Managerial Risk Accounting and Control – A German perspective

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21 August 2007

Title

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Abstract

Recent developments have sparked a renewed interest concerning risk related topics in non-financial companies. Risk management issues directly touch the domain of management accounting and control. In Germany, topics related to the support of corporate or enterprise risk management are commonly discussed under the label of "*Risikocontrolling*", which will be translated as Managerial Risk Accounting and Control. However, the conceptual foundation of a risk oriented management accounting respectively managerial accounting for the purpose of decision-facilitation and decision-influence pertaining to risk management is neither well developed nor well diffused and integrated. Therefore, the development of special risk oriented management accounting instruments is considered necessary.

The paper aims at giving an overview of the subject and development of "*Risikocontrolling*" in Germany as well as discussing the necessity and (measurement and behavioural) problems of managerial risk accounting. Finally, a proposal for the design of managerial risk accounting systems will be presented.

Keywords

- Controlling
- Germany
- Management Accounting
- Risk
- Risk Management
- Risk Measurement

1. Introduction

Research and practices in management accounting are subject to a broad range of influences connected to developments in the environment of the firm such as globalization, harmonization of accounting standards and corporate governance issues. An important recent development for managerial accountants and researchers around the world and especially in Germany was the increased importance of risk management and its integration into general management, which mainly results from laws and standards concerning internal control systems and requirements like the German "Gesetz zur Kontrolle und Transparenz im Unternehmensbereich" (KonTraG, Corporate Sector Supervision and Transparency Act), the US-American Sarbanes Oxley Act (SOA), or the revised international capital framework (Basel II). For example, the regulations of the KonTraG obliged the board of directors of German capital market oriented companies to "take measures to insure that developments that threaten the continued existence of the company are recognized early, especially to establish an internal controls system". This passage is being interpreted as an obligation to establish working early warning and enterprise risk management systems in German corporations. The legislator explicitly mentioned the role of managerial accountants and management accounting and control systems as vital part of the internal controls system and accordingly the enterprise risk management system. Also, companies and business researchers readily ascribed an important role concerning the design, development, and implementation of managerial accountants of formal enterprise risk management systems to management accounting practice and research. The interface of risk management and management accounting and control was labelled "*Risikocontrolling*". Thereby, new fields of function and activity were attributed to the already burdened managerial accountants as well as the insufficiently consolidated management accounting theory. Consequently, time pressure and pretension of competence led to insufficiently grounded concepts and practices and unclear terminology.

The aim of this article is to provide a profound insight into the subject, development and shortcomings of the German *Risikocontrolling* concept as well as offering a proposal of a substantiated concept for practice and research in risk management oriented management accounting and research.

2. Subject and development of "Risikocontrolling" in Germany

Before the subject and development of Risikocontrolling are examined, it is necessary to provide an overview of the research and practice of management accounting and control in Ger-

man speaking countries. First of all, there exists a distinct separation of managerial and financial accounting, both in academia and practice. The function of management accounting and control is usually discussed under the label "*Controlling*", which signifies a bundle of tasks concerned with decision support and management control by means of management accounting methods such as business planning, cost accounting, budgeting, capital budgeting, transfer pricing, reporting and performance measurement as well as management consulting and "checking and balancing" (critical counterpart) activities (Becker and Messner, 2005; Wagenhofer, 2006; Ewert and Wagenhofer, 2007). The managerial accountant is usually called "*Controller*" (Ahrens and Chapman, 2000).

The strong connection of *Controlling* to formal management tasks and systems especially connected to planning and controlling lead to a direct and profound impact of the risk management related stipulations of the KonTraG on Controlling methods and practices. The implementation and operation of enterprise wide formal risk management systems necessitated the design and integration of effective and practicable risk identification, risk assessment, risk treatment and risk monitoring methods and procedures on a scale and in a quality which were new to most companies. In order to keep the costs of the risk management system low and assure the data reliability as well as the effectiveness of risk management activities, an integration of risk management methods and procedures in existing planning and control systems were advocated. As the design and improvement of planning and control systems are usually part of the area of responsibility of Controllers, companies often relied on their management accounting departments concerning leading or supporting the task of implementing and operating formal risk managements systems (Hoitsch, Winter and Baumann, 2006). Also, based on the notion of the tight relationship of information and risk in decision theory, and the decision support function of *Controlling*, the special relationship of *Controlling* and risk management has been pointed out since long (Horváth, 1979).

As a result, the term "*Risikocontrolling*" or "*risikoorientiertes Controlling*" came into use in regard to enterprise risk management related tasks, methods and practices. Originally, *Risikocontrolling* designated a system or department concerned with measuring and monitoring of risks resulting from the trade of financial instrument in German banks or financial service companies which were to be strictly separated from the front office or trading department and which corresponds to the middle office. In course of the adoption of the term to non financial enterprises, the meaning blurred and broadened, and a number of coexisting diverging notions came into existence. Hence, the meaning of *Risikocontrolling* ranges from a synonym for risk management to risk reporting and monitoring activities. *Risikocontrolling* is now treated as an

own topic in renowned Controlling textbooks and has become part of the management accounting and control education at universities in German speaking countries.[1] Based on an analysis of publications and empirical results concerning *Risikocontrolling*, the following consensus can be deducted: Managerial Accounting and Managerial Accountants are assigned an important role in the design and operation of formal risk management systems. The most important tasks are related to risk measurement including risk aggregation, risk reporting and risk monitoring (Winter, 2007).[2] However, a conclusive integration of these tasks and related instruments in the elementary tasks and instruments of management accounting has been barely attempted. Therefore, the design and implementation of management accounting methods and practices that support risk management tasks and are also integrated into management accounting are advocated.

