In other words, we aim to observe whether overconfidence of the person responsible for preparing an investment project's cash flow (CF) estimates influences the risk-adjusted hurdle rate (HR) estimate. We would expect that in the case of perceived overconfident CF estimates, the estimated hurdle rate is significantly higher than the one in a neutral control condition. This would in fact – and as opposed to the previous experiments' expectations – represent a rational way of explaining the biased cash flow projections.

In this experiment (see Appendix 3), the respondent is asked to act as the finance director responsible for investments who has been reassigned from the finance director position of its sister company, both located in Germany. S/he receives the following case description: A new investment proposal has to be decided on: A new production plant is required in the Lithuanian division because of the growing market and increasing demand. However, the level of automation would be different. In the German plant, it was a fully automated plant, whereas in Lithuania it will be semi-automated. Respondents are told that a technical manager was responsible for providing extensive data applicable to such a technically complex project; a scenario analysis by the finance department has shown high risk in the implementation and the timetable implies hardly any slacks. The outcome of 2 out of 4 equally likely scenarios would suggest the project could fail so that a positive NPV is unlikely. Further information is that the company's WACC of 6.5% is applied as hurdle rate for all projects. The respondent decides whether a project-specific rate – instead of the WACC – is adopted due to the project's specific characteristics.

The control condition then adds: "As you are new to the company you do not know the technical manager or what drives him." The treatment condition instead presents the following piece of information: Respondents are told that they are new to the company but they know that the technical manager receives performance-related pay on successful projects. Moreover, they learn that this year this manager did not have any project approved: This year he has proposed only one project but it was rejected; he insists that the new project is undertaken. This is clearly showing that this manager must have provided ambitious cash flow projections and a strong interest in getting the project approved.

As indicated, we will assess whether decision-makers suspecting overconfident CF projections will implement an upwards adjustment of the rate as theory suggests; we will compare a condition where respondents could infer that the CFs are optimistic to a condition where no information is provided about the person who determined the CFs.

However, we should consider that the experiment, i.e. the wording itself, might not have sufficiently triggered all respondents' perception of a particular level of confidence. To address this limitation, the experiment was modified after the first cohort. It incorporated an additional question asking the respondents to indicate whether they think that the technical manager – who has provided the CF estimates – is likely to have underestimated the project's risk and thus was too confident with his CF estimates (options included 'yes', 'no' and 'I can't say'). Which group (control or treatment groups) the respondents belonged to therefore depended on their response to the additional question.

6.1.8 Design of Experiment 5: Cash Flows – Representativeness Heuristic

Experiment 5 explores to what extent more or less similar instances or outcomes collected in accounting records are considered representative for and therefore impact the cash flow estimate required for the financial appraisal of an investment proposal.

We can examine attribute substitution here in that we identify an inaccessible target attribute which is the case for the judgement required to come up with the most likely outcome to derive a cash flow ('best') estimate, as argued above in Section 6.1.1. A heuristic attribute, representativeness/similarity, may serve as a cue to arrive at an estimate. We assume that similarity is easier to recall/access because it is a "routinely evaluated ... and therefore always accessible" natural assessment (Kahneman and Frederick, 2002; Tversky and Kahneman, 1983; Goldstone and Son, 2005). "Similarity is an excellent example of a domain-general source of information" only not applicable if a person knows that similarity is not indicative in a particular context (Goldstone and Son, 2005, p.14).

Target attribute: Most likely cash outflow.

Heuristic attribute: Similar instances from accounting records.

The target question of how likely a particular outcome (the production stoppage) is, and consequently, what the most likely outflow estimate is, may be answered by the easier question of what the outcome of the most similar project was.

Based on Kahneman and Frederick (2002), a person who recently heard about particular maintenance costs may use the availability heuristic. If no instances come to mind (s/he has not been primed for this and we assume our large sample will provide a balanced picture about the population having heard about maintenance problems and/or production stops), people may take

similarity as a cue. Several cues being accessible at the same time can also result in a situation with competing accessible cues, the heuristic that will be dominant, is not clear upfront (Kahneman and Frederick, 2002).

Respondents received a case (see Appendix 3) acting as the finance decision-maker responsible for investments of a car component company situated in Germany having to decide about a new investment project: A random sampling machine should be purchased, which will be attached to another machine to operate a random sample test of the products and to check whether they adhere to all norms. The respondents are told that their finance department has provided them with the data about the project – they are shown a screenshot of the forecasted cash outflows at the beginning ($t=0$) and at the end of the project's first year ($t=1$). And before the investment proposal is presented to the board of directors, the respondent looks at the CF profile of the project and thinks about necessary adjustment.

For Period $t=1$, respondents learn that cash inflows are assumed constant since no additional copies of the product will be produced due to the new machine; they learn that energy cost in the first year has been fixed by contract (\$10,010) and that costs for supplies are considered certain (\$5,000). The only uncertain component refers to the maintenance costs. The description says that to maintain the machine in the production process, production has to be stopped: "Maintenance costs in Year 1 are projected to be \$4,330 and have been entered in the cash flow profile below. The costs of \$4,330 are based on maintenance that is scheduled to take one hour and thus a production stop of one hour. Each hour the production is stopped costs \$600/h."

Depending on the treatment, the case leaves the respondent with different pieces of information from the company's accounting records. Both treatments provide information about two machines, a similar random sampling machine (1) and a seven-year-old steel milling machine (2).

The first treatment, the 'similar' condition tells the participant that a random sampling machine also had to be stopped for the reason of maintaining the machine; and that in the first period it actually had to be stopped for 2h instead of the projected 30min due to installation problems. Attaching the new machine was a very sensitive process and when adjusting it, one part of the existing machine was damaged and had to be fixed. Therefore, the total cost actually turned out higher than projected. The case continues with information about another project related to a seven-year-old steel milling machine: It tells the participant that production had to be stopped for the reason of maintaining the machine. And that production actually had to be stopped for the projected period of time. Adjusting the machine went without problems. Therefore, the total cost actually turned out as projected.

The second treatment tells the participant that the maintenance of the random sampling machine went without problems when maintaining it and that the total cost turned out as projected (which equals the outcome of the seven-year-old steel milling machine (2) of the first treatment). The case continues referring to the seven-year-old steel milling machine: Here the participants are told that it actually had to be stopped for 2h instead of the projected 30min (which equals the outcome of the similar random sampling machine (1) of the first treatment) because when replacing one old worn out part, some specific tool had to be delivered first. Therefore, the total cost actually turned out higher than projected.

The respondents were asked whether they would adjust the estimated sum of cash outflows (\$19,340) of Year 1 due to uncertainty in the maintenance costs? And if so, they had to indicate what their final estimate for the sum of cash outflows of Year 1 is. The word 'similar' was not used in this case.

As price of the machine, energy and costs of supplies were indicated as fixed, the only uncertain component in the CF profile was the maintenance costs. Their final estimate will now depend on how long they believe production will be stopped. We apply the following reasoning as regards the lowest and highest estimate estimates that will be considered plausible for the subsequent analysis:

A theoretically lowest estimate would amount to \$15,010 if the participant thinks maintenance costs will go down to \$0. As the information provided implies that maintenance will take place and that it is scheduled with one hour, there is no reason to believe that costs lower than \$4,330 will occur. If for example, respondents believe that 1h of maintenance is sufficient, they would keep the maintenance costs estimate of \$4,330 and estimate a total cash outflow of \$19,340 for this period. If they believe that other maintenance costs will stay constant but the new machine behaves similarly to one of the two machines from accounting records and would be stopped for four times the projected time, they may add $\$600 \times 4 = \$2,400$ to the fixed amount of \$15,010 and the other maintenance costs, and end up with an estimate of \$21,130. Even in an extreme case, if they expected the production stoppage to be twice as long as of the time mentioned in the accounting records, the estimate would result in $\$15,010 + \$3,720 + \$600 \times 8 = \$23,530$.

We will compare the CF estimate based on the 'similarity' condition, where the similar project's production stoppage time turns out to be four times the originally scheduled stoppage and the dissimilar project is as scheduled, against the 'dissimilarity' condition where these outcomes are reversed. We will be able to observe whether similarity serves as a cue for making a judgement and what role a dissimilar event plays, both compared to a control condition where no information is provided from accounting records.

Referring to whether a heuristic is at work here, we can state, as mentioned above: The actual question to be answered (target attribute) in this task is, ‘What is the best estimate, i.e. most likely to happen, for the maintenance costs in $t=1$?’ The easier question (heuristic attribute) may be ‘What outcome did a similar past instance produce (that can be applied to the maintenance cost estimate)?’ This corresponds to the type of judgement of Type *I/b* outlined in Chapter 5; that is the use of explicitly available information about the value of another variable. The value of another variable in this case represents the outcome of a similar machine which is available from accounting records. “[T]he substitution of representativeness for probability and the neglect of known (but not explicitly mentioned) base rates” (Kahneman and Frederick, 2002, p.62) may also be observed in the hurdle rate context. In our example case, the base rate is the scheduled one-hour production stoppage, which since it is a new machine may be quite reasonable.

6.1.9 Design of Experiment 6: Cash Flows – Anchoring Effect

The sixth experiment intends to examine the ‘anchoring effect’ on cash flow projections. This experiment tests the impact of provided estimates – be they plausible and thus potentially informative or arbitrary and thus uninformative. Even though anchoring and adjustment is no longer considered a heuristic in a narrow sense (based on attribute substitution), this effect worth investigation since in the preceding interview study, it turned out to be relevant in the reasoning process of arriving at a CF estimate.

Analogous to Experiment 3, we proceed in characterising the anchoring experiment: We expect to observe similar results in the domain of the cash flow projections, that is a highly accessible value serves as a cue for the estimate of the growth rate of the cash flows.

Target value: Growth rate of energy costs.

Salient value of the target attribute: Informative (plausible) and uninformative (implausible) growth rates provided.

Experiment 6 is based on the same role, company and investment proposal case as Experiment 5. The respondent now learns that for the whole economic life of the project (4 years), further estimates are required to complete the appraisal (see Appendix 3). For the supplies, an annual increase is assumed using the current inflation rate. It continues indicating that the respondent considers adjusting the energy cost estimate knowing about the uncertainty of energy costs and that for example energy costs may depend on state regulations and of how much companies are being subsidised for the use of renewable resources. (The company uses renewable resources and uses solar generator panels of their own.)

Besides this control condition, where the case description was followed by the question of which hurdle rate to recommend for the project appraisal, three treatments were included: A first treatment group (A) gets further information: A quick analysis of past accounting data has shown that energy costs in general have increased by 6.5% per year over the last three years. A second treatment group (B) in turn learns: Yesterday during lunch in your firm's cafeteria you caught a sentence from the talk of two managers sitting at the neighbouring table. You understood something like "...cost increased by 6.5%". The third treatment (C) is analogous to B except that "...cost decreased by 6.5%".

Thereafter, every participant in a treatment was asked, "Thinking about your best estimate of the rate that energy costs will increase/decrease, do you think this rate should be higher or lower than [figure depending on the Treatment A, B or C]%?" A final question asked all participants for the dependent variable: "What is your best estimate of the rate that energy costs will increase/decrease in the following Years 2, 3 and 4 (on average, per year)?"

Our expectation was that A and B, where the provided growth rate is significantly higher than in Condition C, will result in a similarly higher estimate than in Condition C, where a negative value is provided. We test whether there is a difference between the plausible anchor point (A) and an arbitrary anchor point of the same size (B) contrasting them to responses from the control group's estimate representing the unbiased estimate. We would think that since the latter anchor (B) is irrelevant, there will be some orientation towards it but to a lower extent than in A. Similarly, we will test the effect of the negative anchor of the same size expecting some influence despite being irrelevant as well. 6.5% or even 13% as provided figures do not lie outside a generally plausible range¹¹³ as for example a growth rate of 79% would.

For the second cohort of respondents, we investigate whether a larger anchor point has the same effect as relatively moderate ones. We take double the previous anchor, i.e. 13%, since it may still be in a plausible range, but essentially higher;¹¹⁴ we will examine all hypotheses equally.

Section 6.2 will elaborate on the analysis and results of all experiments: The section begins by outlining the relevant descriptive statistics for all treatments under consideration and furthermore describe how data have been prepared. Inferential statistics will be used to infer about the significance and generalisation of the results. The interpretation and discussion of the results concludes each experiment's section.

¹¹³ Actual growth rate of electricity in Germany between the second half of 2014 (2013) and the second half of 2015 (2014) were -.7% (+5.5%); the price for natural gas decreased by 5% (17%) (Eurostat, 2016).

¹¹⁴ For example, Chapman and Johnson (1994) found that implausibly extraordinarily high uninformative anchors did still have an impact on judgement, but proportionally smaller.

6.2 Analysis

6.2.1 Experiment 1: Hurdle Rate – Availability Heuristic

First of all, we are interested in examining whether the more failures of investment projects a decision-maker has experienced, the higher their estimated probability of failures (and thus the perceived risk) in general. The estimated percentage of failures is expressed by function F_e ($e \in [0, 1, 2, 3]$: number of failures experienced). A null hypothesis therefore states that there is no relationship between the number of experienced failures and the estimated percentage of failures (and thus the perceived general risk of projects). As we intend to draw conclusions about the potentially different impact of each additionally experienced failure(s), we develop hypotheses on pairwise comparisons of all treatment groups¹¹⁵ 0, 1, 2 and 3 using the non-parametric Wilcoxon-Mann-Whitney test.¹¹⁶

We will develop Hypothesis 1 (H1) exemplarily: We assume X and Y to be random variables with continuous cumulative distribution functions F_0 and F_1 with independent observations: $X_1, \dots, X_m \sim F_0$ and $Y_1, \dots, Y_n \sim F_1$.¹¹⁷ In a situation where F_1 is a shifted version of F_0 in the form of $F_1(x) = F_0(x + \Delta)$ for all $x \in \mathbb{R}$ and an unknown $\Delta \in \mathbb{R}$, we will test $H_0: \Delta = 0$ against an alternative $H_a: \Delta \neq 0$ or against a directional $H_a: \Delta > 0$ or $\Delta < 0$ using the Wilcoxon-Mann-Whitney test.¹¹⁸ We thereby assume that two samples (e.g. respondents in $e = 0$ having ‘experienced’ 0 failures; and respondents in $e = 1$ having experienced 1 failure) follow the same distribution except for the location and can test whether the distribution of a treatment group (e.g. F_1) is a shifted version of another treatment or control group’s (e.g. F_0) distribution; or in other words, whether the treatment group shows generally different (higher or lower) values. The shift in location of the two distributions will be estimated using the Hodges-Lehman two-sample estimator, the median of the pairwise differences.¹¹⁹

The null hypothesis can thus be defined as, based on $F_1(x) = F_0(x + \Delta)$, the two distributions F_0 and F_1 being equal, and thus their percentage estimates not differing, with:

$$H1_0: \Delta = 0.$$

The null hypotheses of all pairwise comparison of F_0, F_1, F_2 , and F_3 are analogous.

¹¹⁵ With $4!/[(4-2)! \times 2!]=6$ combinations.

¹¹⁶ An OLS regression analysis cannot be conducted since the assumption of normality of residuals does not hold. Normality has been tested by the Shapiro-Wilk test of normality

¹¹⁷ Largely relying upon Fried and Dehling’s (2011, pp.409-410) terminology and derivation of hypotheses, also in the following.

¹¹⁸ Fried and Dehling (2011, p.410) furthermore explain: “The Wilcoxon test rejects the null hypothesis H_0 if the sum W of the ranks $R_1, \dots, R_n$ of $Y_1, \dots, Y_n$ in the sample of all observations $X_1, \dots, X_m, Y_1, \dots, Y_n$ is too large or too small. Critical values are determined by permutational arguments since all possible $\binom{m+n}{n}$ assignments of the ordered ranks $n, R_{(1)} < \dots < R_{(n)}$ are equiprobable under H_0 .”

¹¹⁹ The true location shift (differences in location) between two samples are neither approximated by the difference in means nor in medians but by the robust Hodges-Lehman (HL) two-sample estimator: $\text{med}\{Y_j - X_i, i = 1, \dots, m, j = 1, \dots, n\}$; it is the the median of the cross-sample pairwise differences, i.e. the median of the set of pairwise differences of the observations of the sample of x and of the sample of y (Fried and Dehling, 2011; Hodges and Lehmann, 1963).

Based on the expectation that more experienced failures will lead to a higher risk perception, i.e. that the value determined in condition F_1 (having experienced 1 failure) is higher than the one in the in condition F_0 (not having experienced any failure) on average ($F_1 > F_0$), the alternative hypotheses for H1 – can be derived as F_1 being to the right of F_0 with:

$$\mathbf{H1_a}: \Delta > 0.$$

Hypotheses have been derived for all other five hypotheses of the pairwise comparisons F_0 , F_1 , F_2 , and F_3 analogously with F in the case of more failures to be shifted to the right of a condition F with fewer failures:

Hypotheses	H_0	H_a
H1 $F1(x) = F0(x + \Delta)$	$F_1 = F_0: \Delta = 0$	$F_1 > F_0: \Delta > 0$
H2 $F2(x) = F0(x + \Delta)$	$F_2 = F_0: \Delta = 0$	$F_2 > F_0: \Delta > 0$
H3 $F3(x) = F0(x + \Delta)$	$F_3 = F_0: \Delta = 0$	$F_3 > F_0: \Delta > 0$
H4 $F2(x) = F1(x + \Delta)$	$F_2 = F_1: \Delta = 0$	$F_2 > F_1: \Delta > 0$
H5 $F3(x) = F1(x + \Delta)$	$F_3 = F_1: \Delta = 0$	$F_3 > F_1: \Delta > 0$
H6 $F3(x) = F2(x + \Delta)$	$F_3 = F_2: \Delta = 0$	$F_3 > F_2: \Delta > 0$

Table 15 Experiment 1: hypotheses relating prior failure to perceived future risk

As outlined in Figure 17 and after analysing the impact of the number of failures ‘experienced’ e on the perceived probability of a project failure f in general, we will explore the relationship of e and the hurdle rate determined for a future similar project appraisal r . Hypotheses and logic derive analogously to Table 15: F_e is substituted by the distribution function R_e ceteris paribus (Table 16). As outlined above, we are interested whether positive relationships will be found in that a higher number of ‘experienced’ salient instances such as failures will result in a higher rate:

Hypotheses	H_0	H_a
H7 $R1(x) = R0(x + \Delta)$	$R_1 = R_0: \Delta = 0$	$R_1 > R_0: \Delta > 0$
H8 $R2(x) = R0(x + \Delta)$	$R_2 = R_0: \Delta = 0$	$R_2 > R_0: \Delta > 0$
H9 $R3(x) = R0(x + \Delta)$	$R_3 = R_0: \Delta = 0$	$R_3 > R_0: \Delta > 0$
H10 $R2(x) = R1(x + \Delta)$	$R_2 = R_1: \Delta = 0$	$R_2 > R_1: \Delta > 0$
H11 $R3(x) = R1(x + \Delta)$	$R_3 = R_1: \Delta = 0$	$R_3 > R_1: \Delta > 0$
H12 $R3(x) = R2(x + \Delta)$	$R_3 = R_2: \Delta = 0$	$R_3 > R_2: \Delta > 0$

Table 16 Experiment 1: hypotheses relating prior failure to the future hurdle rate

Of 328 responses, five neither estimated a hurdle rate r nor a failure estimate f and were not considered further in the analysis. Among the 323 remaining data points, 226 responded correctly to the control question and are thus result classified as ‘experts’ and form the group of interest to this study.

As shown in Table 17, out of the 226 responses 37% were based on scenarios where no prior failure was experienced in the three investment proposals presented sequentially; 40% of participants experienced one failure (i.e. either the first, second or third proposed investment project failed), 20% experienced two failures, and 3% observed all three projects fail. Based on the three projects' risk, the probability to get a project fail three times in a row amounts to $.25 \times .5 \times .35 = .044$, i.e. only 4% of all respondents would theoretically belong to this group, some deviations from this figure may occur since this is a random process first and foremost and some participants did not complete the survey. 2 responses (NA) would not be attributed to any of the treatments because they rejected the proposed investment project each time and did therefore not receive feedback (success or failure).

No. of failures <i>e</i>	n	rel freq	Estimated% of project failure <i>f</i>						Hurdle rate <i>r</i>				
			mean	median	sd	min	max	mean	median	sd	min	max	
0	83	.367	35.69	30	23.76	0	90	13.45	12.00	7.43	6.5	60	
1	90	.398	33.60	30	21.81	5	90	12.32	10.75	5.23	8.0	50	
2	44	.195	34.50	30	22.92	5	90	11.29	11.00	2.88	6.0	18	
3	7	.031	46.43	48	16.30	15	70	11.50	10.00	4.05	8.0	20	
NA	2	.009	44.00	44	22.63	28	60	10.00	10.00	0.00	10.0	10	
Total	226	1	35.03	30	22.57	0	90	12.49	11.00	5.80	6.0	60	

Table 17 Experiment 1: descriptive statistics¹²⁰

Evidence that more experience of project failure led to higher estimates of future failure (*Hypotheses 1-6*) could only partially be found. A 'gap' in the estimate between 'no failure at all' and 'one or more failures' could not be observed. We did find three failures resulted in a significantly higher percentage estimate than less than three failures (Table 18).

Thus, looking at the data, there does not seem to be strong effect on the overall estimate. However, as some respondents may not have accepted all three proposals, they may only have 'experienced' two failures or one. We may hence consider a variable that expresses the number of failures experienced in relation to the number of proposals accepted, a 'failure rate'. If we in fact control for the failure rate, we do not find statistically significant differences, neither of a positive relationship in general nor with a 'gap' between 100% experienced failures.¹²¹ A slightly higher probability estimate in the case of 100% failures could not be confirmed statistically. However, we have to consider that one failure out of one proposal may not trigger any generalisation effects. Perhaps altering the salience of the experience, i.e. the seriousness of a failure and the number of proposals to decide about, might yield a different result.