3. On the necessity of the consideration of risk and uncertainty in management accounting

The necessity of a managerial risk accounting system should be grounded in the need for the measurement and communication of risk through management accounting systems. A management accounting system as a set of resource consuming potentials and activities should be useful for the firm by helping to achieve the goals of the stakeholders or the basic functions of a firm. Basically, management accounting systems help to ensure the effective and efficient use of scarce resources (Sprinkle, 2003) by enabling the management to enforce changes in hierarchical organizations and to find possibilities for gaining (arbitrage) profits to generate income for the stakeholders (Schneider, 1997). Thus, the main purposes of management accounting systems are seen in the decision-facilitating or decisions-making and the decision-influencing or stewardship roles by providing respectively relevant information to improve the ability and willingness of the employees to achieve the firm's goals and objectives (Demski and Feltham, 1976; Gjesdal, 1981). A management accounting systems provides accounting measures to (partly) satisfy the heterogeneous or even conflicting informational needs of managers by representing and communicating the firm's state and activities in numerical or monetary terms (Kaplan and Atkinson, 1998; Horngren, Bhimani, Datar and Foster, 2005; Zimmerman, 2006).

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1 For a listing of renowned German language management accounting and control textbooks as well as their comparison to their English language counterparts see Hoffjan and Wömpener (2005).

2 The attribution of an important role in risk management to management accountants is not limited to Germany. E. g., the Institute of Management Accountants (2006) proposes that management accountants should play an important role in the implementation of Enterprise Risk Management by supporting managers in the execution risk management process and the linking of risk management to strategic and operational planning and control as well as designing risk reports and metrics for the evaluation of the effectiveness of risk treatment options etc.

The main purposes of management accounting systems are directly linked to the concepts of risk and uncertainty in the business context. Firstly, risk and uncertainty can be understood as a specific property of information or a lack of information pertaining to the occurrence of an event and the associated goal relevant outcomes (Knight, 1921; Christensen and Demski, 2003). Management accounting systems contribute to the reduction of uncertainty through the supply of information that would be otherwise not available to the management (Christensen and Demski, 2003). Furthermore, the importance of the management accounting purposes stems partly from the existence of uncertainty. E.g. if there wouldn't exist the possibility of variances between expected and realised outcomes, control activities or variance analyses would be unnecessary. However, accounting information is usually presented in the form of "monovalent" or deterministic measures. That is, a single accounting value is attributed to a specific object or purpose. In contrast, risk and uncertainty are formally characterised by a whole range of possible values connected to an object. The decision-facilitating purpose necessitates the supply of decision useful information. In terms of normative decision theory, management accounting has to provide the decision makers with an accounting representation of the state-act-outcome set (Christensen and Demski, 2003; Ewert and Wagenhofer, 2005). Especially, it is necessary to provide statements concerning the likelihood or probability of states and outcomes. Similarly, the decision-influencing purpose is important because the behaviour and actions of subordinates or agents are uncertain. Management Accounting should enable managers to obtain a reliable picture of the riskiness of activities and the firm as a whole. In this regard, following commonplaces are to be observed: "you can only manage what you can measure" and "what gets measured gets managed". Only those aspects of the firm's activities that are covered by the management accounting and control system are going to be addressed systematically and with prudence. The need for uncertainty or risk related information is not limited to managers but extents as well to other stakeholders, especially concerning the likelihood of bankruptcy. The creditable proof of applied systems and procedures for the reduction of the possibility of bankruptcy or financial distress to stakeholders serve to reduce transaction costs and thereby to increase the firm's value (Stulz, 1996; Shapiro and Titman, 1998 Tufano, 1998).

Up to now, the representation of risk and uncertainty in accounting systems is limited and dispersed. In financial accounting, explicit risk representation is mainly restricted to financial instruments (cp. IFRS 7). Furthermore, fair value accounting conveys no information about existing downside risk. In cost accounting uncertain costs are normalised, so risk rendering uses the mean or expected value. In capital budgeting risk representation ranges from flat ad-

justments to cash flows and duration via risk adjusted discount rates to decision tree analysis, stochastic simulation and real options. Also, in performance measurement, risk is usually represented in form of risk adjusted discount rates or hurdle rates (Atkinson, Kaplan and Young, 2004; Horngren, Bhimani, Datar and Foster, 2005). To provide adequate risk or uncertainty related information for fulfilling the accepted purposes of management accounting, management accounting systems should supply a more integrated and comprehensive accounting representation of the firm's risk. This could be achieved by adjusting existing management accounting subsystems and techniques to encompass risk related representations, that should be as mutually compatible as possible, or by designing and implementing a separate managerial risk accounting subsystem, that focuses on risk representation and is integrated in established managerial accounting subsystems such as cost accounting, capital budgeting and performance measurement.

Of course, the statement that while the rendering of risk in accounting systems is important relevant for the achievement of management accounting purposes, it is not done satisfyingly, leaves the legitimate question why this is. Regarding this problem, the following considerations are offered. Firstly, management accounting systems are not the only means to achieve decision-facilitation and decision-influence. Uncertainty and risks might be considered for planning and control proposes in other ways. Secondly, humans in general and managers particular might be able to intuitively assess risks and uncertainty without the help of management accounting information. In fact, they even might prefer an intuitive judgement over a formal risk measurement. These aspects are toughed upon below. Thirdly, formalised management accounting practices are often designed to meet external requirements, such as the evaluation of inventory by means of cost accounting systems. As no compulsory requirements for a numerical risk measurement exist outside the financial sector, risk accounting systems are not usually implemented. Lastly, it has to be observed, that the representation of risk and uncertainty in accounting systems and by accounting measures faces unique difficulties. These are also addressed below.

4. On the problems concerning the measurement of risk for the purposes of decision support and influencing

We define managerial risk accounting as methods and practices for numerically rendering past, present, and future risk related issues such as risks and risk bearing capacity, especially the risk position and risk bearing ability of the entire firm, and the corresponding influencing factors. Managerial risk accounting therefore encompasses the measurement of business related risk and uncertainty, i.e. a homomorphous rendering of the empiric risk structure of a

firm into a numerical structure by means of risk measures, which are useful to satisfy the risk and uncertainty related informational needs of management (cp. Schneider, 1997 regarding accounting in general).

The basic issue of managerial risk accounting is therefore the risk concept, i.e. the business oriented operationalisation of risk. In that respect, it has to be observed that there is no universally accepted notion of risk. The conceptualisation of risk differs across academic disciplines like psychology, engineering and economics as well as in economics and business itself such in finance, operations research and insurance. It is not only depended on factual aspects such as context and application, but also on subjective judgements and circumstances (Byrne, Charnes, Cooper and Kortanek, 1968; Brachinger and Weber, 1997; Pedersen and Satchell, 1998). Results from empirical and experimental research show that human and managerial risk or uncertainty judgements are often not in line with risk perception and behaviour implied by normative decision theory (especially subjective expected utility maximisation) or modern portfolio theory (mean-variance) (Kahneman and Tversky, 1982; March and Shapira, 1987). It is advisable to keep psychological and cognitive aspects of risk perception and behaviour in mind for designing practicable managerial risk accounting systems, which are to serve the decision-facilitating and decision-influencing functions as desired. From a cognitive point of view, two modes of thinking and deciding can be distinguished: intuition and reasoning. Intuition enables us to make fast, automatic and effortless judgements, whereas reasoning is done deliberately and effortfully. Most thought and actions can be classified as intuitive. Humans are often satisfied by intuitively plausible judgements. These are derived by means of consciously or unconsciously applied mental heuristics, which reduce complexity and speed up judgement. The accuracy of these judgements depends strongly on the particular context, such as framing or presentation and accessibility of information and experience and skills of the judging person. So it is important that the quality of the judgemental output is subjected to monitoring (Kahneman, 2003). Regarding risk perception and conceptualisation the following is of interest: Humans can understand risk as a meaningful concept on its own, not just as a kind of negative preference, but risk perception is context and subject dependent. For example, the judgement of the likelihood of an event can be biased by such factors as desirability or familiarity. Risk is usually associated with negative outcomes or losses and is therefore dependent on a chosen reference point. Instead of distributions, only a few possible outcomes are used for judgement of alternatives. Furthermore, mathematical probabilities are rescaled, which leads to an overweighting of the perceived likelihood of small possibilities and an underweighting of large possibilities. The perceived riskiness of an alternative is only insuffi-

ciently explained by the variance, but depends positively on expected losses and negatively on expected gains. Usually, verbal representation of risk and uncertainty are preferred over numerical risk measures. These findings imply that people often rely on intuitive and heuristic judgements of risks instead of formal calculations. Managers, which can be characterised as information workers and decision experts, are also subject to these psychological effects. They often don't understand risk as a probability concept and doubt that risks can be reduced to a single quantifiable construct. Risk perception and risk taking propensity are influenced by attention factors such as the attainability of applicable performance and survival targets (March and Shapira, 1987; MacCrimmon and Wehrung, 1988; Brachinger and Weber, 1997; Helliar, Lonie, Power and Sinclair, 2001; Berry, Collier and Helliar, 2005).

These findings have important implications for managerial risk accounting systems. Firstly, subjective risk or likelihood judgements are likely to be subjective and biased and therefore posses only a limited credibility. Secondly, some resistance is to be expected concerning the implementation of probability based risk measures. Thirdly, the setting and monitoring of risk limits connected to performance and survival targets are important factors of the management control system.

Keeping these findings in mind, we turn to risk measures and risk measuring as the core issue of managerial risk accounting. A risk measure is a numerical expression or indicator, which quantitatively renders the risk of objects of interest and allows the comparison of their riskiness. The numerical rendering of risk requires an adequate measurement of relevant risks, especially the total risk of a firm or a decision object. The psychological effects described above affect the feasibility of risk measurement, because risk has to be characterised as a construct, that is as a not directly observable object or characteristic of an object (Becker and Bayerische Rückversicherung Aktiengesellschaft, 1993). It has to be observed that many accounting measures are calculative and have therefore also to be described as constructs.

The measurement of risk holds some unique problems which are addressed now. According to Vickrey (1970) measurement can be defined as "the assignment of numerals to represent elements or a property of elements in a specified system on the basis of isomorphism or homomorphism existing between one or more empirical relational systems (ERS) and one or more numerical relational systems (NRS)". Measurement is often linked to the desire of controlling the measured properties (Balzer, 1985; Kürsten and Straßberger, 2004). Accounting is often seen as a measurement discipline (Larson, 1969; Vickrey, 1970). Although, it has to be observed that the characterisation of accounting systems as measurement tools requires the existence of an objective or at least an interpersonally verifiable economical reality, so that the

reality and eventually the output of measurement is not influenced or distorted by the act of measurement itself (Weber, 2005). If management accounting systems are used for decision influencing, the independence of measurement act and measurement object is to be doubted.