¹²⁰ Across this thesis and as it is common practice, we shall use the following abbreviations, unless noted otherwise: n: number of respondents; rel freq: relative frequency; sd: standard deviation; NA: not available

¹²¹ The HL estimator for comparing 100% failures to no failure yielded a difference of 5 percentage points, however, insignificant. No significant difference could be found for either pairwise comparison. Effect sizes were negligible.

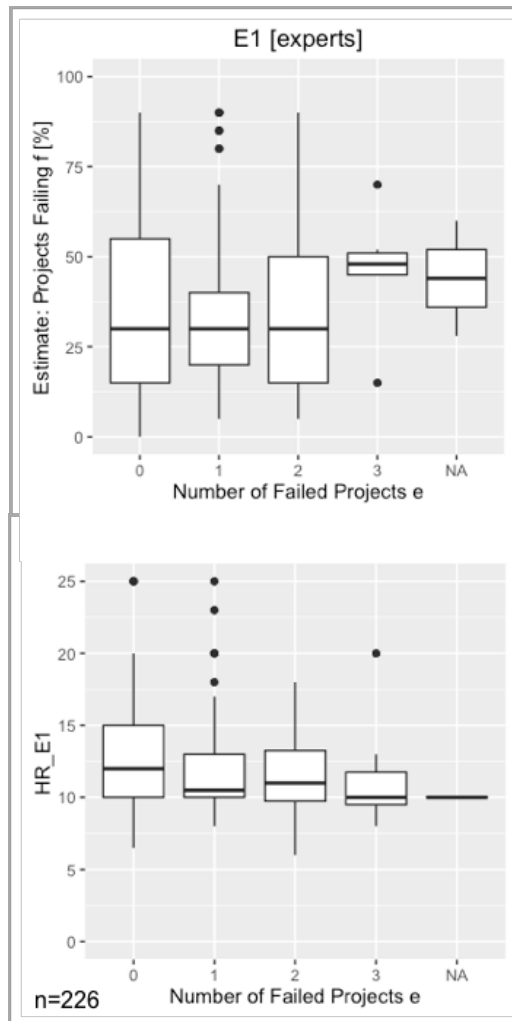


Figure 18 Experiment 1: estimated project failure and hurdle rate estimate (experts)¹²²

What we have seen above is that failures experienced, with the limitations mentioned before, generally do not become sufficiently available to alter the general belief about probability (and thus the perceived risk).

As regards *Hypotheses 7-12*, no significant influence of previously experienced failures on a particular future hurdle rate estimate of a subsequent similar proposal was detected (HR_E1, see Figure 18 and Table 19).

¹²² HR_E1: hurdle rate estimate.

Bottom figures: relationship between the number of failures (*e*) and the probability estimate of failures (*f*).

Top figure: relationship between the number of failures (*e*) and the hurdle rate estimate (*r*).

Hypotheses	H _a	Test statistics	Δ^{123}	Effect size ¹²⁴
H1	$F_1 > F_0: \Delta > 0$	W ¹²⁵ p ¹²⁶ 3852.5 .6404	.00	-.0542 negligible
H2	$F_2 > F_0: \Delta > 0$	W p 1885 .6188	.00	-.0551 negligible
H3	$F_3 > F_0: \Delta > 0$	W p 186* .0580	15.00	.3277 small
H4	$F_2 > F_1: \Delta > 0$	W p 1997 .5331	.00	-.0301 negligible
H5	$F_3 > F_1: \Delta > 0$	W p 172** .0232	17.00	.4224 medium
H5	$F_3 > F_2: \Delta > 0$	W p 95* .0542	16.86	.3230 small

Table 18 Experiment 1: results of hypothesis tests of the availability heuristic in probability estimates

Results as to whether ‘the more project failures have been experienced, the higher the hurdle rate estimate’, could not be found. The distributions of R_e with $e=[1, 2, 3]$ obviously do not differ sufficiently that a location shift (in the sense the more failures, the higher the rate) could be identified. On the contrary and against what was expected – a negative difference in location and thus a negative influence is indicated comparing one or more failures to zero failure, though their effect sizes are small; this may also be the reason why this relationship may not be found in the pairwise comparisons that did not compare to zero failures. It may mean that failures obviously did not negatively influence them. Finance and accounting experts thus seem to behave rather rationally – as was indicated in the first part of the experiment. They may not want to be influenced by the ‘artificial’ setting of cases and their feedback and thus are prone to overcompensate the correction of the hypothetical cases’ failure, yet, through the algorithm of project failure that depended on the reported risk, deception was avoided. In summary, experiencing failures obviously did not positively impact the risk premium incorporated into the hurdle rates applied in future project appraisals; and a negative impact or further effects such as overcorrection remain to be answered.

¹²³ The true location shift Δ is estimated by the Hodges-Lehman two-sample estimator.

¹²⁴ Effect size is measured using Cliff’s δ throughout this work. The most commonly used effect size measures such as Cohen’s d are parametric effect size measures and should not be deployed if parametric tests cannot be used as they will lead to bias if for example the normality assumption is violated or sample size is small (Leech and Onuegbuzie, 2002). The effect size is considered small if $|\delta| > .147$, medium if $|\delta| > .33$ and large if $|\delta| > .474$ (based on Romano *et al.*, 2006), which are much more conservative than e.g. the cut-off values mentioned in Vargha and Delaney (2000) or Vargha and Delaney’s A itself.

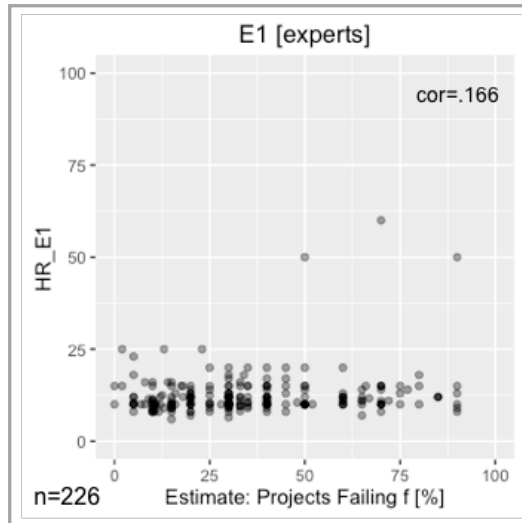
¹²⁵ W-statistic from the Wilcoxon-Mann-Whitney test. The Mann-Whitney-U statistic can be calculated as $U = W - n(n+1)/2$.

¹²⁶ P-value. *, ** and *** denote significance at $p \leq .1$, $p \leq .05$ and $p \leq .01$ respectively (based on one-tailed tests for directional alternative hypotheses and two-tailed tests otherwise). For an individual test, we accept a significance level of 10%. To avoid an increase in Type I-error due to repeated statistical tests with the same dataset, we will make use of the Bonferroni correction and apply a more conservative, corrected significance level of $p_B = .1/m = .1/3 = .0333$ (m : number of tests with one (part of the) dataset, e.g. the control group ($e=0$) as one part of the dataset is used three times in the hypothesis tests).

Hypotheses	H _a	Test statistics	Δ^{127}	Effect size ¹²⁸
H1	$R_1 > R_0: \Delta > 0$	W 129 p 130 4275.5 .9520	-.50	-.1648 small
H2	$R_2 > R_0: \Delta > 0$	W p 2216 .9771	-1.00	-.2321 small
H3	$R_3 > R_0: \Delta > 0$	W p 378 .9099	-1.50	-.3176 small
H4	$R_2 > R_1: \Delta > 0$	W p 2141 .7807	.00	-.1013 negligible
H5	$R_3 > R_1: \Delta > 0$	W p 360.5 .7424	-.50	-.1630 small
H6	$R_3 > R_2: \Delta > 0$	W p 164 .6141	.00	-.1025 negligible

Table 19 Experiment 1: results of hypothesis tests of the availability heuristic in the setting of hurdle rates

Thus we have drawn different conclusions as to how the number of failed projects impacts future probability estimates, and future hurdle rates. These results are largely confirmed by the correlation between estimated probability of a project failing and a hurdle rate estimate for a future investment project proposal: As illustrated in Figure 19, there is no correlation between the estimated percentage of failures of projects in the automobile industry and the hurdle rate for a subsequent similar future project; and thus the perceived risks of such projects failing, which may indeed depend on past experience, does not influence future hurdle rate for similar projects.



¹²⁷ The true location shift Δ is estimated by the Hodges-Lehman two-sample estimator.

¹²⁸ Effect size is measured using Cliff's δ . The effect size is considered small if $|\delta| > .147$, medium if $|\delta| > .33$ and large if $|\delta| > .474$ (based on Romano *et al.*, 2006).

¹²⁹ W-statistic from the Wilcoxon-Mann-Whitney test.

¹³⁰ P-value. *, ** and *** denote significance at $p \leq .1$, $p \leq .05$ and $p \leq .01$ respectively (based on one-tailed tests for directional alternative hypotheses and two-tailed tests otherwise). To avoid an increase in Type 1-error due to repeated statistical tests with the same dataset, we will make use of the Bonferroni correction and apply a more conservative, corrected significance level of $p_B = .1/m = .1/3 = .0333$ (m: number of tests with one (part of the) dataset, e.g. the control group ($e=0$) as one part of the dataset is used three times in the hypothesis tests).

Figure 19 Experiment 1: correlations between estimated probability of failure and future hurdle rate¹³¹

In summary, these results suggest that we cannot confirm the hypothesised relationship of the more failures experienced, a) the higher the perceived risk of such projects failing and b) the higher the hurdle rate for future similar projects. The contribution to explain the Hurdle Rate Premium Puzzle as hypothesised in Hornung, Luther and Schuster (2016) can therefore not be established. They therefore seem to confirm that experts are not influenced by salient events in the same way as many other decision-makers might be; at least their judgement of general likelihood of a related instance is not affected by few events and a future rate to be determined is also considered a new, unrelated instance viewed independently of judgements in the past. These findings are therefore indicative of the rationality of accounting and/or finance experts and do not support heuristic reasoning based on availability in the sphere of risk-adjusted hurdle rates.

6.2.2 Experiment 2: Hurdle Rate – Affect Heuristic

This experiment assesses whether positive and negative affective responses influence the setting of the hurdle rate. It was designed in three conditions, a positive-affect condition (T_+), a negative-affect condition (T_-) and a control condition (CG). For the control group and analogous to Experiment 1, we assumed the hurdle rate's distribution function F with $X_1, \dots, X_m \sim F$, for the positive-affect group we assumed the rate's distribution function T_+ with $Y_1, \dots, Y_n \sim T_+$ and for the negative-affect group T_- with $Z_1, \dots, Z_o \sim T_-$.

The hypotheses include pairwise comparisons of the respective conditions based on contrasting two conditions at a time: a positive, a negative and a neutral affect condition: According to the affect heuristic, we hypothesise that a positive feeling toward a project is used as a cue for a low risk project and results in a lower hurdle rate. Thus, for $T_+(x) = F(x + \Delta)$:

$$\mathbf{H1_0}: \Delta = 0 \quad \mathbf{H1_a}: \Delta < 0 \quad (T_+ < F)$$

In contrast, a **negative feeling** toward a project is used as a cue for a high risk project and results in a higher hurdle rate. Thus, for $T_-(x) = F(x + \Delta)$:

$$\mathbf{H2_0}: \Delta = 0 \quad \mathbf{H2_a}: \Delta > 0 \quad (T_- > F)$$

Lastly, we additionally examine the difference of the positive feeling of like and the negative feeling of dislike in a hurdle rate decision. Thus, for $T_-(x) = T_+(x + \Delta)$:

$$\mathbf{H3_0}: \Delta = 0 \quad \mathbf{H3_a}: \Delta > 0 \quad (T_- > T_+)$$

¹³¹ HR_E2: hurdle rate estimate.

The first cohort consisted of 275 participants.¹³² After excluding one data point for not having indicated a hurdle rate estimate in this experiment, we find 67.2% (184) have correctly responded to the control question. Respondents were randomly assigned to roughly equal group sizes: Of 184 respondents, 31% were in the control group, 38% were in the T₊ condition and 32% in the T₋ condition. See Table 20 for the descriptive statistics.

		n	rel freq	mean	median	sd	min	max
Control group	<i>F</i>	57	.310	9.825	8.0	6.651	5.2	45
Like	<i>T₊</i>	69	.375	10.223	8.0	10.035	5.0	80
Dislike	<i>T₋</i>	58	.315	9.222	8.0	2.906	3.5	16
Total		184	1	9.784	8.0	7.332	3.5	80

Table 20 Experiment 2 – original: descriptive statistics of hurdle rate estimate

We find no significant difference between a neutral and a ‘like’ condition in terms of the hurdle rates set (see Table 21). Similarly, a negative feeling does not seem to significantly influence the rate among experts according to the data. Thus, we cannot find clear tendencies of the rate being influenced by affect as compared to a condition where affect was not triggered. Comparing conditions T₊ and T₋ against each other, the reported hurdle rates in T₋ were estimated to 40bp higher than in T₊, but not significantly so and effect sizes were negligible.

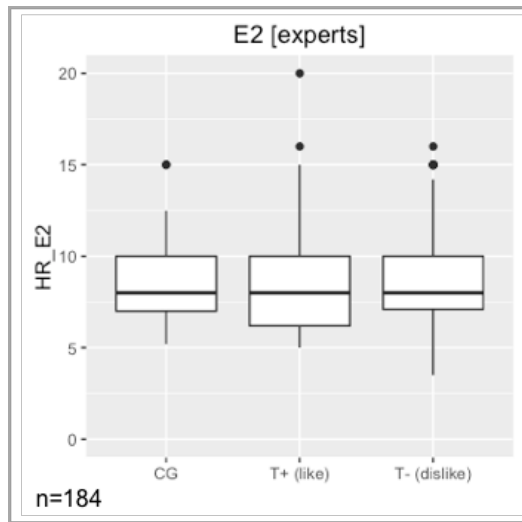


Figure 20 Experiment 2 – original: hurdle rate estimate (experts)¹³³

¹³² As explained in Section 6.1.5, the experiment was modified after the first cohort. Therefore, we report the findings of the different cohorts separately.

¹³³ HR_E2: hurdle rate estimate. Data points not displayed: HR_E2=[40, 45] in the control group (CG); HR_E2=[45, 80] in the Treatment Group T₊ (‘like’). These data points have not been removed from the dataset and are included in the calculations.

Hypothesis				H _a	Test statistics Δ^{134}		Effect size ¹³⁵	
H1	$T+(x) = F(x + \Delta)$	$T+ < F$	$\Delta < 0$	W_p^{136}	2145 .1894	.00	.0908	negligible
H2	$T-(x) = F(x + \Delta)$	$T- > F$	$\Delta > 0$	W_p	1575.5 .3320	.00	.0469	negligible
H3	$T-(x) = T+(x + \Delta)$	$T- > T+$	$\Delta > 0$	W_p	2245 .1175	.40	.1219	negligible

Table 21 Experiment 2 – original: results of hypothesis tests of the affect heuristic in the setting of hurdle rates

In this original experiment, the feeling under consideration was induced rather than personally felt by the respondents. This strongly limits this experiment's expressiveness.

Furthermore, the neutral condition did not necessarily mean that the respondents are emotionally uninvolved if no feeling is triggered. Not triggering a feeling does not mean it does not exist. Hence, neutrality may also include people with different feelings toward this product. This logic might also be the reason why the interpretation of H1 and H2 is inconclusive, which we will have to elaborate on. Nevertheless, as a 'default' i.e. non-manipulated, condition to compare the treatment conditions to, it was considered acceptable.

As indicated above (6.1.5), to account for these limitations and to better control for affect, a second modified experiment was run to observe actual feelings. Their answer to the question about their feeling toward the technical assistance feature of the new prototype, translated into the 'treatment' condition. This also means that the control group now represents a group of 'no affect' serving to determine a better 'neutral' default. Both limitations were therefore overcome.

The modified experiment included 53 participants of the second cohort with one response not having indicated a hurdle rate estimate in this experiment; 44 participants answered the control question correctly (Table 22). The distribution was slightly unbalanced with a large portion liking the prototype (59%), the control group (CG) with no feeling of 25%, and 16% in the dislike condition.

		n	rel freq	mean	median	sd	min	max
Control group	<i>F</i>	11	.250	8.073	7.0	2.737	6.0	15
Like	<i>T+</i>	26	.591	8.377	8.0	1.870	6.2	15
Dislike	<i>T-</i>	7	.159	9.171	9.0	1.440	8.0	12
Total		44	1	8.427	8.0	2.047	6	15

Table 22 Experiment 2 – modified: descriptive statistics of hurdle rate estimate

¹³⁴ The true location shift Δ is estimated by the Hodges-Lehman two-sample estimator.

¹³⁵ Effect size is measured using Cliff's δ . The effect size is considered small if $|\delta| > .147$, medium if $|\delta| > .33$ and large if $|\delta| > .474$ (based on Romano *et al.*, 2006).

¹³⁶ W-statistic from the Wilcoxon-Mann-Whitney test.

¹³⁷ P-value. *, ** and *** denote significance at $p \leq .1$, $p \leq .05$ and $p \leq .01$ respectively (based on one-tailed tests for directional alternative hypotheses and two-tailed tests otherwise). To avoid an increase in Type 1-error due to repeated statistical tests with the same dataset, we will make use of the Bonferroni correction and apply a more conservative, corrected significance level of $p_B = .1/2 = .05$ (m: number of tests with one (part of the) dataset).

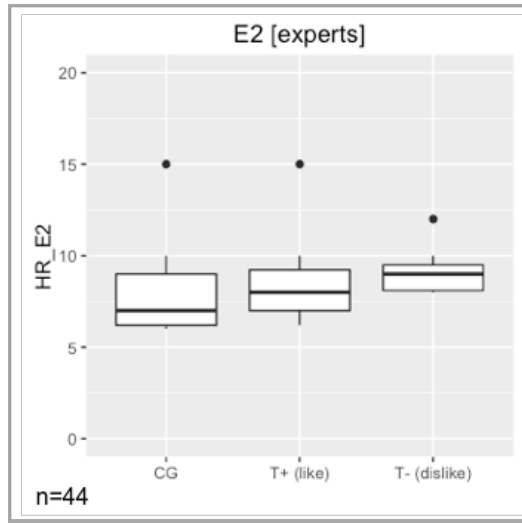


Figure 21 Experiment 2 – modified: hurdle rate estimate (experts)¹³⁸

The modified experiment provided more expressive results than the original experiment – effect sizes are not negligible (Table 23). It, to some extent, showed what the inducement of affect caused. Medians now differ from each other, even though we observe that the ‘like’-condition shows a higher median than the no-affect condition; as opposed to what we hypothesised. The treatments’ variances are substantially lower than in the neutral state which may point to a more confident opinion if a feeling was present and indicating that the feeling was relied on partially.

Alternative hypothesis				Test statistics Δ ¹³⁹		Effect size ¹⁴⁰	
H1	$T+(x) = F(x + \Delta)$	$T+ < F$	$\Delta < 0$	W ¹⁴¹ p ¹⁴²	108.5 .8804	.80	-.2413
H2	$T-(x) = F(x + \Delta)$	$T- > F$	$\Delta > 0$	W p	20** .0493	1.80	.4805
H3	$T-(x) = T+(x + \Delta)$	$T- > T+$	$\Delta > 0$	W p	121.5* .0914	1.00	.3352

Table 23 Experiment 2 – modified: results of hypothesis tests of the affect heuristic in the setting of hurdle rates

¹³⁸ HR_E2: hurdle rate estimate. CG: control group.

¹³⁹ The true location shift Δ is estimated by the Hodges-Lehman two-sample estimator.

¹⁴⁰ Effect size is measured using Cliff’s δ . The effect size is considered small if $|\delta| > .147$, medium if $|\delta| > .33$ and large if $|\delta| > .474$ (based on Romano *et al.*, 2006).

¹⁴¹ W-statistic from the Wilcoxon-Mann-Whitney test.

¹⁴² P-value. *, ** and *** denote significance at $p \leq .1$, $p \leq .05$ and $p \leq .01$ respectively (based on one-tailed tests for directional alternative hypotheses and two-tailed tests otherwise). To avoid an increase in Type 1-error due to repeated statistical tests with the same dataset, we will make use of the Bonferroni correction and apply a more conservative, corrected significance level of $p_B = .1/2 = .05$ (m: number of tests with one (part of the) dataset).

From the hypothesis tests, we learn that statistically, there is no difference between the neutral and the ‘like’ condition in terms of the hurdle rates set; and there is no significant indication from the Hodges-Lehmann estimator that liking the prototype led to a higher rate.

However, a negative feeling significantly influenced the rate, with a relatively strong effect. Disliking the project yielded a location shift of 180bp and thus almost two percentage points as a premium due to additionally perceived risk. We can claim that a negative feeling will make the project appear riskier and result in a higher hurdle rate set by expert decision-makers such as finance professionals.

Comparing conditions T_+ and T_- directly to each other in this modified experiment, the rates in T_- appear to be higher than in T_+ by 100bp; at a medium effect size, yet at no significant level from a conservative point of view. Differences seem to be obvious but cannot be significantly confirmed.

Based on the improved, modified experiment investigating the affect heuristic, we find evidence that affect plays a role in determining an appropriate risk-adjusted rate, namely in the case of a negative affect such as a feeling of dislike. Negative affect must have been associated with low benefit and thus high risk and as a consequence led to a hurdle rate premium.

If we assume that a naturally occurring feeling (as in the modified experiment) is more expressive, we can furthermore conclude: The feeling of dislike (negative affect) results in a much higher rate (180bp) than if no feeling was reported. Different to what was hypothesised, the feeling of like (positive affect) does not result in a lower rate than if no feeling was felt. Positive affect does not make a project appear less risky and thereby reduce the project-specific hurdle rate; in contrast, negative affect does make a project appear riskier and it results in a relatively higher risk-dependent rate.

With affect, by definition we cannot conclude, as in the previous experiment, that experts may be aware that affect as part of intuition should not play a role. However, this will have to be examined in a future experiment.