The theoretical construct to be measured by a risk measure is of course risk related to a real object or a decision. As mentioned above, risk is not directly observable and risk judgements are subjects to individual and context dependent factors, so that is has to be characterised as a subjective or social construct (Brachinger and Weber, 1997). Therefore, it should be asked if risk can be "measured objectively" or at least "rendered interpersonally verifiably" at all. If managerial risk accounting is used for decision facilitating and influencing purposes in organisations with asymmetric knowledge and distributed responsibility, a reliable and interpersonally meaningful rendering of risk is a very desirable characteristic. Should a managerial risk accounting system be only capable of producing and conveying subjective risk judgements, risk measurement would be inconsistent and inconstant, and the reliability and validity would be questioned. This would undoubtedly lead to a lack of confidence and acceptance of risk measurement. Therefore, it is necessary to find ways and means to render the construct risk as interpersonally verifiably as possible. Arguably, this calls for a rendering of risk by means of substantiated stochastic characteristics of economically meaningful objects, processes and structures. Nevertheless, we will assume that risk is a meaningful construct in economic context, which can be measured with a certain degree of reliability, validity and objectivity.

Here, risk measurement denominates the attribution of numerical values to objects, structures and processes of economic interest with the purpose of permitting comparative statements about their riskiness relative to one another (ordering) or a capability to bear risk. The attribution is given by a risk measurement function or risk measure. Note that this risk measurement function can differ according to subject and context (Brachinger and Weber, 1997). The risk measure R assigns a distinct non-negative real number to an object, for which is to be made a risk judgement and which is described by a random number X (Szegö, 2002; Cheng, Liu and Wang, 2004; Goovaerts and Laeven, 2005):

$$R: X \rightarrow \mathbb{R}.$$

The probability distribution of X contains all information about the (isolated) uncertainty concerning the object of interest, whereas R only captures those aspects, which are relevant according to the concept of risk used. The mapping of the random number to a single value is an aggregation of information, which leads to a reduction of complexity as well as a loss of detail.

Whereas the reduced complexity is better suited for the unambiguous information processing by decision makers, the loss of detail should be kept in mind.

Depending on which kind of measurement scale or level of measurement is used different comparative statements regarding the riskiness of the objects of interest are permissible. Under a nominal scale, only the assignment of risks to risk categories is meaningful. An ordinal scales permits an ordering of objects regarding to their riskiness (risk ordering). Further statements and operations are only permissible under cardinal scales. Especially, the determination of necessary risk capital for risk budgeting and risk adjusted performance measurement purposes requires the use of an absolute scale. Naturally, this poses high requirements on risk measurement (Szegö, 2002; Hanisch, 2004).

Initially, in business economics and economics, risk was usually measured as the variance or negative deviation relative to a reference point, without further theoretical foundation or axiomatisation. The resulting risk measures draw directly on characteristics or moments of the regarded probability distributions, and are therefore sometimes called "naïve". The theoretical foundation and axiomatisation of risk measures were mainly advanced by psychologically oriented decision research. These risk measures, mostly measures of perceived risk, also rely on stochastic characteristics of the regarded distributions (primarily gambles), but are usually further transformed to yield measures of (individually) perceived riskiness, so that empirical findings concerning risk perception and risk judgement are incorporated (Brachinger and Weber, 1997; Pedersen and Satchell, 1998; Pedersen and Satchell, 2004). However, as these measures of perceived risk are designed to render subjective risk judgements through appropriate transformation of stochastic properties, interpersonally verifiable risk measurement is not intended. Therefore, measures of perceived risk are not adequate for managerial risk accounting in organisations with distributed decision-making authority. Nevertheless, the knowledge gleaned by the survey of these measures can be useful for the support of certain decisions and the modelling of expected behaviour for decision influencing purposes. Since the computation of measures of perceived risk is based on stochastic properties of the distributions, which are used to describe the objects of interest, we will concentrate on distribution based or stochastic risk measures (Albrecht and Maurer, 2005).

Stone (1973) and Pedersen and Satchell (1998) propose parametric families of stochastic risk measures, which capture many risk measures (and distribution measures) used in economics and finance. A general risk measure of risk conceptualised as shortfall-risk is proposed by Albrecht, Maurer and Möller (1998), which will be presented now. A random number X, which represents the distribution of an object of interest, is divided into a loss or shortfall area

$X_-(z) = \max(z - X, 0)$, a gain or excess area $X_+(z) = \max(X - z, 0)$, and a target area z by means of a reference point or target z:

$$X = X_+(z) + z - X_-(z).$$

The shortfall-risk relative to the chosen reference point z of the object of interest is determined by a risk measure SR, which yields the expected value of a loss function $L(X_-(z))$ that represents an evaluation by the decision maker:

$$SR_z(X) = E[L(X_-(z))] = E[L(\max(z - x, 0))].$$

L is real numbered, non-negative, continuous, and monotonically increasing. Given a continuously distributed random number X, $L(0) = 0$ and $y = z - x$ it follows that:

$$SR_z(X) = \int_{-\infty}^{\infty} L(\max(z - x, 0)) f(x) dx = \int_{-\infty}^{z} L(z - x) f(x) dx = \int_{-\infty}^{\infty} L(z - x) f_-(x) dx = \int_{0}^{\infty} L(y) f(z - y) dy .$$

Regarding L, arbitrary transformations are conceivable, which represent different evaluations by a decision-maker. A particularly interesting class of loss function are power functions of the kind $L(y) = y^n$, $n \in \mathbb{R}$. These show the technical property that they match the lower partial moments (LPM) of the (continuous) distribution of X:

$$SR_z^{pot}(X) = E[X_-(z)^n] = E[\max(z - x, 0)^n] = LPM_z^n(X) = \int_{-\infty}^{z} (z - x)^n f(x) dx, \; n \geq 0 .$$

For $n > 1$ LPM can be normalised $(LPM_z^n(X))^{1/n}$ (Pedersen and Satchell, 1998; Albrecht, 2003). Of particular interest are values of n, which yield well known shortfall-risk measures:

- $LPM_z^0(X) = \int_{-\infty}^{z} f(x) dx = F(z) = P(X \leq z) = SW_z(X)$: Shortfall probability, which gives the probability that the realisation of X is less than or equal to the target z. The amount of shortfall is not taken into account.

- $LPM_z^1(X) = \int_{-\infty}^{z} (z-x) f(x) dx = SE_z(X)$: Shortfall expected value, which yields the mean of the shortfalls relative to the target. All negative deviations are weighted equally.
- $LPM_z^2(X) = \int_{-\infty}^{z} (z-x)^2 f(x) dx = SV_z(X)$: Shortfall variance, which yields the mean squared shortfall relative to the target. Greater shortfalls are thus attributed a greater weight.

All these risk measures can be interpreted in an economically meaningful way. If $n > 1$ and X pertains to an uncertain monetary amount, the normalised risk measures have the dimension of monetary units.

Albrecht (2003) distinguishes between two types of ideal risk conceptions, which provide two kinds of risk measures:

- Type 1: Risk as the degree of deviation from a target (location independent, deviation oriented risk conceptualisation).
- Type 2: Risk as the capital necessary to set off a risky position for attaining a acceptable total risk position (location dependent, risk capital oriented risk conceptualisation).

Analogously, excess or opportunity measures for the gain or excess part of the distribution can be defined by means of upper partial moments. These can be used as value measures for use in risk-value-models (Albrecht, Maurer and Möller, 1998).

The presented families of risk measures provide a considerable number of conceivable, concrete risk measures. This leads to the problem of selecting adequate risk measures, which can only be solved on a normative basis. The selection of adequate risk measures should be grounded on the specification of reasonable properties of a risk measure (according to a chosen risk conceptualisation), which are used to survey concrete risk measures (Goovaerts and Laeven, 2005). This should also ensure a considerable reduction of the set of adequate risk measures (Pedersen and Satchell, 2004). The reasonable properties are usually defined by axioms, which allow formulating the requirements with a minimal set of precise statements and representing the risk concept (Acerbi and Tasche, 2002a). It has to be observed, though, that reasonable axioms will not yield reasonable risk measures automatically. To obtain meaningful risk measures, the risk perception of the concerned subjects in the relevant situation are

to be observed (Goovaerts and Laeven, 2005). There are different set of axioms proposed in economic and psychological literature. Of particular interest to managerial risk accounting are those that pertain to financial risks. Based on the axioms put forward by Kijima and Ohnishi (1993), Pedersen and Satchell (1998) propose a set of axioms describing four basic properties of financial risk measures: non-negativity, positive homogeneity, subadditivity, and shift-invariance. Risk measures adhering to these axioms yield risk of zero for certain results and capture diversification effects and are compatible with second order stochastic dominance. Rockafellar, Uryasev and Zabarankin (2002) propose a nearly identical set of axioms, which lead to totally location-free risk measures. The best acknowledged and most influential set of axioms was presented by Artzner, Delbaen, Eber and Heath (1997, 1999). These axioms are designed to provide risk measures which are useable for the regulation of the risk assumed by financial institutions and for risk capital allocation purposes. Therefore, risk is defined as the minimal capital requirement in a risk free investment in conjunction with a risky investment that is necessary to provide an acceptable total risk position. In other words, risk is conceptualised as necessary risk capital and requires an absolute scale of measurement. The four proposed properties are translation invariance, subadditivity, positive homogeneity and monotonicity. Risk measures, which satisfy these properties, are called "coherent". Rockafellar, Uryasev and Zabarankin (2002) proposed a modified set of properties to generate expectation bounded risk measures, which means that the riskiness of an object can never be lower than its negative expected value. This property allows for the conversion of deviation oriented risk measures and risk capital oriented risk measures, which are not compatible because of the mutually exclusive properties of non-negativity and translation invariance (cp. Albrecht, 2003). Thus, the situation that one risk measure satisfies one set of axioms while breaching another is avoided, so using risk capital oriented and deviation oriented risk measures, which cater for different informational needs, together in one risk accounting system is possible. Regarding managerial risk accounting, the property of subadditivity is of special importance. It ensures that diversifications aspects are observed at calculating aggregate risk positions. Also, in conjunction with positive homogeneity, incentives for adverse risk control activities, which nominally decrease rendered risk while not decreasing real riskiness, are avoided.

Using the presented properties risk measures can be judged. Table 1 gives an overview about the properties of some common and advanced risk measures (cp. Pedersen and Satchell, 1998; Albrecht, 2003; Koryciorz, 2004; Scherpereel, 2006).