In summary, and partially confirming the findings of the interview study in Chapter 5, only negative affect influences the hurdle rate setting – thus pointing to bounded rationality. There tends to be a particular upwards bias in the hurdle rate. This behaviour was found among experts, who are expected to focus on relevant information rather than being influenced by intuitions and feelings.

6.2.3 Experiment 3: Hurdle Rate – Anchoring Effect

Experiment 3 assesses whether a salient value – an informative or an uninformative rate – serves as a cue for a project-specific hurdle rate. Being designed in four treatments with

different anchors, we can separate the effects of a plausible (informative) anchor point and an implausible (uninformative) one and observe the effect of different size anchor points.

In general and in accordance with previous findings, we expect that a mentioning a rate will result in a different hurdle rate estimate compared to the same situation without the provided rate. I.e., the distributions in the alternative conditions/samples differ, i.e. different anchor points affect the rate.

To derive our hypotheses, we will proceed analogously to above and assume X and Y to be random variables with continuous cumulative distribution functions F and G with independent observations: $X_1, \dots, X_m \sim F$ and $Y_1, \dots, Y_n \sim G$. We assume that G is a shifted version of F , $G(x) = F(x + \Delta)$ for all $x \in \mathbb{R}$ and an unknown $\Delta \in \mathbb{R}$. The shift in location Δ of the two distributions (e.g. A and control group CG) will be estimated using the Hodges-Lehman two-sample estimator.

First, we hypothesise that a proposed plausible hurdle rate – an *informative* anchor¹⁴³ that lies *more than 50% above* the average company cost of capital – will influence people's judgements resulting in a different hurdle rate estimate. We will therefore compare Treatment A (assuming a distribution function $Y_1, \dots, Y_n \sim A$) to the control group (CG, with a distribution function $X_1, \dots, X_m \sim F$) and thus examine whether A is a shifted version of F , i.e. $A(x) = F(x + \Delta)$:

$$\mathbf{H1_0}: \Delta = 0 \quad \mathbf{H1_a}: \Delta > 0 \quad (A > F)$$

Secondly, we hypothesise that a provided implausible hurdle rate – an *uninformative*¹⁴⁴ anchor that lies *more than 50% above* the average company cost of capital – will influence people's judgements resulting in a different hurdle rate estimate. We will therefore compare Treatment B (assuming a distribution function $Y_1, \dots, Y_n \sim B$) to the control group (CG, with a distribution function $X_1, \dots, X_m \sim F$), ceteris paribus, and thus examine whether B is a shifted version of F , i.e. $B(x) = F(x + \Delta)$:

$$\mathbf{H2_0}: \Delta = 0 \quad \mathbf{H2_a}: \Delta > 0 \quad (B > F)$$

Analogously to H2, we define our third hypothesis: We hypothesise that a provided implausible hurdle rate – an *uninformative*¹⁴⁵ anchor that lies *more than 25% above* the average company cost of capital and half the distance to the cost of capital assumed in H2 – will influence people's judgements resulting in a different hurdle rate estimate. We will therefore

¹⁴³ We introduce an anchor of 9.75% that a colleague recommends for the particular project proposal considered; company WACC amounts to 6.2%.

¹⁴⁴ We introduce an anchor of 9.75% that represents a randomly generated number drawn from a set of numbers from 0.00 to 20.00; company WACC amounts to 6.2%.

¹⁴⁵ We introduce an anchor of 7.98% that represents a randomly generated number drawn from a set of numbers from 0.00 to 20.00; company WACC amounts to 6.2%.

compare Treatment C (assuming a distribution function $Y_l, \dots, Y_n \sim C$) to the control group (CG, with a distribution function $X_l, \dots, X_m \sim F$), ceteris paribus, and thus examine whether C is a shifted version of F , i.e. $C(x) = F(x + \Delta)$:

$$\mathbf{H3_0}: \Delta = 0 \quad \mathbf{H3_a}: \Delta > 0 \quad (C > F)$$

Also analogously to H2, we define our fourth hypothesis: We hypothesise that a provided implausible hurdle rate – an *uninformative*¹⁴⁶ anchor that lies *more than 50% below* the average company cost of capital – will influence people’s judgements resulting in a different hurdle rate estimate. We will therefore compare Treatment D (assuming a distribution function $Y_l, \dots, Y_n \sim D$) to the control group (CG, with a distribution function $X_l, \dots, X_m \sim F$), ceteris paribus, and thus examine whether C is a shifted version of F , i.e. $D(x) = F(x + \Delta)$:

$$\mathbf{H4_0}: \Delta = 0 \quad \mathbf{H4_a}: \Delta > 0 \quad (D > F)$$

For a direct comparison of the impact of a plausible as opposed to an implausible anchor in hurdle rate decisions, we develop H5: We hypothesise that an anchor of an informative rate has a stronger effect than an uninformative rate of the same size. Analogous to above, we assume Condition B’s distribution function with $X_l, \dots, X_m \sim B$ and Condition A’s distribution function with $Y_l, \dots, Y_n \sim A$; and based on $A(x) = B(x + \Delta)$, we hypothesise:

$$\mathbf{H5_0}: \Delta = 0 \quad \mathbf{H5_a}: \Delta > 0 \quad (A > B)$$

Analogously to H5, we hypothesise than an anchor of an uninformative rate of more than 50% above the company cost of capital has a stronger effect than a similarly uninformative rate of half the difference above the company cost of capital. Ceteris paribus, we assume Condition C’s distribution function with $X_l, \dots, X_m \sim C$ and Condition B’s distribution function with $Y_l, \dots, Y_n \sim B$; and based on $B(x) = C(x + \Delta)$, we hypothesise:

$$\mathbf{H6_0}: \Delta = 0 \quad \mathbf{H6_a}: \Delta > 0 \quad (B > C)$$

		n _{orig}	+ n _{mod}	= n	rel freq	mean	median	sd	min	max
CG	F	44	10	54	.236	8.367	7.00	4.825	5.0	40
A (9.75c)	A	43	12	55	.240	10.759	9.75	7.646	6.2	65
B (9.75r)	B	51	11	62	.271	9.294	9.50	1.990	6.2	15
C (7.98r)	C	46		46	.201	8.832	8.10	2.334	5.0	15
D (2.65r)	D		12	12	.052	7.296	7.25	1.124	6.0	10
Total		184	45	229	1	9.230	8.50	4.735	5.0	65

Table 24 Experiment 3: descriptive statistics of hurdle rate estimate¹⁴⁷

¹⁴⁶ We introduce an anchor of 2.65% that represents a randomly generated number drawn from a set of numbers from 0.00 to 20.00; company WACC amounts to 6.2%.

¹⁴⁷ CG: control group; A(9.75c): Treatment Group A with an informative anchor of 9.75% provided by the colleague (c); B(9.75r): Treatment Group B with an uninformative anchor of 9.75% randomly (r) generated. C(7.98r) and D(2.65r) represent Treatment Groups C and D, analogous to B.

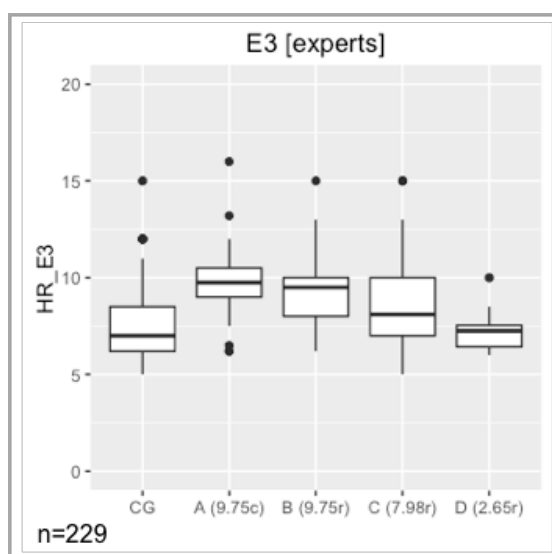


Figure 22 Experiment 3: hurdle rate estimate (experts)¹⁴⁸

Based on the sample size of 328 in total, two NA values in the hurdle rate estimate reduce the total number of valid responses in this experiment to 326 including 97 experts. All groups (control and treatment groups, except for D due to its late inclusion) are of roughly equal size. Our main focus, the expert group, consists of 229 subjects (see Table 24).

For the expert, we find evidence of the effectiveness of all anchor points larger than the company cost of capital of 6.2% (see Table 25): All anchors (Conditions A, B and C) other than Condition D (below cost of capital) significantly positively influenced the rate estimate, i.e. their rates are set significantly higher than the subjects' rate in the control condition.

An informative anchor (9.75%) of more than 50% above the cost of capital (6.2%) leads to a distribution of hurdle rates 250bp above the no-anchor condition's distribution. Assuming the control group's median represents the unbiased estimate's location (median hurdle rate of 7%¹⁴⁹), we find the estimate based on the anchor is 9.5%, implying a premium of approximately 35%. Hence, the anchoring effect works almost perfectly. Thus, the hurdle rate estimate was found to be strongly affected by the informative anchor of 9.75% (in the context of a WACC of 6.2% and a project that is of only slightly higher than average company risk).

¹⁴⁸ HR_E3: hurdle rate estimate. Data points not displayed: HR_E3=[40] in the control group (CG); HR_E3=[65] in treatment A. These data points have not been removed from the dataset and are included in the calculations.

¹⁴⁹ We could additionally estimate the 'true' location of the control group in inferential statistics based on the pseudomedian, which is the median of all average pairs of the sample and which is used in inferential statistics as a location parameter for one sample, similarly to the Hodges-Lehmann estimator for two samples. Both, median and pseudomedian coincide if the distribution is symmetric. If we based our reasoning on the pseudomedian, the reliance on the anchor and adjustment due to the anchor is even stronger.

Alternative hypothesis				Test statistics Δ^{150}		Effect size ¹⁵¹	
H1	$A(x) = F(x + \Delta)$	$A > F$	$\Delta > 0$	W_{p152}	642*** .0000	2.50	.5677 large
H2	$B(x) = F(x + \Delta)$	$B > F$	$\Delta > 0$	W_p	904*** .0000	1.50	.4597 medium
H3	$C(x) = F(x + \Delta)$	$C > F$	$\Delta > 0$	W_p	887*** .0067	.90	.2858 small
H4	$D(x) = F(x + \Delta)$	$D < F$	$\Delta < 0$	W_p	342.5 .381	.00	.0571 negligible
H5	$A(x) = B(x + \Delta)$	$A > B$	$\Delta > 0$	W_p	1413* .0537	.50	.1713 small
H6	$B(x) = C(x + \Delta)$	$B > C$	$\Delta > 0$	W_p	1202* .0812	.50	.1571 small

Table 25 Experiment 3: results of hypothesis tests of the anchoring effect in the setting of hurdle rates

An uninformative anchor of yet the same size and of the same unit (9.75%) of more than 50% above the cost of capital leads to a distribution of hurdle rates 150bp above the no-anchor condition's distribution. Again, the hurdle rate estimates were strongly affected by even the implausible reference rate of 9.75%. Nevertheless, its effect appears weaker than in the plausible anchor condition i.e. the premium on the cost of capital is slightly lower, though the effect is still of medium size.

Investigating the relationship between informative and uninformative anchors in more detail via a direct comparison of the anchors' effects, we are unable to confirm a different influence: A statistically conservative¹⁵⁴ evaluation of the results suggests that there is no difference between hurdle rates based on the semantically different anchor points that were nevertheless provided in the same format as the target variable. This would imply that the informative anchor has the same effect as the uninformative anchor, which seems surprising. Investigating anchors that do not have the same format as the target value may provide a direction of future research. In this way, we would be able to find whether any numerical figure influences judgement.

Even the hurdle rate estimates based on a relatively lower anchor point of 7.98% resulted in 90bp higher rate than the control group's distribution (which was also roughly mirrored in their medians). However, the differences in direct comparisons of A-B and B-C cannot be precisely estimated since effect sizes were small and significance low, so we can conclude that they weakly differed from each other by about 50bp, as was indicated in H1-3.

¹⁵⁰ The true location shift Δ is estimated by the Hodges-Lehman two-sample estimator.

¹⁵¹ Effect size was measured using Cliff's δ . The effect size is considered small if $|\delta| > .147$, medium if $|\delta| > .33$ and large if $|\delta| > .474$ (based on Romano *et al.*, 2006).

¹⁵² W-statistic from the Wilcoxon-Mann-Whitney test.

¹⁵³ P-value. *, ** and *** denote significance at $p \leq .1$, $p \leq .05$ and $p \leq .01$ respectively (based on one-tailed tests for directional alternative hypotheses and two-tailed tests otherwise). To avoid an increase in Type 1-error due to repeated statistical tests with the same dataset, we will make use of the Bonferroni correction and apply a more conservative, corrected significance level of $p_B = .1/4 = .025$.

¹⁵⁴ The difference in estimates of 50bp cannot be confirmed if we assume a conservative significance level of 2.5%.

Anchor point D, 2.65% – more than 50% below the company's average cost of capital, showed no impact on the final risk-adjusted hurdle rate estimate.

In the scenarios presented, the WACC as the average cost of capital can also be perceived as a reference point and potential anchor by itself. However, it is always present in any corporate setting and thus provides a permanent and thus negligible reference point.

In summary, by increasing the accessibility of judgment-relevant and -irrelevant knowledge at a time, we tested the impact of informative and uninformative anchors on the setting of hurdle rates. Not surprisingly, strong evidence was found for the orientation toward informative anchor points when determining the hurdle rate; this evidence was also stronger for the informative anchor than for the uninformative one (cf. the findings by e.g. Mussweiler and Strack, 2001). Nevertheless, even though the anchor points in Conditions B and C were uninformative, they influenced judgement and increased the project's hurdle rate. One facet worth noting is that although it was obvious to the respondents that these anchor points in B and C (9.75 and 7.98) were uninformative ("randomly generated"), they were nevertheless numerically in the plausible zone since they elicited rates above the control of 6.2%.

By contrast we see that anchor D lower than the cost of capital and thus outside the range of a plausible rate – did not significantly influence the rate estimate. We therefore conclude that the anchoring effect in this context does not depend on whether the salient rate is informative or not, but depends on whether the informative or uninformative anchor is generally plausible, i.e. part of the possible 'solution set'. We do not find unreflective reliance on any salient anchor; however, a first step seems to be to test whether the anchor – be it informative or not – fits to a particular context. If so, any anchor will work. If an uninformative anchor fulfils the condition of matching the 'solution set' – which only experts can evaluate – then it serves as an anchor influencing the final hurdle rate estimate.

The plausible anchor did in fact have the strongest effect on the subjects' estimate implying that the experts did not act completely irrationally. We also expect that finance and accounting experts as "knowledgeable people are less susceptible to basic anchoring effects" (Wilson *et al.*, 1996, p.401). However, the respondents appear to have given too much weight to the uninformative anchor probably due to its proximity to the estimate that was considered 'right'. It is worth noting that even 'experts' in this context were clearly prone to insufficiently adjusting to the irrelevant anchor provided. This confirms Wilson *et al.*'s (1996) findings as regards the influence of purely numerical anchors if at least some attention is paid to them.

This finding is nevertheless in line with the experts' background: Due to their expertise, more semantic knowledge can be activated and thus even arbitrary anchors may have a stronger effect. However, at the same time, and from a normative perspective, an arbitrary rate should

not influence their reasoning. This finding might therefore have serious consequences in corporate decision-making as numerical estimates may be easily transferred to a hurdle rate frame and hurdle rate estimates can in this way be easily manipulated.

All anchors provided in the scenarios, also in Experiment 6, are provided in the same format, for example as a percentage. Future work may address the effect of anchors provided in a different format but with the same meaning, such as anchors provided in basis points as opposed to a percentage (cf. Mussweiler and Strack, 2001).

6.2.4 Experiment 4: Hurdle Rate – Correction of Overconfidence

In Experiment 4 we are interested in investigating whether decision-makers exposed to overconfident cash flow (CF) projections will adjust hurdle rates upward; we will therefore compare a condition where respondents are informed that the person having prepared the CF projections may have been too confident to a condition where no information is provided about the person who determined the CFs. Similarly to the previous derivation of hypotheses, we will compare the treatment condition T (assuming a distribution function with independent observations of $Y_1, \dots, Y_n \sim T$) to the control condition CG (with $X_1, \dots, X_m \sim F$) with X and Y being random variables with continuous cumulative distribution functions F and T . We hypothesise that decision-makers will adjust the hurdle rate upwards in the case of an overconfident ‘supplier’ who has probably provided inflated cash flow projections. Thus, we will examine whether T is a shifted version of F , i.e. based on $T(x) = F(x + \Delta)$:

$$\mathbf{H}_0: \Delta = 0 \quad \mathbf{H}_a: \Delta > 0 \quad (T > F)$$

		n	rel freq	mean	median	sd	min	max
Control group	F	96	.522	12.706	10.25	7.429	5.0	60
Treatment group	T	88	.478	12.179	10.00	6.335	6.5	51
Total		184	1	12.450	10.00	6.913	5.0	60

Table 26 Experiment 4 – original: descriptive statistics of hurdle rate estimate

Based on the sample size of 275 in total for the first cohort (original experiment), two unavailable (NA) values in the hurdle rate estimate (HR_E4) reduce the total number of valid responses in this experiment to 273 including 89 non-experts. Both groups (control and treatment) are about equal in terms of size. Our main group to focus on, the expert group, comprises 184 subjects.

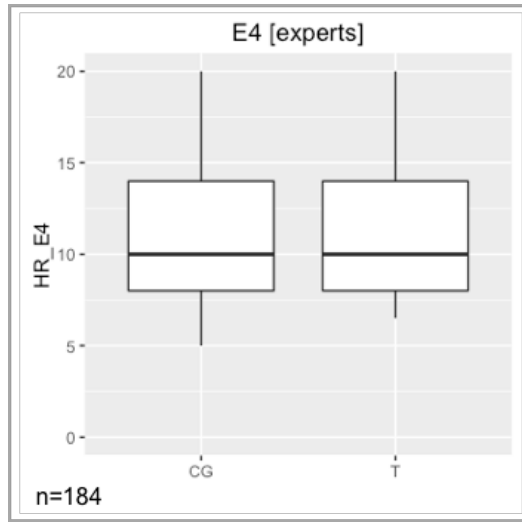


Figure 23 Experiment 4 – original: hurdle rate estimate (experts)¹⁵⁵

From reviewing the descriptive statistics (Table 26) and the hypothesis tests (Table 27), we do not find the treatment condition, which implies an overconfident technical manager, systematically leads to higher hurdle rates.

Alternative hypothesis				Test statistics Δ ¹⁵⁶		Effect size ¹⁵⁷	
H	$T(x) = F(x + \Delta)$	$T > F$	$\Delta > 0$	W ¹⁵⁸	4336	.00	-.0265
				p ¹⁵⁹	.6229		negligible

Table 27 Experiment 4 – original: results of hypothesis tests of the correction due to overconfidence

However, as we have noted above in Section 6.1.7, the wording of the experiment may not have sufficiently triggered all respondents' (or made them aware of) perception of a particular level of confidence. We therefore refined this experiment so that the treatment groups were based on the respondents' (reported) consideration of overconfidence as displayed in Table 29 below.

The modified experiment was conducted with 53 graduate students (described above in Section 6.1.2). Two unavailable (NA) values in HR_E4 reduce the total number of valid responses in this slightly modified experiment to 51 in total including 43 experts. Group sizes

¹⁵⁵ HR_E4: hurdle rate estimate. Data points not displayed: HR_E4=[22, 25, 25, 25, 30, 30, 35, 60] in the control group (CG); HR_E4=[25, 28, 30, 51] in the Treatment Group T). These data points have not been removed from the dataset and are included in the calculations.

¹⁵⁶ The true location shift Δ is estimated by the Hodges-Lehman two-sample estimator.

¹⁵⁷ Effect size was measured using Cliff's δ . The effect size is considered small if $|\delta| > .147$, medium if $|\delta| > .33$ and large if $|\delta| > .474$ (based on Romano *et al.*, 2006).

¹⁵⁸ W-statistic from the Wilcoxon-Mann-Whitney test.

¹⁵⁹ P-value. *, ** and *** denote significance at $p \leq .1$, $p \leq .05$ and $p \leq .01$ respectively (based on one-tailed tests for directional alternative hypotheses and two-tailed tests otherwise).

differed depending on their assessment of overconfidence; the no-overconfidence ('NoOC') sample was particularly small.

Table 28 shows the overconfidence perceptions of the respondents based on which case description (CG or T, see original experiment) they had received. The treatment T is equivalent to the original experiment telling about the technical manager's performance-related pay ("You are new to the company but you know that the technical manager receives performance-related pay on successful projects and that he insists on the project being undertaken.") As expected, the treatment condition as in the original experiment in general evoked more judgements (perceptions) of overconfidence (67%) than the control condition did. This was to test whether the two different case descriptions (control and treatment) evoked the desired perception of too high or no confidence and we can see that as a tendency, it does. However, neither the control group case description alone made the respondents perceive non-overconfident CF projections, nor did the treatment group case description always make the respondents perceive overconfident projections. Consequently, we have to be careful drawing conclusions from this original experiment's results as indicated before. Instead, we should and will rely on the reply to the additional question (perceived overconfidence) because whether a correction of perceived overconfidence occurred or not is what we are interested in.

	OC	NoOC	Can't say	Sum
Control_orig	.21	.08	.71	1
Treatment_orig	.67	.04	.30	1

Table 28 Experiment 4 – modified: contingency table

The modified experiment includes three conditions so we have to refine the hypotheses. First of all, and as in the original experiment, we hypothesise that decision-makers will adjust upwards the hurdle rate in the case of an overconfident 'supplier' of cash flow projections and thus probably inflated projections. Thus, in a comparison against both the no-overconfidence and the indifference ('can't say') conditions we expect the rate to be higher.