Risk Measure	Desirable Properties					
	Translation invariance	Sub-additivity	Positive homogeneity	Monotonicity	Non-negativity	Shift invariance
Standard deviation	No	Yes	Yes	No	Yes	Yes
Variance	No	No	No	No	Yes	Yes
Absolute Value at risk	Yes	No	Yes	Yes	Yes	No
Relative Value at risk	No	No	Yes	No	No	Yes
Conditional Value at risk	Yes	Yes	Yes	No	Yes	No
Expected Shortfall	Yes	Yes	Yes	Yes	Yes	No

Table 1: Properties of common and advanced risk measures

Interestingly, the common risk capital oriented risk measure Value at risk, while being the standard measure for financial risk, doesn't satisfy desirable properties of risk measures, especially the important property subadditivity. This can lead to the undesirable situation that the shown risk for aggregated positions is larger than the sum of the shown risk for the captured individual positions. This measurement problem gives rise to adverse incentives regarding the management of risk, such impeding diversification and tactical behaviour to reduce shown risk such as canny splitting of reporting and management objects without beneficial effect on real risk (for the shortcomings of Value at Risk cp. Artzner, Delbaen, Eber and Heath, 1999; Acerbi and Tasche, 2002a; Acerbi and Tasche, 2002b; Szegö, 2002). Therefore, it seems advisable to use "advanced" stochastic risk measures for the purposes of managerial risk accounting, such as Conditional Value at Risk or Expected Shortfall.

However, stochastic risk measures rely on reliable information about probability distributions of single and aggregated objects of interest. As mentioned above, it is often problematic to assume, that reliable information about the probability distribution or "certainty about uncertainty" exists. In most cases, only historic frequencies and subjective estimations will be available. Furthermore, the determination of the probability distribution of an object of interest often requires the aggregation of several sources of uncertainty or risk factors, e. g. probability distributions (risk analysis). For this, information about the stochastic dependencies is necessary. Also, the computational treatment is more demanding than the usual basic operations used in management accounting. The rendering of risk in management accounting systems required the knowledge about the following: distribution of the relevant risk factors, effect of the relevant risk factors on accounting measures, and stochastic dependencies of the risk factors. Only if all of these are known, risk in the sense of properties of the distribution of accounting measures is computable. The determination of probability distributions, dependen-

cies and stochastic risk measures are all grounded in mathematical probability theory. However, it has to be observed, that it can not be applied without restrictions to all areas of business management, as it poses high demands on the determination of probabilities, which can often not be met in reality. For one, there are different concepts or interpretations of probability, especially the frequency probability (empirical observable relative frequency of outcomes in well defined experiments) and the Bayesian probability (personal degree of believe) (for interpretations of probability cp. http://plato.stanford.edu/entries/probability-interpret/). For practical applications, ample historic samples will often not be available for objects of interest, so one will commonly have to rely on subjective or personal probability judgements. These can be elicited for almost any object of interest from people, but they heavily rely on personal experience, intuition, mood etc. and are therefore hardly verifiable. What's more, subjective possibility judgements may violate the propositions of probability theory. Schneider (1997) shows, that the probability theory demands "complete certainty about uncertainty". If this prerequisite is not satisfied, one has to use a lower level of measurement, like nominal or ordinal scales for probabilities. This would of course inhibit the use of stochastic risk measures. Similar restrictions apply to the determination of stochastic dependencies and risk analysis for the aggregation of probability distributions and risk (Hull, 1977; Kottas and Lau, 1978).

These comments show that the measurement of risk is a rather complex undertaking, which heavily draws on subjective judgements, relies on non-linear transformations, and yields ambiguous results. While acknowledging these problems, we proceed by providing some thoughts on the design of a managerial risk accounting system.

5. Proposal for the design of managerial risk accounting systems

The design of accounting systems is a fundamental problem of business economics, in academia as well as in business practice. An adequate design will allow for the attainment of the goals or purposes of management accounting, whereas an inadequate design will surely lead to dysfunctional effects such as unintended behavioural incentives and improper decision support (cp. Johnson and Kaplan, 1999; Cooper and Kaplan, 1998). However, the design of management accounting systems is seldom addressed from a holistic or fundamental perspective. Accordingly, the lack of coherent design oriented management accounting theories is pointed out (cp. Mathews, Perera, Chua and Ng, 1991; Schmitz, 2004). E. g., a primarily design oriented accounting theory is the Conditional-Normative Accounting Methodology proposed by Mattessich (1995a, 1995b). Schmitz (2004) maintains that a design oriented theory should compromise measurement theories and effect-of-accounting theories (effects on deci-

sion, behaviour, and evaluation of accounting systems). Relating to managerial risk accounting, risk measurement theories briefly discussed above address the first group, as well as party the second.

Concerning the structuring of the design task, Grochla (1980) discerns three design dimensions: object area (structural vs. procedural design task), design level (global-fundamental vs. detailed-particular design level), and feasibility (factual-logical vs. political-social implementation barriers). Design goals, design options, and design factors are proposed as (interdependent) elements of the design task (Brink, 1985; Brink, 1992). The more specific design proposals are the stronger specific context factors have to be considered. E.g., the information demand of the recipients of management accounting information, the empirical object of management accounting (potentials, structures and processes of the firm), and general environmental conditions (technology, laws, accounting knowledge etc.) are considered to be specific context factors relevant to the design of cost accounting systems (Krieger, 1995). Accordingly, the proposal presented here can be characterised as belonging to the global-fundamental design level addressing structural design tasks and considering factual-logical aspects. The underlying goal for the design is considered to be the monetary rendering of relevant risks for the purposes of decision-facilitation and decision-influence, which are considered instrumental in helping the management in attaining the goal of ensuring the survival of the firm. Because of the high level of abstraction at hand, only a generic information demand deducted from the purposes of managerial risk accounting can be considered. It is argued that risk accounting information can be differentiated into genuine and supplemental information. The former is information that can only be generated and processed by means of a risk accounting system, whereas the later supplements and augments information supplied by other accounting systems (see table 2).

<table>
<tr><td>Purpose/
Information demand</td><td colspan="2">Genuine risk accounting information</td><td>Supplemental risk accounting information</td></tr>
<tr><td>Decision-facilitation</td><td>Risk situation forecast</td><td colspan="2">Risk capital forecast</td><td>All kinds of operational and strategic decisions
Risk adjusted evaluation of alternatives</td></tr>
<tr><td rowspan="2">Decision-influence</td><td>Target and actual risk situation / risk limits / risk capital allocation
Monitoring of risk situation / limits</td><td colspan="2">Target and actual risk capital</td><td>Risk adjusted performance measurement</td></tr>
<tr><td colspan="3">Realised risks</td></tr>
<tr><td rowspan="2">Accountability</td><td colspan="3"></td></tr>
<tr><td>Actual risk situation</td><td colspan="2">Actual risk capital</td></tr>
</table>

Table 2: generic information demands

Design options are closely related to characteristics of management accounting systems. A specific management accounting system can be described by the combination of the values of the characteristics at hand. Similarly, the set of design options can be described by the number of possible combinations of relevant characteristic values (Schmitz, 2004). Because a potentially large number of relevant characteristics with associated values exist, we rely on a framework for design oriented characteristics of cost accounting systems suggested by Hoitsch and Schmitz (1998). The five characteristics are cost concept (or in general accounting measure used), cost attribution (or allocation) principle, reference object (or objects of cost attribution), cost categorisation, and structure of the cost accounting system. Cost accounting information is mainly influenced by the combination of cost concept, reference object, and attribution principle. Although this framework was specifically developed for the design of cost accounting systems, we consider these five dimensions as rather generic and suitable for the high level of abstraction of our proposal. Therefore, we modify these characteristics for our purposes as follows: risk concept and accounting measures, reference object (or objects of risk attribution), risk attribution/allocation principles, risk categorisation, and structure of the risk accounting system. We will briefly review each characteristic below.

We've already discussed matters related to risk concepts at some length above. The risk concept in the context of risk accounting refers to the risk measure used and the accounting measures, which distributions are captured. We recommend the use of stochastic risk measures, which satisfy axiomatic requirements, such as Conditional Value at Risk or Expected Shortfall. These should refer to distributions of accounting measures, which are directly related to the risk bearing ability of the firm, and therefore inform about required liquidity and capital buffers to prevent illiquidity and insolvency. Accordingly, we recommend the application of stochastic risk measures to cash flows, earnings, and capital. The risk measures should relate to actual, target, and forecasted accounting measures. The use of established accounting measures as basis for risk measures should also facilitate the integration into existing accounting systems as well as the acceptance by the users of risk accounting information.

Reference objects are objects of interest that are attributed risk measures for decision-facilitation and decision-influence proposes. The potential information demand deducted from the purposes of managerial risk accounting might lead to a rather large number of reference objects. Possible reference object categories include amongst others organisational units (whole firm, business units, profit centres etc.), products, processes, resources, customers, suppliers, periods, projects etc. A multitude of inter- and intra-categorical relationships can exist between reference objects. E. g., Riebel (1994b) differentiates between six types of hier-

archical relationships: decisions (connected decision objects, decision chains), characteristics (products and services, resources, transaction partners such as suppliers and customers, regions, areas of responsibility), time periods, aggregation levels (according to attribution principle), and targets (top-down break-down of targets). The aggregation and disaggregation is conducted according to "natural", that is organisational determined, or problem specific hierarchies. Pertaining to the presented proposal of managerial risk accounting, two broad categories of reference objects should be distinguished: supplemental risk accounting information should be attributed to reference objects used in existing accounting systems, whereas genuine risk accounting information should accommodate risk specific aggregation/disaggregation needs. Therefore, reference objects categories like risk type should be introduced. For aggregation purposes, the strength of stochastic dependencies should be considered in the formation of risk types. Thus, aggregation within these risk types can be conducted, while disregarding risk type external dependencies, so that distortion by this simplification is potentially kept to a minimum and the complexity of the operation is reduced (Hoffjan, 2006). Furthermore, temporal reference objects necessitate the consideration of discounting effects and the possibility of stochastic paths.