Analogous to above, we compare the treatment (overconfidence) condition (assuming a distribution function with independent observations of $Y_1, \dots, Y_n \sim T$) to the control (no overconfidence) condition (with $X_1, \dots, X_m \sim F$) with X and Y being random variables with continuous cumulative distribution functions F and T ; and based on $T(x) = F(x + \Delta)$, we hypothesise:

$$\mathbf{H1_0: \Delta = 0 \quad H1_a: \Delta > 0 \quad (T > F)}$$

Contrasting the treatment condition with the function $T (Y_l, \dots, Y_n \sim T)$ against the indifference (‘can’t say’) condition G (with $X_l, \dots, X_m \sim G$), with the same assumptions applying ceteris paribus; based on $T(x) = G(x + \Delta)$, we hypothesise:

$$\mathbf{H2_0: \Delta = 0 \quad H2_a: \Delta > 0 \quad (T > G)}$$

Finally, we find a difference contrasting the indifference condition with the function $G (Y_l, \dots, Y_n \sim G)$ against the control condition of no-overconfidence F (with $X_l, \dots, X_m \sim F$) with the same assumptions applying ceteris paribus. The respondents in the indifference condition are not sure of whether they consider the technical manager too confident with his cash flow projections; however, since the no-overconfidence group have clearly pointed out they don’t think so, we hypothesise that on average people apply a lower hurdle rate when indifferent, and with $G(x) = F(x + \Delta)$:

$$\mathbf{H3_0: \Delta = 0 \quad H3_a: \Delta > 0 \quad (G > F)}$$

		n	rel freq	mean	median	sd	min	max
No overconfidence	<i>F</i>	2	.047	8.250	8.25	2.475	6.5	10
Overconfidence	<i>T</i>	19	.442	11.118	10.00	2.641	7.0	18
Can’t say	<i>G</i>	22	.512	10.591	10.00	3.696	6.5	20
Total		43	1	10.720	10.00	3.215	6.5	20

Table 29 Experiment 4 – modified: descriptive statistics of hurdle rate estimate

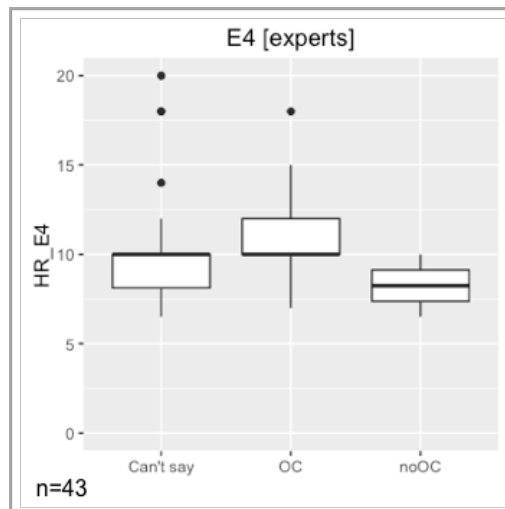


Figure 24 Experiment 4 – modified: hurdle rate estimate (experts)¹⁶⁰

In the modified experiment, we do now find a weak difference between cash flows perceivably based on overconfidence (*T*) and the control group condition of no-overconfidence

¹⁶⁰ HR_E4: hurdle rate estimate. OC: overconfidence; noOC: no overconfidence.

(*F*): Those having perceived the cash flows to be too confident, even set the rate more than 300bp higher than those who did not perceive overconfidence (see Table 30). Despite the weak significance and the small sample size of the no-overconfidence group, the effect size is considered moderate.

Alternative hypothesis				Test statistics Δ^{161}		Effect size 162	
H1	$T(x) = F(x + \Delta)$	$T > F$	$\Delta > 0$	W_{p164}^{163}	30* .0949	3.28 .3947	medium
H2	$T(x) = G(x + \Delta)$	$T > G$	$\Delta > 0$	W_p	259* .0909	.50 .2392	small
H3	$G(x) = F(x + \Delta)$	$G > F$	$\Delta > 0$	W_p	30.5 .1951	1.5 .2727	small

Table 30 Experiment 4 – modified: results of hypothesis tests of the correction due to overconfidence

We take this experiment as an indication that adjustment due to overconfidence may in fact happen, but to be sure it would have to be replicated with a higher sample size in the no-overconfidence condition. Knowing that we should treat this insight with care, we could therefore compare the overconfidence condition to not only the no-overconfidence condition alone, but also to the judgements of all other respondents taken together, i.e. the no-overconfidence condition and the indifference condition, both expressed by a distribution function H (with $X_1, \dots, X_m \sim H$) keeping all other assumptions constant. With $T(x) = H(x + \Delta)$:

$$\mathbf{H4_0:} \Delta = 0 \quad \mathbf{H4_a:} \Delta > 0 \quad (T > H)$$

Alternative hypothesis				Test statistics Δ^{165}		Effect size 166	
H4	$T(x) = H(x + \Delta)$	$T > H$	$\Delta > 0$	W_{p168}^{167}	289* .0632	.50 .2675	small

Table 31 Experiment 4 – modified: results of hypothesis tests of the correction due to overconfidence with cumulated control condition

¹⁶¹ The true location shift Δ is estimated by the Hodges-Lehman two-sample estimator.

¹⁶² Effect size was measured using Cliff's δ . The effect size is considered small if $|\delta| > .147$, medium if $|\delta| > .33$ and large if $|\delta| > .474$ (based on Romano *et al.*, 2006).

¹⁶³ W-statistic from the Wilcoxon-Mann-Whitney test.

¹⁶⁴ P-value. *, ** and *** denote significance at $p \leq .1$, $p \leq .05$ and $p \leq .01$ respectively (based on one-tailed tests for directional alternative hypotheses and two-tailed tests otherwise). To avoid an increase in Type I-error due to repeated statistical tests with the same dataset, we will make use of the Bonferroni correction and apply a more conservative, corrected significance level of $p_B = 1/3 = .0333$ due to three tests of each group, see below for a fourth hypothesis.

¹⁶⁵ The true location shift Δ is estimated by the Hodges-Lehman two-sample estimator.

¹⁶⁶ Effect size was measured using Cliff's δ . The effect size is considered small if $|\delta| > .147$, medium if $|\delta| > .33$ and large if $|\delta| > .474$ (based on Romano *et al.*, 2006).

¹⁶⁷ W-statistic from the Wilcoxon-Mann-Whitney test.

¹⁶⁸ P-value. *, ** and *** denote significance at $p \leq .1$, $p \leq .05$ and $p \leq .01$ respectively (based on one-tailed tests for directional alternative hypotheses and two-tailed tests otherwise). See Footnote 164 for the Bonferroni correction.

If we now contrast the overconfidence condition (OC) to non-overconfidence (NoOC) and indifference (Can't say), we find a weakly higher hurdle rate in the case of overconfidence, with the premium amounting to 50bp on average and a small, yet non-negligible effect size (see Table 31). From a conservative point of view, we would not reject H_{40} and thus find this difference in hurdle rates estimates insignificant.

Hence, we can only very weakly show that overconfidence of a person responsible for the cash flow projections impacts the decision-maker's hurdle rate estimate. As previous research indicated, an upwards adjustment of the hurdle rate due to overconfidence in cash flow forecasts is not only theoretically recommendable (e.g. Gervais, 2010), but does occur in practice (e.g. Mukherjee, 1991), as also indicated in our interview study. This however does not seem common, systematic intuitive practice but rather done on an individual case basis. The adjustment may also depend on how obvious, and therefore how accessible the cash flow forecasts' overestimation is; this may be a topic of further research.

6.2.5 Experiment 5: Cash Flows – Representativeness Heuristic

In Experiment 5, we investigate to what extent more or less similar, but unrelated instances or outcomes from accounting records impact the projections of cash flows (CF) required for the financial appraisal of an investment proposal. The experiment required the decision-maker to make an estimate about a cash outflow based on scheduled production stoppage for the maintenance of a new random sampling machine. As indicated above in Section 6.1.8, we consider three conditions, a similarity condition (S), a dissimilarity condition (D) and a control condition (CG). The control group received information about the scheduled production interruption and the resulting costs only. S and D additionally provided two instances from accounting records with variation which of the two instances – the similar or the dissimilar machine – showed a significant, unexpected delay in production stoppage; the other machine, respectively, showed a maintenance outcome as scheduled.

For the control group¹⁶⁹ and analogous to the previous derivation of hypotheses, we assumed the CF projection's distribution function F with independent observations $X_1, \dots, X_m \sim F$, for the similarity group we assumed the distribution function S with $Y_1, \dots, Y_n \sim S$ and for the dissimilarity group D with $Z_1, \dots, Z_o \sim D$. We will then examine whether S and D are each shifted versions of F .

The hypotheses imply pairwise comparisons based on comparing two conditions at a time: The first hypothesis refers to the impact of highly similar project which shows an unexpected outcome (production stoppage much longer than expected) and the dissimilar project with an

¹⁶⁹ Assuming a particular distribution of how much a person likes the described model.

outcome as expected (production stoppage as scheduled). Based on $S(x) = F(x + \Delta)$, we hypothesise:

$$\mathbf{H1_0}: \Delta = 0 \quad \mathbf{H1_a}: \Delta > 0 \quad (S > F)$$

The second hypothesis refers to the impact of high similarity to a past instance that showed an expected outcome and low similarity to a project with an unexpected outcome. Based on $D(x) = F(x + \Delta)$, we hypothesise:

$$\mathbf{H2_0}: \Delta = 0 \quad \mathbf{H2_a}: \Delta > 0 \quad (D > F)$$

We expect that decision-makers rely on the unexpected outcome as a potential outcome for the current cash outflow to project (i.e. the maintenance of random sampling machine) and thus the cash outflow estimate to depend on the level of similarity, therefore, based on $S(x) = D(x + \Delta)$, we hypothesise:

$$\mathbf{H3_0}: \Delta = 0 \quad \mathbf{H3_a}: \Delta > 0 \quad (S > D)$$

Inspecting the responses – both graphically and by their descriptive statistics (see Figure 25 left) – confirms the above reasoning referring to the lower and upper limits of plausible values: The values' range is extremely wide [0; 233,500] with a mean of \$27,180 – which is probably distorted, due to the extreme values of more than 10 times the median – it has an enormous standard deviation of \$31,885.¹⁷⁰ We may spot a 'gap' above values of \$50,000 assuming that \$50,000 may already be an extreme value that respondents may use when rounding off from a production stoppage of eight hours.¹⁷¹ The next value above \$50,000 is \$65,485 and undoubtedly appears implausible. Thus, for the following analysis, we will concentrate on data points in a range of [15,010; 50,000].¹⁷²

¹⁷⁰ 1st quartile: 19,340, median=19,940, mean=27,180, 3rd quartile=21,280.

¹⁷¹ Assuming that the other maintenance costs would increase proportionally.

¹⁷² The following data points were removed:

Control group: CF_E5=[50; 600; 4,930; 5,000; 5,000; 15,000; 72,000; 151,705; 161,705; 200,385; 233,475]

Similarity condition: CF_E5=[7; 1,460; 2,155; 4,630; 4,930; 5,530; 8,000; 14,000; 15,000; 15,000; 68,955; 100,000; 140,000; 200,000; 200,385].

Dissimilarity condition: CF_E5=[0; 10; 25; 300; 5,000; 10,000; 10,000; 15,000; 65,485; 80,000; 150,000; 166,715; 171,045; 171,045; 200,000].

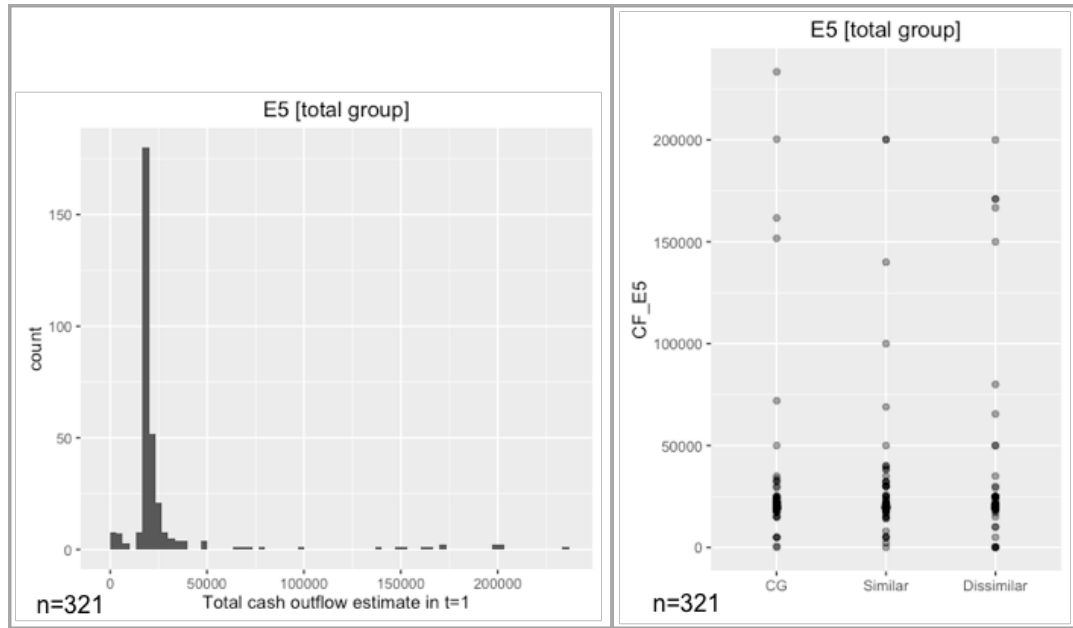


Figure 25 Experiment 5: cash flow estimate – all data points (total group)¹⁷³

For this type of decision, i.e. making cash flow (CF) projections for appraising an investment, we have treated the responses of both ‘experts’ and ‘non-experts’ relevant. As we have focused on expert decision-making so far, we may also refer to the experts if their judgement particularly differs.

	Group	n	rel freq	mean	median	sd	min	max
Control group	Total	98	.350	21,109.9	19,940	4,500.6	15,010	50,000
	Experts	69	.345	20,582.4	19,940	3,097.0	15,010	33,740
Similarity	Total	86	.307	22,438.2	20,000	6,069.5	17,000	50,000
	Experts	62	.310	22,394.1	20,000	6,197.0	17,000	50,000
Disimilarity	Total	96	.343	21,225.5	19,940	4,949.0	17,000	50,000
	Experts	69	.345	21,487.1	19,940	5,648.0	18,140	50,000
Total	Total	280	1	21,560.0	19,940	5,191.6	15,010	50,000
	Experts	200	1	21,460.0	19,940	5,146.7	15,010	50,000

Table 32 Experiment 5: descriptive statistics of cash flow estimate

¹⁷³ CF_E5: cash flow estimate.

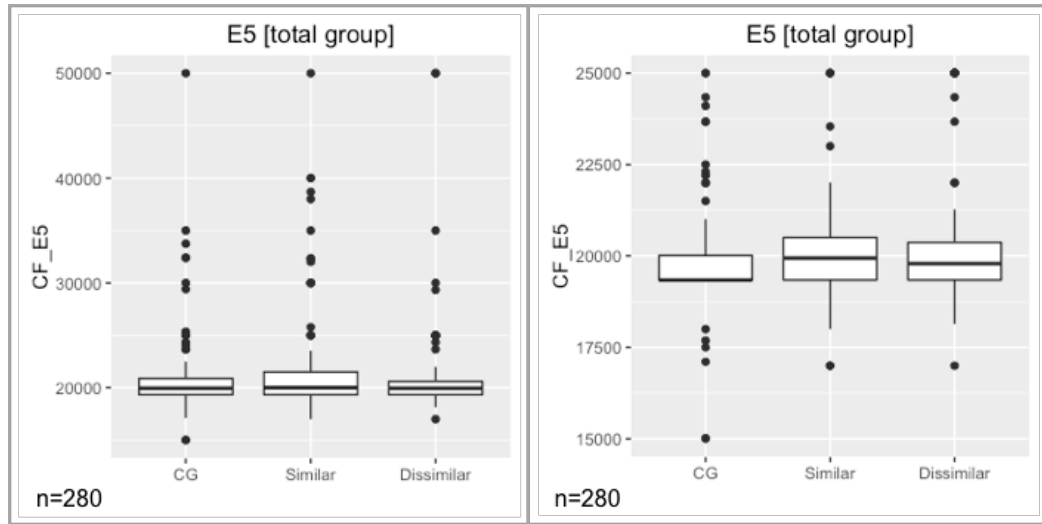


Figure 26 Experiment 5: cash flow estimate (total group)¹⁷⁴

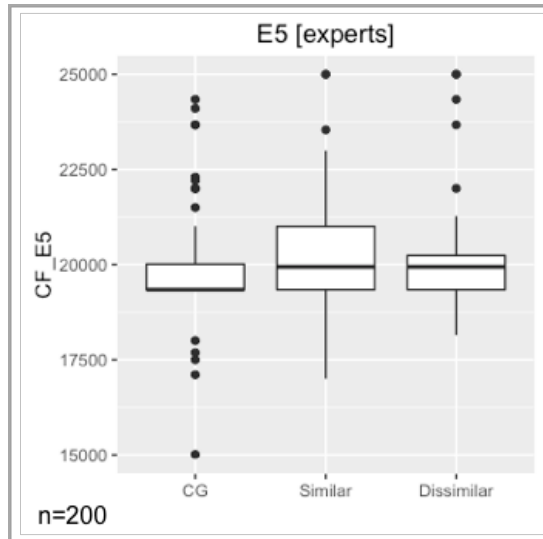


Figure 27 Experiment 5: cash flow estimate (experts)¹⁷⁵

Based on the descriptive statistics, we observe that all groups included a safety margin to the initial maintenance cost estimate of \$4,330. The control group's median of \$19,940 would imply a premium of \$600 (to the outflow of \$19,340), i.e. an average estimated production stop of 2 hours, *ceteris paribus*.¹⁷⁶

¹⁷⁴ CF_E5: cash flow estimate.

Left figure: all data points are displayed; right figure: extract/magnification of the left figure for better readability; with an axis limit of 15,000 and 25,000; it does not display CF_E5= [25,340; 29,410; 30,000; 32,400; 32,400; 33,740; 35,000; 50,000] for the control group, CF_E5= [25,780; 30,000; 30,000; 30,000; 30,000; 32,000; 32,330; 32,330; 35,000; 38,000; 38,680; 40,000; 40,000; 50,000] for 'similarity' and CF_E5= [29,340; 30,000; 35,000; 50,000; 50,000] for 'dissimilarity'. These data points have not been removed from the dataset and are included in the calculation.

¹⁷⁵ CF_E5: cash flow estimate.

¹⁷⁶ The control group's average cash flow estimate is significantly different to the initially proposed total cash outflow of Period 1 (\$19,340), $p < .0000$ (for the group in total and for the experts, too). The pseudomedian amounts to \$21,110 (experts: \$20,835).

While we still observe very high standard deviations despite the exclusion of implausible values (see Table 32), the medians indicate that similarity may have resulted in a higher estimate on average. This, however, is only weakly confirmed by the results of the hypothesis tests (Table 33).

Examining our hypotheses, we find the similarity condition leads only to higher CF estimates among the experts. The expert group may have used similarity as an (additional) cue to arrive at a CF estimate. It resulted in an estimate of \$140 higher than the control group's estimate, i.e. on average, they estimated the time the production is stopped to be .23 hours or 14 min longer on average than those without having had access to records of a past similar instance. This difference appears relatively small but, given the considerable sample size, is worth noting.

Dissimilarity however does not seem to be a cue for judgement. D seems to lie in between F and S and thus statistically significant differences cannot be identified. But this may be due to the very scattered overall distribution and the difference between the distributions not being substantial.

Alternative hypothesis		Total	Δ ¹⁷⁷	Effect size ¹⁷⁸		Experts	Δ	Effect size	
H1	$S > F \Delta > 0$	W_p^{179} 3741* .0889	.0	.1122	negligible	1787.5** .0482	139.8	.1643	small
H2	$D > F \Delta > 0$	W_p 4610 .4017	.0	.0120	negligible	2161 .1669	.0	.0922	negligible
H3	$S > D \Delta > 0$	W_p 3710 .1135	.0	.1013	negligible	1948 .1841	.0	.0893	negligible

Table 33 Experiment 5: results of hypothesis tests of the representativeness heuristic in the projection of cash flows

We have found that similarity only very weakly serves as a cue for a cash flow judgement which is surprising. As the past event refers to a very similar machine, this may represent relevant information and conclusions on this basis may be acceptable; however, on the other hand, a single instance is never representative and should not be over-weighted. We observed that, a overweighting of past (similar or dissimilar) information due to its similarity did not take place.

This implies additionally forecasted maintenance cost of \$1,770, which is equivalent to an additional production stop of almost 3h, thus 4h in total.

¹⁷⁷ The true location shift Δ is estimated by the Hodges-Lehmann two-sample estimator.

¹⁷⁸ Effect size was measured using Cliff's δ . The effect size is considered small if $|\delta| > .147$, medium if $|\delta| > .33$ and large if $|\delta| > .474$ (based on Romano *et al.*, 2006).

¹⁷⁹ W-statistic from the Wilcoxon-Mann-Whitney test.

¹⁸⁰ P-value. *, ** and *** denote significance at $p \leq .1$, $p \leq .05$ and $p \leq .01$ respectively (based on one-tailed tests for directional alternative hypotheses and two-tailed tests otherwise). To avoid an increase in Type I-error due to repeated statistical tests with the same dataset, we will make use of the Bonferroni correction and apply a more conservative, corrected significance level of $p_B = .1/4 = .05$.

Therefore, we can conclude that the heuristic attribute of the similar project's outcome does not play a role in the reasoning of a corporate decision-maker being involved in cash flow projections. For finance/accounting experts, similarity may only to some extent play a role, the similar instance's implication however is not overestimated. Hence, we observe a reasoning process which is relatively independent of reliance on similar related or unrelated data from accounting records, and which does not one-sidedly rely on one cue; obviously the situation at hand is crucial for making a cash flow estimate.

6.2.6 Experiment 6: Cash Flows – Anchoring Effect

In the anchoring and adjustment experiment, we expect the highly accessible value to serve as a cue for the growth rate estimate on which the CF forecast will be based. We expect a mentioned cash flow growth rate to result in a different CF estimate compared to the same situation without the provided value. I.e., we expect the distributions in the different conditions to differ meaning that different anchor points, whether informative or uninformative and of different size to affect the growth estimate in the following way:

Analogously to the previous experiments, we assume X and Y to be random variables with continuous cumulative distribution functions F (representing the control group) and A (representing Condition A) with independent observations: $X_1, \dots, X_m \sim F$ and $Y_1, \dots, Y_n \sim A$. We assume A is a shifted version of F , $A(x) = F(x + \Delta)$ for all $x \in \mathbb{R}$ and $\Delta \in \mathbb{R}$ to be unknown, we hypothesise that a salient informative anchor of a potential value of the target criterion will influence the judgement which in our context means: A plausible growth rate of 6.5% results in a higher rate estimate than if no rate is proposed – assuming 6.5% is slightly higher than the average estimate made by the control group. Thus, for $A(x) = F(x + \Delta)$:

$$\mathbf{H1_0}: \Delta = 0 \quad \mathbf{H1_a}: \Delta > 0 \quad (A > F)$$

We similarly expect participants of Condition B (with a distribution function of $Y_1, \dots, Y_n \sim B$; ceteris paribus) with a provided uninformative growth rate of 6.5% – listening to some managers talking about a cost increase of this size – to estimate the growth rate to be higher than if no rate is present. As no informative anchor is available, they may take the purely numerical and thus uninformative anchor. Thus for $B(x) = F(x + \Delta)$:

$$\mathbf{H2_0}: \Delta = 0 \quad \mathbf{H2_a}: \Delta > 0 \quad (B > F)$$

Condition C with a provided implausible growth rate of -6.5% (with a distribution function of $Y_1, \dots, Y_n \sim C$) is assumed to result in a growth rate lower than if no rate is provided – assuming -6.5% is slightly lower than the average growth rate estimate made by the control group, with $C(x) = F(x + \Delta)$ ceteris paribus:

$$\mathbf{H3_0}: \Delta = 0 \quad \mathbf{H3_a}: \Delta < 0 \quad (C < F)$$

In a direct comparison, we believe the proposed plausible rate may (and should) represent a stronger anchor and thus the adjustment to it weaker than if an implausible rate is provided. With the distribution functions B (representing Condition B) and A (representing Condition A) with independent observations: $X_1, \dots, X_m \sim B$ and $Y_1, \dots, Y_n \sim A$, and $A(x) = B(x + \Delta)$, ceteris paribus, we hypothesise:

$$\mathbf{H4_0}: \Delta = 0 \quad \mathbf{H4_a}: \Delta > 0 \quad (A > B)$$

Considering implausible rates only, we expect that none of them should influence judgement and thus the growth rate estimate in the described scenario. However, knowing that the anchoring effect does occur, we will test whether a particular uninformative anchor of 6.5% induces higher growth rates than an equal absolute, but negative anchor. With continuous cumulative distribution functions C (representing Condition C) and B (representing Condition B) with independent observations: $X_1, \dots, X_m \sim C$ and $Y_1, \dots, Y_n \sim B$, we hypothesise with $B(x) = C(x + \Delta)$, ceteris paribus:

$$\mathbf{H5_0}: \Delta = 0 \quad \mathbf{H5_a}: \Delta > 0 \quad (B > C)$$

Considering the sample's medians, we find the informative anchor and the uninformative anchor of the same size yield essentially higher estimates (6.5 and 4.0 respectively) than in the control condition (median of 3.0); the uninformative negative anchor of the same size also yielded the same estimate (3.0) (see Table 34). If we – similarly to Experiment 5 – additionally consider the experts as our main group of interest from a management accounting perspective, we find exactly equivalent statistics; with the exception that the uninformative negative anchor in fact resulted in a lower estimate (2.25) than control group.

	Group	n	rel freq	mean	median	sd	min	max
CG	Total	56	.206	4.864	3.00	6.734	-15.0	30.0
	Experts	36	.199	5.219	3.00	6.420	-.5	30.0
A (6.5h)	Total	87	.320	5.906	6.50	4.998	-5.0	30.0
	Experts	54	.298	5.988	6.50	5.093	-5.0	30.0
B (6.5r)	Total	62	.228	5.206	4.00	5.017	-3.5	30.0
	Experts	41	.227	5.000	4.00	3.352	-3.0	15.0
C (-6.5r)	Total	67	.246	3.204	3.00	5.929	-9.0	25.6
	Experts	50	.276	2.222	2.25	4.896	-6.5	16.0
Total	Total	272	1	4.867	4.00	5.693	-15.0	30.0
	Experts	181	1	4.571	4.00	5.190	-6.5	30.0

Table 34 Experiment 6 – original: descriptive statistics of cash flow growth estimate¹⁸¹

¹⁸¹ CG: control group; A(6.5h): Treatment Group A with an informative anchor of 6.5% historically (h) derived; B(6.5r): Treatment Group B with an uninformative anchor of 6.5% randomly (r) generated. C(-6.5r): Treatment Group C with an uninformative anchor of -6.5% randomly (r) generated.

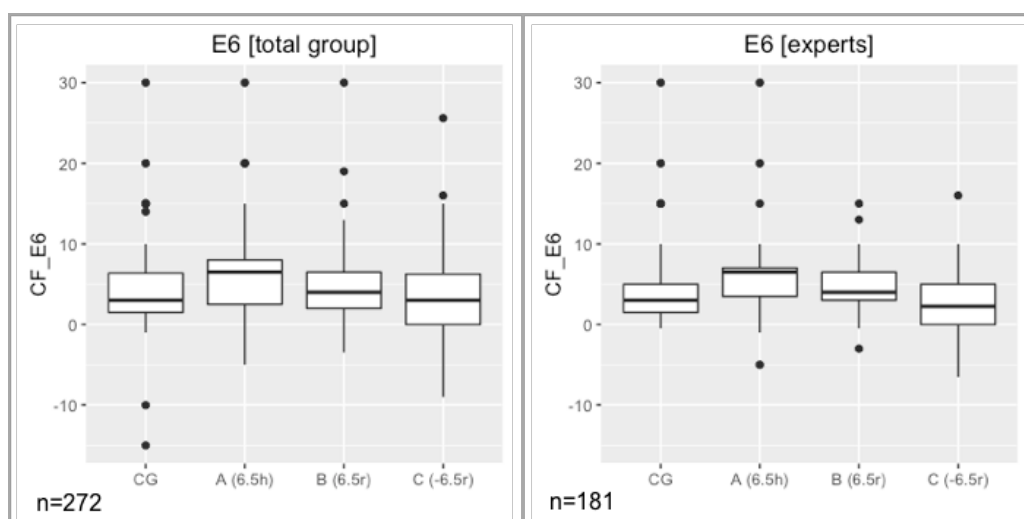


Figure 28 Experiment 6 – original: cash flow growth estimate (total group and experts)¹⁸²

We generalise these observations as follows (see Table 35): An informative plausible anchor of 6.5% (A) has the strongest impact in that it resulted in the highest estimate with 150bp higher than the no-anchor condition (control group, CG). An uninformative implausible anchor of 6.5% (B), i.e. of the same size and the same unit but meaningless, is estimated to lie around 100bp above it, i.e. a difference of 50bp which – in direct comparison to B – unfortunately cannot be shown to be significant. The negative anchor point of the same size and unit results in a downward adjustment, i.e. a lower growth estimate 100bp in contrast to no reference point provided. Finance or accounting professionals are shown to be even more influenced by the anchors provided.

Adopting a more conservative view and reducing the accepted significance level to .0167¹⁸³, we observe the effect of anchoring interestingly to apply to experts only. The informative anchor of 6.5% significantly affected the expert judgement, though the effect is estimated to be of small size only. We however observe the uninformative anchor of 6.5 to arrive in significantly higher rates than the similarly uninformative anchor of -6.5.

Up to this point, these findings have indicated a relatively analytical reasoning of those individuals involved in cash flow projections in that they do not seem to be strongly influenced by anchors. As regards the finance/accounting professionals in particular, plausible pieces of information might be taken into consideration without allowing for a too strong impact, which appears to be relatively rational behaviour. However, and in the absence of informative anchors, uninformative numerical anchors do not seem to influence judgement compared to no anchor. But in view of a significant difference between the two random anchors (B and C), we should

¹⁸² CF_E6: cash flow growth estimate.

¹⁸³ Bonferroni correction: Required significance level: .1/6=.0167.

have a closer look. We may not have found significant and strong effects comparing anchors to a no-anchor condition because the anchors were relatively (and potentially too) close to the unbiased growth rate estimate. A clear influence of an anchor – if one could be found – might not be observable by this design.

Alternative hypothesis			Total	Δ^{184}	Effect size ¹⁸⁵		Experts	Δ	Effect size	
H1	$A > F$	$\Delta > 0$	1937.5** .0195	1.50	.2046	small	697.5** .0118	2.00	.2824	small
H2	$B > F$	$\Delta > 0$	1490.5* .0927	.99	.1414	negligible	548** .0261	1.50	.2575	small
H3	$C < F$	$\Delta < 0$	2089.5 .1391	-1.00	.1138	negligible	1067.5* .0713	-1.40	.1861	small
H4	$A > B$	$\Delta > 0$	2312* .0687	1.00	.1428	negligible	967.5 .1466	.50	.1260	negligible
H5	$B > C$	$\Delta > 0$	1630** .0174	1.50	.2150	small	654*** .0015	2.50	.3620	medium

Table 35 Experiment 6 – original: results of hypothesis tests of the anchoring effect in the projection of cash flows

As described in Section 6.1.9, we will now examine whether a larger anchor point – double the previously applied one – has the same effect as a relatively moderate one. In a second experiment (see the second cohort above that was selected based on the same criteria as before) we will test for this. The now smaller sample size is used to examine a general tendency and to find an indication of whether the results found before can be confirmed.

	Group	n	rel freq	mean	median	sd	min	max
CG	Total	11	.212	2.591	2.00	5.504	-7.00	10
	Experts	10	.222	3.550	2.25	4.734	-2.00	10
A (13h)	Total	19	.365	11.421	13.00	8.257	-5.00	35
	Experts	16	.356	11.938	13.00	8.670	-5.00	35
B (13r)	Total	10	.192	6.267	5.50	4.097	1.67	13
	Experts	10	.222	6.267	5.55	4.097	1.67	13
C (-13r)	Total	12	.231	-3.333	-3.50	9.081	-20.00	11
	Experts	9	.200	.000	.00	7.420	-13.00	11
Total	Total	52	1	5.157	4.50	9.165	-20.00	35
	Experts	45	1	6.426	7.00	8.064	-13.00	35

Table 36 Experiment 6 – modified: descriptive statistics of cash flow growth estimate¹⁸⁸

¹⁸⁴ The true location shift Δ is estimated by the Hodges-Lehmann two-sample estimator.

¹⁸⁵ Effect size was measured using Cliff's δ . The effect size is considered small if $|\delta| > .147$, medium if $|\delta| > .33$ and large if $|\delta| > .474$ (based on Romano *et al.*, 2006).

¹⁸⁶ W-statistic from the Wilcoxon-Mann-Whitney test.

¹⁸⁷ P-value. *, ** and *** denote significance at $p \leq .1$, $p \leq .05$ and $p \leq .01$ respectively (based on one-tailed tests for directional alternative hypotheses and two-tailed tests otherwise). To avoid an increase in Type I-error due to repeated statistical tests with the same dataset, we will make use of the Bonferroni correction and apply a more conservative, corrected significance level of $p_B = .1/6 = .0167$.

¹⁸⁸ CG: control group; A(13p): Treatment Group A with an informative anchor of 13% historically (h) derived; B(13r): Treatment Group B with an uninformative anchor of 13% randomly (r) generated. C(-13r): Treatment Group C with an uninformative anchor of -13% randomly (r) generated.

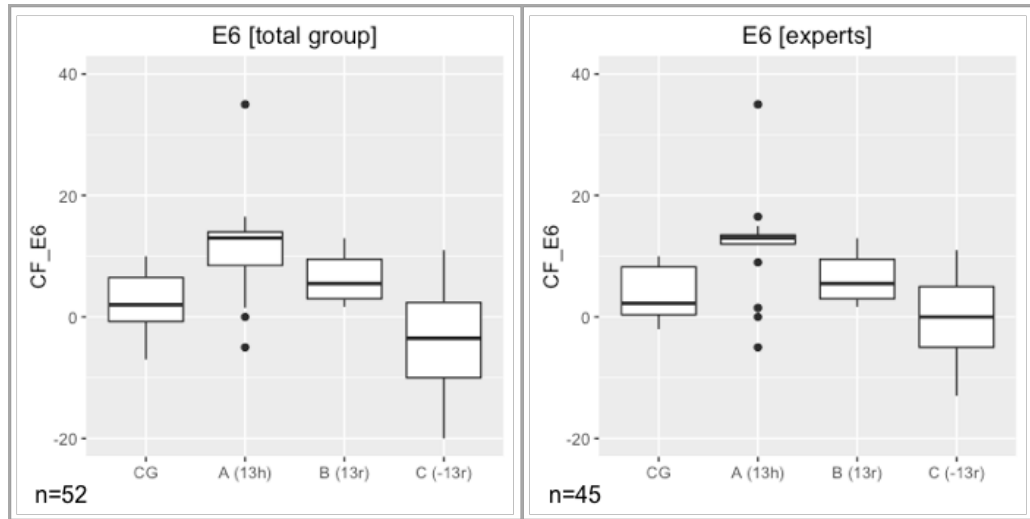


Figure 29 Experiment 6 – modified: cash flow growth estimate (total group)¹⁸⁹

As regards the sample statistics of the modified experiment, we find the control group yielding a median only slightly lower than in the original experimental and not as far away as an estimate of an anchor condition yielded before (see Table 36). The unbiased estimates do not seem to differ and thus we can assume both experiments to be comparable. The medians indicate that the weak effects found in the original experiment may actually be stronger.

Alternative hypothesis		Total	Δ ¹⁹⁰	Effect size ¹⁹¹		Experts	Δ	Effect size	
H1	$A > F \Delta > 0$	33.5*** .0011	10.00	.6794	large	27*** .0025	10.50	.6625	large
H2	$B > F \Delta > 0$	29** .0356	3.40	.4727	medium	29* .0596	3.00	.42	medium
H3	$C < F \Delta < 0$	93.5** .0480	-5.43	.4167	medium	59.5 .1258	-3.32	.3222	small
H4	$A > B \Delta > 0$	47.5** .0142	5.00	.5000	large	37** .0111	6.00	.5375	large
H5	$B > C \Delta > 0$	20*** .0046	9.33	.6667	large	20** .0226	6.26	.5444	large

Table 37 Experiment 6 - modified: results of hypothesis tests of the anchoring effect in the projection of cash flows

Based on the hypothesis tests (Table 37), all three anchors seem to significantly influence judgement. Even from a conservative¹⁹⁴ point of view, there is no doubt that the informative¹⁹⁵

¹⁸⁹ CF_E6: cash flow growth estimate.

¹⁹⁰ The true location shift Δ is estimated by the Hodges-Lehmann two-sample estimator.

¹⁹¹ Effect size was measured using Cliff's δ . The effect size is considered small if $|\delta| > .147$, medium if $|\delta| > .33$ and large if $|\delta| > .474$ (based on Romano *et al.*, 2006).

¹⁹² W-statistic from the Wilcoxon-Mann-Whitney test.

¹⁹³ P-value. *, ** and *** denote significance at $p \leq .1$, $p \leq .05$ and $p \leq .01$ respectively (based on one-tailed tests for directional alternative hypotheses and two-tailed tests otherwise). To avoid an increase in Type I-error due to repeated statistical tests with the same dataset, we will make use of the Bonferroni correction and apply a more conservative, corrected significance level of $p_B = .1/6 = .0167$.

anchor of past energy costs of 13% has an immense effect, the estimate on average lies 10 percentage points above the control group, at a very large effect size. Assuming that the control group's average estimate is around 2-3% (as the median suggests), we find the average growth rate in the anchor condition to be around 12-13%; this would be evidence for an almost perfect dependency on the anchor. The expert group shows the same strong effect. However, the past should never be an indicator of the future. Taking the anchor as the best estimate may be reasonable to some extent. If people believe that the trend of the recent past will continue, and environmental conditions such as state regulations do not change radically. Besides, as we have seen, people's 'true' expectations of energy price increases seem to range between 2 and 3%. A deviation of this amount to 12-13% can hardly be justified as fully rational.

The uninformative, implausible anchor of a 13% cost increase caught from the talk of two managers sitting at the neighbouring table in the cafeteria, an irrelevant and thus implausible anchor, only results in a weakly significantly higher growth rate estimate. The difference from no anchor in growth rate is estimated to be 340bp higher, twice as much as in the case with the irrelevant anchor of 6.5%. Doubling the irrelevant anchor has therefore resulted in doubling the 'premium' on the growth estimate in a general interpretation. Judging conservatively, the weakly higher rate based on the implausible anchor leads some people to higher estimates but not systematically.

The direct comparison of treatments A and B confirms this; the plausible anchor self-evidently yielded a location difference of 500bp to the implausible one – significantly. This implies a difference between the control group and B, but that difference was weak. In response to the implausible anchor of 13%, a slight impact on the corporate decision-makers' judgement, was found.

Doubling the irrelevant negative anchor had a similar effect as doubling the irrelevant positive anchor: The anchor of -13% led to a growth estimate around 500bp lower than in the no-anchor case, whereas a -6.5% anchor significantly lowered the growth estimate by 140 percentage points. In general, doubling the anchor had more than proportional impact: It resulted in more than double (up to more than six times) the distances in locations of all compared groups and thus, decision-makers in this cash flow setting revise their estimate relatively strongly: In most cases, it led to at least double the mark-up that decision-makers intuitively add.

In summary, we find strong evidence in favour of an anchoring effect; yet we do not detect a perfect influence of the anchor on the growth rate estimate of the maintenance costs. That is

¹⁹⁴ After considering family-wise error and a corrected significance level of .0167.

¹⁹⁵ By informative, we do not mean that it should tell how the actual estimate of energy cost growth should be; historical data do never give a hint on how the future may be. It is semantic in that it is the historical value of and has the same meaning as the target value (as opposed to for example a random number).

particularly true for uninformative anchors. For plausible, i.e. informative anchors, final growth rates of cash flow estimates seem strongly dependent on the provided past growth estimate. Thus, we find the anchoring effect in cash flow forecasts weak if an anchor is uninformative but quite strong if it is informative. This finding is largely in accordance with previous findings. Experts in finance and/or accounting seem to be particularly prone to the anchoring effect. This is, however, is not surprising as outlined in Section 6.1.6.

6.2.7 Limitations and Outlook

Several limitations of previous studies – partially mentioned above – have to be taken into consideration. To start with, how to determine the ‘correct’ hurdle rate certainly is an issue. How can we be sure that a rate is ‘too high’ or ‘too low’ or what is the ‘correct’ one? But as argued in the previous chapters, there is no truly ‘correct’ rate due to the many soft factors that influence a project’s riskiness and due to the required judgement. However, this ‘problem’ is not considered a problem here, since in the experiments we do not compare to an objectively correct rate, but compare treatment and control groups to each other. And finding significant differences on average allows for the conclusion that the differences in the case descriptions do lead to the different rates. We therefore take the judgement of the control group as the ‘default’ and are able to attribute differences to the manipulated independent variable. And by referring to this reference point we are able to conclude about ‘too high’ or ‘too low’ estimates.

As to the quantitative study of experiments, we derived a model that to our knowledge was applicable to investigate the hypothesised effects. Different approaches or different models may yield different results. The current perspective describes a ‘one-shot’ situation only: Judgement and Decisions and heuristic reasoning developing over time are not considered.

As several experiments or cases are provided one after each other (which cannot be avoided), we have to consider sequence effects. The influence of the three initial sequential cases was intentional; it was to make respondents get used to the way of questioning, but even more importantly to induce experience about the outcomes of projects and their reasons. A particular bias that has influenced all participants equally was not identified, however it may theoretically occur.

With higher cognitive load, people tend to reason more heuristically (Shah and Oppenheimer, 2008). For example, putting respondents under time pressure, we might see that their use of heuristics in the domains of this thesis increases. However, we deliberately refrained from doing so for the reason that different people require different amounts of time to grasp problem from the large amount of text; particularly since the sample included English non-native speakers. Moreover, in practice time is a valuable resource and decisions of this kind cannot take infinite time; time however may be constrained but it is not objectively

determinable what amount of time is required for understanding the tasks and to solve the problem at hand. In addition, participants have no incentive not to spend hours of their time. We therefore decided to not induce time pressure.

Another decision concerns the size of information load and its effect on decision-making, as for example Swain and Haka (2000) addressed when researching the level of experience in capital budgeting. “Furthermore, it is of interest to know whether multiple effort-reduction strategies are used as load increases, or whether any given effort-reduction principle becomes single-handedly more prominent under significant load.” (Shah and Oppenheimer, 2008, p.219). This may be worth further investigation in a future study.

A participant was randomly assigned to a treatment group or depending on his or her answers was considered to be part of a particular group. The only criterion that sampling relied on was the previous knowledge on investment appraisal. Other factors like age, gender, social class were not accounted for. By conducting the research internationally and in international study programmes in Germany, we can be sure that results are not only valid for German decision-makers. A bias towards including more highly educated people is obvious, but this is due to the nature of the research goal: The aim was to get insights about the decision-making process of corporate decision-makers, who – as professionals – certainly have reached a relatively high level of knowledge.

As regards filtering for experts and non-experts, we have indicated before, that to give this reasoning a sounder foundation, for future experiments we may require a set of control questions to verify the background knowledge that is of interest to the study.

As regards Experiment 1 in particular, a drawback included the feedback about the event of success or failure; it induces experience. The real experience that a participant may have had is not considered. However, we can hardly control for this long-term behaviour since the sample size of people with experience about a similar number of similar investment projects would have been extremely small. Furthermore, when considering feedback such as a failure (a project with a negative NPV ex post), we must recognise that people did not *really feel* the loss and or face the consequences, such as loss of bonus or reputation, they would have in a corporate context. Nevertheless, some consequences of having experienced failed projects were obvious despite this simulated environment.