Attribution principles determine which accounting measures can be attributed to which reference objects, and therefore the information content the attributed measures posses for specific accounting purposes. The selection of attribution principles is obviously intimately connected to the selection of reference objects. Measurement theories should provide statements on the connection of accounting measures and reference objects, whereas effect-of-accounting theories should furnish statements on the behavioural effects of specific attribution principles and attributes like perceived fairness and motivational effects (Schmitz, 2004). If a direct, interpersonally verifiable relationship between reference object and accounting measure exists, the accounting measure can be considered as an attribute of this specific reference object, and the attribution operation is rather trivial. This is especially the case with cash in- and outflows resulting from market transactions. If this is not the case, and the value of an accounting measure is affected by a multitude of reference objects, an indirect relationship that is characterised by compound effects exists. In that case, a definite and unambiguous attribution can not be derived. Because an objective solution is not possible, behavioural effects of the attribution gain in importance. Whereas arguably all accounting systems face such compound problems, risk compound effects are immanent in managerial risk accounting because of the prevalence of stochastic dependencies. Diversification effects on a higher level in reference objects hierarchies that result from the aggregation of single risk positions can not be attrib-

uted in an undisputable way to lower level reference objects. E. g., the aggregate risk situation of the firm is regularly expected to be lower than the sum of the stand-alone risk situation of its organisational units. Whereas the ability to bear risk is determined on firm level, the management of risk is conduced on unit level in decentralised firms. This leads to the problem, if the risk situation and risk capital are to be measured as aggregate risk or stand-alone risk or both (Scherpereel, 2006). The accounting treatment of diversification effects is still considered as an unsolved problem (Pfaff and Kühn, 2005). Scherpereel (2006) surveyed a number of well-known allocation schemes (Activity Level Method, Incremental Method, Beta Method, Shapley Method, Cost Gap Method, Nucleolus Method) applied to risk capital allocation in a game-theoretic simulation approach with respect to properties like fairness and quality of risk control. Using Value at Risk as risk measure for normally distributed risk positions (portfolios), he concludes that the Cost Gap Method and Nucleolus Method meet the requirements best. We propose the measurement of risk at a level as low as possible (risk factor level) and an aggregation up to firm level. For every reference object and aggregation level, stand-alone risk as well as attributed top-down aggregated risk should be reported. According to the relevant purposes the risk measure is used for, multiple aggregate risks based on different attribution principles might be calculated.

Risk categorisation groups risks according to one or more relevant characteristics with the goal to enhance transparency of the risk situation. A possible distinction is based on risk sources, i.e. risk factors that affect the achievement of a target, vs. targets at risk, i.e. affected accounting measures such as cash flow, earnings, and asset value. A different categorisation is linked to the aggregation level, so that stand-alone, aggregated risk, and risk contribution of a reference object to a reference object of higher order (component risk, incremental risk, marginal risk) can be distinguished (Dowd, 1998; Marrison, 2002; Pearson, 2002). It is obvious that the chosen risk categories should correspond to the purposes pursued. It follows that different categorisation dimensions might be used simultaneously. This also means that a non-overlapping categorisation might not be possible.

The structure of the accounting system determines the elements of the managerial risk accounting system and their relationship or connection, i.e. the organisation and workflow. Therefore, the structure is to be designed in such a way that the other design options are accommodated. We propose a structure that is based on Riebels (1994a, 1994b) distinction in a basic accounting database, which collects accounting relevant data in such a way that it can be used for multiple purposes, and purpose specific analysis, i.e. information selections based on the combination and aggregation of items of the basic accounting database to satisfy specific

informational needs. Data contained in the basic accounting database is gathered and stored at a disaggregate level without arbitrary allocation of composite elements, and is characterised with all attributes relevant for all needed analyses (Riebel, 1994a).[3] Recurring on the risk accounting information addressed above, we propose the following building blocks of a managerial risk accounting system: identification and determination of risk factors, risk treatment options, and risk capital (these constitute the primary risk accounting database), attribution and aggregation/disaggregation of risk factors, risk treatment options, and risk capital (these constitute the secondary risk accounting database), and analyses (risk bearing capability, risk adjusted performance measurement, external risk reporting, and decision specific special analyses).

The proposal presented is a generalisation of existing risk accounting approaches proposed for financial institutions and non-financial companies (cp. Schindel, 1978; Schulz, 1980; Walker, 1997; Eller, Schwaiger and Federa, 2002; Hoffjan, 2006). Best practices for determining and controlling risk and risk capital such as risk budgeting (Pearson, 2002) or risk adjusted performance measurement as well as strategic management accounting approaches like the Balanced Scorecard can be integrated into this framework, while it maintains a strong connection to management accounting systems.

6. Conclusions

In this paper, we discussed the relationship of risk management issues and management accounting and control practice and research in Germany. Starting with on brief survey of the subject and development of "*Risikocontrolling*", we concluded that this field of interest lacks a conclusive conceptual foundation; we argued that the design and implementation of managerial risk accounting systems can provide just that. Therefore, we set out to outline the necessity of such a managerial risk accounting and addressed the inherent problems of measuring risk for the management accounting purposes of decision-facilitation and decision-influence. We concluded our considerations with the proposal of a generic framework for a capable managerial risk accounting system.

However, it has to be stated that many problems regarding risk measurement and risk capital allocation remain unsolved. Especially, risk measurement for many types of risk has to rely on subjective risk judgements, which are hardly interpersonally verifiable. Furthermore,

[3] Riebel (1994a) points out strongly that the basic accounting database should be "realistic" in the sense that they convey an undistorted, true reconstruction of the captured economic reality (*hard data*). Subjective fictions have to be explicitly declared as such. As discussed above, risk measures are seldom interpersonally verifiably and therefore for the most part subjective fictions. Strictly speaking, merely the direct cash flow effects of realised risk events can be captured in an interpersonally verifiable way.

"elaborate" or computationally demanding management accounting methods are often not applied in practice. Therefore, the presented proposal will be most certainly met with reluctance.

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