Considering the affect heuristic (Experiment 2) and as indicated above, the results for the experts in the original experiment when contrasting affect against a ‘neutral’ condition came with weaknesses concerning what to infer about the control group. The neutral condition did actually not mean that the respondents are emotionally uninvolved if no feeling is ‘induced’ or if affect is not triggered; it nevertheless can reflect the population with its variety of feelings.

And the interpretation may then instead relate to whether making the decision-maker aware of a feeling – rather than the available feeling itself – may cause the hurdle rate to be different. The feeling under consideration was induced rather than personally felt by the respondents. This limits this experiment's expressiveness.

To better control for affect, the experiment was developed further and repeated with a new cohort of students fulfilling the same requirements; participants were asked to indicate their perception of the proposed project. In this way, we can be sure that it is their real feeling – at least to how much can be inferred from reporting a feeling – to potentially influence their judgement. The shortcoming in interpreting the control group responses was similarly overcome.

As described earlier, the anchoring effect addressed in Experiments 3 and 6, would benefit from an analysis of extreme uninformative anchors outside a plausible range of solutions. Similarly interesting would be an analysis of the relationship between informative and uninformative anchors, for example the role of uninformative anchors when informative anchors are present as is discussed by psychology literature.

As regards Experiment 4, the original experiment's analysis of the effect of overconfident CF projections on the hurdle rate decision was problematic since we cannot be sure that the wording used affected the participants in the way intended. The modification of the experiment included a question to identify this perception. Further research may focus in more detail on investigating different levels of overconfidence and how strongly the net present value may vary.

With regard to the investigations on representativeness, drawing a clear line between which estimates are considered rational and which based on boundedly rational reasoning would be of benefit. We nevertheless were able to examine whether the similar or dissimilar projects were crucial for arriving at a cash flow estimate and we would have been able to detect irrational reasoning, which in fact did not take place.

Small sample sizes in the modified experiments were a limitation to the study, as mentioned above; Repeating the modified experiments with an equally high number of respondents as in the second cohort was considered outside the scope of this work and may be done in future research. However, they did show how modifications could and did add benefit.

7 Discussion of Findings

7.1 Summary and Discussion

The experimental study in Chapter 6 intended to inform our conceptual model of heuristic reasoning derived in Chapter 4 and refined by the interview study in Chapter 5. We will now examine the main findings. With regard to the setting of hurdle rates, we examined whether availability and affect are used as heuristic attributes and whether an anchoring effect can be observed. For this analysis, we relied on responses from finance or accounting experts who are familiar with the role of discount rate in a DCF analysis.

In summary, the hypothesised *availability heuristic* in the particular context of salient past events represented by project failures – that is, that the more failures are experienced, the higher the perceived risk of such projects failing and the higher the hurdle rate for future similar projects – could interestingly not be found (Experiment 1). Thus, the explanation hypothesised in Hornung, Luther and Schuster (2016), of the Hurdle Rate Premium Puzzle was not confirmed. This supports the claim of some of practitioners that they are not overly influenced by specific salient events but nevertheless seems inconsistent with their very detailed memories of negative past events. In fact, we find a relatively rational way of dealing with negative events; an expert's judgement of general likelihood of a related instance is not affected by a few events so rates for future projects are viewed independently of unrelated past instances.

Based on Experiment 2, we indeed found evidence for the *affect heuristic* influencing the hurdle rate. This might not have been expected given their rather rational approach to updating prior probabilities as in Experiment 1. Only negative affect was shown to influence the hurdle rate. Thus, a negative feeling towards the project made experts to set the hurdle rate higher than if no feeling was reported. Our hypothesis also relied on the finding that positive affect is related to high benefit and thus low perceived risk (Slovic *et al.*, 2002). Positive affect, surprisingly, did not result in a lower rate than in a situation where no feeling was felt. These findings overall may be more or less relevant perhaps depending on the industry sector. Investing in a new car prototype may be more likely to invoke affect than investing in a new random sampling machine or a nuclear energy plant.

Relatively strong evidence was found in support of an *anchoring effect*, as hypothesised (Experiment 3). Experts unsurprisingly relied on a hurdle rate that provided a plausible hint of appropriateness given the described risk of the project. Basic anchoring effects, i.e. relying on an anchor that was completely uninformative, were found even though experts were generally found to be less susceptible (Wilson *et al.*, 1996). As regards the basic anchoring effects, the

uninformative anchor was presented in the form of a percentage, i.e. it had the same format as a hurdle rate. Future research may address variation of this aspect.

This implies that even an arbitrary anchor activates semantic knowledge in the range of the anchor. For this reason, the reliance on an anchor in the final hurdle rate judgement was stronger, the closer the arbitrary anchor was to a generally plausible value of a hurdle rate. As noted in Chapter 6, this finding might have serious consequences in corporate decision-making as numerical estimates are widely available and easily transferable to a discount rate format. The probability of being influenced is therefore relatively high. However, and as regards all judgement included in the hurdle rate, the bias' impact on the NPV may be smaller or larger depending on the individual case and the particular cash flow profile. It therefore cannot be measured generally. A small deviation may not influence the target criterion. Additionally, one would have to carefully examine which reference points are informative by including relevant information for the rate to be judged.

We found *overconfidence* resulting in overstated cash flow projections to be a highly debated topic as is the issue of whether an adjustment is required – be it in the cash flows or in the hurdle rate. Assuming a situation where correction or trimming of cash flow projections is not possible, we examined whether the project-specific hurdle rate is actually adjusted to account for excessive confidence (Experiment 4). Surprisingly, we found no support for an adjustment of the hurdle rate in this case. When decision-makers were particularly asked to judge whether excessive confidence can be detected, we found weak evidence for a slight upwards adjustment of the rate and confirmation of our hypothesis. Therefore, the adjustment may depend on how aware professionals are of this matter and how obvious the excessive confidence or optimism is and thus, how accessible the cash flow forecasts' overestimation is. This certainly represents a topic for further research.

Heuristic reasoning involved in the projection of cash flows utilised responses from all participants, not only accounting and finance experts. We found that *representativeness* does not seem to be applied as heuristic attribute to substitute for the more difficult task of capturing uncertainty (Experiment 5). This seems surprising because it stands in contrast to the findings of the study of practitioners' views. We find finance and accounting expert judgement to only weakly rely on similarity. Hence, we observe a reasoning process which is relatively objective and independent of reliance on similar related or unrelated data from accounting records, and which does not one-sidedly rely on one cue. Again, observed behaviour seems to be relatively rational, as far as this can be determined. As was found in respect of the availability heuristic, separating instances rather than integrating them, as dealt with in mental accounting (see Chapter 3), i.e. the evaluating a new situation independently of what has happened before, points to an objective and thus rational approach.

Similarly to the findings on the anchoring affect in the judgement of hurdle rates, an *anchoring effect* in a typical judgement of cash flow estimates is found (Experiment 6). For the informative, thus plausible, anchor we find evidence of an almost perfect dependency of the growth estimate in the case. Random anchors also seem to activate relevant knowledge and thus influence cash flow growth, though to a lower extent. Finance or accounting experts seem to be particularly prone to the anchoring effect. Again, any numerical figure may activate semantic knowledge of the to-be-judged hurdle rate. As regards the experts, and in line with their expertise, the effect may be stronger, the closer the numerical anchor to the objectively more appropriate one. This is unsurprising because due to their expertise, more semantic knowledge can be activated. However, at the same time, and from a normative perspective, an arbitrary rate should not influence their reasoning.

Our results may imply that actors involved in the setting of hurdle rates and in the projection of cash flows do not generally rely on the heuristics examined in this work. The alternative conclusion may be that decision-makers, particularly finance and accounting experts do not strongly rely on heuristics as simplifying strategies but strive for and succeed in a more rational approach.

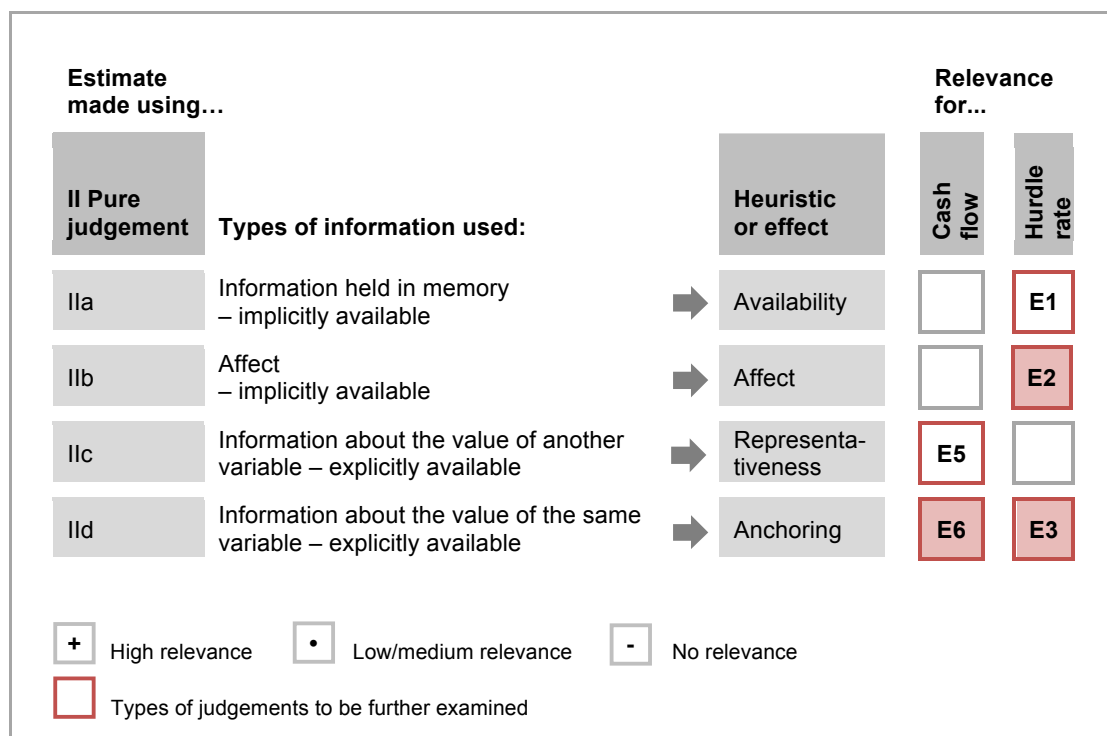


Figure 30 Evidence of heuristics in the projection of cash flows and in the setting of the hurdle rate¹⁹⁶

¹⁹⁶ The types of information used and related heuristics are based on Harvey (2007).

Figure 30 consolidates the above findings with regard to whether the hypothesised heuristics or effects (indicated by squares with red borders) could be empirically validated or not (indicated by the red shading or no shading respectively). E1-E6 denote the experiments as above. Experiment 4 addresses the correction of a potential overconfidence bias in the setting of the hurdle rate; it is not directly related to heuristics and is therefore not listed in this figure.

The starting point of this thesis was ‘how decision-making should be done’ (or how theory tells how things are), as opposed to ‘how it is done’. As is often the case the assumptions underlying the normative model of investment appraisal and methods are not, in reality, reflected by current practice. Investigating actual behaviour is therefore appropriate to identify theory’s shortcomings, why they occur and derive an improved model.

Heuristics are natural and refer to the underlying process of reasoning rather than its outcome. We indeed found biased behaviour, but we were more focused on the underlying process than the biases. Undoubtedly, biases may occur but they may differ significantly depending on the context. Determining the optimum is a highly theoretic concept and it is doubtful that an objective general optimum can be identified for determining the parameters or process of an investment’s appraisal. Nevertheless, the mechanics of how information is processed such as heuristics may conceptually always be the same and we can learn from this more than we can learn from particular distortions.

We explicitly did not consider the decision ‘point’ of investment appraisal. Judgement always precedes a decision; and consists of many aspects to consider and various judgements of many people involved. We, therefore, adopted a more ‘atomic’ view. Knowing and shedding light on judgement as one part of the ‘big picture’ that a decision is based on, is what we consider important and can undoubtedly contribute to explain decision-making.

Critics may argue that investment appraisal is not primarily about individual judgement but many practical decisions are board decisions, as also mentioned at various points through the thesis. However, the validity of the results of this work remain. Board decision-making and achieving consensus are indeed worth being investigated and their role has to be acknowledged (see e.g. Harris, Emmanuel and Komakech, 2009). Moreover, our results certainly require further analysis as regards the factors playing a subsequent role in arriving at consensus, particular in hurdle rate decision-making if several persons are involved. However, the process of arriving at a personal judgement including its potential for bias has not comprehensively been covered with regard to narrow investment appraisal. Presumably, ahead of a board meeting or before other board members have started to express their opinion, a personal judgement about an aspect to discuss has been formed. Thus, group dynamics may be influenced depending on the individual actors’ judgements; this not only justifies but requires an approach to address individuals’ judgement.

Financial analysis may not be the most important component in many investment decisions. However, normative literature has shaped current practice – investment appraisal methods applied in practice have evolved over time and certainly will continue to evolve. And as long as literature and university curricula continue to recommend investment appraisal methods and consider them crucial for corporate success, examining actual decision-making practice remains important. In particular, actual appraisal methods and the respective parameters should continually be illuminated from a cognitive psychology perspective for the sake of a more objective appraisal and avoidance of bias.

But, as briefly outlined, learning based on empirical events may be particularly difficult at the stage of the hurdle rate decision due to scarcity and sensitivity of feedback about precise values that were adopted. Even if a project's actual cost of capital can be approximated based on for instance precise knowledge about its financing, learning may be limited.

The review of the literature relating to the projection of cash flows attributable to a potential investment project, and the setting of a risk-adjusted rate to discount projected cash flows, identified indications of subjective judgement in investment appraisal in general and in these two dimensions. Synthesising existing literature of bounded rationality in investment appraisal with a review of the field of judgement and decision-making including an in-depth focus on heuristic reasoning, this work identified the scope for JDM concepts applicable to capital investment decision-making.

This work contributes to existing literature by an interdisciplinary approach between cognitive psychology and narrow investment appraisal. Interdisciplinary approaches have been widely adopted in fields such as economics, finance and also corporate finance/management accounting, as has been extensively reviewed. It is considered crucial for an improved understanding of corporate processes and the causes of behaviour and eventually for corporate success.

The research has identified and contributed to filling a gap in knowledge; the projection of cash flows and the setting of a discount rate, parameters required by commonly employed DCF methods, are explored with regard to intuitive reasoning. Most judgements in the business context rely on subjective estimates, particularly on simplifying strategies, i.e. heuristics, that human beings employ facing a high degree of complexity or uncertainty. The application of heuristics has been previously studied in various fields including auditing or management accounting and also with reference to the general investment decision stage – but only insufficiently with particular regard to the projection of cash flows and the setting of the hurdle rate. As outlined in Chapter 4, both dimensions have been touched in few publications. The projection of cash flows has been primarily addressed with regard to the effects of overconfident or optimistic decision-makers, i.e. by focusing on distorted estimates. As regards

the setting of the hurdle rate, a variety of publications deal with its flaws in that theory does not correspond to practice, in particular with regard to the finding of the rate significantly exceeding the cost of capital (see Chapter 2). Few publications have addressed heuristics in the setting of the hurdle by a domain-specific approach. We could not find evidence for either dimension being systematically examined with regard to widely applicable heuristics. And thus, the processes underlying judgement to arrive at cash flow estimates or risk-adjusted hurdle rates have not been adequately addressed elsewhere.

We have filled this gap in that we first of all examined the scope of heuristic reasoning given the type of judgement required in the respective contexts, which was verified in a qualitative study of practitioners. Secondly, in a large experimental study, we addressed the particular types of judgement that were previously identified to be susceptible to heuristic reasoning. As a third contribution, we addressed the Hurdle Rate Premium Puzzle. Within the experimental study, we examined whether the availability heuristic may contribute to explain the paradox of systematically setting the hurdle rate too high. The availability heuristic based on previously experienced project failures, however, was not found to have a significant impact on the setting of the hurdle rate. This work thereby contributed to a better understanding of individual boundedly rational behaviour of the actors involved in the vital field of investment decision-making.

7.2 Practical Implications

This work has contributed to the explanation of what many practitioners in the investment appraisal stage describe as ‘gut feeling’, intuition or similar. Estimates or rates are formed without an explicit idea of the mechanisms that formed them. They are usually considered quite helpful to master uncertainty and complexity even though they might not be fully explainable or justifiable. What happens in practitioners’ minds – the simplifying strategies, i.e. heuristics, due to the complexity and uncertainty of the environment – is worth investigation.

Taking for granted that corporate decision-making takes place under a high degree of uncertainty, most judgements are based on estimates and thus intuition (Knight, 1921). Corporate decision-making has always been intended to be understood, structured and improved to stay competitive and survive in the long run for the benefit of its shareholders and stakeholders. Not only should decision-making at the managerial level descriptively be examined by making use of cognitive psychology, so should the behaviour of all other actors including those involved in investment appraisal processes. This work first of all helps to raise awareness of the underlying mechanisms in the practice of projecting cash flows and determining hurdle rate; and also to gain awareness of the potential drawbacks of natural

heuristic reasoning, i.e. biases. Secondly and despite the fact that different roles and persons may be involved at these decisions at different hierarchical levels of the organisation, this work allows for a deeper understanding what types of information are used and what simplifying strategies may result from these. Understanding own judgement including the way it is formed does certainly not guarantee improved judgement. However, due to the limited options to learn from feedback, improvement – if at all – can arise from understanding own judgement.

As regards learning from feedback, a project may ex post be reviewed in terms of its success, for example its actual value added to the firm, and whether the decision or the appraised parameters were correct. The appraisal parameters, however, are only imperfectly reviewable. Actual cash flows undoubtedly can be compared with projected figures. It is however questioned whether the correct conclusion is drawn about why figures deviated from forecast. Furthermore, the ‘correct’ discount rate ex post can hardly be determined. The actual cost of capital may not be easily determined. Moreover, other factors such as a delay in feedback play a role.

Therefore, an as unbiased as possible review process based on a well-documented appraisal is worth striving for: Project reviews during and after completion are common practice and should not neglected – also if a project’s outcome is clearly positive and has exceeded expectations. Corporate memory, which is commonly consulted in future appraisals as we have seen, should be as comprehensive and transparent as possible. All assumptions, including assumed risk factors, estimated cash flow ranges, applied methods including those for considering uncertainty, have to be clearly outlined for each project that were evaluated in a particular business case. This should also include rejected projects.

There may be political or other reasons for top management to not fully disclose to ‘corporate memory’ why or why not a financially favourable project has been rejected; but this should not lead to generalised amnesia. Reviewing rejected projects does consume additional resources and may not be unambiguous and judgemental; and certainly, reaching a representative sample of the population of instances is unrealistic. But such reviews enrich the generally poor feedback to previous judgements to view a more objective picture – if ensured that it is not prepared only to make the undertaken project appear most beneficial. Even if the conclusion is that the appraisal or the decision about the undertaken project was the preferred one, such an evaluation provides facets of feedback that otherwise could only have been conjectured.

Admittedly, the problems with interpreting feedback such as self-attribution reinforcing overconfidence would not be eliminated. It may be ‘painful’ for the decision-maker, but separating environmental influences that made actual project cash flows deviate from forecast should clearly be marked to extract judgemental ‘performance’. Moreover, we cannot expect

corporate decision-makers to adopt different, more sophisticated techniques to arrive at estimates: Joyce and Biddle (1981, p.143) have already noted that “Even where heuristics lead to systematic, costly errors, the cost of adopting an alternative procedure which eliminates the error might outweigh the incremental benefit.” Certainly, an atmosphere of acceptance and trust if judgements turned out biased may help reduce future flawed estimates and manipulation due to personal interest.

7.3 Limitations and Directions for Future Research

The limitations of the qualitative and quantitative studies have been elaborated on in the respective Chapters 5 and 6. Following the analysis of an experiment’s results and as a consequence of their limitations, we recommended potential refinements and developments to address in future research. We would particularly consider the further development of the experiments as a next step of research, for instance with a larger sample size. A more general limitation that can be addressed in future research is including professionals into the sample of experiments rather than relying solely on a postgraduate student sample.

The experimental study’s design provided a business frame to the respondents; a business context is assumed to evoke particular accounting knowledge and knowledge structures (Vera-Muñoz, 1998). The particular business frame thus had to provide the necessary context for examining heuristic reasoning in investment appraisal including precise enough but not too specific scenarios to prevent generalisation to other scenarios. This threat to external validity, i.e. the narrowing down to a particular investment case which may not necessarily generalise to different situations, may represent a limitation of the experimental study. Replication with different hypothetical or even real companies or projects may test the robustness of the observed effects but might impose more details, i.e. manipulation, and would therefore have further consequences as regards interpretation.

We strongly relied on Harvey (2007) in the way how we distinguished between settings of information use which provided an excellent link to identification of heuristics taking place. Certainly, and as implied in attribute substitution theory (Kahneman and Frederick, 2002, 2005), the representativeness heuristic and the anchoring effect do not necessarily rely on information that is only explicitly available as Harvey (2007) implied. Nor can we assume that the availability heuristic relies on purely implicitly available information because easily stored or retrieved information may also derive from explicitly available information.

An interesting aspect of further research in this context would also represent the effect of the same information provided in different ways touching the concept of framing. As indicated in the interview study, information about a previous project’s risk may be provided either by the

previous project-specific hurdle rate or by other means such as verbally or formulated by a percentage of failure. In this way, various formats of the same information may influence judgement differently.

When addressing cues in heuristic reasoning, and, we do not claim that the cues, i.e. pieces of information such as a particular risk factor, are ‘atomic’; they may consist of more elemental cues or can be further separated (based on Shah and Oppenheimer, 2008). This however does not pose a problem since the functioning of heuristics does not depend on whether a cue can be subdivided (see also Shah and Oppenheimer, 2008). Moreover, there are also further ways to identify heuristic reasoning; Shah and Oppenheimer (2008) outline further ways to examine and identify heuristic reasoning, i.e. by computer simulations for measuring effort and accuracy, or by process tracing such as eye-tracking.

As regards the heuristics that were considered in this work, we based our analysis on the second principle that Shah and Oppenheimer (2008) considered distinctive of heuristics, i.e. those that imply the simplified retrieval and storage of cues, which can be related to the attribute substitution approach to heuristics by Kahneman and Frederick (2002, 2005). Following Shah and Oppenheimer’s (2008) framework, heuristics can rely on more than just one principle, which may play a role in the judgement of cash flow estimates and hurdle rates. Moreover, judgement also depends on further factors as Libby and Lewis (1977) have comprehensively studied such as the characteristics of the cues, of the judge, or of the feedback to previous judgements. This is also noted by Kahneman and Frederick (2005, p.287) who additionally touch the function of the two systems of reasoning (see e.g. Stanovich and West, 2000):

Although attribute substitution provides an initial input into many judgments, it need not be the sole basis for them. Initial impressions are often supplemented, moderated, or overridden by other considerations, including the recognition of relevant logical rules and the deliberate execution of learned algorithms. The role of these supplemental or alternative inputs depends on characteristics of the judge and the judgment task.

Moreover, as has been elaborated on, there are different approaches to heuristics such as the fast-and-frugal framework (e.g. Gigerenzer, Todd and the ABC research group); examining fast-and-frugal heuristics may also provide potential for further research. For these reasons, this work does not claim to conclusively approach heuristic reasoning.

This work focused on a narrow aspect of investment appraisal. Approaching the projection of cash flows and the setting of the (mostly project-specific) hurdle rate was done at a relatively high level of abstraction. Conceptualising the judgement required for the parameters under consideration in a rather isolated way, however, was required to analytically approach the mechanics of judgement and to examine whether heuristic reasoning takes place. The focus on only two parameters could be extended in future research: Heuristic reasoning could be examined with regard to further parameters to be determined in other DCF methods or in

different investment appraisal techniques beyond DCF analysis; for example, determining a required (static or dynamic) payback period or the economic life of a project, or the number of scenarios considered in a related analysis, or parameters for a real options analysis.

The financial impact of the use of heuristics is certainly impossible to measure due to the lack of identifying objectively 'correct' estimates. We may detect more or less biased behaviour in practice depending on the experiences made. However, the impact of potential biases on the final decision and deviations of the financial target criterion such as NPV may only be measurable if precise assumptions are made about the specific case (see e.g. Butler and Schacter, 1989) which may preclude generalisation.

Practice undoubtedly implies a complex interplay of many drivers that psychological research is not yet able to fully capture. If possible, we identified overlap and contradictions to other JDM effects and also address links between cash flow projections and hurdle rates. We do furthermore not deny the strong relation to the decision stage of investment appraisal and relevance of further decision structures such as board decisions. Instead, we approached investment appraisal differently and from an angle it has not been addressed yet.

8 Conclusion

Research on bounded rationality in investment appraisal has seen considerable development in recent decades. In investment appraisal, heuristic reasoning has generally been addressed with regard to the investment decision stage itself. However, the practice of estimating cash flows and the setting the hurdle rate for a project appraisal shows a significant degree of subjectivity and required judgement. From an interdisciplinary synthesis of the literatures relating to investment appraisal and to heuristics (RQ1), this thesis found significant scope for examining heuristic reasoning in the projection of cash flows and in the setting of the hurdle rate. A framework was developed to identify the potential for heuristics; it links the different types of judgement required in these two dimensions to particular heuristics.

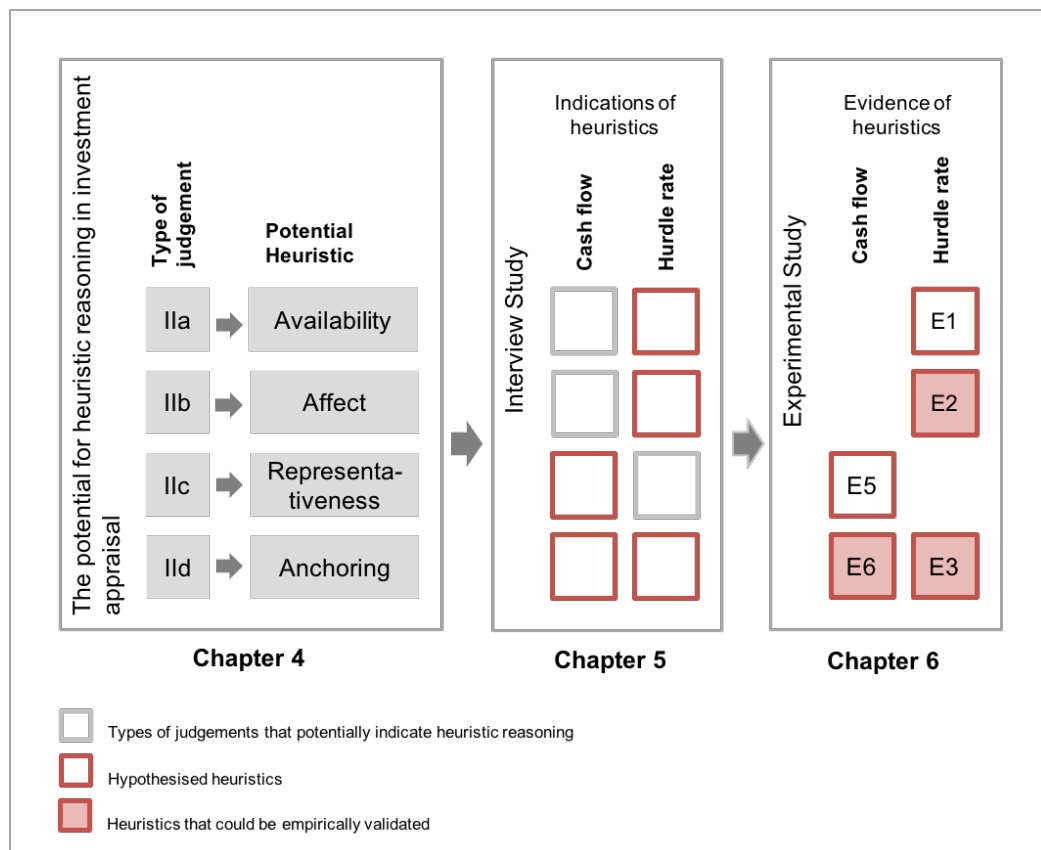


Figure 31 Schematic procedure of analysis and generalised findings of the qualitative and quantitative studies

This theorised potential for heuristics has been verified in a qualitative study of practitioners. Thereby, we examined how judgement and thus potentially bounded rationality enter the projection of cash flows (thereby addressing RQ2) and the setting of the discount rate (thereby addressing RQ3). Findings from the qualitative study then informed a quantitative

experimental study. The experimental study investigated selected heuristics and demonstrated to what extent the previously identified potential for heuristics is applicable investment appraisal practice. Figure 31 schematically outlines the procedure of analysis of this thesis.

Heuristic reasoning in this work was examined from a different perspective than commonly approached. We relied on the attribute substitution approach by Kahneman and Frederick (2002, 2005). We thus considered whether availability, affect or representativeness are employed as heuristic attributes to arrive at a cash flow estimate or hurdle rate respectively. The anchoring effect has also been included as an additional important effect to consider; yet, it cannot be considered a heuristic under the narrow attribute substitution approach.

As regards the projection of cash flows, we found evidence for the following heuristics, thereby addressing the second aspect of RQ2: In contrast to our expectations, the representativeness heuristic could not be confirmed. Cash flow estimates did not seem to be influenced by outcomes of similar projects. However, a strong anchoring effect could be identified.

As regards the setting of the hurdle rate and thereby addressing the second aspect of RQ3, we hypothesised that the availability heuristic may be applicable. In this way, we established a potential explanation for the widely known paradox of setting hurdle rates higher than appropriate. The availability of salient past instances could however not be found to result in an upwards bias of the hurdle rate.

Interestingly, we detected evidence for the affect heuristic in hurdle rate judgements. A negative personal feeling towards the project was found to lead to a higher rate than if no or positive affective responses were observed.

Project-specific hurdle rates applied for similar projects in the past showed a strong influence on the hurdle rate. An anchor of this kind may also be indicative of the risk of a project and can thus be justified. We even found substantive evidence that arbitrary benchmarks influence the hurdle rate estimate. This may imply that due to the expertise of the decision-makers, more semantic knowledge is activated.

Overconfidence as a well-studied effect was additionally approached in the experimental study. Overconfidence potentially leading to biased cash flow projections, however, was not found to be a reason to adjust the hurdle rate.

Investment appraisal practice undoubtedly implies a complex interplay of many drivers and that psychological research is not yet able to fully capture. Yet, this work contributes to an improved understanding of a narrow aspect of investment appraisal, i.e. the projection of cash flows and the setting of hurdle rates. It adds to literature by approaching these dimensions from a new perspective that sheds light on the effort-reducing strategies that corporate decision-

makers employ. It can therefore serve for an improved understanding of managerial processes and the causes of behaviour and ultimately for corporate success.

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Appendix 1: Compilation of Heuristics

Heuristic	Domain-specific	Domain-general	Source ¹⁹⁷	Indicative Reference
Affect		X	BSP/SO08	Slovic <i>et al.</i> (2002); Finucane <i>et al.</i> (2000); Monin (2003); Monin and Oppenheimer (2005)
Anchoring and adjustment		X	SO08	Tversky and Kahneman (1974)
Audience response	Persuasion		SO08	Axsom <i>et al.</i> (1987)
Availability		X	SO08	Tversky and Kahneman (1973, 1974)
Balance	Consumer Behaviour		PsycInfo	Cheng <i>et al.</i> (2012)
Brand name	Marketing		SO08	Maheswaran <i>et al.</i> (1992)
Categorization by elimination		X	SO08	Gigerenzer <i>et al.</i> (1999)
Choice by most attractive aspect		X	SO08	Svenson (1979)
Comparison-to-the-strongest		X	PsycInfo	Windschitl and Wells (1998); Nakamura and Yamagish (2009)
Compatibility		X	PsycInfo	Espino and Byrne (2013)
Competitors' private information	Management/Strategy		BSP	Lin and Muehlegger (2013)
CONF		X	SO08	Karelaia (2006)
Confirmatory search		X	BSP	Klayman and Ha (1987); Swann Giuliano (1987)
Consensus	Persuasion		SO08	Giner-Sorolla and Chaiken (1997)
Country of origin	Marketing		SO08	Chang (2004)
Default		X	GB09	Johnson and Goldstein (2003); Pichert and Katsikopoulos (2008)
Deservingness	Social welfare		BSP	Petersen (2012)
Deterministic elimination by aspects		X	SO08	Hogarth and Karelaia (2005b)
Discount percentage	Consumer Behaviour		SO08	Darke <i>et al.</i> (1995)
Distinctiveness		X	SO08	Schacter <i>et al.</i> (2001)
Do-no-harm	Political Science		SO08	Baron and Jurney (1993)
Domran		X	SO08	Hogarth and Karelaia (2005b)
Downgrading	Organisational Behaviour		PsycInfo	Barclay and Bunn (2006)
Duration	Marketing		BSP/PsycInfo	Yeung and Soman (2007)
Ease of processing (and stability bias)		X	BSP	Kornell <i>et al.</i> (2011)
Effort	Marketing		SO08	Kruger <i>et al.</i> (2004)
Elimination by aspects		X	SO08	Tversky (1972)
Elimination by least attractive aspect		X	SO08	Svenson (1979)
Endorsement	Persuasion		SO08	Forchand <i>et al.</i> (2004)
Equal weighting, tallying,		X	SO08/GB09	Dawes (1979)

¹⁹⁷ SO08: Shah and Oppenheimer (2008); GB09: Gigerenzer and Brighton (2009); BSP: Business Source Premier. For the heuristics collated in SO08 and GB09, see the respective indicative references in their papers.

unit-weight linear model				
Equality = 1/N		X	SO08/GB09	Messick (1993); Roch <i>et al.</i> (2000); DeMiguel <i>et al.</i> (2009)
Expectancy		X	BSP/PsycInfo	McCabe and Balota (2007)
Expertise	Persuasion		SO08	Ratneshwar and Chaiken (1991)
Fairness		X	BSP	Lind (2001)
Fluency		X	SO08	Whittlesea and Leboe (2003)
Generation		X	BSP	Kleider Goldinger (2006); Whittlesea and Leboe (2000); Leboe and Whittlesea (2002)
Idiosyncratic fit	Marketing		SO08	Kivetz and Simonson (2003)
Imitate the majority		X	GB09	Boyd and Richerson (2005)
Imitate the successful		X	GB09	Boyd and Richerson (2005)
Inherence		X	PsycInfo	Cimpian and Steinberg (2014)
Instrumentality		X	PsycInfo	Labroo and Kim (2009)
Interpretative		X	PsycInfo	Macchi and Bagassi (2014)
Lemon avoidance		X	PsycInfo	Ert and Erev (2008)
Leniency		X	BSP	Schriesheim <i>et al.</i> (1979); Marsden, Veeraraghavan and Min (2008)
Lexicographic		X	SO08	Fishburn (1967, 1974)
Lexicographic semi-order		X	SO08	Tversky (1969)
Likeability	Persuasion		SO08	Chaiken (1980)
Loss	Finance		BSP	Pinnuck and Shekhar (2013)
Majority of confirming dimensions		X	SO08	Russo and Doshier (1983)
Market value	Marketing		BSP	Boothe, Schwartz and Chapman (2007)
Matching		X	BSP	Dhami and Ayton (2001)
Memory for past-test	Learning		BSP	Serra and Ariel (2014)
Mill worker's son	Political Science		BSP	Carnes and Sadin (2015)
Minimalist		X	SO08	Gigerenzer <i>et al.</i> (1999)
Outrage		X	SO08	Kahneman and Frederick (2002)
Peak-end		X	SO08	Kahneman <i>et al.</i> (1993)
PEG (trading heuristic)	Financial Investment		BSP	Fafatas and Shane (2011)
Perceived diversity		X	BSP	Ayal and Zakay (2009)
Performance		X	PsycInfo	Critcher and Rosenzweig (2014)
Pollution tax heuristics	Political Science		BSP	Hsu, Walters and Purgas (2008)
Price	Marketing		SO08	Mitra (1995)
Price-quality	Marketing		BSP	Gneezy <i>et al.</i> (2014)
Priority		X	SO08	Brandstätter <i>et al.</i> (2006)
Probability to win		X	BSP	Venkatraman, Payne and Huettel (2014)
Quantity-matching	Marketing		BSP	Chernev (2008)
QuickEst		X	SO08	Gigerenzer <i>et al.</i> (1999)
Recognition		X	SO08	Gigerenzer and Goldstein (1996)
Recommendation agents	Marketing/ Consumer behaviour		BSP	Aljukhadar, Senecal and Daoust (2010)
Representativeness		X	SO08	Tversky and Kahneman (1974)
Resemblance		X	BSP	Kleider Goldinger (2006); Whittlesea and Leboe (2000);

Leboe and Whittlesea (2002)			
Return to Volatility ri/stdi	Financial Investment	BSP	Tarrazo (2009)
Satisficing	X	SO08	Simon (1955, 1956, 1990)
Scarcity	Marketing	SO08	Brannon and Brock (2001)
Secrecy	Political Science	BSP	Travers, VanBoven and Judd (2014)
Self-based	X	PsycInfo	Ready <i>et al.</i> (2000)
Similarity	X	PsycInfo	Read and Grushka-Cockayne (2009)
Single variable	X	SO08	Hogarth and Karelaia (2005a, 2007)
Social comparison	X	PsycInfo	Corcoran and Mussweiler (2010)
Social exchange	X	PsycInfo	Yamagishi <i>et al.</i> (2007)
Specificity	Marketing	BSP	Palmeira and Spassova (2012)
Structuring	Organisational Behaviour	PsycInfo	Barclay and Bunn (2006)
Sustainability	Sustainability/Policy	BSP	Fischer, Klauer and Schiller (2013)
Take the Best	X	SO08	Gigerenzer <i>et al.</i> (1999)
Take the First	X	BSP/PsycInfo	Johnson and Raab (2003)
Take the Last	X	SO08	Gigerenzer <i>et al.</i> (1999)
Thoughtfulness	X	BSP	Barden and Petty (2008)
Time pressure	X	PsycInfo	Rice <i>et al.</i> (2010)
Tit-for-tat	X	GB09	Axelrod (1984)
Transaction cost	Organisational Behaviour	BSP	Miranda and Kim (2006)
Trust and advice-taking	Financial Investment	BSP	Monti <i>et al.</i> (2014)
Unit bias	Consumer Behaviour	PsycInfo	Geier, Rozin and Doros (2006)
Value	X	BSP	Dai, Wertenbroch and Brendl (2008)
Vision	Music	BSP	Tsay (2014)
Visual preference	Marketing	BSP	Townsend and Kahn (2014)
Warm glow	X	SO08	Monin (2003)
Weighted pros	X	SO08	Huber (1979)
Weighted recalled stepwise comparing WReST	X	PsycInfo	Brunner and Opwis (2008)
Total: 97	37	60	

The table provides a compilation of domain-specific and domain-general heuristics. It is based on Shah and Oppenheimer's (2008) list completing it by Gigerenzer and Brighton (2009) and Kahneman and Frederick (2002) and a systematic search of relevant journal databases related to psychology, business, management, accounting and finance (Business Source Premier BSP, PsycInfo) from 2006-2015, since Shah Oppenheimer's list was submitted during 2006. Business Source Premier is assumed to include journal articles that apply heuristics to business aspects. And as the application and identification of new heuristics is not to be left out, this database is considered suitable for search here. In this way we have captured various approaches to heuristics including such that cannot be attributed to either 'camp'.

The database search required ‘heuristic’ in the title of a peer-reviewed journal, assuming that the identified or developed heuristic is mentioned in such a prominent feature. We explicitly excluded heuristics as solving problems in computer science (algorithms, programming etc.), operations and logistics and heuristics from a neuroscience and medical point of view.¹⁹⁸

When compiling the list, those domain-specific heuristics that have their origin in a domain-general heuristic¹⁹⁹ have been excluded for reasons of not artificially extending the already extensive list to the best knowledge of the author. The list may not be free of heuristics that are only termed ‘heuristic’ as indicated in Chapter 3.²⁰⁰

¹⁹⁸ ‘Heuristic algorithm’, ‘heuristic programming’, ‘computer science’, ‘mathematical’, ‘algorithm’, ‘mathematics’, ‘programming’, ‘machine’, ‘operations’, ‘transportation’.

¹⁹⁹ E.g. the ‘ease-of-retrieval heuristic’ referred to by Kühnen (2010) actually refers to the availability heuristic by Tversky and Kahneman (1973).

²⁰⁰ E.g. Rice *et al.* (2010) investigate the time-pressure heuristic by actually referring back to Gigerenzer and Goldstein (1996) and Hogarth (1981) who never derived such a heuristic.

Appendix 2: Retrievability Bias in Explaining the Hurdle Rate Premium Puzzle

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Appendix 3: Cases and Questionnaire of the Experimental Study

Welcome

Dear participant,

A warm welcome and many thanks for your participation in our study.

You are now taking part in a decision-making experiment. You have been selected as an advanced business student. The study is part of a research project of the University of the West of England and Schmalkalden University of Applied Sciences in Germany. We would very much appreciate you taking about 30 minutes to fill out the following questionnaire. We will be monitoring responses for plausibility and ask you please not to simply 'click through' questions. We are sincerely grateful for your participation – all completed surveys will qualify for a lottery for two USD50 Amazon.com gift vouchers.

In the following you will get different cases on corporate investment decision-making. The different cases either represent different companies with new settings or they may refer to the same company and setting. You will receive further instructions during the study. You will then be asked to make decisions based on the case descriptions provided.

In all experiments you are responding as the decision maker and you have a small equity stake in the firm. There will be one basic scenario with 3 investment projects to decide on, followed by 6 variations: For all 3 initial projects and based on your decision to accept or reject the project, you will get feedback on whether the project was a success or a failure. You will learn about the reason for the failure, if applicable, and view the actual cash flows. In the following 6 scenarios you are asked to determine parameters required for the investment appraisal (such as cash flows or hurdle rate) and apply your judgement. Once a decision is made, you cannot go back. Please avoid using the 'back' button of your browser.

If you wish, you can use your calculator or the one provided by your operating system.

The instructions which we will provide to you, are solely for your private information. Other respondents may or may not get different cases and questions. This study is about your individual judgement. Therefore, you must not communicate with other participants during the experiment. For the same reason, using further sources such as the Internet is not allowed. We kindly ask you to help us and respect this requirement.

Should you have any questions, please contact us.

Yours sincerely, Mareike Hornung [mareike2.hornung@live.uwe.ac.uk]

Consent

In order to participate in this research and access the main survey, you must first provide informed consent. The purpose is to make sure that you are happy to take part in this study and that you know what is involved.

- I confirm that I have read and understood the instructions for the experiment and am willing and able to participate;
- I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without any further questions asked;
- I understand that I am free to take breaks at any point during the experiment by asking the research team and that some breaks will be offered;
- I agree that the data compiled may be used in research publications, but my data/details will always remain anonymous;
- I understand that my details of participation in this study will remain anonymous and that my data is only identifiable by a numerical participant code. Thus, my data

cannot be traced back to me.

- I agree to answer questions honestly and to carefully read the information provided.
- ☐ I have read and understood the above information and agree to participate in this study.

Case 1

Imagine you are the Finance Director of AutoParts Inc., a producer of car parts for major car producers. You have been educated in corporate finance, are experienced in your job and have participated in a number of investment decisions in this company before. You, like all senior managers in the company, have a small equity stake.

You consider a new capital investment project: Your company plans to expand capacity since demand for your product has increased. Capacity expansion will allow increased output and deliver the desired quantity faster to your clients.

There is sufficient space for the new machinery at the production site; only minor rearrangement is required as the plant was built with flexibility in order not to run into space problems.

In preparation, your finance department has gathered data from the project manager and the divisions, contracts and accounting records from previous projects (e.g. projected cash inflows, projected outflows related to the price for the machine, transportation, installation, electricity consumption, or regular maintenance over the life of the machine). Your finance department has collected the following cash flows [in USD]:

t	0	1	2	3	4
Revenues		350,000	450,000	580,000	655,000
Cost of installing and maintaining		-60,000	-30,000	-20,000	-20,000
Energy costs		-27,000	-29,700	-32,670	-35,937
Direct labour costs		-90,000	-90,000	-90,000	-90,000
Initial investment and residual value	-1,120,000				25,000
Net cash flow	-1,120,000	173,000	300,300	437,330	534,063

Your company uses the net present value (NPV) to assess how much a project will contribute to the value of the firm. The discount rate is typically a project-specific hurdle rate, i.e. the 8 % company cost of capital (weighted average cost of capital, WACC) is adjusted for a project's riskiness:

Based on a recommendation of your finance department you set the hurdle rate at 8% because the project is considered to be of average risk and this rate has been used for several similar projects.

Using the above data, the NPV amounts to **\$37,362.94**.

Would you accept or reject this project?

- ☐ Accept
- ☐ Reject

Case 1 – Feedback

After its economic life, you review the project and remember its progress:

The project was a success.

All cash flows, and the NPV, were within 5 % of the estimates, which is considered satisfactory by the Board of Directors.

Please proceed to the next case.

After its economic life, you review the project and remember its progress:

The project failed.

Installing the project was unexpectedly complicated and the cash flows between Year 1 and Year 4 declined steeply, so that the NPV also declined and turned negative:

t	0	1	2	3	4
Revenues		350,000	450,000	580,000	655,000
Cost of installing and maintaining		-90,000 -60,000	-65,000 -30,000	-35,000 -20,000	-30,000 -20,000
Energy costs		-27,000	-29,700	-32,670	-35,937
Direct labour costs		-90,000	-90,000	-90,000	-90,000
Initial investment and residual value	-1,120,000				25,000
Net cash flow	-1,120,000	143,000 473,000	265,300 300,300	422,330 437,330	524,063 534,063

[Cash flow changes due to increased installation and maintenance costs are marked in the second row. All net cash flows have been updated.]

Thus, after completing the project, using the same hurdle rate of 8%:

Its NPV in fact amounts to **\$-39,679.48**.

You are now required to provide a report to the Board to Directors to present the outcome and explain the reasons for the failure.

Assume that you are asked to evaluate the same project again (like the one above before knowing about its success or failure), what part of the investment appraisal would you personally adjust? *[Multiple choices possible]*

- ☐ The hurdle rate.
- ☐ The cash flows.
- ☐ None.

If hurdle rate/cash flow or both:

Cash flows: By what percentage would you increase or decrease the net cash flows?

%

Hurdle rate: By how many percentage points would you increase or decrease the actually used hurdle rate?

[Please indicate a decrease with a minus.]

Case 2

In AutoParts Inc., you consider a new capital investment project to expand capacity:

You will have to buy additional real estate for a new building. Your neighbour is willing to sell a piece of his land to you, which has not been developed yet.

Your finance department has collected the following cash flows [in USD]:

t	0	1	2	3	4
Revenues		0	2,011,000	6,480,000	6,480,000
Cost of installing and maintaining		-105,000	-30,000	-10,000	-10,000
Energy costs		-27,000	-29,700	-32,670	-35,937
Direct labour costs		-90,000	-90,000	-90,000	-90,000
Initial investment and residual value	-8,573,000				320,000
Net cash flow	-8,573,000	-222,000	1,861,300	6,347,330	6,664,063

Based on a recommendation of your finance department you set the hurdle rate at **15 %** because the project is considered very risky and this rate has been used for several similar projects.

Using the above data, the NPV amounts to **\$625,038.89**.

Would you accept or reject this project?

- ☐ Accept
- ☐ Reject

Case 2 – Feedback

After its economic life, you review the project and remember its progress:

The project was a success.

All cash flows, and the NPV, were within 5 % of the estimates, which is considered satisfactory by the Board of Directors.

Please proceed to the next case.

After its economic life, you review the project and remember its progress:

The project failed.

Installing the project (building the plant) was unexpectedly complicated and the cash flows between Year 1 and Year 4 declined steeply, so that the NPV also declined and turned negative:

t	0	1	2	3	4
Revenues		0	2,011,000	6,480,000	6,480,000
Cost of installing and maintaining		-105,000 -1,008,600	-30,000	-10,000	-10,000
Energy costs		-27,000	-29,700	-32,670	-35,937
Direct labour costs		-90,000	-90,000	-90,000	-90,000
Initial investment and residual value	-8,573,000				320,000
Net cash flow	-8,573,000	-222,000 -1,025,000	1,861,300	6,347,330	6,664,063

[Cash flow changes due to increased installation and maintenance costs are marked in the second row. All net cash flows have been updated.]

Thus, after completing the project, using the same hurdle rate of 15%:

Its NPV in fact amounts to **\$-160,700.24**.

You are now required to provide a report to the Board to Directors to present the outcome and explain the reasons for the failure.

Assume that you are asked to evaluate the same project again (like the one above before knowing about its success or failure), what part of the investment appraisal would you personally adjust? *[Multiple choices possible]*

- ☐ The hurdle rate.
- ☐ The cash flows.
- ☐ None.

If hurdle rate/cash flow or both:

Cash flows: By what percentage would you increase or decrease the net cash flows?

%

Hurdle rate: By how many percentage points would you increase or decrease the actually used hurdle rate?

[Please indicate a decrease with a minus.]

Case 3

In AutoParts Inc., you consider a new capital investment project to expand capacity:

You will have to buy machinery with functions that are new to your company because the technology you have been using is not offered any more. Your supplier indicates the machinery is adaptable to the existing machines at medium effort.

Your finance department has collected the following cash flows [in USD]:

t	0	1	2	3	4
Revenues		770,000	770,000	1,434,440	1,434,440
Cost of installing and maintaining		-30,000	-25,000	-20,000	-15,000
Energy costs		-35,411	-37,182	-39,041	-40,993
Direct labour costs		-105,000	-105,000	-105,000	-105,000
Initial investment and residual value	-3,407,000				1,015,000
Net cash flow	-3.407.000	599.589	602.818	1.270.399	2.288.447

Based on a recommendation of your finance department you set the hurdle rate at **10.5 %** because the project is considered slightly riskier than average and this rate has been used for several similar projects.

Using the above data, the NPV amounts to **\$105,826.40**.

Would you accept or reject this project?

- ☐ Accept
☐ Reject

Case 3 – Feedback

After its economic life, you review the project and remember its progress:

The project was a success.

All cash flows, and the NPV, were within 5 % of the estimates, which is considered satisfactory by the Board of Directors.

Please proceed to the next case.

After its economic life, you review the project and remember its progress:

The project failed.

Installing the project (attaching the machinery and implementing the new functions) was unexpectedly complicated and the cash flows between Year 1 and Year 4 declined steeply, so that the NPV also declined and turned negative:

t	0	1	2	3	4
Revenues		770,000	770,000	1,434,440	1,434,440
Cost of installing and maintaining		-30,000 -73,200	-25,000 -73,200	-20,000 -76,950	-15,000 -76,950
Energy costs		-35,411	-37,182	-39,041	-40,993
Direct labour costs		-105,000	-105,000	-105,000	-105,000
Initial investment and residual value	-3,407,000				1,015,000
Net cash flow	-3,407,000	556,389 556,389	554,618 554,618	1,213,449 1,213,449	2,226,497 2,226,497

[Cash flow changes due to increased installation and maintenance costs are marked in the second row. All net cash flows have been updated.]

Thus, after completing the project, using the same hurdle rate of 10.5%:

Its NPV in fact amounts to **\$-56,504.86**.

You are now required to provide a report to the Board to Directors to present the outcome and explain the reasons for the failure.

Assume that you are asked to evaluate the same project again (like the one above before knowing about its success or failure), what part of the investment appraisal would you personally adjust? *[Multiple choices possible]*

- ☐ The hurdle rate.
☐ The cash flows.
☐ None.

If hurdle rate/cash flow or both:

Cash flows: By what percentage would you increase or decrease the net cash flows?

%

Hurdle rate: By how many percentage points would you increase or decrease the actually used hurdle rate?

[Please indicate a decrease with a minus.]

Question

Across the motor/automotive industry, what proportion of projects do you think actually fail?

A project is considered to 'fail' if after completion, it has a negative NPV using actual values.

 %

Case 4

As the Finance Director of AutoParts Inc., you again have to decide on a new investment project. This project is also to expand capacity combined with more efficient resource consumption.

- There is sufficient space for the new machinery at the production site since only minor rearrangement is required.
- Your company will order the machines from a new supplier that you have not used before and have very little knowledge about.

It is your task to decide about the hurdle rate applied as a discount rate to calculate the NPV. As mentioned above, your company routinely applies a project-specific rate as a hurdle rate – based on company WACC adjusted for project-specific risk. Your company's WACC is 8 %.

Assume that the only way you can take account of the risk of this new project is through the hurdle rate for the NPV calculation.

Which hurdle rate would you apply for this project?

 %

Experiment 2 – original

Control	Like	Dislike
Imagine you are the Finance Director responsible for investments of the automobile company SchmalleWagen AG. You have to check a project proposal prepared by your department to be approved by the board of directors. The proposal includes your company's plan to invest in an additional plant for the production of a new model. All market studies have been completed and the new model which has many innovative features providing 'technical assistance' to the driver, has passed all reliability checks. The cash flows in the proposal are largely confirmed by the market study outcomes.		
	You like the new prototype. And you think you might buy one for yourself because you are attracted by the increased safety from the technical assistance.	You personally don't like the new prototype. You would not consider buying one. You feel that relinquishing driver responsibility reduces safety.
However, and as always, the risk that the new car will not be popular, remains. Generally the company's cost of capital (WACC = 6.2%) is applied as hurdle rate for all projects. You as the Finance Director responsible for investments can decide whether a project-specific rate – instead of the WACC – is adopted due to a project's specific		

characteristics.

Which hurdle rate would you choose for this project?

%

Experiment 2 – modified

Control	Like	Dislike
Imagine you are the Finance Director responsible for investments of the automobile company SchmalteWagen AG. You have to check a project proposal prepared by your department to be approved by the board of directors. The proposal includes your company's plan to invest in an additional plant for the production of a new model. • All market studies have been completed and the new model which has many innovative features providing 'technical assistance' to the driver, has passed all reliability checks. The cash flows in the proposal are largely confirmed by the market study outcomes. • However, and as always, the risk that the new car will not be popular, remains. Generally the company's cost of capital (WACC = 6.2%) is applied as hurdle rate for all projects. You as the Finance Director responsible for investments can decide whether a project-specific rate – instead of the WACC – is adopted due to a project's specific characteristics Which statement best represents your personal opinion? ☐ I am attracted by additional technical assistance of a car and feel safer. ☐ I am not attracted by additional technical assistance of a car and feel that relinquishing driver responsibility reduces safety. ☐ I am indifferent. Which hurdle rate would you choose for this project? %		

Experiment 3

Control	A	B	C	D
A new capital-intensive investment project is being considered by SchmalteWagen AG: One component of the paintshop in one of your production lines is to be replaced. As usual, the finance department is evaluating the project. The company policy requires all projects to be double checked by an independent colleague who is not involved in the appraisal – to check the project appraisal for plausibility and to decide on a project-specific hurdle rate for the NPV calculation. You have been appointed to that role for this project. • You are provided with a forecast of cash flows and told that the company WACC based				

on overall risk is 6.2 %.

- From the project proposal you know that a part of the project includes software adjustment by your engineers to attach the component to the existing machines. The physical attachment of the new component does not imply higher than average risk. However, your supplier includes a new operating system that the engineers now have to use to technically integrate the component.

Your colleague has proposed a project-specific hurdle rate of 9.75 % indicating: "That seems to be the right figure and I seem to remember that rate was used last year."

Do you think the rate should be higher or lower than your colleague's proposed rate (9.75%)?

- ☐ Higher
☐ Lower
☐ The same

Do you think the rate should be higher or lower than 9.75%?

9.75 was a randomly generated number drawn from a set of numbers from 0.00 to 20.00.

- ☐ Higher
☐ Lower
☐ The same

Do you think the rate should be higher or lower than 7.98%?

7.98 was a randomly generated number drawn from a set of numbers from 0.00 to 20.00.

- ☐ Higher
☐ Lower
☐ The same

Do you think the rate should be higher or lower than 2.65%?

2.65 was a randomly generated number drawn from a set of numbers from 0.00 to 20.00.

- ☐ Higher
☐ Lower
☐ The same

Which hurdle rate would you recommend to use for the project appraisal?

%

Experiment 4 – original

Control	Treatment
You as the Finance Director responsible for investments of SchmaleWagen Inc. have been reassigned to be the Finance Director responsible for investments of Schmaudi, a sister company, both located in Germany. A new investment proposal has to be decided on:	
- A new production plant is required in the Lithuanian division because of the growing market and increasing demand. However the level of automation would be different. In the German plant, it was a fully automated plant, whereas in Lithuania it will be semi-automated. - A technical manager was responsible for providing extensive data applicable to such a technically complex project. After one of your management accountants of your department has collected data from the technical manager, you look at the investment proposal.	
As you are new to the company you do not know the technical manager or what	You are new to the company but you know that the technical manager

drives him.	receives performance-related pay on successful projects. • He insists that the new project is undertaken, even though he knows that:
-------------	---

- A scenario analysis by the finance department has shown high risk in the implementation and the timetable implies hardly any slacks. The outcome of 2 out of 4 equally likely scenarios would suggest the project could fail so that a positive NPV is unlikely.

Generally Schmaudi's cost of capital (WACC = 6.5%) is applied as discount rate for all projects. You as the Finance Director can decide whether a project-specific rate – instead of the WACC – is adopted due to a project's specific characteristics and its risk. Afterwards, you have to present and justify the investment proposal including the assumptions to the board of directors.

Which hurdle rate would you recommend to use for the project appraisal?

%

Experiment 4 – modified

identical to Experiment 4 – original except for the following insertion at ***:

Do you think the technical manager – who has provided the cash flow estimates – is likely to have underestimated the project's risk and thus was too confident with his/her cash flow estimates? ☐ Yes. ☐ No. ☐ I can't say
--

Experiment 5

Control	Similar	Dissimilar
As the Finance Director of AutoParts Inc., you again have to decide about a new investment project: • A new machine part should be purchased. It will be attached to another machine to operate a random sample test of the products to check whether they adhere to all norms. Its additional utility would be high because it can save time-consuming manual checks and eventually claims by customers. Before you present the investment proposal to the board of directors, you look at the cash flow profile of the project: Your finance department has provided you with the data about the project. The cash flow figures have been derived from what is known about the project: • As regards the cash inflows: Revenues will stay constant since no additional copies of the product will be produced due to the new machine. They will therefore not be regarded further. • As regards the cash outflows, you learn about the price of the machine, the regular maintenance costs, installation costs. Energy cost in the first year have been fixed by		

contract as well; costs for supplies are considered certain. Furthermore the labour costs are assumed to not affect the project as one worker has some capacity to also take care of the machine.

You consider its cash flow forecasts in the first year. To maintain the machine in the production process, production has to be stopped:

- Maintenance costs in Year 1 are projected to be \$4,330 and have been entered in the cash flow profile below. The costs of \$4,330 are based on maintenance that is scheduled to take one hour and thus a production stop of one hour. Each hour the production is stopped costs \$600/h.
- Maintaining the new machine requires a high degree of sensitivity to not damage parts of the rest of the machine.

All data known have been included in the cash flow profile (see below for a screenshot of the forecasted *cash outflows*).

Before you present it you think about the proposal and about necessary adjustment

You look into your company's accounting records and find the following two instances from last year where the production also had to be stopped:

1. Another project also included attaching a random sampling machine to an existing machine operating in the neighbouring manufacturing department.

- Production in the first period also had to be stopped for the reason of maintaining the machine.
- Production in its first period actually had to be stopped for 2h instead of the projected 30min due to installation problems. Attaching the new components was a very sensitive process and when adjusting the new part, one part of the existing machine was damaged and had to be fixed. Therefore the total cost actually turned out higher than projected.

2. Another project related to a seven-year old steel milling machine:

- Production also had to be stopped for the reason of maintaining the machine.
- Production actually had to be stopped for the projected period of time. Adjusting the machine went without problems. Therefore the total cost actually turned out as projected.

You look into your company's accounting records and find the following two instances from last year where production also had to be stopped:

1. Another project also included attaching a random sampling machine to an existing machine operating in the neighbouring manufacturing department.

- Production in the first period also had to be stopped for the reason of maintaining the machine.
- Production in its first period actually had to be stopped for the projected period of time. Attaching the new machine went without problems. Therefore the total cost actually turned out as projected.

2. Another project related to a seven-year-old steel milling machine.

- Production also had to be stopped for the reason of maintaining the machine.
- Production actually had to be stopped for 2h instead of the projected 30min because when replacing one old worn out part, some specific tool had to be delivered first. Therefore the total cost actually turned out higher than projected.

Here is the screenshot of the

forecasted cash outflows (for the beginning of the project and for Year 1) of the new machine to be purchased:

Cash outflows (\$)	Year 0	Year 1	...
Initial investment	162,000		
Installation	9,045		
Energy		10,010	...
Supplies		5,000	...
Maintenance		4,330	...
Cash outflows	171,045	19,340	...

Would you personally adjust to adjust the estimated sum of cash outflows (\$19,340) of Year 1 due to uncertainty in the maintenance costs?

☐ Yes. Please fill in your best estimate below. ☐ No. My best estimate is \$19,340.

If yes, what is your final estimate for the sum of cash outflows in Year 1?

\$

Experiment 6 – original

Control

A

B

C

[Previous case continued]

Now for the whole economic life of the project (4 years), further estimates are required to complete the appraisal. For the supplies, an annual increase is assumed using the current inflation rate.

Cash outflows (\$)	Year 0	Year 1	Year 2	Year 3	Year 4
Initial investment	162,000				
Installation	9,045				
Energy		10,010			
Supplies		5,000	5,075	5,151	5,228
Maintenance		4,330	4,330	4,330	4,330
Cash outflows	171.045	...	...	...	...

You consider adjusting the energy cost estimate knowing about the uncertainty of energy costs and that for example energy costs may depend on state regulations and of how much companies are being subsidised for the use of renewable resources. (Your company uses renewable resources and uses solar generator panels of their own.)

A quick analysis of past accounting data has shown that energy costs in general have increased by 6.5% per year over the last three years.

Thinking about your best estimate of the rate that energy costs will increase/decrease, do you think the rate should be higher or lower than 6.5 %?

- ☐ Higher.
☐ Lower.
☐ The same.

Yesterday during lunch in your firm's cafeteria you caught a sentence from the talk of two managers sitting at the neighbouring table. You understood something like "...cost increased by 6.5%".

Thinking about your best estimate of the rate that energy costs will increase/decrease, do you think the rate should be higher or lower than 6.5 %?

- ☐ Higher.
☐ Lower.
☐ The same.

Yesterday during lunch in your firm's cafeteria you caught a sentence from the talk of two managers sitting at the neighbouring table. You understood something like "...cost decreased by 6.5%".

Thinking about your best estimate of the rate that energy costs will increase/decrease, do you think the rate should be higher or lower than -6.5 %?

- ☐ Higher.
☐ Lower.
☐ The same.

What is your best estimate of the rate that energy costs will increase/decrease in the following years 2, 3 and 4 (on average, per year)?

[Please indicate a decrease with a minus.]

%

Experiment 6 – modified

identical to Experiment 6 – original except for: '6.5%' is substituted with '13%' in all conditions.

Which statement is true for a 'typical' investment project? (typical: an initial cash outflow followed by mainly cash inflows over the life of the project)

Please select one answer.

- ☐ The higher the discount rate, the lower the net present value.
- ☐ The higher the discount rate, the higher the net present value.
- ☐ A net present value is not affected by the discount rate.
- ☐ Don't know.

The study has almost been completed. Please fill in some demographic information.

1. What is your gender? ☐ Female. ☐ Male.

2. How old are you? I am years old

3. What is your highest educational achievement?

Please select the highest level of qualification you have obtained.

- ☐ High school diploma, secondary school-leaving certificate or equivalent
- ☐ Completed apprenticeship
- ☐ Vocational secondary certification
- ☐ A-levels/Higher education entrance qualification
- ☐ Undergraduate degree (e.g. Bachelor)

If 'undergraduate' or higher:

4. Which field is your degree in?

- ☐ Business
- ☐ Finance/Accounting

☐ Other, please specify:

- ☐ Yes ☐ No

If 'no': Question 9. If 'yes':

6. Which study programme are you currently enrolled in?

- ☐ Undergraduate programme (e.g. Bachelor)
- ☐ Graduate programme (e.g. Master)

If 'undergraduate':

7. Which undergraduate programme are you enrolled in?

- ☐ Business
☐ Finance/Accounting
☐ Other, please specify:

If 'graduate':

8. Which graduate programme are you enrolled in?

- ☐ MBA ☐ Master of Arts in Finance/Accounting ☐ Master of Science in Finance/Accounting

☐ Other, please specify:

9. How many years of work experience do you have?

10. Which field have you worked in?

[Multiple choices possible]

- ☐ Management
☐ Finance/Accounting
☐ Other (business-related)
☐ Other (not related to business)

11. Do you have managerial experience?

- ☐ No

☐ Yes. Please specify, which position you held:

12. How many years of managerial experience do you have?

13. Which is the country, you're currently living?

Country:

14. What's your nationality?

Country:

Thank you for participating!

You can win a an Amazon.com voucher of \$50USD. The winnner will be randomly chosen among all participants. To participate in the lottery, please indicate your e-mail-address below.

- ☐ I would like to participate in the **lottery**. I agree that my e-mail address will be saved until the winner is drawn. My interview will continue to be anonymous and my email address will not be passed on to third parties.

E-Mail:

Would you like to comment this questionnaire, or would you like to add information for us to better understand your answers? My interview will continue to be anonymous and my response will not be linked to my e-mail address.